Executive Summary

This report describes the results of the Use Attainability Analysis (UAA) for Crystal and Keller Lakes in Burnsville, MN. The UAA provides the scientific foundation for a lake-specific best management plan that will permit maintenance of or attainment of intended beneficial uses of Crystal and Keller Lakes. The UAA is a scientific assessment of a water body's physical, chemical, and biological condition.

This study includes both a water quality assessment and prescription of protective and/or remedial measures for Crystal and Keller Lakes and their watersheds. The conclusions and recommendations are based on historical water quality data, the results of an intensive lake water quality monitoring in 2001-02, and computer simulations of land use impacts on water quality in Crystal and Keller Lakes using watershed and lake models calibrated to the 2002 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* with the lake's beneficial uses.

Black Dog Watershed Management Organization Water Quality Goals

Many factors affect the relative health of a water body, and the processes that control the water quality of a lake or pond are complex. The primary determinants of water quality include: the size, condition, and degree of urbanization of the lake's or pond's watershed; the morphometry of the basin; weather conditions, particularly as they affect the amount of runoff that reaches the water body; and in urbanized settings, the degree to which the surface water runoff has been filtered or treated before it reaches the lake or pond.

Total phosphorus, chlorophyll *a*, and Secchi disc transparency are key water quality parameters by which water quality assessments are made. Water quality assessments focus on these three parameters for the following reasons:

- Phosphorus generally controls the growth of algae in lake systems. Of all the substances needed for biological growth, phosphorous is typically the limiting nutrient. Increasing phosphorus concentrations generally mean that the water is more fertile, and will produce more algae.

- Chlorophyll *a* is the main pigment in algae. Therefore, the amount of chlorophyll *a* in the water indicates the abundance of algae present in the lake. Increasing algal content is usually considered to be undesirable form the standpoint of human use of the lake or pond.
- Secchi disc transparency is a measure of water clarity and is inversely related to the abundance of algae. Water clarity is generally the primary determinant of the public's perception of the water quality of any given water body.

The water quality of the lakes and ponds can be quantified using a standardized lake rating system know as the Carlson's Trophic State index (TSI) (Carlson, R.E., 1977). The rating system uses the lake's total phosphorus, chlorophyll *a*, and Secchi disc transparency measurements to assign a water quality index number that gives an overall indication of the water body's level of fertility. Because the public perception of the water's suitability for recreational-use is often based on water clarity, the trophic state index based on Secchi disc transparency (TSI_{SD}) may provide the most useful single index for lake water quality. Characteristics of lakes in different trophic status categories are listed below with their respective TSI ranges.

1. **Oligotrophic**—[$20 \leq TSI_{SD} \leq 38$] Oligotrophic lakes are 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**—[$38 \leq TSI_{SD} \leq 50$] These lakes have intermediate productivity, 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—**[$50 \leq TSI_{SD} \leq 62$] Eutrophic lakes are highly productivity lakes when compared to lakes in a natural conditions, with 25 to 57 µg/L of phosphorus, 8 to 26 µg/L of chlorophyll *a* concentrations, and Secchi disc measurements of 0.85 to 2 meters (2.7 to 6 feet).
4. **Hypereutrophic**—[$62 \leq TSI_{SD}$] Beyond eutrophic, hypereutrophic lakes are extremely productive, disturbed, and unstable; fluctuating in their water quality on a daily and seasonal scale, producing gases, noxious and toxic substances, experiencing periodic anoxia and fish kills, etc. These lakes have 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).

In general, oligotrophic lakes and ponds are considered to be most desirable, and hypereutrophic lakes and ponds are considered to be least desirable. The desired water quality of an open water body corresponds to its expected use. For example, a large lake in the midst of a residential area may be expected to provide safe and healthful swimming for local citizens. Water quality in this situation would need to be excellent. By contrast, the water quality expectations for a small and relatively unused pond in a predominantly commercial zone would be lower.

The approved Black Dog Watershed Management Organization's (BDWMO) *Watershed Management Plan* (Barr, 2002b) preliminarily assessed ultimate watershed water quality for Crystal and Keller Lakes and articulated specific goals for each lake. The goals of the BDWMO are to:

- Manage the BDWMO water resources on a regional basis to meet their established goals.
- Maintain or restore the water quality of the BDWMO water resources to allow for the continuation or enhancement of existing recreational-use activities and habitat.

To accomplish its goals, the BDWMO established a water body classification system and determined the respective roles of the BDWMO and the cities in water quality management. The BDWMO lake and pond classification system contains five categories that were used by the BDWMO and member cities to classify lakes and ponds. Table EX-1 (below) gives the recreational-use criteria used in defining the water quality classifications, and gives their associated water quality goals as indicated in the 2002 plan:

Table EX-1 Water Quality Management Goals

Water Quality Management Category	Desired TSI	Desired Total Phosphorus (µg/L)	Desired Chlorophyll *a* (µg/L)	Desired Secchi Disc Transparency (m)
Level I Level I water bodies will support aquatic life and recreation including full-body contact aquatic activities (swimming, snorkeling, etc.)	<55	<45	<20	>1.4
Level II Level II water bodies will support aquatic life and recreation except those activities that require full-body contact with the water. Activities may include sailboating, water skiing, canoeing, jet-skiing, wind-surfing, etc.	55-60	45-75	20-40	1.4-0.9
Level III Level III water bodies will support waterfowl or other wildlife, and may be used for non-contact recreational use (boating, fishing, etc.)	60-65	75-105	40-60	0.9-0.7
Level IV Level IV water bodies in this category are intended to reduce downstream loading of phosphorus and other nutrients that contribute to water pollution. These ponds are designed to have phosphorus removal efficiencies of at least 50 percent.	>65	>105	>60	<0.7
Level V Level V water bodies are similar to Category IV water bodies, but are too small to effectively remove a significant fraction of nutrients. These basins will generally have phosphorus removal efficiencies of less than 50 percent	>65	>105	>60	<0.7

The specific classification and numeric goals for the Crystal and Keller Lakes are as follows:

- ***Crystal Lake*** —Based on its existing and desired use, the BDWMO classified Crystal Lake as a Category I water body. The specific goal for Crystal Lake is a trophic state index based on Secchi disc transparency (TSI_{SD}) ≤53, which is equivalent to a Secchi disc reading of 1.6 meters. Additional water quality goals for Crystal Lake are listed below:
    - Summer average Secchi disc depth of at least 1.6 meters
    - Total phosphorus concentration of less than 45 µg/L
    - Chlorophyll *a* concentration of less than 20 µg/L

  In response to the City of Burnsville's request to elevate the water quality goal for Crystal Lake from a summer average Secchi disc transparency of 1.6 meters (the action level given in the BDWMO *Watershed Management Plan)* to a goal of from 2.3 to 2.6 meters, the BDWMO decided to accelerate completion of this UAA. Water quality predictions from computer simulation models indicate that in its "pre-development" state, the water clarity of Crystal Lake was between 2.3 meters and 2.7 meters. This means that achieving a water clarity goal of 2.6 meters will very likely require extensive remedial measures.

- ***Keller Lake***—The BDWMO classified Keller Lake as a Category III water body, based on its existing and projected future use, and its water quality (with the Crystal Lake water quality demonstration project ***not*** in operation [see Section 1.2.1 of this report]). The BDWMO *Water Management Plan* lists the following criteria for a Category III water body:
    - Summer average Secchi disc depth of at least 0.7 meters
    - Total phosphorus concentration of at least 75 µg/L, but less than 105 µg/L
    - Chlorophyll *a* concentration of at least 40 µg/L, but less than 60 µg/L

  The City of Burnsville also requested an elevated water quality goal for Keller Lake—a summer average Secchi disc transparency of 1.7 meters. Since Keller Lake is tributary to Crystal Lake, this UAA investigated improving the water quality of Keller Lake to improve the water quality of Crystal Lake. Model results indicate that in its "pre-development" state, the water clarity of Keller Lake was about 2.0 meters. This means that achieving a water clarity goal of 1.7 meters will very likely require extensive remedial measures.

Lake Characteristics and Recreational-Uses

Crystal Lake

Crystal Lake, a 292-acre, dimictic lake (mixing twice per year) has a 3,370-acre tributary watershed (excluding the lake surface area and 185 acres of land tributary to Lac Lavon, a landlocked lake), which includes portions of the cities of Apple Valley, Burnsville, and Lakeville. Crystal Lake receives outflows directly from Keller Lake and indirectly from Lee Lake via storm sewers. Crystal

Lake drains northwest to Earley Lake, ultimately reaching the Minnesota River via Sunset Pond. The area of the lake shallow enough for aquatic plants to grow, the littoral zone, is approximately 208 acres. Its average depth is 10 feet, and its maximum depth is 27 feet.

Crystal Lake is considered one of the most important water bodies in the City of Burnsville. The lake has a public boat access and fishing pier on its north side, and is intensively used during both summer and winter months. Fishing, boating, swimming, water-skiing and aesthetic viewing are some of the major recreational-uses made of the lake. In addition, the City of Burnsville's Tyacke Park, Crystal Lake West Park, and Crystal Beach Park are all located along the lakeshore. The Metropolitan Council considers Crystal Lake a "Priority Lake" because of its recreational-uses and public access.

