DRAFT COLLECTION SYSTEM REPORT

FOR

CITY OF BEND, OREGON

December 2007

Prepared by:

MURRAY, SMITH & ASSOCIATES, INC.
Engineers/Planners
950 W. Bannock Street, Suite 910
Boise, Idaho 83702

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

OVERVIEW

Background

The City of Bend, Oregon Collection System model was originally built and calibrated in 2005. The model simulations are performed using the InfoSWMM (MWH Soft) software which utilizes the industry standard SWMM 5 hydraulic engine developed by the Environmental Protection Agency (EPA). In 2006, the model was used to develop the City of Bend Collection System Master Plan (CSMP) including a Capital Improvement Program (CIP) for a full build-out condition and conceptual planning of large sewer interceptors in North and Southeast Bend. The model was also intended for use in on-going development review and future alternatives analysis for large interceptor projects.

In 2007, the City of Bend asked CH2M HILL to provide an independent review of the Collection System Model. During the model review, several recommendations were provided to improve and further refine the model and CIP. The recommendations are listed below:

1. Revise the diurnal pattern set-up in the model to avoid multiplication of weekday and weekend diurnal patterns.
2. Conduct additional flow monitoring during a precipitation event to understand the system response to infiltration and inflow (I/I) in varied sub-basins.
3. Re-calibrate the model using new flow monitoring data and implementing sub-basin specific responses to I/I.
4. Perform a storm frequency analysis and select a design storm which meets Oregon Department of Environmental Quality (DEQ) regulations for collection system design.
5. Validate the CIP using the newly calibrated model and the selected design storm.

Based on these recommendations, the City authorized additional gravity flow monitoring. In July 2007, the firm of Murray, Smith & Associates, Inc. (MSA) was authorized by the City to re-calibrate the collection system model, perform the storm frequency analysis, and provide additional analysis on the CIP.

Purpose

The purpose of this report is to provide documentation on revisions to the City of Bend Collection System Model and to amend the City of Bend CSMP. The model revisions include the following:

1. Updates of model loading to reflect 2007 winter time water usage.
2. Model calibration to refine dry weather loading and capture system response to infiltration and inflow during a storm event.
3. Selection of a design storm event for modeling collection system deficiencies and improvements.

With the model revisions, the capital improvements identified in the CSMP were re-evaluated for two planning densities: 2030 build-out and full build-out. This report describes the assumptions, procedures, and results used to revise the Collection System Model and to amend the CIP. The report includes the following sections:

1. Model Calibration
2. Design Storm Selection
3. Planning Horizons, Loading, & Cost Assumptions
4. 2030 Build-out CIP Results
5. Full Build-out CIP Results

NOTE: The CSMP is referenced many times in this document. The CSMP referenced in this document includes the draft CSMP, draft tech memos, lift station master plan, and study area plans.

MODEL CALIBRATION

Calibration Theory and Background

Calibration is one of the most important tasks in developing a computer model. Model calibration consists of adjusting model response to match field data. The logic behind the calibration procedure is that each step in the calibration is more specific than the previous step. At the conclusion of each step, the field results are compared with the modeled data to determine the model's level of accuracy. Once the desired level of accuracy has been achieved, the calibration is complete.

In collection system modeling, the calibration level of accuracy is more qualitative than quantitative. Flow rates measured at each flow monitoring site are visually compared to model flow rates for an extended period of time. Typically a dry weather period including both weekdays and weekend days and a wet weather period are selected for model calibration. The dry weather flows are calibrated first with adjustments to the model loading and diurnal patterns until field and model flows match. The wet weather flows are calibrated second with adjustments to wet weather hydrographs and I/I sewersheds (wet weather impact areas) until field and model flows match during a rain event. Actual precipitation gauge data is used in the model during the wet weather calibration. Once the wet weather calibration is completed, additional calibration may be required to increase loading and diurnal patterns to a peak dry weather day.

The City of Bend contracted with V&A Consulting to perform gravity flow monitoring during May and June 2007 in 15 sub-basins. During the flow monitoring period, 9 rain gauges were installed throughout the City to measure precipitation. The flow monitoring sub-basin boundaries are shown in Figure 1. The sub-basins were selected to represent major City sewer drainages with an emphasis on understanding the impact of I/I during a rain event.

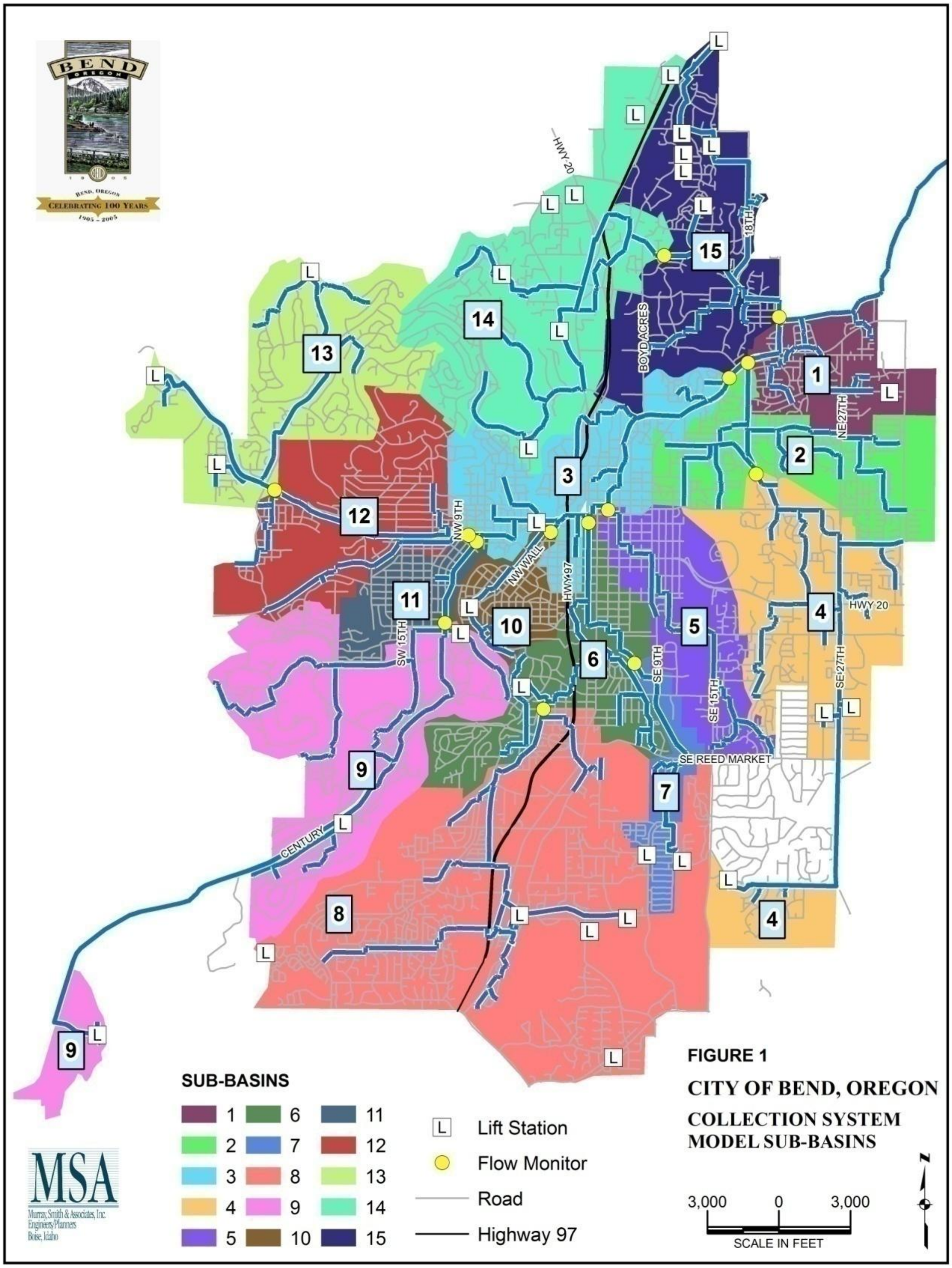


Figure 1. Flow Monitoring Sub-basin Boundaries, May – June 2007

The modeling parameters that impact the dry weather and wet weather calibration are described below:

Dry Weather

The dry weather flow component of the model consists of a daily average load and a normalized diurnal pattern which tells the model how to adjust the average flow throughout the day. In the Bend model, daily average flows and diurnal patterns for each sub-basin were calculated for weekdays and weekend days separately. Initially, the daily average loads and diurnal patterns were calculated by averaging all of the respective weekday or weekend dry weather days during the flow monitoring period. Once the wet weather calibration was completed, the loading and diurnal patterns were adjusted to reflect the peak days during the flow monitoring period.

Several flow monitoring sub-basins are downstream of another sub-basin (for example, sub-basins 14 and 15). This required that the flows from the upstream sub-basin be subtracted from flows in the downstream sub-basin to create the basin specific diurnal patterns and average loading. During the subtraction, adjustments were made for travel time based on visual comparison of peaking. In several sub-basins (for example, sub-basin 3) multiple upstream sub-basins exist, requiring coordination of many travel time adjustments. In these cases, the subtracted sub-basins resulted in an adequate average daily load, but a flattened diurnal pattern. Where this was the case an alternate upstream diurnal pattern was applied to the sub-basin.

Within each sub-basin, the daily average loads from the flow monitors were distributed to model nodes based on winter-time water usage as defined by the City's billing records. Each metered address was spatially geo-coded. The same node service area boundaries previously defined in the CSMP were used to load the model (see Figure 2).

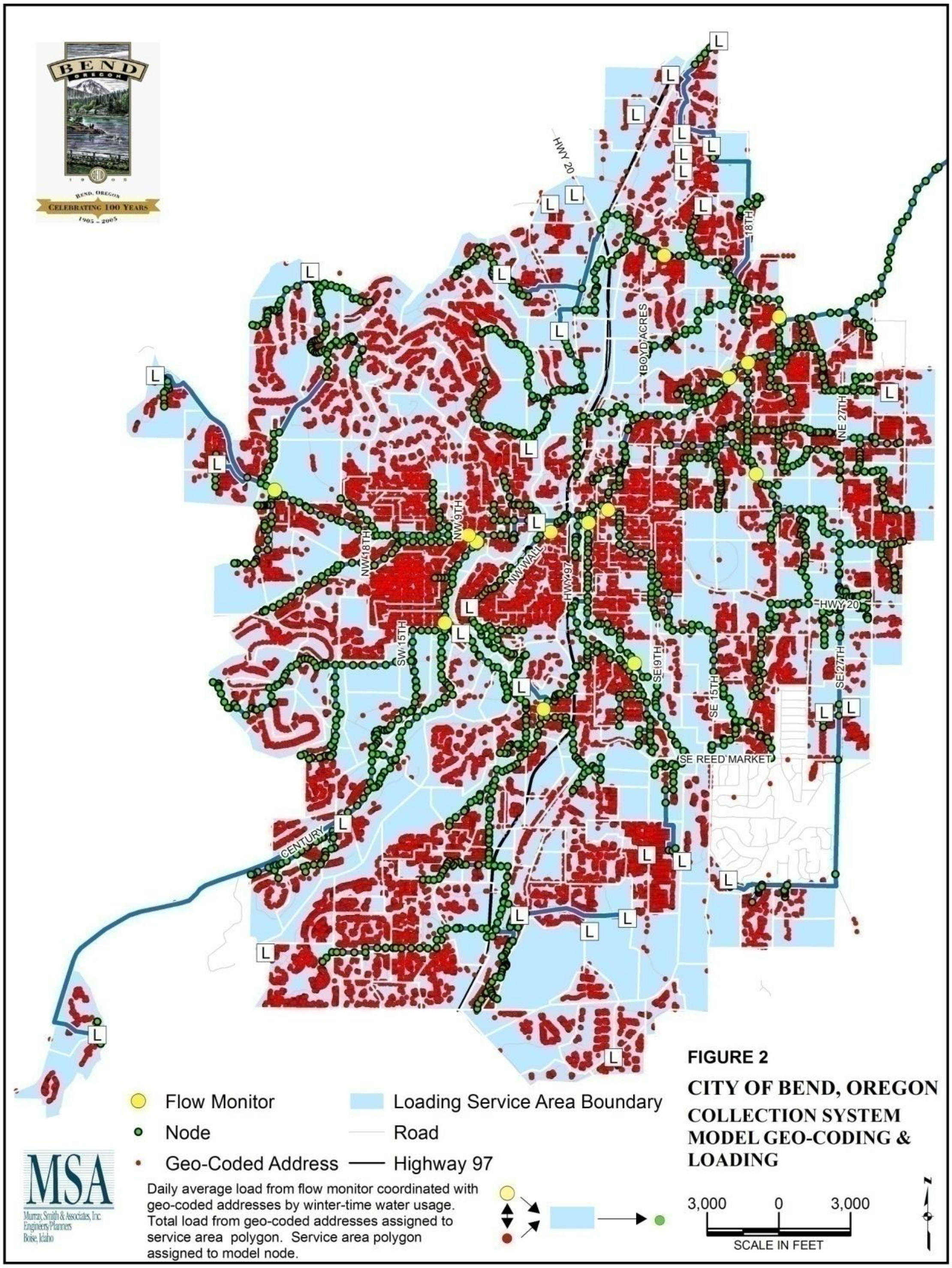


Figure 2. Existing System Dry Weather Model Loading

Wet Weather

The wet weather flow component of the model consists of a storm event, sewershed acreage (wet weather area of impact), and rainfall distributed infiltration and inflow (RDII) unit hydrograph. During the model calibration, actual precipitation data is modeled. Precipitation from the rain event falls on the sewershed acreage creating a volume of water. In the Bend model, the sewersheds are defined by placing a 20 ft buffer around all system pipes. The sewershed areas are assigned to model nodes using the node service area polygons defined in the CSMP (see Figure 3).

The unit hydrograph defines the amount of runoff (percentage of the volume created from the sewershed and rain depth) which enters the system and the travel time. The unit hydrograph is broken into an initial, intermediate, and long-term hydrograph response. The three hydrographs combine to form a composite unit hydrograph. Each of the three hydrographs is defined by three parameters which are adjusted during model calibration until field and model flows match. The unit hydrograph parameters are described below and shown in Figure 4.

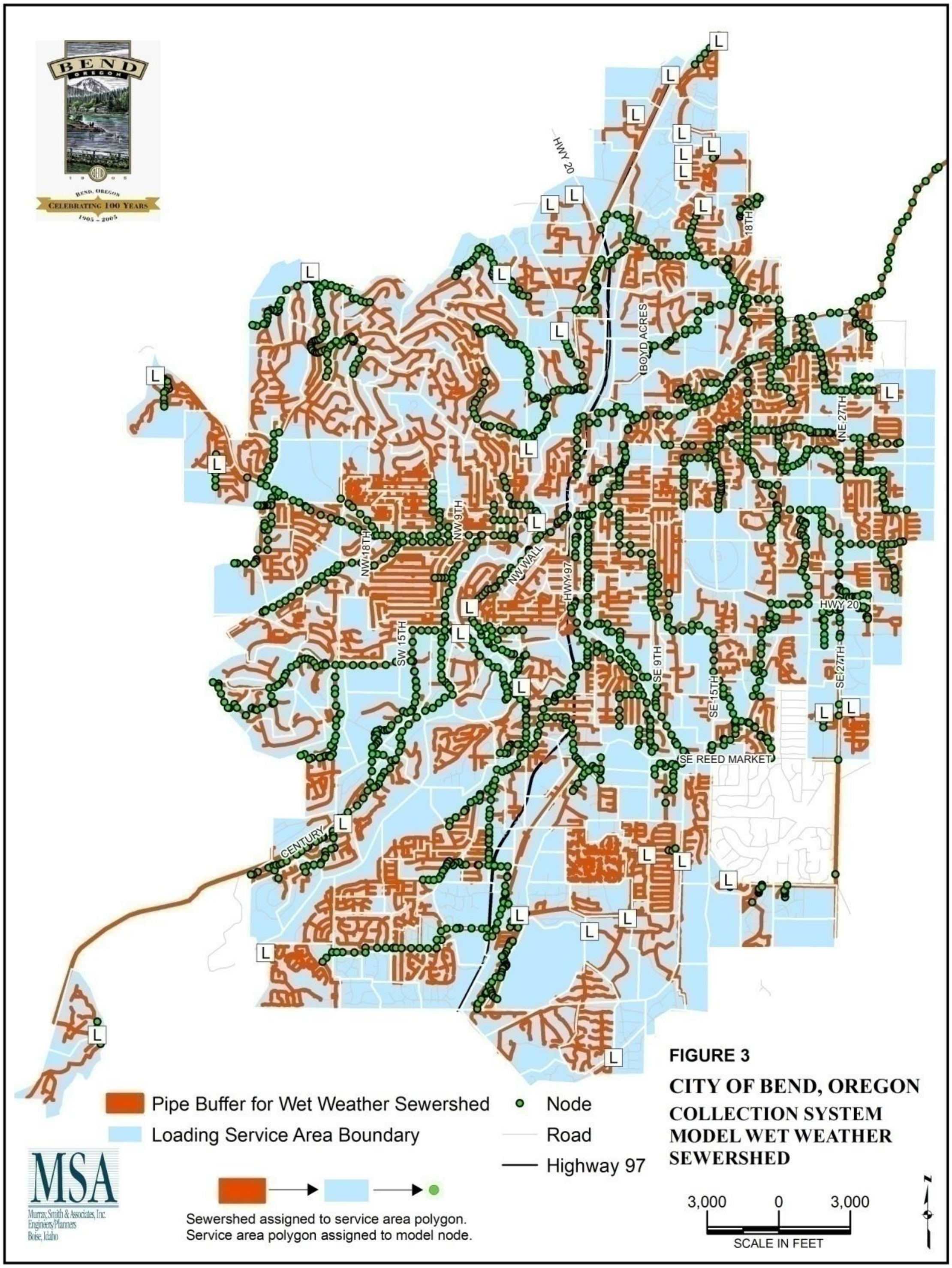


Figure 3. Existing System Model Sewersheds (Wet Weather Area of Impact)

Unit Hydrograph Parameter 1 - R1, **R2**, **R3 -** Response ratios for the short-term, intermediate-term, and long-term UH responses, respectively.

Unit Hydrograph Parameter 2 - T1, **T2**, **T3 -** Time to peak for the short-term, intermediate-term, and long-term UH responses, respectively.

Unit Hydrograph Parameter 3 - K1, **K2**, **K3 -** Recession limb ratios for short-term, intermediate-term, and long-term UH responses, respectively.

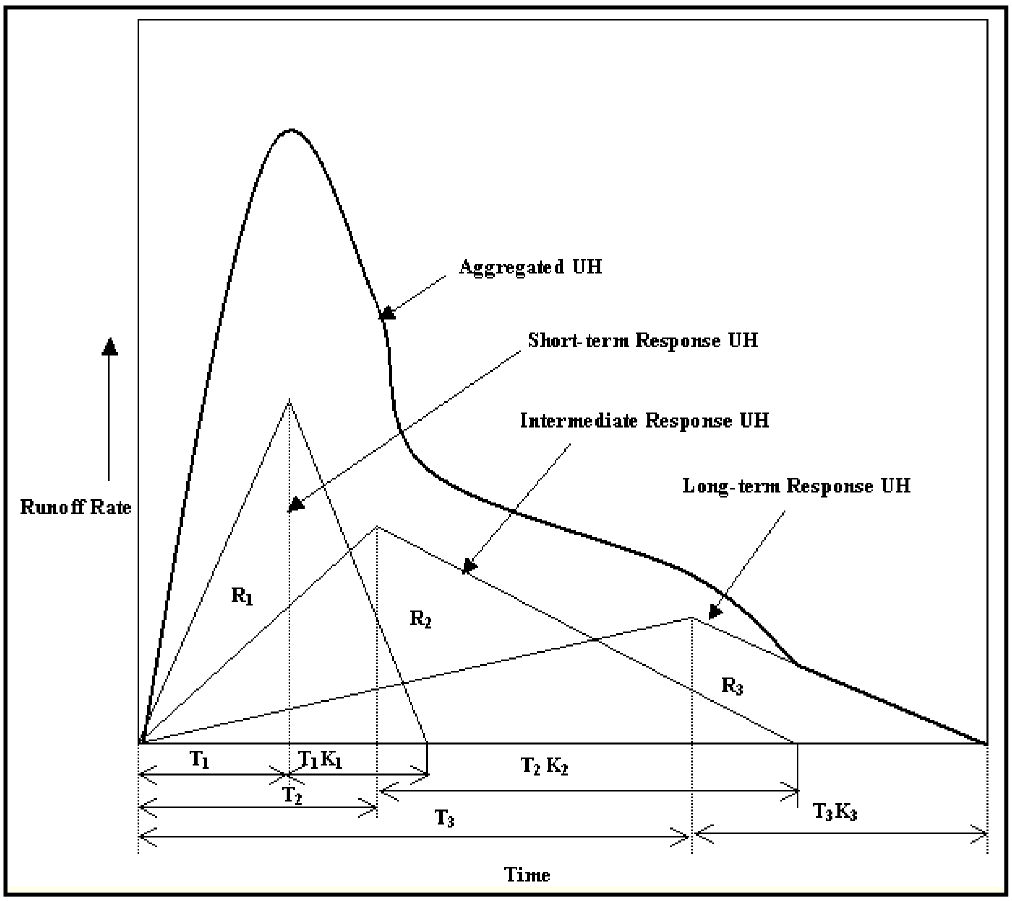


Figure 4. SWMM Unit Hydrograph Description

Calibration Results

As discussed above, the calibration is broken into three steps:

1. Dry weather calibration using average flow data from all of the dry weather days during the flow monitoring period.
2. Wet weather calibration using precipitation and flow data collected during the flow monitoring period.
3. Additional dry weather calibration to adjust loading and diurnal patterns to peak days.

The results for each of the three calibration steps are presented below.

<u>Dry Weather Calibration (Average Dry Weather Data from Flow Monitoring Period)</u>

The diurnal pattern peaking factors for each of the 15 sub-basins are presented in Table 1 for the average dry weather calibration. The comparison of field and model flows are presented in Figures 5a and 5b.

