Storm Drain Master Plan

DRAFT 2015

Prepared by:

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

Prepared for:

OREM

STORM DRAIN MASTER PLAN

2015

DRAFT

Prepared for:

Prepared by:

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

TABLE OF CONTENTS

Page No.

CHAPTER 1 – INTRODUCTION 1-1
Introduction 1-1
Scope of Services 1-1
Acknowledgements 1-2
Project Staff 1-3

CHAPTER 2 – EXISTING FACILITIES 2-1
Introduction 2-1
Service Area 2-1
Storm Water Collection System 2-1
Detention Basins 2-1
Sumps 2-2

CHAPTER 3 – HYDROLOGIC ANALYSIS 3-1
Drainage Basin Delineation 3-1
Hydrologic Model Parameters 3-1
Hydrology Method 3-1
Loss Method 3-2
Design Storm Parameters 3-3
Model Calibration 3-3
Calibration Target Range 3-4
Subcatchment Width 3-4
Hydrologic Modeling Assumptions 3-4
Existing Inlet Capacity Issues 3-4

CHAPTER 4 – HYDRAULIC MODELING 4-1
Geometric Model Development 4-1
Modeled Conveyance 4-1
Detention Basins 4-1
Profiles 4-1

CHAPTER 5 – SYSTEM EVALUATION 5-1
Evaluation Criteria and Level of Service 5-1
Storm Drain Pipelines 5-1
Open Channels 5-1
Culverts 5-1
Detention Basins 5-1
Sumps 5-1
Irrigation Canals 5-1
Existing Conveyance System Analysis 5-2
Future Conveyance System Analysis 5-2

TABLE OF CONTENTS
(continued)

Page No.

CHAPTER 6 – RECOMMENDED SYSTEM IMPROVEMENTS 6-1
Types of Recommended Improvements 6-1
Recommended Pipeline Improvements 6-1
Open Channel Improvements 6-7
Detention Basin Improvements..... 6-7
Culvert Improvements 6-8

LIST OF APPENDICES

APPENDIX A – HYDROLOGIC DATA
APPENDIX B – INFOSWMM INPUT AND OUTPUT
APPENDIX C – COST ESTIMATE DATA
APPENDIX D – STORM WATER ORDINANCE
APPENDIX E – STORMWATER STANDARDS MANUAL

TABLE OF CONTENTS
(continued)

LIST OF TABLES

No.	Title	Page No.
2-1	Orem Storm Water Pipe Lengths	2-1
3-1	SCS Curve Number	3-2
3-2	Average Imperviousness Based on Land Use	3-3
6-1	Storm Drain Trunkline Improvements	6-1
6-2	Natural Channel Improvements	6-7
6-3	Required Capacity at Detention Basins	6-7
6-4	Required Capacity at Culverts	6-9

TABLE OF CONTENTS
(continued)

LIST OF FIGURES

No.	Title	On or Following Page No.
2-1	Existing Storm Water System	2-1
2-2	Existing Sump Storm Water Systems	2-2
3-1	Subcatchment Boundaries	3-1
4-1	Modeled System	4-1
5-1	Safe Sump Zone	5-1
5-2a	Existing North Model Results	5-2
5-2b	Existing South Model Results	5-2
6-1a	Proposed Projects North Model	6-1
6-1b	Proposed Projects South Model	6-1

CHAPTER 1
INTRODUCTION

INTRODUCTION

The City of Orem (City) retained Bowen Collins & Associates (BC&A) to prepare this master plan for the City's storm drain system. The City determined that a new storm water master plan was needed before a new Capital Facilities Plan could be completed.

The primary purpose of this Storm Drain Master Plan is to provide recommended improvements to resolve existing and projected future deficiencies in the City's storm drain system based on the adopted General Plan. The resulting Rate Study will be used to establish storm drain rates for the City.

This document is a working document. Some of the recommended improvements identified in this report are based on the assumption that development and/or potential annexation will occur in a certain manner. If future growth or development patterns change significantly from those assumed and documented in this report, the recommendations may need to be revised. The status of development should be reviewed at least every five years. This report and the associated recommendations should also be updated every five years.

SCOPE OF SERVICES

The general scope of this project involved a thorough analysis of City's storm drain system and its ability to meet the present and future storm drain needs of its residents. As part of this project, BC&A completed the following tasks:

Task 1: Review existing InfoSWMM model and other data provided by Orem City. Collect and review state and federal guidelines.

Task 2: Review existing deficiencies with City personnel and develop conceptual solutions. Categorize these deficiencies into 3 categories based on priority year.

Task 3: Work with City personnel to collect supplemental data and input data into InfoSWMM model.

Task 4: Establish appropriate rainfall depths for the hydrologic model for a storm with a 10% probability of occurring in any given year (10-yr Storm). Develop a hydrologic computer model of the study area for land use conditions, using City zoning and land use information. Update subcatchment boundaries for the use of this model. Develop parameters for these subcatchments. Calibrate model to runoffs reasonable to the area. Insert detention basins with the associated stage storage curves.

Task 5: Modify Existing Conditions Hydraulic model (Task 1) for future conditions based on the City's zoning and land use information. Identify both existing and

future deficiencies. Propose improvements for each deficiency including cost estimates and a phasing plan for implementing these improvements.

Task 6: Evaluate city's storm water program and propose recommended improvements. Develop strategies for new UPDES monitoring requirements and prepare an updated UPDES Storm Water Management Plan.

Task 7: Collect and review city's existing storm water standards. Identify any needed changes and apply these changes to a new Stormwater standards manual. Post manual on website for public discussion and make the necessary updates to finalize the manual.

Task 8: Identify a rate approach for the city and develop a rate model for the city. Develop three CIP rate schedules and present the results to city council.

Task 9: Involve the public in the master planning effort by presenting results at three city council meetings. Conduct three public information open houses.

Task 10: Prepare a draft master plan report to be reviewed with city personnel. Incorporate comments and finalize master plan report.

This report is prepared as part of Task 10. In conjunction with the master plan, a connection fee and rate study were also completed by BC&A's financial subconsultant, Lewis Young Robertson & Burningham. The results of these activities are documented in a separate report.

ACKNOWLEDGMENTS

The BC&A team wishes to thank the following individuals from Orem City for their cooperation and assistance in working with us in preparing this report:

Chris Tschirki	Public Works Director
Neal Winterton	Water Resources Division Manager
Sam Kelly	City Engineer
Steve Weber	Maintenance Division Manager
Rick Sabey	Public Works Field Supervisor
Stan Orme	Streets/Storm Water Section Manager
Steve Johnson	Storm Water Engineer Specialist

PROJECT STAFF

The project work was performed by the BC&A team members listed below. Team members' roles on the project are also listed. The project was completed in BC&A's Draper, Utah office. Questions may be addressed to Matt Stayner, Project Manager at (801) 495-2224.

Mike Collins	Principal In Charge
Matt Stayner	Project Manager
Nathan Wright	Project Engineer
Mike Hilbert	Word Processing

CHAPTER 2
EXISTING FACILITIES

INTRODUCTION

As part of this Master Plan, BC&A has assembled an inventory of existing infrastructure within the storm drain system. The purpose of this chapter is to present a summary of the inventory of Orem City's existing storm drain system that can be used as a reference for future studies.

SERVICE AREA

The City of Orem, is located about 30 miles South of Salt Lake City. The topography of the majority of the City slopes from East to West towards Utah Lake. Figure 2-1 shows the approximate planning extent of Orem along with the City's storm water collection system components.