The current water quality of Crystal Lake is considered "average," with recreational-use activities being impaired by late-summer algae blooms. It received a "C" grade from the Metropolitan Council on its "Lake Quality Report Card." Additionally, Crystal Lake is a eutrophic lake according to the trophic state classifications listed above.

Keller Lake

Keller Lake is located on the Burnsville/Apple Valley border, just northeast of Crystal Lake, in the southern portion of the BDWMO. The 1,387-acre Keller Lake subwatershed represents roughly 40 percent of the Crystal Lake watershed. Roughly 44 percent of the Keller Lake watershed (629 acres) is within the City of Burnsville while the remaining area is within the City of Apple Valley. The Keller Lake outlet, a 72-inch arch concrete pipe with weir structure, is located on the west side of the lake and conveys stormwater to the northeast shore of Crystal Lake. Keller Lake's water surface area is 55 acres. Its average depth is about 3.7 feet, and its maximum depth is about 10 feet. Because the lake is so shallow and polymictic (mixing many times per year), aquatic plants can grow over the entire lakebed and a summer thermocline is not usually present.

The primary use of Keller Lake is for fishing, canoeing, and wildlife viewing by local residents. There is a large amount of park land on the south side of the lake, but there is no public beach or boat access. The MPCA lists Keller Lake as impaired for swimming. The Metropolitan Council's Lake Quality Report Card typically gives Keller Lake a "D", indicating worse water quality when compared to other metro area lakes and impaired recreation for Keller Lake.

Water Quality Problem Assessment

Water Quality

Crystal Lake

Crystal Lake water quality exhibits significant variations, both temporally and spatially. For instance, the 2002 spring total phosphorus concentration was 18 μg/L for the main basin of the lake (see Figure EX-1). This would place the lake at the upper end of the mesotrophic status category. However, due to summer inputs of phosphorus (primarily from watershed runoff, die-off of curlyleaf pondweed, and biochemical release by anoxic lake sediments); the corresponding summer average and late-summer concentrations rose to 41 μg/L and 68 μg/L during the calibration year (2002). The latter total phosphorus concentration would classify Crystal Lake as hypertrophic. The late-summer algal blooms caused by these elevated phosphorus concentrations already interfere with the recreational-use of Crystal Lake, and changes in watershed land use threaten to exacerbate this situation.

The current (2002) water quality of Crystal Lake (total phosphorus concentration, chlorophyll *a* concentration and Secchi disc transparency) places the lake within Category I, but the water quality varies greatly over the summer, typically beginning the summer recreational-use season with Category I water quality, then the degrading to Category II levels as chlorophyll *a* concentrations increase during the latter part of the summer. Based on the 2002 summer average Secchi disc data, the goal has already been breached on Crystal Lake and management actions are needed. Figure EX-2 shows the Secchi disc transparency goal in relation to historic summer average data.

Although the trend analyses of historical water quality data (see Figure EX-2) for Crystal Lake indicates no long-term (over the 29-year period of record) water quality trends, the lake's overall condition has generally degraded during the past 12 years at a rate of 0.1 meters of Secchi disc transparency per year. This degradation is most likely due to the concurrent transition of natural open lands into low-density residential and commercial development.

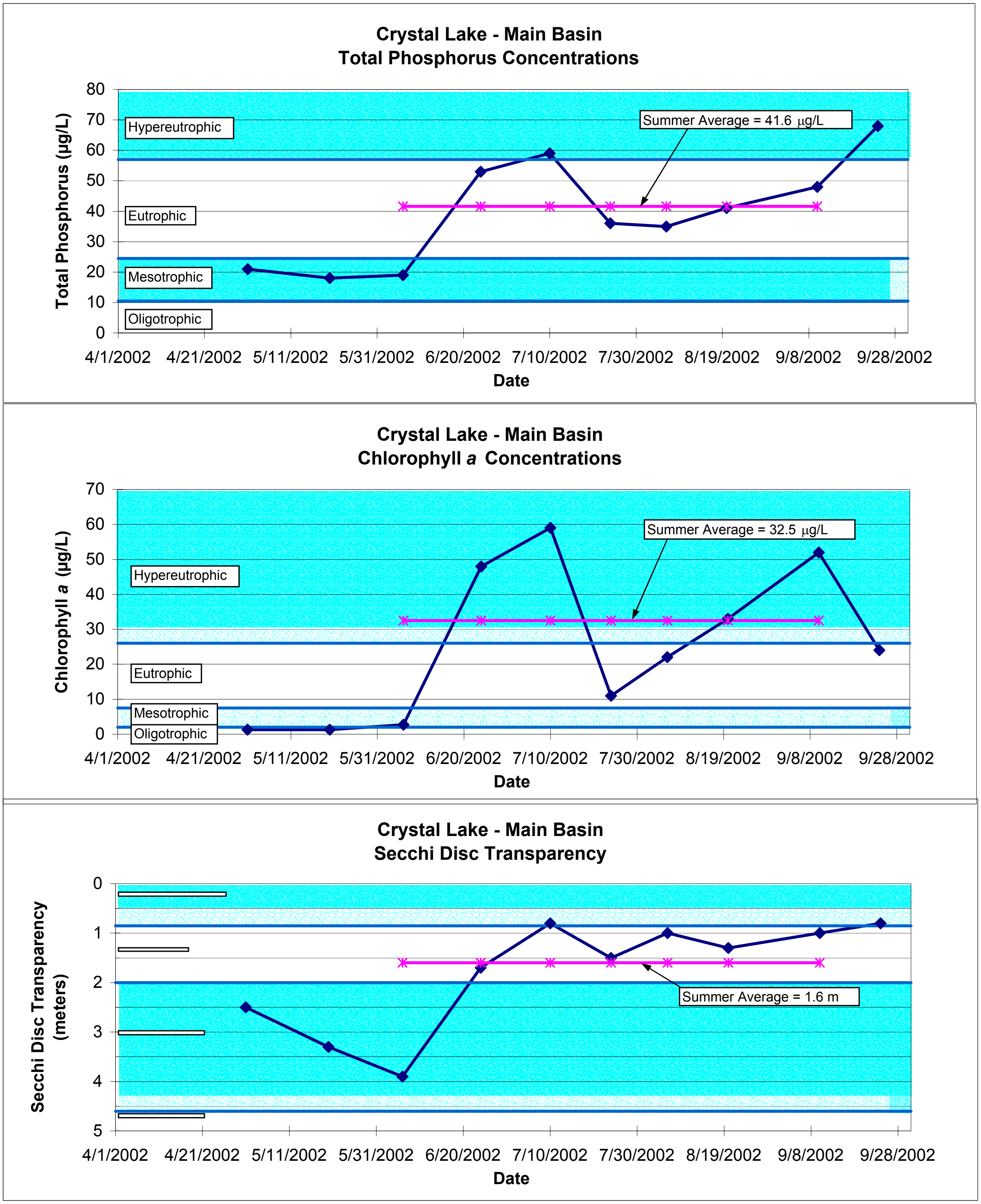
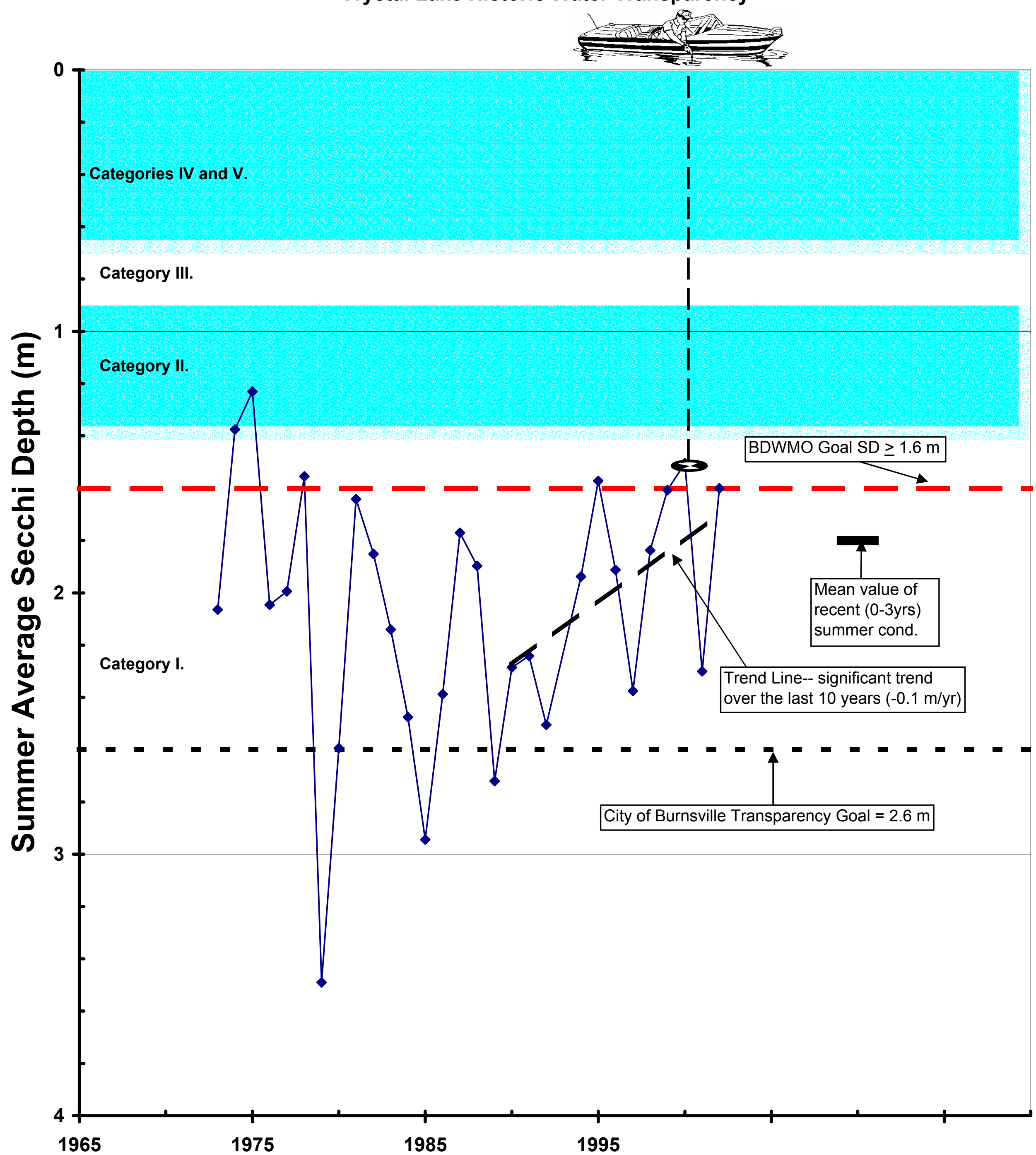


