CITY OF ORLAND

STORM DRAINAGE MASTER PLAN

August, 2009

Prepared By:

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Council Member	Wade S. Elliott
Council Member	Reggie Olney

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1.0 Introduction

This section summarizes the results from the Master Storm Drain Plan Study and identifies drainage deficiencies throughout the city and within the collection and detention system.

1.1 Existing Storm Drainage System

The storm drain system is comprised of surface drainage, junction boxes, minor collection lines, major collection lines and detention basins. The purpose of the system is to transmit storm water runoff to one common location so as to eliminate flooding and provide erosion control. The existing system currently utilizes a common city collection system as well as privately developed on-site retention and/or detention systems.

1.2 Existing System Deficiencies

The first indicator of insufficient drainage is localized flooding. Localized flooding is caused by poor surface drainage, clogged or undersized storm drain drop inlets, and clogged or undersized collection lines. Areas with missing sections of curb and gutter are extremely susceptible to localized flooding. Orland has soil with an extremely high percolation rate, which helps to prevent flooding. However, when rainfall exceeds the percolation rate, the areas without surface drainage accumulate water that cannot drain away from the road. Approximately 25% of the city's streets lack curb and gutter to carry storm water runoff to the collection system.

Many streets within the city have no collection system, forcing water to flow overland for extremely long lengths. Long overland drainage causes flows to become more characteristic of open channel flows. This type of flow is faster, deeper and more turbulent. In areas without continuous curb and gutter, the flow is more destructive to the edge of the roadway. This causes the edge of the pavement to fail and in some cases it can begin to undermine the roadway. Approximately half of the city area exhibits excessive overland flow lengths. In many cases, these lengths exceed 2000 feet. Preferable maximum overland flow lengths would not exceed 500 feet.

Areas of town lacking a collection system often utilize siphons at intersections to move surface drainage across elevated roadways. In order for the siphon to operate, the water must first fill the pipe entirely and begin to fill the inlet boxes so as to create an equal pressure at both ends. Once equal pressure is achieved, gravity will pull the water through the pipe from the higher end to the lower end of the pipe. This method encourages localized flooding in the vicinity of the inlet boxes, and still relies on surface flow to move the water away from the siphon. Siphon pipes and inlets can easily become filled with silt and debris, which reduces their efficiency and reliability. Siphons are not a substitute for a collection system and should only be used as a temporary solution. Approximately half of the city is without a storm drain collection system.

The city has five major collection lines that convey storm water from different regions within the same tributary area to Lely Aquatic Park. Most of the major collection lines are undersized. During high rainfall periods, the pipelines become surcharged. This incites localized flooding at drop inlets due to the accumulation of surface drainage.

The primary concern with the existing storm water pipeline infrastructure is the undersized major collection mains. Until major collection mains are installed throughout the City, the increase of surface runoff will not be adequately handled.

2.0 Purpose

This Storm Water Master Plan was authorized by the Orland City Council to provide planning for current and future development within the Planning Area of the City of Orland. The main objectives of this report are to (1) evaluate the existing storm drain infrastructure and its ability to collect and transmit existing storm water flows, (2) determine deficiencies within the system and to evaluate feasible solutions to correct them, (3) select the most economical solutions to correct deficiencies (4) identify potential storage locations for storm water detention within the City's sphere of influence, and evaluate methods of transmission to the proposed locations.

The principal elements of this study include the following:

- Description of the existing storm water collection system and detention basin.
- Evaluation of the existing storm water collection system, and its ability to handle existing and future flows.
- Guidelines for future pipe sizes and infrastructure improvements within the storm water collection system.
- Evaluation of the Lely Aquatic Park basin, and its ability to handle existing and future flows.
- Preparation of a Capital Improvement Program that identifies a prioritized schedule of recommended improvements and replacement of facilities.
- Development of cost estimates to complete the recommended Capital Improvement Program to identify the impact on maintenance and future development revenues.

2.1 Sources of Information

Operational data including historical storm water flows and depths were obtained from the City of Orland Department of Public Works.

Information about the existing storm water collection system including pipe sizes, types and grades was collected from "As-Built" Improvement Plans and field surveys conducted by Rolls, Anderson and Rolls.

Future development and planned land use within the planning area of the city of Orland were obtained from the Amendment to the City of Orland General Plan prepared by Pacific Municipal Consultants and adopted by the City Council in March of 2003.

2.2 Engineering Analysis

Evaluation of the storm water collection system included an engineering analysis of several different scenarios that compared current and future flows to the existing capacity of the system. This analysis was conducted using conventional methods for calculating pipe flows. The results of the analysis were confirmed through field observations of current pipe sizes and routing at manholes and outfall structures throughout the system.

Lely Aquatic Park was analyzed for its ability to handle existing and future flows. This analysis was based on the existing system capacity and needed capacity determined from calculations using 10, 50 and 100 year storm events to identify storage volume deficiencies.

3.0 Introduction

The City of Orland maintains five storm drain detention basins within the city limits. The primary storm drainage system collects and transmits storm water from residential and commercial properties within the city limits to the Lely Aquatic Park basin. The other four detention basins provide storage for individual developments.