STORM WATER COLLECTION SYSTEM

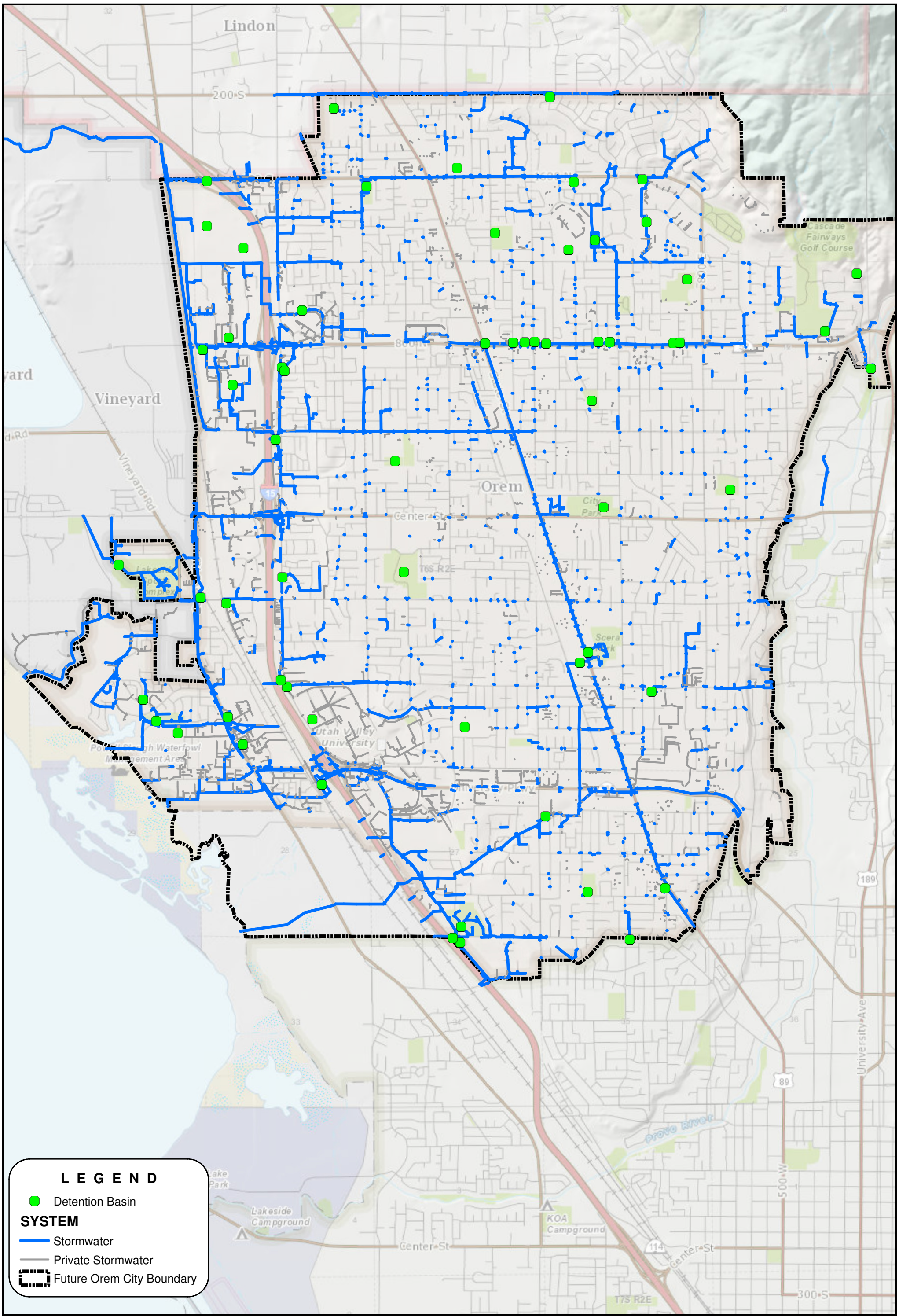
There are just over 1 million feet (190 miles) of storm water pipe and over 3,400 manholes in the Orem City Sewer System that are cataloged in the GIS database. Table 2-1 contains a summary of the storm water pipes for the Orem City collection system.

Table 2-1
Orem Storm Water Pipe Lengths

Diameter (in)	Length (ft)	Length (mi)
<12"	178,241	33.8
12"-17"	288,207	54.6
18"-23"	181,559	34.4
24"-29"	211,708	40.1
30"-35"	63,161	12.0
36"-41"	50,983	9.7
42"-47"	10,875	2.1
48"	8,642	1.6
>48"	13,263	2.5
Total	**1,006,639**	**190.7**

DETENTION BASINS

There are over 130 detention facilities in the existing storm water system. The majority of these detention facilities are local detention basins and were not modeled in this study. The primary purpose of the detention facilities is to attenuate peak storm water discharges. Many of the detention facilities serve the dual purpose of a recreational park. Figure 2-1 shows the detention facilities included in the InfoSWMMM model.



Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

OREM CITY
STORM WATER MASTER PLAN

EXISTING STORM WATER SYSTEM

NORTH:

SCALE: 0 1,250 2,500 Feet

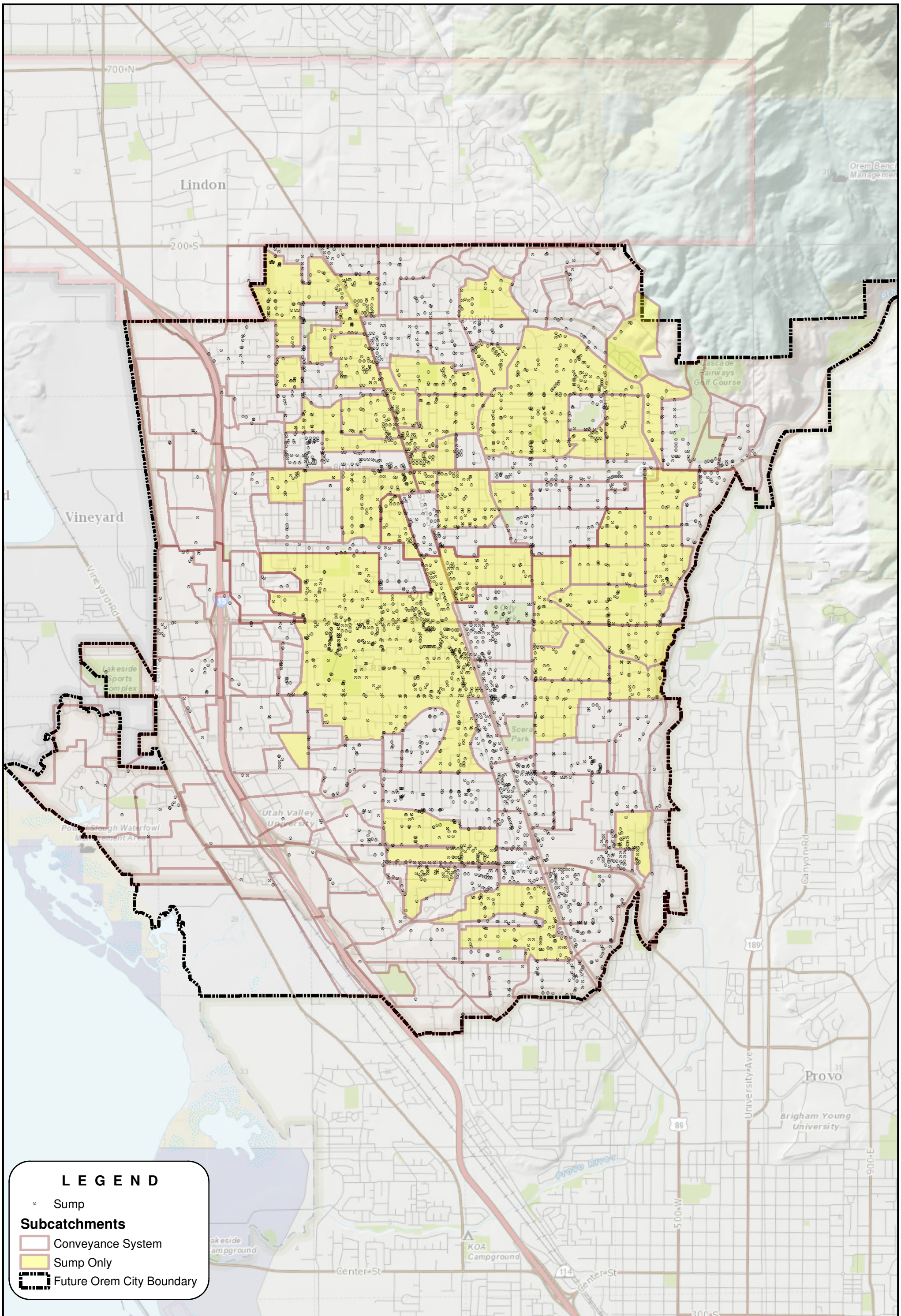
FIGURE NO. 2-1

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure2-1_Existing_Facilities.mxd nwright 6/3/2015

SUMPS

A large portion of Orem City is built upon gravely soil which allows for significant infiltration. Currently, there are over 3,500 sumps located across most of Orem City (see Figure 2.2). Portions of the city rely completely on sumps to manage the storm water runoff and are not connected to storm water system for the city. For the purpose of this report, the capacity/effectiveness of sumps was not analyzed. It was assumed that the areas with sumps that are not connected to the storm water system do not produce runoff to surrounding subbasins during the 10-year design storm event. There are also many areas where sumps are interspersed with storm water pipes. To be conservative, the infiltration of sumps in areas connected to the collection system was not modeled.

Orem City also has a few detention basins which have significant infiltration. Orem City personnel estimate the detention basins at Timpanogos High School and Bonneville School to have estimated infiltrate rates of 12 cfs and 10 cfs, respectively. There is also a perforated pipe in 400 North that has an estimated infiltration capacity of 70 cfs. For the purpose of this study, it was assumed that these facilities will provided the stated infiltrate rate for the entire. It should be noted that with time the sumps may fill with sediment and other debris leading to a decrease in infiltration capacity. The city should maintain, monitor, and rehabilitate those facilities as necessary to maintain the infiltration rates stated.



Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

OREM CITY
STORM WATER MASTER PLAN

EXISTING SUMP
STORM WATER SYSTEM

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 2-2

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure2-2_Existing_Sumps.mxd nwright 6/3/2015

CHAPTER 3
HYDROLOGIC ANALYSIS

Orem City was divided into two hydrologic study areas for the purposes of this master plan update, a North Study Area and a South Study Area. A hydrologic computer model was developed for both study areas in InfoSWMM, Suite 12.0, for the purpose of estimating storm water runoff volume and peak discharges generated by a design cloudburst event. InfoSWMM uses an Environmental Protection Agency Storm Water Management Model (EPA-SWMM) engine to perform computations. As with EPA-SWMM, InfoSWMM has the capability to model the hydrologic and hydraulic components of storm water runoff, and was used to model both in this study. See Chapter 4 for a description of the hydraulic modeling.

The model development process includes delineating drainage basins, estimating hydrologic parameters, developing a design storm and calibrating the model. Each one of these steps is described below.

DRAINAGE BASIN DELINEATION

The first step in developing a computer hydrologic model is to delineate drainage basins and subcatchments. Two InfoSWMM models were develop for this study – a North Study Area and a South Study Area (See Figure 3-1). Orem City previously delineated over 450 subbasins. Those subbasins were combined for this study. Approximately 150 subbasins were included in the the two models. Subcatchment boundaries associated with the hydrologic model are shown in Figure 3-1.