Table 1. Dry Weather Diurnal Pattern Peaking Factors (Average Dry Weather Data for Flow Monitoring Period)

Flow Monitoring Sub-basin	Weekday	Weekend	Comment
1	2.05	1.76	Use Sub-basin 2 Diurnal Pattern
2	2.05	1.76	
3	2.05	1.76	Use Sub-basin 2 Diurnal Pattern
4	1.26	1.35	
5	1.48	1.65	
6	1.36	1.43	
7	1.86	1.83	
8	1.53	1.74	
9	1.55	1.67	
10	1.35	1.44	
11	1.62	1.83	
12	1.62	1.83	Use Sub-basin 11 Diurnal Pattern
13	2.4	2.04	
14	1.53	1.53	
15	1.53	1.53	Use Sub-basin 14 Diurnal Pattern

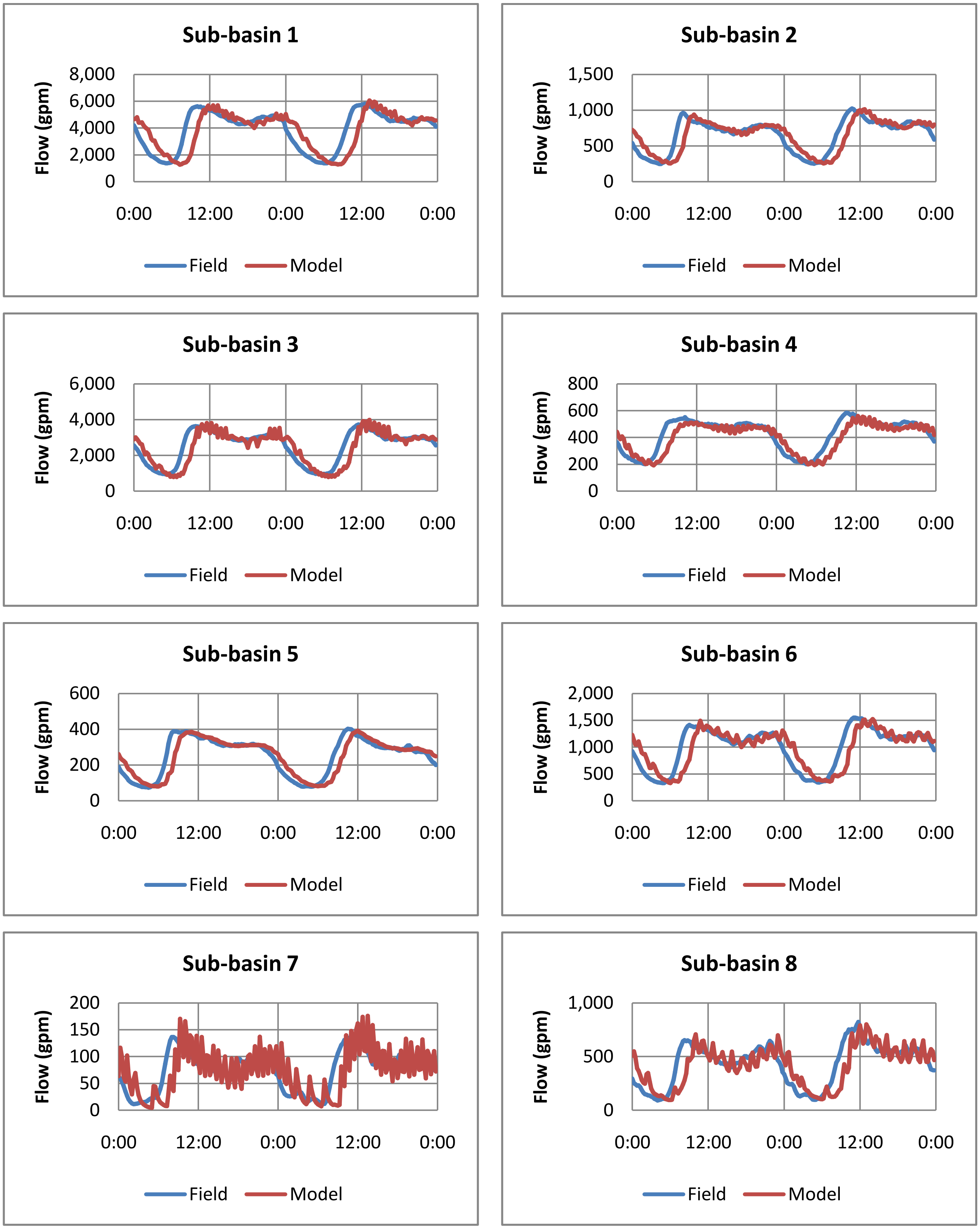


Figure 5a. Dry Weather Calibration Results, Sub-basins 1-8 (Average data for flow monitoring period, 1st day shown is a weekday and 2nd day shown is a weekend day)

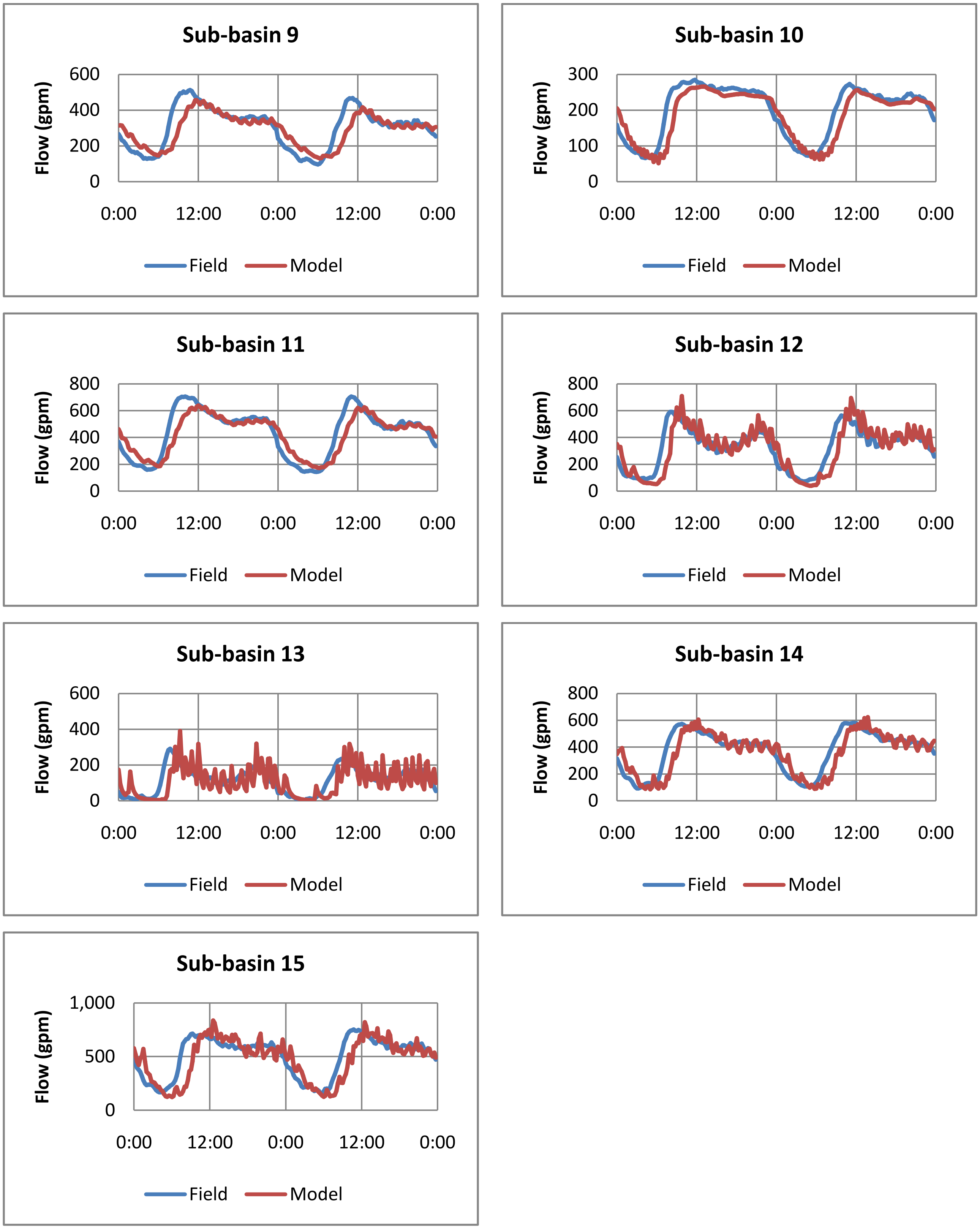


Figure 5b. Dry Weather Calibration Results, Sub-basins 9-15 (Average data for flow monitoring period, 1st day shown is a weekday and 2nd day shown is a weekend day)

Visual comparisons of the field and model dry weather flows show a reasonable model calibration. Peak flows and daily patterns from the field and model match for most sub-basins. The peaks are slightly under-estimated in sub-basins 9, 10, and 11. Sub-basins 9 and 10 are low flow areas which are impacted by lift station operations. Sub-basin 11 is downstream of sub-basin 9. Additionally, the oscillations seen in some of the model flows are caused by pumps turning on and off in the model. Future calibration efforts should focus on improving the accuracy of lift station variables throughout the model.

One item of concern is a two hour time shift between the field and model flows. Prior to the wet weather calibration the diurnal patterns were shifted to correct for the time delay.

The average dry weather calibration results are used during the wet weather calibration. If the peak day dry weather flows and diurnal patterns were used instead of the average, the difference between wet weather peaks and dry weather peaks would be minimized and the wet weather component would be under-estimated. Using the average dry weather calibration during the wet weather calibration, results in a conservative wet weather model.

Wet Weather Calibration

The hydrograph parameters for each of the 15 sub-basins are presented in Table 2. The comparison of field and model flows and field precipitation are presented in Figures 6a and 6b.

During the flow monitoring period, 9 precipitation gauges were installed to measure precipitation and precipitation variability throughout the City of Bend. V&A Consulting used a triangulation method to define precipitation for each of the 15 sub-basins (see Appendix A for the V&A flow monitoring report). The largest storm event during the two month flow monitoring period was chosen to calibrate the model. This storm event occurred on June 4, 2007 and can be characterized as a summer-time thunderstorm with high intensity rain during the peak hour of the storm.

The wet weather unit hydrograph parameters were adjusted through 17 model iterations until the wet weather portion of the model was calibrated. During the initial model iterations the short-term, intermediate, and long-term unit hydrographs were all used to create a composite unit hydrograph. The model calibrated best when eliminating the intermediate and long-term response portions of the unit hydrograph. This means that the Bend collection system is primarily impacted by inflow during a wet weather event with little to no impact from infiltration. The R parameter for the unit hydrograph provides a measure of the total volume of inflow which enters the collection system by sub-basin. The sub-basin R values range from 0.5% to 10%. In some older areas of town such as sub-basins 4 and 5, downspouts still drain directly to the sewage collection system resulting in high I/I flows.

Table 2. Wet Weather Unit Hydrograph Parameters

Flow Monitoring Sub-basin	R	T (hrs)	K
1	0.011	0.50	1.0
2	0.011	0.50	1.0
3	0.030	0.50	1.0
4	0.044	0.75	1.2
5	0.099	0.75	1.0
6	0.034	0.50	1.0
7	0.018	0.50	1.0
8	0.019	0.50	1.0
9	0.011	0.50	1.0
10	0.031	0.50	1.0
11	0.023	0.50	1.0
12	0.005	0.50	1.0
13	0.031	0.50	1.0
14	0.014	0.50	1.0
15	0.034	0.50	1.0

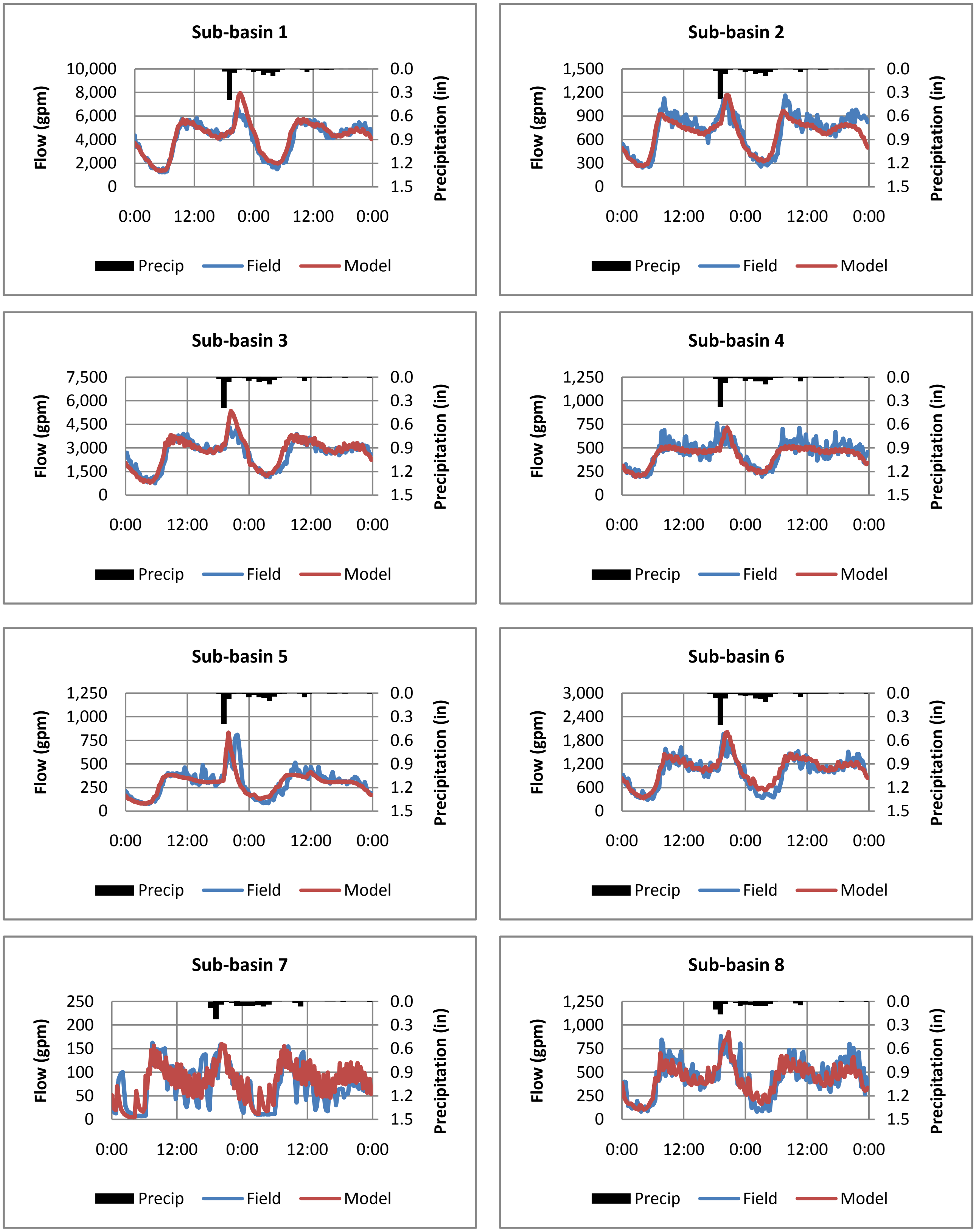


Figure 6a. Wet Weather Calibration Results, Sub-basins 1-8 (1st day shown is a weekday and 2nd day shown is a weekend day)

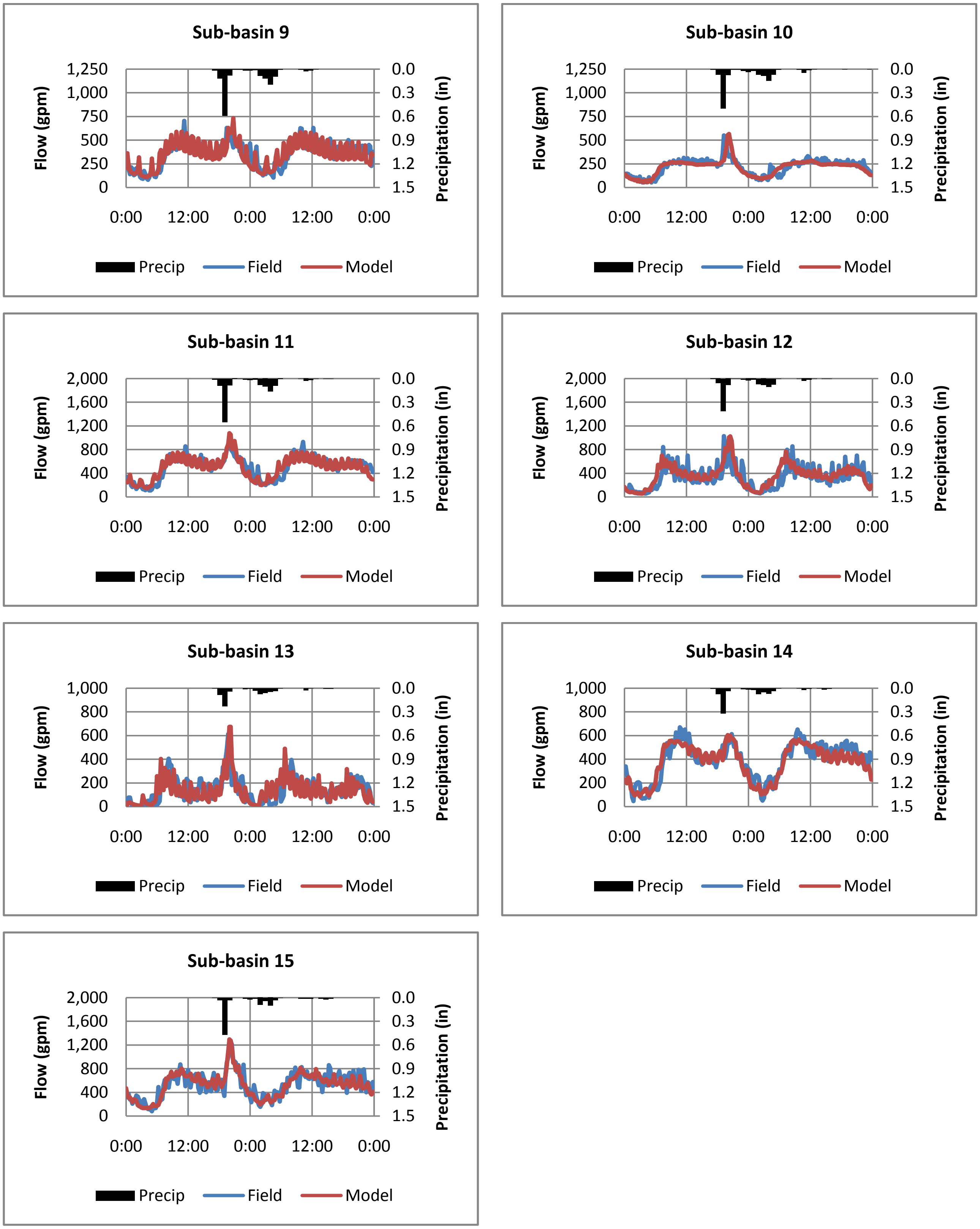


Figure 6b. Wet Weather Calibration Results, Sub-basins 9-15 (1st day shown is a weekday and 2nd day shown is a weekend day)

Visual comparisons of the field and model wet weather flows show a reasonable model calibration. Peak flows and daily patterns from the field and model match for most sub-basins. The wet weather response in sub-basins 1 and 3 was conservative throughout the calibration effort. This is primarily caused by conservative estimates in upstream basins cumulating and surfacing in the downstream sub-basins.

During the model calibration, additional information on the pump curves and pump controls at the Westside Lift Station was implemented into the model. Future calibration efforts should focus on improving the accuracy of lift station variables throughout the model.

Dry Weather Calibration (Peak Day)

Once the wet weather calibration was completed, the dry weather loading and diurnal patterns were adjusted to peak day dry weather flows. To avoid potential anomalies or spikes in the flow monitor data, the second highest dry weather flow day was chosen for each of the sub-basins during the flow monitoring period. To maintain the general shape of the averaged diurnal patterns, the patterns developed in calibration step 1 (average dry weather calibration) were adjusted to meet the peak flows for the chosen peak day. The peaking factors for each of the 15 sub-basins are presented in Table 3 for the peak dry weather calibration. Using the results of the peak day calibration provides a conservative dry weather model. On average the peaking factors are 18% greater for the peak day when compared with the peaking factors for the average day calibration. Weekday and weekend diurnal patterns for each of the sub-basins for both the averaged data and the peak day are presented in Figures 7a and 7b. The comparison of field and model flows are presented in Figures 8a and 8b.

Table 3. Dry Weather Peak Day Diurnal Pattern Peaking Factors

Flow Monitoring Sub-basin	Weekday	Weekend	Comment
1	2.185	1.872	Use Sub-basin 2 Diurnal Pattern
2	2.185	1.872	
3	2.185	1.872	Use Sub-basin 2 Diurnal Pattern
4	1.618	1.688	
5	1.734	1.914	
6	1.49	1.619	
7	2.164	2.493	
8	1.927	2.157	
9	2.079	2.208	
10	1.847	1.609	
11	1.701	2.028	
12	1.701	2.028	Use Sub-basin 11 Diurnal Pattern
13	2.9	2.595	
14	1.93	1.882	
15	1.93	1.882	Use Sub-basin 14 Diurnal Pattern

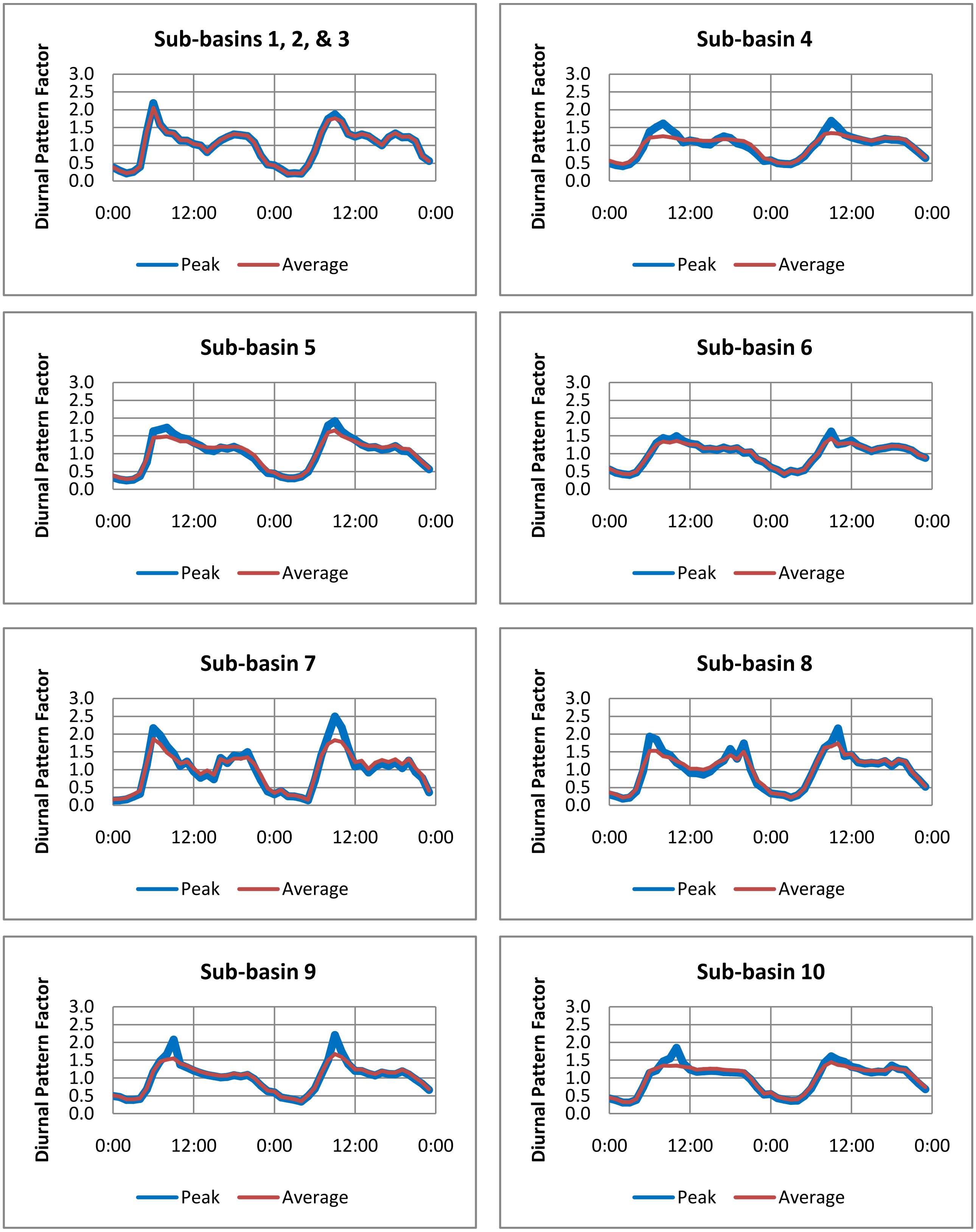
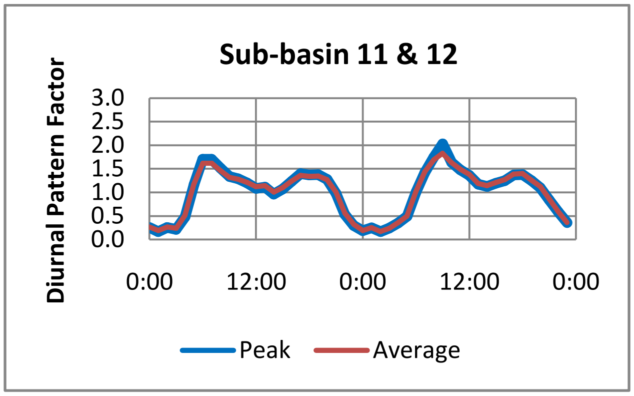
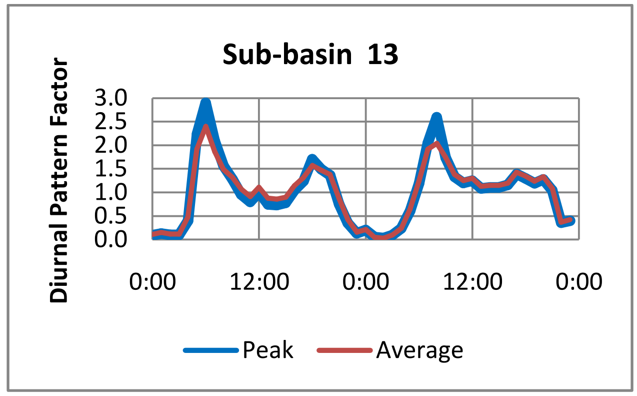


Figure 7a. Peak and Average Model Diurnal Patterns, Sub-basins 1-10 (1st day shown is a weekday and 2nd day shown is a weekend day)





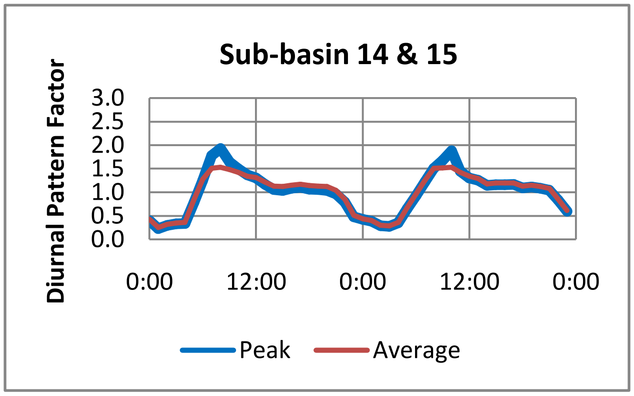


Figure 7b. Peak and Average Model Diurnal Patterns, Sub-basins 11-15 (1st day shown is a weekday and 2nd day shown is a weekend day)