Figure EX-1

Crystal Lake - Main Basin 2002 Seasonal Changes in Total Phosphorus and Chlorophyll *a* Concentrations and Secchi Disc Transparencies

Figure EX-2
Crystal Lake Historic Water Transparency

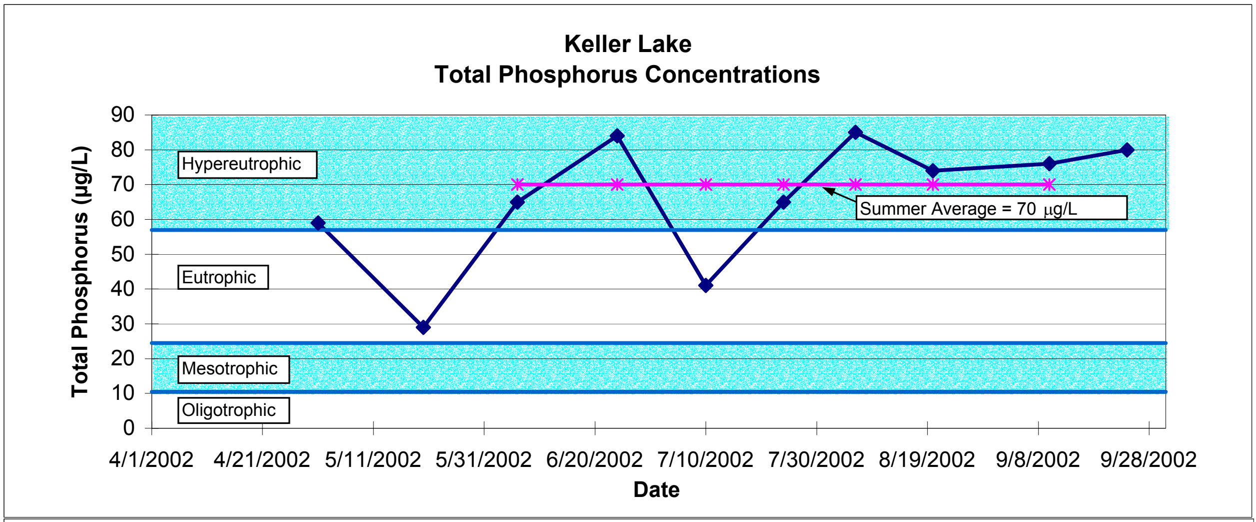


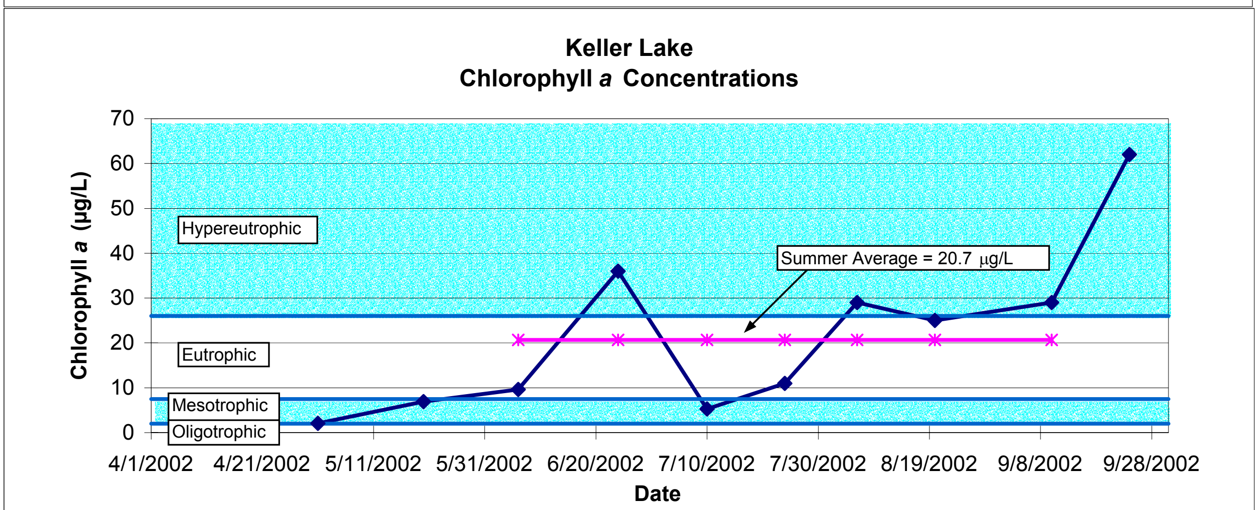
Keller Lake

Water quality measurements for 2002 indicate that Keller Lake is a hypereutrophic system. The trophic state index (TSI), based on measurements for clarity, phosphorus, and chlorophyll *a*, was 66 in 2002, characteristic of hypereutrophic lakes. Keller Lake's average summer total phosphorus concentration was 70 µg/L, and chlorophyll *a* concentration was 21.0 µg/L, which are within the range of a hypereutrophic lake (see Figure EX-3). The average summer Secchi disc depth was 1.1 meters, which is within the eutrophic range. Keller Lake chlorophyll *a* and total phosphorus concentrations exhibited a seasonal increase from May to September of 2002. The 2002 data did not indicate the extreme total phosphorus concentration peak during summer that has been historically observed.

Summer water quality data was collected on Keller Lake from 1996 to 1998, when Keller Lake received the treated water from the Crystal Lake water quality demonstration project (see Section 1.2.1 of this report). Data were also collected from 1999 to 2002, after discontinuation of the water quality demonstration project. The 1996 water quality data show Keller Lake fell within Category III before the project was operated. Operation of the Crystal Lake water quality demonstration project appeared to cause Keller Lake water quality to improve; the water quality then declined after the system was shut-off. However, the inflow from the Crystal Lake project led to increased water clarity in Keller Lake, which led to increased weed growth. With the water quality demonstration project no longer in operation, the 1999 to 2002 water quality data appear to show that Keller Lake has returned to the more eutrophic conditions that existed in the lake prior to system operation.

A trend analysis of Keller Lake's water quality data was also completed to determine if the Keller Lake had experienced significant degradation or improvement during the years for which water quality data are available. There was a noticeable improvement in water clarity from 1996 to 1998, and then a marked decline in the water quality between 1999 and 2002 (see Figure EX-4). This improvement in 1998 was likely partially the result of the Crystal Lake hypolimnetic withdrawal/ferric chloride treatment project, which added significant quantities of iron into Keller Lake. Keller Lake water clarity has remained relatively unchanged, ignoring the 1998 summer average Secchi disc transparency. As a result there is no statistically significant trend in Keller Lake water clarity, total phosphorus, or chlorophyll *a*.