HYDROLOGIC MODEL PARAMETERS

The following hydrologic model parameters were used to develop the InfoSWMM computer model.

Hydrology Method

In the InfoSWMM software there are multiple options for Hydrology Method. The EPA-SWMM non-linear reservoir method was used in this study. The EPA-SWMM non-linear reservoir method is the same method EPA SWMM uses. This method requires "subcatchment width" and slope as input parameters. The subcatchment width was calculated using one of InfoSWMM built in functions:

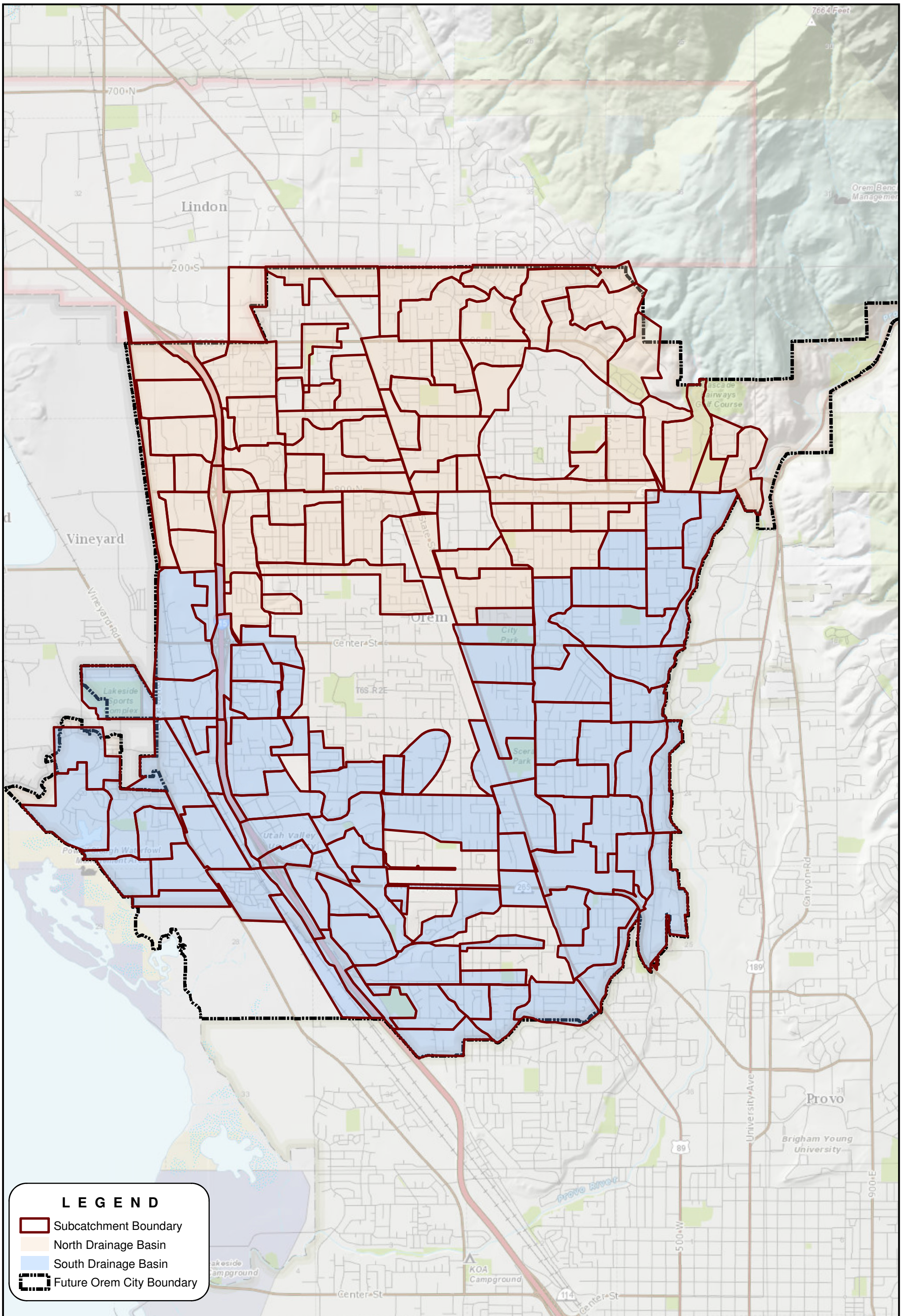
$$W = k * \text{Area}^{0.5}$$

Where:

W – Subcatchment Width

k – Coefficient

Area – Area (acres)



Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

OREM CITY
STORM WATER MASTER PLAN

SUBCATCHMENT BOUNDARIES

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 3-1

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure3-1_Subcatchment_Boundaries.mxd nwright 6/3/2015

Several values of *k* were use throughout the City. See "Model Calibration" for additional information.

Loss Method

The SCS Curve Number method was used in InfoSWMM to calculate infiltration losses (see Natural Resources Conservation Service (NRCS) TR-55 publication for additional information). This method requires the input of a composite Curve Number and the percent impervious for each subcatchment.

Composite Curve Number. Curve Numbers were estimated for each subcatchment based on soil type and vegetative ground cover. The hydrologic soil type was obtained from the NRCS Soil Survey Geographic (SSURGO) dataset. Table 3-1 shows the Curve Numbers used in this study, based on soil type and assumed vegetative ground cover for developed areas.

Table 3-1
SCS Curve Number

Soil Type	Curve Number*
A	39
B	61
C	74
D	80

* From Table 2-2 in TR-55 "Open Space – Grass Cover 75%"

Directly-Connected Impervious Area. The amount of directly-connected impervious area for existing conditions was estimated using the 2012 High Resolution Orthophotography (HRO). Each Land Use type was analyzed and the estimated impervious area was recorded. The amount of directly-connected impervious area was also estimated for full build-out conditions based on land use from the General Plan. For areas that are currently undeveloped, the General Plan was used in conjunction with Table 3-2 to estimate the impervious area.

Table 3-2
Average Imperviousness Based on Land Use

General Plan Land Use Type	Directly Connected Imperviousness (Percent)
Open Space	0
Low Density Residential (LDR)	27
Medium Density Residential (MDR)	35
High Density Residential (HDR)	55
Industrial	72
Church	75
Light Industrial	85
Community Commercial	85
Professional Services	85
Regional Commercial	85

Slope. The slope for each subcatchment was calculated using 2' contour data provided by Orem City. The average slope for each subcatchment was calculated using tools within InfoSWMM. Average slopes ranged throughout the city from 0.9% to 27%.

DESIGN STORM PARAMETERS

The parameters for the design storm are described below:

- Storm Duration: 3 Hours
- Storm Distribution: Modified Farmer and Fletcher
- Recurrence Interval:
  - Storm Drain Pipelines: 10-Year Storm
  - Detention Basins: 10-Year Storm
- Storm Depth (From NOAA Atlas 14):

  10-Year: 1.12 inches

Model Calibration

The final step in the hydrologic modeling process is model calibration. In general, calibration of a hydrologic model of an urban area refers to the process of adjusting parameters to achieve results consistent with available reference information in nearby areas rather than adjusting for actual measured discharge observations in the study area.

Calibration Target Range

A study was performed in 1989 by the U.S. Geological Survey, to help understand typical discharges for urban drainages along the Wasatch Front. The study was printed as the Water-Resources Investigations Report 89-4095 entitled, "Peak-Flow Characteristics of Small Urban Drainages along the Wasatch Front Utah". This report was used as a basis for estimating reasonable unit discharges for the subcatchments of Orem City.

Subcatchment Width

The subcatchment width is the theoretical width of the overland flow. For the purpose of this report the subcatchment width was calculated using the following methods to get reasonable unit discharges.

- Lower impervious areas (DCIA less than 38): $k = 0.2$
- Higher impervious areas (DCIA greater than 38): $k = 0.4$

HYDROLOGIC MODELING ASSUMPTIONS

The following assumptions were also made in completing the hydrologic analyses of the study area:

1. Rainfall return frequency is equal to associated runoff return frequency.
2. Design storm rainfall has a uniform spatial distribution over the watershed.
3. Normal (SCS Type II) antecedent soil moisture conditions exist at the beginning of the design storm.
4. The hydrologic computer model adequately simulates watershed response to precipitation.
5. Hydrologic parameters for non-developable areas were assumed to have normal mid-summer vegetation cover, free from recent fire damage.
6. Runoff produced by the 10-yr storm event can collect in each detention basin and eventually flow into the City Facilities.

Existing Inlet Capacity Issues

The collective assumption was made that there are enough existing storm water inlets in each subcatchment to collect runoff from a 10-year design storm event. In areas where ponding or flooding occurs, the inlet capacity should be evaluated and additional inlets should be added if necessary.

CHAPTER 4
HYDRAULIC MODELING

A hydraulic computer model of the study area was developed in InfoSWMM for the purpose of routing storm water runoff and estimating the capacity of the existing storm water facilities. InfoSWMM uses an EPA-SWMM engine to perform hydraulic computations. As with EPA-SWMM, InfoSWMM can be used to model the hydrologic and hydraulic components of the study. See Chapter 3 for a description of the hydrologic modeling.

GEOMETRIC MODEL DEVELOPMENT

There are two major types of data required to create a hydraulic model of a storm drain system: geometric data and flow data. Geometric data consists of all information in the model needed to represent the physical characteristics of the system, including pipelines, open channels and detention basins. Flow data is reported in Chapter 3.

