Agenda
Village of Glen Ellyn
Special Village Board & Park District Workshop
Tuesday, May 28, 2013
6:00 P.M.
Park District Lake Ellyn Boathouse

1. Call to Order

2. Roll Call – Village

3. Roll Call – Park District

4. Pledge of Allegiance

5. Lake Ellyn Study Review – Professional Engineer Bob Minix (6:00 p.m. – 6:45 p.m.)

6. Lake Ellyn / Channel Tour (6:45 p.m. – 7:45 p.m.)

7. Other Items?

8. Adjournment

MEMORANDUM

DATE: 5/20/13

TO: Mark Franz, Village Manager

FROM: Julius Hansen, Director of Public Works

RE: Joint Meeting with the Park District about Lake Ellyn

VILLAGE OF GLEN ELLYN 1834

1). Consultant Summary and Report:

RHMG is the consultant engineer that has been commissioned by the Village and the Park District to perform a drainage study incorporating Lake Ellyn (Lake Ellyn Hydrologic and Hydraulic Study). The findings of this study were reported to the Village Board on April 23, 2012 (original report) and January 21, 2013 (supplemental studies). The following is a brief summary of the actions recommended based on the report.

2). Measures Taken to Date:

These measures have been completed to reduce the frequency of Lake Ellyn from overflowing but are only a partial list of action that can be taken.

a). Decreasing the normal level of the lake by 6 inches on a permanent basis and proactively lowering the lake level even further in advance of a major storm event. These actions effectively increase the storage capacity of the lake. Twice in 2013 the proactive step has been taken by the Park District. This action takes place 24 hours or more prior to the onset of heavy rain based on available forecasts.

b). Removal of the restrictor plate that was in place to control the release rate out of Lake Ellyn. Based on the system operating parameters agreed to in the late 1980's, the plate reduced the flow out of the lake by decreasing the diameter of the outflow opening and limited the outflow rate to about 25 cubic feet per second. (1 cfs = 450 gallons per minute). This was removed to allow water to drain from the lake at a faster, but allowable, rate by using the full diameter of the outlet opening and increasing the rate of discharge to about 37 cfs.

c). Channel improvements were recently completed in 2012. The project involved removing trees and the installation of heavy duty block walls on both sides of the channel. The entire area was restored with native plantings and looked very attractive once completed. The main purpose of the channel is to convey water from the Lake to the pond between two homes without causing erosion during high flows.

3). Proposed Projects

Additional recommendations from the Lake Ellyn H&H study and other actions include:

a). An additional restriction in the outflow pipe can be removed once it is determined that this action is within the limits of the DuPage County Countywide Stormwater and Floodplain Ordinance and all Ordinance requirements are satisfied. This restriction in the Lake Ellyn outlet structure caused by a difference between the outlet opening (24-inch diameter) and the outlet pipe (33-inch diameter) and can be readily accomplished once the change is approved. This is the next step to be completed. The maximum allowable release rate by Ordinance is 61.4 CFS.

b). The outflow structure should be expanded to increase the ability of the lake water to enter into the outlet structure during the earlier portions of a storm. An additional 8 feet of weir length is recommended. By expanding the control structure the drainage of the lake is accelerated.

c). The outlet channel east of Riford Road was damaged during the April 2013 event. The repairs will be taking place as quickly as possible. Additional measures will be installed during these repairs to the channel that will prevent collateral damage from overland flows during a heavy event or the overtopping of the lake. The damage that overland flows outside the channel had on the channel itself were underestimated during the 2012 construction.

d). Construction of an inlet structure in Perry's Preserve to capture water and convey it to the channel in a controlled manner during heavy rain events and overtopping of the lake. Building a structure in Perry's Preserve would require permission from the Park District. This structure would be 12 foot square box that would be connected to a 42"inch diameter pipe that would tie into the existing headwall at the channel.

e). Re-grading side yards between 729 and 735 Riford Rd. requires a swale to be cut to drain water in a controlled manner from Riford Rd. to Perry's Pond. This location is an advantageous drainage point that would facilitate improved drainage of the area during heavy rain events and overtopping of the lake. Overland flow would follow the swale directly to the pond rather than going to the channel.

4). Future Options – Everything is Still on the Table

Management is working with the County and the Forest Preserve District to analyze Perry's Pond and determine how much additional capacity exists in the East Branch of the DuPage River due to the removal of the Crescent dam and other improvements recently made in this area. If river capacity is available and downstream parties agree, the flow rate from Lake Ellyn could be increased above the current prescribed maximum of 61.4 cfs. Given this significant change and in conjunction with other improvements, the likelihood of overflow events would be further reduced and consideration given to the desires of other Lake Ellyn area stakeholders.

Other recommendations in the report will be considered in conjunctions with these proposed plans. Those ideas stem for the initial report and include Buy-Out programs and flood proofing properties impacted by the overflow.

5). Questions/Answers

The consultant and Village and Park District staff will be in attendance to answer board member questions. In addition, an invitation to the May 28 joint workshop meeting has been extended to approximately 50 residences downstream of Lake Ellyn along the Lake, Grand, Riford and Chidester corridors that may be impacted or have an immediate interest in Lake Ellyn operations.

6). Walking Tour

Our goal is to provide a summary of the original study and supplemental study as well as conduct a short Q/A session with both Boards at the Park District Boat House. We hope to wrap that session up before 7pm. The walking tour of Lake Ellyn control structure, Perry's Preserve and Channel will like take another 45 minutes. We need to adjourn the meeting around 7:45 to get back to the Civic Center for the scheduled 8pm meeting.

5

I. INTRODUCTION

The Lake Ellyn Hydrologic and Hydraulic Study was issued in April of 2012. The report was presented at Village and Park District Board Meetings as well as during a special session with residents. There was intelligent discussion regarding the contents of the report and several questions were asked that were not included in the scope of the original study. As a result, the Village and Park District requested that additional investigations be performed relative to the following items:

1. Perform future condition modeling to project the impact of increases in the impervious area within the upstream tributary area to Lake Ellyn and the associated lake levels for the 100-year critical duration event.

2. Further investigate the feasibility of increasing the release rate from Lake Ellyn to the maximum allowable release rate per the DuPage Countywide Stormwater and Flood Plain Ordinance of 61.4 cubic feet per second (CFS), including discussions with the Village's Stormwater and Flood Plain Ordinance Administrator and limited hydraulic modeling of Perry's Pond.

3. Identify the optimum additional weir length/width to be incorporated into the modified outlet control structure.

4. Perform a conceptual design and cost estimate for augmenting the downstream overland flow capacity during overtopping events via a storm sewer and inlet structure from the Sam Perry Nature Preserve under Riford Road to the sideyard channel that drains to Perry's Pond.

5. Perform a topographic survey of the sideyards between 729 and 735 Riford Road and determine whether the side yard swale could be re-graded to be more hydraulically efficient.

6. Prepare an addendum to the April, 2012 "Hydrologic and Hydraulic Study for Lake Ellyn" report summarizing the findings of these additional engineering investigations

II. IMPERVIOUS COVERAGE SENSITIVITY

A. General

A previous report which investigated the sensitivity of impervious area increases was prepared as part of the updated Comprehensive Analysis of Stormwater Drainage in 2000. The condition that 50% of the houses within a given area increased their building footprint by 50% was analyzed in the report. The building footprint only accounts for approximately 37% of the total impervious area on a lot. If the building footprint is increased by 50%, then the impervious percentage for the lot increases by 30% and the total impervious coverage increases 18% (accounting for streets and sidewalks). Therefore, if the building footprint of all of the residences within the tributary area to Lake Ellyn increased by 50%, then the overall impervious coverage percentage would increase from 40% to 47.2%.

The model of Lake Ellyn and its tributary areas was run with several scenarios of differing impervious coverage. The existing coverage of the residential tributary areas is approximately 40%. Scenarios of 50%, 55% and 60% were modeled using the SWMM model created during the initial study. These scenarios represent extreme scenarios in the basin, including every house expanding the footprint by more than 50%. The model was run using the 100-year 48, 12 and 18 hour events, the three events that produce the highest rise in the water surface elevation of Lake Ellyn in the model, respectively (note that the 48 hour event overtops the dam under existing conditions).

B. Existing Lake Conditions

The model was run using the existing conditions discussed in the report, including the orifice with a restrictor plate, 3.25 foot weir and normal water level of 707.5 feet. The results are included in Table 8 below.

TABLE 8 – IMPACT OF FUTURE IMPERVIOUS COVERAGE INCREASES WITH NO CHANGES TO THE LAKE NWL OR OUTLET				
Event	**Peak Flow into Lake Ellyn (CFS)**	**Peak Water Surface Elevation**	**Peak Discharge from Lake Ellyn (CFS)**	**Time of Peak Discharge**
50% Impervious				
100 Year, 48 Hour	159	713.37	107.01 (84 CFS over dam)	44:39 (2nd day of event)
100 Year, 12 Hour	241	713. 20	57.21 (34 CFS over dam)	09:15
100 Year, 18 hour	196	713.17	50.60 (27 CFS over dam)	14:48

If the impervious coverage in the residential areas is increased to 50%, then the 12, 18, and 48 hour events all overtop the dam under existing conditions with a peak flow over the dam of 84 CFS at the 48 hour event. Under current impervious limits, the dam is overtopped under the 48-hour critical duration analysis.

C. Proposed Lake Conditions per April 2012 Report

The model was run using the proposed conditions recommended in the April, 2012 report, including an additional 6-foot weir length, the existing 24-inch diameter orifice with no restrictor plate and a normal water level in Lake Ellyn of 707.0 feet. The results are presented in Table 9 below.

TABLE 9 – IMPACT OF FUTURE IMPERVIOUS COVERAGE INCREASES WITH RECOMMENDED CHANGES TO LAKE NWL AND OUTLET PER APRIL, 2012 REPORT

Event	Peak Flow into Lake Ellyn	Peak Water Surface Elevation	Peak Discharge from Lake Ellyn	Time of Peak Discharge
50% Impervious				
100 Year, 48 Hour	159	713.25	82.24 (44 CFS over dam)	48:06 (3rd day of event)
100 Year, 12 Hour	241	712.82	36.61	11:03
100 Year, 18 hour	196	712.59	36.23	16:39
55% Impervious				
100 Year, 48 Hour	170	713.28	94.67 (56 CFS over dam)	47:57 (2nd day of event)
100 Year, 12 Hour	255	713.05	43.18 (5 CFS over dam)	10:54
100 Year, 18 hour	207	712.88	36.72	18:18

If the impervious coverage in the residential areas is increased to 50%, then the 48 hour event causes overtopping of the dam with a peak flow over the dam of 44 CFS. Under 55 percent impervious conditions, the 48 and 12 hour events overtop the dam, with a peak flow over the dam of 56 CFS.

D. Proposed Lake Conditions with Maximum Release Rate

The model was run using the maximum allowable release rate of 61.4 CFS (0.10 CFS/acre) based on the DuPage County Countywide Stormwater and Floodplain Ordinance, an additional weir length of 8 feet and a normal water level of 707.0 feet in Lake Ellyn. The results are given in Table 10 below.

TABLE 10 – IMPACT OF FUTURE IMPERVIOUS COVERAGE INCREASES WITH MAXIMUM LAKE RELEASE RATE				
Event	**Peak Flow into Lake Ellyn**	**Peak Water Surface Elevation**	**Peak Discharge from Lake Ellyn**	**Time of Peak Discharge**
50% Impervious Coverage				
100 Year, 48 Hour	159	712.34	59.4	48:24 (3rd day of event)
100 Year, 12 Hour	241	712.05	58.53	9:12
100 Year, 18 hour	196	711.52	56.34	14:30
55% Impervious Coverage				
100 Year, 48 Hour	170	712.73	60.55	48:24 (3rd day of event)
100 Year, 12 Hour	255	712.33	59.38	09:18
100 Year, 18 hour	207	711.81	57.82	14:36
60% Impervious Coverage				
100 Year, 48 Hour	179	713.08	71.46 (	48:21 (3rd day of event)
100 Year, 12 Hour	269	712.61	60.19	09:21
100 Year, 18 hour	218	712.10	58.69	14:42

There is no overtopping observed under the 50% and 55% impervious coverage conditions for any event. Overtopping is observed during the 48-hour event with an impervious coverage of 60%, with the maximum flow over the dam of 45 CFS.

E. Zoning Considerations

The majority of the residences in the area tributary to Lake Ellyn are in the R-2 zoning district (lots that are greater than 8,700 square feet). There are limits on impervious coverage on individual lots, however, there is not a discrete limit. Instead, the impervious coverage is a function of the area of the front and rear yards and the size of the house on the lot. Consequently, establishing a standard maximum impervious coverage for the basin is not feasible. Based on the model results, the impervious coverage should not be permitted to exceed 55%. The Village could further investigate upper limits of impervious coverage based on the current zoning classifications to determine if impervious coverages on individual lots can reach or exceed 55% coverage. As previously noted, if all of the lots tributary to the Lake Ellyn increase their footprint by 50%, then the impervious coverage would increase to 47.2%, significantly less than the recommended 55% coverage and the 60% coverage condition that causes overtopping of Lake Ellyn under the maximum lake discharge. Realistically, it is not expected that the entire residential tributary area to Lake Ellyn would reach an aggregate 55% impervious coverage.

III. INCREASING THE PEAK DISCHARGE RATE FROM LAKE ELLYN

Representatives from RHMG and the Village of Glen Ellyn's Public Works Department met with the Village's Stormwater and Flood Plain Ordinance Administrator to discuss the potential to increase the peak discharge from Lake Ellyn. The Stormwater and Flood Plain Ordinance Administrator was amenable to increasing the discharge, but wanted to confirm that the discharges to Perry's Pond would not exceed historyical peak discharges.

Events that cause the highest water surface elevation in Perry's Pond under existing conditions are low frequency, high-intensity events that cause over topping of Lake Ellyn and result in a discharge several magnitudes greater than the expected 28 CFS capacity of the existing outlet control structure. Increasing the discharge by a factor of 2.19 to 61.4 CFS results in discharges from the lake that are smaller in magnitude than the flows that occur during an overtopping event.

Several events were modeled to quantify the water surface increase. A node representing Perry's Pond was added to the model. A simplified Perry's Pond storage curve was assumed (footprint of the lake measured from aerial photographs, vertical side slopes) and the outlet was modeled as a broad crested weir at an elevation of 690.20 feet. The modeling did not account for the sag in the weir at an elevation of

689.90 feet. The assumptions for both the storage and discharge curves for Perry's Pond are conservative in that they result in a higher normal water level and a lower discharge rate.

The 100 year, 48-hour; July 23, 2010; 5-year, 24-hour; and 2-Year 24-hour events were routed through the model under existing conditions (28 CFS) and the proposed 61.4-CFS outlet with modified weir condition. The results are shown below in Table 11 below.

TABLE 11 – DISCHARGES INTO PERRY'S POND

Condition	Peak WSEL*	Peak Inflow (CFS)	Peak Outflow (CFS)
100 year, 48 hour Event			
Existing Conditions	692.55	87	86
Proposed Conditions	692.32	79	66
July 23, 2010 Event			
Existing Conditions	693.57	208	202
Proposed Conditions	692.60	96	92
5 year, 24 hour Event			
Existing Conditions	691.80	27	26
Proposed Conditions	692.13	50	50
2-Year, 24 hour Event			
Existing Conditions	691.84	30	28
Proposed Conditions	692.18	54	54

* Water Surface Elevation

There is an increase in the peak water surface elevation of Perry's Pond due to the increased capacity of the Lake Ellyn outlet control structure. However, the peak WSEL observed under existing conditions (693.57 feet) is not reached during any of the modeled events under the proposed conditions. For most events, the peak water surface elevation in Perry's pond will be higher, but the water surface will be reduced to the normal water level quicker due to Lake Ellyn draining faster.

Prior to 1991, the discharge configuration of Lake Ellyn was not restricted. The peak discharge from the lake was controlled by the capacity of the two storm sewer pipes that discharge into Perry's Pond via the channel between 717 and 725 Riford Road. Under the proposed configuration with a peak discharge of 61.4 CFS, the outlet of the lake will still be restricted, and the capacity of the storm sewer discharging into the pond will not be increased.

IV. ADDITIONAL OUTLET CONTROL STRUCTURE WEIR LENGTH

Increasing the weir length (width) in the outlet control structure will cause the discharge from Lake Ellyn to be outlet controlled at a lower elevation, thereby increasing the effective storage of the lake. Several weir lengths and outlet configurations were modeled and analyzed. There are several factors that need to be considered in the design of the new outlet, including rate of discharge, location relative to the existing features of the lake and protection from floating debris.

An additional weir length of 8 feet in conjunction with the existing 3.25 foot weir would lower the elevation at which the Lake Ellyn outlet control structure is orifice controlled. If the orifice is modified to produce a peak discharge of 61.4 CFS, then the lake outflow will be orifice controlled at an elevation of 708.5 feet, 1.5 feet above the normal water level of 707.0 feet. The existing weir and unmodified outlet control structure transitions to orifice control at 709.5 feet, 2.0 feet above the normal water level of 707.5 feet. If the additional weir length is not constructed, then the outlet would transition to orifice control at an elevation of 711.8 feet.

There are several potential configurations for the new outlet. Construction of a box structure that would convey flow via weirs on all sides would reduce the total footprint of the structure. Additionally, a submerged weir system similar to the inlet structures for the lake would prevent debris from flowing downstream and fouling trash grates.

The additional weir length and increased orifice size were modeled to determine the effect on the downstream storm sewer. The 5-year 1 hour and 5-year 24 hour events were modeled to determine the effect of the OCS modifications on the peak discharges downstream. The results, along with the peak discharges associated with existing conditions, are compared in Exhibits N and O. For both conditions, the peak discharges are increased primarily as a result of the increased capacity of the outlet. For the 5-year, 24-hour event, the peak discharge into Perry's Preserve increased from 27 CFS, to 50 CFS. For the 5-year, 1 hour event the peak discharge increases from 80 CFS to 82 CFS. The minimal increase is due to the timing of the peak discharge in the downstream storm sewer system with respect to the timing of the peak discharge from Lake Ellyn.

