Project #08223

CRYSTAL LAKE

FLOODING STUDY

EXECUTIVE SUMMARY



PREPARED FOR:

City of Crystal Lake
100 West Woodstock Street
Crystal Lake, Illinois 60014

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INTRODUCTION

In August of 2007, the area surrounding Crystal Lake received between 11 and 12 inches of rainfall. The rainfall produced the highest lake level ever recorded and groundwater levels around the lake reached the ground surface in several locations. Storm sewers were at capacity, overland flow occurred and depressions filled with water that could not drain fast enough.

At least 60 residents around the lake reported flooding complaints and many more probably experienced at least some type of flooding problem or inconvenience. North Shore Drive was closed as Cove Pond overflowed and traffic was rerouted down Woodland Avenue by a temporary connection. Residents in the Oriole Trail vicinity and on the south side of the lake experienced sanitary sewer backups as well.

The City categorized flooding complaints in a report issued in April 2008. Four areas were identified as shown on Exhibit 1. The City did not include a study of Crystal Creek below the lake at this time. The City also provided residents an opportunity to voice their flooding complaints at an Open House held December 9, 2008. The additional input received from over 50 residents was included with the earlier complaint database and all are shown on Exhibit 1.

The scope of the study was to examine area-wide flooding rather than individual lot drainage issues. The study determined the causes of flooding to develop conceptual solutions with cost estimates that can address areawide flooding complaints. The level of protection provided by the solutions was qualitatively assessed as well. The flooding complaints in each area were classified as follows:

- Inadequate storm sewer capacity (minor drainage system)
- Inadequate overland flow capacity (major drainage system when the minor system is full)
- High groundwater either natural or due to rainfall in excess of normal or failed drain tiles
- Overbank flooding including FEMA floodplain

This study has identified a number of viable solutions to minimize flooding within the study areas which are described later.

AUGUST 2007 FLOODING

The severity of flooding around Crystal Lake depends on a number of independent events including the Lake elevation, groundwater elevations, and rainfall intensity and duration. For example, when the Lake is

high as it was in August 2007, groundwater is high and excessive rainfall can cause more severe flooding. If the August 2007 rainfall had occurred in August 2005, when the Lake was low, the impact certainly would have been much less.

At the end of July 2007, Crystal Lake had been at or above its weir elevation nearly the entire year. The groundwater table above and below the Lake was 2 to 4 feet higher than normal. Storage that was normally available within the soil was already filled with water.

The unusually high amounts of rainfall on August 5th through 9th caused the Crystal Lake Drainage District tile system and the storm sewers into Cove Pond to discharge at full capacity into the Lake. These inflows to the Lake exceeded outflows from the Lake and water levels rose. The rising Lake levels reduced the already small capacity of the Cove Pond outlet and caused the pond to rise, flooding the storm sewers that lead into it from the north and east.

When another 5 inches of rainfall occurred August 19th through the 23rd there was nowhere for the water to go since groundwater infiltration was impossible because of already high water tables. Storm sewer flow into Cove Pond caused it to flood over North Shore Drive because inadequate capacity was available through its outlet pipe and because of its limited storage volume. The depressions in Areas 1, 2 and 3 all filled with water. Overland flow filled the detention area at Lippold Park and flowed along its natural drainage path and into Area 2 making flooding problems worse.

Below the Lake, the 24-inch tile line that acts as a storm sewer from Broadway Street under Crystal Creek was flowing full and had no capacity. This caused water to pond in Area 4 as the groundwater table rose to at or near the surface. The limited capacity in the County Club Road storm sewer was exceeded causing overland flow. The lack of a defined major drainage system caused overland flow to enter and pond in Area 4.

FLOODING CAUSES

The causes of flooding determined by this study are summarized below. A common cause of flooding for all areas was high Lake levels.