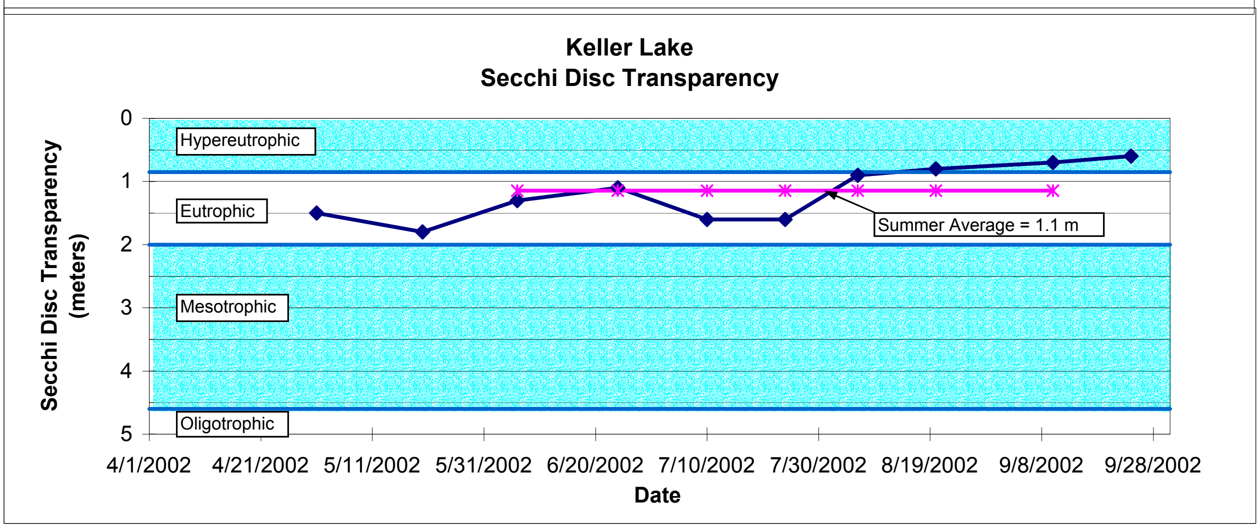
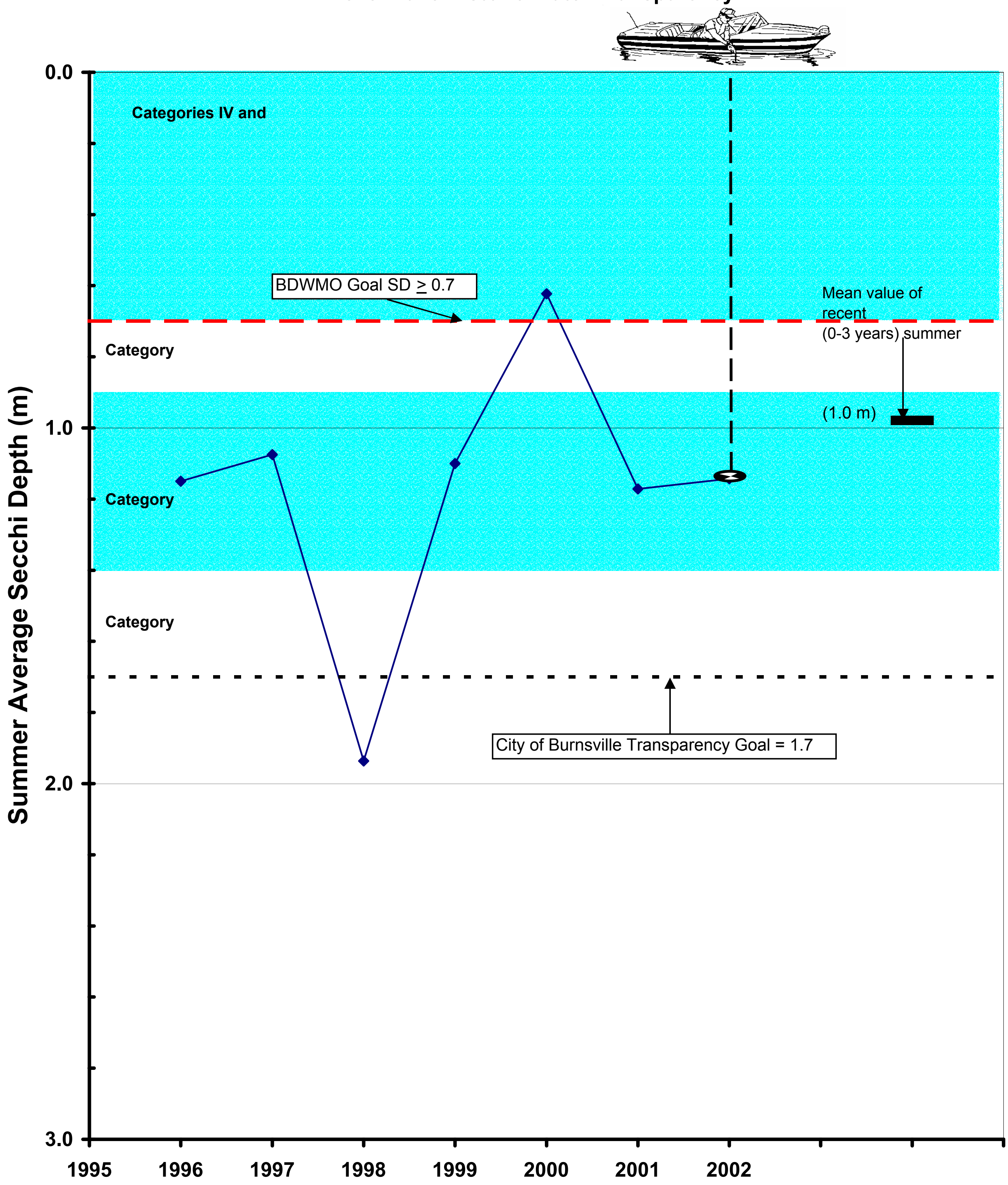


Figure EX-3

Keller Lake - Main Basin 2002 Seasonal Changes in Total Phosphorus and Chlorophyll *a* Concentrations and Secchi Disc Transparencies

Figure EX-4
Keller Lake Historic Water Transparency



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Watershed Runoff Pollution

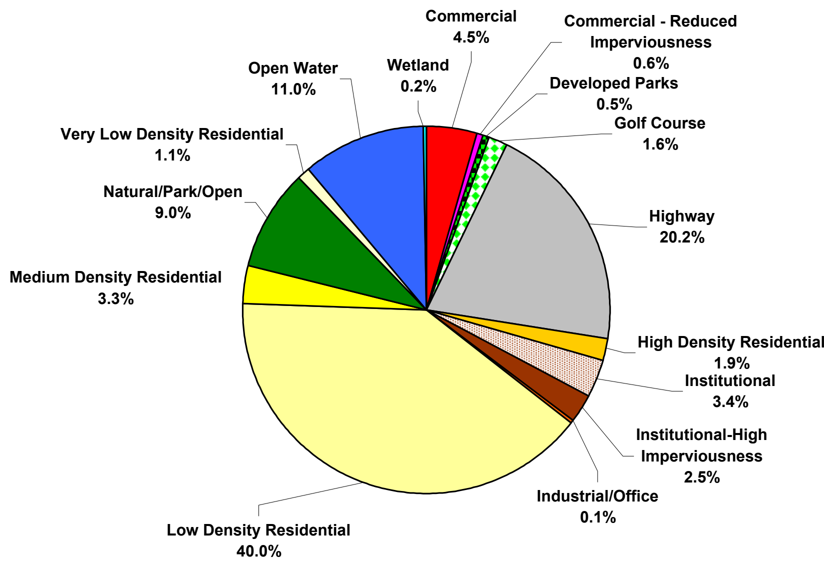
Crystal Lake

Development is ongoing in parts of the Crystal Lake watershed. The majority of this development is occurring in the portions of the watershed that lie in Lakeville. There are several large plots of land along County Road 46 that are currently being developed and several tracts along the Interstate 35 corridor that will like be developed in the near future. However, the City of Lakeville is requiring that this development result in less than a 70 percent total imperviousness in order to help mitigate both stormwater quantity and quality concerns. In addition some developed areas within Burnsville may experience redevelopment that will likely increase the density of residential areas.

The land use change from existing conditions to future full-development conditions are illustrated on Figure EX-5 (land use maps of the watershed) and Figure EX-6 (pie charts illustrating watershed land use compositions).

Figure EX-7 shows annual total phosphorus loads to Crystal Lake by source based on 2002 climatic conditions. Computer simulations of runoff water quality indicate that the average 2002 phosphorus yield from the existing Crystal Lake watershed is only 0.18 lbs./acre/year, under current land use. This average annual phosphorus yield is at the lower end of the range of corresponding yields determined for many other watersheds in the Twin Cities Metropolitan Area, and is presumably due to the abundance of wetlands and stormwater detention ponds within the Crystal Lake watershed that detain and improve the quality of runoff reaching Crystal Lake. Modeling results also show that there is significant (~34 percent) internal phosphorus loading to Crystal Lake from the die-off of curlyleaf pondweed in early-July and from the release of phosphorus from anoxic bottom sediments during at fall overturn.