Downstream Storm Sewer - 5 Year, 1 Hour Event - Existing Conditions Compared to Proposed Maximum Discharge Rate

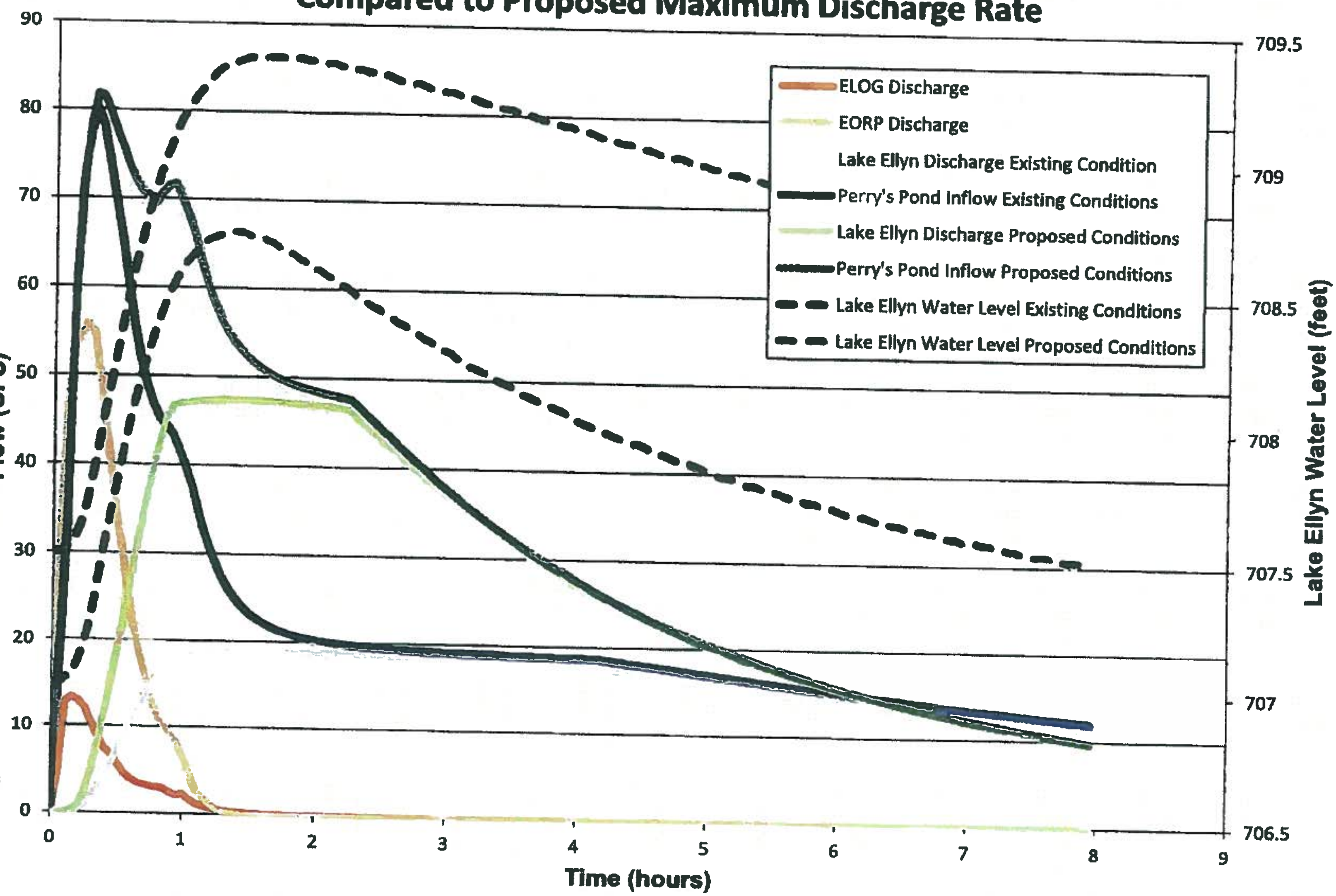
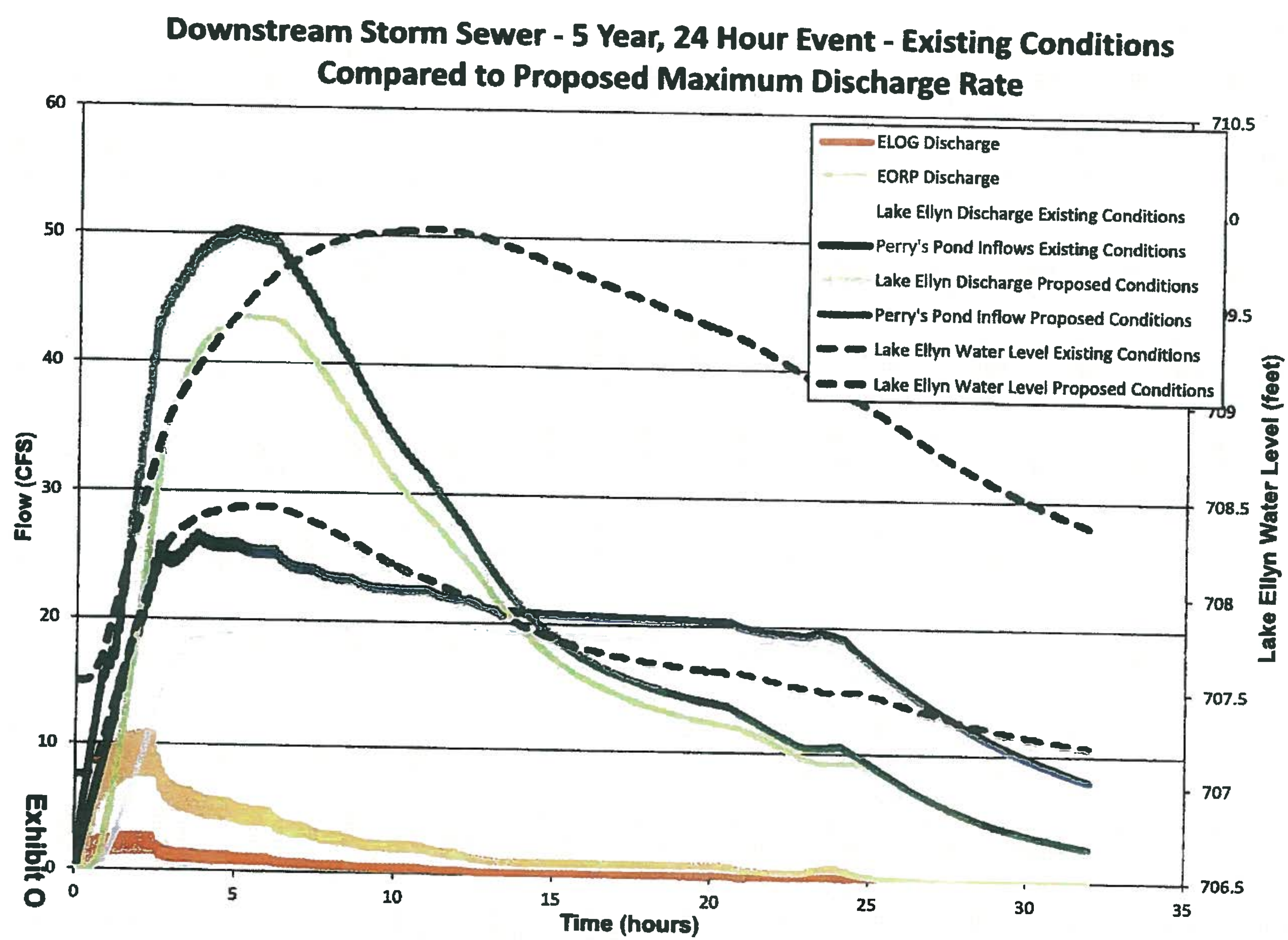


Exhibit N



Downstream Storm Sewer - 5 Year, 24 Hour Event - Existing Conditions
Compared to Proposed Maximum Discharge Rate
Flow (CFS)
Lake Ellyn Water Level (feet)
Time (hours)
ELOG Discharge
EORP Discharge
Lake Ellyn Discharge Existing Conditions
Perry's Pond Inflows Existing Conditions
Lake Ellyn Discharge Proposed Conditions
Perry's Pond Inflow Proposed Conditions
Lake Ellyn Water Level Existing Conditions
Lake Ellyn Water Level Proposed Conditions
0
10
20
30
40
50
60
5
15
25
35
706.5
707
707.5
708
708.5
709
9.5
710.5

Exhibit O

V. PROPOSED STORM SEWER

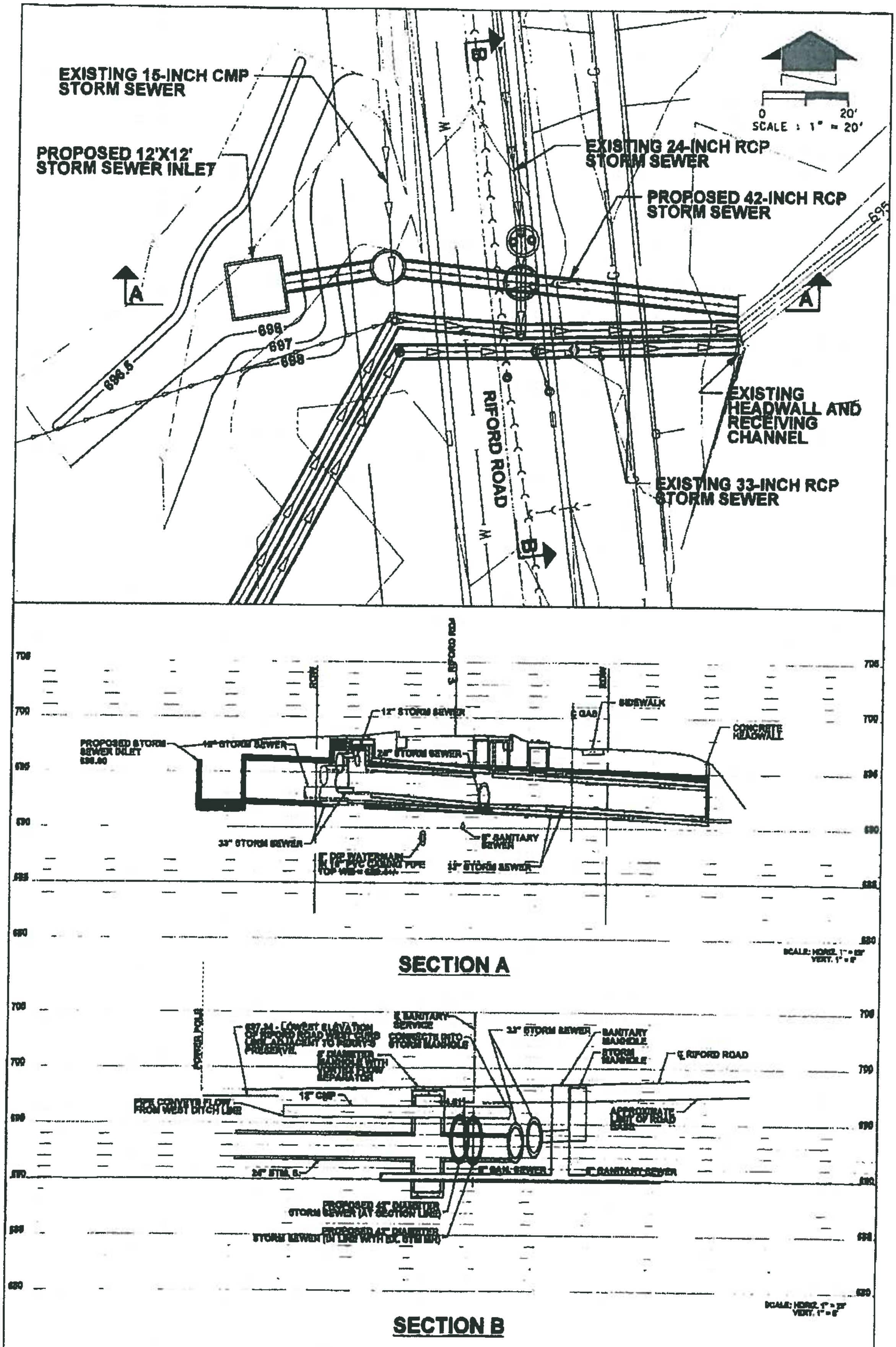
The potential to install a storm sewer connecting the Joseph "Sam" Perry Preserve area bounded by Oak Street, Grand Avenue and Riford Road to the sideyard channel that drains to Perry's Pond was also evaluated. The preserve is along the natural overland flow path that stormwater follows during overtopping events of the Lake Ellyn dam. Installation of the pipe connecting Perry's Preserve and Perry's Pond would reduce the amount of flow conveyed overland via the sideyard swale between 729 and 735 Riford. A brief discussion on the proposed location, size and design of the pipe is given below.

A concrete pipe interconnecting Perry's Preserve and Perry's Pond can be installed across Riford Road north of the existing 33-inch dual storm sewer crossing. The storm sewer would receive high flows from Perry's Preserve as well as from two storm sewers that convey flow from the north along Riford Road. The two storm sewers are a 24-inch reinforced concrete pipe (RCP) storm sewer that flows from north to south along the centerline of Riford Road and a 15-inch corrugated metal pipe (CMP) along the west ditch of Riford Road that conveys flow from the ditch within Perry's Preserve. In order to avoid increasing peak flows to Perry's Pond, a control structure would be installed at the upstream end of the storm sewer to prevent stormwater from low intensity, low duration (frequent) rain events from being conveyed to Perry's Pond. The inlet structure would be a 12-foot by 12-foot box structure with a rim elevation of 696.00.

A berm with a crest length of 100 feet and an elevation of 696.5 feet will be constructed upstream of the box structure to provide additional storage in the preserve and minimize the instances of the storm sewer conveying flow. The berm will allow for ponding water within the preserve, maintaining and preserving the existing wetland characteristics. See Exhibit P for a plan, profile and cross section view of the crossing. Additionally, a cost estimate is included as Exhibit Q.

There are several potential utility conflicts that would need to be evaluated during the design phase. There is potential for a conflict with the existing watermain along the west side of Riford Road. The watermain was installed below the existing storm sewers and within a casing pipe in 2010. Installation of the new 42-inch storm sewer could require additional lowering of the watermain in order to maintain the required vertical separation distance. Additionally, a sanitary sewer service and the gas main along the east side of Riford may need to be relocated. Finally, the headwall will need to need to be expanded to accommodate the additional 42-inch pipe.

The capacity of the proposed storm sewer and inlet structure is 86 CFS at a headwater elevation of 697.4 feet. The sag point of Riford Road is approximately 697.4 feet and is located approximately 165 feet north of the existing storm sewer crossing. During events that cause overtopping of the Lake Ellyn dam, stormwater is conveyed over the low point and through the sideyards of 735 and 729 Riford. The additional storm sewer will convey up to 86 CFS prior to the overtopping of the road. In modeling



RHMG

REZEK, HENRY, MEISENHEIMER, AND GENDE, INC.

EXHIBIT P - RELIEF STORM SEWER RIFORD ROAD CROSSING

DATE: 9/17/2012

PROJ#: 21222001

EXHIBIT Q

ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

VILLAGE OF GLEN ELLYN - LAKE ELLYN H&H STUDY

RIFORD ROAD RELIEF SEWER

September 20, 2012

Item No.	Description	Quantity	Unit	Unit Price	Total
1	42-Inch Diameter Storm Sewer	106	LF	$ 150.00	$ 15,900
2	7-Foot Diameter Manhole	2	EA	$ 7,500.00	$ 15,000
3	12-Foot x 12-Foot Box	1	EA	$ 18,000.00	$ 18,000
4	Sanitary Service Relocation	1	EA	$ 2,500.00	$ 2,500
5	Headwall Expansion	1	LS	$ 12,000.00	$ 12,000
6	Sidewalk Remove and Replace	60	SF	$ 7.00	$ 420
7	Curb and Gutter Remove and Replace	24	LF	$ 40.00	$ 960
8	Pavement Patching -- 6-Inch Section	40	SY	$ 65.00	$ 2,600
9	Trench Backfill	30	LF	$ 40.00	$ 1,200
10	Watermain Encasement/Adjustment	1	LS	$ 5,000.00	$ 5,000
11	Limited Clearing and Site Grading within Perry's Preserve	1	LS	$ 8,000.00	$ 8,000
12	Soil Erosion and Sediment Control	1	LS	$ 2,500.00	$ 2,500
13	Site Restoration	1	LS	$ 3,000.00	$ 3,000
14	Traffic Control	1	LS	$ 14,000.00	$ 14,000
	Subtotal				**$ 101,080**
	15% Contingency				**$ 15,162**
	15% Engineering				**$ 15,162**
	Total				**$ 131,404**

of Lake Ellyn, the peak flow observed entering Perry's Preserve during the 2010 event is 151 CFS and the peak flow exiting the preserve and overtopping Riford Road is 145 CFS. The flows include overland flow from the Oak Street Basin and surrounding areas. There is not sufficient capacity in the proposed 42-inch storm sewer to convey all overtopped flow; however, the amount of stormwater required to be conveyed overland is reduced by more than 50% when examining the July 2010 event. The remainder of the flow not conveyed by the proposed storm sewer is conveyed through the sideyard swale and peak water surface elevation in the model is 697.70 feet, below the window well at 729 Riford but above the garage floors are 729 and 735 Riford.

VI. MODIFICATIONS TO THE SIDEYARD SWALE BETWEEN 729 AND 735 RIFORD

It can be observed from visual inspection of the sideyard swale that there is not a uniform grade from the back of curb along Riford Road to the rear yards. Videos of the July 23, 2010 overtopping event published on Youtube.com that show the sideyard swale were also examined as part of this analysis. In watching the videos, it appears there is highpoint and constriction between the existing garages at 729 and 735 Riford that reduces the conveyance of the sideyard swale. There may be potential for increasing the conveyance by regrading the swale. There are several critical elevations along the sideyard – the window well (698.02 feet) and finished garage floor (697.42 feet) at 729 Riford and the finished garage floor (697.49 feet) at 735 Riford. The objective is to lower the water surface to an elevation below these critical elevations. The July 23, 2010 event was used as the reference point for the investigation.

RHMG performed a survey from the sideyard between 729 and 735 Riford to Perry's Pond in the rear of 725 and 729 Riford. A base map was prepared using the survey data, contours were generated and the sideyard swale was modeled using the United States Army Corps of Engineers' HEC-RAS hydraulic model. There is no available flow data for the July 23, 2010 event, but the flow overtopped the window well at 729 Riford per anecdotal evidence. The window well was surveyed and the rim is at an elevation of 698.02 feet, and therefore the stormwater reached at least that elevation. The peak flow observed overtopping the dam in the SWMM model for the

July 23, 2010 event is approximately 145 CFS. The peak model-generated flow through the sideyard swale is 145 CFS, including overland flows from the Oak Street Basin and the surrounding areas directly tributary to the sideyard and Perry's Preserve. The HEC-RAS model was run with this flow input and the observed water surface elevation at the upstream end of the swale is 698.48, higher than the lip of the window well. Due to lack of calibration data, it is difficult to accurately quantify the flow through the sideyard swale. However, the relative reduction in water surface elevation as a result of the proposed swale modifications can be determined.

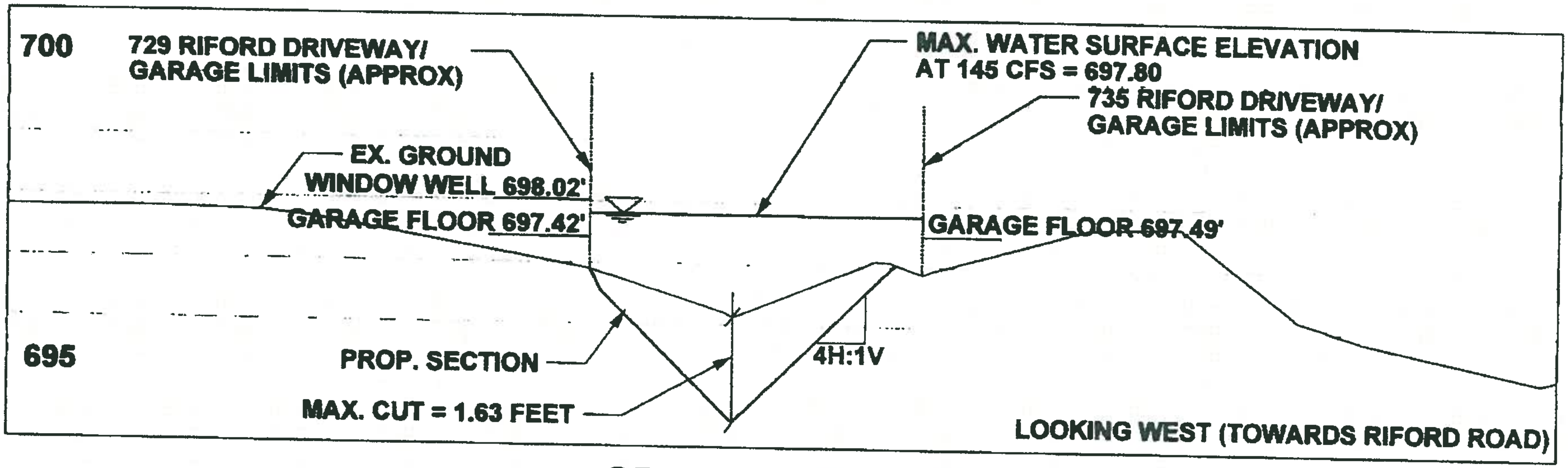
There were several proposed scenarios modeled in HEC-RAS, two of which are discussed in detail below. The proposed typical cross sections and profiles for the sideyard swale are included in Exhibits R and Exhibit S. Additionally, a cost estimate is provided in Exhibit T.