Due to the configuration of irrigation canals throughout the city, the primary collection system tributary area is bounded by the following features:

- South Canal and Irrigation Lateral Number 40 to the north
- Irrigation Lateral Number 50 to the east
- City Limit Line to the south
- Interstate 5 to the west

Design and construction limitations in the vicinity of irrigation canals, makes it difficult to connect new development to the primary collection system. As a result, new development outside of the primary tributary area has had to provide on-site storm water detention designed for a 100 year storm event. Figure 3-1 shows the boundary of the primary collection system tributary area.

3.1 Location and Capacity of Existing Detention Basin

The primary collection system drains to the Lely Aquatic Park Basin located in the southeast portion of the city limits on the northeast corner of Road 200 and Road MM. The overall ground gradient throughout the city is from northwest to southeast, making Lely park a natural location for storm water accumulation. The storage capacity of Lely Park is approximately 52 acre-feet of water, at which point the water would be at the same elevation as the entrance. The current storm capacity of the Lely Aquatic Park basin is approximately a 25 year storm rating.

3.2 Adequacy of Existing System

Flow capacity calculations based on a 10 year storm show that the majority of the primary collection lines are undersized, and therefore not able to handle the needed capacity of a 10 year storm occurrence. Table 3-1 shows the existing capacities of the main collection lines and the proposed replacement pipe sizes based on design flows for a 10 year storm. Figure 3-2 shows the replacement pipe locations and sizes. Many areas of the city have no storm drain improvement, which hinders the movement of storm water off of street surfaces and into the storm drain system. At this time, the lack of storm drainage improvements in many areas is preventing the undersized collection lines from becoming inundated during normal storm conditions. Though it may help to mediate current storm water flows, insufficient storm drain improvements are often more destructive to transportation infrastructure.

Insufficient collection lines force water to remain on the surface and flow along the edge of the roads. If the road surface has little to no crown, then the water can remain on the road. Though asphalt has oil, which helps to repel water, cracks in the asphalt allow water to penetrate through the asphalt and into the base section. This softens the base section and makes the road surface stability vulnerable to the weight of traveling cars. Over time, an area of asphalt that is subject to routine ponding will begin to deteriorate faster and create potholes.

A major cause of ponding within the City of Orland is missing segments of curb and gutter. Curb and Gutter provides a means for directing surface flow off of road surfaces and into a collection system. Most of the streets within the city have curb and gutter improvements, but the improvements are not continuous. When gaps in the curb and gutter exist, water drains from one section of curb and gutter and then onto the existing ground at the edge of the road. Existing ground between sections of curb and gutter is typically lower than the flow line of the gutter, forcing water to pond up before it continues to drain through the next section of curb and gutter. When the water travels along the edge of the road and into a gutter, it collects more silt and debris. The silt and debris is then deposited into the collection box, if it does not get trapped by the grate first. Silt and debris settle out in the pipes and collection boxes causing restriction to the flow of storm water and reducing the pipe's flow capacity. Figure 3-2 shows all the areas within the city limits with missing curb and gutter.

Most of the older concrete in town was only constructed as a barrier curb, not having a gutter pan. The barrier curb helps to channel water towards a collection box; however, the water drains along the seam between the asphalt and the concrete curb. Over time the water penetrates the seam and begins to degrade the asphalt and the base section below it.

3.3 Effects of Exceeding Existing Capacity

During storms with high rainfall intensities (greater than a 25-year storm event), the major collection lines reach their capacity and cause localized flooding at the collection boxes and areas of lower elevation in the streets. Water flowing to Lely Park fills the basin beyond its storage capacity and the water begins to flow out of the basin at the entrance. Water exiting the Lely Park basin begins flowing south and east along Road 200 to the intersection of Road MM. Localized flooding at the northeast corner of the intersection of Road 200 and Road MM occurs before the water continues to flow south and east along Road 200. Once across the intersection, the lack of roadside drainage improvements allows water to flow into the commercial properties on the north side of Road 200 beginning at the county building and flowing towards the Tehama-Colusa Canal. Once the water reaches the intersection of Road 200 and Road N, it begins to accumulate in the parcels of land to the northwest of Road 200 and Road N.