Crystal Lake Watershed (3,662 acres including lake surface)
Existing Land Use



Crystal Lake Watershed (3,662 acres including lake surface)
Full Development (Ultimate) Land Use

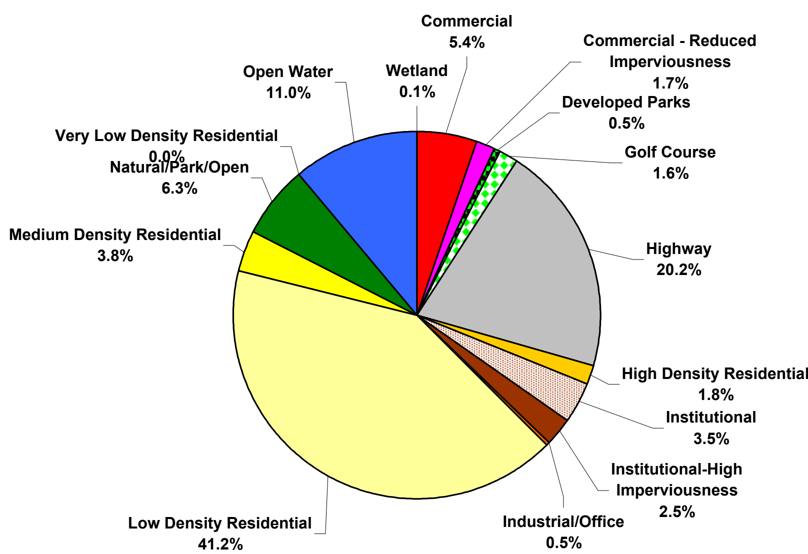
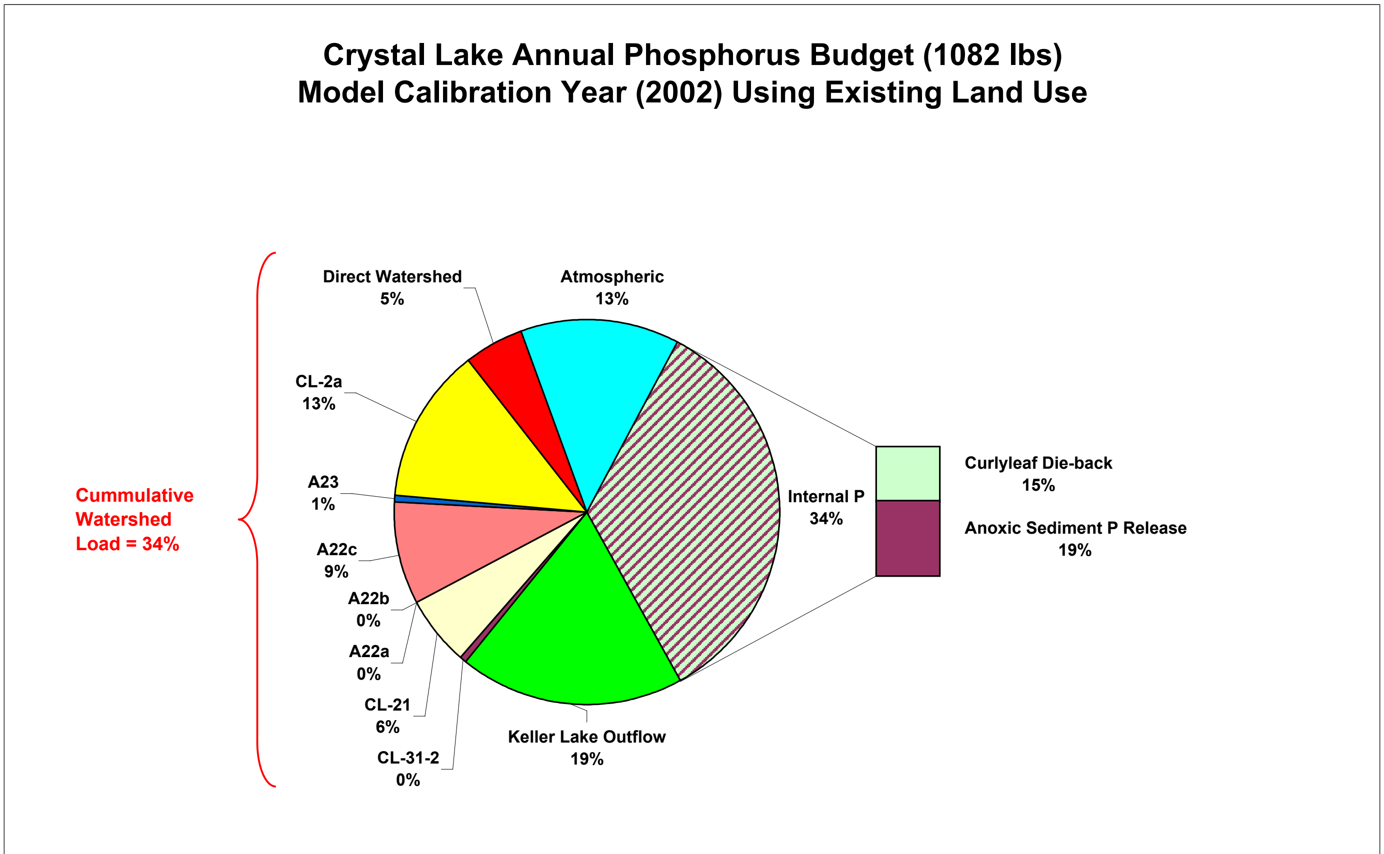


Figure EX-6
Crystal Lake Watershed: Existing and Full Development Land Uses



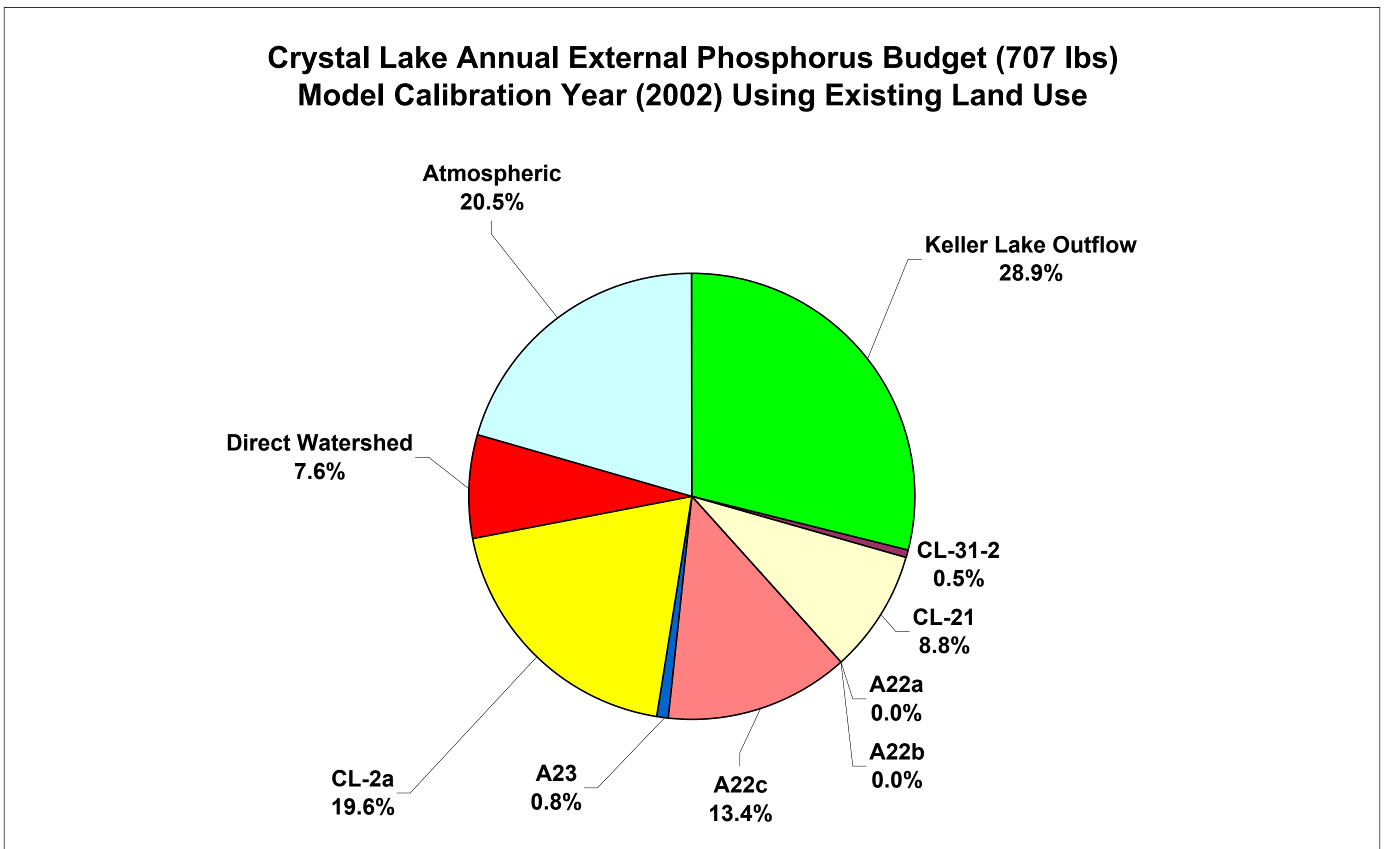


Figure EX-7
Crystal Lake Annual Total and External Phosphorus Budgets for Existing (2002) Land Use

Keller Lake

Because of the timing of their development the cities of Burnsville and Apple Valley were allowed to use Keller Lake for stormwater detention and water quality treatment. As a result, runoff from roughly 644 acres (46 percent) enters Keller Lake without first passing through some form of wet detention for water quality treatment. Nearly the entire subwatershed is developed, with the majority of the land use being low-density residential (53 percent), with some roadway right-of-way (ROW, 21 percent), institutional (7 percent), commercial (4 percent), park/open space (9 percent), and higher-density residential (2 percent) uses. There is also a large wetland area adjacent to the southwest side of Keller Lake.