1. **V-Ditch from the front yard inlet to the rear yard** – A proposed ditch straight-graded from the front yard to the rear yard was modeled. The grading starts approximately 8 feet east of the beehive inlet in the front yard and removes all high points from the front to rear side yard. The ditch is at a slope of 0.87%, less than the preferred minimum slope of 2% for vegetated ditches. The maximum cut from existing grade to the proposed invert is 1.63 feet. It is not possible to match existing grade at a 4:1 side slope at the north garage face of 729 Riford (2:1 slope for approximately 2.5 feet). Regrading the swale at this slope would

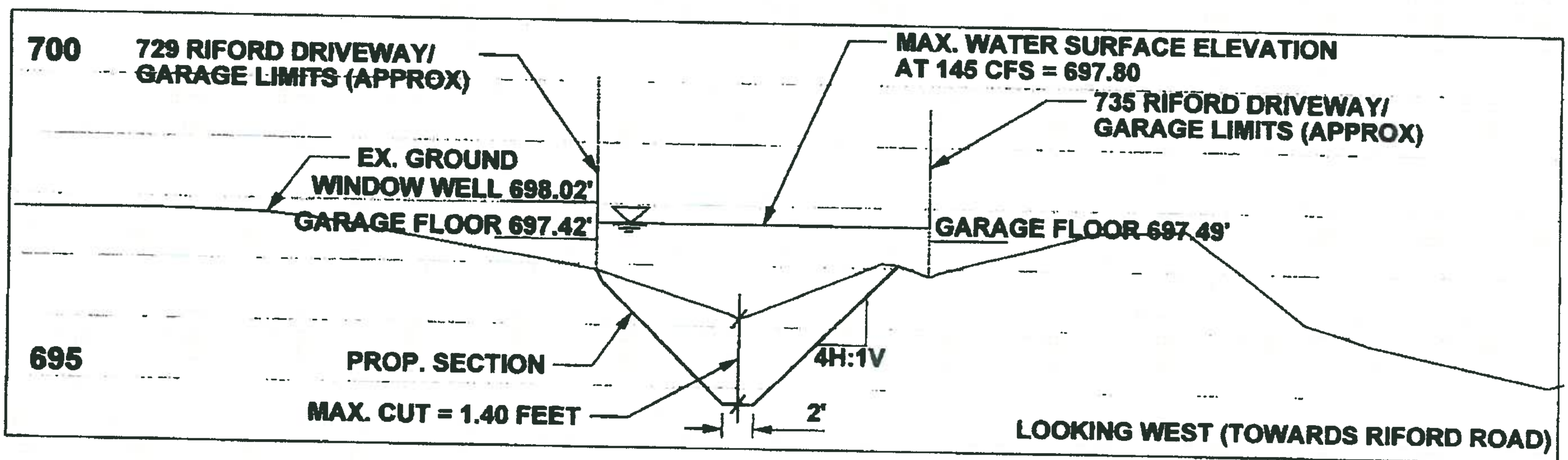
decrease the water surface elevation for a flow of 145 CFS to 697.80 feet, a reduction of 0.68 feet from the existing conditions.

2. **Trapezoidal Ditch from the front yard inlet to the rear yard** – A proposed 2-foot wide flat bottomed, 4:1 side sloped trapezoidal ditch was modeled. The grading starts 18 feet east of the beehive inlet in the front yard. The local low point at the beehive is preserved with this grading option, as is a local highpoint east of the inlet. The length of grading is shorter and the slope of the swale is steeper due to a higher upstream elevation (at the local highpoint). The ditch is at a slope of 1.33%, which is still less than the preferred minimum slope of 2% for vegetated ditches. The maximum cut from existing grade to the proposed invert is 1.40 feet. It is not possible to match existing grade at a 4:1 side slope at the west garage face of 729 Riford and a small retaining wall will be required. Regrading the swale to this slope and cross section would increase conveyance and decrease the water surface elevation for a flow of 145 CFS to 697.69 feet at the upstream end, 0.79 feet lower than the existing conditions.

Option 2 provides a larger reduction in water surface elevation. If Option 2 were in place during the July, 2010 event, the water surface elevation would still be above the garage floor but below the top of the window well. Installation of Option 2 will not prevent all instances of overtopping a window well or flow into a garage, but will reduce the potential for damage as well as reducing the duration and severity of the events.



OPTION 1 - V-DITCH



OPTION 2 - TRAPEZOIDAL DITCH

RHMG
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EXHIBIT R - TYPICAL CROSS SECTIONS FOR SIDEYARD SWALE REGRADING

DATE: 09/17/2012

PROJ#: 21220001

NAT/PROJECTS/20420000-WONDERLAKE/7-11-06/FIGURE 4.DGN

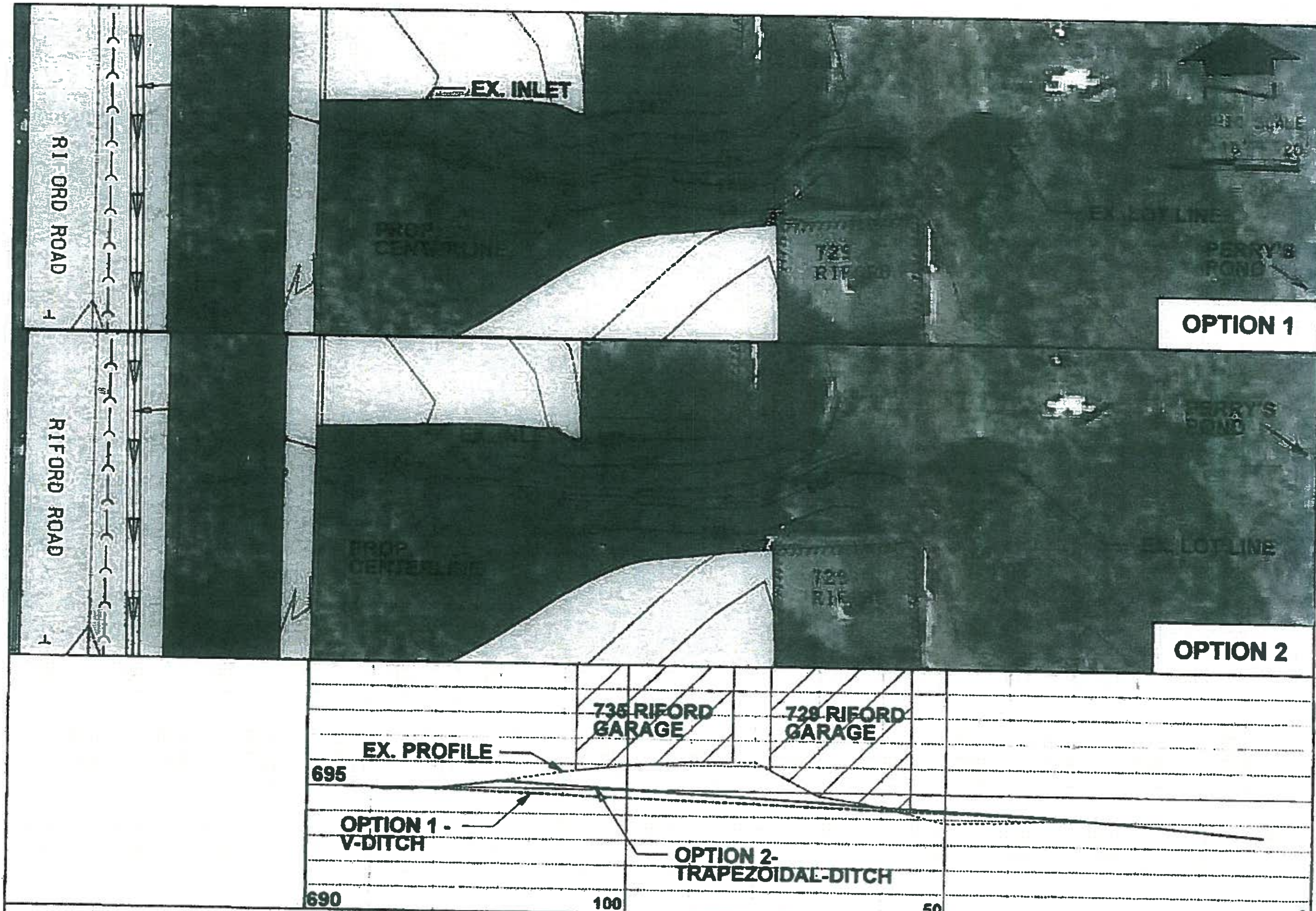

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EXHIBIT S - EXISTING AND PROPOSED SIDEYARD PROFILES

DATE: 9/28/2012

PROJ#: 21220001

NAT/PROJECTS/20420030-WONDERLAKE/7-11-08/FIGURE 4.DGN

EXHIBIT T

ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

VILLAGE OF GLEN ELLYN - LAKE ELLYN H&H STUDY

729 AND 735 RIFORD ROAD SIDEYARD GRADING

September 20, 2012

Item No.	Description	Quantity	Unit	Unit Price	Total
1	Grading Sideyard Ditch	1	LS	$ 10,000.00	$ 10,000
2	Soil Erosion and Sediment Control	1	LS	$ 1,000.00	$ 1,000
3	Restoration	1	LS	$ 5,000.00	$ 5,000
	Subtotal				**$ 16,000**
	15% Contingency				**$ 2,400**
	15% Engineering				**$ 2,400**
	Total				**$ 20,800**

Another consideration of the proposed regrading is the effect on velocity. It is desirable to reduce the velocity of the flow in order to reduce the potential for scour along the channel and general safety. Velocity of flow increases as the area of flow decreases. The constriction in the sideyard swale between the two garages increases velocity through the sideyard swale, as observed in video of a previous overtopping event. The proposed solutions reduce the peak velocity at the downstream end of the swale from 12 feet per second to 10.8 and 10.5 feet per second for Options 1 and 2, respectively. Additionally, the average velocity downstream of the two garages decreases from 11.1 for the existing condition to 10.1 and 8.2 feet per second for Options 1 and 2, respectively.

VII. SIDEYARD REGRADING AND PROPOSED STORM SEWER

The two proposed solutions were also examined in aggregate to determine the effect on the downstream properties during the 2010 event. The proposed storm sewer under Riford Road was included in the SWMM model to determine the flow split between overland flow over Riford Road and the proposed storm sewer. The peak flow conveyed via the storm sewer is 84.8 CFS and the peak flow overtopping Riford Road is 55.3 CFS at 6:09 a.m., according to the model results. The peak water surface elevation in Perry's preserve is 698.0 feet.

The sideyard swale regraded to the recommended Option 2 would convey the 55.3 CFS without overtopping existing window wells or seeping into a garage with a water surface elevation of 696.82 feet.

VII. CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations of this additional study are as follows:

1. Increasing the building footprint of all of the houses in the tributary area to Lake Ellyn will result in an aggregate impervious area increase of 7.2% to approximately 47.2%.

2. Under existing lake conditions, Lake Ellyn would overtop the dam if the impervious area increased to 50%. Under the recommended conditions in the April, 2012 report, the lake would overtop if the impervious area increased to 50%. If the outlet is modified to produce the maximum permitted discharge per the DuPage Countywide Stormwater and Flood Plain Ordinance, then the lake would overtop if the impervious area increased to 60%.

3. It is recommended that the total impervious coverage ratio not be permitted exceed 55% for the residential portions of the area tributary to Lake Ellyn. Realistically, it is not expected that the upstream area will be developed to that coverage in the future.

4. As a result of discussions with the Village's Stormwater and Flood Plain Administrator and examination of previous conditions, it is recommended that the peak discharge rate from Lake Ellyn be increased to the maximum allowable rate

of 61.4 CFS. If this recommendation is implemented, it is also recommended that the outlet control structure for Lake Ellyn be modified to incorporate an additional 8 feet of weir length.

5. Installation of a 42-inch storm sewer under Riford Road adjacent to the existing 33-inch storm sewer crossing under Riford appears to be feasible. The new storm sewer could not contain all flow from Lake Ellyn overtopping events, but would reduce the amount of flow discharged over Riford Road and through the sideyards of 729 and 735 Riford. The estimated cost for this work, including 15% contingency and engineering, is approximately $132,000.

6. The sideyard between 729 and 735 Riford can be regraded to a trapezoidal cross section at a slope of 1.33% to be more hydraulically efficient. The estimated cost for this work, including 15% contingency and engineering, is approximately $21,000.

7. Installation of both the 42-inch storm sewer and regrading of the swale will reduce the potential for property damage during future overflow events. These improvements would have prevented property damage during the July 23, 2010 event.

5

HYDROLOGIC AND HYDRAULIC STUDY

FOR

LAKE ELLYN

PREPARED FOR

VILLAGE OF GLEN ELLYN

AND

GLEN ELLYN PARK DISTRICT

PREPARED BY

REZEK, HENRY, MEISENHEIMER AND GENDE, INC.
CONSULTING ENGINEERS
975 CAMPUS DRIVE, MUNDELEIN, IL 60060
535 TOLLGATE ROAD, SUITE F., ELGIN, IL 60123

APRIL, 2012

Rezek, Henry, Meisenheimer and Gende, Inc.

CONSULTING ENGINEERS

April 17, 2012

Mr. Robert J. Minix, P.E.
Professional Engineer
Village of Glen Ellyn
30 South Lambert Road
Glen Ellyn, IL 60137

Re: Lake Ellyn Hydrologic and Hydraulic Studies
Project No. 21220000

Dear Mr. Minix:

In accordance with our engineering agreement, we are pleased to submit the enclosed Lake Ellyn Hydrologic and Hydraulic Studies Report.

This report assesses the impact of improvements and changes within the Lake Ellyn tributary drainage area and provides recommendations for minimizing the frequency and impacts of future overtopping of the Lake Ellyn dam.

We appreciate this opportunity to be of service; and we gratefully acknowledge the assistance provided by you and your staff, as well as the Glen Ellyn Park District staff in the preparation of this report.

Sincerely yours,

REZEK, HENRY, MEISENHEIMER AND GENDE, INC.

William R. Rickert, P.E., BCEE, CFM
President

Benjamin W. Metzler, P.E., CFM
Project Engineer

WRR/amd

Enclosure

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I. EXECUTIVE SUMMARY

A. Background

Lake Ellyn is a manmade lake that is an important asset of the Glen Ellyn Park District. The lake is utilized by residents for a multitude of year-round recreational activities, but it also functions as a regional stormwater detention facility for a significant portion of the Village of Glen Ellyn.

Within the past 11 years there have been three significant rainfall events that resulted in the overtopping of the Lake Ellyn dam and the flooding of properties within and along the downstream overland flow route. The most recent and significant overflow event occurred on July 23 - 24, 2010. As a result of these overflow events, the Village of Glen Ellyn and the Glen Ellyn Park District retained RHMG Engineers, Inc. to undertake hydrologic and hydraulic studies of the lake to assess current conditions and make recommendations to minimize the frequency and impacts of future lake overflows.

B. Purpose and Scope

The specific scope of the Lake Ellyn Hydrologic and Hydraulic Study includes:

1. Perform a hydrologic and hydraulic analysis of the Lake Ellyn tributary area utilizing the USEPA's SWMM computer model in order to assess the impact of improvements and changes within the drainage area on stormwater flows into Lake Ellyn.

2. Evaluate the stormwater detention capabilities of Lake Ellyn and answer the following critical questions.

    a. What is the optimal normal water level of the lake?

    b. What is the appropriate release rate for the lake?

    c. Is the lake outlet system operating correctly?

    d. Is it possible to increase the capacity of the lake?

3. Analyze the downstream overland flow route and evaluate alternatives to better protect homes that are along the route during extreme storm events which result in overflow of the lake's emergency spillway.

4. Update the Lake Ellyn Dam Operation and Maintenance Manual that was originally prepared in 1991 and amended in 2010.

C. Summary

Other than the planned diversion of a portion of the Maple Basin, the tributary area to Lake Ellyn has not increased significantly since last analyzed in 1991. The current modeling shows that the peak inflow rate to Lake Ellyn for the 100-year, 6-hour event increased approximately 14%. However, there is adequate capacity in Lake Ellyn to detain stormwater flows from all 100-year events except the 48-hour duration event. Furthermore, there are modifications to the existing lake components that can be easily implemented to increase the storage capacity of the lake and the ability to store all flows from the 100-year, 48-hour event. In addition, if desired, improvements can be made downstream of the dam to improve conveyance capacity and reduce the potential for property damage. Areas along the overland flow route may be able to be regraded to provide more capacity for flows resulting from the overtopping of Lake Ellyn. If necessary, floodproofing initiatives can be pursued as well. Finally the recommended modifications will not result in any negative impacts on the downstream storm sewer system or on Perry's Pond.

D. Conclusions and Recommendations

Conclusions and recommendations of this study are as follows:

1. The total area tributary to Lake Ellyn as delineated in this study is 614 acres. This represents a 9% increase from the area delineated in the 1979 "Comprehensive Analysis of Stormwater Drainage System". The increase is attributable to basin boundary adjustments resulting from updated contour information.

2. The maximum storage volume available in Lake Ellyn at the high water level of elevation 713 is 70.9 acre-feet. This is approximately 27% greater than the value reported by Harza Engineering in 1991.

3. It is recommended that the normal water level in Lake Ellyn be lowered by 6-inches to 707.0 feet to provide an additional 4.5 acre-feet of storage capacity. This can easily be accomplished by lowering the adjustable weir

in the outlet control structure. The lowered normal water level will still be within the limits of previously installed streambank stabilization measures. However, during site visits, it was observed that there are areas of the shoreline where rock or vegetative stabilization measures are in need of maintenance.

4. The modeling performed as part of this study determined that the peak inflow rates to Lake Ellyn for both the 5-year and 100-year frequency events increased approximately 14% from those calculated in the 1990 and 1991 studies. These increases are attributable to the increased tributary area, increases in impervious area, and drainage system improvements.

5. Future increases in the peak inflow rates to Lake Ellyn are expected to be minimal for the following reasons:

   a. No increases in storm sewer conveyance capacity are planned as all major storm sewer improvement projects have been completed within the last 20 years.

   b. Increases in impervious area, such as from tear-downs, are limited by the Village Zoning Code. Furthermore, a sensitivity analysis demonstrated that even if half of the homes increased their building footprint by 50%, the corresponding increase in runoff volume would be approximately 3 percent.

6. A critical duration analysis has determined that there is adequate capacity in Lake Ellyn to detain stormwater flows from all 100-year events except the 48-hour duration event.

7. The outlet restrictor as installed in 1991 was intended to limit the maximum release rate to 28 cubic feet per second (cfs). Testing performed as part of this study determined that the actual maximum release rate is 22.7 cfs.

8. The release rate from Lake Ellyn is currently governed by Section 15-114.2 of the DuPage Countywide Stormwater and Flood Plain Ordinance, which has been adopted by the Village of Glen Ellyn. This limits the release rate to 0.10 cfs/acre. Therefore, based on the current tributary area of 614 acres, the maximum allowable release rate is 61.4 cfs.

9. It is recommended that the restrictor plate on the outlet control structure orifice be removed to increase the discharge rate to a peak rate of 37 cfs. This will result in a peak discharge of 0.06 cfs/acre, which is still well below the maximum allowance of 0.10 cfs/acre per the DuPage County - with Stormwater and Flood Plain Ordinance. Increasing the discharge

rate to greater than 37 cfs would require a more detailed study of the effects on Perry's Pond and other downstream features.

10. It is recommended that the outlet control structure be modified to increase the weir length to 6-feet. This will reduce the time that the outlet is weir-controlled and increase the discharge rate of the lake at lower heads. The estimated cost of this modification to the OCS, including a 15% contingency and engineering fees, is approximately $152,000.

11. The Lake Ellyn outlet control structure (OCS) operates as a free outfall. In other words, the downstream storm sewer system does not create a backwater condition that interferes with operation of the OCS.

12. The two principal inflows into the storm sewer system downstream of Lake Ellyn peak before the outflow from Lake Ellyn peaks. Specifically the discharges from the Elm, Oak, Riford, and Park (EORP) and the Essex, Lake, Oak and Grand (ELOG) Basins peak approximately one hour before the discharge from Lake Ellyn peaks.