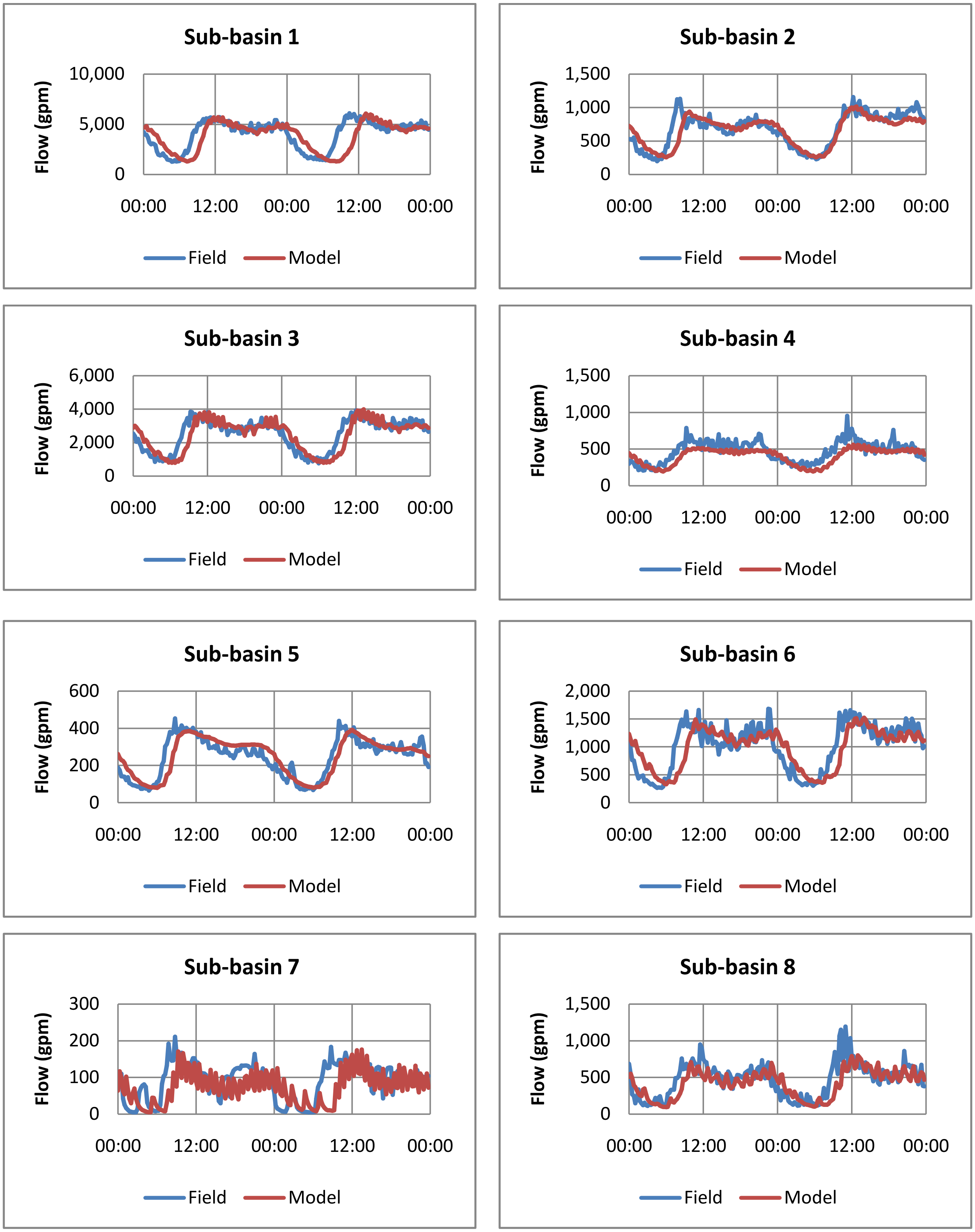


Figure 8a. Peak Day Dry Weather Calibration Results, Sub-basins 1-8 (1st day shown is a weekday and 2nd day shown is a weekend day)

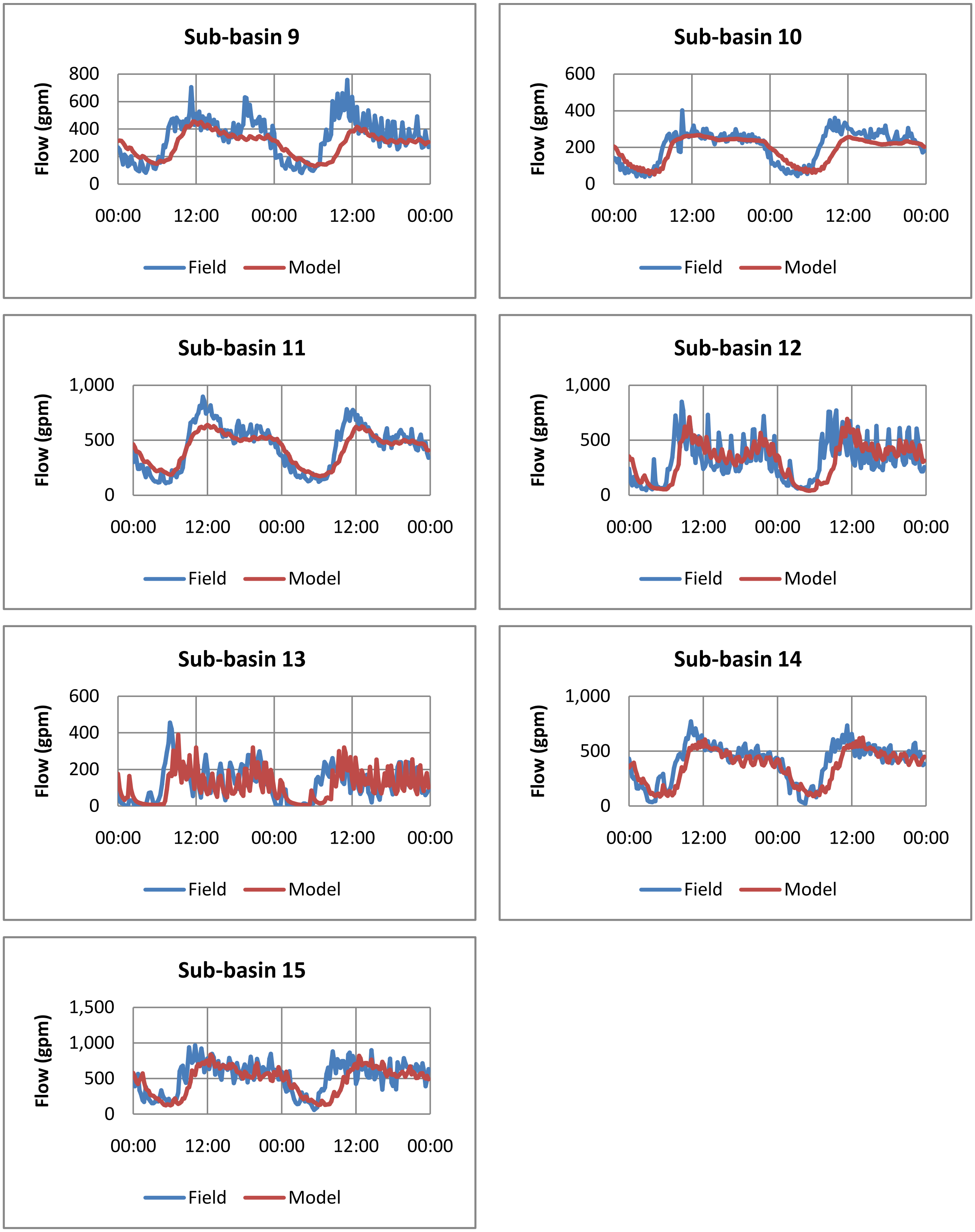


Figure 8b. Peak Day Dry Weather Calibration Results, Sub-basins 9-15 (1st day shown is a weekday and 2nd day shown is a weekend day)

Visual comparisons of the field and model wet weather flows show a reasonable model calibration. Peak flows and daily patterns from the field and model match for most sub-basins. In sub-basins 9, 10, and 11, peak flows are slightly under-estimated. Sub-basins 9 and 10 are low flow areas which are impacted significantly by lift station operations. Sub-basin 11 is downstream of sub-basin 9. During the flow monitoring period, these sub-basins saw the greatest variability of flow. The diurnal patterns were adjusted in sub-basins 9 and 10 so that the maximum peak day flows are 35% greater than the maximum average day flows. Additional peaking in these sub-basins would have caused significant reductions in the base flow component of the diurnal pattern.

The diurnal patterns and average loading established in the peak dry weather calibration and the unit hydrographs and sewersheds established in the wet weather calibration are used to model system deficiencies and improvements. The combination of the wet weather calibration and the peak day dry weather calibration, results in a conservative model approach. Any remaining issues with time shifts or delays between the model and field data will be eliminating by placing the design storm peak at the same time as the calibrated system-wide dry weather diurnal peak.

DESIGN STORM SELECTION

General

Once an actual storm event has been used to calibrate the model and to define appropriate sewersheds and unit hydrographs, the model can be simulated with varied design storms to determine system deficiencies and improvements. This section of the report will address the design storm selection for the City of Bend collection system based on historic precipitation data and Oregon DEQ requirements.

Oregon Department of Environmental Quality Design Storm Requirement

Oregon DEQ has the following requirements for design storm events when designing collection systems (Oregon Administrative Rule 340-041-0009 items 6 and 7):

> (6) Sewer Overflows in winter: Domestic waste collection and treatment facilities are prohibited from discharging raw sewage to waters of the State during the period of November 1 through May 21, except during a storm event greater than the one-in-five-year, 24-hour duration storm**.**
>
> (7) Sewer Overflows in summer: Domestic waste collection and treatment facilities are prohibited from discharging raw sewage to waters of the State during the period of May 22 through October 31, except during a storm event greater than the one-in-ten-year, 24-hour duration storm.

Based on the above requirements either the 5-year, 24 hour storm event or the 10-year, 24 hour storm event should be used as the design storm. Whichever storm causes a greater impact to the system should be chosen when sizing improvements.

Total Storm Depth

The total storm depths from the NOAA Atlas II precipitation maps are 1.9 inches and 2.1 inches for the 5-year, 24 hour and 10-year, 24 hour storm events respectively. An additional storm frequency analysis was completed to validate the NOAA Atlas II precipitation maps using the Bend airport precipitation gauge data for the period of record (1949-2006). The resulting storm depths for the frequency analysis are shown in Table 4.

The maximum 24 hour storm event for each year during the period of record was used to estimate the storm frequency. Because the maximum precipitation events typically occur during the winter months in the City of Bend, the total storm depths presented in the frequency analysis are representative of winter-time precipitation. The runoff characteristics of a winter-time event are different than a summer time event since much of the winter-time precipitation occurs as snowfall.

The frequency analysis does not account for variation in intensity or rainfall distribution by season. To understand storm depths during the spring and summer months, the frequency analysis was repeated, considering precipitation from April through September only. The resulting spring/summer storm depths are shown in Table 4. The storm depths for the April through September time period were compared to similar storm depths for the summer period in the DEQ rule (May 22 – Oct 31). The comparison showed that the April through September period storm depths are more conservative.

Table 4. Storm Frequency Analysis, City of Bend Airport

Source	5-year 24 hour Storm Depth (inches)	10-year 24 hour Storm Depth (inches)
NOAA Atlas II	1.9	2.1
Bend, Airport Period of Record (1949-2006), results typical of winter months	1.8	2.5
Bend, Airport Period of Record April-September (1949-2006), results typical of spring/summer months	1.0	1.2
Bend, Airport Period of Record May 22-October 31 (1949-2006), results during summer-time dates established by DEQ	0.8	1.1

Storm Distribution

The Oregon DEQ requirements do not specify a required storm distribution. Applicable storm distributions for Oregon are SCS Type IA for longer duration, lower intensity storms typical of winter and spring-time rain events and SCS Type II for shorter duration, higher intensity storms typical of summer-time localized thunder showers. The Bend, Oregon hourly precipitation record at the airport gauge (1949-2006) was reviewed for the period of record to determine an appropriate storm distribution. All storms with 24 hour cumulative precipitation greater than 1.8 inches were reviewed for months from October through March. All storms with 24 hour cumulative precipitation greater than 1.2 inches were reviewed for months from April through September. The precipitation data collected with temporary rain gauges throughout the City in May and June of 2007 was also reviewed. Three representative storm events were selected to assist in selecting an appropriate storm distribution. These three storms are described below:

1. A storm occurring in January 1980 with a total storm depth of 2.0 inches over 24 hours. This storm was selected to represent the DEQ requirement for a 5-year, 24 hour winter-time storm event. The actual storm distribution is compared to theoretical SCS Type IA and Type II storm distributions in Figure 9. The January 1980 storm event resembles the SCS Type IA storm distribution with a more intense peak.

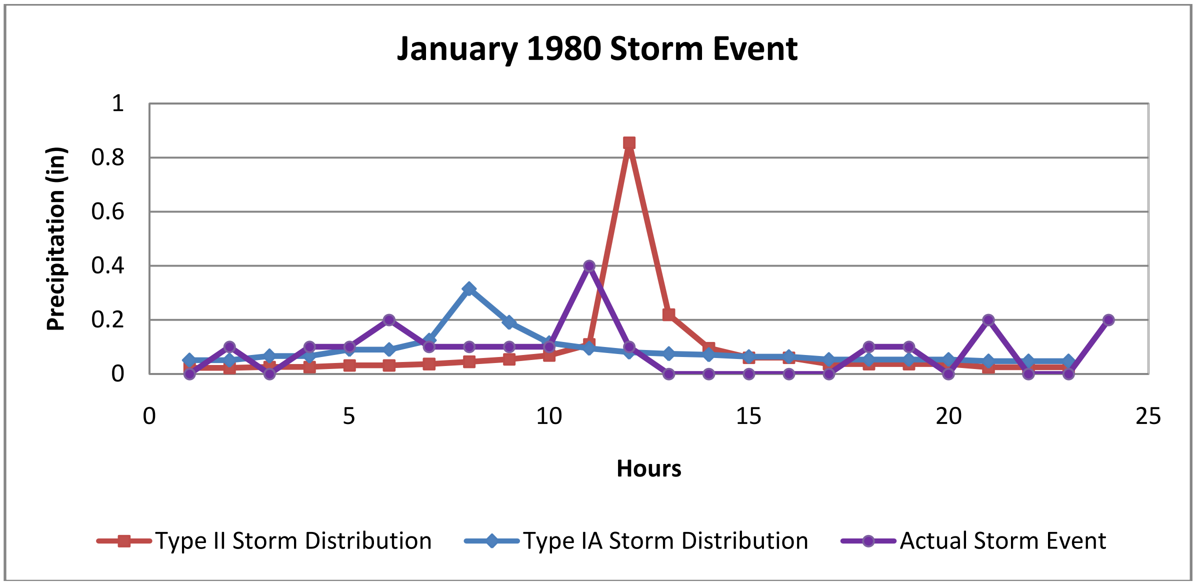


Figure 9. January Storm Event (2.0 inches) with SCS Type IA and Type II Theoretical Storm Distributions

2. A storm occurring in June 1965 with a total storm depth of 1.47 inches over 24 hours. This storm was selected to represent the DEQ requirement for a 10-year, 24 hour summer-time storm event. The actual storm distribution is compared to theoretical SCS Type IA and Type II storm distributions in Figure 10. The June 1965 storm event resembles both distribution types with the peak rainfall occurring somewhere between the two.

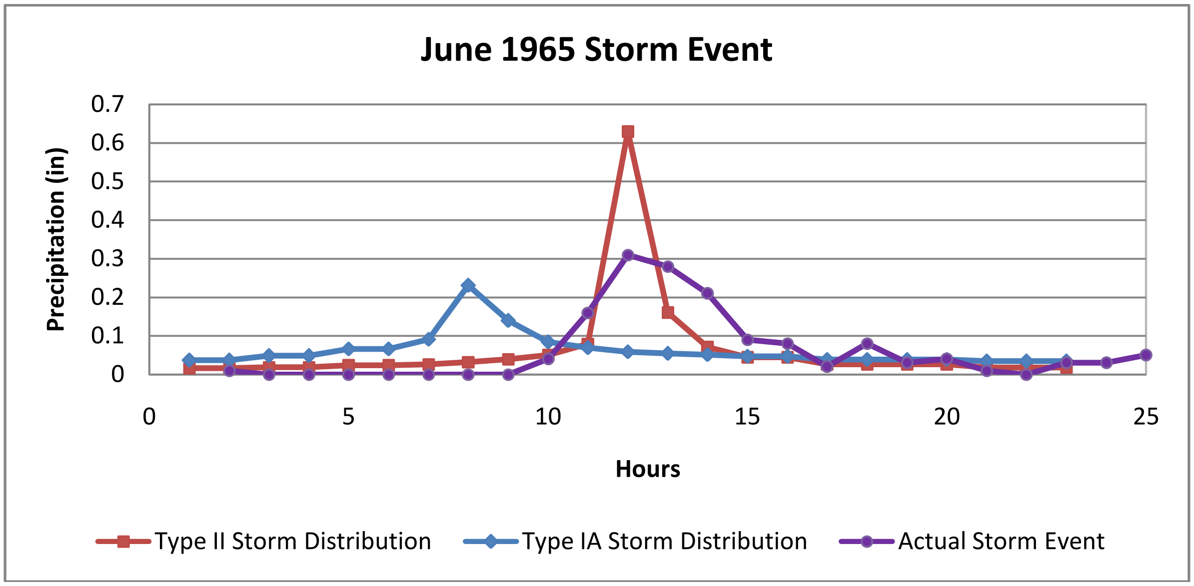


Figure 10. June 1965 Storm Event (1.47 inches) with SCS Type IA and Type II Theoretical Storm Distributions

3. A storm occurring in June 2007 and recorded at a temporary precipitation gauge in the City of Bend with a total storm depth of 1.4 inches over 24 hours. This storm was selected to represent a high intensity summer-time thunderstorm. The actual storm distribution is compared to theoretical SCS Type IA and Type II storm distributions in Figure 11. The June 2007 storm event resembles the Type II storm distribution.

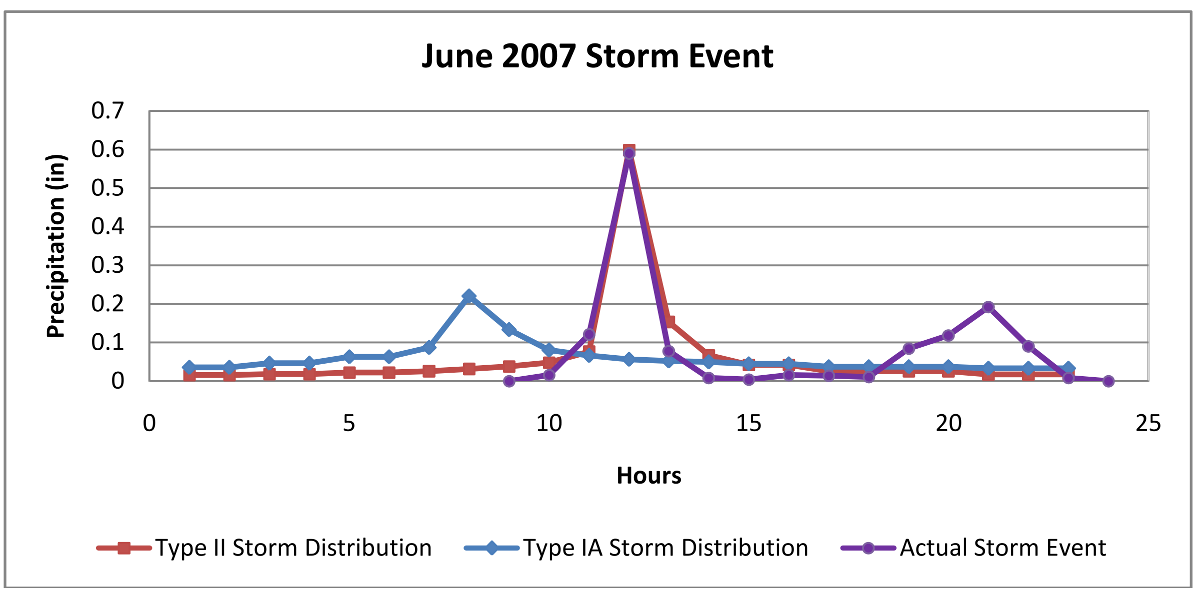


Figure 11. June 2007 Storm Event (1.4 inches) with SCS Type IA and Type II Theoretical Storm Distributions

The storm event example in Bend from June 2007 indicates that the SCS Type II distribution is more appropriate for a summer-time storm event; while the storm event example from January 1980 indicates that the SCS Type IA distribution is more appropriate for a winter-time storm event. The June 1965 storm event example indicates that there are a number of summer-time storm events that fall somewhere between the two distributions with the SCS Type II distribution being more conservative.

Infrastructure sizing in a sewage collection system are more sensitive to storm distribution and peak intensity than to total storm depth. For example, flooding may occur in a 1.2 inch, high intensity, summer-time thunderstorm and may not occur in a 2.1 inch, uniform intensity, winter-time storm. This concept is presented in two model profile results shown in Figures 12 and 33. Figure 12 shows model results with a 2.1 inch 24 hour storm event using a Type IA storm distribution. Figure 13 shows model results with a 1.2 inch 24 hour storm event using a Type II storm distribution. The Type II storm distribution results in a higher peak intensity, greater flow depths, and more substantial surcharging. Based on these results, the Type II storm distribution is recommended to model collection system deficiencies and improvements.

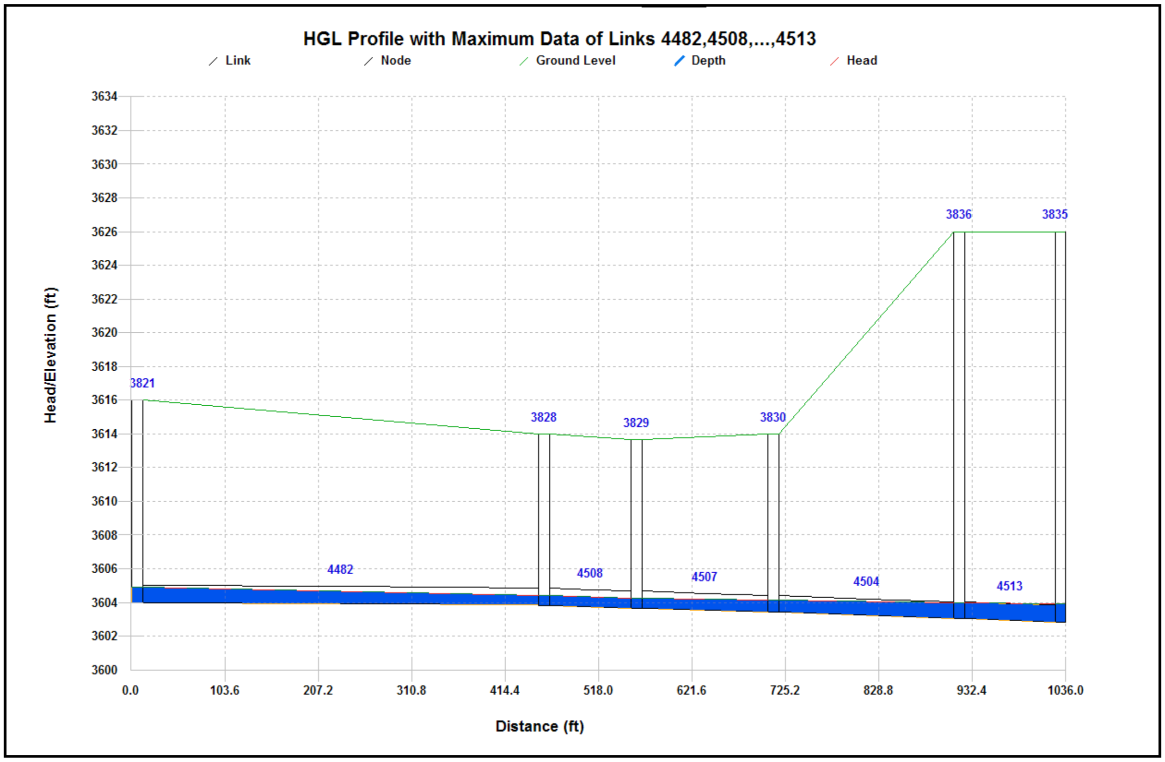


Figure 12. Model Results for Type IA Distribution, 2.1 inch 24 hour Storm Event

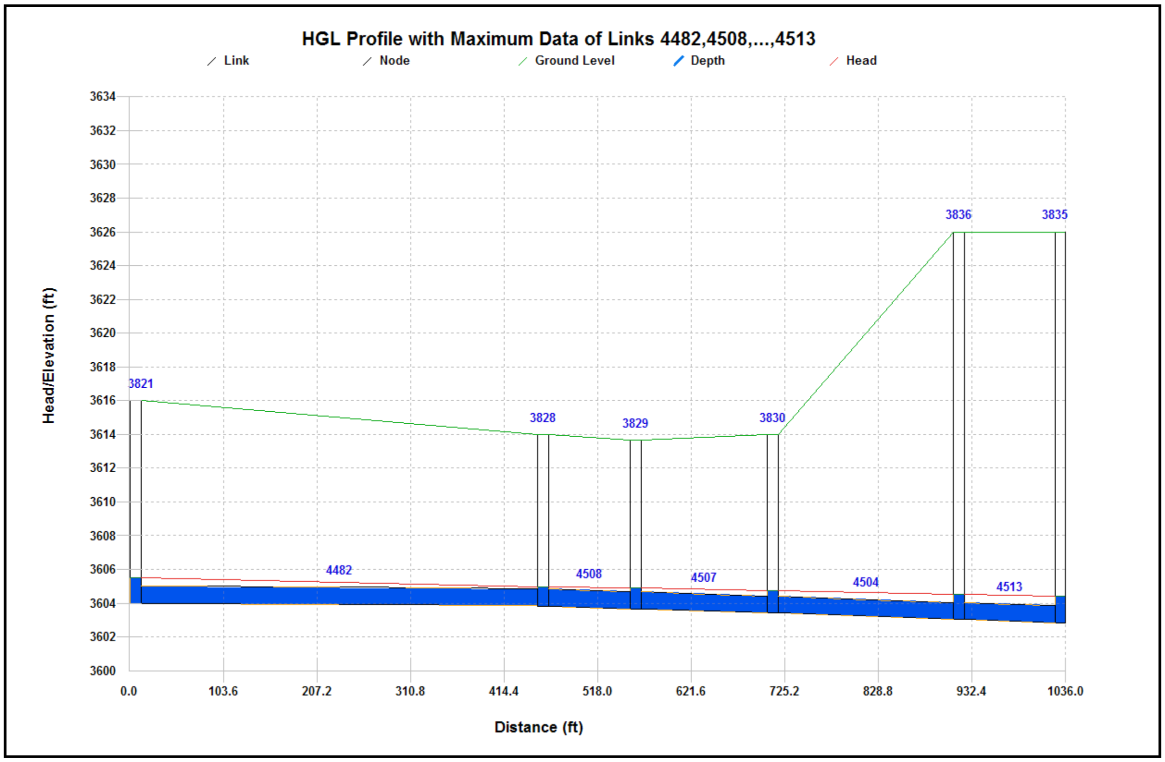


Figure 13. Model Results for Type II Distribution, 1.2 inch 24 hour Storm Event

Selecting the Design Storm Depth

Another method for determining adequate design storm depth is to review the number of times a peak hour storm depth is exceeded over the precipitation gauge period of record. This analysis was performed to confirm the results of the storm frequency analysis. The hourly storm depths selected for this analysis were derived from the peak hour of the SCS Type II distribution. With the SCS Type II distribution, approximately 50% of the design storm depth falls during the peak hour. Four design storms were analyzed. The design storms are described and the results of the analysis are shown in Table 5. Note that the hourly occurrence intervals reported are "on-average." Multiple hourly occurrences may in actuality have occurred within the same day during one large storm event.