Area 1 North Shore Drive

- Inadequate outlet capacity from Cove Pond
- Inadequate safe major drainage system conveyance from Cove Pond to the Lake
- Lack of both a minor and a major drainage outlet from the Woodland Wetland to the Lake
- High groundwater

Area 1 Sycamore and Green Oaks

- Inadequate culvert outlet capacity from Cove Pond
- High groundwater due to high Cove Pond elevations, inadequate tile capacity and large rainfall volume
- Inadequate major drainage system conveyance
- Inadequate minor drainage system for Hoyne, State Farm, and DiMonte properties

Area 1 Pine Street and Oriole Trail

- Inadequate outlet capacity from Cove Pond which causes ponding, which in turn reduces the capacity of the Crystal Lake Avenue storm sewer
- High groundwater due to high Cove Pond elevations, unavailable storm sewer capacity and large rainfall volume
- Inadequate minor and major drainage system conveyance from the Oriole and Pine depression

Area 2 North Shore, East End Avenue to Crystal Beach Avenue

- Lack of an adequate and maintained minor drainage system to convey routine flows
- High groundwater related to high Lake levels that restricted infiltration of the large amounts of runoff
- Lack of a major drainage route to reduce flood heights in the existing depression and to convey extreme runoff events safely through the area
- Large runoff volumes from the entire watershed to the north

Area 3 West End, North Avenue to Floresta Lane

- Lack of an adequate minor drainage system to convey routine flows

- High groundwater related to high Lake levels that restricted infiltration of the large amounts of runoff
- Lack of a major drainage route to reduce flood heights in the existing depressions and to convey extreme runoff events safely through the area

Area 4 South End, Broadway Street to Country Club Road

- Inadequate minor drainage system capacity for Crystal Creek including the entire system to at least St. Andrews Lane.
- Inadequate minor drainage capacity for both Broadway Street and Country Club Road.
- Inadequate major drainage system capacity including the entire length of Crystal Creek to at least St. Andrews Lane.
- Inadequate major drainage capacity and routing along Broadway Street, Country Club Road and through Area 4.
- High groundwater resulting from high Lake levels and unusually large rainfall volumes.

ALTERNATIVE SOLUTIONS

Twenty-five potential solutions were evaluated using the following criteria:

- Severity of flooding problem addressed
- Residences and businesses affected and complaints addressed
- Potential offsite impacts resulting from implementation
- Cost

The specific types of solutions considered to address the above causes of flooding included the following:

- New or larger storm sewers or smooth walled perforated pipe
- Improved overland flow conveyance
- New or repaired field tiles to lower groundwater levels
- Stormwater pumping stations
- Additional flood storage

One significant alternative that was considered but not selected was lowering the spillway of the Lake from its current elevation of 890.9. Normal water levels on the Lake are below the spillway based on many years

of observation (CLPD, 2006 Clean Lakes Phase I Diagnostic Report). Lowering the spillway to the normal Lake elevation should not adversely affect low Lake water levels; however, it could lower flood elevations by making additional storage available during wet weather patterns. It also would help to lower groundwater levels around the Lake and would increase the culvert capacity under North Shore Drive. If this alternative was combined with increased culvert capacity under Lake Avenue it also could reduce the 100-year floodplain on the Lake by a foot and remove as many as 150 residences from the FEMA floodplain. This option requires significant additional analysis combined with Alternative 5 below.

SELECTED OPTIONS

After considering the probable benefits and costs of the 25 alternatives, the following projects were selected as options for the City to consider. Each provides varying degrees of relief from flooding in the study areas. Table 1 summarizes costs for each option.

1. Area 1, New culverts under North Shore Drive and out of the Woodland Wetland with an expanded open channel from North Shore Drive to the Lake.

High water levels on Cove Pond make flooding worse in all parts of Area 1 in addition to the overtopping of North Shore Drive and flooding of the Woodland Wetland. Larger culverts under North Shore Drive can reduce the frequency of this occurrence from once every two or three years to once in 25 years or less on average. Adding an outlet culvert from the Woodland Wetland to the new outlet channel will reduce the high water levels along Woodland Drive as well. These areas will still be in the floodplain and will still experience high water levels when the Lake is high as happens now. However, flooding from Cove Pond and the Woodland Wetland will be reduced.

This option has significant advantages from an ecological standpoint since it would add habitat to the Lake by connecting Cove Pond to the Lake. Water quality benefits would not be compromised since the area of wetland treatment would be increased by the addition of the outlet channel.

Over 250 residences and 40 flooding complaint sites will benefit from this option. In addition the costs associated with traffic delays, re-routing, and safety will be reduced significantly. Total conceptual construction cost is estimated at $94,000 for the larger culverts under North Shore Drive and $90,000 for the expanded open channel. The Woodland Wetland culvert is estimated to add another $32,000. Total construction cost is estimated to be $216,000.