13. Increasing the release rate from Lake Ellyn will not increase the peak flow rate to Perry's Pond, due to the fact that the peak discharges from the downstream storm sewer system are greater and occur before the discharge from Lake Ellyn peaks. However, the ELOG improvements will

result in a 10.0 cfs increase in the peak flow to Perry's Pond for a 5-year, 1-hour event. The impact of this on the water level in Perry's Pond will vary depending on the downstream water level and will cause an increase in water level from one half of an inch to one and one quarter inches.

14. Lowering the normal lake level and increasing the release rate will allow Lake Ellyn to store all flows from the 100-year rainfall events. This is consistent with accepted stormwater management practice, the DuPage Countywide Stormwater and Flood Plain Ordinance, and the criteria used by Harza Engineering in their 1990 and 1991 studies and designs. However, it is recommended that the Village also pursue conversations with homeowners downstream of Lake Ellyn and within the overland flow route regarding increasing the conveyance of stormwater through side yards and/or installing floodproofing measures to lower the potential for property damage in the unlikely event of a future overflow.

15. Raising the high water level of the lake by increasing the dam height and expanding the footprint of the lake were also investigated as alternatives for providing additional stormwater storage. However, both of these alternatives were determined to not be feasible.

16. The Park District should continue to monitor the lake level and the Village should continue to monitor the outlet structure discharge to ensure that the

lake is operating properly. As part of this effort, the Park District has recently installed lake level gauges on the outlet control structure and the wing walls by the boat house.

17. It is recommended that the Village and the Park District periodically review the instructions contained in the revised "Operations and Maintenance Manual," originally issued by Harza Engineering and amended by RHMG in 2010 and 2012 and follow these instructions during storm events.

18. The Lake Ellyn stormwater management system is designed to work passively, that is, with no manipulation of operating parameters either during or in advance of storm events. It is recommended that the passive operating mode be continued.

II. INTRODUCTION

A. Background

Lake Ellyn is 10 acre manmade lake created by an earthen embankment on its north end. The lake is an important asset of the Glen Ellyn Park District; and it is utilized by Village residents for a multitude of year-round recreational activities. In addition, the lake acts as a regional detention and stormwater treatment facility for a 614 acre urbanized watershed.

In July of 2010, there was a rainfall event that resulted in the overtopping of the Lake Ellyn dam and flooding of properties within and along the downstream overland flow route. Previously, there were overflow events in October, 2001 and September, 2008. Consequently, it is desired by the Village of Glen Ellyn and the Glen Ellyn Park District to undertake hydrologic and hydraulic studies of the lake to assess current conditions and make recommendations to minimize the frequency and impacts of future lake overflows.

B. Purpose and Scope

The specific scope of the Lake Ellyn Hydrologic and Hydraulic Study includes:

1. Perform a hydrologic and hydraulic analysis of the Lake Ellyn tributary area utilizing the USEPA's SWMM computer model in order to assess the

impact of improvements and changes within the drainage area on stormwater flows into Lake Ellyn.

2. Evaluate the stormwater detention capabilities of Lake Ellyn and answer the following critical questions.

   a. What is the optimal normal water level of the lake?
   b. What is the appropriate release rate for the lake?
   c. Is the lake outlet system operating correctly?
   d. Is it possible to increase the capacity of the lake?

3. Analyze the downstream overland flow route and evaluate alternatives to better protect homes that are along the route during extreme storm events which result in overtopping of the Lake Ellyn dam.

4. Update the Lake Ellyn Dam Operation and Maintenance Manual that was originally prepared in 1991 and amended in 2010.

It is the intent that this report will provide the Village of Glen Ellyn and the Glen Ellyn Park District with recommendations that can be considered in order to reduce the potential for overflowing of Lake Ellyn and for better protecting downstream properties during overflow events.

III. TRIBUTARY AREA HYDROLOGIC AND HYDRAULIC ANALYSIS

A. Background

Lake Ellyn receives flows from the 614 acres of the Main, Linden and Maple Basins. The lake discharges through an outlet control structure located in the dam at the north end of the lake into a storm sewer system. The storm sewer flows through the parkway of Lake Road and Grand Avenue, under Riford Road and discharges into a channel located between the residences at 725 and 717 Riford Road into Perry's Pond and ultimately the East Branch of the DuPage River (See Exhibit A). In 1979, the Village performed a "Comprehensive Analysis of Storm Water Drainage System" to determine locations of hydraulic bottlenecks, localized flooding and areas where improvements to the storm sewer system were required. There have been numerous improvements to the Lake Ellyn tributary area storm sewer system based on the recommendations of that study. The constructed improvements are shown in Exhibit B, a map provided by the Village of Glen Ellyn that itemizes the improvements and dates constructed. In 2000, a stormwater master plan update was performed by RHMG Engineers in association with Clark Dietz Engineering. Portions of several basins were modeled and additional problem areas and solutions were identified.

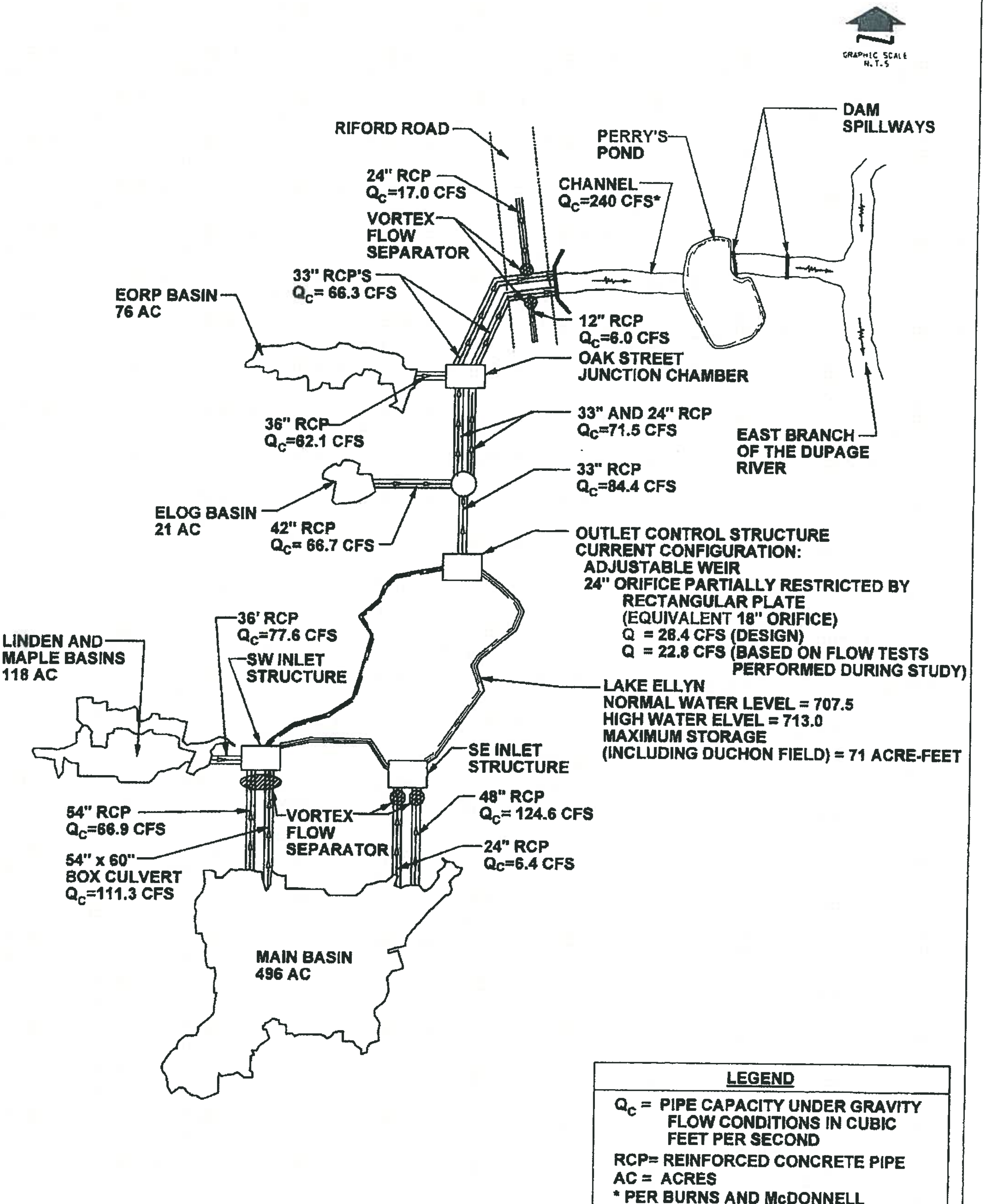

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EXHIBIT A - LAKE ELLYN DRAINAGE BASIN STORM WATER SYSTEM AT TIME OF STUDY

DATE: JANUARY, 2012

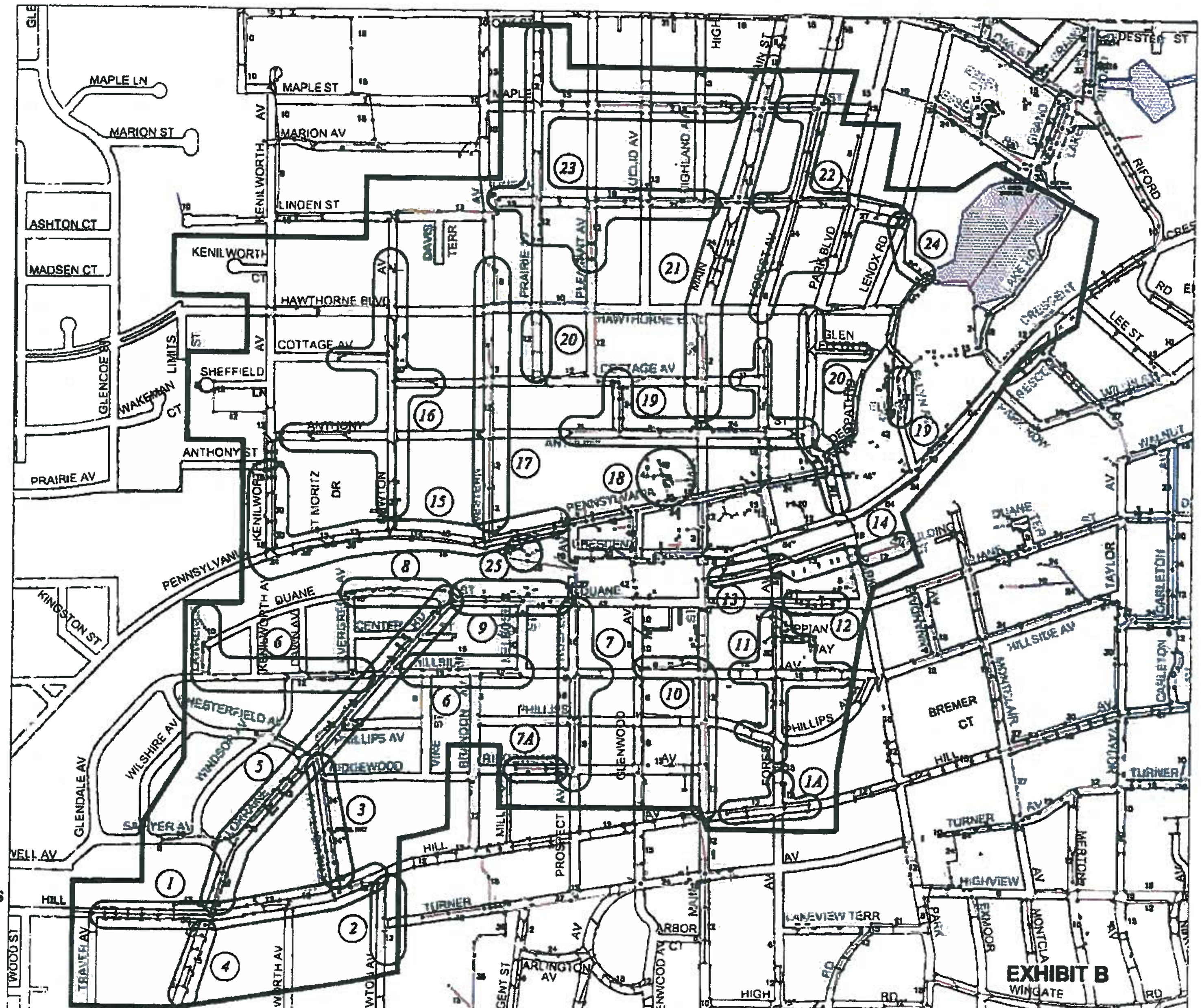
PROJ#: 21220000

Lake Ellyn Drainage Basin

1. Hill Ave West '87
1A. Hill Ave East '88-89
2. Sunset/Manor Woods '06
3. Kenilworth Ave '02
4. Lorraine Rd Phase I '96
5. Lorraine Rd Phase II '97
6. Hillside Ave '02
7. Prospect Ave '06
7A. Ridgewood Ave '91
8. Duane St '99-00
9. Duane St '96-97
10. Main St '95
11. Forest-Hillside '05
12. Duane St '07
13. Stewart Ave Parking Lot '92
14. Montclair Parking Lot '08
15. Pennsylvania Ave '87
16. Newton/Anthony/Cottage '03
17. Western Ave '92
18. Main-Pennsylvania Parking Lot '99
19. North Main Basin & Ellyn Ave '05
20. Park/Glen Ellyn Place/ Prarie '09
21. Main St '87-88
22. Maple/Linden Phase I '93
23. Maple/Linden Phase II '02
24. Lake Ellyn Rehab '91
25. Harris Bank '09

Note: Hawthorne to be reconstruced in its entirety in 2012; design engineering currently underway

8/24/2011



In 1990, the Glen Ellyn Park District contracted with Harza Engineering Corporation to analyze the operating conditions of Lake Ellyn, water quality effects from stormwater inflows and depth of sediment deposits in the lake. Harza Engineering Company also analyzed the storage capacity of the lake to determine if the lake could contain the critical duration 100-year event. A direct result of the study was a rehabilitation project for Lake Ellyn including updated inlet structures, modifications to the outlet control structure, removal of sediment and raising of the dam spillway crest. During the study, the Village of Glen Ellyn contacted the Park District to request additional storage in the lake to offset increased flows in adjacent basins. The Park District and Harza worked with the Village to provide 15.8 additional acre-feet of storage to account for planned storm sewer improvements in the Elm, Oak, Linden and Maple basins.

For this current analysis, the tributary area to Lake Ellyn was modeled using the United States Environmental Protection Agency's "Storm Water Management Model" (SWMM) to analyze the effects of the improvements installed throughout the upstream tributary area. The tributary area is a mix of urban commercial and residential zones, both of which are within the intended use of SWMM.

B. Model Input

1. Basin Characteristics

The area tributary to Lake Ellyn was delineated into 89 sub-basins using 2-foot contours provided by the Village of Glen Ellyn. The contours were used to determine the average basin slope and the longest flow path through the basin. The impervious percentage was determined using aerial photography over several blocks in the residential areas and was found to be approximately 40%. Per the Village Zoning Code, the maximum lot coverage ratio in the zoning district of the study area, R2 residential district, is 35%. However, up to 740 square feet of impervious area (approximately 6.8% of a ¼ acre lot) can be excluded from the lot coverage calculations. Additionally, sidewalk and driveways are not included in the lot coverage calculations. The initial impervious percentage input into the model was 40%, but during calibration it was reduced to 35%.

The impervious coverage used for the Central Business District area is 95%. There are no lot coverage restrictions included in the Central Business District sections of the Village of Glen Ellyn's Zoning Code. Impervious area percentages for sub-basins that are a combination of business and residential districts were scaled proportionally based on the business and residential district areas within the sub-basin.

Soil maps were examined to determine the soil group breakdown in the study area. Most of the tributary area is Group B soils. Closer to Lake Ellyn, Group C and D soils are more prevalent. The infiltration method used for modeling was Green and Ampt, with inputs based on soil type for each basin.

As shown on Exhibit C, the area tributary to Lake Ellyn is comprised of three drainage basins: Main, Linden and Maple. The areas of these basins as given in

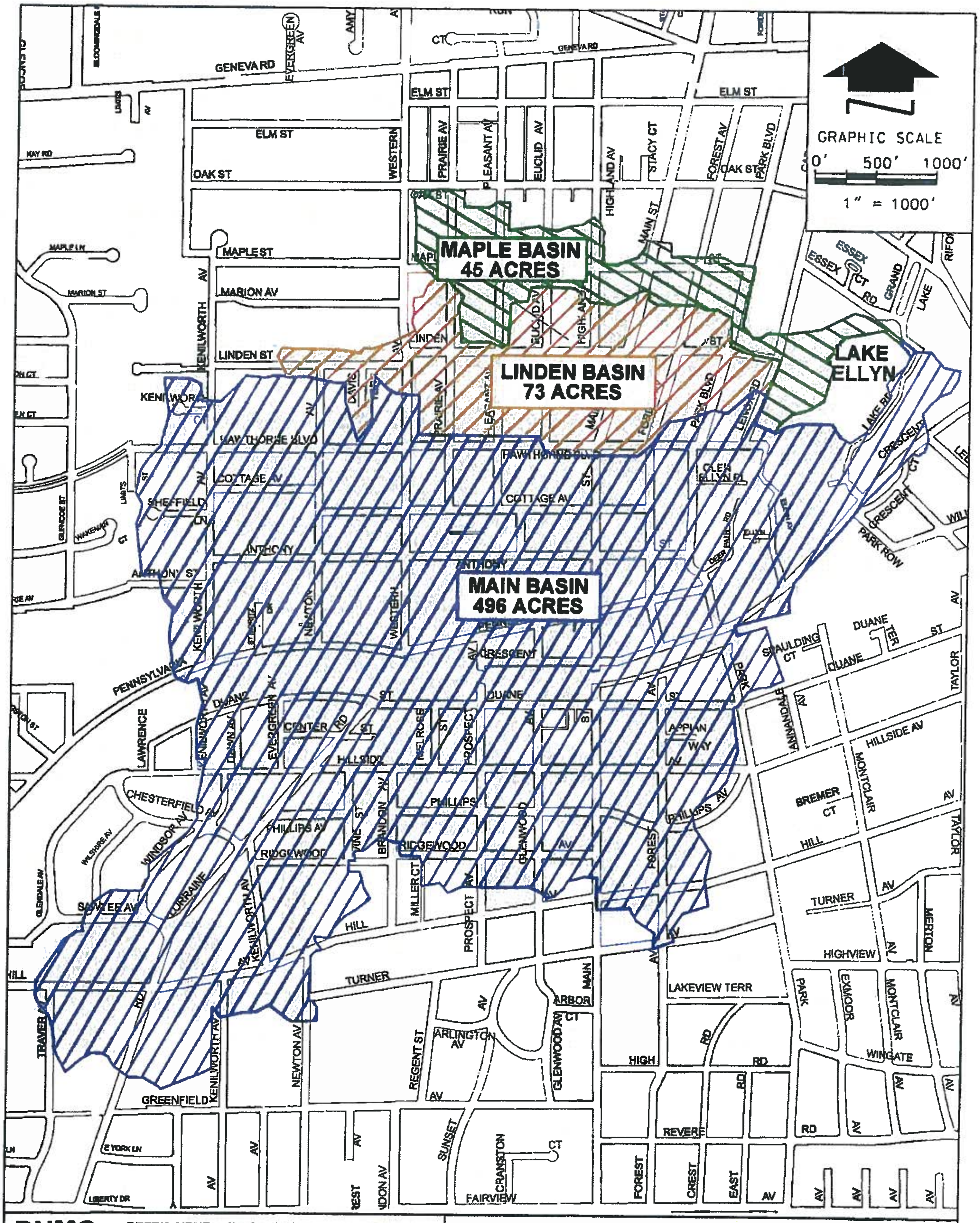


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EXHIBIT C - BASINS TRIBUTARY TO LAKE ELLYN

DATE: JANUARY, 2012

PROJ#: 21220000

the "Comprehensive Analysis of Stormwater Drainage System" performed by Clark Dietz Engineers in 1979 and as delineated during this study are summarized in Table 1 below:

TABLE 1 - TRIBUTARY BASIN AREAS		
Basin	**1979 Comp. Analysis of Stormwater Drainage System (ac)**	**Current Study (ac)**
Main	440	496
Linden	83	73
Maple	40	45
Total	**563**	**614**

This summary shows an increase in the total tributary area of 9%. The changes in areas are a result of updated contour information. Although the general boundaries of the basins have not changed, there were minor boundary adjustments. The most significant adjustments were at the northeast and southeast extents of the Main basin.