Modeled Conveyance

The scope of this storm drain master plan included a hydraulic analysis of only the storm drain trunklines. The storm drain trunklines included in the hydraulic model are shown in Figure 4-1.

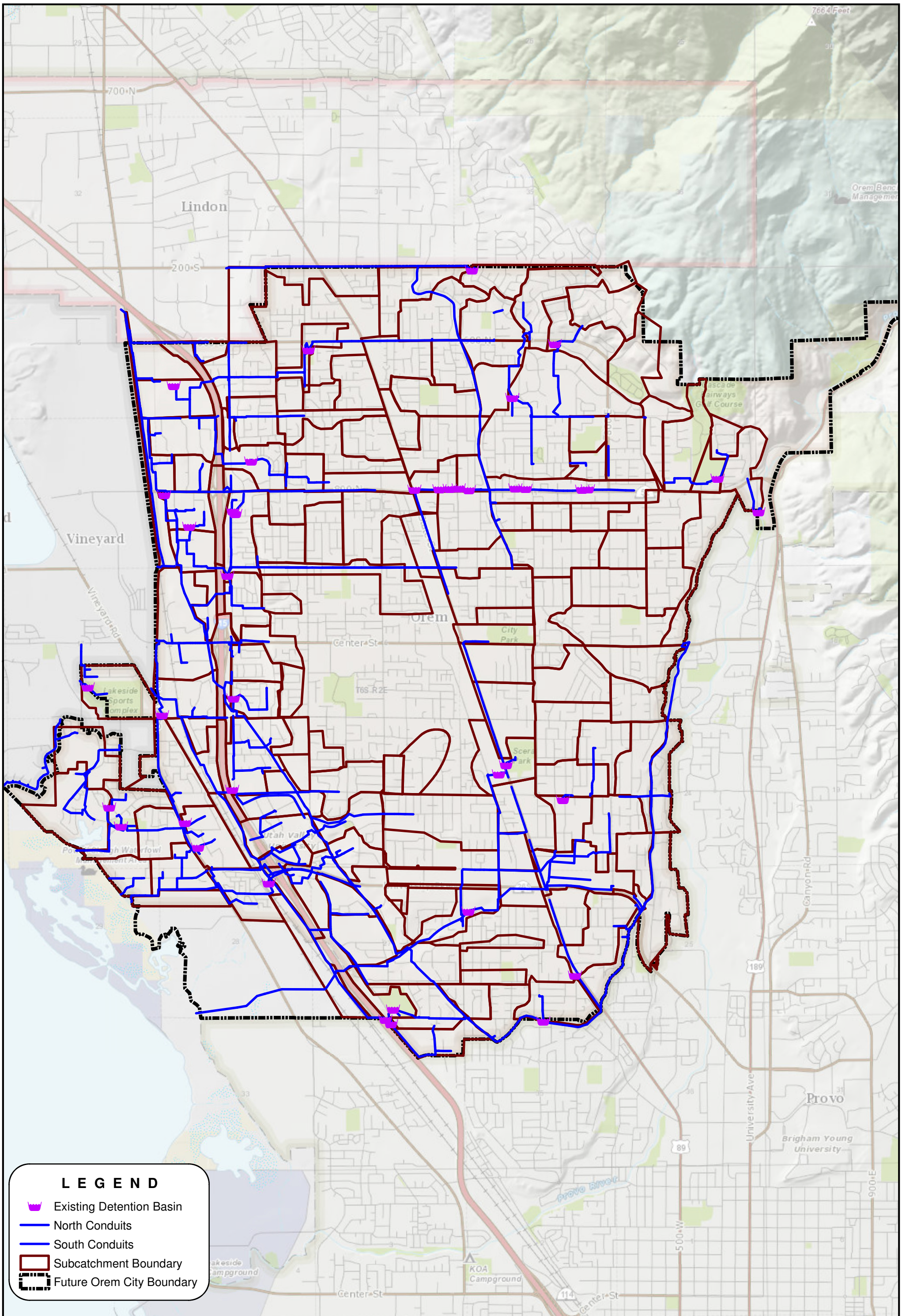
A basic framework for the model was developed using a previous InfoSWMM model provided by Orem City. Additional information on the physical characteristics of the trunklines included in the model was collected and assembled by Orem City personnel. The database included information on the type, diameter, depth, width, length, material and location of each pipe included in the model. Rim elevations were collected by a City survey crew. Inverts based on measure downs were included as well.

Detention Basins

Stage-storage curves were provided by City personnel for the detention basins and were entered into the model. Orifice information, including size, location, or lack thereof, was provided by the City, and was included in the existing conditions model. The majority of the detention basins are equipped with a flow control gate, orifice sizes are an approximation based on the position of the gate. If a detention facility does not currently have an orifice, it is recommended that a flow control gate be installed to regulate flow. Therefore, an outlet or an orifice was included on all detention facilities in the future conditions model. Future detention basins were modeled with a synthetic stage storage curve and an outlet that released the appropriate flow rate. Figure 4-1 presents the modeled existing detention basins.

Profiles

Profiles for each existing trunkline were examined for unusual data (ie adverse slopes, diameter contractions, etc.) and any areas identified as concerns were field verified by City personnel. Updated data was provided by city personnel and inputted into the model.



Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

OREM CITY
STORM WATER MASTER PLAN

MODELED SYSTEM

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 4-1

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure4-1_Hydraulic_model.mxd nwright 6/3/2015

CHAPTER 5
SYSTEM EVALUATION

With the development and calibration of a hydraulic storm drain model, it is possible to simulate storm drain system operating conditions for both existing and future conditions. The purpose of this chapter is to document the hydraulic performance evaluation of the collection system and identify potential hydraulic deficiencies.

EVALUATION CRITERIA AND LEVEL OF SERVICE

To define deficiencies in the system, the desired level of service for each of the storm drain components needs to be defined.

Storm Drain Pipelines

Storm drain pipelines do not surcharge into the street during the 10-year storm event. It is important to note that roadways become the major storm water conveyance facility during storms that are larger than the 10-yr design event.

Open Channels

Open channels should be designed to safely convey the 10-year design storm event.

Culverts

Culverts should be designed to safely convey the 10-year design storm event.

Detention Basins

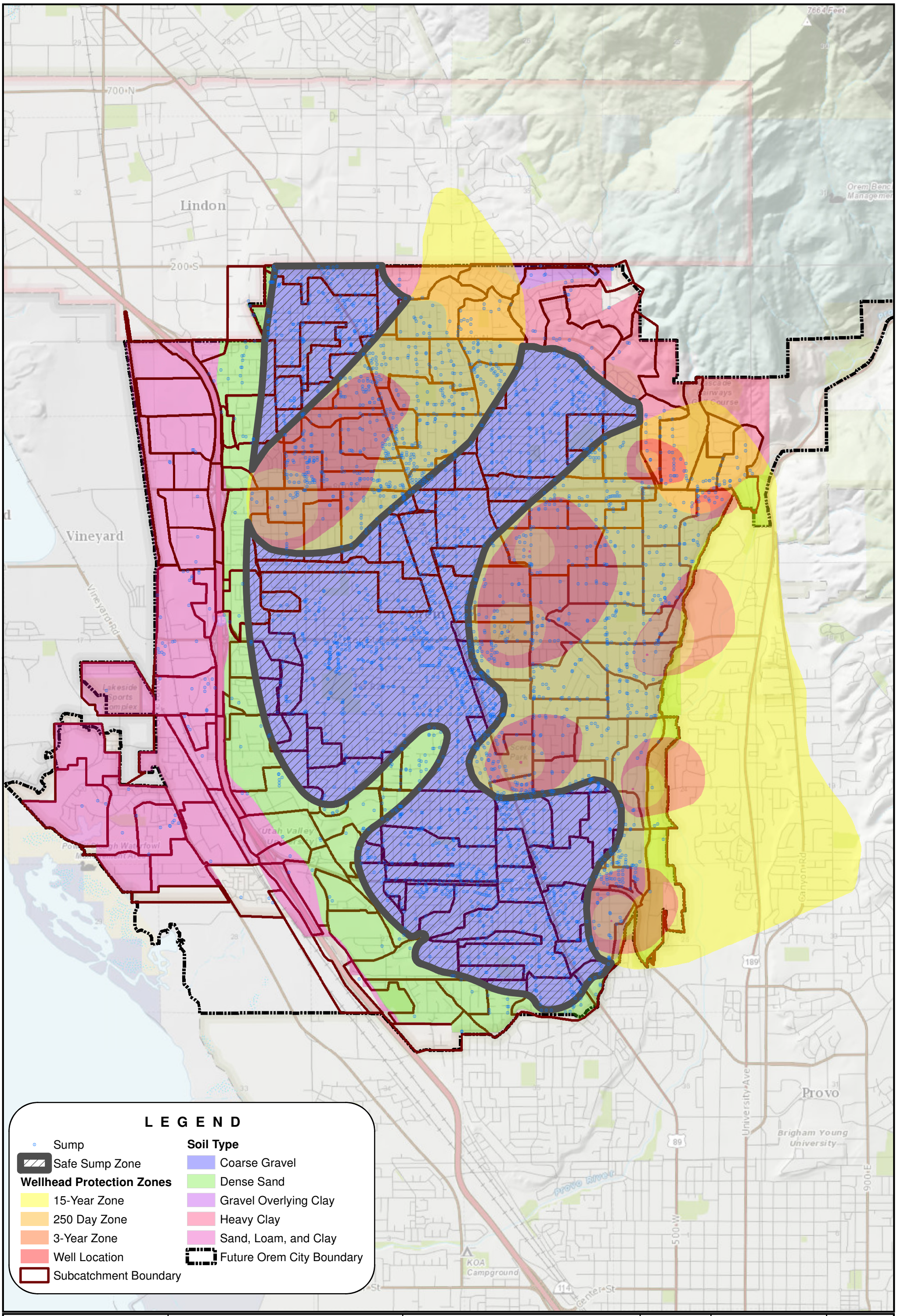
Detention facilities should be designed to have capacity for the 10-year design storm event, and have an emergency overflow that directs water away from private property.