1A. Area 1, Re-route North Shore Drive

This would be a highly desirable choice as an option to 1 above. However, it has possible time delays and higher costs than the previous option but provides the same benefits. It also provides the added benefits of providing a signalized intersection for North Shore Drive with Virginia Street and the ecological and water quality benefits of combining Cove Pond with the Woodland Wetland. If funding and timing were equal, it would be superior to the previous option. Total conceptual construction cost is estimated at $551,000.

2. Area 4, Further analyze the flooding south of the Lake and along Crystal Creek.

All of the options available to improve flooding in Area 4 are complicated by the lack of available drainage capacity in Crystal Creek or under it. This option is not a construction project but rather additional analysis and conceptual design. Improvements to Crystal Creek's drainage capacity would facilitate improvements to the drainage in Area 4. It may be possible to remove over 50 residences from the FEMA 100-year floodplain and stabilize Lake levels as well. Over 500 residences including 80 flooding complaint sites and over 100 floodplain or floodway properties will benefit from this option. Total cost is estimated at $35,000.

3. Area 2, Replace the existing drainage network along Greenfield Road and East End Avenue.

This option provides a minor drainage system for Area 2. It is proposed to also act as a field tile to lower normal groundwater within Area 2. It will not create a new storm sewer to the Lake since it will use the existing tile outlet. The total conceptual construction cost is estimated at $263,000. It does not appear feasible at this time to provide a major overflow route from Area 2 based on existing infrastructure. However, the additional options discussed below would help to address this issue.

The efficiency of this alternative can be enhance by the addition of two other projects,

- **Build a new field tile across the south property line of Lippold Park above Area 2 and**
- **Divert the discharge from the CLPD detention facility above Greenfield Road to the west to the Lippold wetland restoration.**

Adding a drain tile to lower groundwater immediately above Area 2 will help to facilitate infiltration in this area. Groundwater collected would be sent to the Lake through the existing tile outlet below Greenfield Road. The estimated construction cost is $104,000.

Diverting water from its natural drainage pathway through Area 2 and re-routing it to the Lippold Wetland prevents any surface flow from the entire Crystal Lake watershed to the north from entering Area 2 and causing increased flooding. There is sufficient capacity to receive this detained flow in the Lippold Wetland without increasing flood risk. All runoff would discharge down the Honeysuckle Drive storm sewer to the Lake. The estimated construction cost is $63,000.

Approximately 125 residences and 20 flooding complaint sites will benefit from these three options. Depending on Lake levels the level of flood protection would be about the 10-year event. Total conceptual construction cost is estimated at $430,000 for all three options.

4. Area 1, Replace field tile system adjacent to Sycamore Lane and Green Oaks Drive.

This option would replace the existing field tile system through the Hoyne property and would include an improved overland flow route to the Lake. In combination, these two options would provide a minor and major overland flow route for this area. The field tile would act to lower the normal groundwater. This would benefit residents on Sycamore Lane by reducing sump pump usage and standing water issues. The field tile also would improve the function of the State Farm infiltration basin by lowering groundwater to 4 feet below its bottom. The installation of the tile would also allow new infiltration basins to be built to meet the Crystal Lake Stormwater Management Watershed Design Manual within the area. Approximately 50 residences and 10 flooding complaint sites will benefit from this alternative. Total conceptual cost is estimated at $104,000. The level of flood protection would be about the 100-year event depending on Lake levels.

5. Area 1, Pine Street and Oriole Trail relief storm sewer.

This option would provide positive drainage from the Pine Street depression through a storm sewer when the Lake is below its spillway and Cove Pond is below elevation 890.0. The efficiency of this option is improved by new culverts under North Shore Drive. This is because more capacity under North Shore Drive will lower Cove Pond water levels and reduce groundwater levels. Total construction cost is estimated at $132,000. Approximately 50 residences and 10 flooding complaint sites will benefit. Level of flood protection would be about the 10-year event depending on Lake levels.