It should also be noted that prior to 1993, only the Main and Linden Basins were tributary to Lake Ellyn. In 1993, the storm sewers from a portion of the Maple basin were rerouted to discharge into Lake Ellyn instead of into the storm sewer system downstream of Lake Ellyn. This was done in accordance with the recommendations from the 1979 "Comprehensive Analysis of Stormwater Drainage System". However, design flows from the Maple Basin were included in the previous studies of Lake Ellyn conducted by Harza Engineering Company in 1990 and 1991, even though this storm sewer diversion had not yet been constructed.

2. Storm Sewer

Storm sewer data was input using information from the Village of Glen Ellyn's paper stormwater atlas maps, record drawings for recent projects (within the past 25 years) and field data gathered by RHMG personnel. There are four storm sewer trunk lines – three in the Main Basin and one collecting all flows from the Maple and Linden Basins. Exhibit D shows the trunk lines relative to the tributary area and basins to Lake Ellyn.

The storm sewer system downstream of Lake Ellyn was also included in the model. The storm sewer discharges into an open channel between the residences at 717 and 725 Riford Road. The channel is the upstream extent of a floodplain that causes a tailwater condition at the outlet of the downstream storm sewer system. The tailwater is the base flood elevation of approximately 691.5 feet, per FEMA Map # 17043C0068A.

3. Storage Capacity

Harza Engineering Company previously prepared reports entitled "Detention Storage Capacity of Lake Ellyn" (Appendix B) and "Supporting Design Report for Lake Ellyn Rehabilitation Project" (Appendix C). The reports included stage-storage and outlet control structure rating curves. The published storage in Harza's Report at the high water level of Lake Ellyn (713 feet) is 56 acre feet. The high

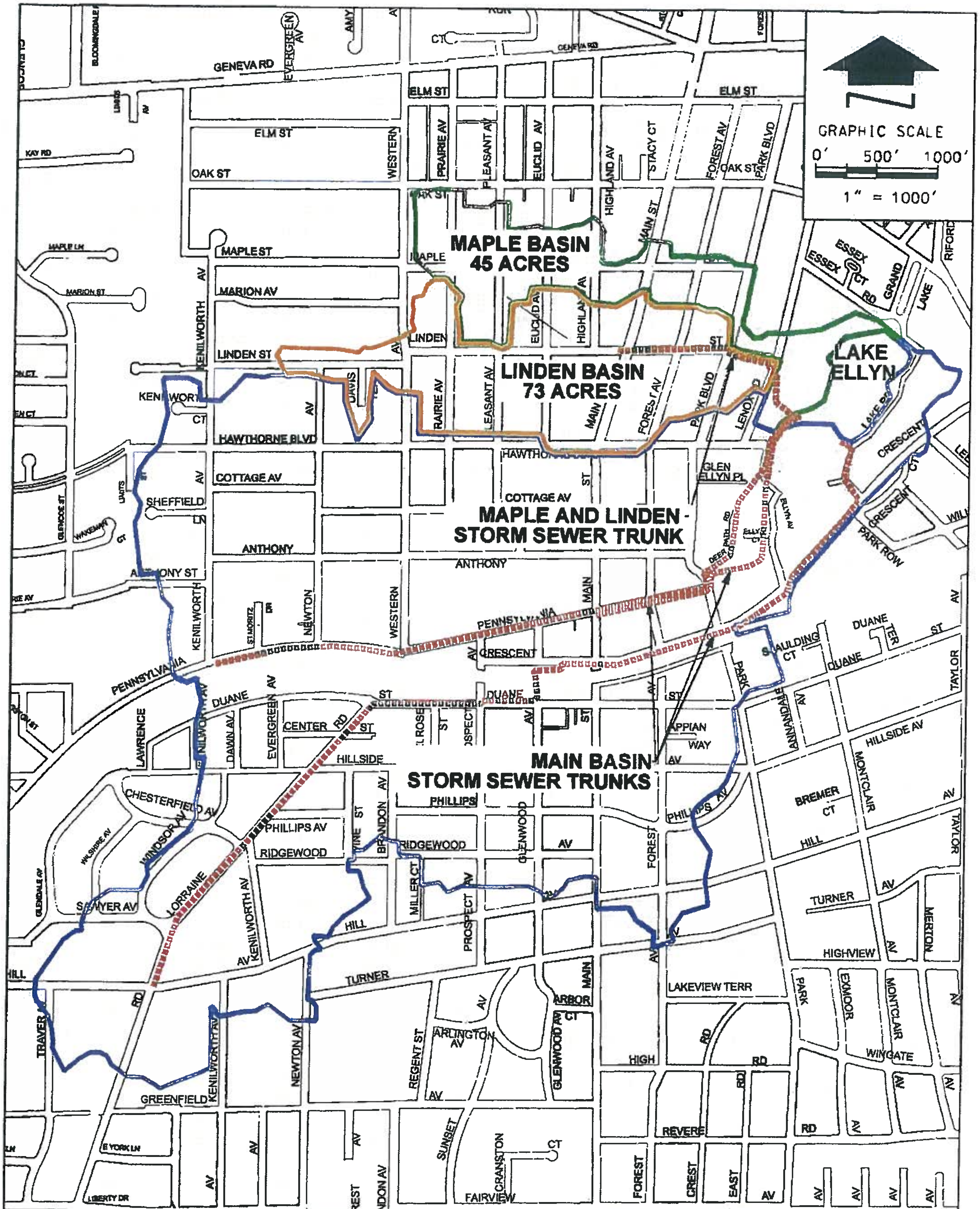

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EXHIBIT D - STORM SEWER TRUNK LINES

DATE: JANUARY, 2012

PROJ#: 21220000

water elevation is 5.5 feet above the normal water level of 707.5 feet; and with a 10-acre footprint and vertical side slopes the minimum storage volume is 55 acre-feet. As the water level rises in Lake Ellyn during rain events, the athletic field and track at Glenbard West High School are inundated with at least one foot of water. Additionally, the shoreline of the lake gradually recedes in most areas, increasing the lake footprint as the water rises.

As part of this current study, contour data from previous projects along the perimeter of Lake Ellyn was used to reevaluate the previously published stage-storage curve. Minor assumptions were necessary to delineate contour data around the track and athletic field due to the lack of a comprehensive survey, and it was determined that the maximum storage at the high water level is approximately 70.9 acre-feet. The revised calculated storage values at all stages are greater than shown on the previously published curve. A comparison of the previously published and revised stage storage curves can be found in Exhibit E.

4. Release Rate

Prior to 1990, Lake Ellyn discharged to parallel 24-inch and 33-inch storm sewers. In the early 1990's the current outlet control structure (OCS) was installed and the 24-inch pipe was blocked off such that the 33-inch pipe receives all discharge from Lake Ellyn. The Lake Ellyn OCS is a two-stage outlet (see Exhibit F). Water first flows over an adjustable stainless steel weir slide gate in the OCS and then continues through

Lake Ellyn Stage-Storage Curve Comparison

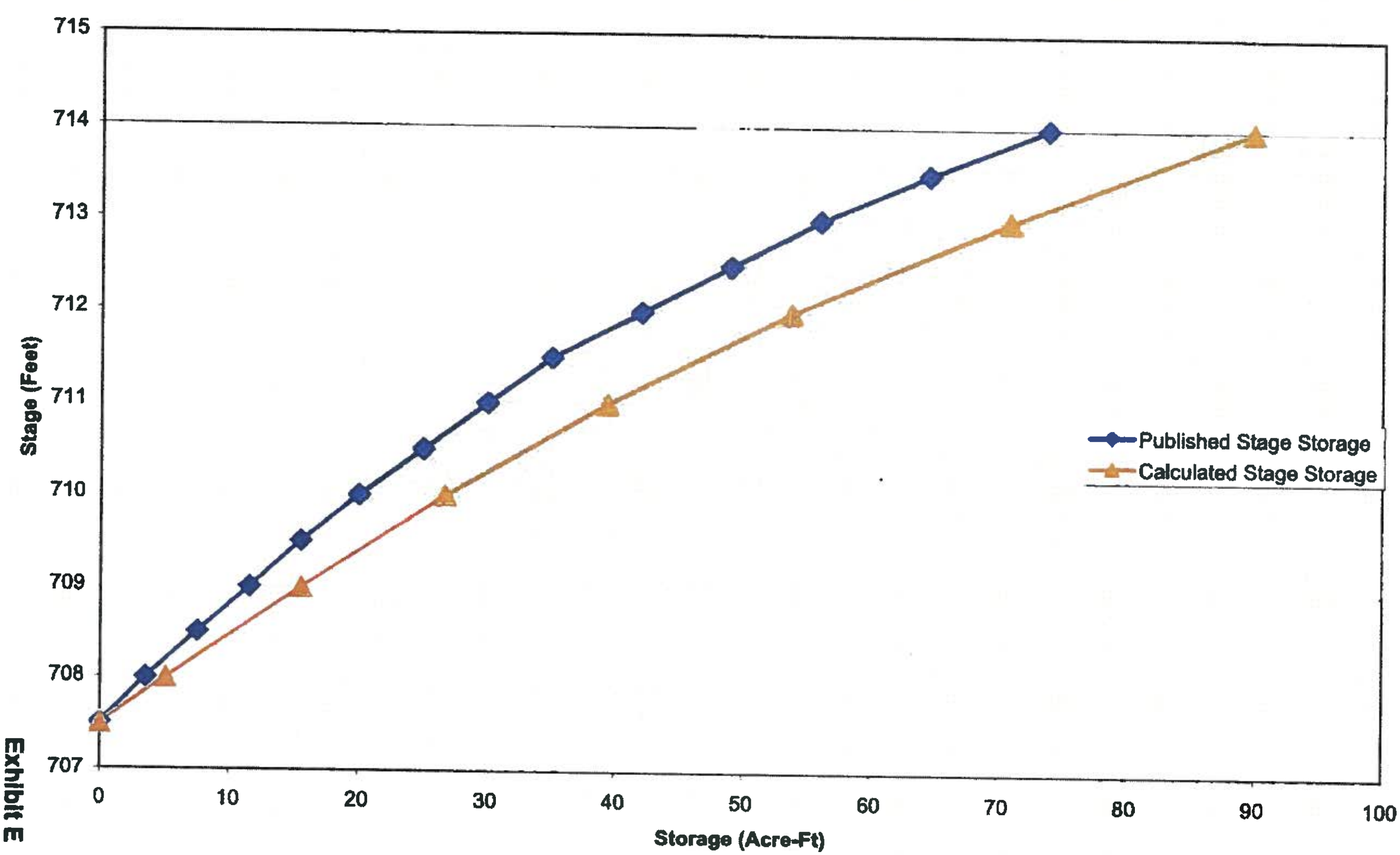

Exhibit E

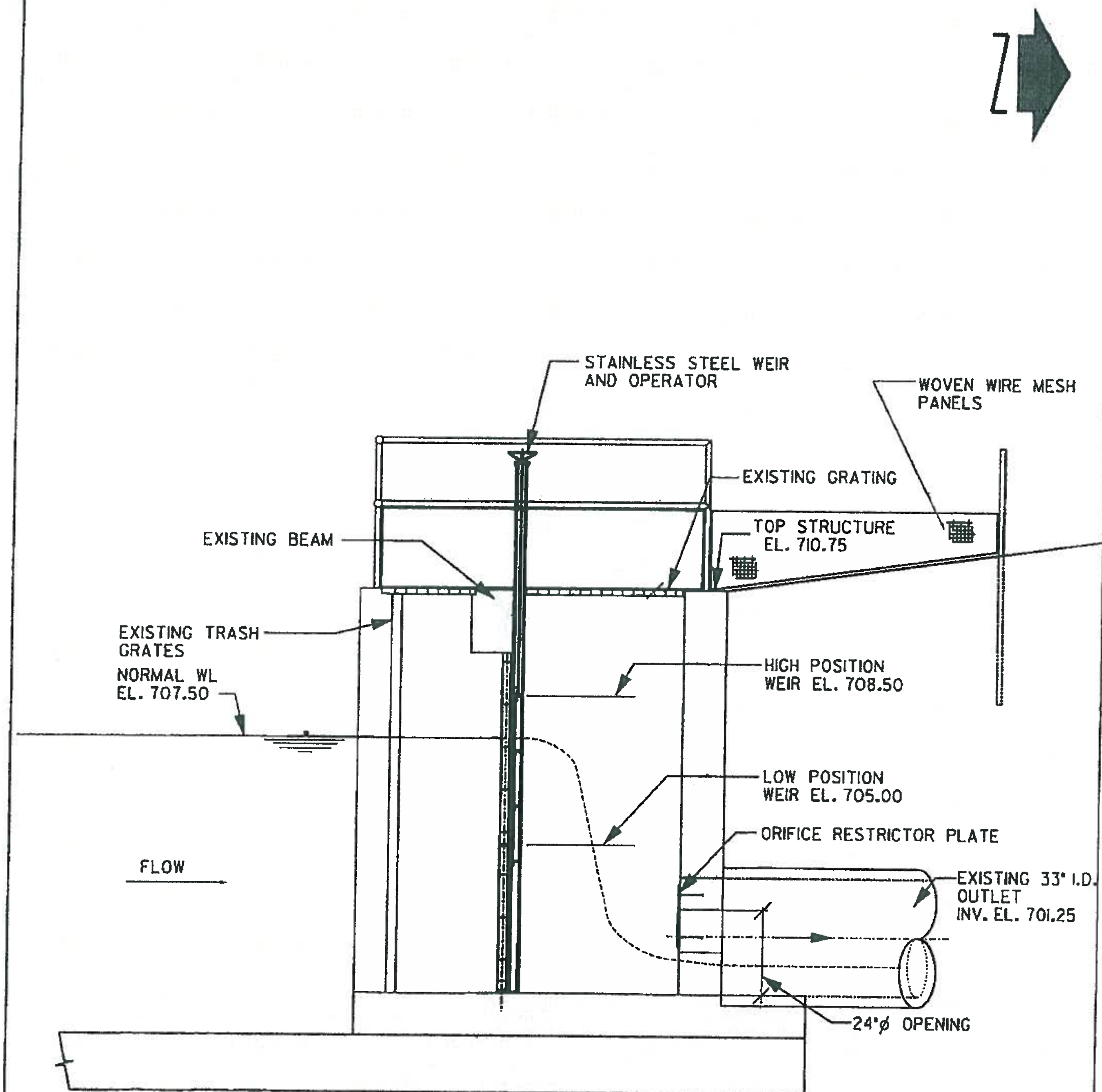

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EXHIBIT F - OUTLET CONTROL STRUCTURE SECTIONAL VIEW

DATE: JANUARY, 2012

PROJ#: 21220000

an orifice at the invert of the structure. The adjustable weir establishes the normal water level of the lake and is therefore typically set at elevation 707.5 feet. The orifice is a 24-inch diameter opening in the wall of the structure connected to a 33-inch pipe downstream. There is a restrictor plate bolted across the upper portion of the 24-inch opening to restrict the discharge to a maximum flow rate of 28 cubic feet per second (cfs) at a water surface elevation of 713.0 feet. During high flow events, the restricted orifice controls the release rate from the lake and ultimately establishes the lake level.

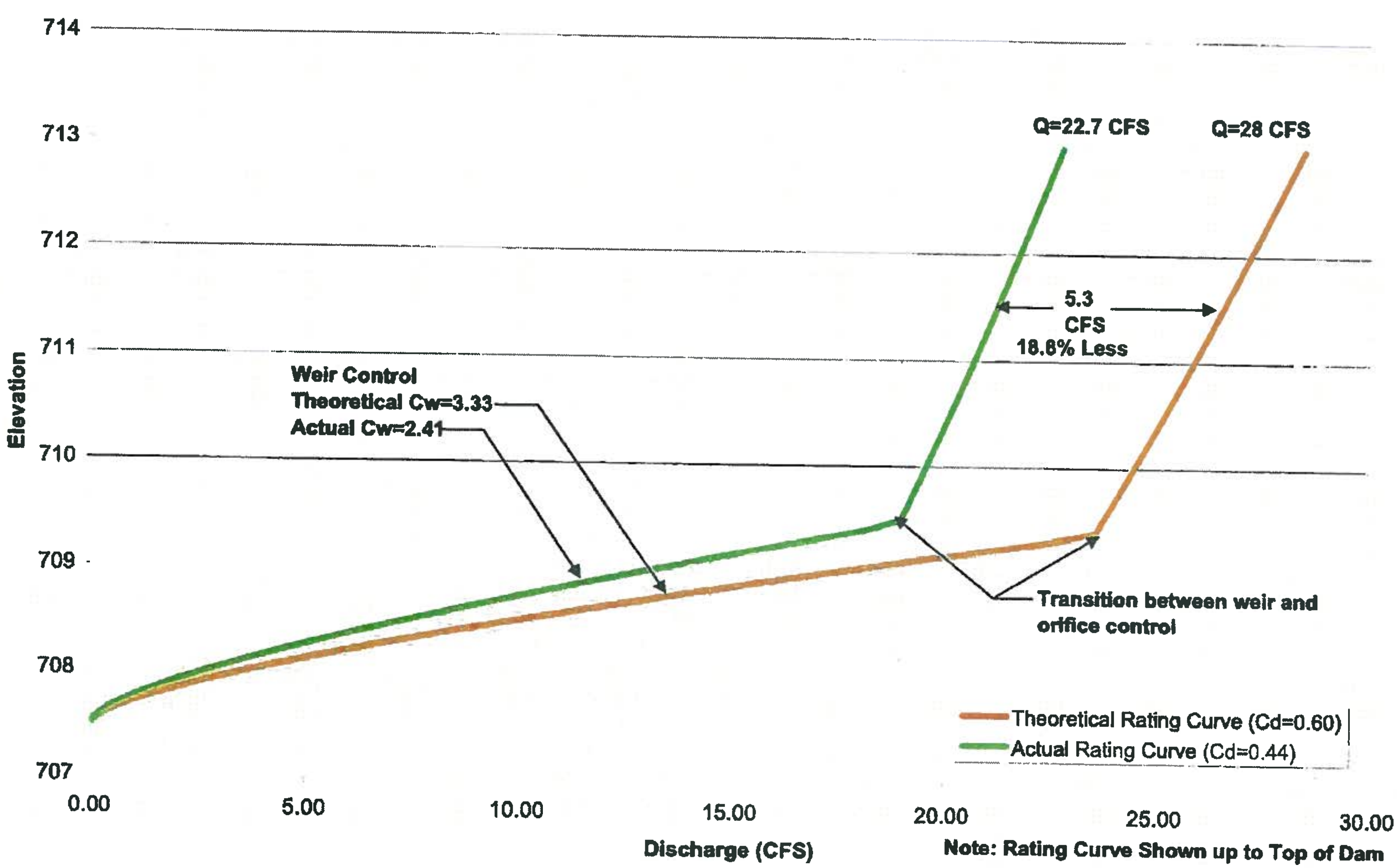
A portable flow meter was installed as part of this study to aid in calibration of the orifice and to confirm the existing discharge rate from Lake Ellyn. Because of the absence of significant rain events during the flow monitoring period, two flow tests were performed at the Lake Ellyn OCS. During the first flow test, the weir in the OCS was lowered and held at predetermined elevations in an attempt to create distinct water surface elevations to confirm the discharge rate through the orifice. Prior to the test, it was confirmed theoretically that enough flow could pass over the weir at its lowest position (705.0 feet) to surcharge the orifice and provide data points for calibration. During the flow test, the weir was lowered to its lowest position and therefore should have been discharging at a rate greater than the 28 cfs theoretical capacity of the orifice. However, the water surface elevation in the OCS only surcharged approximately 3 feet above the invert and the maximum flow measured by the downstream flow meter was 8.5 cfs.