Table 5. Hourly Storm Depth Occurrence, City of Bend, Oregon

Storm Description	Total Storm Depth (inches)	Peak Hour Depth (inches)	Number of Hours Peak Hour Depth Equaled or Exceeded During Period of Record (1949-2006)	Number of Hours Peak Hour Depth Equaled or Exceeded During Period of Record (summer-time)	On Average Occurrence (summer-time)	Number of Hours Peak Hour Depth Equaled or Exceeded During Period of Record (winter-time)	On Average Occurrence (winter-time)
10-year, 24 hour Storm (NOAA Atlas II)	2.1	0.9	6	2	1 hour every 29 years	4	1 hour every 14.5 years
5-year, 24 hour Storm (NOAA Atlas II)	1.9	0.81	7	2	1 hour every 29 years	5	1 hour every 11.6 years
June 1965 Actual Storm Depth at Bend Airport	1.47	0.63	13	4	1 hour every 14.5 years	9	1 hour every 6.4 years
10-year, 24 hour Storm, April-Sept precip data at Bend Airport	1.2	0.51	21	8	1 hour every 7.3 years	13	1 hour every 4.5 years

The challenge in collection system master planning is to meet the DEQ standard for overall storm depth and frequency, while not over-sizing improvements. Over-sized improvements are costly and may not meet the minimum velocity requirements for scour and prevention of sediment build-up.

Based on the analysis shown in Table 5, using the SCS Type II distribution, the NOAA Atlas II storm depths (1.9 inches and 2.1 inches) appear overly conservative. When considering winter-time months, peak hour storm depths are equaled or exceeded only 4 and 5 times over 58+ years (on average 1 hour every 11.6 – 14.5 years during the winter). When considering the same peak hour storm depths during a summer-time storm, the results are even more conservative with depths being equaled or exceeded only 2 times over 58+ years (on average 1 hour every 29 years during the summer).

A more appropriate storm event would fall somewhere between the April-September storm (1.2 inches) and the June 1965 storm (1.47 inches). The peak hour depths are equaled or exceeded 9 and 13 times over 58+ years during the winter-time (on average 1 hour every 4.5 and 6.4 years during the winter) and 4 and 8 times over 58+ years during the summer-time (on average 1 hour every 7.3 and 14.5 years during the summer) for the two storms respectively. A 1.3 inch design storm depth can be interpolated from the two winter storm depths at a 5-year winter-time interval. A 1.3 inch design storm depth can also be interpolated from the two summer time storm depths at a 10-year summer-time interval.

Based on the two interpolated numbers, the minimum design storm recommendation is 1.3 inches with an SCS Type II distribution. This means that the peak hour storm depths derived from the recommended storm depth and distribution will be exceeded less than once every 5 years during the winter on average and less than once every 10 years during the summer on average. The 1.3 inch storm depth also exceeds the 1.2 inch storm depth calculated for the spring/summer event during the storm frequency analysis (see Table 4).

Comparing Peak Intensities

Another verification of the recommended design storm is to equate the peak intensity of the 1.3 inch SCS Type II distribution summer-time storm (peak intensity = 0.4 in/hr) with the peak intensity of a 2.6 inch SCS Type IA distribution winter-time storm (peak intensity = 0.40 in/hr). In both cases the total design storm depths at their respective distributions satisfy the storm frequency analysis shown in Table 4 and meet the DEQ requirement (summer-time storm depth, 1.3 inches > 1.2 inches; winter-time storm depth, 5-year, 24 hour event 2.6 inches > 1.8 inches).

DEQ Approval

The results of the storm frequency analysis and the recommended design storm were presented to Walt West with the DEQ Bend office in a technical memorandum dated September 20, 2007. In a meeting on October 16, 2007, DEQ confirmed that the recommended design storm of 1.3 inches with an SCS Type II distribution would be adequate for modeling collection system improvements. The City of Bend is expecting a confirmation letter from DEQ acknowledging their approval.

PLANNING DENSITIES, LOADING, AND COST ASSUMPTIONS

General

The purpose of this section of the report is to provide background for the collection system build-out models and CIP development. This section includes information on planning densities, growth boundaries, build-out model loading, deficiency and improvement design criteria, and unit cost assumptions.

Planning Densities and Growth Boundaries

Two planning densities will be referenced in this document (2030 build-out and full build-out). Both planning densities include the same growth boundaries defined in the CSMP. These boundaries include all areas in the City Limits or Urban Growth Boundary (UGB) and additional areas outside of the City Limits or the Urban Reserve Area (UAR). The growth boundary was divided into nine study areas for the CSMP. The growth boundary and study areas are shown in Figure 14.

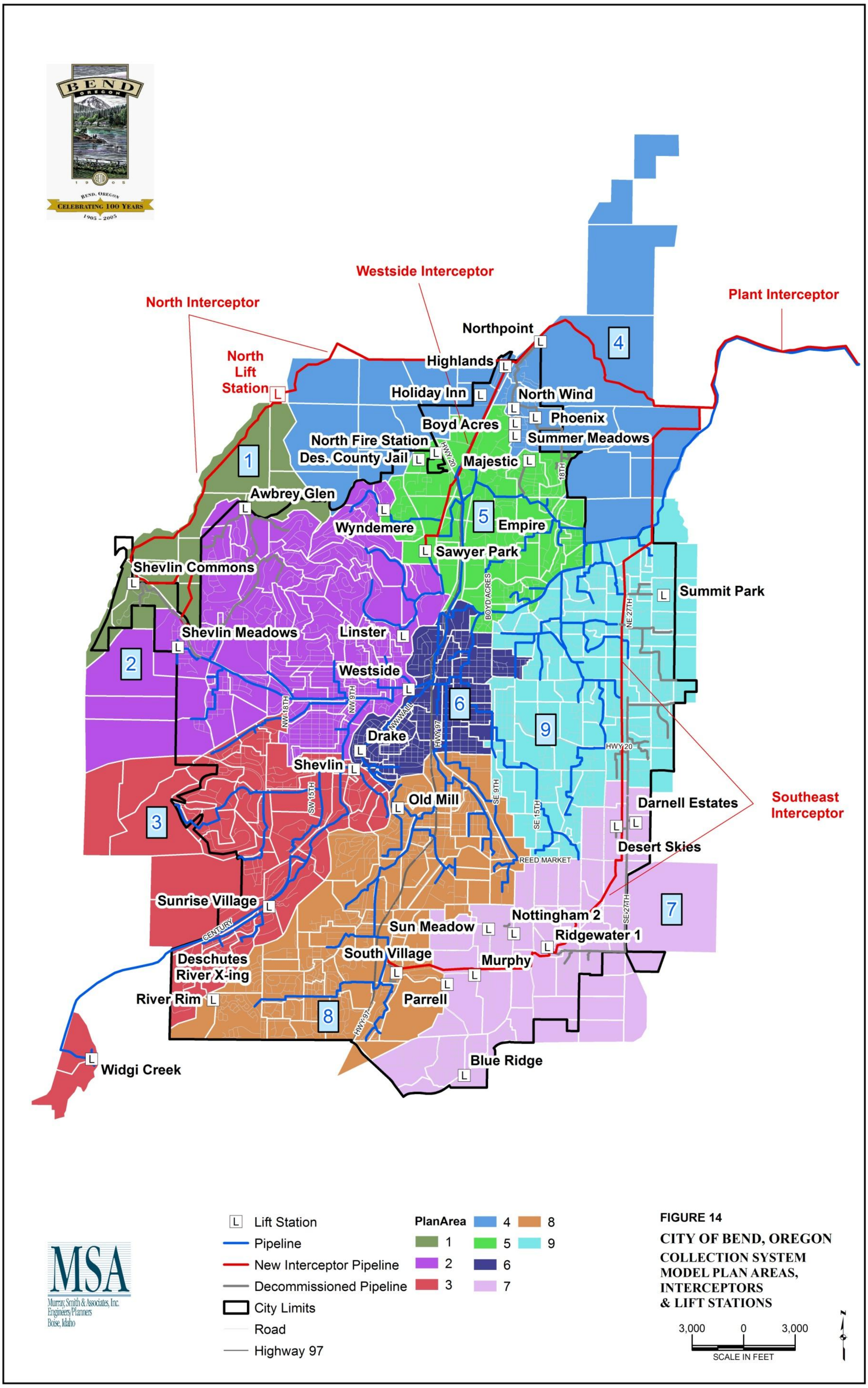


Figure 14. CSMP Plan Areas, Interceptors, and Lift Stations

The two planning/population densities are defined below and referenced in this document:

1. <u>2030 build-out</u>: the planning density established for the 2030 build-out CIP with reduced population estimates. This projection assumes a varied growth rate through 2030 with a final population of 119,009. The population growth rates were established by the State of Oregon Office of Economic Analysis and are presented in Table 6. The 2030 build-out planning density is used to establish flows and size improvements for the 2030 build-out CIP.

2. <u>Full build-out</u>: the planning density established in the CSMP. This projection assumes a 5% growth rate through 2030 with a total population of 238,162 (see Table 6). Flows are defined and improvements are sized in the CSMP based on the full build-out planning density. The "original" full build-out CIP (referenced as the "original" CIP) is presented in the CSMP. The "revised" full build-out CIP (referenced as the "full build-out" CIP) is presented in this document and includes revised improvements based on analysis with the newly calibrated model.

Table 6. Planned Growth Rates for the City of Bend, Oregon

Year	2030 Build-out Population Estimate	2030 Build-out Annual Growth Rate Estimate	Full Build-out Density Population Estimate	Full Build-out Annual Growth Rate Estimate
2000 (actual)	52,800	-	52,800	-
2005 (actual)	70,330	4.74%	70,330	5.00%
2010 (estimate)	81,242	2.52%	89,761	5.00%
2015 (estimate)	91,158	2.33%	114,560	5.00%
2020 (estimate)	100,646	2.00%	146,211	5.00%
2025 (estimate)	109,389	1.68%	186,606	5.00%
2030 (estimate)	119,009	1.70%	238,162	5.00%

Dry Weather Flow Generation

For the build-out models, the average flows were generated from planning and land-use data. The average flows were assigned to model nodes based on service areas defined in the CSMP. Diurnal patterns established during the most recent model calibration were then applied to each node in the existing sub-basins. Areas outside of the existing system were assigned diurnal patterns of near-by sub-basins. The diurnal patterns represent primarily residential flows. The sub-basin diurnal pattern assignment for both existing and growth areas as well as the City's land-use data are shown in Figure 15.

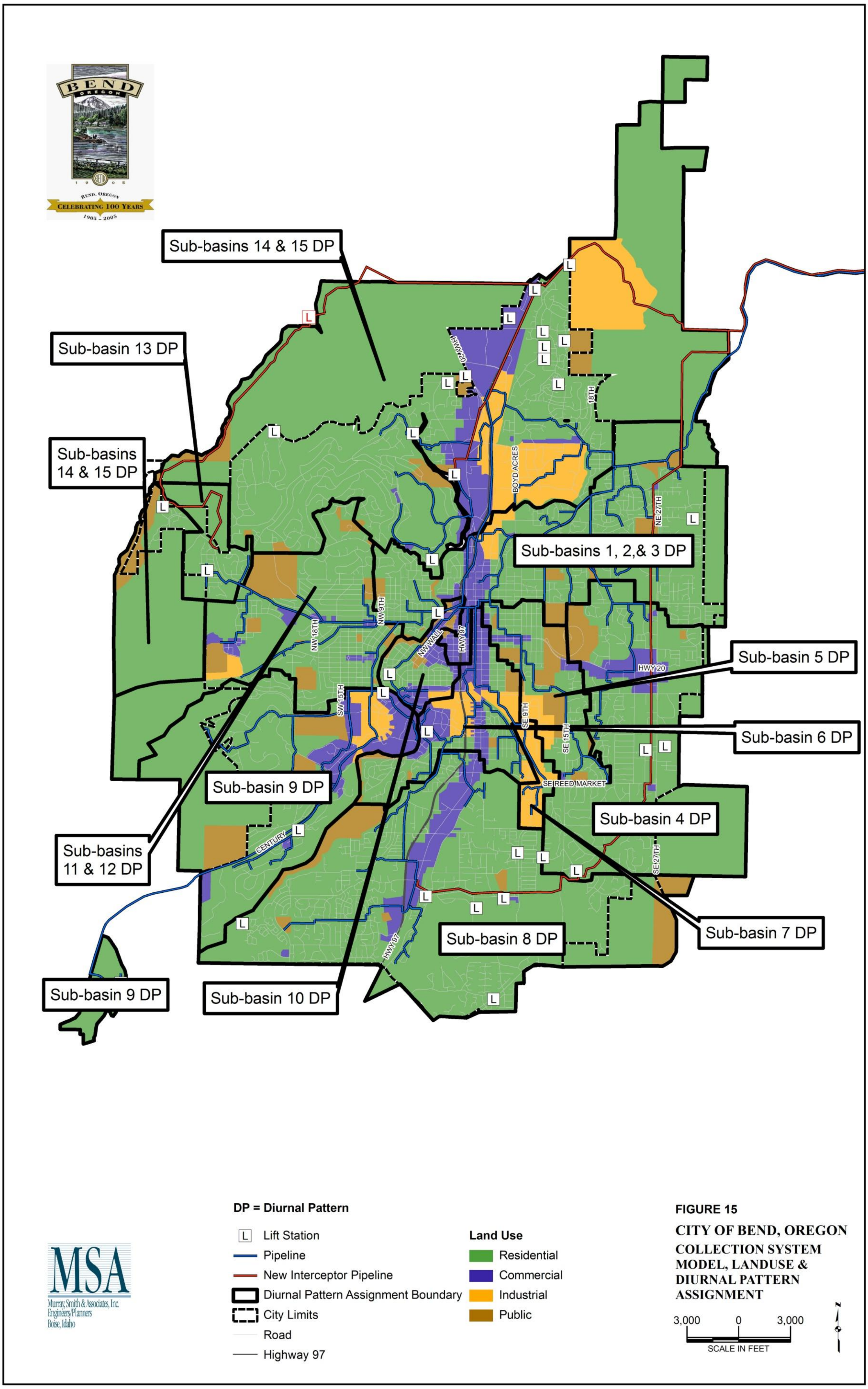


Figure 15. Land-use and Diurnal Pattern Assignment for 2030 and Full Build-out Dry Weather Loading

2030 Build-out Flows

The 2030 build-out average dry weather flows were estimated from land-use data, residential per capita water usage criteria provided by the City, and commercial and industrial per acre water usage estimated from 2006 City meter records. The water usage criteria are presented in Table 7.

Table 7. 2030 Build-out, Dry Weather Flow Assumptions

Land Use	Growth Boundary	Units per Acre	People per Unit	Average Gallons per Capita	Average gpcd for residential and gpad for commercial & industrial
Residential High Density	UGB	19	2.3	100	4,370
Residential Medium Density	UGB	12	2.3	100	2,760
Residential Standard Density	UGB	4	2.3	100	920
Residential Low Density	UGB	2	2.3	100	460
Proposed Residential Outside of UGB	UAR	5.3	2.3	100	1,219
Central Business District	UGB				3,920
Commercial Convenience	UGB				2,690
Commercial General	UGB				970
Commercial Limited	UGB				2,120
Industrial General	UGB				680
Industrial Limited	UGB				670
Industrial Park	UGB				680
Mixed Employment	UGB				2,610
Mixed Use Riverfront	UGB				540
Professional Offices	UGB				2,120
Public Facility	UGB				260

The percentage of land developed and population served in each study area were reduced so that overall population would not exceed 119,009. The population and average dry weather flow for each study area were estimated with the following procedure:

1. Assume that all existing developed lands both served and un-served by the City collection system will be served by 2030 in the UGB and UAR.
2. Categorize the study areas by growth potential in undeveloped lands.
3. Assume a maximum of 68% development by 2030 of existing undeveloped lands for the highest growth category.
4. Reduce percentages for each lower growth category by approximately 50% (highest growth = 68%, 2nd highest growth = 36%, 3rd highest growth = 15%, lowest growth = 6%)
5. Reduce total build-out flows in each study area by applying percentages in step four.

The populations derived from this procedure are presented in Table 8. The categories and growth percentages were reviewed and approved by the City prior to the analysis. 2030 build-out flows were assigned to model nodes using the service area delineation from the CSMP.

Table 8. Estimated 2030 Build-out Population and Growth Percentages by Study Area

Area	Existing Population Developed & Served	Existing Population Developed & Unserved (septic systems)	Existing Population Developed	Growth Potential Category by 2030	Percent Undeveloped Expected to be Developed by 2030	Estimated Additional Population by 2030	2030 Build-out Estimated Population
1	5	18	23	4	6%	629	652
2	12,432	422	12,854	3	15%	4,613	17,467
3	4213	1,062	5,275	3	15%	3,873	9,148
4	362	560	922	2	36%	9,579	10,501
5	3872	878	4,750	1	68%	4,215	8,965
6	5455	1,042	6,497	1	68%	3,651	10,148
7	3562	4,095	7,657	2	36%	8,560	16,217
8	7592	3,775	11,367	2	36%	5,378	16,745
9	18,078	2,127	20,205	2	36%	8,962	29,167
TOTAL	**55,571**	**13,979**	**69,550**			**49,459**	**119,009**

Full Build-out Flows

The full build-out average dry weather flows were generated for the original build-out model using City land use and planning data within the UAR and UGB. The flow generation is documented in detail in section 2 of the CSMP. The flows were not modified for the revised full build-out model except to apply revised sub-basin specific diurnal patterns from the new calibration to the original average flows. Assumptions from the CSMP for build-out flow generation are listed below:

1. Residential loading: 200 gpd/dwelling unit for single family dwelling units and 180 gpd/dwelling unit for multi-family dwelling units. Dwelling units were established from City tax lot information and parcel data.

2. Non-residential loading: 1300 gpd/acre for commercial, 700 gpd/acre for industrial, 130 gpd/acre for public, and 630 gpd/acre for other land uses.

3. Seasonal Occupancy: reductions to average loading for residential areas including 50-100% occupancy for single family dwelling units depending on location and 80-100% occupancy for multi-family dwelling units depending on location. No seasonal occupancy reductions were implemented for not-residential loading.

4. Summer peaking factor: a conservative 1.25 peaking factor was assigned to all average loading as a summer-time peaking factor. This peaking factor was not removed or modified resulting in a conservative full build-out model.

5. Specific adjustments: additional specific adjustments were made to general assumptions 1-4 for several areas of the City where specific planning data was known. These areas include Juniper Ridge development, Section 11, and Tetherow (see CSMP section 2 for more information).

Wet Weather Flow Generation

As previously described in the “Calibration” and “Design Storm” sections of this report, the wet weather flow component of the model consists of a storm event, sewershed acreage (wet weather area of impact), and rainfall distributed infiltration and inflow (RDII) unit hydrograph. For the 2030 and full build-out model analysis, the peak of the 10-year, 24 hour design storm (1.3 inch, SCS Type II) was set to coincide with the general diurnal peak for dry weather throughout the collection system. This peak occurs on a weekend day at 10:00 am.

The unit hydrographs defined during the calibration for each of the 15 sub-basins were used for existing service areas including potential growth within the existing areas. This results in a conservative wet weather component to the model. For build-out areas which are outside of the existing system service areas, a composite unit hydrograph was developed from the sub-basins with the least impact from I/I. The build-out unit hydrograph is defined by R, T, and K values of 0.015, 0.5 hrs, and 1 respectively. These values are conservative for new construction since new pipelines and manholes will see minimal impacts from I/I caused by leaks and broken seals. Five sub-basins have R values which are slightly lower than the build-out unit hydrograph and range from 0.005 – 0.014 (see Table 2 for comparison; see Figure 16 for unit hydrograph assignment).

The variability in the wet weather component of the model between the 2030 and full build-out scenarios is due to the differences in sewershed acres. The total sewershed acres are proportional to the total percentage of developed land for each scenario. As previously described, the sewersheds in the existing system were defined by placing a 20 ft buffer around all system pipes. The existing sewershed acres and existing developed acres were used to calculate the density of sewersheds for each plan area. These percentages were used to extrapolate the sewershed acres for both the 2030 and full build-out conditions by multiplying the existing sewershed density in each respective plan area by the expected development acres for each scenario. Sewershed acreages were assigned to model nodes using the service area delineation from the CSMP. The procedures and results for the sewershed extrapolation are shown in Tables 9a and 9b and Figure 16.