Sumps

There are currently over 3,500 sumps in Orem City. Due to water quality concerns with wells that provide drinking water, a large portion of these sumps are planned to eventually be connected to the storm water system and they infiltration discontinued. A “Safe Sump Zone” was defined by overlaying the soil types and wellhead protection zones. Sumps shown in the “Safe Sump Zone” were assumed to have sufficient capacity for the design storm. It should be noted that the infiltration rate of sumps tends to dimension over time. Sumps should be tested periodically and rehabilitated as necessary to assure they have sufficient capacity.

Irrigation Canals

Irrigation Canals are located throughout the City. In several locations storm water pipes discharge into the irrigation canals. In general, the goal of the City is to limit the use of the irrigation canals



Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

OREM CITY
STORM WATER MASTER PLAN

SAFE SUMP ZONE

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 5-1

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure5-1_Sump_Areas.mxd nwright 6/3/2015

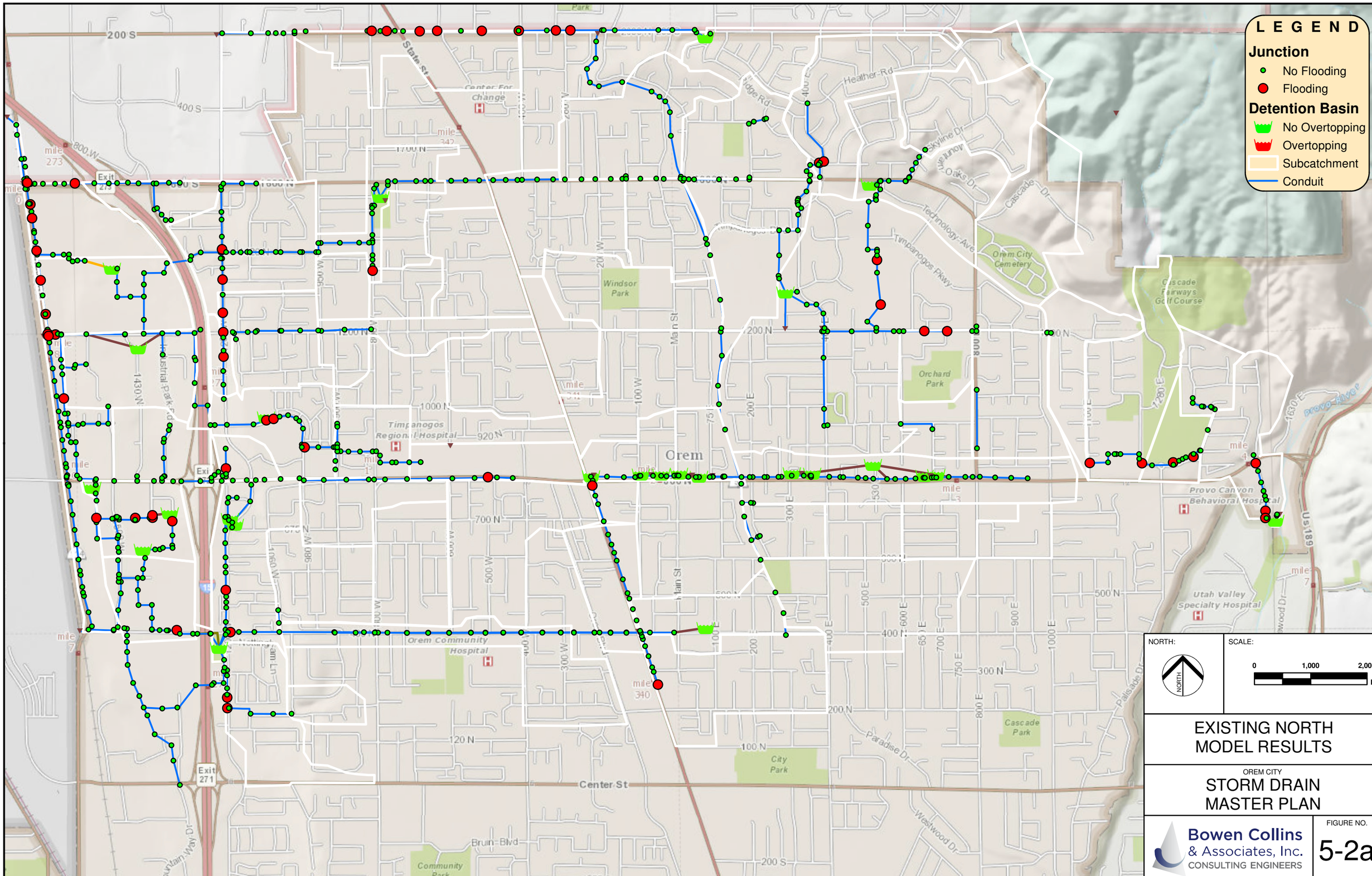
to convey storm water runoff as much as is practical. For the purpose of this study we looked at canal capacity based only on the storm drain flows in the system. Further analysis should be performed to verify if the necessary capacity exists when irrigation flows are present in the canal.

EXISTING CONVEYANCE SYSTEM ANALYSIS

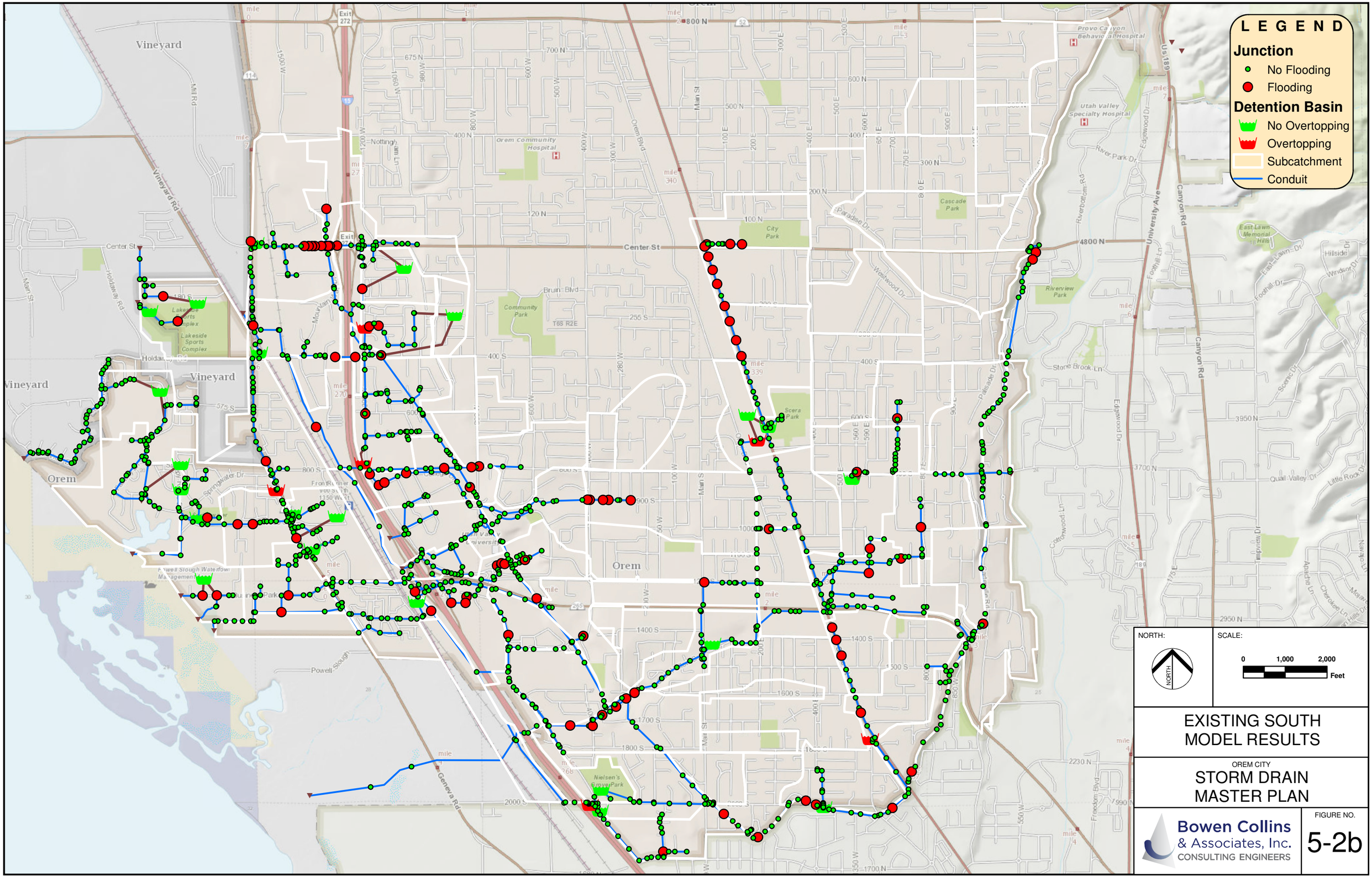
Figures 5-2a and 5-2b show the deficiencies in the storm drain system under existing development conditions. As can be seen from the Figures, both detention basins and trunklines were found to be deficient. Due to the significant amount of sumps that are present in the city, some of these deficiencies may not be seen today, but as the sumps loose capacity or are abandoned in the future it is like these deficiencies will become more prevalent without mitigating action.