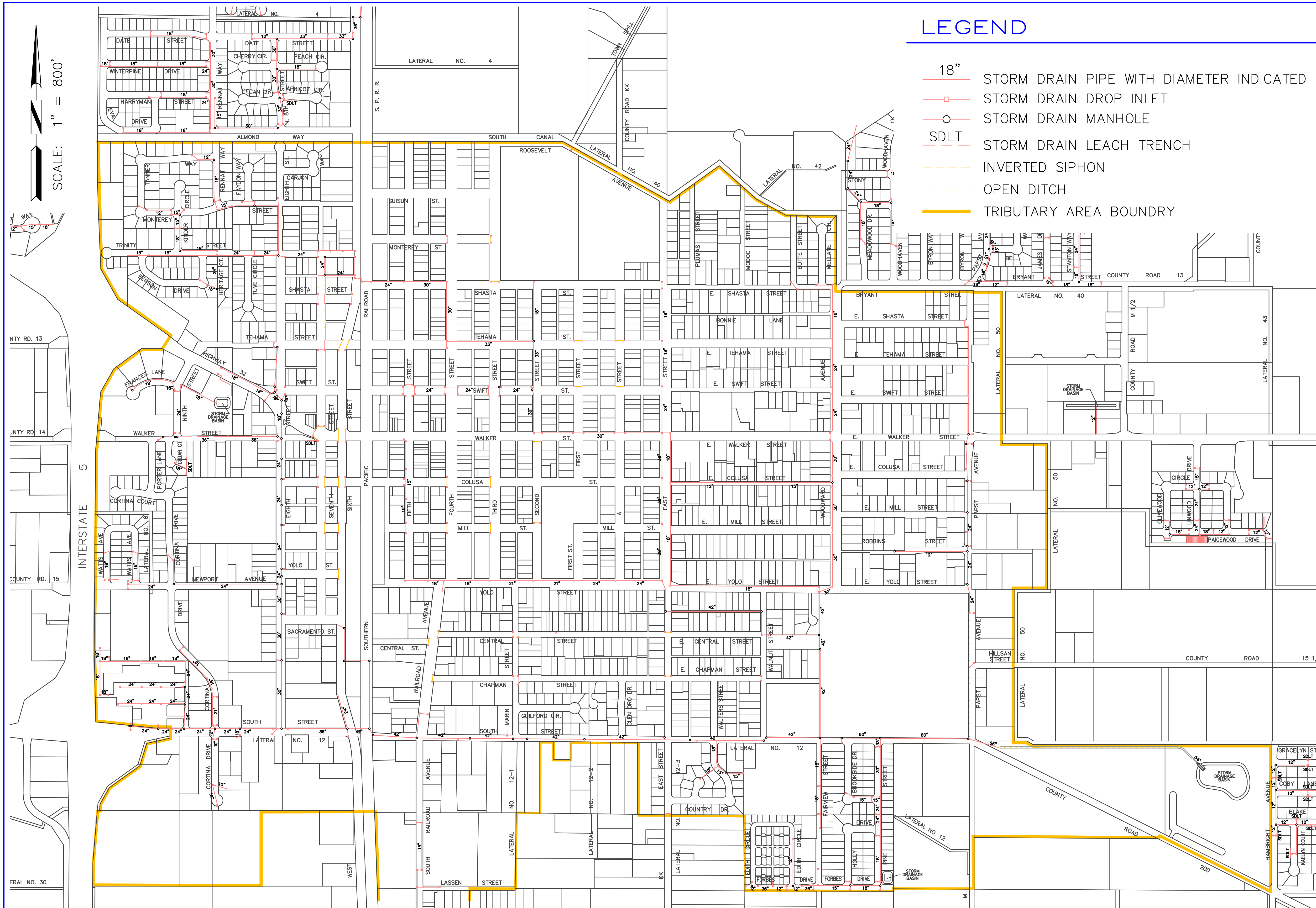

FIGURE 3-1

CITY OF ORLAND

LELY PARK BASIN
TRIBUTARY STORM WATER AREA

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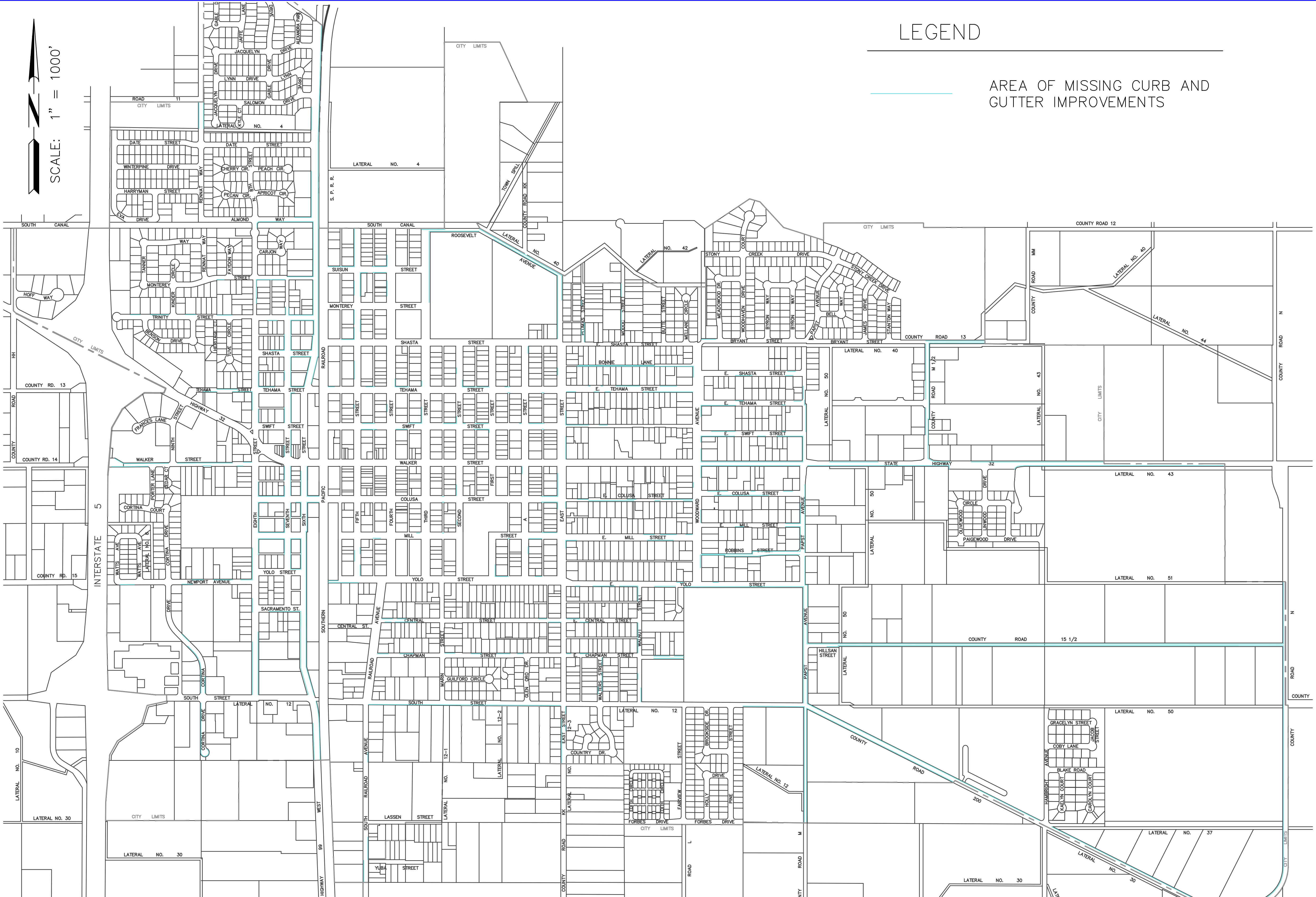