Table 9a. Extrapolation of Wet Weather Sewersheds for 2030 Build-out Model

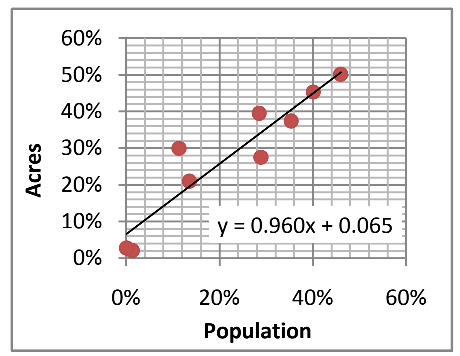
1	2	3	4	5	6	7	8	9	10	11	12
Plan Area	Total Acres	Existing Percent of Total Acres Developed and Served (from CSMP)	2030 % Developed and Served of Total Population (developed from 2030 loading assumptions)	Correlation of % Developed by Population and Acres for Existing System (each data point represents a study area)	2030 % Developed and Served of Total Acres (use correlation, y = 0.96x + 0.065)	2030 Acres Developed (column 6 * column 2)	Existing Acres Developed (from CSMP)	Existing Sewershed Acres (from calibrated model)	Existing Ratio of Sewershed Acres to Developed Acres (column 8/ column 9)	Expected 2030 Sewershed Acres (column 7 * column 10)	Sewershed Percent of Total Acres (column 11/ column 2)
1	1,300	3%	6%		13%	163	36	6	18%	29	2%
2	4,986	40%	40%		45%	2,241	1,970	200	10%	227	5%
3	3,919	21%	29%		35%	1,361	824	93	11%	154	4%
4	4,665	2%	38%		43%	2,011	96	17	18%	368	8%
5	2,154	37%	82%		85%	1,834	807	90	11%	205	10%
6	1,217	50%	86%		89%	1,078	611	77	13%	135	11%
7	3,942	30%	52%		56%	2,209	1,182	87	7%	163	4%
8	3,925	28%	64%		68%	2,654	1,081	150	14%	369	9%
9	3,854	45%	65%		69%	2,643	1,748	170	10%	256	7%
Total	29,962					16,194	8,355	890		1,906	

Table 9b. Extrapolation of Wet Weather Sewersheds for Full Build-out Model

1	2	3	4	5	6	7	8	9	10	11	12
Plan Area	Total Acres	Existing Percent of Total Acres Developed and Served (from CSMP)	Full Build-out % Developed and Served of Total Population (assumed 100%)		Full Build-out % Developed and Served of Total Acres (assume 100%)	Full Build-out Acres Developed (column 6 * column 2)	Existing Acres Developed (from CSMP)	Existing Sewershed Acres (from calibrated model)	Existing Ratio of Sewershed Acres to Developed Acres (column 8/ column 9)	Expected Full Build-out Sewershed Acres (column 7 * column 10)	Sewershed Percent of Total Acres (column 11/ column 2)
1	1,300	3%	100%		100%	1,300	36	6	18%	232	18%
2	4,986	40%	100%		100%	4,986	1,970	200	10%	505	10%
3	3,919	21%	100%		100%	3,919	824	93	11%	444	11%
4	4,665	2%	100%		100%	4,665	96	17	18%	853	18%
5	2,154	37%	100%		100%	2,154	807	90	11%	240	11%
6	1,217	50%	100%		100%	1,217	611	77	13%	153	13%
7	3,942	30%	100%		100%	3,942	1,182	87	7%	290	7%
8	3,925	28%	100%		100%	3,925	1,081	150	14%	546	14%
9	3,854	45%	100%		100%	3,854	1,748	170	10%	374	10%
Total	29,962					29,962	8,355	890		3,637	

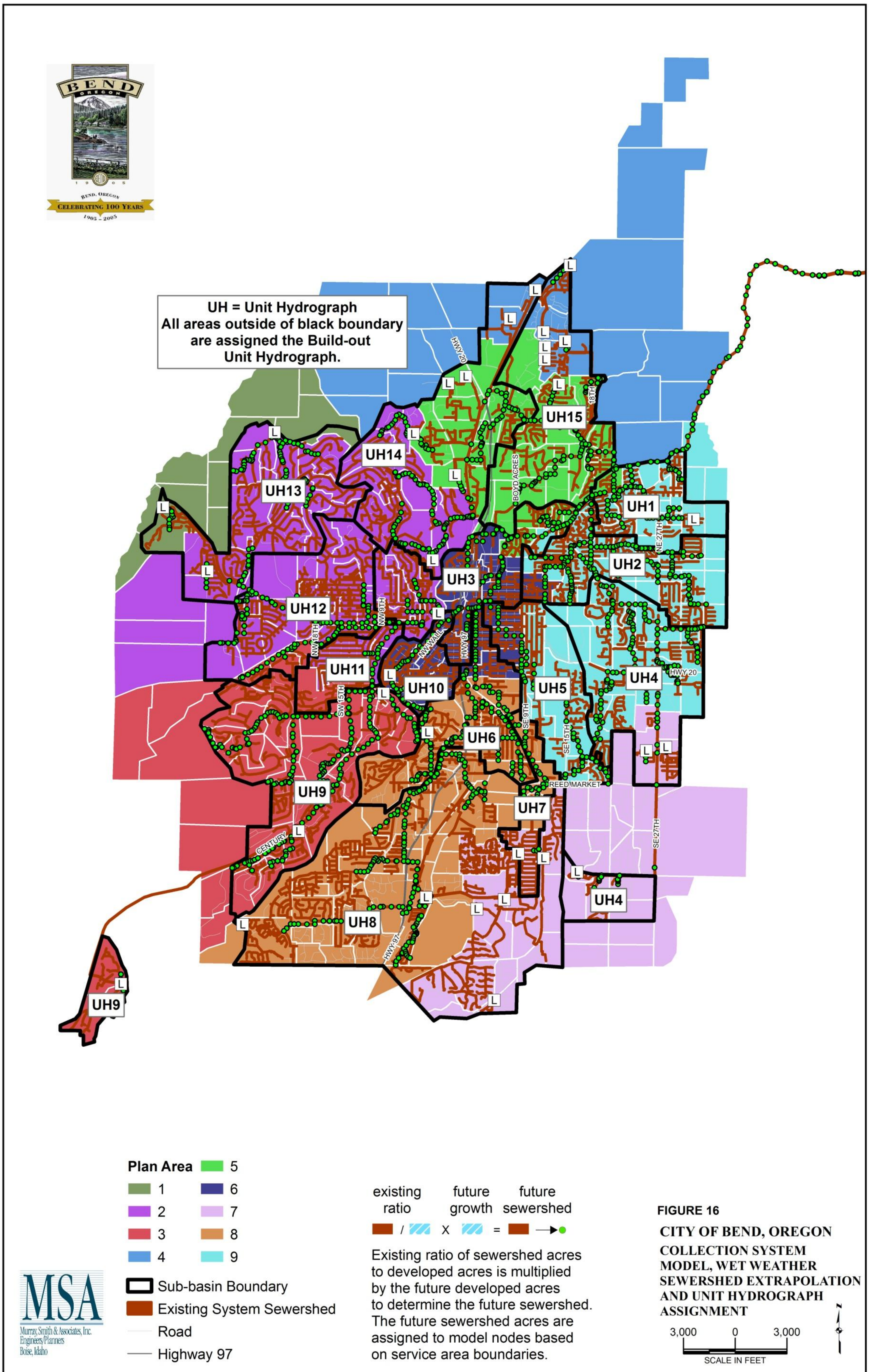


Figure 16. Unit Hydrograph Assignment and Sewershed Derivation for 2030 and Full Build-out Models

Statistical Comparison of Models

The 2030 and full build-out models predict flows which are less than the original build-out model. The flow comparisons are shown in Table 10. For the 2030 build-out model, the reduced flows are caused by a reduction in population (119,000 compared to 238,000). For the full build-out model, the reduced flows are a combination of revised dry weather and wet weather model set-up.

Table 10. Average and Peak Flow Comparison for Model Scenarios

Scenario	Average Dry Weather Flow (mgd)	Peak Flow, Wet and Dry (mgd)	Reduction from Original Build-out
Original Build-out	23.1	64.0	--
2030 Build-out	15.6	33.5	48%
Revised Full Build-out	23.1	52.8	18%

System Criteria for Deficiencies and Improvements

The City of Bend criteria for determining system deficiencies are shown in Table 11. These criteria were used to determine deficiencies and size improvements for the 2030 and full build-out CIPs. Three categories of improvements were considered (see Figure 14):

1. Gravity and forcemain improvements in the 9 study areas.
2. Lift station upgrades and decommissioning in the 9 study areas.
3. Planned interceptors (Plant Interceptor, North Interceptor, Southeast Interceptor, and Westside Interceptor).

Table 11. Deficiency and Improvement Design Criteria for CIP Development

Category	Criteria
During peak dry weather flows, d/D	<= 0.8
During peak wet weather flows, maximum surcharge (clearance from water surface to manhole rim)	>= 2.5 ft
Shallow Manhole (crown of pipe to rim < 2.5 ft), during peak wet weather flows, maximum surcharge (clearance from water surface to manhole rim)	>= 0.5 ft
Pump Station firm capacity	Lift stations have capacity to pump at flows greater than or equal to peak hour flows with largest pump out of service
Maximum force main velocity	< 6 ft/sec
Maximum gravity pipeline velocity	< 10 ft/sec or anchored appropriately for extreme slopes
Minimum cleansing/scouring velocity, gravity pipeline and force main (criteria ignored for existing pipelines that did not experience other deficiencies)	2 ft/sec
Minimum cleansing/scouring velocity, siphon (2 barrels required)	3 ft/sec

CIP Cost Criteria

The unit costs and cost assumptions for the 2030 build-out CIP and the full build-out CIP are the same as presented in the CSMP. A full explanation of costs is presented by MWH in TM 3.6 attached as Appendix B and entitled "Cost Criteria." The costs are based on local contractor information from 2005. All costs are order of magnitude with expected accuracy of +30 percent to -20 percent. Construction and material costs have increased substantially since 2005. The City is currently developing updated unit costs for 2007. Once the new unit costs have been fully developed and reviewed, it is recommended that the CIP costs be revised with the 2007 unit costs.

Gravity pipeline costs are per unit length with variation for diameter, depth, and surface restoration categories. Manhole costs are per manhole with variation for diameter and depth. Force main costs are per unit length with variation for diameter. Considerations are also provided for bypass pumping and reconnection fees. Where improvements are required for the 2030 build-out CIP and the full build-out CIP, the major change in costs from the original CIP are adjustments to pipe diameter and manholes sizes.

In the original CIP, the number of manholes for each improvement were calculated by dividing the total length of the improvement by a maximum 400 ft spacing. This method is adequate for new interceptor improvements; however, it underestimates the number of manholes for gravity improvements in the existing system. The existing system manholes are often spaced at less than 400 ft to account for grade changes and road alignment changes. To maintain consistency between the original build-out CIP, the 2030 build-out CIP, and the full build-out CIP, the method for calculating the numbers of manholes was NOT modified. The cost discrepancy from the underestimation of manhole numbers is expected to be less than 4% of the overall gravity and forcemain CIP cost.

In the original CIP, all gravity improvement cost estimates used the unit costs for a 0-10 ft construction depth even though the CSMP stated that the same unit costs should be applied to both new improvements and replacement/upgrade improvements. The 2030 build-out CIP and full build-out CIP utilize all of the unit cost data with variation for construction depth. Because of the modified assumption, the cost differences between the original build-out CIP and the other CIPs are less exaggerated than if both CIPs had utilized the variation in construction depth. The original CIP costs were re-calculated with variation in construction depth to provide an adequate comparison of costs. These "revised" original CIP costs are presented in the full build-out CIP section of this document. Additionally, the 2030 and full build-out costs may be conservative since a replacement or upgrade improvement would require less excavation than a new improvement. It is recommended for future CIPs and master planning efforts that separate unit costs be developed for new improvements and upgrade/replacement improvements.

Other cost considerations are given to canal crossings, railroad and highway under-crossings, erosion control, siphon structures, traffic control, and easements. The available documentation for these considerations in the original CIP is limited to general approach and total cost by improvement. For the 2030 build-out CIP and the full build-out CIP, these costs were assumed to be identical to the original CIP.

In the CSMP, specific procedures for pump station upgrades and decommissioning cost estimates are documented for the original CIP; however, the specific procedural worksheets and assumptions for each pump station were unavailable for CIP revisions. For the 2030 build-out CIP and the full build-out CIP, pump station improvements are classified into three categories and utilize the total costs from the original CIP with the following rules to arrive at the revised costs:

Category 1 – No pump station upgrade or decommissioning required for the 2030 build-out CIP or the full build-out CIP.

Rule 1 – Eliminate improvement and cost.

Category 2 – Reduced pump station upgrade or decommissioning required for the 2030 build-out CIP or the full build-out CIP.

Rule 2 – Reduce the original CIP cost using the six-tenths factor rule. The six-tenths factor rule is defined below (see United States Department of Energy, Document DOE G 430.1-1, Chapter 20, page 20-4, order of wording changed slightly from original document):

> If a new piece of equipment is similar to one of another capacity for which cost data are available, good results (cost estimates) can be obtained from a scaling factor by using the logarithmic relationship known as the "six-tenths-factor rule." According to this rule, if the cost of a given unit at one capacity is known, the cost of a similar unit with X times the capacity of the first is approximately $(X)^{0.6}$ times the cost of the initial unit.
>
> Cost of equip. a = cost of equip. b* (capac. equip. a/ capac. equip. b)$^{0.6}$

Category 3 – Full pump station upgrade or decommissioning required for the 2030 build-out CIP or the full build-out CIP.

Rule 3 – Maintain original build-out improvement and cost.

Category 4 – Additional pump station upgrade or decommissioning required above the original CIP for the 2030 build-out CIP or the full build-out CIP.

Rule 4 – Increase the original CIP cost using the six-tenths rule. See rule 2 for a definition of the six-tenths rule.

The costs for the 2030 build-out CIP and the full build-out CIP assumed 35-40% engineering, administration, and legal fees as well as a 30% contingency. These percentages were extracted directly from the original CIP for each improvement.

Because of the revised loading and wet weather components of the model, several new improvements are identified for the 2030 build-out CIP and the full build-out CIP which were not included in the original CIP. For the new improvements, the percentage of total costs for other considerations (easements, crossings, etc.), engineering/admin/legal, and contingency were based on the averages of the "known" improvements costs from the original CIP and were estimated at 14%, 35%, and 30% respectively.

2030 BUILD-OUT CAPITAL IMPROVEMENT PROGRAM

General

The planning density established for the 2030 build-out CIP assumes a varied growth rate through 2030 with a final population of 119,009. The 2030 build-out CIP is divided into three sections:

1. Gravity and forcemain improvements in the 9 study areas.
2. Lift station upgrades and decommissioning in the 9 study areas.
3. Planned interceptors (Plant Interceptor, North Interceptor, Southeast Interceptor, and Westside Interceptor).

All improvements are dependent on each other unless otherwise noted. For example, an upstream improvement is sized adequately if the downstream interceptor is also constructed. At the time of project implementation, additional modeling scenarios and analysis will be required to determine whether each improvement is adequate without other applicable downstream improvements.

Gravity and Forcemain Improvements

The gravity and forcemain improvements in the nine study areas are presented in Figure 17 (E-size folded map), Table 12a, Table 12b, and Table 12c. The velocity, depth/diameter (d/D), and surcharge clearance results are included in Table 12a for each improvement. All improvements from the original build-out CIP are included in the tables and figure. Also included in Table 12a are the model results compared with the design criteria for each improvement at the next smallest pipe size unless the improvement can be eliminated from consideration. The detailed cost breakdown for each improvement is provided in Table 12b including a comparison to the original build-out cost. A summary of the gravity improvements is provided in Table 12c. Improvements are categorized as follows:

1. No Improvement – Improvement not required for the 2030 build-out or the existing system.

2. Reduced Improvement – Improvement required for the 2030 build-out, but size is less than the original build-out.

3. Full Improvement – Improvement required for the 2030 build-out and size is identical to the original build-out.

4. Additional Improvement – Improvement required for the 2030 build-out and size is calculated to be greater than the original build-out size.

5. Improvement dependent on Interceptor – Improvement not required, unless interceptor is not completed.

6. New Improvement- Improvement not considered in the original build-out CIP.

When compared with the original build-out CIP, there is a 64% reduction in length of gravity and forcemain improvements for the 2030 build-out CIP. The reduction is primarily caused by the reduced planning densities and population estimates. Only 16,000 feet of the 67,300 feet of pipeline improvements identified in the original build-out CIP are required for the 2030 build-out CIP. An additional 8,400 feet of pipeline improvements not previously identified in the original build-out CIP are also required. The 64% reduction includes the additional 8,400 feet of new improvements.

Some improvements are required to correct the existing system deficiencies as well as the 2030 deficiencies. A growth share is defined for each improvement to identify the percentage of the cost associated with growth. A zero percent growth share indicates that the improvement is entirely caused by an existing deficiency. The growth share information can be used to prioritize improvements. The gravity and forcemain growth share is calculated with the following formula:

Growth Share = 1 – (Existing Dry Weather Peak Flow location specific/2030 Build-out Dry Weather Peak Flow location specific).

Table 12a. 2030 Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to 2030 build-out)	Final Model Results for 2030 Build-out CIP Diameter						Comparison Model Results for 2030 Build-out CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than 2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstrea m Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
2.1	2.1a	775	10	12	no improvement	10	0.5	>=0.5, shallow manhole	>=0.5, shallow manhole	2.1	2.1	NA	--	--	--	--	--	--
2.1	2.1b	464	8	12	no improvement	8	0.5	>=3.5	>=3.5	2.3	2.2	NA	--	--	--	--	--	--
2.1	2.1c	2,892	8	10	no improvement	8	0.5	>=1.5, shallow manhole	>=1.5, shallow manhole	4.3	4.3	NA	--	--	--	--	--	--
2.2	2.2a	310	12	15	no improvement	12	0.6	>=3.5	>=3.5	2.4	2.3	NA	--	--	--	--	--	--
2.2	2.2b	450	10	12	no improvement	10	0.6	>=3.5	>=3.5	3.4	3.3	NA	--	--	--	--	--	--
2.3	2.3a	425	8	12	reduced improvement	10	0.7	>=3.5	>=3.5	4.6	4.5	8	>0.9	>=2.5	>=3.5	<6	>4	d/D
2.4	2.4a	252	8	10	no improvement	8	0.5	>=3.5	>=3.5	3.1	3.1	NA	--	--	--	--	--	--
2.5	2.5a	232	8	15	no improvement	8	0.6	>=3.5	>=2.5	2.6	2.6	NA	--	--	--	--	--	--
2.5	2.5b	244	8	10	no improvement	8	0.5	>=2.5	>=3.5	3.3	3.3	NA	--	--	--	--	--	--
2.5	2.5c	52	8	12	no improvement	8	0.5	>=3.5	>=3.5	3.0	3.0	NA	--	--	--	--	--	--
2.5	2.5d	1,182	8	10	no improvement	8	0.5	>=3.5	>=3.5	3.5	3.5	NA	--	--	--	--	--	--
2.5	2.5e	767	8	12	no improvement	8	0.5	>=3.5	>=3.5	4.0	4.0	NA	--	--	--	--	--	--
2.5	2.5f	392	8	15	no improvement	8	0.6	>=3.5	>=3.5	2.6	2.6	NA	--	--	--	--	--	--
2.6	2.6a	619	8	10	no improvement	8	0.2	>=3.5	>=3.5	6.1	6.1	NA	--	--	--	--	--	--
2.6	2.6b	245	8	10	no improvement	8	0.2	>=3.5	>=3.5	8.3	8.1	NA	--	--	--	--	--	--
2.6	2.6c	435	8	12	no improvement	8	0.3	>=3.5	>=3.5	8.0	7.9	NA	--	--	--	--	--	--
2.6	2.6d	156	8	10	no improvement	8	0.3	>=3.5	>=2.5	6.8	6.8	NA	--	--	--	--	--	--
2.6	2.6e	690	8	18	no improvement	8	0.4	>=2.5	>=3.5	5.7	5.6	NA	--	--	--	--	--	--
2.6	2.6f	325	10	15	no improvement	10	0.4	>=3.5	>=3.5	2.7	2.7	NA	--	--	--	--	--	--
2.7	2.7a	989	27	30	no improvement	27	0.5	>=3.5	>=3.5	3.1	3.1	NA	--	--	--	--	--	--
2.8	2.8a	305	8	24	no improvement	8	0.7	>=3.5	>=3.5	1.2	1.0	NA	--	--	--	--	--	--
2.8	2.8b	877	21	24	no improvement	21	0.6	>=3.5	>=3.5	2.7	2.6	NA	--	--	--	--	--	--
2.8	2.8c	1,606	21	27	no improvement	21	0.6	>=3.5	>=3.5	2.9	2.8	NA	--	--	--	--	--	--

Table 12a. 2030 Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to 2030 build-out)	Final Model Results for 2030 Build-out CIP Diameter						Comparison Model Results for 2030 Build-out CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than 2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
2.9	2.9a	249	21	24	no improvement	21	0.5	>=3.5	>=3.5	2.7	2.7	NA	--	--	--	--	--	--
2.10	2.10a	798	30	36	no improvement, assumes that the Westside Interceptor is constructed	30	0.6	>=3.5	>=3.5	2.9	2.9	NA	--	--	--	--	--	--
2.11	2.11a	294	10	15	reduced improvement, assumes that the Westside Interceptor is constructed	12	0.4	>=2.5	>=3.5	1.1	1.1	10	>0.4	<0.5	<2.5	<2	>1	surcharge clearance
2.12	2.12a	986	8	10	no improvement	8	0.5	>=3.5	>=3.5	2.4	2.2	NA	--	--	--	--	--	--
2.13	2.13a	93	8	10	no improvement	8	0.5	>=2.5	>=2.5	2.5	2.3	NA	--	--	--	--	--	--
2.14	2.14a	1,843	8	10-15	no improvement, assumes that the Awbrey Glen Lift Station is decomissioned and North Interceptor is constructed	8	<0.8	>2.5	>2.5	<10	>2	NA	--	--	--	--	--	--
2.15	2.15a1	546	8	10	no improvement	8	<0.8	>2.5	>2.5	<10	>2	NA	--	--	--	--	--	--
2.15	2.15a2	368	8	10	no improvement, assumes that the Awbrey Glen Lift Station is decomissioned and North Interceptor is constructed	8	<0.8	>2.5	>2.5	<10	>2	NA	--	--	--	--	--	--
2.15	2.15b	477	8	12	no improvement	8	0.2	>=3.5	>=3.5	3.4	3.3	NA	--	--	--	--	--	--
2.15	2.15c	504	8	15	no improvement	8	0.2	>=3.5	>=3.5	2.3	2.3	NA	--	--	--	--	--	--
2.15	2.15d	282	8	12	no improvement	8	0.2	>=3.5	>=3.5	3.1	2.9	NA	--	--	--	--	--	--

Table 12a. 2030 Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to 2030 build-out)	Final Model Results for 2030 Build-out CIP Diameter						Comparison Model Results for 2030 Build-out CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than 2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
2.16	2.16a	351	4	NA	new improvement not considered in original build-out analysis, forcemain	8	0.7	sealed manhole	>=3.5	4.3	5.1	6	>0.8	sealed manhole	>=3.5	<8	>7	velocity
3.1	3.1a	446	8	12	no improvement	8	0.7	>=3.5	>=3.5	1.7	1.7	NA	--	--	--	--	--	--
3.2	3.2a	473	8	10	no improvement	8	0.5	>=3.5	>=3.5	2.4	2.3	NA	--	--	--	--	--	--
3.2	3.2b	167	8	10	no improvement	8	0.6	>=3.5	>=3.5	2.2	2.1	NA	--	--	--	--	--	--
3.2	3.2c	504	8	15	reduced improvement	10	0.6	>=2.5	>=1.5, shallow manhole	1.9	1.8	8	>0.7	<0.5	<2.5	<3	>2	surcharge clearance
3.3	3.3a	1,141	8	10	no improvement	8	0.5	>=3.5	>=3.5	7.4	7.2	NA	--	--	--	--	--	--
3.3	3.3b	660	10	15	no improvement	10	0.6	>=1.5, shallow manhole	>=1.5, shallow manhole	3.7	3.6	NA	--	--	--	--	--	--
3.3	3.3c	333	10	12	no improvement	10	0.5	>=3.5	>=1.5, shallow manhole	3.8	3.8	NA	--	--	--	--	--	--
3.3	3.3d	364	8	15	reduced improvement	10	0.7	>=2.5	>=3.5	3.0	3.0	8	>0.8	>2.5	>2.5	<10	>2	d/D
3.3	3.3e1	453	10	15	no improvement	10	0.7	>=3.5	>=3.5	2.8	2.8	NA	--	--	--	--	--	--
3.3	3.3e2	1,126	10	15	reduced improvement	12	0.6	>=3.5	>=3.5	2.8	2.7	10	>0.8	>=3.5	>=3.5	<3	>2	d/D
3.3	3.3f	663	10	15	no improvement	10	0.6	>=1.5, shallow manhole	>=3.5	3.4	3.3	NA	--	--	--	--	--	--
3.3	3.3g	1,012	10	15	no improvement	10	0.7	>=1.5, shallow manhole	>=1.5, shallow manhole	3.6	3.4	NA	--	--	--	--	--	--
3.3	3.3h	936	10	12	no improvement	10	0.5	>=3.5	>=3.5	6.2	6.1	NA	--	--	--	--	--	--
3.4	3.4a	352	15	18	no improvement	15	0.6	>=3.5	>=3.5	2.3	2.3	NA	--	--	--	--	--	--
3.5	3.5a	110	8	10	no improvement	8	0.4	>=3.5	>=3.5	2.6	2.6	NA	--	--	--	--	--	--
3.5	3.5b	347	8	12	no improvement	8	0.8	>=3.5	>=3.5	2.6	2.6	NA	--	--	--	--	--	--
3.6	3.6a	796	8	10	no improvement	8	0.5	>=3.5	>=3.5	3.2	3.1	NA	--	--	--	--	--	--

Table 12a. 2030 Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to 2030 build-out)	Final Model Results for 2030 Build-out CIP Diameter						Comparison Model Results for 2030 Build-out CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than 2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstrea m Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
3.7	3.7a	185	8	10	no improvement	8	0.3	>=3.5	>=3.5	4.7	4.7	NA	--	--	--	--	--	--
3.8	3.8a	143	6	8	no improvement	6	0.4	>=3.5	>=3.5	1.4	1.4	NA	--	--	--	--	--	--
3.9	3.9a	258	6	NA	new improvement not considered in original build-out analysis, forcemain	8	0.8	sealed manhole	sealed manhole	3.7	3.5	6	>0.9	sealed manhole	sealed manhole	<7	>6	velocity
3.10	3.10a	1,846	6	NA	new improvement not considered in original build-out analysis	8	0.6	sealed manhole	>=3.5	3.4	3.3	6	>0.9	sealed manhole	>=3.5	<6	>5	d/D
5.1	5.1a	425	24	30	no improvement	24	0.5	>=3.5	>=3.5	7.7	6.8	NA	--	--	--	--	--	--
5.2	5.2a	1,931	12	15	no improvement	12	0.7	>=3.5	>=3.5	4.2	3.9	NA	--	--	--	--	--	--
5.2	5.2b	651	12	15	no improvement	12	0.7	>=3.5	>=3.5	2.8	2.7	NA	--	--	--	--	--	--
5.3	5.3a1	2,654	6	8	additional improvement above original build-out	10	0.8	sealed manhole	>=3.5	4.3	4.3	8	>0.8	sealed manhole	>=3.5	<4	>3	d/D
5.3	5.3a2	932	6	8	additional improvement above original build-out	12	0.6	sealed manhole	sealed manhole	3.5	3.5	10	>0.8	sealed manhole	sealed manhole	<4	>3	d/D
5.4	5.4a1	691	8	10	no improvement	8	0.8	>=2.5	>=2.5	2.8	2.7	NA	--	--	--	--	--	--
5.4	5.4a2	264	8	10	full improvement from original build-out	10	0.8	>=3.5	>=3.5	2.3	2.0	8	>0.8	>2.5	>2.5	<10	>2	d/D
5.4	5.4b	268	8	12	reduced improvement	10	0.8	>=3.5	>=3.5	3.0	2.8	8	>0.8	>2.5	>2.5	<10	>2	d/D
5.4	5.4c	494	12	15	no improvement	12	0.6	>=3.5	>=3.5	3.4	3.2	NA	--	--	--	--	--	--
5.5	5.5a	15	15	18	no improvement	15	0.5	>=3.5	>=3.5	2.3	2.1	NA	--	--	--	--	--	--
5.6	5.6a	351	21	24	no improvement	21	0.6	>=3.5	>=3.5	2.3	2.0	NA	--	--	--	--	--	--
5.7	5.7a	3,931	4	NA	new improvement not considered in original build-out analysis, forcemain	6	1.0	sealed manhole	sealed manhole	6.8	6.3	4	>1	sealed manhole	sealed manhole	<10	>9	velocity