Therefore, the first flow test did not yield any data useful to confirm the performance of the outlet control structure restrictor. However, the test did highlight the fact that the grates along the entrance to the OCS restrict the volume of flow into the structure. A portion of the flow capacity through the grate is lost due to sediment and trash caught in the rack below the normal water level. While difficult to quantify, it appears that the grate is a flow restriction during lower flows, and the restriction is exacerbated when clogged with debris and trash.

A second flow test was performed with the assistance of Village and Park District staffs. The grates were removed from the OCS to ensure sufficient flow for the test. Discrete data points were collected and used to determine the actual discharge coefficient of the orifice. The discharge coefficient represents the percentage of the maximum flow that can be discharged through the orifice. Different orifice types will operate at different capacities – smooth edged orifices will convey flow more efficiently than sharp edge orifices which cause constriction of the flow cross section through the orifice and have a lower coefficient of discharge. After comparing the data from the flow test to calculated values it was determined that the orifice operates at a discharge coefficient of 0.44, which is lower than the accepted theoretical value of 0.60 for such an orifice. The lower discharge coefficient for the Lake Ellyn outlet structure may be a result of the sharp edged restrictor plate on upper portion of the outlet. A graph comparing the theoretical and actual rating curves for the OCS is included in Exhibit G. As shown in Exhibit G, the actual maximum release rate is 22.7 cfs, or 19% less than the intended 28 cfs.

Exhibit G

Lake Ellyn Discharge Rating Curve Comparison



The capacity of the existing weir in the outlet control structure was also confirmed via the flow test. The weir coefficient was determined to be approximately 2.41, which is lower than the accepted theoretical value of 3.33. The lower weir coefficient means the outlet of Lake Ellyn has a reduced capacity during periods when the water surface elevation is at or below 709.0 feet. From the normal water surface (707.5 feet) up to 709 feet, the weir controls (and restricts) the discharge rate. At a water surface elevation of 708.0 feet, 2.7 cfs of stormwater is discharged over the weir, significantly below the 17 cfs capacity of the orifice. Exhibit H shows a comparison between the discharge capabilities of the weir and orifice from 707.5 to 709.0 feet.

5. Calibration Events

Three rain events were used to calibrate the model: the July 23-24, 2010 event, the July 23, 2011 event and the September 26, 2011 event. Hourly rainfall data from weather gauges located in Wheaton, Illinois were used. These gauges are the closest gauges to the tributary area with data for all events. When available, data from the Lake Ellyn level monitoring station and the portable flow meter installed as a part of this study were also used.

- July 23-24, 2010: Approximately 5.5 inches of rain fell between 11:00 p.m. on July 23 and 5:00 a.m. on July 24, 2010. The water level in Lake Ellyn rose high enough to overtop the dam, starting at

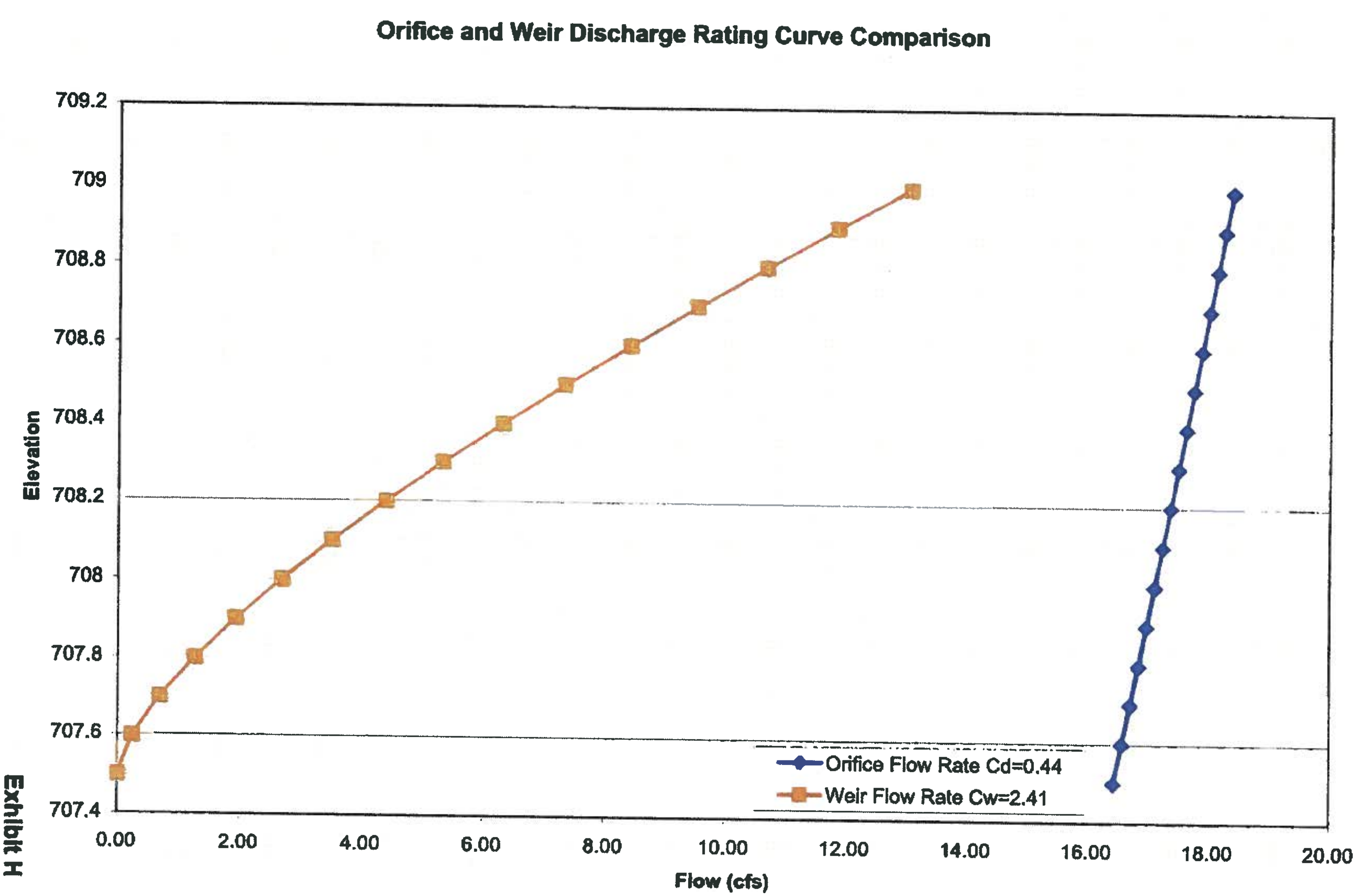

Orifice and Weir Discharge Rating Curve Comparison
709.2
709
708.8
708.6
708.4
708.2
708
707.8
707.6
707.4
Elevation
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Flow (cfs)
Orifice Flow Rate Cd=0.44
Weir Flow Rate Cw=2.41

Exhibit H

approximately 6 a.m. and continuing through at least 7:30 a.m. There is not any measured data regarding the level or discharge rate of Lake Ellyn for this event. Based on total rainfall depth and duration, the rainfall is close to a 50-year, 12-hour event. However, the rainfall intensity distribution differed significantly from theoretical events in that instead of a steady accumulation of precipitation there were four smaller events that contributed to the overall storm. Although the total precipitation depth for the event is less than the 100 year depth, the intensity with which the rain occurred led to significant amounts of runoff. Specifically, the volume of stormwater entering Lake Ellyn for this event exceeded the volume of stormwater entering Lake Ellyn during the theoretical 100-year 48-hour event.

- July 23, 2011: Approximately 3 inches of rain came down in three hours starting in the early morning hours of July 23, 2011. The measured lake high water level at the Lake Ellyn level monitoring station during the event was 710.8 feet at approximately 3:59 a.m. There is not any lake discharge flow data for this event. This rainfall event is similar to a 15-year 3-hour event.

- September 26, 2011: This was the only calibration event with both flow and lake level data. The event is a low intensity, high frequency event, with approximately 1.4 inches of rain over 12 hours. The peak lake level was 708.3 feet and the peak discharge of 5.6 cfs occurred at approximately 8:30 a.m. Based on rainfall depth and duration, this rain event is close to a 3-month, 12-hour event.

C. Model Results

The model was calibrated using the previously described events. The pattern noticed during calibration events and other precipitation events run through the model was quick peaks in flow and a short lag time for runoff to begin, due to the urban characteristics of the watershed and relatively high impervious ratios. Depending on the rain event, approximately 25% to 40% of precipitation eventually reaches Lake Ellyn either through the storm sewer system or via overland flow. The remainder is infiltrated into the soil or ponds in depressional areas and evaporates. During less frequent (e.g. 50-year and 100 year events) and shorter duration events (e.g. 3-hour and 5-hour events), the runoff percentage is increased due to high rainfall intensities and less soil infiltration. Four high intensity mini-peaks occurred during the July 23, 2010 rain event, leading to the increased runoff and overtopping of Lake Ellyn. If the event had a similar volume of rainfall but with a lower peak intensity over a longer period of time, then the percentage of runoff into Lake Ellyn would decrease, and the lake might not have overtopped. The results of the calibration are included on the following page in Table 2.

TABLE 2 - CALIBRATION RESULTS			
Parameter or Observation	**Calibration Event**		
	July 23-24, 2010	**July 23, 2011**	**September 26, 2011**
Measured Peak Water Surface Elevation	Overtopping, Approximately 3 hours*	710.8**	708.3**
Calculated Peak Water Surface Elevation	Overtopping, Approximately 8 hours	710.0	708.6
Measured Peak Lake Discharge	-	-	5.3 cfs
Calculated Peak Lake Discharge	140 cfs	19.5 cfs	11.7 cfs
Measured Peak Time	5-8 a.m., Approximately*	3:59 a.m.	8:35 a.m.
Calculated Peak Time	3:50 a.m. – 12:09 p.m.	3:57 a.m.	10:51 a.m.
* Based on anecdotal data from Village Staff **Data from Lake Ellyn Level Monitoring Station			

The calibrated model exhibits overtopping during the July 23, 2010 event. The duration of the overtopping exceeds what was anecdotally reported. The remaining two modeled events yield high water levels reasonably close to the observed conditions of the lake.

A critical duration analysis using rainfall depths from the Illinois State Water Survey's Bulletin 70 and the Huff rainfall distributions was performed as part of this study. The results are included in Table 3. The only event that caused overtopping of Lake Ellyn was the 100-year, 48 hour event.

TABLE 3 - CRITICAL DURATION ANALYSIS - EXISTING CONDITIONS							
100-Year Event Duration	Runoff Volume (Acre-Feet)	Rainfall Depth (Inches)	Peak Inflow (CFS)	Peak Inflow Time	Peak Water Level in Lake Ellyn (feet)	Time to Peak Water Level	Peak Discharge out of Lake Ellyn (CFS)
1 Hour	34	3.56	397.14	0:18	710.32	1:36	19.92
2 Hour	47	4.47	378.28	0:30	711.22	2:36	20.91
3 Hour	56	4.85	370.27	0:45	711.71	3:30	21.44
6 hour	73	5.68	358.42	0:39	712.5	6:18	22.25
12 hour	90	6.59	213.73	4:54	712.98	12:21	22.73
18 hour	95	6.97	172.76	11:30	712.92	18:12	22.67
24 hour	104	7.58	142.06	15:15	712.92	24:21	22.67
48 hour	146	8.16	137.12	42:36	713.39*	48:09	104.35
72 hour	134	8.78	73.61	63:54	712.34	72:09	22.09
*Overtopping of Lake Ellyn							

D. Discussion

Overtopping of Lake Ellyn is a result of the constraints of the current OCS and the available storage volume. As previously noted, the OCS of Lake Ellyn is weir controlled up to an elevation of 709.0 feet. Inflows into the lake during the 48-hour event are at a low flow rate, but 30 hours into the event, the water level in the lake is at 709.0 feet with only 3-inches of precipitation having fallen. An additional 5.16 inches of rain will fall during the next 18 hours, similar to a 25-year 18-hour event with a starting lake level of 709.

The 100-year, 12-hour event was the event that caused the second highest rise in water surface elevation. The water level in Lake Ellyn rose to an elevation of 712.0 feet in approximately 6 hours and crested at 12 hours at elevation 712.98 feet. When filling, the water level in Lake Ellyn will peak after the most intense portion of the storm, when the inflows to the lake decrease to a rate lower than the discharge rate of the outlet control structure. This is due to a lag in inflows into the lake attributable to the characteristics of the storm sewer system and the time it takes for stormwater to flow from the extents of the basin.

The storm sewer system improvements installed in the mid-1980's and early 1990's increased the conveyance capacity of the storm sewer system discharging into the lake. The additional improvements installed in the 1990's and 2000's addressed localized flooding issues in upstream basins. The capacity of the system discharging into Lake Ellyn was not impacted by the latter improvements as the amount of flow entering Lake Ellyn via the storm sewer system is controlled by the capacity of the downstream storm sewers i.e. the slope and size of downstream storm sewers limits the amount of flow conveyed. When the storm sewer system is pressurized due to surcharging, the maximum capacity will increase. However as the storm sewer surcharges, the water surface will rise in the structures and eventually be stored in the streets or conveyed via overland flow routes, the same way it was stored prior to the storm sewer improvements. The model incorporates overland flow during events when surcharging occurs.

Previous studies performed by Harza Engineering Company determined the 100-year 6-hour event to be the critical duration event – the event that caused the greatest rise in water surface elevation of Lake Ellyn. The Harza studies included a critical duration analysis for the 1-hour to 48-hour events. The peak inflow into the lake as a result of the critical duration event is 315 cfs, according to the "Operations and Maintenance Manual," prepared in 1991 (Appendix C). The peak inflow to Lake Ellyn during the 100-year 6-hour event for the current model is 358 cfs, an increase of approximately 14% from the previous peak inflow. Table 4 compares peak flows cited in previous studies to peak flows from the current study.

TABLE 4 - PEAK INFLOWS INTO LAKE ELLYN		
Data Source	**5-Year, 1 hour Event (cfs)**	**100-Year, 6 hour Event (cfs)**
Previously Cited Peak Flows	350*	315**
Current Study Peak Flows	398	358

* From letter report to Ms. Lois Gordon at the Glen Ellyn Park District, re: Detention Storage Capacity of Lake Ellyn, dated February, 1990 by Harza Engineering Corporation

** From Lake Ellyn Dam Operations and Maintenance Manual, dated 1991 by Harza Engineering Company

Increased flows into the lake of the magnitudes identified in Table 4 are not unexpected and are a result of storm sewer improvements, increased tributary area and increases in impervious coverage in the upstream tributary area. There is not detailed information about the impervious coverages Harza used in preparing their model. However, when the update to the "Comprehensive Analysis of Stormwater Drainage System" was prepared in 2000 by RHMG and Clark Dietz Engineers, a sensitivity analysis was performed (a copy of the report is attached as Appendix A). The report compared the base impervious ratio used in the modeling (33.7%) to potential future ratios based on a

50% increase in the building footprint of 25%, 50%, 75% and 100% of the lots in the study basin. The corresponding percent increases in runoff volume are 1.6%, 3.2%, 4.8% and 6.4%, respectively. As noted previously, the impervious percentage used in this study was 35%.

Both impervious area and stormwater conveyance have increased over the past 20 years. Increases in impervious area have less of an effect on the volume and magnitude of flows into Lake Ellyn than the increases in storm sewer conveyance capacity. The previously discussed storm sewer improvements were not all included in previous studies, and since the previous studies, the Village has completed the major trunk line installations recommended by the 1979 "Comprehensive Analysis of Stormwater Drainage." The capacity of the system is not expected to increase significantly in the future.

Section 15-114.3 of the DuPage County Countywide Stormwater and Floodplain Ordinance requires that all detention basins require the 24-hour 100-year storm runoff volume be contained within the banks. The previous Harza studies recommended improvements to contain the critical duration event, and the Village and Park District desire to continue to protect against the 100-year critical duration event. The current operating conditions of the lake need to be modified to increase the detention storage capacity to contain the critical duration 100-year event without overtopping.

IV. STORMWATER DETENTION CAPACITY OF LAKE ELLYN

A. Optimal Normal Water Level

The current normal water level in Lake Ellyn is 707.5 feet. In discussions with Park District staff, it was noted that the ideal water level is determined in part by existing facilities, including the existing fascia of the deck of the boat house and other surface features. Park District staff further indicated that they had lowered the normal water level 6 -inches below 707.5 feet without any negative impacts to recreational use of the lake or to the shoreline.

From a stormwater detention perspective, the optimal normal water level in Lake Ellyn is determined by the volume of storage required to contain the runoff volume from the 100-year critical duration event. There are also other operational aspects of lake that need to be considered as well, including the effects the normal water level has on the existing shorelines, the depth to the bottom of the lake adjacent to the shorelines, recreational uses of the lake and aesthetics.

The normal water level in the lake is currently determined by markings on the tube surrounding the threaded rod that controls the weir in the outlet control structure. This method will accurately set the lake level at the desired elevation of 707.5 feet. The Park District has recently installed permanent, elevation based scales on the outlet control structure and on the boat house wing wall to confirm the water level in the lake at any time. The scale will provide an easy reference for lake level during rain events and also aid in setting the lake level at other elevations if desired.

B. Release Rate

In DuPage County there are three regulatory agencies that could have jurisdiction over the release rate from a lake such as Lake Ellyn that is utilized for stormwater detention. These include the Illinois Department of Natural Resources, Office of Water Resources (IDNROWR), the DuPage County Stormwater Management Department, and the local municipality. Based on correspondence with IDNROWR, they would not regulate the release rate from Lake Ellyn because its tributary area is less than 10 square miles. Instead, such regulation is delegated to DuPage County under its County-Wide Stormwater and Flood Plain Ordinance. The Village of Glen Ellyn has adopted the County's stormwater ordinance and is a full wavier community. Therefore, the Village has jurisdiction over any modifications to the release rate from Lake Ellyn.

The release rate is currently governed by Section 15-114.2 of the DuPage Countywide Stormwater and Flood Plain Ordinance, which has been adopted by the Village of Glen Ellyn. This limits the release rate to 0.10 cfs/ace. Therefore, based on the current tributary area of 614 acres, the maximum allowable release rate is 61.4 cfs.

The current theoretical maximum release rate of 28 cfs was established in the early 1990's in conjunction with the design and construction of the Elm/Oak/Riford/Park (EORP Project) storm sewers improvements. Prior to that time, the release rate was controlled by two parallel unrestricted outlet pipes: one 24-inch and one 33-inch diameter. As reported in the February 15, 1990 Harza Engineering Report, the peak release rate from those two pipes when the lake was full (elevation 712.0) was 85 cfs. In the early 1990's the reduction in the release rate from 85 cfs to 28 cfs was implemented in conjunction with a 1 foot increase of the spillway elevation in order to provide an increased detention volume in the lake of 15.8 acre-feet to offset increased peak flows from the downstream EORP Project.

The following is a comparison of historical and maximum allowable release rates from Lake Ellyn:

TABLE 5 - HISTORICAL AND CURRENT RELEASE RATES FROM LAKE ELLYN

Condition	Peak Release Rate (cfs)	Tributary Area (ac)	Release Rate (cfs/acre)
Pre-1990	85 cfs	534	0.16
Post - 1991 (theoretical)	28 cfs	534	0.05
Current (actual)	22.7 cfs	614	0.04
Max. Allowable per Ordinance	61.4 cfs	614	0.10

C. Possibility of Increasing the Capacity of the Lake

There are limited options to increase the capacity of Lake Ellyn. Raising the high water level, expanding the area of the lake, lowering the normal water level and increasing the discharge rate of the outlet would increase the detention capacity of the lake. However, existing constraints discussed below affect the ability to modify the capacity of the lake.