LEGEND

AREA OF MISSING CURB AND GUTTER IMPROVEMENTS

FIGURE 3-2

CITY OF ORLAND

MISSING SEGMENTS OF CURB AND GUTTER

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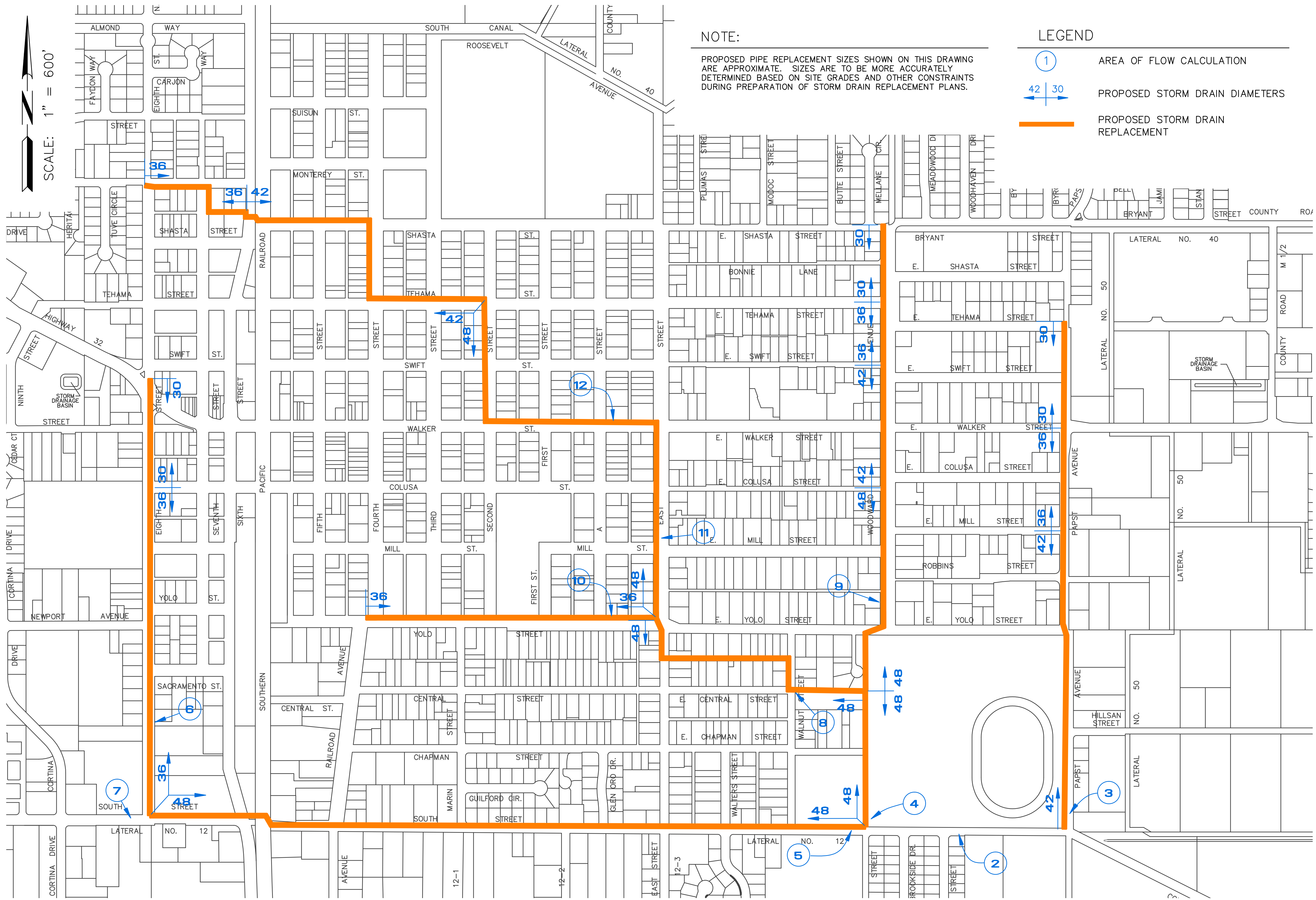
Pipe Design Flows for a 10 Year Storm Occurrence

For a given location, flows are to be at a minimum equal to
flows upstream of that location.