Table 12a. 2030 Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

						Final Model Results for 2030 Build-out CIP Diameter						Comparison Model Results for 2030 Build-out CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						
Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to 2030 build-out)	2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than 2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstrea m Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	Controlling Criteria for Improvement
5.8	5.8a	987	8	NA	new improvement not considered in original build-out analysis	10	0.7	>=2.5	>=2.5	2.8	2.6	8	>0.8	<2.5	<2.5	<3	>2	d/D, surcharge clearance
6.1	6.1a	95	8	12	reduced improvement	10	0.8	>=3.5	>=3.5	3.1	2.9	8	>0.8	>2.5	>2.5	<10	>2	d/D
6.2	6.2a1	323	12	15	additional improvement above original build-out	18	0.7	>=2.5	>=3.5	1.4	1.3	15	>0.8	<2.5	>=3.5	<2	>1	d/D, surcharge clearance
6.2	6.2a2	1,912	12	15	full improvement from original build-out	15	0.8	>=1.5, shallow manhole	>=2.5	2.5	2.4	12	>1	<0.5	<0.5	<3	>2	d/D. surcharge clearance
6.2	6.2b	195	15	15	additional improvement above original build-out	18	0.7	>=3.5	>=3.5	2.1	1.8	15	>0.8	>=3.5	>=3.5	<3	>2	d/D
6.3	6.3a	1,043	12	NA	new improvement not considered in original build-out analysis	15	0.6	>=3.5	>=1.5, shallow manhole	5.0	4.8	12	>1	>=3.5	<0.5	<3	>2	d/D, surcharge clearance
8.1	8.1a	533	8	12	no improvement	8	0.7	>=1.5, shallow manhole	>=2.5	3.8	3.3	NA	--	--	--	--	--	--
8.1	8.1b	962	10	12	full improvement from original build-out	12	0.4	>=3.5	>=3.5	3.0	2.5	10	>0.7	<0.5	<0.5	<3	>2	surcharge clearance
8.1	8.1c	494	8	12	reduced improvement	10	0.6	>=3.5	>=3.5	3.2	2.4	8	>0.8	<1.5	>=3.5	<5	>2	d/D surcharge clearance
8.2	8.2a	1,741	12	15	full improvement from original build-out	15	0.5	>=0.5, shallow manhole	>=0.5, shallow manhole	3.0	2.6	12	>0.7	<0.5	<0.5	<4	>2	surcharge clearance
8.2	8.2b	80	15	18	no improvement	15	0.5	>=3.5	>=3.5	3.2	2.9	NA	--	--	--	--	--	--
8.2	8.2c	1,496	12	18	reduced improvement	15	0.6	>=1.5, shallow manhole	>=1.5, shallow manhole	3.6	3.2	12	>1	<0.5	<0.5	<5	>3	d/D, surcharge clearance
8.2	8.2d	937	12	18	no improvement	12	0.8	>=3.5	>=3.5	3.9	2.6	NA	--	--	--	--	--	--
8.2	8.2e	208	12	15	no improvement	12	0.3	>=3.5	>=3.5	9.7	9.0	NA	--	--	--	--	--	--

Table 12a. 2030 Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to 2030 build-out)	Final Model Results for 2030 Build-out CIP Diameter						Comparison Model Results for 2030 Build-out CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than 2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
8.3	8.3a	640	8	10	no improvement	8	0.6	>=3.5	>=3.5	2.7	2.5	NA	--	--	--	--	--	--
8.4	8.4a	576	12	15	no improvement	12	0.6	>=3.5	>=3.5	3.0	2.7	NA	--	--	--	--	--	--
8.4	8.4b	161	12	15	no improvement	12	0.5	>=3.5	>=3.5	2.9	2.6	NA	--	--	--	--	--	--
8.5	8.5a	212	10	12	no improvement, assumes upgrades to Old Mill pump station are implemented	10	0.4	>=3.5	>=3.5	2.8	2.1	NA	--	--	--	--	--	--
8.6	8.6a	527	8	10	no improvement	8	0.4	>=3.5	>=3.5	2.0	1.7	NA	--	--	--	--	--	--
8.7	8.7a	522	8	10	no improvement, assumes flows are re-directed through Southeast Interceptor	8	0.6	>=3.5	>=3.5	3.2	2.4	NA	--	--	--	--	--	--
9.1	9.1a	703	8	10	no improvement, assumes flows are re-directed through Southeast Interceptor	8	0.6	>=3.5	>=3.5	2.4	1.8	NA	--	--	--	--	--	--
9.1	9.1b	268	10	12	no improvement, assumes flows are re-directed through Southeast Interceptor	10	0.4	>=3.5	>=3.5	2.2	1.7	NA	--	--	--	--	--	--
9.2	9.2a	136	8	10	no improvement	8	0.5	>=3.5	>=3.5	5.4	4.1	NA	--	--	--	--	--	--
9.3	9.3a	797	12	15	full improvement from original build-out	15	0.4	>=0.5, shallow manhole	>=0.5, shallow manhole	3.3	2.7	12	>0.6	<0.5	<0.5	<4	>2	surcharge clearance
9.3	9.3b	18	8	15	full improvement from original build-out	15	0.3	>=3.5	>=3.5	3.8	3.1	12	>0.3	>=3.5	>=3.5	<5	>3	improvement required in combination with downstream improvement 9.3a

Table 12a. 2030 Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to 2030 build-out)	Final Model Results for 2030 Build-out CIP Diameter						Comparison Model Results for 2030 Build-out CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than 2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
9.3	9.3c1	627	12	15	full improvement from original build-out	15	0.4	>=1.5, shallow manhole	>=1.5, shallow manhole	3.1	2.3	12	>0.5	<1.5	<1.5	<4	>2	surcharge clearance
9.3	9.3c2	2,495	12	15	no improvement	12	0.6	>=3.5	>=3.5	3.3	2.7	NA	--	--	--	--	--	--
9.4	9.4a	6,534	8	10	no improvement	8	0.7	>=2.5	>=2.5	3.4	3.4	NA	--	--	--	--	--	--
9.4	9.4b	313	8	12	no improvement	8	0.7	>=2.5	>=3.5	3.0	2.4	NA	--	--	--	--	--	--
9.4	9.4c	97	8	10	no improvement	8	0.5	>=3.5	>=1.5, shallow manhole	4.1	3.4	NA	--	--	--	--	--	--
9.4	9.4d	1,020	10	12	no improvement	10	0.6	>=2.5	>=2.5	3.5	3.1	NA	--	--	--	--	--	--
9.5	9.5a	297	15	18	no improvement	15	0.6	>=3.5	>=3.5	3.9	3.6	NA	--	--	--	--	--	--
9.5	9.5b	100	15	18	no improvement	15	0.6	>=2.5	>=3.5	3.4	3.1	NA	--	--	--	--	--	--
9.6	9.6a	538	10	12	no improvement	10	0.8	>=3.5	>=3.5	2.9	2.9	NA	--	--	--	--	--	--
9.7	9.7a	515	8	10	no improvement	8	0.4	>=2.5	>=2.5	1.6	1.6	NA	--	--	--	--	--	--
9.8	9.8a	359	12	15	no improvement	12	0.8	>=3.5	>=2.5	2.7	2.7	NA	--	--	--	--	--	--
9.8	9.8b	515	12	18	reduced improvement	15	0.7	>=2.5	>=3.5	1.8	1.8	12	>1	<0.5	>=2.5	<3	>2	d/D, surcharge clearance
9.8	9.8c	334	12	15	no improvement	12	0.7	>=3.5	>=3.5	2.4	2.4	NA	--	--	--	--	--	--

NOTES FOR TABLE 12A

Note 1. The cleansing velocity criteria of 2 ft/sec was ignored if an improvement was not required. For some improvements, multiple criteria conflicted such that an improvement satisfied one criteria, but caused a deficiency in another criteria. For these improvements, the priority of the criteria was established as (1) d/D, (2) surcharging clearance, (3) maximum velocity, (4) cleansing velocity.

Table 12b. 2030 Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	2030 CIP Dia. (in)	Category (mod from Build-out to 2030)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	2030 Materials ($/ft)	2030 Installation ($/ft)	2030 Bypass Pumping ($/ft)	2030 Depth Range (ft)[3]	2030 Manhole Dia.	2030 Manhole ($/each)	2030 Reconnect Fee ($/each)	2030 Restore Fee ($/ft)	2030 Easement, Crossing, Etc. ($)	2030 Subtotal ($)	2030 Engr/Legal/ Admin@35-40% ($)	2030 Contingency @30% ($)	2030 Build-out Total ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Original Build-out Total ($)
2.1	2.1a	10	10	no improvement	775	2	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	180,500
2.1	2.1b	8	8	no improvement	464	1	0.00	0.00	0.00	15-20	48-inch	0	0	0.00	0	0	0	0	0	0%	0	108,000
2.1	2.1c	8	8	no improvement	2,892	7	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	643,500
2.2	2.2a	12	12	no improvement	310	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	78,500
2.2	2.2b	10	10	no improvement	450	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	105,000
2.3	2.3a	8	10	reduced improvement	425	1	8.85	70.00	11.60	0-10	48-inch	3,640	1,000	7.35	7,700	53,900	18,900	21,800	94,500	0%	0	99,000
2.4	2.4a	8	8	no improvement	252	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	56,000
2.5	2.5a	8	8	no improvement	232	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	59,000
2.5	2.5b	8	8	no improvement	244	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	54,500
2.5	2.5c	8	8	no improvement	52	0	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	12,000
2.5	2.5d	8	8	no improvement	1,182	3	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	263,500
2.5	2.5e	8	8	no improvement	767	2	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	179,000
2.5	2.5f	8	8	no improvement	392	1	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	99,500
2.6	2.6a	8	8	no improvement	619	2	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	138,000
2.6	2.6b	8	8	no improvement	245	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	54,500
2.6	2.6c	8	8	no improvement	435	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	101,500
2.6	2.6d	8	8	no improvement	156	0	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	34,500
2.6	2.6e	8	8	no improvement	690	2	0.00	0.00	0.00	20-25	48-inch	0	0	0.00	0	0	0	0	0	0%	0	185,500
2.6	2.6f	10	10	no improvement	325	1	0.00	0.00	0.00	15-20	48-inch	0	0	0.00	0	0	0	0	0	0%	0	82,500
2.7	2.7a	27	27	no improvement	989	2	0.00	0.00	0.00	20-25	60-inch	0	0	0.00	0	0	0	0	0	0%	0	465,000
2.8	2.8a	8	8	no improvement	305	1	0.00	0.00	0.00	0-10	60-inch	0	0	0.00	0	0	0	0	0	0%	0	103,500
2.8	2.8b	21	21	no improvement	877	2	0.00	0.00	0.00	0-10	60-inch	0	0	0.00	0	0	0	0	0	0%	0	298,500
2.8	2.8c	21	21	no improvement	1,606	4	0.00	0.00	0.00	0-10	60-inch	0	0	0.00	0	0	0	0	0	0%	0	654,000
2.9	2.9a	21	21	no improvement	249	1	0.00	0.00	0.00	10-15	60-inch	0	0	0.00	0	0	0	0	0	0%	0	84,500

Table 12b. 2030 Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	2030 CIP Dia. (in)	Category (mod from Build-out to 2030)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	2030 Materials ($/ft)	2030 Installation ($/ft)	2030 Bypass Pumping ($/ft)	2030 Depth Range (ft)[3]	2030 Manhole Dia.	2030 Manhole ($/each)	2030 Reconnect Fee ($/each)	2030 Restore Fee ($/ft)	2030 Easement, Crossing, Etc. ($)	2030 Subtotal ($)	2030 Engr/Legal/ Admin@35-40% ($)	2030 Contingency @30% ($)	2030 Build-out Total ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Original Build-out Total ($)
2.10	2.10a	30	30	no improvement, assumes that the Westside Interceptor is constructed	798	3	0.00	0.00	0.00	15-20	60-inch	0	0	0.00	0	0	0	0	0	0%	0	410,000
2.11	2.11a	10	12	reduced improvement, assumes that the Westside Interceptor is constructed	294	1	12.75	72.00	11.60	0-10	48-inch	3,640	1,000	7.35	3,900	39,000	13,700	15,800	68,500	0%	0	74,500
2.12	2.12a	8	8	no improvement	986	2	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	219,500
2.13	2.13a	8	8	no improvement	93	0	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	20,500
2.14	2.14a	8	8	no improvement, assumes that the Awbrey Glen Lift Station is decomissioned and North Interceptor is constructed	1,843	5	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	431,000
2.15	2.15a1	8	8	no improvement	546	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	119,500
2.15	2.15a2	8	8	no improvement, assumes that the Awbrey Glen Lift Station is decomissioned and North Interceptor is constructed	368	1	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	83,500
2.15	2.15b	8	8	no improvement	477	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	111,000
2.15	2.15c	8	8	no improvement	504	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	127,500
2.15	2.15d	8	8	no improvement	282	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	65,500

Table 12b. 2030 Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	2030 CIP Dia. (in)	Category (mod from Build-out to 2030)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	2030 Materials ($/ft)	2030 Installation ($/ft)	2030 Bypass Pumping ($/ft)	2030 Depth Range (ft)[3]	2030 Manhole Dia.	2030 Manhole ($/each)	2030 Reconnect Fee ($/each)	2030 Restore Fee ($/ft)	2030 Easement, Crossing, Etc. ($)	2030 Subtotal ($)	2030 Engr/Legal/ Admin@35-40% ($)	2030 Contingency @30% ($)	2030 Build-out Total ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Original Build-out Total ($)
2.16	2.16a	4	8	new improvement not considered in original build-out analysis, forcemain	351	1	7.87	67.00	11.60	0-10	48-inch	3,640	1,000	7.35	5,000	42,600	16,000	17,600	76,000	36%	27,000	0
3.1	3.1a	8	8	no improvement	446	1	0.00	0.00	0.00	25-30	48-inch	0	0	0.00	0	0	0	0	0	0%	0	108,000
3.2	3.2a	8	8	no improvement	473	1	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	109,500
3.2	3.2b	8	8	no improvement	167	0	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	38,500
3.2	3.2c	8	10	reduced improvement	504	1	8.85	70.00	11.60	0-10	48-inch	3,640	1,000	7.35	10,000	64,000	25,600	26,900	116,500	77%	89,000	132,500
3.3	3.3a	8	8	no improvement	1,141	3	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	263,500
3.3	3.3b	10	10	no improvement	660	2	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	173,500
3.3	3.3c	10	10	no improvement	333	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	80,500
3.3	3.3d	8	10	reduced improvement	364	1	8.85	70.00	11.60	0-10	48-inch	3,640	1,000	7.35	6,000	46,200	18,500	19,400	84,000	62%	52,500	95,500
3.3	3.3e1	10	10	no improvement	453	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	117,500
3.3	3.3e2	10	12	reduced improvement	1,126	3	12.75	90.00	11.60	10-15	48-inch	4,990	1,000	7.35	19,600	174,600	69,900	73,300	318,000	64%	202,500	297,500
3.3	3.3f	10	10	no improvement	663	2	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	174,000
3.3	3.3g	10	10	no improvement	1,012	3	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	266,000
3.3	3.3h	10	10	no improvement	936	2	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	226,000
3.4	3.4a	15	15	no improvement	352	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	98,000
3.5	3.5a	8	8	no improvement	110	0	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	25,500
3.5	3.5b	8	8	no improvement	347	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	84,500
3.6	3.6a	8	8	no improvement	796	2	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	183,500
3.7	3.7a	8	8	no improvement	185	0	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	42,500
3.8	3.8a	6	6	no improvement	143	0	0.00	0.00	0.00	>30	48-inch	0	0	0.00	0	0	0	0	0	0%	0	31,500

Table 12b. 2030 Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	2030 CIP Dia. (in)	Category (mod from Build-out to 2030)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	2030 Materials ($/ft)	2030 Installation ($/ft)	2030 Bypass Pumping ($/ft)	2030 Depth Range (ft)[3]	2030 Manhole Dia.	2030 Manhole ($/each)	2030 Reconnect Fee ($/each)	2030 Restore Fee ($/ft)	2030 Easement, Crossing, Etc. ($)	2030 Subtotal ($)	2030 Engr/Legal/ Admin@35-40% ($)	2030 Contingency @30% ($)	2030 Build-out Total ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Original Build-out Total ($)
3.9	3.9a	6	8	new improvement not considered in original build-out analysis, forcemain	258	1	7.87	67.00	11.60	0-10	48-inch	3,640	1,000	7.35	3,800	32,700	12,300	13,500	58,500	9%	5,500	0
3.10	3.10a	6	8	new improvement not considered in original build-out analysis	1,846	5	5.65	67.00	11.60	0-10	48-inch	3,640	1,000	7.35	25,500	217,800	81,900	89,900	389,500	65%	251,500	0
5.1	5.1a	24	24	no improvement	425	1	0.00	0.00	0.00	10-15	60-inch	0	0	0.00	0	0	0	0	0	0%	0	178,000
5.2	5.2a	12	12	no improvement	1,931	5	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	507,000
5.2	5.2b	12	12	no improvement	651	2	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	171,000
5.3	5.3a1	6	10	additional improvement above original build-out	2,654	7	8.85	70.00	11.60	0-10	48-inch	3,640	1,000	7.35	46,600	338,600	135,500	142,200	616,500	69%	426,500	616,000
5.3	5.3a2	6	12	additional improvement above original build-out	932	2	12.75	72.00	11.60	0-10	48-inch	3,640	1,000	7.35	16,000	121,900	48,800	51,200	222,000	65%	144,000	211,500
5.4	5.4a1	8	8	no improvement	691	2	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	169,500
5.4	5.4a2	8	10	full improvement from original build-out	264	0	8.85	70.00	11.60	0-10	48-inch	3,640	1,000	7.35	4,700	30,500	12,200	12,800	55,500	0%	0	57,000
5.4	5.4b	8	10	reduced improvement	268	1	8.85	70.00	11.60	0-10	48-inch	3,640	1,000	7.35	3,200	34,000	13,600	14,300	62,000	0%	0	66,500
5.4	5.4c	12	12	no improvement	494	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	133,000
5.5	5.5a	15	15	no improvement	15	0	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	4,000
5.6	5.6a	21	21	no improvement	351	1	0.00	0.00	0.00	0-10	60-inch	0	0	0.00	0	0	0	0	0	0%	0	124,000
5.7	5.7a	4	6	new improvement not considered in original build-out analysis, forcemain	3,931	1	6.00	0.00	11.60	0-10	48-inch	3,640	1,000	7.35	13,600	116,400	43,800	48,000	208,000	0%	0	0

Table 12b. 2030 Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	2030 CIP Dia. (in)	Category (mod from Build-out to 2030)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	2030 Materials ($/ft)	2030 Installation ($/ft)	2030 Bypass Pumping ($/ft)	2030 Depth Range (ft)[3]	2030 Manhole Dia.	2030 Manhole ($/each)	2030 Reconnect Fee ($/each)	2030 Restore Fee ($/ft)	2030 Easement, Crossing, Etc. ($)	2030 Subtotal ($)	2030 Engr/Legal/ Admin@35-40% ($)	2030 Contingency @30% ($)	2030 Build-out Total ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Original Build-out Total ($)
5.8	5.8a	8	10	new improvement not considered in original build-out analysis	987	2	8.85	70.00	11.60	0-10	48-inch	3,640	1,000	7.35	14,100	119,900	45,100	49,500	214,500	0%	0	0
6.1	6.1a	8	10	reduced improvement	95	0	8.85	113.00	11.60	15-20	48-inch	6,740	1,000	7.35	2,800	16,100	6,500	6,800	29,500	43%	12,500	23,000
6.2	6.2a1	12	18	additional improvement above original build-out	323	1	17.00	87.00	11.60	0-10	48-inch	3,640	1,000	8.40	5,500	50,100	20,100	21,100	91,500	49%	44,500	86,000
6.2	6.2a2	12	15	full improvement from original build-out	1,912	5	18.80	95.00	11.60	10-15	48-inch	4,990	1,000	7.88	31,700	316,500	126,600	132,900	576,000	48%	277,500	501,000
6.2	6.2b	15	18	additional improvement above original build-out	195	0	17.00	105.00	11.60	10-15	48-inch	4,990	1,000	8.40	5,700	33,400	13,300	14,000	60,500	22%	13,500	51,000
6.3	6.3a	12	15	new improvement not considered in original build-out analysis	1,043	3	18.80	95.00	11.60	10-15	48-inch	4,990	1,000	7.88	20,900	177,800	66,900	73,400	318,000	49%	154,500	0
8.1	8.1a	8	8	no improvement	533	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	124,000
8.1	8.1b	10	12	full improvement from original build-out	962	2	12.75	72.00	11.60	0-10	48-inch	3,640	1,000	7.35	18,700	127,800	44,700	51,700	224,000	55%	122,500	224,000
8.1	8.1c	8	10	reduced improvement	494	1	8.85	70.00	11.60	0-10	48-inch	3,640	1,000	7.35	9,700	62,700	21,900	25,400	110,000	52%	57,000	115,000
8.2	8.2a	12	15	full improvement from original build-out	1,741	4	18.80	95.00	11.60	10-15	48-inch	4,990	1,000	7.88	32,100	288,100	100,800	116,700	505,500	48%	244,500	436,500
8.2	8.2b	15	15	no improvement	80	0	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	21,500
8.2	8.2c	12	15	reduced improvement	1,496	4	18.80	77.00	11.60	0-10	48-inch	3,640	1,000	7.88	25,000	216,000	75,600	87,500	379,000	53%	201,000	405,500
8.2	8.2d	12	12	no improvement	937	2	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	254,000
8.2	8.2e	12	12	no improvement	208	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	52,000
8.3	8.3a	8	8	no improvement	640	2	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	142,500
8.4	8.4a	12	12	no improvement	576	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	146,500

Table 12b. 2030 Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	2030 CIP Dia. (in)	Category (mod from Build-out to 2030)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	2030 Materials ($/ft)	2030 Installation ($/ft)	2030 Bypass Pumping ($/ft)	2030 Depth Range (ft)[3]	2030 Manhole Dia.	2030 Manhole ($/each)	2030 Reconnect Fee ($/each)	2030 Restore Fee ($/ft)	2030 Easement, Crossing, Etc. ($)	2030 Subtotal ($)	2030 Engr/Legal/ Admin@35-40% ($)	2030 Contingency @30% ($)	2030 Build-out Total ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Original Build-out Total ($)
8.4	8.4b	12	12	no improvement	161	0	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	41,000
8.5	8.5a	10	10	no improvement, assumes upgrades to Old Mill pump station are implemented	212	1	0.00	0.00	0.00	15-20	48-inch	0	0	0.00	0	0	0	0	0	0%	0	51,500
8.6	8.6a	8	8	no improvement	527	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	117,000
8.7	8.7a	8	8	no improvement, assumes flows are re-directed through Southeast Interceptor	522	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	116,500
9.1	9.1a	8	8	no improvement, assumes flows are re-directed through Southeast Interceptor	703	2	0.00	0.00	0.00	10-15	48-inch	0	0	0.00	0	0	0	0	0	0%	0	162,500
9.1	9.1b	10	10	no improvement, assumes flows are re-directed through Southeast Interceptor	268	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	65,000
9.2	9.2a	8	8	no improvement	136	0	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	31,500
9.3	9.3a	12	15	full improvement from original build-out	797	2	18.80	95.00	11.60	10-15	48-inch	4,990	1,000	7.88	13,900	132,100	52,800	55,500	240,500	32%	78,000	209,500
9.3	9.3b	8	15	full improvement from original build-out	18	0	18.80	120.00	11.60	15-20	48-inch	6,740	1,000	7.88	500	3,400	1,400	1,400	6,000	32%	2,000	4,500
9.3	9.3c1	12	15	full improvement from original build-out	627	2	18.80	77.00	11.60	0-10	48-inch	3,640	1,000	7.88	11,000	92,600	37,000	38,900	168,500	33%	55,500	168,500
9.3	9.3c2	12	12	no improvement	2,495	6	0.00	0.00	0.00	20-25	48-inch	0	0	0.00	0	0	0	0	0	0%	0	651,500
9.4	9.4a	8	8	no improvement	6,534	16	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	1,509,000

Table 12b. 2030 Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	2030 CIP Dia. (in)	Category (mod from Build-out to 2030)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	2030 Materials ($/ft)	2030 Installation ($/ft)	2030 Bypass Pumping ($/ft)	2030 Depth Range (ft)[3]	2030 Manhole Dia.	2030 Manhole ($/each)	2030 Reconnect Fee ($/each)	2030 Restore Fee ($/ft)	2030 Easement, Crossing, Etc. ($)	2030 Subtotal ($)	2030 Engr/Legal/ Admin@35-40% ($)	2030 Contingency @30% ($)	2030 Build-out Total ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Original Build-out Total ($)
9.4	9.4b	8	8	no improvement	313	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	75,500
9.4	9.4c	8	8	no improvement	97	0	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	22,500
9.4	9.4d	10	10	no improvement	1,020	3	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	246,500
9.5	9.5a	15	15	no improvement	297	1	0.00	0.00	0.00	25-30	48-inch	0	0	0.00	0	0	0	0	0	0%	0	83,000
9.5	9.5b	15	15	no improvement	100	0	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	28,000
9.6	9.6a	10	10	no improvement	538	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	130,000
9.7	9.7a	8	8	no improvement	515	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	103,000
9.8	9.8a	12	12	no improvement	359	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	93,500
9.8	9.8b	12	15	reduced improvement	515	1	18.80	77.00	11.60	0-10	48-inch	3,640	1,000	7.88	10,300	74,400	29,700	31,200	135,500	47%	63,500	145,000
9.8	9.8c	12	12	no improvement	334	1	0.00	0.00	0.00	0-10	48-inch	0	0	0.00	0	0	0	0	0	0%	0	87,000
TOTAL															368,000	3,023,000	1,153,000	1,253,000	5,429,000		2,525,000	17,314,000

NOTES FOR TABLE 12B

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the CSMP. 2030 build-out cost estimates are for improvements for population growth to 119,009 by year 2030 in 2005 dollars. The first number of each project ID indicates the study area where the improvement is located. For example, project 2.1 is located in study area 2. Unit costs were taken directly from the CSMP and applied to revised improvements.