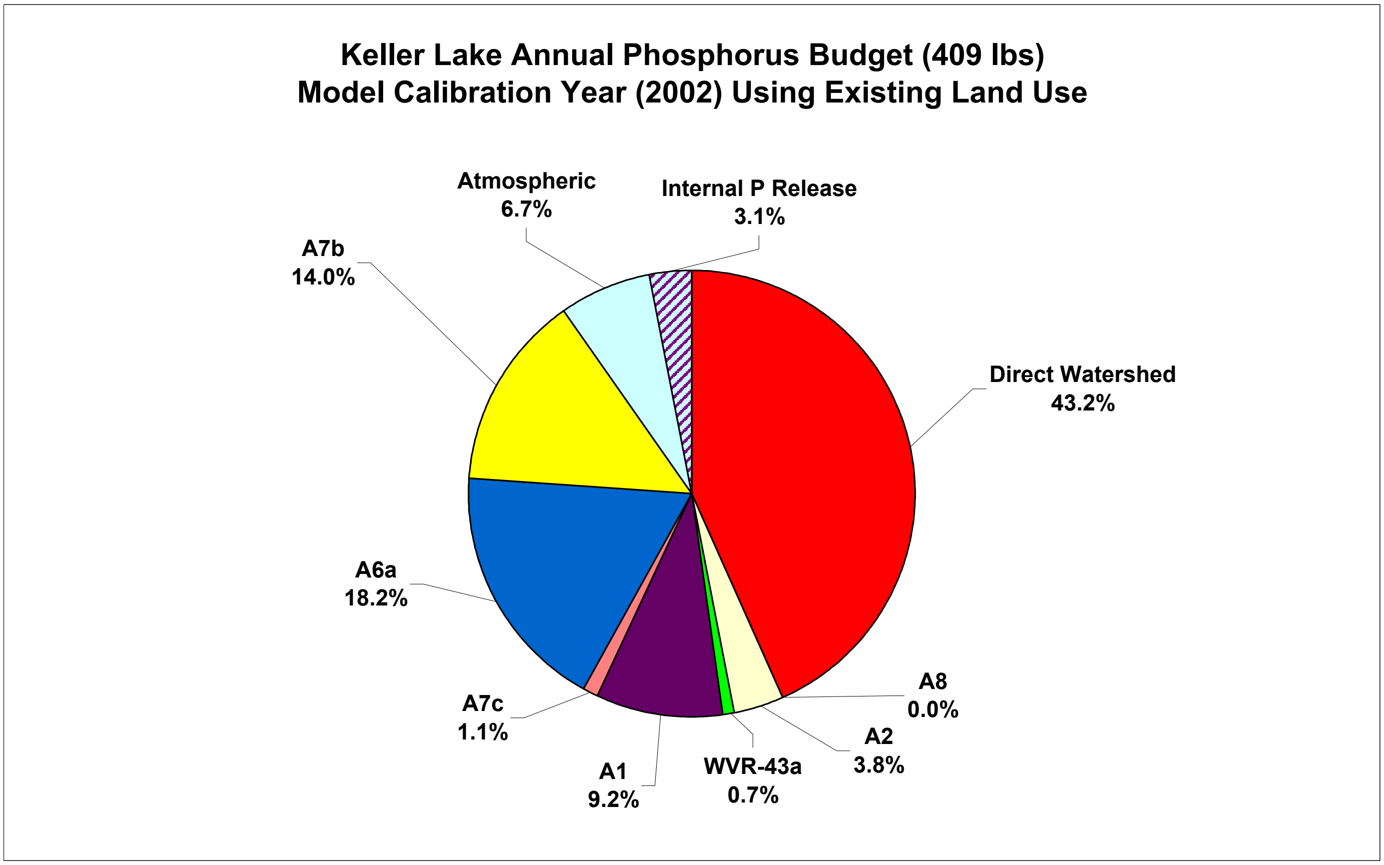
Figure EX-8 shows annual external total phosphorus loads to Keller Lake by inflow location. Computer simulations of runoff water quality indicate that the average 2002 phosphorus yield from the existing Keller Lake watershed is only 0.27 lbs./acre/year, under current land use. Modeling results also show that there is likely significant internal phosphorus loading to Keller Lake from the die-off of curlyleaf pondweed in early-July and from the release of phosphorus from bottom sediments throughout the year due to the polymictic natural of the lake.

Aquatic Plants

Crystal Lake

Although it was previously observed in Crystal Lake, macrophyte (i.e., lakeweed) surveys performed during June and August 2002 found no Eurasian watermilfoil present (Bluewater Science, 2002). However, another exotic weed, curlyleaf pondweed, was observed at nuisance levels over roughly 100 acres of the lake in early-June 2002. The June survey reported that curlyleaf pondweed was observed at about 95 percent occurrence rate with medium- to dense-growths. Curlyleaf pondweed is an exotic perennial, rooted, submersed aquatic vascular plant that was first noted in Minnesota about 1910 (Moyle and Hotchkiss, 1945). Native to Eurasia, Africa, and Australia, this species has been found in most of the United States since 1950, and is currently found in most parts of the world (Catling and Dobson, 1985). Curlyleaf pondweed is detrimental to lakes for three reasons:

- It tends to crowd out native aquatic macrophyte species
- Dense colonies of the weed may interfere with recreational activities on the lake
- After curlyleaf pondweed dies out in early-July, it may sink to the lake bottom and decay. When dense colonies of the weed decay, oxygen depletion and release of phosphorus may occur.



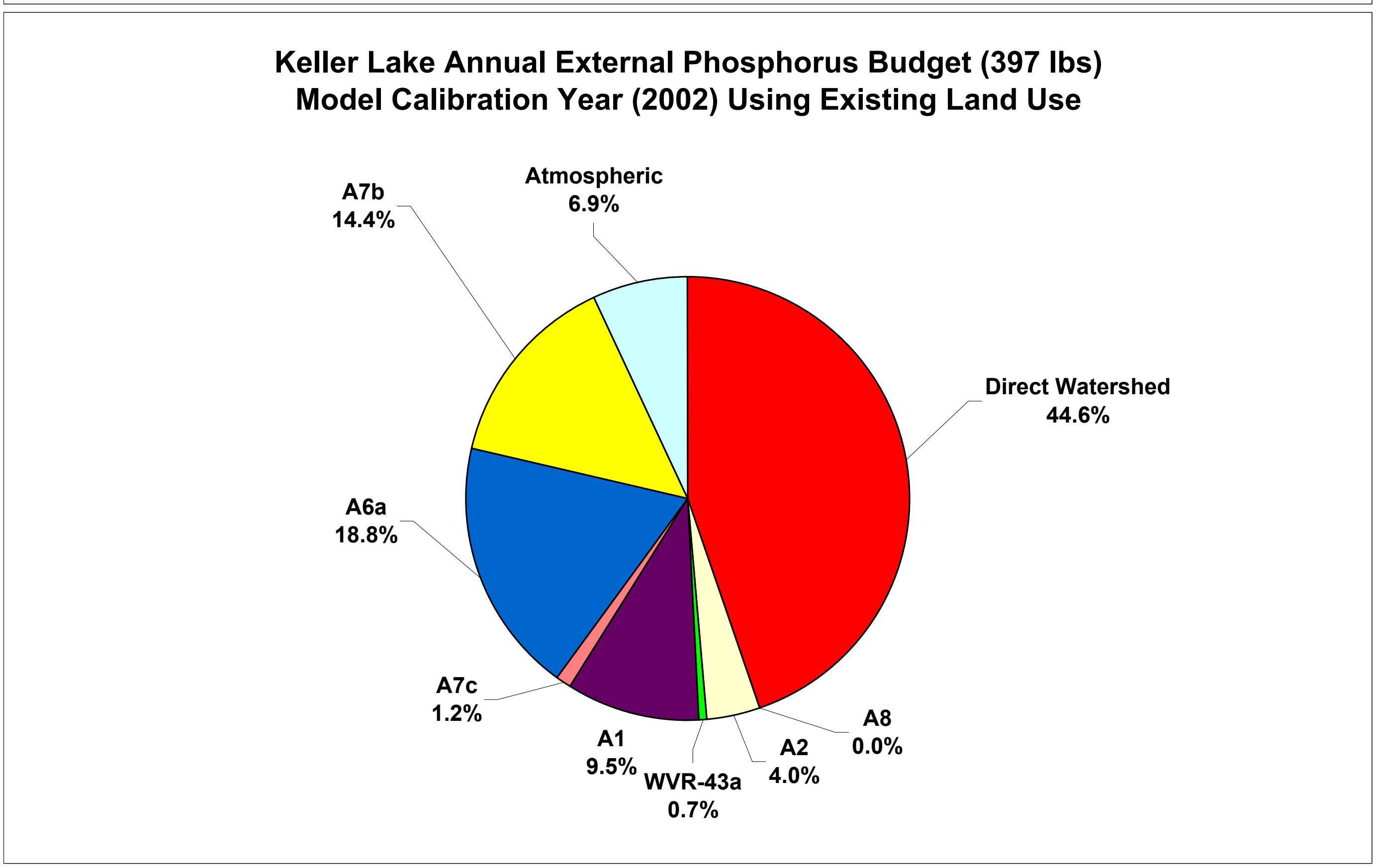


Figure EX-8
Keller Lake Annual Total and External Phosphorus Budgets for Existing (2002) Land Use

Coontail had the second highest rate of occurrence in the June survey (22 percent). Eight other aquatic plants were observed during the June survey (including white waterlily, northern watermilfoil, cabbage, Illinois pondweed, floating pondweed, claspingleaf pondweed, and stringy pondweed). By the August 2002 survey 16 aquatic plants were observed in Crystal Lake. The dominant macrophyte during this survey was coontail (92 percent occurrence rate) followed by water celery (35 percent occurrence rate). Curlyleaf pondweed was only observed at 4 out of 52 stations due to its life cycle.