		Loc. 1	Loc. 2	Loc. 3	Loc. 4	Loc. 5	Loc. 6	Loc. 7	Loc. 8	Loc. 9	Loc. 10	Loc. 11	Loc. 12
Required Capacity	Calculated	78	70	38	40	32	31	11	29	44	26	50	56
	Minimum	70	60	0	56	60	0	0	60	0	0	56	0
	Design Flow	**78**	**70**	**38**	**56**	**60**	**31**	**11**	**60**	**44**	**26**	**56**	**56**
Existing Capacity (Calculated from Mannings Equation)	Dia.(in)	60	60	24	42	42	30	24	42	30	24	39	30
	Area (sq. ft.)	20	20	3	10	10	5	3	10	5	3	8	5
	Slope	0.0010	0.0018	0.0030	0.0020	0.0020	0.0020	0.0020	0.0020	0.0023	0.0018	0.0018	0.0018
	n	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
	V_full (fps)	4.6	6.1	4.3	5.1	5.1	4.1	3.5	5.1	4.4	3.3	4.6	3.9
	Q_full (CFS)	**89**	**120**	**13**	**49**	**49**	**20**	**11**	**49**	**21**	**10**	**38**	**19**
Replacement Pipe (Calculated from Mannings Equation)	Dia.(in)	0	0	**42**	**48**	**48**	**36**	0	**48**	**48**	**36**	**48**	**48**
	Area (ft^2)	0	0	10	13	13	7	0	13	13	7	13	13
	Slope	0.0010	0.0018	0.0012	0.0020	0.0020	0.0020	0.0020	0.0020	0.0023	0.0018	0.0018	0.0018
	n	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
	V_full (fps)	0.0	0.0	3.9	5.6	5.6	4.6	0.0	5.6	6.0	4.3	5.3	5.3
	Q_full (CFS)	**0**	**0**	**38**	**70**	**70**	**32**	**0**	**70**	**75**	**31**	**66**	**66**

TABLE 3-1



NOTE:

PROPOSED PIPE REPLACEMENT SIZES SHOWN ON THIS DRAWING ARE APPROXIMATE. SIZES ARE TO BE MORE ACCURATELY DETERMINED BASED ON SITE GRADES AND OTHER CONSTRAINTS DURING PREPARATION OF STORM DRAIN REPLACEMENT PLANS.

LEGEND

1 — AREA OF FLOW CALCULATION

42 | 30 — PROPOSED STORM DRAIN DIAMETERS

PROPOSED STORM DRAIN REPLACEMENT

FIGURE 3–3

CITY OF ORLAND

RECOMMENDED STORM DRAIN PIPE REPLACEMENT

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4.0 Introduction

This section provides the following pertaining to storm water collection and detention:

- The effect of future growth within the existing tributary area on the storm water collection system and detention basin
- The effect of future growth in the east side of the city on the collection system and detention basin
- Current and future storage requirements based on a 50 year storm with no increase from future developments
- Current and future storage requirements based on a 50 year storm when new development is allowed to connect to the city storm drain system

4.1 Development Within the Existing Tributary Area

Gravity fed irrigation canals within the city limits act as a levee system, which defines the existing tributary area for storm water runoff on the north and east sides of the city. The existing tributary area is defined in the introduction of section 3.0. Residential and commercial areas within the existing tributary area are nearing maximum infrastructure build-out. Any development within the existing tributary area would have a negligible impact on the storage capacity of a storm water basin or the flow capacity of the collection system. Tables 4-1, 4-2 and 4-3 show storm water flows and storage volumes for a 10, 50, and 100 year storm occurrence.

TABLE 4-1
Storm Water Flows at Lely Park Basin
(10 Year Storm)

Storm Duration (Hours)	Net Flow Into Lely Park Basin (Cubic Feet per Second)	Cumulative Storm Water Volume (Acre-Feet)
7.4	0	0
8.9	12	1
10.4	24	4
11.9	32	8
13.3	37	13
14.8	37	17
16.3	37	22
17.8	32	26
19.3	27	29
20.8	21	32
22.2	13	33
23.7	4	34
25.2	-3	33
26.7	-9	32
28.2	-13	31
	Maximum Cumulative Volume	34 Acre-Feet
	Lely Park Storage Provided	50 Acre-Feet
	Additional Storage Required	**0 Acre-Feet**

TABLE 4-2
Storm Water Flows at Lely Park Basin
(50 Year Storm)

Storm Duration (Hours)	Net Flow Into Lely Park Basin (Cubic Feet per Second)	Cumulative Storm Water Volume (Acre-Feet)
5.9	0	0
7.4	17	2
8.9	40	7
10.4	58	14
11.9	71	23
13.3	78	32
14.8	79	42
16.3	78	52
17.8	71	60
19.3	63	68
20.8	54	75
22.2	42	80
23.7	28	83
25.2	16	85
26.7	8	86
28.2	1	86
29.7	-5	85
32.6	-14	82
35.6	-21	77
	Maximum Cumulative Volume	86 Acre-Feet
	Lely Park Storage Provided	50 Acre-Feet
	Additional Storage Required	**36 Acre-Feet**