NOTE 2. In the original CIP, the number of manholes for each improvement was calculated by dividing the total length of the improvement by a maximum 400 ft spacing. This method is adequate for new interceptor improvements; however, it may underestimate the number of manholes for gravity improvements in the existing system. The existing system manholes are often spaced at less than 400 ft to account for grade changes and alignment changes. To maintain consistency between the original build-out CIP and the 2030 build-out CIP, the method for calculating the numbers of manholes was NOT modified for the 2030 build-out CIP. The cost discrepancy from the underestimation of manhole numbers is expected to be less than 4% of the overall gravity and forcemain CIP cost.

NOTE 3. In the original CIP, all gravity improvement cost estimates used the unit costs for a 0-10 ft construction depth even though the CSMP stated that the same unit costs should be applied to both new improvements and replacement/upgrade improvements. The 2030 build-out CIP utilizes all of the unit cost data for the gravity improvements with variation for construction depth. Because of the modified assumption, the cost differences between the original build-out CIP and the 2030 build-out CIP are less exaggerated than if both CIPs had utilized the variation in construction depth. The 2030 build-out costs may be conservative since a replacement or upgrade improvement may require less excavation expense than a new improvement. It is recommended for future CIPs and master planning efforts that separate unit costs be developed for new improvements and upgrade/replacement improvements.

NOTE 4. The 2030 build-out growth share is calculated from the existing dry weather peak flow to 2030 dry weather flow ratio at the location of the improvement (1-existing flow location specific/2030 flow location specific).

Table 12c. 2030 Build-out Gravity and Forcemain Cost Summary[1]

Project ID *first number in ID indicates study area	2030 Build-out Cost ($)	2030 Growth Cost[2] ($)	Original Build-out Total ($)
2.1	0	0	932,000
2.2	0	0	183,500
2.3	94,500	0	99,000
2.4	0	0	56,000
2.5	0	0	667,000
2.6	0	0	596,500
2.7	0	0	465,000
2.8	0	0	1,056,500
2.9	0	0	84,500
2.10	0	0	410,000
2.11	68,500	0	74,500
2.12	0	0	219,500
2.13	0	0	20,500
2.14	0	0	431,000
2.15	0	0	507,500
2.16	76,000	27,000	0
3.1	0	0	108,000
3.2	116,500	89,000	280,500
3.3	402,000	255,000	1,694,500
3.4	0	0	98,000
3.5	0	0	110,500
3.6	0	0	183,500
3.7	0	0	42,500
3.8	0	0	31,500
3.9	58,500	5,500	0
3.10	389,500	251,500	0
5.1	0	0	178,000
5.2	0	0	678,000
5.3	838,000	570,500	828,000
5.4	117,500	0	426,000
5.5	0	0	4,000
5.6	0	0	124,000
5.7	208,000	0	0
5.8	214,500	0	0
6.1	29,500	12,500	23,000
6.2	728,000	335,500	638,000
6.3	318,000	154,500	0
8.1	334,000	179,500	463,000
8.2	884,500	446,000	1,169,500
8.3	0	0	142,500
8.4	0	0	187,000
8.5	0	0	51,500
8.6	0	0	117,000
8.7	0	0	116,500
9.1	0	0	227,500
9.2	0	0	31,500
9.3	415,000	135,500	1,034,000
9.4	0	0	1,853,500
9.5	0	0	111,000
9.6	0	0	130,000
9.7	0	0	103,000
9.8	135,500	63,500	325,500
TOTAL	5,429,000	2,525,000	17,314,000

NOTES FOR TABLES 12C

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the CSMP. 2030 build-out cost estimates are for improvements for population growth to 119,009 by year 2030 in 2005 dollars. Unit costs were taken directly from the CSMP and applied to revised improvements. Improvements with costs shown as $0 in the original build-out CIP column indicate additional improvements not previously considered.

NOTE 2. The 2030 build-out growth share is calculated from the existing dry weather peak flow to 2030 dry weather flow ratio at the location of the improvement (1-existing flow/2030 flow).

Lift Station and Decommissioning Improvements

The lift station improvements and decommissioning in the nine study areas are presented in Figure 17 (E-size folded map), Table 13a, and Table 13b. Tables 13a and 13b list all of the lift station and decommissioning improvements identified in the original build-out CIP. The improvements are categorized as follows:

1. No Improvement – Improvement not required for the 2030 build-out or the existing system.

2. Reduced Improvement – Improvement required for the 2030 build-out, but capacity is less than the original build-out.

3. Full Improvement – Improvement required for the 2030 build-out and capacity is identical to the original build-out.

4. Additional Improvement – Improvement required for the 2030 build-out and capacity is estimated to be greater than the original build-out estimate.

5. Improvement dependent on Interceptor – Improvement not required, unless interceptor is not completed. These improvements are described in Table 13b.

6. New Improvement- Improvement not considered in the original build-out CIP.

Some lift stations are being decommissioned to allow gravity service into new interceptor improvements. Other lift stations should be decommissioned in conjunction with identified gravity improvements. Decommissioning typically requires abandoning the lift station and constructing additional gravity pipeline to a collection system trunkline. Tables 13a and 13b include comments to describe the decommissioning activity.

Table 13b highlights lift stations that will need to be improved if the interceptor improvements are not implemented. The costs for these lift stations includes the cost of upgrading the lift station ONLY and does NOT include costs for all downstream pipeline improvements. Additional modeling scenarios and improvements analysis are required to determine whether or not lift station upgrades and additional downstream pipeline improvements provide feasible alternatives to the planned interceptors.

Lift station upgrades are determined by available firm capacity and peak hour flows into the lift station wet well. Where 2030 build-out peak hour flows exceed existing firm capacity, an upgrade is recommended. The firm capacity and peak hour flows for each lift station are presented in Tables 13a and 13b. Firm capacity information for each lift station was found in the CSMP. Peak hour flows into the wet well were extracted from the wet weather model when possible. For lift stations that were not modeled, the peak hour flows were calculated from the average loading in the lift station service area times a peak hour factor of 2.5.

The CSMP analyzes all of the lift stations in the City of Bend Collection System and evaluates the firm capacity requirements at full build-out with the exception of the Parrell Lift Station. It was assumed that the original build-out peak hour flows used in the CSMP are more conservative than the 2030 build-out peak hour flows. Because of this assumption, the 2030 build-out analysis only considered lift stations that were identified for improvement in the original build-out CIP and additional modeled lift stations such as the Parrell Lift Station and Sawyer Park Lift Station.

Some lift station improvements are required to correct existing system deficiencies as well as 2030 deficiencies. Three alternatives for calculating growth share are defined for each improvement to identify the percentage of the cost associated with growth. A zero percent growth share indicates that the improvement is entirely caused by an existing deficiency. The growth share information can be used to prioritize improvements. The growth share alternatives are described below:

> Alternative 1 – The growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to 2030 build-out dry weather peak flow for the entire system (1-existing flow/2030 flow). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.
>
> Alternative 2 - The growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to 2030 build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/2030 flow location specific). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.
>
> Alternative 3 - The growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to 2030 build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/2030 flow location specific) unless the existing firm capacity exceeds the 2030 capacity requirement. If the existing firm capacity exceeds the 2030 capacity requirement then the growth share for lift station decommissioning is 100%. The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

Table 13a. 2030 Build-out Lift Station and Decommissioning Cost Specifics (All costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action[2]	Original Build-out Activity	Original Build-out Total ($)	2030 Build-out Loading Estimate (gpm, Peak Hour)	Source of 2030 Loading	2030 Firm Pump Capacity (gpm)	2030 Firm Capacity Comment	2030 Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[3]	2030 Build-out Cost ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Alt 2 2030 Growth[5] (%)	Alt 2 2030 Growth Total ($)	Alt 3 2030 Growth[6] (%)	Alt 3 2030 Growth Total ($)
Shevlin Commons 1.PS03	118	52	Model	202	Decommission	380-foot gravity sewer to North Interceptor	$72,500	52	Equal to Existing Loading	NA		Decommission	100%	$72,500	60%	$43,500	0%	$0	100%	$72,500
Shevlin Commons 1.PS04	118	52	Model	202	Decommission	Removal of Pump Station	$25,000	52	Equal to Existing Loading	NA		Decommission	100%	$25,000	60%	$15,000	0%	$0	100%	$25,000
Shevlin Meadows 2.PS04	145	130	Model	464	Upgrade	New Pumps with Increased Capacity	$66,500	143	Model	145	Use Existing Station Firm Capacity	**No Upgrade**	0%	$0	0%	$0	9%	$0	100%	$0
Shevlin Meadows 2.PS05	145	130	Model	464	Upgrade	Activated Carbon Odor Scrubber	$25,000	143	Model	145	Use Existing Station Firm Capacity	**No Upgrade**	0%	$0	0%	$0	9%	$0	100%	$0
Awbrey Glen 2.PS06	450	440	Model	1,747	Decommission	8350-foot Gravity Sewer	$1,433,000	747	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$1,433,000	60%	$855,500	41%	$589,000	41%	$589,000
Awbrey Glen 2.PS07	450	440	Model	1,747	Decommission	Remove the Pump station	$50,000	747	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$50,000	60%	$30,000	41%	$20,500	41%	$20,500
Sunrise Village #1 3.PS01	250	73	Model	660	Upgrade	New Pumps with Increased Capacity	$80,000	289	Model	289	Use 2030 Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	61%	$49,000	75%	$36,500	75%	$36,500	75%	$36,500
Widgi Creek 3.PS02	297	61	Model	420	Flow Testing and Further Evaluation	A flow test performed by City staff showed station not able to pump design capacity. The problem is likely caused by conficting HGL from Sunrise Village pump station. Additional flow testing and evaluation recommended.	$15,000	102	Model	297	Use Existing Station Firm Capacity	Flow Testing	100%	$15,000	0%	$0	40%	$6,000	100%	$15,000
Boyd Acres 4.PS01	65	17	Master Plan	31	Decommission	New 460-ft 8" Sewer	$72,000	19	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$72,000	60%	$43,000	11%	$7,500	100%	$72,000
Boyd Acres 4.PS02	65	17	Master Plan	31	Decommission	Removal of Pump Station	$25,000	19	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$25,000	60%	$15,000	11%	$2,500	100%	$25,000
Highlands 4.PS03	250	27	Master Plan	196	Decommission	New 2512-ft 8" Sewer	$393,000	84	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$393,000	60%	$234,500	68%	$266,500	100%	$393,000

Table 13a. 2030 Build-out Lift Station and Decommissioning Cost Specifics (All costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action[2]	Original Build-out Activity	Original Build-out Total ($)	2030 Build-out Loading Estimate (gpm, Peak Hour)	Source of 2030 Loading	2030 Firm Pump Capacity (gpm)	2030 Firm Capacity Comment	2030 Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[3]	2030 Build-out Cost ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Alt 2 2030 Growth[5] (%)	Alt 2 2030 Growth Total ($)	Alt 3 2030 Growth[6] (%)	Alt 3 2030 Growth Total ($)
Highlands 4.PS04	250	27	Master Plan	196	Decommission	Removal of Pump Station	$25,000	84	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$25,000	60%	$15,000	68%	$17,000	100%	$25,000
Holiday Inn 4.PS05	Unknown	Unknown	Master Plan	Unknown	Decommission	New 382-ft 8" Sewer	$60,000	NA	NA	NA		Decommission	100%	$60,000	60%	$36,000	60%	$36,000	100%	$60,000
Holiday Inn 4.PS06	Unknown	Unknown	Master Plan	Unknown	Decommission	Removal of Pump Station	$10,000	NA	NA	NA		Decommission	100%	$10,000	60%	$6,000	60%	$6,000	100%	$10,000
Northpointe 4.PS07	265	58	Model	157	Decommission	New 350-ft 8" Sewer	$55,000	80	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$55,000	60%	$33,000	28%	$15,500	100%	$55,000
Northpointe 4.PS08	265	58	Model	157	Decommission	Removal of Pump Station	$25,000	80	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$25,000	60%	$15,000	28%	$7,000	100%	$25,000
North Wind 4.PS09	270	16	Model	34	Decommission	New400-ft 8" Sewer	$63,000	16	Equal to Existing Loading	NA		Decommission	100%	$63,000	60%	$37,500	0%	$0	100%	$63,000
North Wind 4.PS10	270	16	Model	34	Decommission	Removal of Pump Station	$25,000	16	Equal to Existing Loading	NA		Decommission	100%	$25,000	60%	$15,000	0%	$0	100%	$25,000
Phoenix 4.PS11	228	85	Model	44	Decommission	Removal of pump station including the inter-tie between Phoenix and Northpointe Pump station basin	$41,000	85	Equal to Existing Loading	NA		Decommission	100%	$41,000	60%	$24,500	0%	$0	100%	$41,000
Summer Meadows 4.PS12	125	11	Master Plan	31	Decommission	New 450-ft 8" Sewer	$70,000	19	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$70,000	60%	$42,000	42%	$29,500	100%	$70,000
Summer Meadows 4.PS13	125	11	Master Plan	31	Decommission	Removal of Pump Station	$25,000	19	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$25,000	60%	$15,000	42%	$10,500	100%	$25,000
Empire 5.PS02	50	22	Model	96	Upgrade	Installation of New Pumps	$25,500	58	Model	58	Use 2030 Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	74%	$18,500	61%	$11,500	61%	$11,500	61%	$11,500
Deschutes County Jail 5.PS03 ***see Table 13b and NOTE 2***	115	41	Master Plan	129	Decommission	8" Gravity Sewers discharging to the North Interceptor, no cost identified	$0	127	Estimated from Average Load x Peak Hour Factor of 2.5	NA		**No improvement currently identified, evaluate decommissioning as part of future development, *see Table 13b and NOTE 2***	100%	$0	60%	$0	68%	$0	68%	$0

Table 13a. 2030 Build-out Lift Station and Decommissioning Cost Specifics (All costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action[2]	Original Build-out Activity	Original Build-out Total ($)	2030 Build-out Loading Estimate (gpm, Peak Hour)	Source of 2030 Loading	2030 Firm Pump Capacity (gpm)	2030 Firm Capacity Comment	2030 Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[3]	2030 Build-out Cost ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Alt 2 2030 Growth[5] (%)	Alt 2 2030 Growth Total ($)	Alt 3 2030 Growth[6] (%)	Alt 3 2030 Growth Total ($)
Majestic 5.PS04	265	102	Model	170	Decommission	New 1800-ft 8" Sewer	$281,000	137	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$281,000	60%	$167,500	26%	$72,000	100%	$281,000
Majestic 5.PS05	265	102	Model	170	Decommission	Removal of the Pump Station	$25,000	137	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$25,000	60%	$15,000	26%	$6,500	100%	$25,000
North Fire Station 5.PS06 ***see NOTE 2***	Unknown	Unknown	Master Plan	Unknown	Decommission	8" Gravity Sewers discharging to the North Interceptor, no cost identified	$0	NA	NA	NA		**No improvement currently identified, evaluate decommissioning as part of future development, *see NOTE 2***	100%	$0	60%	$0	60%	$0	100%	$0
Drake Pump Station 6.PS01	650	233	Model	446	Replacement	Replace Drake Pump Station with new station	$363,000	460	Model	460	2030 Peak Hour Flow Exceeds Full Build-out Estimate, Use 2030 Peak Hour Flow for Firm Capacity	**Replacement @ less than existing capacity**	81%	$295,000	49%	$145,500	49%	$145,500	100%	$295,000
Addison Pump Station 6.PS02 (previously 6.3)	100	61	Master Plan	88	Replacement	Correct grade problem at 4th and Addison	$575,000	176	Estimated from Average Load x Peak Hour Factor of 2.5	176	2030 Peak Hour Flow Exceeds Full Build-out Estimate, Use 2030 Peak Hour Flow for Firm Capacity	**Replacement @ greater than original build-out**	152%	$871,500	65%	$569,500	65%	$569,500	65%	$569,500
Nottingham #2 7.PS02	55	81	Master Plan	202	Upgrade	Replace with new 200gpm pumps	$30,500	81	Equal to Existing Loading	81	Use Existing Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	58%	$17,500	0%	$0	0%	$0	0%	$0
Blue Ridge 7.PS03	70	28	Master Plan	39	Decommission	Installation of inter-tie to new gravity sewers	$16,000	36	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$16,000	60%	$9,500	22%	$3,500	100%	$16,000
Blue Ridge 7.PS04	70	28	Master Plan	39	Decommission	Removal of Pump Station	$25,000	36	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$25,000	60%	$15,000	22%	$5,500	100%	$25,000
Darnell Estates 7.PS05	170	100	Model	98	Decommission	Construction of a 300-foot 8" Sewer	$49,000	100	Equal to Existing Loading	NA		Decommission	100%	$49,000	60%	$29,000	0%	$0	100%	$49,000
Darnell Estates 7.PS06	170	100	Model	98	Decommission	Removal of Pump Station	$25,000	100	Equal to Existing Loading	NA		Decommission	100%	$25,000	60%	$15,000	0%	$0	100%	$25,000

Table 13a. 2030 Build-out Lift Station and Decommissioning Cost Specifics (All costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action[2]	Original Build-out Activity	Original Build-out Total ($)	2030 Build-out Loading Estimate (gpm, Peak Hour)	Source of 2030 Loading	2030 Firm Pump Capacity (gpm)	2030 Firm Capacity Comment	2030 Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[3]	2030 Build-out Cost ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Alt 2 2030 Growth[5] (%)	Alt 2 2030 Growth Total ($)	Alt 3 2030 Growth[6] (%)	Alt 3 2030 Growth Total ($)
Desert Skies 7.PS07	95	65	Model	176	Decommission	Construction of a 550-ft 8" Sewer	$86,000	154	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$86,000	60%	$51,500	58%	$49,500	58%	$49,500
Desert Skies 7.PS08	95	65	Model	176	Decommission	Removal of Pump Station	$25,000	154	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$25,000	60%	$15,000	58%	$14,500	58%	$14,500
Ridgewater #1 7.PS09	118	32	Model	26	Decommission	Construction of 250-foot 8" Sewer	$39,000	32	Equal to Existing Loading	NA		Decommission	100%	$39,000	60%	$23,500	0%	$0	100%	$39,000
Ridgewater #1 7.PS10	118	32	Model	26	Decommission	Removal of Pump Station	$25,000	32	Equal to Existing Loading	NA		Decommission	100%	$25,000	60%	$15,000	0%	$0	100%	$25,000
Sun Meadows 7.PS11	380	90	Master Plan	196	Decommission	Construction of 1500-foot 8" Sewer	$204,000	90	Equal to Existing Loading	NA		Decommission	100%	$204,000	60%	$122,000	0%	$0	100%	$204,000
Sun Meadows 7.PS12	380	90	Master Plan	196	Decommission	Removal of Pump Station	$25,000	90	Equal to Existing Loading	NA		Decommission	100%	$25,000	60%	$15,000	0%	$0	100%	$25,000
Deschutes River X-ing 8.PS01 ***see NOTE 2***	148	12	Master Plan	19	Reduce Pumping Capacity	Reduce pumping capacity to 100-gpm when pumps are replaced	$0	26	Estimated from Average Load x Peak Hour Factor of 2.5	148	Use Existing Station Firm Capacity	**No Upgrade, *see NOTE 2***	0%	$0	0%	$0	54%	$0	100%	$0
Old Mill 8.PS02	300	264	Model	600	Upgrade	Installation of 2 new 600-gpm VFD pumps	$60,000	475	Model	475	Use 2030 Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	87%	$52,000	45%	$23,000	45%	$23,000	45%	$23,000
River Rim 8.PS03	150	66	Master Plan	200	Upgrade	Installation of new 200-gpm pumps	$40,000	227	Estimated from Average Load x Peak Hour Factor of 2.5	227	2030 Peak Hour Flow Exceeds Full Build-out Estimate, Use 2030 Peak Hour Flow for Firm Capacity	**Greater than Original Build-out Upgrade**	108%	$43,000	71%	$30,500	71%	$30,500	71%	$30,500
Tri-Peaks 8.PS05	120	45	Master Plan	150	Upgrade	Installation of 2 new 150-gpm pumps	$25,000	147	Estimated from Average Load x Peak Hour Factor of 2.5	147	Use 2030 Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	99%	$24,500	69%	$17,000	69%	$17,000	69%	$17,000
South Village 8.PS06	265	19	Model	330	Decommission	Construction of 400-ft 8" trunk Sewer	$63,000	420	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$63,000	60%	$37,500	96%	$60,000	96%	$60,000
South Village 8.PS07	265	19	Model	330	Decommission	Removal of Pump Station	$25,000	420	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$25,000	60%	$15,000	96%	$24,000	96%	$24,000

Table 13a. 2030 Build-out Lift Station and Decommissioning Cost Specifics (All costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action[2]	Original Build-out Activity	Original Build-out Total ($)	2030 Build-out Loading Estimate (gpm, Peak Hour)	Source of 2030 Loading	2030 Firm Pump Capacity (gpm)	2030 Firm Capacity Comment	2030 Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[3]	2030 Build-out Cost ($)	2030 Growth Share[4]	2030 Growth Cost ($)	Alt 2 2030 Growth[5] (%)	Alt 2 2030 Growth Total ($)	Alt 3 2030 Growth[6] (%)	Alt 3 2030 Growth Total ($)
Parrell (new 8.PS08)	150	76	Model	NA	NA	Not identified in Pump Station Master Plan. 2030 condition requires pump station upgrade.	NA	454	Model	454	Use 2030 Peak Hour Flow as Station Firm Capacity	**Upgrade** (cost assumed similar to other pump upgrades	NA	$50,000	83%	$41,500	83%	$41,500	83%	$41,500
Summit Park 9.PS01	125	14	Master Plan	50	Decommission	Construction of new 500-ft 8" gravity sewer	$78,500	50	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$78,500	60%	$47,000	72%	$56,500	100%	$78,500
Summit Park 9.PS02	125	14	Master Plan	50	Decommission	Removal of Pump Station	$15,000	50	Estimated from Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$15,000	60%	$9,000	72%	$11,000	100%	$15,000
Westside (no id)	3,600	2,191	Model	4,500	Replacement	Replace Westside Pump Station with new station	$3,770,000	3,256	Model	3,600	Use Existing Station Firm Capacity, , 2030 capacity assumes that the North Interceptor will be completed near-term.	**Reduced Upgrade**	87%	$3,297,500	39%	$1,291,000	33%	$1,078,500	100%	$3,297,500
Wyndemere (no id)	240	85	Model	214	Wyndemere Pump Station is currently being re-built. No Build-out action recommended in the Pump Station Master Plan.		$0	NA	Model	254	Use 2030 Peak Hour Flow as Station Firm Capacity	Wyndemere Pump Station is currently being re-built.	NA	$0	0%	$0	67%	$0	67%	$0
Total							$8,552,000							$8,210,000		$4,243,000		$3,270,000		$6,889,000

NOTES FOR TABLE 13A

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the City of Bend CSMP. 2030 build-out cost estimates are for improvements for population growth to 119,009 by year 2030 in 2005 dollars. The first number of each project ID indicates the study areas. For example project 2.PS04 is located in study area 2.

NOTE 2. The CSMP identifies the North Fire Lift Station and Deschutes County Jail Lift Station as decommissioning improvements; however, no cost is provided. The CSMP suggests that the lift stations should be considered for decommissioning with gravity conveyance to the North Interceptor when growth occurs in the area. The City may elect to have cost estimates provided for these lift stations and added to the CIP. If the Deschutes County Jail Lift Station is not decommissioned, the lift station upgrades described in Table 13b should be implemented.

Likewise, the CSMP identifies the Deschutes River X-ing Lift Station as a potential "downgrade" or pump capacity reduction improvement, but does not provide costs for new pumps. The City may elect to have cost estimates provided for this lift station improvement.

NOTE 3. Information in the CSMP for all Lift Station cost estimates for the original build-out are limited. Where only reduced or additional improvements are required for pumping capacity under 2030 build-out conditions, Lift Station 2030 cost estimates were calculated as a percent of the original build-out cost. The percentage was calculated using the six-tenths rule $(Q_{2030}/Q_{build\text{-}out})^{0.6}$.