FUTURE CONVEYANCE SYSTEM ANALYSIS

A few of the existing storm drain collection trunks in Orem are undersized for ultimate development conditions in Orem. Additional trunks will need to be constructed. Also, there are several detention basins that need to be constructed/modified. Chapter 6 discusses conceptual improvements that will be needed to fix existing deficiencies and serve areas currently using sumps.



P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Innovyze Data\2014 North and South Models\From Orem\September\North_Model.mxd nwright 6/3/2015



EXISTING SOUTH MODEL RESULTS

OREM CITY

STORM DRAIN MASTER PLAN

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

FIGURE NO.
5-2b

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Innovyze Data\2014 North and South Models\From Orem\September\South_Model.mxd nwright 6/3/2015

CHAPTER 6
RECOMMENDED SYSTEM IMPROVEMENTS

The InfoSWMM model was used to evaluate various alternatives for mitigating the identified existing deficiencies and sizing future storm water facilities under projected future development conditions. In accordance with instruction from City personnel, the 1998 Master Plan's recommended improvements were used as a basis for recommended improvements outlined in this chapter. This chapter describes the storm drain improvements, based on estimated runoff and ground slopes.

TYPES OF RECOMMENDED IMPROVEMENTS

The recommended improvements identified in this master plan included only major storm drain facilities. Local storm drain facilities, typically associated with development projects, are not included in the storm drain master plan. A brief description of the difference between local facilities and major facilities are found below.

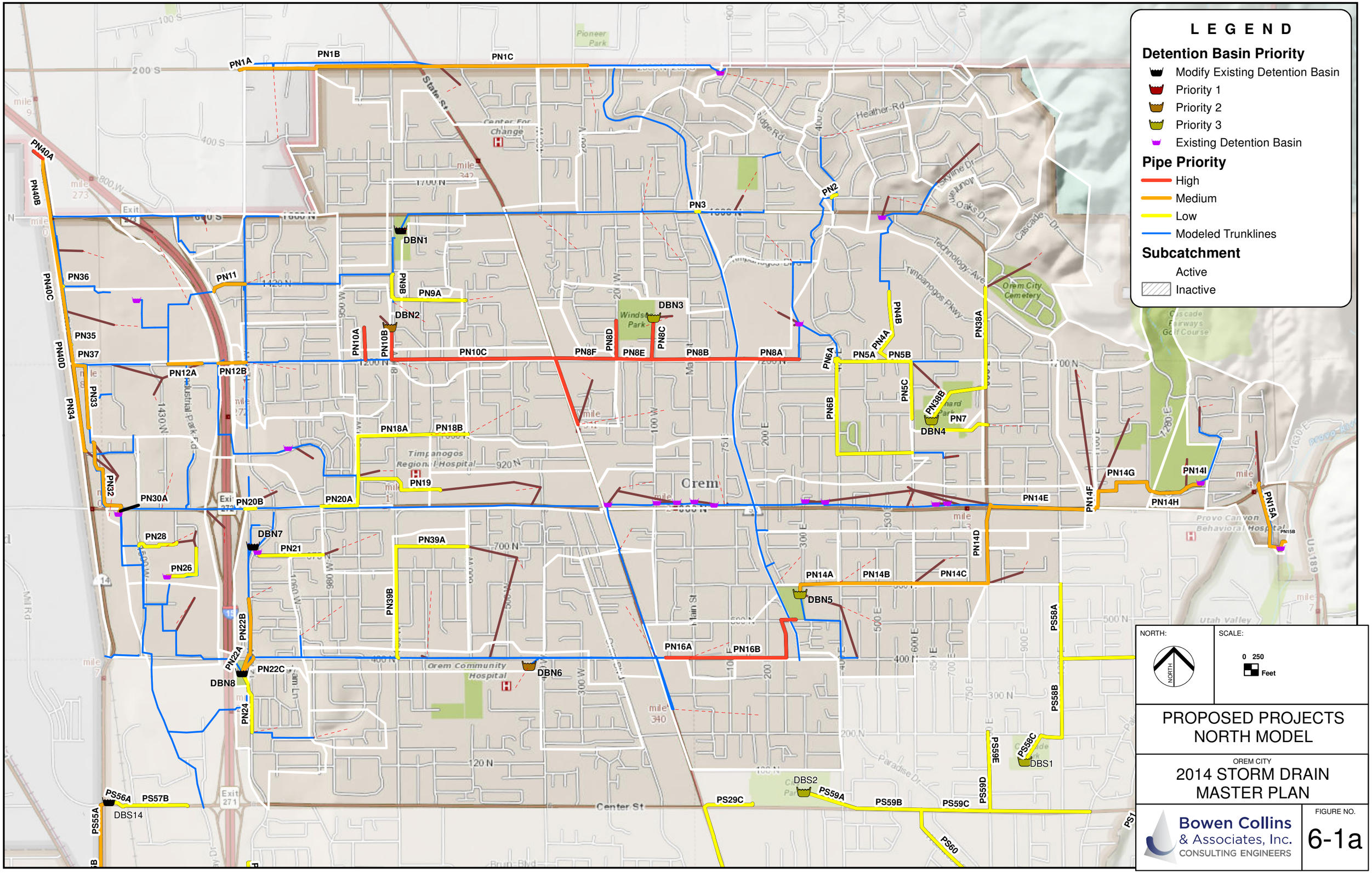
- **Major Conveyance Facilities** – Major storm drain conveyance facilities include pipelines or major channels that typically service multiple developments. Local facilities include smaller storm drain conveyance facilities that typically only serve one small development, and are used to convey storm water runoff from the 10-yr design storm to the major conveyance facilities.
- **Regional Detention Facilities –**Orem City requires all new development to provide local detention facilities to attenuate peak discharge from storm water runoff to the limits stated in this report. A major regional detention facility will attenuate peak runoff from the 10-yr design storm to levels that can be safely conveyed through existing downstream facilities.

RECOMMENDED PIPELINE IMPROVEMENTS

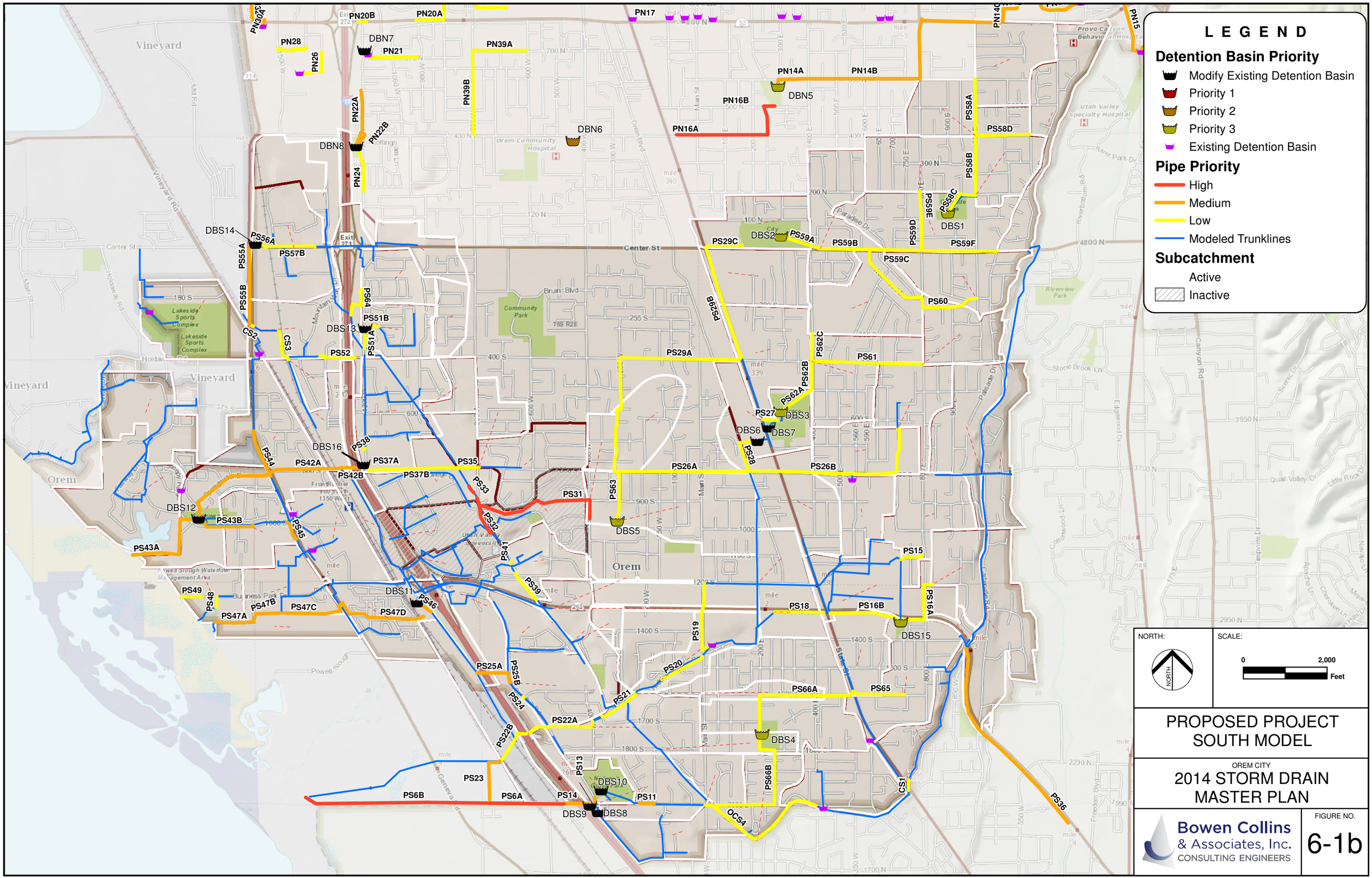
Figures 6-1a and 6-1b shows the location of recommended pipeline improvements that are needed to meet future growth in Orem. Table 6-1 summarizes the cost of the proposed pipe improvements in 2014 dollars.