TABLE 4-3
Storm Water Flows at Lely Park Basin
(100 Year Storm)

Storm Duration (Hours)	Net Flow Into Lely Park Basin (Cubic Feet per Second)	Cumulative Storm Water Volume (Acre-Feet)
4.4	0	0
5.9	15	2
7.4	42	7
8.9	74	16
10.4	101	28
11.9	120	43
13.3	130	59
14.8	132	75
16.3	130	91
17.8	120	106
19.3	108	119
20.8	94	130
22.2	77	140
23.7	57	147
25.2	40	152
26.7	28	155
28.2	18	157
29.7	9	159
32.6	-3	158
35.6	-13	155
38.6	-20	150
	Maximum Cumulative Volume	159 Acre-Feet
	Lely Park Storage Provided	50 Acre-Feet
	Additional Storage Required	**109 Acre-Feet**

4.2 Future Development on the East Side

The majority of new developments within the city limits will occur on the east side of Lateral No. 50 and extending to the city limits at Road N. Currently, all new and planned developments on the east side of the city have been required to design for on-site storm drain detention utilizing a 100 year storm capacity. This method of development planning, places the cost of storm drain improvements with the developer. The city then accepts the maintenance requirements of the on-site system one year after completion. An additional requirement of the on-site retention is the creation of a maintenance assessment district, which places the cost of maintenance for the system on the individual property owners within the affected development. Requiring developments to design for on-site storm water detention provides no net increase to the city collection system.

The tributary area of east side Orland is approximately one-third that of the existing Orland tributary area. If a need to connect the east side of Orland to the city's storm drain system ever arises, it could be assumed that storm water runoff flows would be approximately 33% of the existing runoff. This would also require 33% more storage capacity than the city's current needs which equates to approximately 29 acre-feet of additional storage based on a 50 year storm occurrence.

5.0 Introduction

The difficulty with planning for storm water storage is locating and acquiring a large enough detention site in a suitable area. This section will provide the storage capacity and needs of the existing tributary area based on 10, 50, and 100 year storms. It will also provide an alternative storage location and methods for moving water to an alternative storage location.

5.1 Storage Requirement for Existing Tributary Area

The existing capacity of Lely Aquatic Park is approximately 50 acre-feet of fluid storage. This provides enough storage capacity for a 25 year storm occurrence. The ideal solution would be to have a storage capacity large enough to accommodate the storm water runoff from a 100 year storm event. The storage capacity needed for a 100 year storm occurrence is approximately 114 acre-feet, more than double that of the available storage at Lely Park. A more practical solution would be for the City to provide adequate storage capacity capable of mitigating a 50 year storm occurrence with a needed capacity of 86 acre-feet. Because Lely Park does not provide enough storage for a 50 year storm occurrence, it is necessary to identify and obtain a second location for storm water storage.

5.2 Additional Storage Location and Capacity

Located 1.2 miles southeast of Lely Aquatic Park is a former gravel borrow area which can function as a storm drainage basin. This borrow area/basin is at the northwest corner of the Haigh Field Airport. The existing size of the basin provides an estimated 35-40 acre-feet of storage volume. It is possible that the basin could also be enlarged to provide an additional 10 acre-feet of storage, if needed. The airport basin would act as an overflow location for the Lely Park Basin. Due to the extremely flat grading conditions throughout the City of Orland, as well as the Tehama-Colusa Canal, methods for moving water from one basin to the other are limited.

At this time there are no other properties owned by the City of Orland that are located near the Lely Park basin. Any property other than the basin at the airport would have to be purchased by the City of Orland and then improved as a basin.

5.3 Future Storm Drainage Infrastructure between Basins

The most cost effective method for transmitting water is a gravity pipe line. In this situation a gravity line is not practical due to required pipe sizes and the depth necessary to pass beneath the Tehama-Colusa (TC) Canal. A more feasible solution is the use of a pump station at the Lely Park basin. The pump station would have to convey the storm water through a smaller diameter pressure pipe to the east side of the TC Canal. The advantages of a pressure system are that the pipe does not have to be set at a defined slope and that the pipeline could be placed in a relatively shallow trench. The pipeline would be much smaller in diameter (40%), allowing it to be installed over the canal as opposed to boring beneath the canal. Once storm water is on the east side of the canal, it could be discharged into a gravity flow line that would carry the water to the basin at the airport.