Keller Lake

The Keller Lake aquatic plant survey report for 2000 (Blue Water Science, 2001) states that aquatic plant growth in the lake in 2000 was similar to the 1999 results, but less than what was found in 1998. Coontail and elodea were the dominant submerged plant species in the lake; stringy pondweed and curlyleaf pondweed were also observed. Plant coverage of the lake bottom in late-summer was about 30 percent in 2000 and 1999, compared to 60 percent coverage in late-summer 1998. Plant coverage was nearly 100 percent in the early-summer of 2000. Metropolitan Council reports indicate that aquatic plants covered nearly 100 percent of Keller Lake in mid-July 1999. The aquatic plant coverage and algae prevented sampling of the lake at that time. The 2001 report notes the following dominant plants in the springtime: curlyleaf pondweed in 1997, stringy pondweed in 1998, and back to curlyleaf pondweed in 2000. In late-May 2002, a dense nuisance growth of curlyleaf pondweed covering most of the lake littoral area was observed during routine water quality sampling.

Recommended Lake and Watershed Management Practices

Implementation of conventional stormwater BMPs, either good housekeeping BMPs (e.g., source control activities such as street sweeping) or stormwater BMPs (e.g., treatment mechanisms like runoff detention basins) are already mandated by the stormwater management plans of Burnsville, Lakeville, and Apple Valley. These practices will likely partially offset any increases in annual phosphorus loading to Crystal and Keller Lakes from future development in the watershed. In-lake improvement options and site-specific structural BMPs were evaluated for their feasibility and cost-effectiveness. It is important that all BMPs currently required by the BDWMO and member municipalities continue to be implemented in addition to those recommended below. While the implementation of structural and in-lake BMPs are usually given priority, it is important to note that source control through the implementation of nonstructural BMPs is crucial to protecting the water quality in Crystal and Keller Lakes.

Thirty-nine BMPs or BMP combinations were analyzed as part of this UAA (a detailed description and discussion of each BMP or BMP combination is located in the main report). Four of the BMP combinations were selected by the BDWMO Board to be presented to City staffs and neighborhood residents to gather feedback and develop a final recommendation. These four BMP management options, their BMP elements, their anticipated costs, and resulting water quality in Crystal Lake are summarized in Table EX-2 and Figure EX-9 relative to the BDWMO water clarity goal. Corresponding Keller Lake statistics are presented in Table EX-3 and Figure EX-10

The recommended management option (Management Option III.14) was developed with extensive input from the BDWMO Board, City staffs, and neighborhood residents. This management option is an enhancement of Management Option III.10. The following elements were combined to form this management option (see Figure EX-11 for the location of the recommended BMPs):

- Fertilizer P Limitation.
- Upgrade ponds A1, WVR-43a, A46a, A6a, A7a, and CL-21 to provide sufficient water quality treatment storage volume to meet NURP criteria.
- Add Pond A7a-1 designed to meet NURP criteria as a regional water quality treatment basin.
- Enhance Redwood Pond (Pond A1) to act as an infiltration basin.
- Add a regional infiltration basin north of Valley Middle School and in West Buckhill Park.
- Resume operation of the $FeCl_3$ treatment system withdrawing near surface water.
- Manage aquatic macrophytes, primarily curlyleaf pondweed, in both Crystal and Keller Lakes by mechanical harvesting.

Model simulations indicate that this BMP combination (Management Option III.14) would result in summer average total phosphorus concentrations of 30 µg/L and 32 µg/L in Crystal and Keller Lakes, respectively (see Figures EX-9 and EX-10). These concentrations would translate into summer average Secchi disc transparencies of 2.1 meters and 1.8 meters, respectively, thus achieving the BDWMO's goal for both lakes. The capital cost of this management option ($860,000) combined with annual operations and maintenance costs ($112,400) results in a 20-year annualized cost of $187,357.

Figure EX-9

Crystal Lake Secchi Disc Transparencies, Total Phosphorus Concentrations and Annualized Costs Estimated for Several Goal Achieving BMP Combination Options – Modeled Full Development

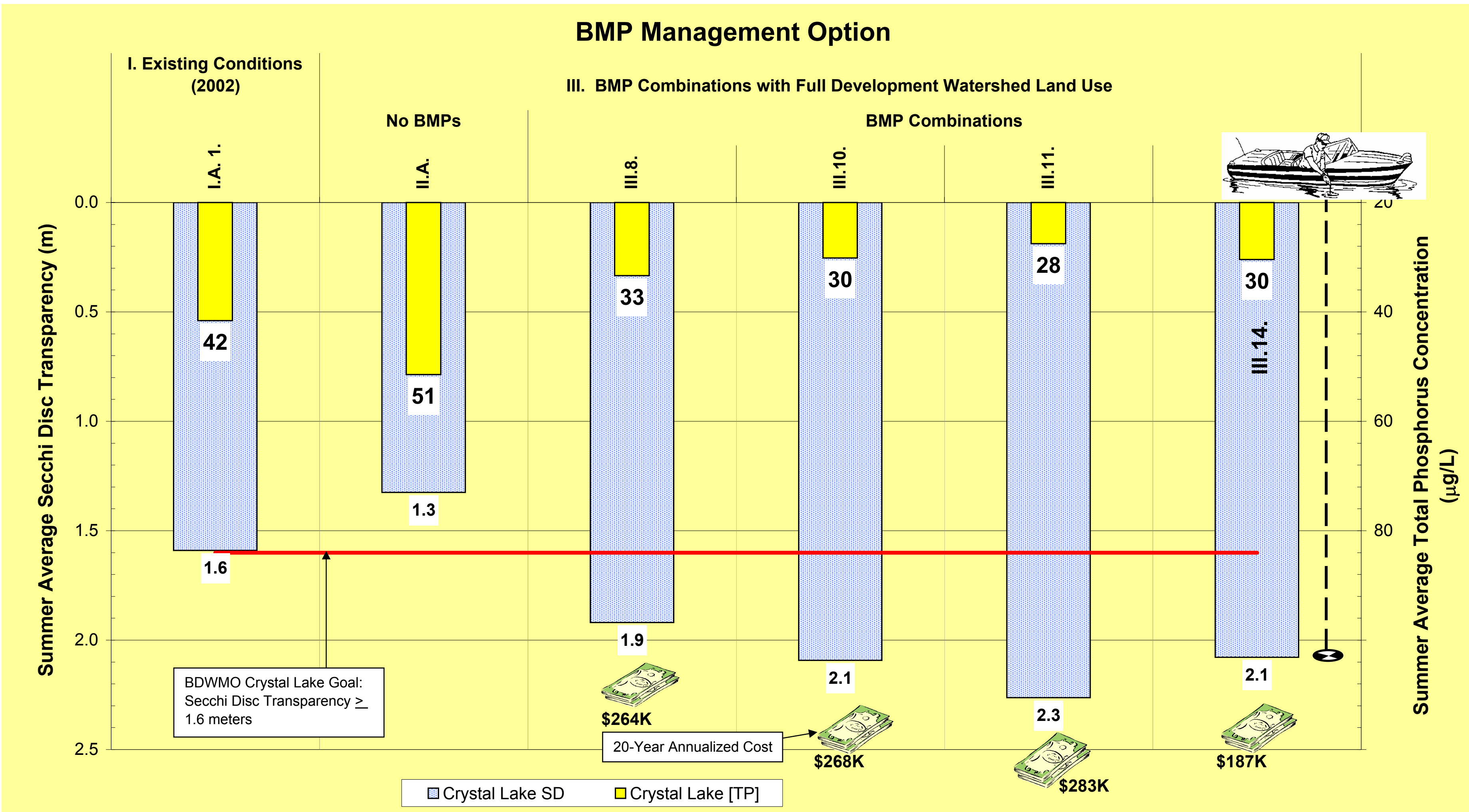


Table EX-2. Summary of Select BMP Combinations for Crystal Lake

Best Management Practices (BMPs)	Existing Conditions	Full Development Land Use					Capital Cost	Annual O&M	20-Year Annualized Cost
		No BMPs	BMP Combinations						
	I.A.1	II.A	III.8	III.10	III.11	III.14			
Source Reduction Efforts									
Fertilizer P Limitation			X	X	X	X	$0	$0	$0
Infiltration of Runoff									
Upgrade Redwood Pond			X	X	X	X	$105,315	$843	$10,024
Add Regional Infiltration Basins (Valley M.S., West Buckhill Park, & Rolling Oaks Park)			X	X	X		$160,257	$1,282	$15,254
Add Regional Infiltration Basins (Valley M.S. & West Buckhill Park)						X	$107,825	$915	$10,315
Runoff Detention Ponding									
Upgrade Existing Ponds to NURP			X	X	X		$977,008	$7,816	$92,996
Upgrade Select Existing Ponds to NURP*						X	$171,938	$1,376	$16,366
Add Pond A7a-1			X	X	X	X	$462,000	$3,696	$43,975
Add Pond A7b-1			X				$131,828	$1,055	$12,548
Restore Wetland between Lac Lavon Drive and Crystal Lake Road East							$195,081	$1,561	$18,569
In-Lake Chemical Treatments									
In-Lake Alum Treatment of Crystal Lake Main Basin			X		X		$169,534	$0	$14,781
In-Lake Alum Treatment of Keller Lake			X				$56,922	$0	$4,963
Resume Operation of $FeCl_3$ Treatment System (in Epilimnetic Mode)				X	X	X	$13,125	$36,520	$37,664
In-Lake Mechanical Treatments									
Mechanical Harvesting of Curlyleaf Pondweed in Crystal Lake			X	X	X	X	$0	$54,600	$54,600
Mechanical Harvesting of Curlyleaf Pondweed in Keller Lake			X	X	X	X	$0	$14,359	$14,359
Predicted Water Quality									
Crystal Lake Summer Average Total Phosphorus Concentrations (µg/L)	42	51	33	30	28	30			
Crystal Lake Summer Average Chlorophyll *a* Concentrations (µg/L)	15	20	11	9	8	9			
Crystal Lake Summer Average Secchi Disc Transparencies (meters)	1.6	1.3	1.9	2.1	2.3	2.1			
Capital Cost	n/a	$0	$2,062,863	$1,711,142	$1,880,677	$860,203			
Annual O&M	n/a	$0	$84,105	$119,115	$119,115	$112,360			
20-Year Annualized Cost	n/a	$0	$263,955	$268,301	$283,081	$187,357			