Table 6-1
Storm Drain Trunkline Improvements

Project Id	Project Name	Pipe Length (ft) ***	Diameter (in)	Estimated Cost (Contingency, Engineering, Admin, and Legal Fees)	Priority Level	Build Year	Design Flow Rate (cfs)*	Status **
PN10A	Bonneville School	590	18	$111,700	1	2018	4	New
PN10B	800 W	680	48	$256,400	1	2018	67	New
PN10C	1200 N (A)	4230	42	$1,376,600	1	2017	67	New
PN16A	400 N (A)	440	24	$93,600	1	2016	28	Upsize
PN16B	250 E	2720	24	$573,200	1	2016	19	New



P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Innovyze Data\2014 North and South Models\From Orem\Combined\North_Model_Final.mxd nwright 6/3/2015



P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Innovyze Data\2014 North and South Models\From Orem\Combined\South_Model_Final.mxd nwright 6/3/2015

Project Id	Project Name	Pipe Length (ft) ***	Diameter (in)	Estimated Cost (Contingency, Engineering, Admin, and Legal Fees)	Priority Level	Build Year	Design Flow Rate (cfs)*	Status **
PN40A	Geneva Rd (A)	90	66	$66,900	1	2015	203	Parallel (2)
PN8A	1200 N (B)	990	24	$208,900	1	2020	15	New
PN8B	1200 N (C)	1670	30	$408,900	1	2020	15	New
PN8C	100 W	770	24	$159,600	1	2020	10	New
PN8D	200 W	700	18	$135,300	1	2020	8	New
PN8E	1200 N (D)	690	18	$133,600	1	2020	5	New
PN8F	1200 N (E)	1110	24	$231,000	1	2020	13	New
PS31	900 S	3240	18	$629,100	1	2015	8	New/Upsize
PS32	Heat Plant Rd (A)	940	42	$307,400	1	2016	53	Upsize
PS33	Heat Plant Rd (B)	160	42	$51,500	1	2015	52	Upsize
PS6A	2000 S (A)	1780	36	$493,900	1	2018	54	New
PS6B	2000 S (B)	4450	42	$1,465,300	1	2019	90	New
PN1A	2000 N (A)	110	36	$31,500	2	2034	95	Upsize
PN11	1420 N	640	36	$179,300	2	2029	98	Upsize
PN12A	1200 N (F)	620	36	$174,300	2	2031	87	Upsize
PN12B	1200 N (G)	520	24	$108,300	2	2031	47	Upsize
PN14A	600 N (A)	860	42	$278,400	2	2033	94	New
PN14B	600 N (B)	1360	42	$441,700	2	2033	83	New
PN14C	600 N (C)	1350	42	$438,800	2	2033	69	New
PN14D	800 E (A)	1430	42	$462,700	2	2033	62	New
PN14E	800 N (A)	1940	36	$539,400	2	2032	58	New/Upsize
PN14F	1100 E	1400	24	$293,300	2	2032	42	New Parallel (3)
PN14G	Foothill School	700	36	$194,500	2	2032	16	Upsize
PN14H	Cascade Pkwy (A)	1190	30	$286,500	2	2032	16	Upsize
PN14I	Cascade Pkwy (B)	290	24	$57,200	2	2032	8	Upsize
PN15A	1550 E (A)	1360	24	$285,900	2	2025	29	Upsize
PN15B	1550 E (B)	180	24	$56,100	2	2025	19	Upsize
PN1B	2000 N (B)	3450	30	$843,400	2	2034	66	Upsize
PN1C	2000 N(C)	2780	30	$679,400	2	2034	42	Upsize
PN22A	1200 W (A)	340	36	$94,700	2	2031	73	Upsize
PN22B	Orem Skate Park (A)	1040	36	$289,200	2	2031	56 (73)	Parallel
PN22C	Orem Skate Park (B)	350	30	$85,300	2	2031	52 (76)	Parallel

Project Id	Project Name	Pipe Length (ft) ***	Diameter (in)	Estimated Cost (Contingency, Engineering, Admin, and Legal Fees)	Priority Level	Build Year	Design Flow Rate (cfs)*	Status **
PN30A	800 N (B)	140	48	$52,800	2	2031	136	Upsize
PN32	800 N (C)	1550	54	$656,200	2	2031	136	Upsize
PN33	1200 N (H)	1370	42	$444,700	2	2030	67 (145)	Parallel
PN34	Geneva Rd (B)	2400	36	$673,200	2	2030	21	Upsize
PN40B	Geneva Rd (C)	1070	66	$550,400	2	2028	166 (207)	Parallel
PN40C	Geneva Rd (D)	2080	66	$1,071,500	2	2029	145 (166)	Parallel
PN40D	Geneva Rd (E)	360	60	$168,500	2	2029	142 (166)	Parallel
PS11	2000 S (C)	380	48	$142,200	2	2023	95	Upsize
PS13	Nielson Grove Park	300	36	$84,600	2	2023	43	Upsize
PS14	2000 S (D)	570	36	$156,600	2	2023	54	Upsize
PS23	Taylor Drain Outlet	1280	42	$417,800	2	2023	47	New
PS25A	I-15 & 1500 S	750	42	$241,800	2	2023	67	Upsize
PS25B	Sandhill Rd (A)	240	36	$64,400	2	2023	35	Upsize
PS36	University Pkwy (A)	5120	36	$1,448,100	2	2021	42	New/UD OT
PS42A	800 S (A)	4090	42	$1,329,700	2	2024	105	New
PS42B	800 S (B)	510	42	$164,900	2	2024	108	Upsize
PS43A	Springwater Park Out	2250	54	$971,100	2	2022	143	Upsize
PS43B	Springwater Park In	1440	36	$399,200	2	2022	39 (62)	Parallel
PS44	Geneva Rd (E)	1180	36	$324,700	2	2025	27	Upsize
PS45	Geneva Rd (F)	500	24	$104,600	2	2025	17	Reroute
PS46	Kent Drain	410	60	$194,300	2	2025	73	Reroute
PS47A	1330 S	940	60	$443,300	2	2027	147	Upsize
PS47B	1300 S (A)	830	54	$351,100	2	2027	137	Upsize
PS47C	1300 S (B)	1460	48	$547,900	2	2026	93	Upsize
PS47D	1300 S (C)	2360	36	$654,400	2	2026	61	Upsize
PS55A	Geneva Rd (G)	710	54	$299,700	2	2028	96	Upsize
PS55B	Geneva Rd (H)	1290	60	$626,500	2	2028	111	Upsize
PN18A	1000 N (A)	2040	42	$662,600	3	2035+	64	New
PN18B	1000 N (B)	670	36	$186,900	3	2035+	40	New
PN19	Timpanogas Hospital	1700	30	$415,500	3	2035+	21	Upsize
PN2	Moore Ln	120	30	$29,900	3	2035+	51	Upsize
PN20A	800 N (E)	1160	42	$373,200	3	2035+	80	New/Parallel
PN20B	800 N (F)	400	30	$99,800	3	2035+	87	Parallel

Project Id	Project Name	Pipe Length (ft) ***	Diameter (in)	Estimated Cost (Contingency, Engineering, Admin, and Legal Fees)	Priority Level	Build Year	Design Flow Rate (cfs)*	Status **
PN21	675 N	1240	18	$243,600	3	2035+	18	New
PN24	1200 W (B)	1130	36	$312,000	3	2035+	51	Upsize
PN26	1340 E	1050	18	$203,000	3	2035+	15	Upsize
PN28	1370 W	800	24	$168,700	3	2035+	22	Upsize
PN3	1600 N	70	24	$16,500	3	2035+	14 (29)	Parallel
PN35	Geneva Rd (J)	20	60	$12,500	3	2035+	3	Connect Parallel Lines
PN36	Geneva Rd (K)	40	60	$21,400	3	2035+	18	Connect Parallel Lines
PN37	Geneva Rd (L)	60	60	$30,200	3	2035+	30	Connect Parallel Lines
PN38A	800 E (B)	1310	24	$276,600	3	2035+	15	New
PN38B	Orchard Park (A)	1740	30	$424,300	3	2035+	14	New
PN39A	Orem Jr. High (A)	1140	36	$314,600	3	2035+	26	New
PN39B	Orem Jr. High (B)	2030	18	$394,100	3	2035+	26	New
PN4A	Research Way (A)	640	24	$135,600	3	2035+	13	Upsize
PN4B	Research Way (B)	800	24	$168,700	3	2035+	13	Upsize
PN5A	1200 N (I)	950	36	$266,500	3	2035+	27	Upsize
PN5B	1200 N (J)	410	30	$102,000	3	2035+	16	Upsize
PN5C	Falcon Way	1030	18	$199,600	3	2035+	7	New
PN6A	400 E (A)	120	30	$29,900	3	2035+	15	New
PN6B	400 E (B)	3040	24	$641,000	3	2035+	6	New
PN7	Orchard Park (B)	1010	30	$247,100	3	2035+	25	New
PN9A	1360 N (A)	1340	36	$373,800	3	2035+	41	New
PN9B	1360 N (B)	880	36	$243,700	3	2035+	50	Upsize
PS15	1100 S	690	36	$192,000	3	2035+	49	Upsize
PS16A	800 E (C)	1660	36	$463,500	3	2035+	43	New
PS16B	University Pkwy (B)	1680	30	$411,100	3	2035+	28	New
PS18	University Pkwy (C)	1190	48	$444,300	3	2035+	96	Upsize
PS19	Main Str.	1870	30	$457,800	3	2035+	11	Upsize
PS20	Hidden Hollow Dr. (A)	1130	36	$312,000	3	2035+	17 (55)	Parallel
PS21	Hidden Hollow Dr. (B)	1010	36	$281,700	3	2035+	60	Upsize