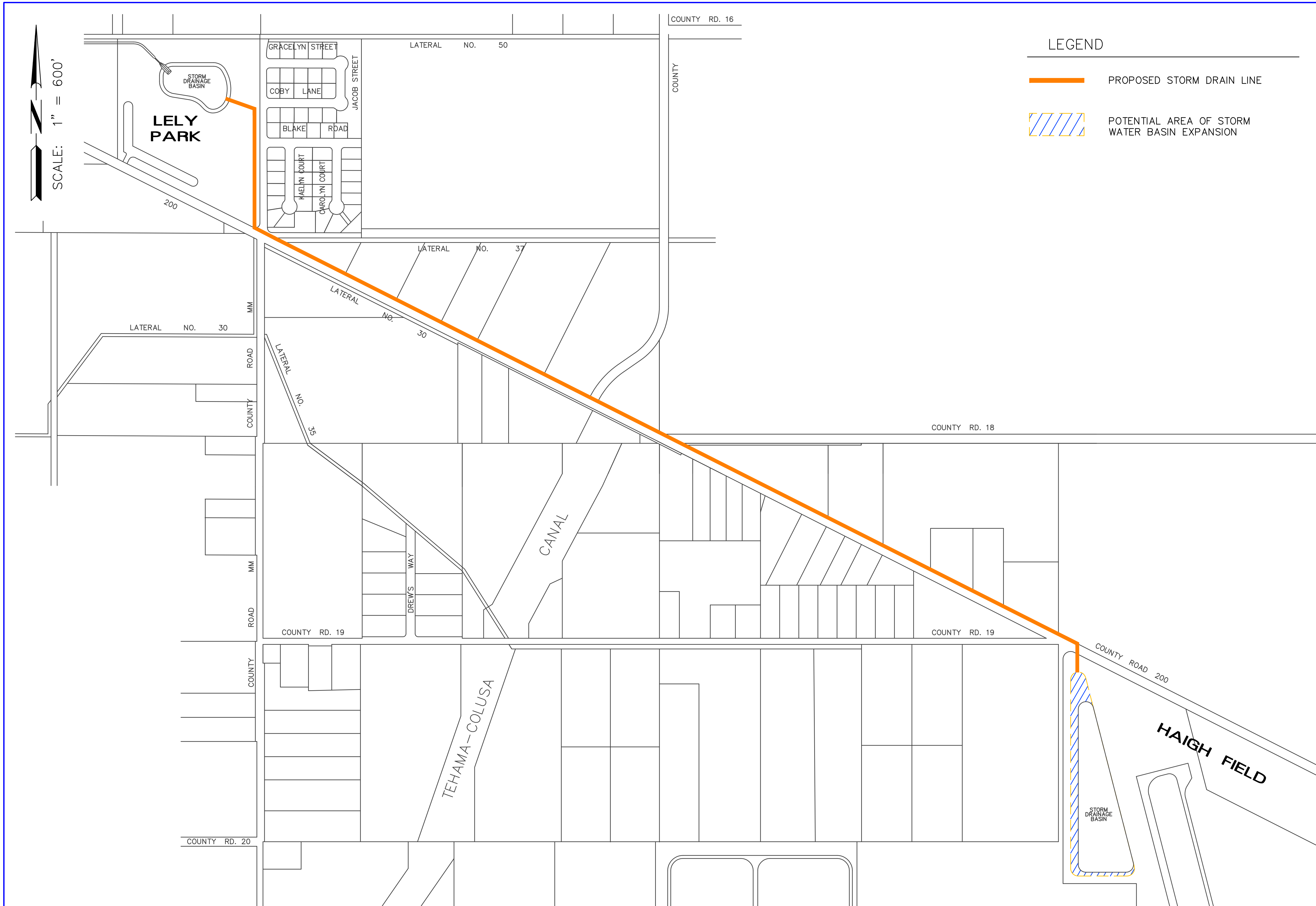

FIGURE 5-1

CITY OF ORLAND

PROPOSED ADDITIONAL STORM WATER RETENTION

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6.0 Introduction

This section describes and provides cost estimates for all capital projects recommended by this report. The unit prices in the cost estimates were obtained from the Butte County Department of Public Works standard estimating rates dated April 8, 2008 and from actual construction costs from similar projects.

6.1 Existing Storm Drain Infrastructure Repair and Replacement

The first priority for upgrades to the City of Orland storm water mitigation plan should be the replacement of the undersized major storm drain collection lines. The main collection lines need to be of the correct size before other improvements are completed that may channel additional runoff into the lines. The approximate cost per lineal foot of reinforced concrete pipe installed for the necessary pipe sizes are as follows:

- 30" Pipe = $100.00 / LF
- 36" Pipe = $120.00 / LF
- 42" Pipe = $145.00 / LF
- 48" Pipe = $170.00 / LF

In addition to replacing the major collection lines, minor collection lines and drop inlets should be installed in areas of the city that do not currently have a collection system. The approximate cost per lineal foot of storm drain pipe installed for typical minor collection line pipe sizes are as follows:

- 12" Pipe = $60.00 / LF
- 15" Pipe = $70.00 / LF
- 18" Pipe = $70.00 / LF
- 24" Pipe = $70.00 / LF

After the collection lines are completed, the second priority for upgrades to the city's system is to install missing concrete curb and gutter sections. The approximate cost per lineal foot of concrete curb and gutter installed is $15- $20.

6.2 New Infrastructure Projects

In order to accommodate storm water flows from a 50 year storm occurrence, construction of a pump and pressure line from Lely Park basin to the east side of the Tehama-Colusa Canal would need to be completed. As well, a gravity pipeline would need to be installed from the canal to the basin at Haigh Field. The peak flow into Lely Park basin during a 50 year storm occurrence is approximately 35,500 GPM (Gallons per Minute). Pump selection does not need to accommodate the peak flow as long as the pump is sized appropriately and begins pumping well in advance of the peak runoff's arrival at Lely Park Basin.