1. **Raising the High Water Level of the Lake**

The boat house foundation (elevation of 713 feet) and athletic track and field (elevation 712 feet) at Glenbard West High School are already susceptible to flooding during 100-year events. Increasing the water level would increase the potential for flood damage to the boathouse and athletic field. The Village and Park District are responsible to reimburse the School District for damages to the track and field caused by flooding due to Lake Ellyn. Additionally, there is an existing intergovernmental agreement between the Village of Glen Ellyn, the Glen Ellyn Park District and School District 87 that requires cooperation and agreement between all three agencies to make changes to the operating characteristics of the lake.

Moreover, Lake Road borders Lake Ellyn on the east side of the banks. Portions of Lake Road are below elevation 714.0 feet and would be inundated during extreme events if the high water level were to be raised.

2. **Expanding the Area of the Lake**

Existing topography and physical features limit the amount of expansion of Lake Ellyn. Expansion of the lake to the north or west cannot occur without impacting existing park land and mature trees. The Park District has expressed a desire to keep the footprint of Lake Ellyn the same in order to avoid land and vegetation impacts. Expansion to the east is limited by Lake Road.

The lake could be expanded to the south, adjacent to the track and athletic field at Glenbard West High School. Cooperation with District 87 would be necessary. The athletic fields and track are subject to flooding during significant rain events and if District 87 were to pursue raising the track and athletic field to avoid periodic flooding, compensatory storage would be required. The logical place for compensatory storage is the portion of land between the track and Lake Ellyn. Based on a cursory examination of existing contour data, expansion of the lake to the south would yield an additional 5.4 acre-feet of storage at elevation 713.0 feet, however this volume of storage would not be adequate to achieve a goal of removing the athletic track and field from the Lake Ellyn flood storage area.

3. Lowering the Normal Water Level

Lowering the normal water level of Lake Ellyn would provide additional stormwater storage. Specifically, lowering the lake level by 6 inches would yield an increase of approximately 4.5 acre feet of storage. Previously installed shoreline stabilization measures and recreational use of the lake could be affected by a lower lake level.

The shoreline stabilization measures installed in the late 1990's are one of the limiting factors to the extent that the normal lake level could be lowered. According to the "Lake Ellyn Improvements" plans for shoreline stabilization prepared by Cowhey, Gudmundson and Leder in 1998, the lower boundary of the rock stabilization along the banks of Lake Ellyn is at an elevation of approximately 705.5 feet. During site visits, it was confirmed that a majority of the rock stabilization measures are installed at the elevations shown on the plans. The rock stabilization along the banks adjacent to the inlet structure are buried in several inches of sediment. Additionally, portions of the northeastern and east shoreline that were stabilized using vegetation are eroding as a result of wave action. Lowering the lake level would not have a significant effect on the installed shoreline stabilization measures outside of required routine maintenance. Additionally, Park District staff have indicated that they believe the normal water level could be lowered by 6 inches without any negative impacts to the recreational use of the lake.

Additionally, according to Harza Engineering Company's "Rehabilitation of Lake Ellyn" design plans, the lake bottom should be sufficiently sloped away from the banks that lowering the lake 6 inches would not expose large areas of the lake bottom between the rock stabilization and the normal water level. The only areas where this would be expected is along the southwest inlet structure, where the Harza plans show a "wetland."

Lowering the lake would decrease the depth to the wetland and allow for the wetland to be re-planted with wetland plantings as shown on the Harza plans.

4. **Increasing the Discharge Capacity of the Lake**

As the discharge rate of the lake increases, the capacity of the lake will also increase. The physical volume of the lake does not change, but increasing the lake discharge rate allows the lake to fill with stormwater over a longer period due to the stormwater leaving the lake quicker. The inflows into the storm sewer downstream of Lake Ellyn have increased over the past 20 years as a result of storm sewer projects, including the Elm, Oak, Riford and Park (EORP) Project in the late 1990's and the Essex, Lake, Oak and Grand (ELOG) Project in 2011. The downstream sewer is near capacity during the 5 year, 10-year and 25-year 1-hour events. However, during longer duration events, there is excess capacity in the pipe. At the very least, the outlet of Lake Ellyn should be modified such that 28 cfs is discharged at peak capacity. More discussion on the potential for removing the restrictor plate can be found in Section IV.D.

Another potential option to increase the discharge capacity of Lake Ellyn and reduce the time of weir-control at the beginning of precipitation events is to increase the weir length. Lengthening the weir would increase the discharge rate during lower head conditions. The low-flow bypass valve could also be kept open to maximize the discharge at the beginning of precipitation events. According to the "Preliminary Engineering Report for Stormwater Treatment and Low Flow Bypass Piping for Lake Ellyn," prepared by RHMG in 2003, the maximum capacity of the 18-inch bypass piping installed under the lake to directly connect the inlet and outlet structures is 7.7 cfs. Both 2-month 24 hour and 6 hour events were run in the model. Sufficient runoff was generated in both scenarios that both the low flow bypass and Lake Ellyn received runoff, ensuring an inflow into the lake and preventing stagnation.

Additionally, 100-year events were modeled with the low flow bypass open. During the 100-year 48 hour event, with the normal water level at 707.5 feet and existing outlet control structure rating curve, the lake still overtopped. The low flow bypass could be kept open to provide increased discharge out of Lake Ellyn during the beginning of storms and as the lake level returns to normal water level. However, the potential water quality effects should be investigated prior to implementing year-round operation of the low flow bypass pipe.

D. Recommended Modifications

Two of the discussed potential modifications in Section IV.C that could easily be implemented by the Village and Park District are lowering the normal water level of the lake and removing the restrictor orifice plate. Removing the restrictor plate would increase the peak discharge out of Lake Ellyn to approximately 37 cfs, or 0.06 cfs per acre of tributary area. Increasing the discharge to more than 37 cfs would require additional investigation of the effect of the increased discharge rates on Perry's Pond and other downstream features.

The previously discussed two options can be implemented without significant construction. There is an additional modification that can be implemented to increase the capacity of the lake without increasing the peak discharge. The length of the weir in the outlet structure could be extended without affecting the peak discharge rate. Increasing the weir length to 6-feet would reduce the time that the outlet is weir controlled and increase the discharge rate at lower heads. After examining the existing conditions, it appears that the most practical and efficient option to increase the weir length is to construct a new outlet control structure approximately 15 feet away from the existing structure and to interconnect the two structures with a pipe. The estimated cost for this work, including a 15% contingency and engineering, is $152,000. A graphical comparison of the rating curve for the outlet modifications discussed above and the theoretical and existing rating curves can be found in Exhibit I. These three modifications were input into the model and a new critical duration analysis was run. The results are shown in Table 6.

TABLE 6 - CRITICAL DURATION ANALYSIS - MODIFIED CONDITIONS

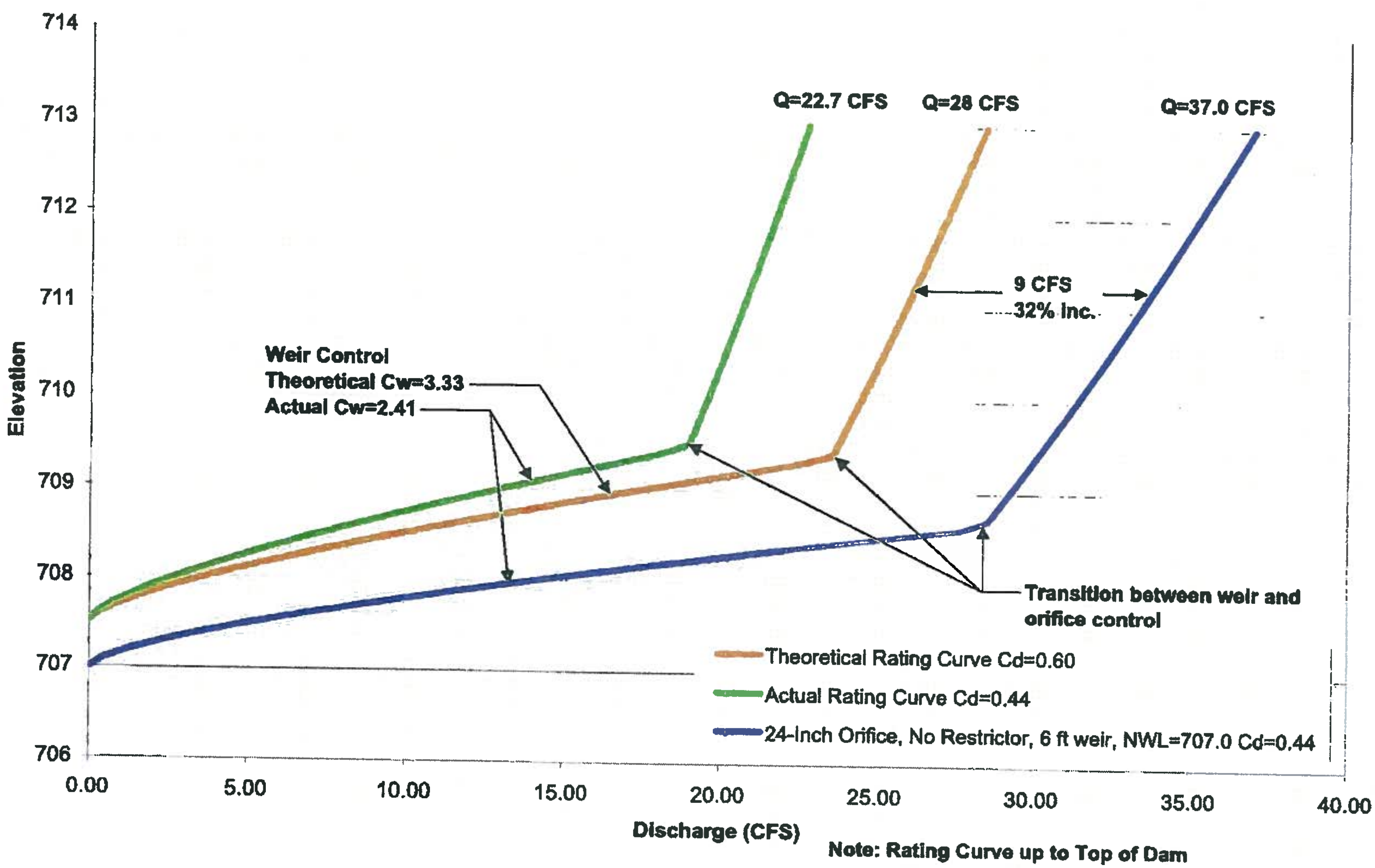
100-Year Event Duration	Runoff Volume (Acre-Feet)	Rainfall Depth (Inches)	Peak Inflow (CFS)	Peak Inflow Time	Peak Water Level in Lake Ellyn (feet)	Time to Peak Water Level	Peak Discharge out of Lake Ellyn (CFS)
1 Hour	34	3.56	396.39	0:18	709.79	1:36	31.13
2 Hour	47	4.47	377.10	0:18	710.69	2:27	32.85
3 Hour	56	4.85	366.35	0:24	711.15	3:24	33.70
6 hour	73	5.68	345.29	0:39	711.82	6:12	34.89
12 hour	90	6.59	213.81	4:54	712.19	10:45	35.55
18 hour	95	6.97	172.78	11:30	711.94	16:18	35.11
24 hour	104	7.58	142.10	15:15	711.80	19:24	34.86
48 hour	146	8.16	137.02	42:36	712.79	48:24	36.57
72 hour	134	8.78	73.74	63:54	710.78	72:09	33.02

If the normal water level were to be decreased to 707.0, the restrictor plate removed from the orifice, and the weir length extended, then the runoff from 100-year, 48 hour event will not overtop the Lake Ellyn dam. Any references to a revised Lake Ellyn OCS from this point forward are in reference to the above described modifications.

The July 23, 2010 and September 14, 2008 events were both run in the model with the revised outlet control structure. The July 23, 2010 event exhibited significant, prolonged overtopping. The September 14, 2008 event also overtopped the dam, however the peak flow rate over the dam was only 18 cfs.

Exhibit I

Lake Ellyn Discharge Rating Curve Comparison



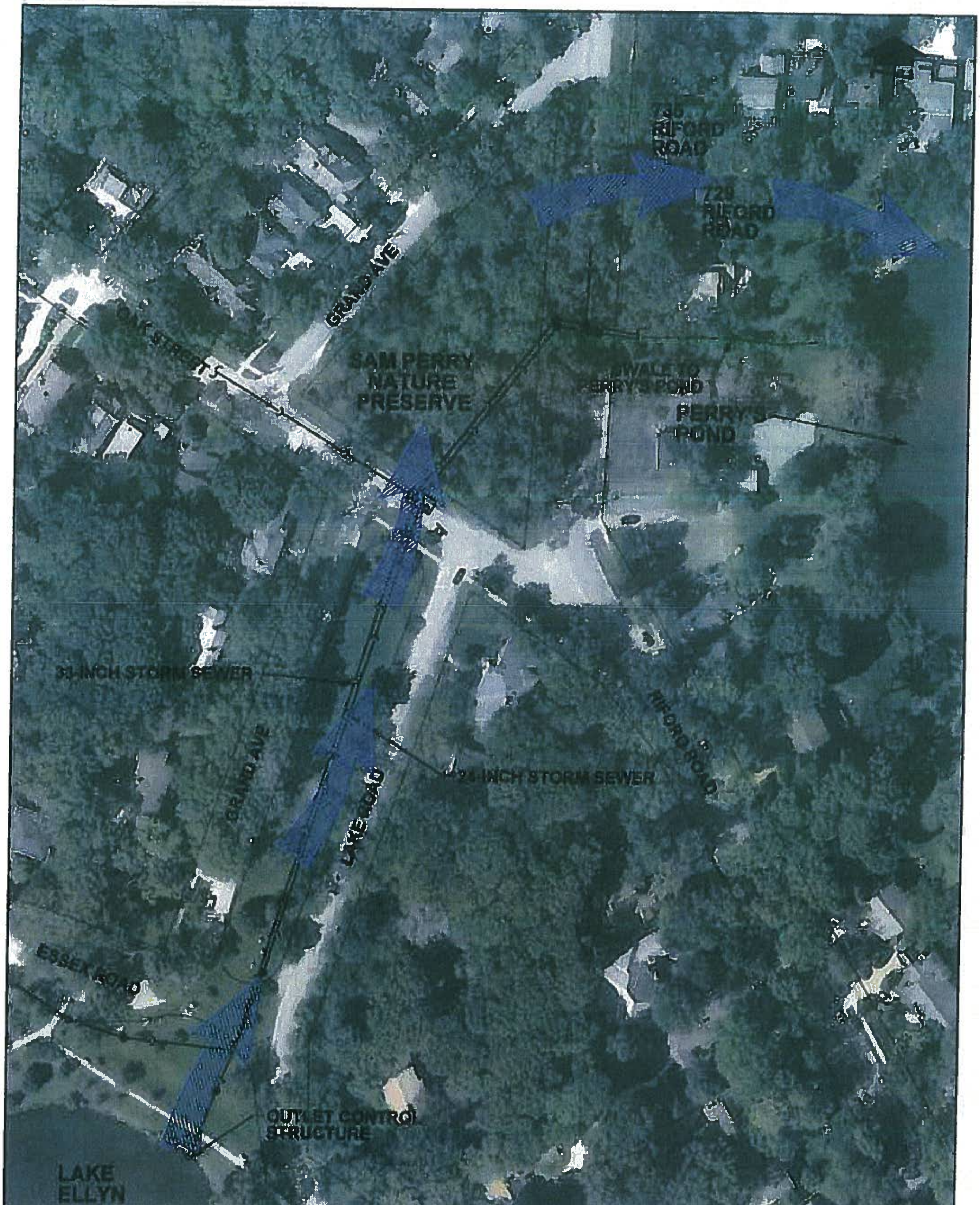
V. DOWNSTREAM AREA ANALYSIS

A. General

The Lake Ellyn outlet control structure discharges to a 33-inch storm sewer north of the lake, which eventually interconnects with a 24-inch parallel storm sewer through the parkway between Lake Road and Grand Avenue to a junction chamber on the north side of Oak Street. The flow continues via storm sewer through the Joseph Sam Perry Nature Preserve bounded by Oak Street, Grand Avenue and Riford Road until it discharges on the east side of Riford Road, north of Oak Street to a drainage channel located in floodplain between the residences at 717 and 725 Riford Road, as shown in Exhibit A. When the Lake Ellyn Dam is overtopped, the flow follows the overland flow path of least resistance, as shown in Exhibit J. Stormwater flows along the Lake Street and Grand Avenue Parkway north to the Joseph Sam Perry Preserve. After the depressional areas in the Sam Perry Nature Preserve are filled, the flow continues to the northeast, across Riford Road at the sag point, approximately 50 feet south of Grand Avenue near 729 Riford Road. The stormwater is conveyed through the side yards of 729 and 735 Riford Road, ultimately discharging into Perry's Pond, with some flow reaching the outlet channel by crossing the 725 Riford property.

B. Capacity of the Downstream Storm Sewer

One of the interesting aspects discovered during modeling is that Lake Ellyn's OCS operates as a free outfall. Stormwater will surcharge out of downstream structures



RHMG REZEK, HENRY, MEISENHEIMER, AND GENDE, INC.

975 CAMPUS DRIVE
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EXHIBIT J - LAKE ELLYN DOWNSTREAM OVERLAND FLOW PATH

DATE: JANUARY, 2012

PROJ#: 21220000

in the parkway of Lake Road and Grand Avenue prior to tailwater effects on the outlet of the lake. Exhibit K contains an annotated profile view of the downstream storm sewer.

The sewer is near capacity during the 5-year, 10-year and 25-year, 1 hour events. The storm sewer downstream of Lake Ellyn was installed with the intent of conveying unrestricted flow from lake. The restriction of stormwater from Lake Ellyn via the outlet control structure has increased the available capacity in the downstream storm sewer. There is excess storm sewer capacity through the 25-year 1-hour event and surcharging into the streets occurs during the 50-year event. For reference, the majority of the storm sewers in the Village are designed to accommodate the 5-year event without surcharging. Surcharging in the storm sewer downstream of Lake Ellyn occurs closer to the beginning of the event, when the discharges from ELOG and EORP both peak. During the 100-year, 1 hour event, surcharging was observed in the model for approximately 15 minutes and ended prior to the peak discharge from the lake. Surcharging will occur at the intersection of Oak Street and Grand Avenue, and the runoff will follow the path of least resistance, which is to the northwest to Grand Avenue along Oak Street, into the Joseph "Sam" Perry Preserve. Stormwater will collect in the preserve and flow to the storm sewer during low flows and when the storm sewer capacity is exceeded it will travel via overland flow across Riford Road and through the side yards of the residences of 729 and 735 Riford Road.