Project Id	Project Name	Pipe Length (ft) ***	Diameter (in)	Estimated Cost (Contingency, Engineering, Admin, and Legal Fees)	Priority Level	Build Year	Design Flow Rate (cfs)*	Status **
PS22A	400 W (A)	1210	36	$340,900	3	2035+	77	Upsize
PS22B	400 W (B)	1530	36	$427,000	3	2035+	62	Upsize
PS24	Sandhill Rd (B)	40	24	$11,000	3	2035+	4	Connect Parallel Lines
PS26A	800 S (C)	3130	42	$1,016,300	3	2035+	74	New
PS26B	800 S (D)	4600	30	$1,126,200	3	2035+	24	New/Upsize
PS27	Scera Park (A)	390	24	$80,700	3	2035+	13	New
PS28	Orem Blvd	1100	42	$355,300	3	2035+	39 (54)	Parallel
PS29A	400 S (A)	11720	30	$2,871,200	3	2035+	64	New Parallel (2)
PS29B	State Str	4360	36	$1,214,100	3	2035+	38	Parallel
PS29C	Center Str (A)	1490	30	$360,900	3	2035+	36	Upsize
PS35	800 S (E)	540	30	$130,500	3	2035+	42	Upsize
PS37A	College Dr (A)	270	36	$72,000	3	2035+	105	Upsize
PS37B	800 S (F)	2120	36	$593,700	3	2035+	72	Upsize
PS38	College Dr (B)	50	36	$16,300	3	2035+	61	Upsize
PS39	Union Canal (D)	820	48	$309,200	3	2035+	50	Upsize
PS41	Union Canal (E)	60	48	$24,700	3	2035+	49	Upsize
PS48	Business Park Dr (A)	280	36	$74,500	3	2035+	24	Upsize
PS49	Business Park Dr (B)	520	24	$127,500	3	2035+	11	Upsize
PS51A	1200 W (C)	450	24	$95,400	3	2035+	28	Upsize
PS51B	1200 W (D)	360	24	$75,200	3	2035+	17	Upsize
PS52	400 S (B)	890	24	$185,400	3	2035+	12	Upsize
PS56A	Center Str (B)	300	42	$98,500	3	2035+	50	Upsize
PS57B	Center Str (C)	1170	36	$322,200	3	2035+	50	Upsize
PS58A	1000 E (A)	1350	36	$376,400	3	2035+	40	New
PS58B	1000 E (B)	2820	36	$788,200	3	2035+	100	New Parallel (2)
PS58C-1	Cascade Park	940	36	$263,900	3	2035+	52 (132)	New Parallel (PS58C-2)
PS58C-2	Cascade Park	940	42	$307,400	3	2035+	70 (132)	New Parallel (PS58C-1)

Project Id	Project Name	Pipe Length (ft) ***	Diameter (in)	Estimated Cost (Contingency, Engineering, Admin, and Legal Fees)	Priority Level	Build Year	Design Flow Rate (cfs)*	Status **
PS58D	400 N (B)	1310	36	$366,300	3	2035+	45	New
PS59A	City Park In	2000	42	$650,600	3	2035+	125	New Parallel (2)
PS59B	Center Str (D)	2360	36	$654,400	3	2035+	107	New Parallel (2)
PS59C-1	Center Str (E)	1250	30	$308,300	3	2035+	35 (85)	New Parallel (PS59C-2)
PS59C-2	Center Str (E)	1250	36	$351,100	3	2035+	50 (85)	New Parallel (PS59C-1)
PS59D	800 E (D)	760	36	$209,700	3	2035+	37	New
PS59E	800 E (E)	670	30	$164,000	3	2035+	25	New
PS59F	Center Str (F)	1810	24	$382,700	3	2035+	19	New
PS60	Westwood Dr	3500	36	$974,000	3	2035+	25	New
PS61	400 S (C)	2660	30	$648,100	3	2035+	24	New
PS62A	Scera Park (B)	1840	36	$514,100	3	2035+	69	New Parallel (2)
PS62B	400 E (C)	1360	30	$332,400	3	2035+	69	New Parallel (2)
PS62C	400 E (D)	680	24	$142,900	3	2035+	18	New
PS63	Lake Ridge Jr. High	2400	36	$673,200	3	2035+	148	New Parallel (2)
PS64	1200 W (D)	900	24	$192,200	3	2035+	22	Upsize
PS65	1600 S (A)	1260	30	$310,500	3	2035+	24	New
PS66A	1600 S (B)	3280	42	$1,064,800	3	2035+	56	New
PS66B	2000 S (D)	3660	18	$713,600	3	2035+	10	New
Total:				$54,580,200				

* First number is the design flow for the proposed parallel pipe. Value in Parenthesis is the total combined design flow.

** Values in Parenthesis represents the number of new parallel pipes.

*** Lengths account for the total length of all barrels even when multiple barrels are present

OPEN CHANNEL IMPROVEMENTS

Figures 6-1a and 6-1b shows the location of recommended open channel improvements that are needed to meet future growth in Orem. Table 6-2 lists the recommended local open channel improvements in Orem City.

Table 6-2
Natural Channel Improvements

Project Id	Project Name	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)	Design Flow Rate (cfs)	Status
OCS4	Union Canal	$ 41,020	80	Modify
	Total:	**$ 41,020**		

DETENTION BASIN IMPROVEMENTS

Figures 6-1a and 6-1b shows the location of recommended detention basin improvements that are needed to meet future growth in Orem City. Table 6-3 lists the recommended detention volumes and costs for detention facilities in Orem City.

Table 6-3
Required Capacity at Detention Basins

Project Id	Project Name	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)	Volume (acre-ft)	Discharge Rate (cfs)	Status
DBN1	Bonneville Park	$19,200	0	8	Modify
DBN2	Bonneville School	$419,600	2.8	3.5	New
DBN3	Windsor Park	$473,800	3.2	7.5	New
DBN4	Orchard Park	$216,000	1.3	6.5	New
DBN5	Sharon Park	$935,000	6.6	19	New
DBN6	Orem Community Hospital	$392,400	2.6	5	New
DBN7	1200 W 675 N	$19,200	0	13.5	Modify

Project Id	Project Name	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)	Volume (acre-ft)	Discharge Rate (cfs)	Status
DBN8	Orem Skate Park	$19,200	0	42	Modify
DBS1	Cascade Park	$677,200	4.7	15.5	New
DBS2	City Park	$1,274,200	9.1	18	New
DBS3	Scera Park (A)	$528,000	3.6	9.5	New
DBS4	Cherryhill Park	$205,700	1.3	10	New
DBS5	Lakeridge Jr. High	$894,300	6.3	6.5	New
DBS6	700 S & State Str.	$19,200	0	41	Upsize
DBS7	Scera Park (B)	$19,200	0	3	Upsize
DBS8	Ercanbrack East	$19,200	0	7	Modify
DBS9	Ercanbrack West	$19,200	0	54	Modify
DBS10	Nielson's Grove	$19,200	0	36	Modify
DBS11	Kent Drain	$19,200	0	61	Modify
DBS12	Springwater Park	$19,200	0	144	Modify
DBS13	12th West	$19,200	0	16.5	Modify
DBS14	Geneva Rd. & Center Str.	$19,200	0	47	Modify
DBS15	Hillcrest Park	$283,900	1.8	28	New
DBS16	8th S & 12th W	$19,200	0	110	Modify
Total:		**$ 6,549,700**			

CULVERT IMPROVEMENTS

Figures 6-1a and 6-1b shows the location of recommended culvert improvements that are needed to meet future growth in Orem City. Table 6-4 lists the recommended culvert sizes and costs needed in Orem City.

Table 6-4
Required Capacity at Culverts

Project Id	Project Name	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)	Design Flow Rate (cfs)
CS1	Union Canal	$72,000	40
CS2	Geneva Rd	$72,000	129
CS3	Holdaway Rd & 1400 W	$72,000	65
	Total:	$216,000	

For a detailed cost estimate of each of the recommended improvements, see appendix C.

Draper, Utah Off ce:
154 East 14000 South
Draper, Utah 84020
Phone: (801) 495-2224
Fax: (801) 495-2225

Eagle, Idaho Off ce:
776 East Riverside Drive
Suite 250
Eagle, Idaho 83616
Phone: (208) 939-9561
Fax: (208) 939-9571

St. George, Utah Off ce:
20 North Main
Suite 107
St. George, Utah 84770
Phone: (435) 656-3299
Fax: (435) 656-2190

WWW.BOWENCOLLINS.COM

Bowen Collins
& Associates, Inc.
CONSULTING ENGINEERS