A pump capable of moving 20,000 GPM would need to begin pumping around nine hours following commencement of a 50 year storm event. The time in which pumping is initiated could be earlier or later based on storm forecasts and desired water level in the Lely Park basin. The associated costs of moving storm water from Lely Park basin to the Haigh Field basin is as follows:

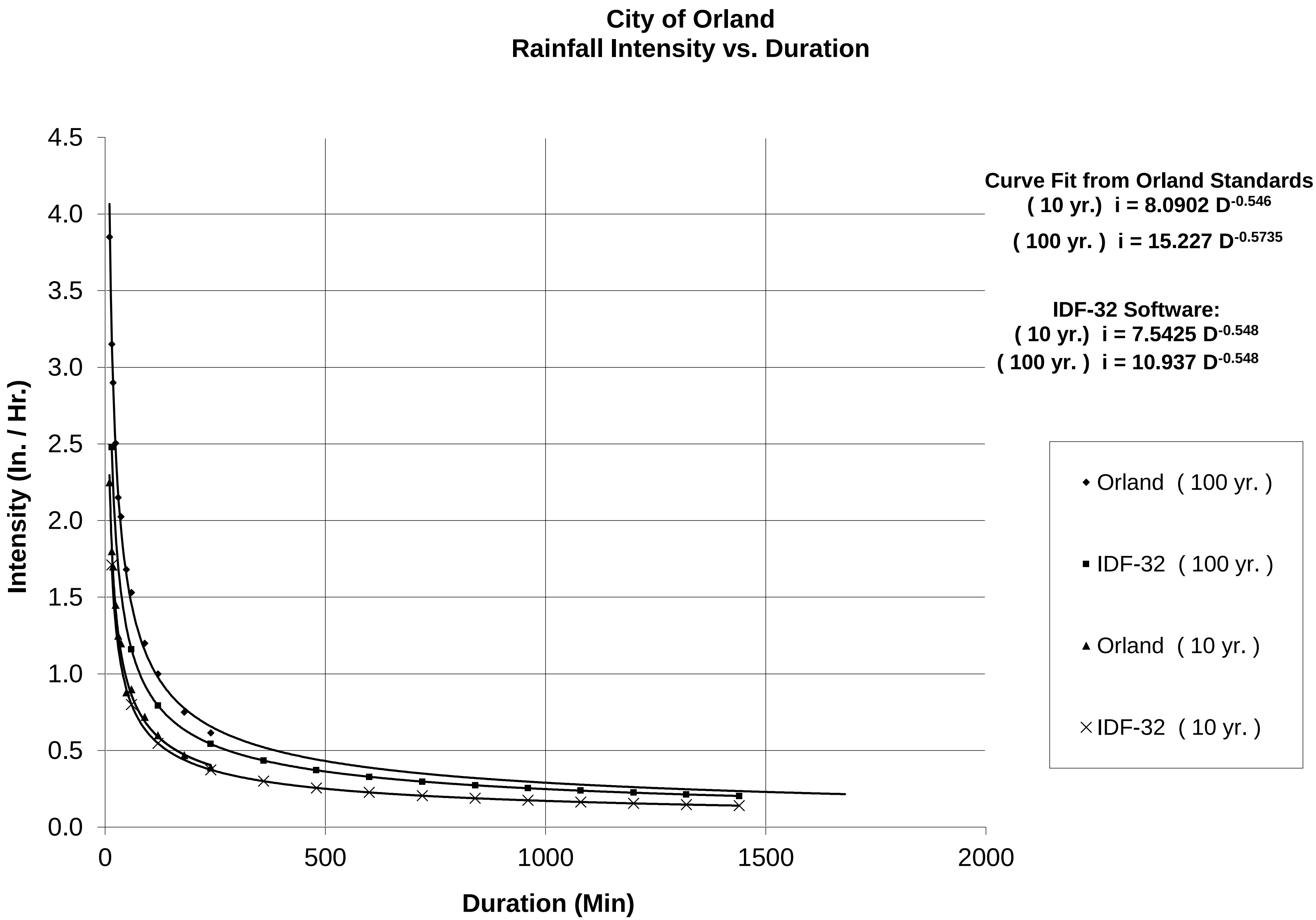
- Pump (20,000 GPM) = $165,000
- 24” Pressure Pipe = $70.00 / LF x 3,753 LF = $262,710
- 48” Gravity Pipe = $170.00 / LF x 3,453 LF = $587,010

The total cost to complete the project is estimated to be $1,014,720.

APPENDIX A

City of Orland

Rainfall Intensity vs. Duration Chart


City of Orland
Rainfall Intensity vs. Duration
Intensity (In. / Hr.)
Duration (Min)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
0
500
1000
1500
2000
Curve Fit from Orland Standards
(10 yr.) i = 8.0902 D^-0.546
(100 yr.) i = 15.227 D^-0.5735
IDF-32 Software:
(10 yr.) i = 7.5425 D^-0.548
(100 yr.) i = 10.937 D^-0.548
Orland (100 yr.)
IDF-32 (100 yr.)
Orland (10 yr.)
IDF-32 (10 yr.)