If new culverts under North Shore Drive are not constructed, a stormwater pumping station near the Pine Street depression, could be implemented. This option relies on pumping instead of gravity discharge of

stormwater. It appears that land could be available to site a pumping station. The pump would function even when Cove Pond is above elevation 890.0. Pumping would provide additional drainage capacity even when the Lake and Cove Pond are high. The pump would add another $30,000 in construction cost for a total cost of $162,000.

6. Area 3, New gravity discharge (or pumping station) from the Snowberry Lane depression.

This option would be effective when the Lake is at or below its spillway. When the Lake is higher, as it was during August 2007, this option will not help without adding a pumping station. In essence this option provides some relief from chronic drainage issues by providing a minor and major drainage system to the Lake out of the Snowberry Lane depression. Approximately 50 residences and 6 flooding complaint sites will benefit from this option. The level of flood protection would be about the 5-year event. Total conceptual cost is estimated at $186,000.

Another option for relief could be obtained by adding a pumping station discharging to the Lake. This would also provide minor drainage capacity (about the 10-year event) for the depression even when the Lake is high. Although this option essentially pumps water in a circle, it would still provide relief because the depression can be pumped down faster than it can refill. Total conceptual construction cost would be $191,000.

7. Area 3, New drain tile from Floresta Lane to the Kishwaukee River

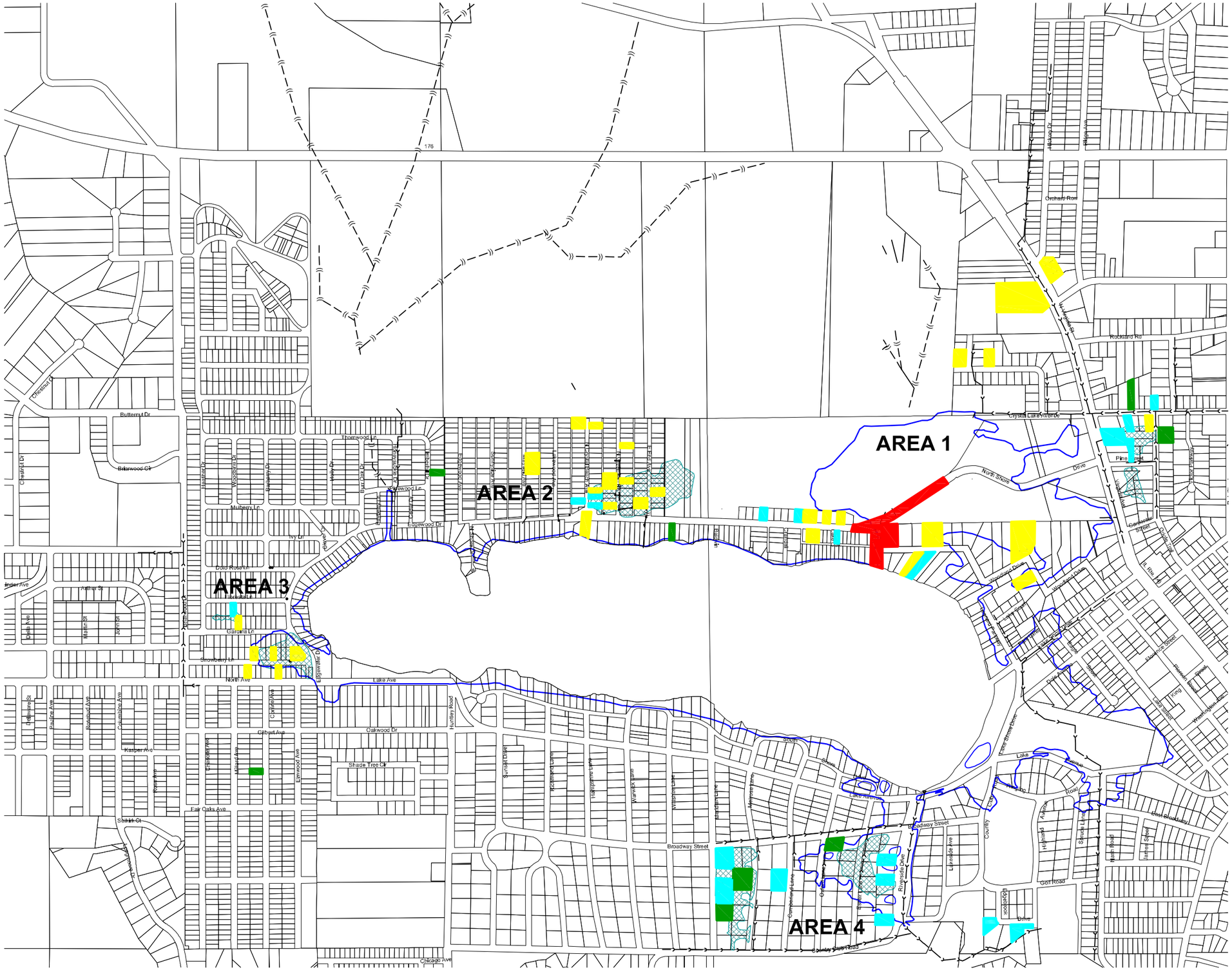
This option would build a new tile drain from the depression on Floresta Lane to the Kishwaukee River. The inlet to the tile would be set at the same elevation as the Lake spillway to minimize diversions to the Kishwaukee. This option would benefit about 10 residences and 2 flooding complaint sites. It would provide about a 10-year level of protection. Total conceptual construction cost is estimated at $123,000.