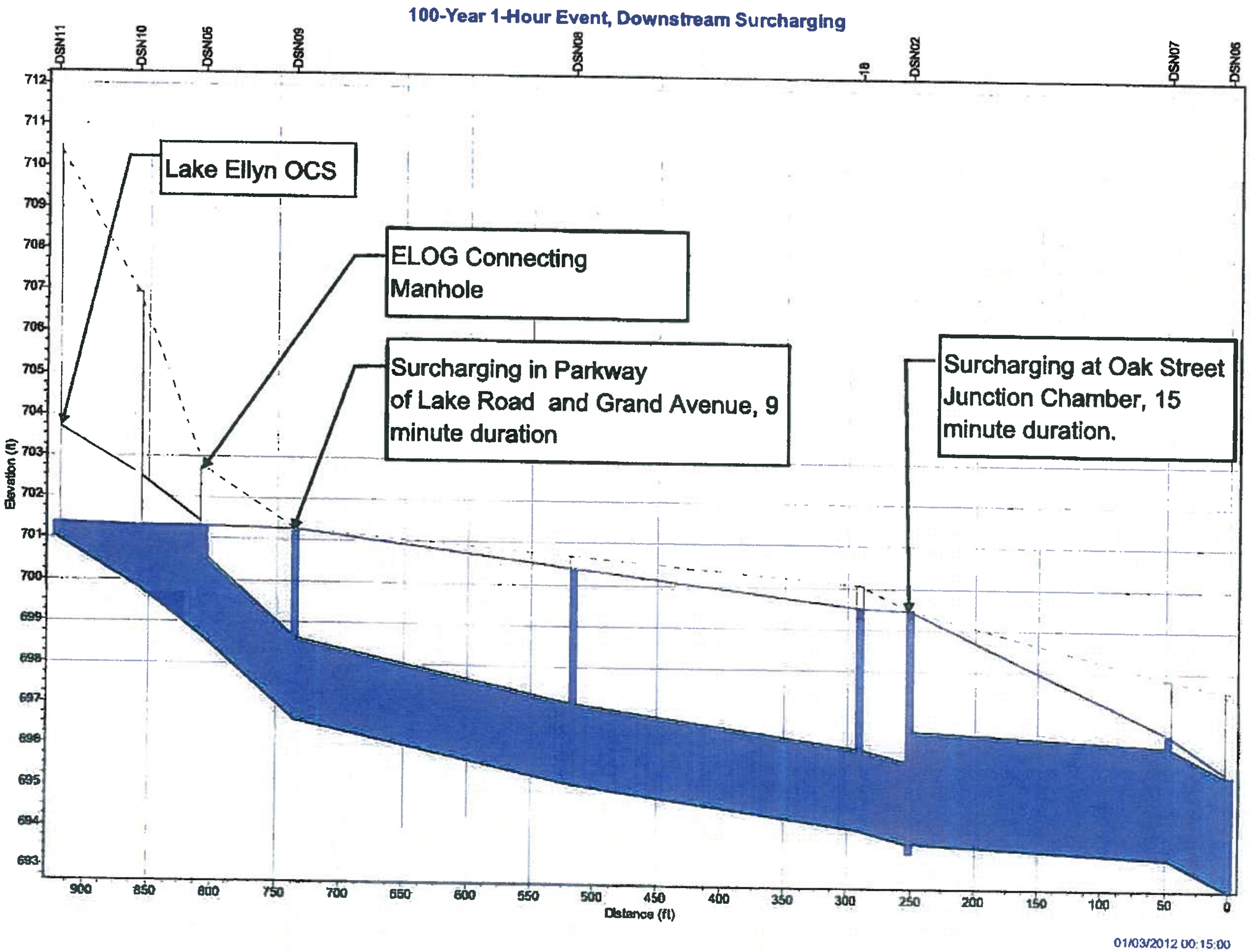

100-Year 1-Hour Event, Downstream Surcharging
DSN11
DSN10
DSN05
DSN09
DSN08
18
DSN02
DSN07
DSN06
Lake Ellyn OCS
ELOG Connecting Manhole
Surcharging in Parkway of Lake Road and Grand Avenue, 9 minute duration
Surcharging at Oak Street Junction Chamber, 15 minute duration.
Elevation (ft)
712
711
710
709
708
707
706
705
704
703
702
701
700
699
698
697
696
695
694
693
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Distance (ft)
01/03/2012 00:15:00

Exhibit K

There is still available capacity in the downstream sewer if the restrictor plate is removed from the outlet structure. The downstream areas discharging into the storm sewer (ELOG and EORP) peak prior to the peak discharge from Lake Ellyn. Increasing the discharge from Lake Ellyn would not significantly affect the capacity of the downstream sewer.

The two principal inflows into the sewer downstream of Lake Ellyn peak before the outflow from Lake Ellyn peaks. The timing of the peaks is more critical during a shorter duration event due to the high intensity and large amount of runoff. During longer duration events, the intensity is lower and the peak runoff into the sewer is reduced. Exhibits L and M show the alignment of the peak discharges for the ELOG and EORP basins for the 5-year, 1-hour event compared to the discharge from Lake Ellyn for existing and recommended conditions. The discharge from the two basins peaks about one hour before the discharge from Lake Ellyn peaks. The discharge from the 100-year, 1-hour event has a similar pattern in that the ELOG and EORP basins peak before the lake discharge peaks. Surcharging occurs as a result of flows from the ELOG and EORP basins during the 100-year, 1-hour event, also before the discharge from Lake Ellyn peaks. As previously noted, the majority of the Village storm sewers are designed to convey a 5-year event without surcharging.

Discharges from the ELOG project will occur for the first time this spring in conjunction with the discharge from the EORP improvements. During shorter duration events, flows from EORP and ELOG will peak quickly and dissipate prior to the peak outflow from Lake Ellyn, which will discharge at a fairly constant rate once the water surface reaches approximately 709.0 feet. If the release rate of Lake Ellyn were to be increased, then the duration of flow discharged downstream would decrease, but the flow rate would increase; however, the combined peak rate conveyed to Perry's Pond would not change, as depicted in Exhibits L and M. When considering a rain event contained within the banks of Lake Ellyn (no overtopping), the total volume discharged through Lake Ellyn will not change.

C. Downstream Channel Flow and Perry's Pond

As noted above, the storm sewer system outlets to a channel between the residences at 717 and 725 Riford Road. The channel is currently in poor condition with overgrown vegetation and erosion along the banks. Erosion is not uncommon at a storm sewer outlet, especially one with two large diameter pipes. The Village is planning a channel remediation project that would stabilize and restore the stream banks to mitigate erosion. Moreover, during field visits it was noted that the noise heard as the outlet was approached belied the amount of flow being discharged. There is a drop from the invert of the headwall/flared end section to the ditch that generates more noise than would be expected for the amount of flow discharged. Installation of the proposed improvements would mitigate erosion as well as the noise generated by the outlet.

Perry's Pond receives flows from the Elm, Oak Maple, Linden and Main Basins. The flows to the pond have changed over time due to storm sewer Improvements, but no

Downstream Storm Sewer - 5 Year, 1 Hour Event - NWL=707.5, Existing OCS

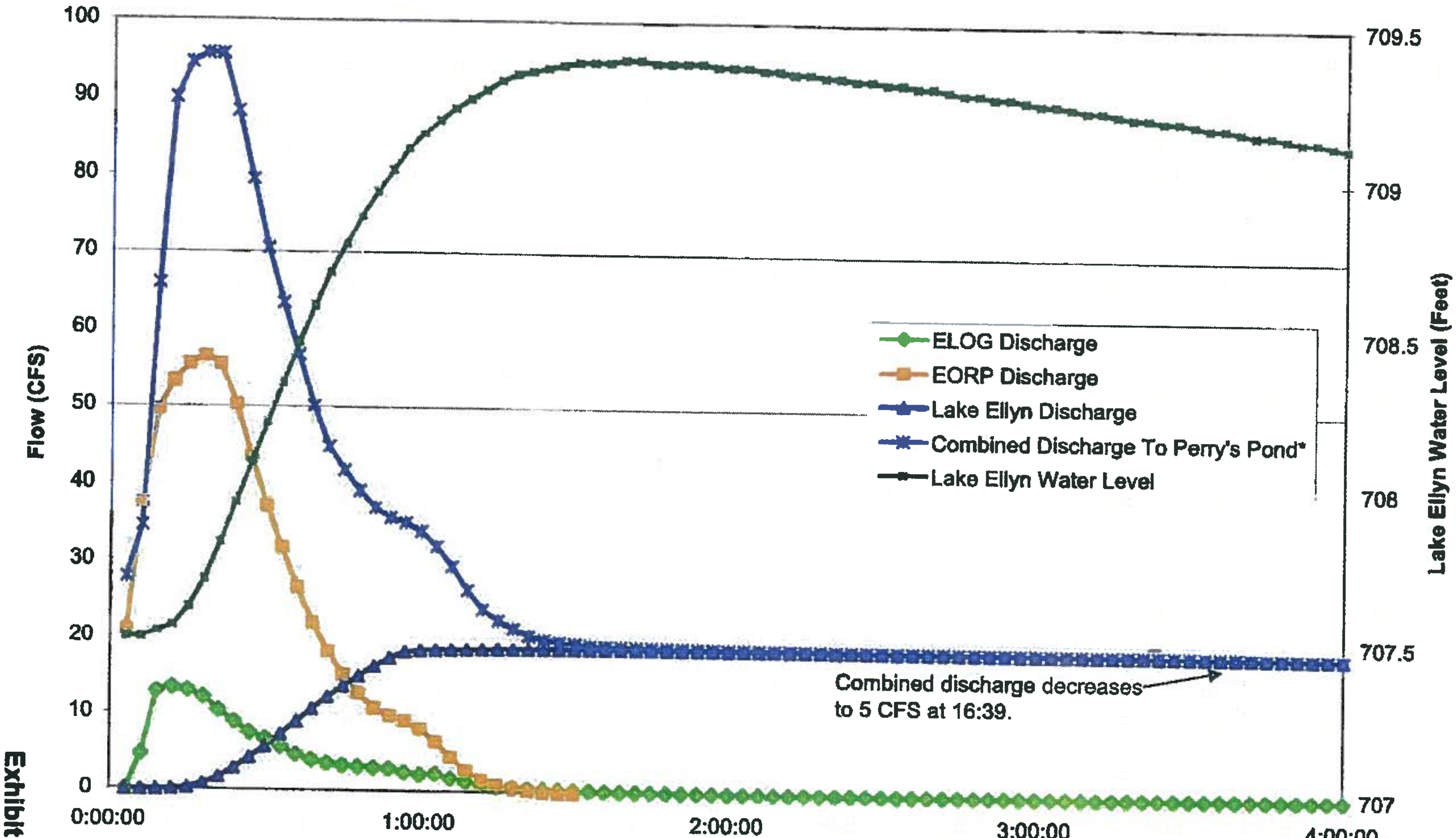
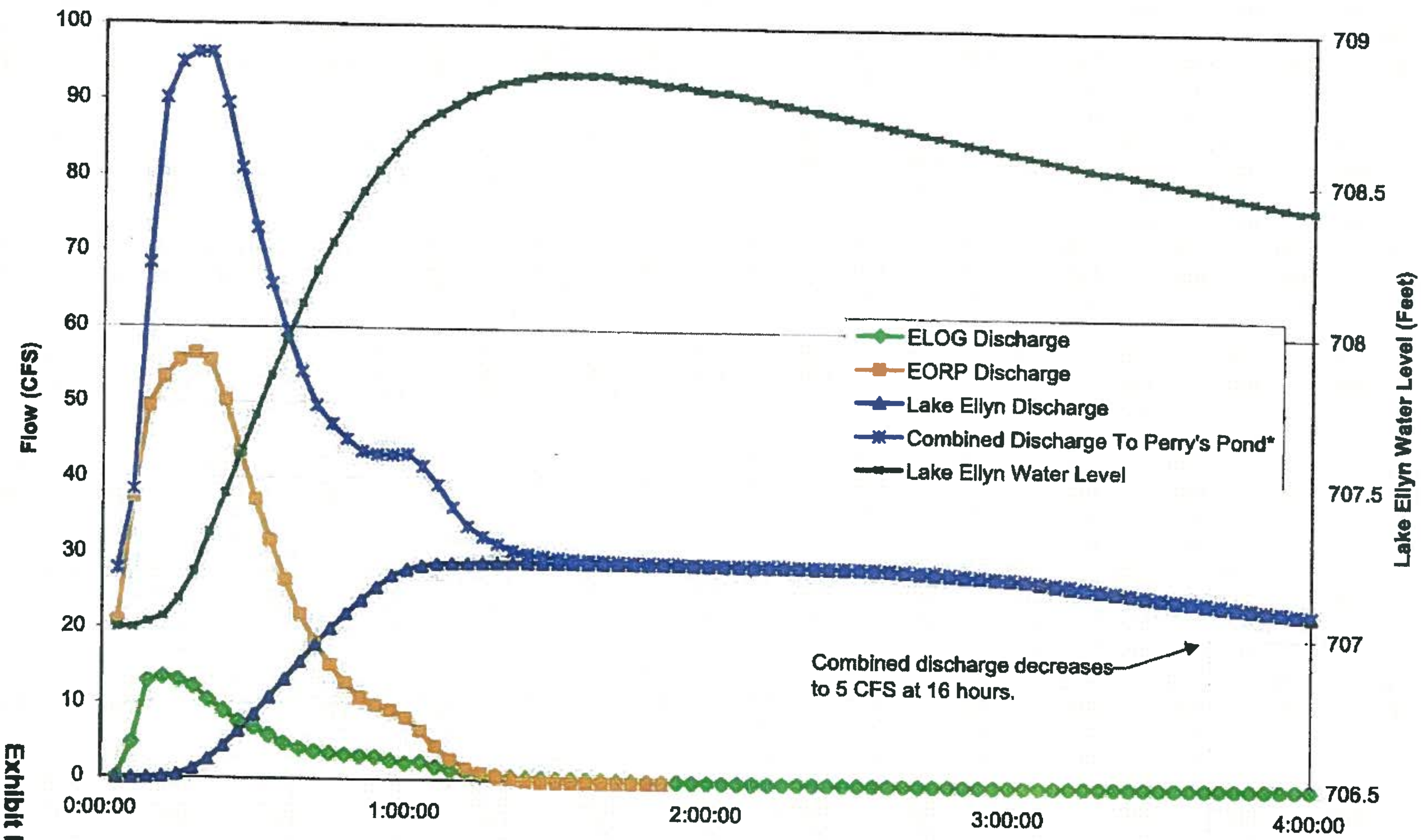


Exhibit L

* Includes flow from Riford Road storm sewer

Exhibit M

Downstream Storm Sewer - 5 Year, 1 Hour Event - Modified Outlet Control Structure



* Includes flow from Riford Road storm sewer

additional outlets have been added, and the capacity of the storm sewer immediately upstream of the pond has not changed. Additionally, prior to 1990, Lake Ellyn discharged via the parallel 33-inch and 24-inch storm sewers and the peak discharge into Perry's Pond from Lake Ellyn during the critical duration 100-year event would cumulatively have been 85 cfs. Table 7 compares the peak flows generated by a 5-year 1-hour rain event for pre- and post-construction of the ELOG improvements and with the existing and proposed modified Lake Ellyn OCS. There is an increase of 10.0 CFS due to the addition of the ELOG improvements. Increasing the discharge from the OCS does not impact the peak discharge into Perry's Pond.

TABLE 7 - PEAK FLOWS INTO PERRY'S POND, 5-YEAR 1 HOUR RAIN EVENT

Condition	**Peak discharge from EORP (cfs @ time)**	**Peak Discharge from Lake Ellyn (cfs @ time)**	**Peak Discharge from ELOG (cfs @ time)**	**Combined Peak Discharge into Perry's Pond** (cfs @ time)**
Pre-ELOG Construction	56.6 @ 00:20	18.83 @ 1:36	5.0 @ 00:12	86.2 @ 00:21
Existing OCS with ELOG Constructed	56.6 @ 00:20	18.83 @ 1:36	13.45 @ 00:12	95.6 @ 00:21
Proposed Modified OCS* with ELOG Constructed	56.6 @ 00:20	29.19 @ 1:36	13.45 @ 00:12	96.2 @ 00:21

*Proposed Modified OCS condition is normal water level of 706.5 with the orifice restrictor plate removed and the weir length increased to 6 feet

**Includes flow from Riford Road Storm Sewer

Moreover, the total volume of flow entering Perry's pond will not be affected by any changes to the outlet structure or lake levels. The runoff characteristics of the Main, Linden and Maple basins are not affected by operational characteristics of Lake Ellyn. As previously noted, increasing the peak discharge from Lake Ellyn will not increase the peak flows in the storm sewer and the lake will drain quicker after rain events. If the lake level is lowered to 706.5 and the orifice restrictor plate removed, the discharge from lake Ellyn will drop to 5 cfs 16.0 hours after the beginning of the storm as opposed to 16.7 hours for the existing OCS conditions for the 5-year 1-hour event.

The impact from potential increased flows on Perry's Pond were also analyzed. A rating curve was established for the first spillway in Perry's Pond with a tail water condition of 691.5 feet, equal to the 100-year base flood elevation. Under that condition, the weir is submerged and the additional 10.0 cfs of discharge would cause a rise of 0.04' over the spillway, or one-half of an inch. If there is not a tailwater condition, the increase in headwater elevation for an additional 10.0 CFS is approximately 0.10', or one and one quarter inches.

D. Modifications to the Overland Flow Route

The ideal overland flow route would terminate at the same location as the underground storm sewer. However, the topography of Riford Road and the area surrounding the Joseph Sam Perry Preserve prevent significant modifications to the overland flow path. The current overland flow route could be modified such that flow is routed through the side yards of 729 and 735 Riford in a more efficient manner. In examining the side yard from the right-of-way and videos published on YouTube.com, it appears that the side yard swale could be graded to be more hydraulically efficient. The side yard appears to be relatively flat between the right-of-way and the east (rear) face of the house at 735 Riford Road. There is a steep drop east of the rear house face and the flow appears to be passing through critical depth to supercritical flow, indicating that the side yard is a hydraulic restriction. It is recommended that the Village pursue discussions with the residents at 729 and 735 Riford Road and investigate the potential to increase flow conveyance through the side yards.

E. Flood Proofing

In addition to modifications of the side yard swale, the Village can discuss floodproofing options with affected residents. The need for floodproofing along the side of the houses may be negated if grading modifications can be made through the side yards. The side yard is abutted by garages attached to residences on the street side. Per FEMA guidelines, attached garages with floors below the base flood elevation (BFE) must be designed to accept floodwaters. The current situation is unique because there is not a BFE in the area, however, there is stormwater that flows towards the garage doors. Potential floodproofing actions include:

1. Creating more positive drainage through the side yard.
2. Increasing the height of window wells where flooding is expected (if window well is not used for emergency escape route).

3. Installing vents along the bottom of the garage wall to allow flood water to flow through.

It should be noted that floodproofing would advertise that there are potential flooding issues on the affected property and could negatively impact the resale value of the homes.

F. Buy-Out Programs

If the above discussed grading and floodproofing options do not provide enough capacity to safely convey stormwater or adequate protection from flooding, then the Village should consider alternate ways to convey stormwater from the emergency overflow spillway. Due to the limited overland flow routes, a buy-out program has been evaluated. Emergency overflows from Lake Ellyn could be safely conveyed with the purchase of one or two strategic lots. The lot(s) could be graded in a manner to channelize and convey the flood flows. There are currently no known federal, state or local funding sources for property buy-outs.

VI. UPDATED OPERATION AND MAINTENANCE MANUAL

The existing Operations and Maintenance Manual for the Lake Ellyn Dam prepared by Harza Engineering Company was prepared in 1991. Since then, there have been improvements to the outlet structure of the lake, and a subsequent Amendment was prepared by Rezek, Henry, Meisenheimer and Gende in 2010. One of the tasks included in this study was to update the Operations and Maintenance Manual to reflect the current operating conditions of the lake. The amended manual is included in Appendix D. There were several additions to the manual, discussed below. If the Village implements certain recommendations from this study, then the O&M Manual will need to be revised to reflect the resulting changes.

A table that lists the time to drain from given elevations for the lake has been added to the operations and maintenance manual. The listed times will actually be longer after rain events due to the inflows from sump pumps and groundwater infiltration, but it provides the Glen Ellyn Park District a basis for monitoring the lake levels after a rain event.

The design storm previously referenced in the O&M manual prepared by Harza was the 100-year, 6 hour event. The critical event noted during this current study was the 100-year 48-hour event. However, the 12 hour event was the event that caused the second highest rise in water level in the lake and was included for reference in the manual rather than the 48 hour event to stress the importance of time. In the original manual, Harza stresses the importance of monitoring the lake during rain events. Including the 48 hour event in lieu of a shorter duration event would not emphasize the importance of time and quick response due to the longer duration of the event.

Lake level gauges have been installed by Park District Staff on the south face of the outlet control structure and along the northwest wing wall adjacent to the boat house. These gauges will allow for more precise monitoring of the lake elevation by staff during rain events. There is also an electronic lake monitoring system connected to an auto dialer that was installed by the Park District as a warning system. The auto dialer is activated as specific lake levels are reached and automatically notifies Park District Staff and residents who have signed up to be on the public call list. Both items have been added to the Operations and Maintenance Manual in Section 2.1.