* Apple Valley Pond Upgrades
- A1 - Redwood Pond - Excavate and Enhance Infiltration (3.2 ac-ft)
- WVR-43a - 153rd St. Pond (Near Old Kmart) - Enlarge and Excavate (2.3 ac-ft)

Burnsville Pond Upgrades
- A46a - North of the Intersection of Southcross Drive and Keller Lake Drive - Excavate (0.6 ac-ft)
- A6a - Keller Lake Park Pond - Excavate (2.0 ac-ft)
- A7c - Northeast Edge of Keller Lake - Excavate (0.8 ac-ft)

Lakeville Pond Upgrade
- CL-21 - Bluebill Pond - Excavate (1.8 ac-ft)

Figure EX-10

Keller Lake Secchi Disc Transparencies, Total Phosphorus Concentrations and Annualized Costs Estimated for Several Goal Achieving BMP Combination Options – Modeled Full Development

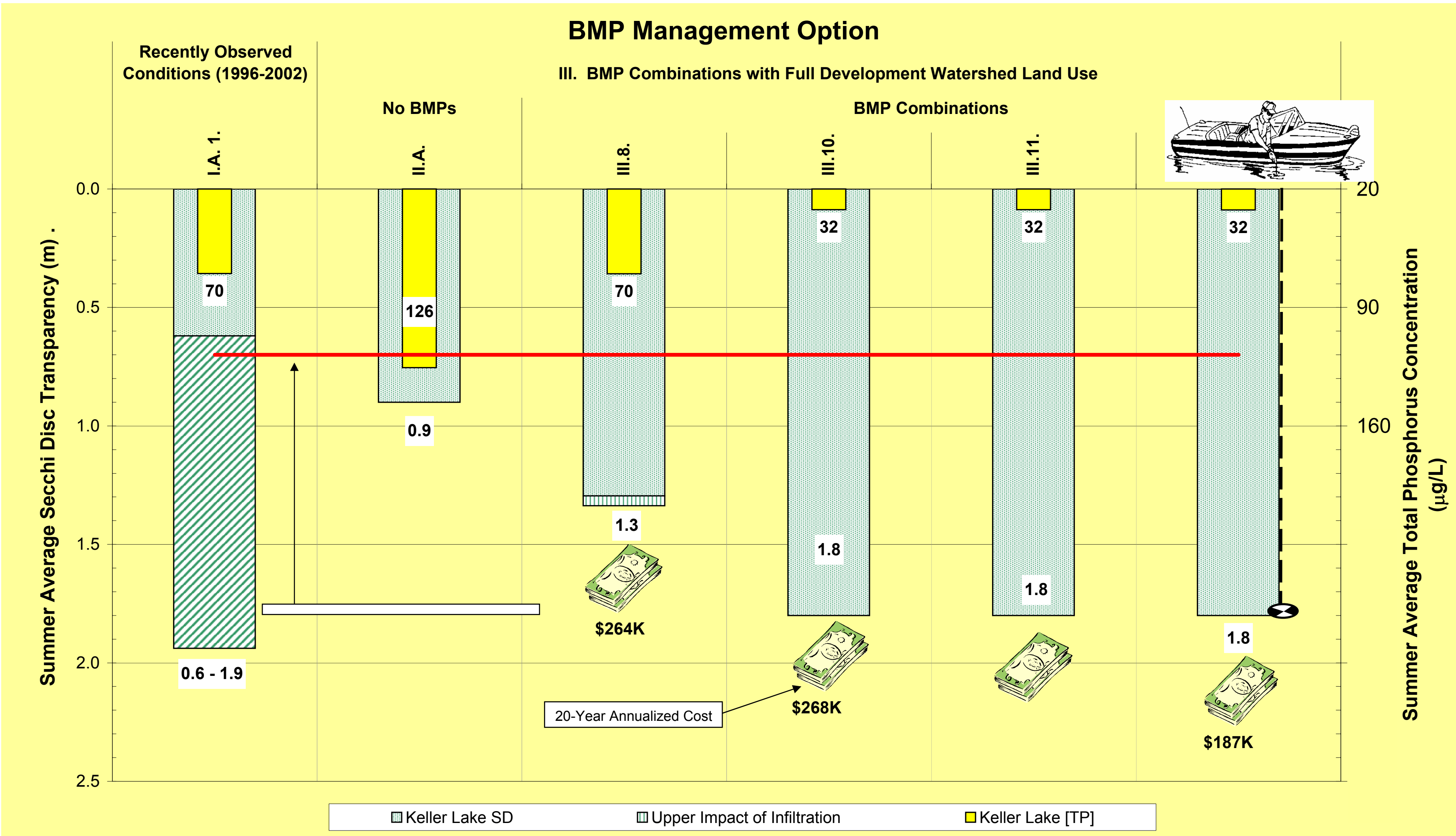


Table EX-3. Summary of Select BMP Combinations for Keller Lake

Best Management Practices (BMPs)	Existing Conditions I.A.1	No BMPs II.A	III.8	III.10	III.11	III.14	Capital Cost	Annual O&M	20-Year Annualized Cost
		Full Development Land Use	BMP Combinations						
Source Reduction Efforts									
Fertilizer P Limitation			X	X	X	X	$0	$0	$0
Infiltration of Runoff									
Upgrade Redwood Pond			X	X	X	X	$105,315	$843	$10,024
Add Regional Infiltration Basins (Valley M.S., West Buckhill Park, & Rolling Oaks Park)			X	X	X		$160,257	$1,282	$15,254
Add Regional Infiltration Basins (Valley M.S. & West Buckhill Park)						X	$107,825	$915	$10,315
Runoff Detention Ponding									
Upgrade Existing Ponds to NURP			X	X	X		$977,008	$7,816	$92,996
Upgrade Select Existing Ponds to NURP*						X	$171,938	$1,376	$16,366
Add Pond A7a-1			X	X	X	X	$462,000	$3,696	$43,975
Add Pond A7b-1			X				$131,828	$1,055	$12,548
Restore Wetland between Lac Lavon Drive and Crystal Lake Road East							$195,081	$1,561	$18,569
In-Lake Chemical Treatments									
In-Lake Alum Treatment of Crystal Lake Main Basin			X		X		$169,534	$0	$14,781
In-Lake Alum Treatment of Keller Lake			X				$56,922	$0	$4,963
Resume Operation of $FeCl_3$ Treatment System (in Epilimnetic Mode)				X	X	X	$13,125	$36,520	$37,664
In-Lake Mechanical Treatments									
Mechanical Harvesting of Curlyleaf Pondweed in Crystal Lake			X	X	X	X	$0	$54,600	$54,600
Mechanical Harvesting of Curlyleaf Pondweed in Keller Lake			X	X	X	X	$0	$14,359	$14,359
Predicted Water Quality									
Keller Lake Summer Average Total Phosphorus Concentrations (µg/L)	70	126	70	32	32	32			
Keller Lake Summer Average Chlorophyll *a* Concentrations (µg/L)	21	51	21	7	7	7			
Keller Lake Summer Average Secchi Disc Transparencies (meters)	1.3	0.9	1.3	1.8	1.8	1.8			
Capital Cost	n/a	$0	$2,062,863	$1,711,142	$1,880,677	$860,203			
Annual O&M	n/a	$0	$84,105	$119,115	$119,115	$112,360			
20-Year Annualized Cost	n/a	$0	$263,955	$268,301	$283,081	$187,357			

* Apple Valley Pond Upgrades
- A1 - Redwood Pond - Excavate and Enhance Infiltration (3.2 ac-ft)
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Burnsville Pond Upgrades
- A46a - North of the Intersection of Southcross Drive and Keller Lake Drive - Excavate (0.6 ac-ft)
- A6a - Keller Lake Park Pond - Excavate (2.0 ac-ft)
- A7c - Northeast Edge of Keller Lake - Excavate (0.8 ac-ft)

Lakeville Pond Upgrade
- CL-21 - Bluebill Pond - Excavate (1.8 ac-ft)