Table 1 Summary of Conceptual Construction Costs

Crystal Lake Flooding Analysis
Preliminary Cost Estimate for Selected Options
February 10, 2009

Flooding Area	Option	Description	Conceptual Cost [1]
Area 1	1	New Culverts Under North Shore Drive	$94,000
		New Open Channel From North Shore to Lake	$90,000
		New Culvert from Woodland Wetland to Lake	$32,000
		Total	**$216,000**
Area 1	1A	Re-route North Shore Drive	**$551,000**
Area 4	2	Analyze Flooding Solutions Below Lake	**$35,000**
Area 2	3	Replace Drainage along Greenfield and East End	$263,000
		New Lippold Tile	$104,000
		Divert CLPD Detention Outflow to Lippold Wetland	$63,000
		Total	**$430,000**
Area 1	4	Replace Field Tile for Hoyne	$104,000
Area 1	5	Relief Sewer for Pine Street and Oriole Trail	$132,000
		Add Pumping Station	$30,000
		Total	**$162,000**
Area 3	6	New Gravity Discharge from Snowberry to Lake	**$186,000**
		or Pumping Station from Snowberry to Lake	**$191,000**
Area 3	7	New Tile Drain to Kishwaukee from Floresta Lane	**$123,000**

[1] Construction Only


AREA 1
AREA 2
AREA 3
AREA 4
176
Orchard Row
Rockland Rd
Crystal Lake Avenue
North Shore Drive
Pine Street
Broadway Street
Lake Avenue
Shady Shore Road
Golf Road
Lake Shore Drive
Lake Ave
North Ave
Chicago Ave
Oakwood Dr
Shade Tree Cir
Fair Oaks Ave
Gilbert Ave
Thornwood Dr
Mulberry Ln
Edgewood Dr
Snowberry Ln
Briarwood Ct
Butternut Dr
Chestnut Dr
Inger Ave
Arthur St
Martin St
John St
Dole Ave
Pauline Ave
Roswood Ave
Columbine Ave
Kasper Ave
Ellsworth Ct
Sunset Drive
Huntley Road
Warwick Lane
Kensington Lane
Ashburn Lane
Melrose Lane
Hollywood Lane
Cumberland Lane
Greenwood Lane
Ridgewood Lane
Lakeside Ave
Hillcrest Ave
Nash Road
James Street
Elmwood Ave
Maple Ave
Clarence Street
Prospect Street
Washington Ave
Lincoln Ave
Jefferson Street
Crystal Lake Ave
Country Club Drive
Rolling Top Road
Arthur Street
Shore Drive
Lakeside Drive
Lakeshore Drive
Woodland Drive
Lawndale Street
Douglas Drive
Hickory Dr
Ridge Ave
Mulberry Ln
Ivy Ct
Woodland Dr
Beverly Dr
Helen Dr
Bay Oaks Dr
Hawthorn Dr
Woodstock Dr
Cherry Ln
Edgewood Dr
Edgewood Dr
Garcinia Ln
Elizabeth Ln
Cherry Knoll Dr
Cherry Knoll Dr
Edgewood Dr
Edgewood Dr
Edgewood