NOTE 4. The growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to 2030 build-out dry weather peak flow for the entire system (1-existing flow/2030 flow). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

NOTE 5. The alternative 2 growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to 2030 build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/2030 flow location specific). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

NOTE 6. The alternative 3 growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to 2030 build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/2030 flow location specific) unless the existing firm capacity exceeds the 2030 capacity requirement. If the existing firm capacity exceeds the 2030 capacity requirement then the alternative 3 growth share for lift station decommissioning is 100%. The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

Table 13b. 2030 Build-out Lift Station and Decommissioning Cost Specifics (improvements that are required only if interceptors are not installed, all costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action	Original Build-out Activity	Original Build-out Total ($)	2030 Build-out Loading Estimate (gpm, Peak Hour)	Source of 2030 Loading	2030 Firm Pump Capacity (gpm)	2030 Firm Capacity Comment	2030 Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[2]	2030 Build-out Cost ($)	2030 Growth Share[3]	2030 Growth Cost ($)	Alt 2 2030 Growth[4] (%)	Alt 2 2030 Growth Total ($)	Alt 3 2030 Growth[5] (%)	Alt 3 2030 Growth Total ($)	Priority Comment[6]
Shevlin Commons 1.PS01	118	52	Model	202	Upgrade	New Pumps with increased capacity	$80,000	52	Equal to Existing Loading	118	2030 Peak Hour Flow does not exceeds Existing Flow Estimate, Use Existing Firm Capacity	**No Upgrade**	0%	$0	0%	$0	0%	$0	100%	$0	If western portion of North Interceptor is not constructed
Shevlin Commons 1.PS02	118	52	Model	202	Upgrade	New 6" force main	$809,000	52	Equal to Existing Loading	118	2030 Peak Hour Flow does not exceeds Existing Flow Estimate, Use Existing Firm Capacity	**No Upgrade**	0%	$0	0%	$0	0%	$0	100%	$0	If western portion of North Interceptor is not consructed
Awbrey Glen 2.PS01	450	440	Model	1747	Upgrade	New Pumps with Increased Capacity	$561,000	747	Estimated from Average Load x Peak Hour Factor of 2.5	747	Use 2030 Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	60%	$337,000	41%	$138,500	41%	$138,500	41%	$138,500	When capacity is reached
Awbrey Glen 2.PS02	450	440	Model	1747	Upgrade	Replace Force Main (8-inch to 12-inch)	$1,970,500	747	Estimated from Average Load x Peak Hour Factor of 2.5	747	Use 2030 Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	60%	$1,183,500	41%	$486,500	41%	$486,500	41%	$486,500	When capacity is reached
Awbrey Glen 2.PS03	450	440	Model	1747	Upgrade	Gravity System at the Station Discharge	$452,000	747	Estimated from Average Load x Peak Hour Factor of 2.5	747	Use 2030 Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	60%	$271,500	41%	$111,500	41%	$111,500	41%	$111,500	If western portion of North Interceptor is not consructed and station must be expanded beyond current capacity
Deschutes County Jail 5.PS01	115	41	Master Plan	129	Upgrade	Installation of New Pumps	$25,500	127	Estimated from Average Load x Peak Hour Factor of 2.5	127	Use 2030 Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	99%	$25,000	68%	$17,000	68%	$17,000	68%	$17,000	When capacity is reached
Desert Skies 7.PS01	95	65	Model	176	Upgrade	Replace with new 180-gpm pumps	$30,500	154	Estimated from Average Load x Peak Hour Factor of 2.5	154	Use 2030 Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	92%	$28,000	58%	$16,000	58%	$16,000	58%	$16,000	When capacity is reached

Table 13b. 2030 Build-out Lift Station and Decommissioning Cost Specifics (improvements that are required only if interceptors are not installed, all costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action	Original Build-out Activity	Original Build-out Total ($)	2030 Build-out Loading Estimate (gpm, Peak Hour)	Source of 2030 Loading	2030 Firm Pump Capacity (gpm)	2030 Firm Capacity Comment	2030 Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[2]	2030 Build-out Cost ($)	2030 Growth Share[3]	2030 Growth Cost ($)	Alt 2 2030 Growth[4] (%)	Alt 2 2030 Growth Total ($)	Alt 3 2030 Growth[5] (%)	Alt 3 2030 Growth Total ($)	Priority Comment[6]
South Village 8.PS04	265	19	Model	330	Upgrade	Installation of 2 new 330-gpm pumps	$25,500	420	Estimated from Average Load x Peak Hour Factor of 2.5	420	2030 Peak Hour Flow Exceeds Full Build-out Estimate, Use 2030 Peak Hour Flow for Firm Capacity	**Greater than Original Build-out Upgrade**	116%	$29,000	96%	$28,000	96%	$28,000	96%	$28,000	When capacity is reached
TOTAL							$3,954,000							$1,874,000		$798,000		$798,000		$798,000	

NOTES FOR TABLE 13B

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the City of Bend CSMP. 2030 build-out cost estimates are for improvements for population growth to 119,009 by year 2030 in 2005 dollars. The first number of each project ID indicates the study areas. For example project 2.1 is located in study area 2.

NOTE 2. Information in the CSMP for all Lift Station cost estimates for the original build-out are limited. Where only reduced or additional improvements are required for pumping capacity under 2030 build-out conditions, Lift Station 2030 cost estimates were calculated as a percent of the original build-out cost. The percentage was calculated using the six-tenths rule $(Q_{2030}/Q_{build\text{-}out})^{0.6}$.

NOTE 3. The growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to 2030 build-out dry weather peak flow for the entire system (1-existing flow/2030 flow). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

NOTE 4. The alternative 2 growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to 2030 build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/2030 flow location specific). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

NOTE 5. The alternative 3 growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to 2030 build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/2030 flow location specific) unless the existing firm capacity exceeds the 2030 build-out capacity requirement. If the existing firm capacity exceeds the 2030 build-out capacity requirement then the alternative 3 growth share for lift station decommissioning is 100%. The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

NOTE 6. Table 13b highlights lift stations that will need to be improved if the interceptor improvements are not implemented. The costs for these lift stations includes the cost of upgrading the lift station ONLY and does NOT include costs for all downstream pipeline improvements. Additional modeling scenarios and improvements analysis are required to determine whether or not lift station upgrades and additional downstream pipeline improvements provide feasible alternatives to the planned interceptors.

Interceptor Improvements

The interceptor improvements are presented in Figure 17 (E-size folded map), Table 14a, Table 14b, and Table 14c. The velocity, depth/diameter (d/D), and surcharge clearance results are included in Table 14a for each interceptor segment. Also, included in Table 14a are the model results compared to the design criteria for each interceptor segment at the next smallest pipe size. The detailed cost breakdown for each improvement is provided in Table 14b including a comparison to the original build-out cost and information on the North Interceptor Lift Station. A summary of the interceptor costs is provided in Table 14c.

The alignments and slopes for each of the interceptor segments were not modified from the original build-out CIP. Additional interceptor alternatives were not considered with the reduced flows. Only the pipe sizes and North Interceptor Lift Station capacity were revised. When compared with the original build-out CIP, there is a 9-inch length weighted average pipe size reduction for the interceptor improvements. The reduction is primarily caused by the reduced planning densities and population estimates.

The interceptor improvements are required to correct for existing system deficiencies as well as the 2030 deficiencies. Two alternatives for calculating growth share are defined for each interceptor improvement segment to identify the percentage of the cost associated with growth. The growth share information can be used to prioritize improvements. The growth share alternatives are described below:

> Alternative 1 - The growth share is calculated from the existing dry weather peak flow to 2030 dry weather peak flow ratio for the entire system (1-existing flow/2030 flow).
>
> Alternative 2 - The growth share is calculated from the existing to 2030 dry weather flow ratio for specific areas of the system where the interceptor is located (1-existing flow location specific/2030 flow location specific). Growth shares for additional items such as crossings, traffic control, erosion control, and siphon structures are length-weighted and averaged for the various sections of each interceptor.

Table 14a. 2030 Build-out Interceptor Improvement Results and Comparison to Design Criteria

Project Element	Original Build-out Diameter (in)	Length (ft)	Final Model Results for 2030 Build-out CIP Diameter						Comparison Model Results for 2030 Build-out CIP at next smallest Pipe Size						Controlling Criteria for Improvement
			2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than 2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
Plant Interceptor															
WWTP Siphon	48	5,003	27	1.0	sealed	sealed	4.6	3.4	24	1.0	sealed	sealed	see note 3	4.0	see note 3
North Trunk Junction to Siphon															
36" segment	48	3,004	36	0.6	>=3.5	>=3.5	5.0	4.9	30	>0.8	see note 2	see note 2	<10	>2	d/D
30" segment	48	5,298	30	0.8	>=3.5	sealed	6.5	4.0	27	>0.8	see note 2	sealed	<10	>2	d/D
North Interceptor															
Plant Interceptor to Hwy 97															
36" segment	48	6,086	36	0.7	>=3.5	>=3.5	3.4	3.4	30	>0.8	see note 2	see note 2	<10	>2	d/D
30" segment	48	5,700	30	0.6	>=3.5	>=3.5	3.2	3.0	27	>0.8	see note 2	see note 2	<10	>2	d/D
Juniper Ridge to Hwy 97	42	2,538	27	0.8	>=3.5	>=3.5	4.0	3.9	24	>0.8	see note 2	see note 2	<10	>2	d/D
Hwy 97 to Deschutes River															
21" segment	30	6,850	21	0.7	sealed	>=3.5	2.1	1.6	18	>0.9	sealed	see note 2	<10	<2	d/D
18" segment	30	7,474	18	0.7	>=3.5	>=3.5	3.1	2.4	15	>0.9	see note 2	see note 2	<10	>2	d/D
Deschutes River Forcemain	15	1,050	10	1.0	sealed	sealed	5.9	3.9	8	1.0	sealed	sealed	>9	>6	velocity
Deschutes River to Shevlin Park															
15" segment		550	15	0.3	>=3.5	>=3.5	6.2	5.6	12	<0.5	<0.5	<0.5	<10	>2	surcharge clearance
10" segment	8-27	367	10	0.2	>=3.5	>=3.5	10.0	8.9	8	<0.5	>=3.5	>=3.5	>10	>9	velocity
8" segment		21,842	8	0.8	>=3.5	>=3.5	7.5	1.1	6	>0.8	see note 2	see note 2	<10	>2	d/D

Table 14a. 2030 Build-out Interceptor Improvement Results and Comparison to Design Criteria

Project Element	Original Build-out Diameter (in)	Length (ft)	Final Model Results for 2030 Build-out CIP Diameter						Comparison Model Results for 2030 Build-out CIP at next smallest Pipe Size						Controlling Criteria for Improvement
			2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than 2030 BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
Southeast Interceptor															
North Trunk Junction to JD Estates Drive	36	3,702	24	0.7	>=3.5	>=3.5	3.8	3.8	21	>0.8	see note 2	see note 2	<10	>2	d/D
JD Estates Drive to hwy 20 (10-15' depth)	24	10,413	18	0.8	>=3.5	>=3.5	7.6	5.9	15	>0.8	see note 2	see note 2	<10	>2	d/D
JD Estates Drive to hwy 20 (15-20' depth)	24	8,280	18	0.8	>=3.5	>=3.5	7.6	5.9	15	>0.8	see note 2	see note 2	<10	>2	d/D
Hwy 20 to Reed Market Rd (10-15' depth)	24	3,291	18	0.6	>=3.5	>=3.5	7.3	5.8	15	>0.8	see note 2	see note 2	<10	>2	d/D
Hwy 20 to Reed Market Rd (15-20' depth)	24	3,856	18	0.6	>=3.5	>=3.5	7.3	5.8	15	>0.8	see note 2	see note 2	<10	>2	d/D
Reed Market Rd to SE 15th St	24	8,985	18	0.8	>=3.5	>=3.5	4.8	3.6	15	>0.8	see note 2	see note 2	<10	>2	d/D
SE 15th to Murphy Rd LS	24	5,505	18	0.6	>=3.5	>=3.5	3.2	3.0	15	>0.8	see note 2	see note 2	<10	>2	d/D
Murphy Rd LS to Hwy 97	18	6,008	12	0.7	>=1.5, existing manhole	>=3.5	6.4	3.8	10	>0.8	see note 2	see note 2	<10	>2	d/D
Westside Interceptor															
Westside Forcemain															
15" segment	18	980	15	1.0	sealed	sealed	6.0	6.0	12	1.0	sealed	sealed	>8	>7	velocity
18" segment (partial gravity)	18	2,018	18	0.8	sealed	>=3.5	4.7	4.7	15	>0.8	sealed	see note 2	<10	>2	d/D
Gravity Interceptor	27	18,018	18	0.8	>=3.5	>=3.5	6.0	5.4	15	>0.8	see note 2	see note 2	<10	>2	d/D

NOTES FOR TABLE 14A

NOTE 1. For several segments of pipeline, the daily cleansing velocity and d/D criteria could not be met simultaneously. For these pipelines, the d/D criteria was given priority.

NOTE 2. Because the smaller pipe size did not meet the d/D criteria during the dry weather model simulation, the smaller pipe size was not simulated for wet weather conditions.

NOTE 3. The siphon size was adjusted until the upstream pipelines met the surcharge clearance criteria and the siphon and parallel siphon into the WWTP met the maximum velocity criteria.

Table 14b. 2030 Build-out Interceptor Improvements Cost Specifics (all costs in 2005 dollars)[1]

Project Element	2030 Dia. (in)	Original BO Dia. (in)	Total Length (ft)	2030 Pipe Unit Cost ($/ft)	2030 Pipe Material ($)	2030 Depth Category (ft)	2030 Pipe Install. Unit Cost ($/ft)	2030 Install. ($)	Manhole Count (400 ft max spacing)	2030 Manhole Unit Cost ($/each)[3]	2030 Manhole Cost ($)	2030 Surface Catetgory	2030 Restore Unit Cost ($/ft)	2030 Restore Cost ($)	Easement Cost ($)	2030 Subtotal Cost ($)	2030 Engr/ Admin Cost @35% ($)	2030 Contig. @30% ($)	2030 Build-out Total ($)	2030 Growth[4] %	2030 Growth Total ($)	Alt. 2030 Growth[5] %	Alt. 2030 Growth Total ($)	Original Build-out Total ($)
Plant Interceptor																								
WWTP to Siphon Inlet - Gravity																								
27" segment	27	48	5,003	35	175,113	0-10	135	675,438	13	8,345	108,485	Dirt	6.00	30,019	100,000	1,089,100	381,200	441,100	1,911,500	60%	1,141,000	60%	1,142,500	3,132,000
North Trunk Junction to Siphon																								
36" segment	36	48	3,004	46	138,180	0-10	190	570,743	8	8,345	66,760	Local	14.18	42,595	54,275	872,600	305,400	353,400	1,531,500	60%	914,000	60%	915,000	5,492,000
30" segment	30	48	5,298	40	211,920	0-10	160	847,680	13	8,345	108,485	Local	12.60	66,755	95,725	1,330,600	465,700	538,900	2,335,000	60%	1,394,000	60%	1,395,500	

Project Element	Quantity	2030 Material Cost ($)	2030 Subtotal Cost ($)	2030 Engr/ Admin Cost @35% ($)	2030 Contig. @30% ($)	2030 Build-out Total ($)	2030 Growth[4] %	2030 Growth Total ($)	Alt. 2030 Growth[5] %	Alt. 2030 Growth Total ($)	Original Build-out Total ($)
Canal Crossings	100	75,000	75,000	26,300	30,400	131,500	60%	78,500	60%	78,500	132,000
Traffic Control/Management	1 EA	20,000	20,000	7,000	8,100	35,000	60%	21,000	60%	21,000	35,000
Erosion Control	1 EA	200,000	200,000	70,000	81,000	351,000	60%	209,500	60%	210,000	351,000
Siphon Structure	1 EA	150,000	150,000	52,500	60,800	263,500	60%	157,500	60%	157,500	263,000
					TOTAL	6,559,000	60%	3,915,000	VARIES	3,920,000	9,405,000

Table 14b. 2030 Build-out Interceptor Improvements Cost Specifics (all costs in 2005 dollars)[1]

Project Element	2030 Dia. (in)	Original BO Dia. (in)	Total Length (ft)	2030 Pipe Unit Cost ($/ft)	2030 Pipe Material ($)	2030 Depth Category (ft)	2030 Pipe Install. Unit Cost ($/ft)	2030 Install. ($)	Manhole Count (400 ft max spacing)	2030 Manhole Unit Cost ($/each)[3]	2030 Manhole Cost ($)	2030 Surface Catetgory	2030 Restore Unit Cost ($/ft)	2030 Restore Cost ($)	Easement Cost ($)	2030 Subtotal Cost ($)	2030 Engr/ Admin Cost @35% ($)	2030 Contig. @30% ($)	2030 Build-out Total ($)	2030 Growth[4] %	2030 Growth Total ($)	Alt. 2030 Growth[5] %	Alt. 2030 Growth Total ($)	Original Build-out Total ($)
North Interceptor																								
Plant Interceptor to Hwy 97																								
36" segment	36	48	6,086	46	279,938	10-15	205	1,247,550	15	10,845	162,675	Local/Dirt	10.84	65,968	0	1,756,100	614,600	711,200	3,082,000	60%	1,839,500	52%	1,610,000	8,810,000
30" segment	30	48	5,700	40	228,000	10-15	175	997,500	14	10,845	151,830	Local/Dirt	9.64	54,920	0	1,432,200	501,300	580,100	2,513,500	60%	1,500,500	52%	1,313,000	
Juniper Ridge to Hwy 97																								
27" segment	27	42	2,538	35	88,844	10-15	150	380,760	6	10,845	65,070	Local/Dirt	8.50	21,576	0	556,300	194,700	225,300	976,500	60%	583,000	50%	484,500	1,543,500
Hwy 97 to Deschutes River																								
21" segment	21	30	6,850	19	126,725	10-15	115	787,750	17	4,990	84,830	Local/Dirt	7.23	49,491	68,577	1,117,400	391,100	452,600	1,961,000	60%	1,170,500	76%	1,481,000	6,553,000
18" segment	18	30	7,474	17	127,056	10-15	105	784,758	19	4,990	94,810	Local/Dirt	6.42	47,982	74,823	1,129,400	395,300	457,400	1,982,000	60%	1,183,000	76%	1,496,500	
Deschutes River Force main																								
10" segment	10	15	1,050	12	12,957	0-10	70	73,500	0	0	0	NA	0.00	0	0	86,500	30,300	35,000	152,000	60%	90,500	61%	93,000	278,000
North Interceptor Pump Station[2]																			637,500	60%	380,500	61%	389,000	1,226,500
Deschutes River to Shevlin Park																								
15" segment	15	8-27	550	19	10,340	0-10	77	42,350	1	3,640	3,640	Local	7.88	4,334	5,756	66,400	23,200	26,900	116,500	60%	69,500	61%	71,000	5,058,000
10" segment	10		367	9	3,248	0-10	70	25,690	1	3,640	3,640	Local	7.35	2,697	3,841	39,100	13,700	15,800	68,500	60%	41,000	61%	42,000	
8" segment	8		21,842	6	123,407	0-10	67	1,463,414	55	3,640	200,200	Local	7.35	160,539	228,603	2,176,200	761,700	881,400	3,819,500	60%	2,280,000	96%	3,684,000	

Project Element	Quantity	2030 Material Cost ($)	2030 Subtotal Cost ($)	2030 Engr/ Admin Cost @35% ($)	2030 Contig. @30% ($)	2030 Build-out Total ($)	2030 Growth[4] %	2030 Growth Total ($)	Alt. 2030 Growth[5] %	Alt. 2030 Growth Total ($)	Original Build-out Total ($)
Canal Crossings(3)	300	225,000	225,000	78,800	91,100	395,000	60%	236,000	77%	305,000	395,000
Traffic Control/Management	1 EA	50,000	50,000	17,500	20,300	88,000	60%	52,500	77%	68,000	88,000
Erosion Control	1 EA	212,640	212,640	74,400	86,100	373,000	60%	222,500	77%	288,000	373,000
Hwy 97 and Hwy 20 Bores	250	250,000	250,000	87,500	101,300	439,000	60%	262,000	77%	339,000	439,000
Railroad Undercrossing	150	150,000	150,000	52,500	60,800	263,500	60%	157,500	77%	203,500	263,500
					TOTAL	16,868,000	60%	10,068,000	VARIES	11,868,000	25,028,000

Table 14b. 2030 Build-out Interceptor Improvements Cost Specifics (all costs in 2005 dollars)[1]

Project Element	2030 Dia. (in)	Original BO Dia. (in)	Total Length (ft)	2030 Pipe Unit Cost ($/ft)	2030 Pipe Material ($)	2030 Depth Category (ft)	2030 Pipe Install. Unit Cost ($/ft)	2030 Install. ($)	Manhole Count (400 ft max spacing)	2030 Manhole Unit Cost ($/each)[3]	2030 Manhole Cost ($)	2030 Surface Catetgory	2030 Restore Unit Cost ($/ft)	2030 Restore Cost ($)	Easement Cost ($)	2030 Subtotal Cost ($)	2030 Engr/ Admin Cost @35% ($)	2030 Contig. @30% ($)	2030 Build-out Total ($)	2030 Growth[4] %	2030 Growth Total ($)	Alt. 2030 Growth[5] %	Alt. 2030 Growth Total ($)	Original Build-out Total ($)
Southeast Interceptor																								
North Trunk Junction to JD Estates Drive	24	36	3,702	22	81,445	0-10	107	396,121	9	8,345	75,105	Local	9.45	34,985	0	587,700	205,700	238,000	1,031,500	60%	615,500	64%	657,500	1,862,000
JD Estates Drive to hwy 20 (10-15' depth)	18	24	10,413	17	177,013	10-15	105	1,093,318	26	4,990	129,740	Arterial	19.09	198,776	0	1,598,800	559,600	647,500	2,806,000	60%	1,675,000	64%	1,790,000	6,748,500
JD Estates Drive to hwy 20 (15-20' depth)	18	24	8,280	17	140,768	15-20	130	1,076,459	21	6,740	141,540	Arterial	19.09	158,074	0	1,516,800	530,900	614,300	2,662,000	60%	1,589,000	64%	1,698,000	2,089,000
Hwy 20 to Reed Market Rd (10-15' depth)	18	24	3,291	17	55,945	10-15	105	345,545	8	4,990	39,920	Arterial	19.09	62,823	0	504,200	176,500	204,200	885,000	60%	528,500	64%	565,000	
Hwy 20 to Reed Market Rd (15-20' depth)	18	24	3,856	17	65,554	15-20	130	501,298	10	6,740	67,400	Arterial	19.09	73,614	0	707,900	247,800	286,700	1,242,500	60%	741,500	64%	793,500	
Reed Market Rd to SE 15th St	18	24	8,985	17	152,738	10-15	105	943,381	22	4,990	109,780	Local	8.40	75,470	0	1,281,400	448,500	519,000	2,249,000	60%	1,342,500	71%	1,596,000	2,279,500
SE 15th to Murphy Rd LS	18	24	5,505	17	93,585	0-10	87	478,935	14	3,640	50,960	Local	8.40	46,242	10,000	679,700	237,900	275,300	1,193,000	60%	712,000	56%	672,500	1,301,500
Murphy Rd LS to Hwy 97	12	18	6,008	13	76,607	10-15	90	540,753	15	4,990	74,850	Arterial	16.71	100,400	0	792,600	277,400	321,000	1,391,000	60%	830,500	37%	515,000	1,811,500

Project Element	Quantity	2030 Material Cost ($)	2030 Subtotal Cost ($)	2030 Engr/ Admin Cost @35% ($)	2030 Contig. @30% ($)	2030 Build-out Total ($)	2030 Growth[4] %	2030 Growth Total ($)	Alt. 2030 Growth[5] %	Alt. 2030 Growth Total ($)	Original Build-out Total ($)
Canal Crossings(2)	200	150,000	150,000	52,500	60,800	263,500	60%	157,500	61%	161,000	263,500
Railroad Undercrossing	230	230,000	230,000	80,500	93,200	403,500	60%	241,000	61%	246,500	404,000
Intertie Structures	2 EA	400,000	400,000	140,000	162,000	702,000	60%	419,000	61%	428,500	702,000
Traffic Control/Management	1 EA	450,000	450,000	157,500	182,300	790,000	60%	471,500	61%	482,500	790,000
Erosion Control	1 EA	195,200	195,200	68,300	79,100	342,500	60%	204,500	61%	209,000	342,500
US Hwy 20 Undercrossing	250	250,000	250,000	87,500	101,300	439,000	60%	262,000	61%	268,000	439,000
					TOTAL	16,401,000	60%	9,790,000	VARIES	10,083,000	19,033,000

Table 14b. 2030 Build-out Interceptor Improvements Cost Specifics (all costs in 2005 dollars)[1]

Project Element	2030 Dia. (in)	Original BO Dia. (in)	Total Length (ft)	2030 Pipe Unit Cost ($/ft)	2030 Pipe Material ($)	2030 Depth Category (ft)	2030 Pipe Install. Unit Cost ($/ft)	2030 Install. ($)	Manhole Count (400 ft max spacing)	2030 Manhole Unit Cost ($/each)[3]	2030 Manhole Cost ($)	2030 Surface Catetgory	2030 Restore Unit Cost ($/ft)	2030 Restore Cost ($)	Easement Cost ($)	2030 Subtotal Cost ($)	2030 Engr/ Admin Cost @35% ($)	2030 Contig. @30% ($)	2030 Build-out Total ($)	2030 Growth[4] %	2030 Growth Total ($)	Alt. 2030 Growth[5] %	Alt. 2030 Growth Total ($)	Original Build-out Total ($)
Westside Interceptor																								
Westside Forcemain	15	18	980	26	25,803	0-10	77	75,460				Local	7.88	7,722	4,900	113,900	39,900	46,100	200,000	60%	119,500	47%	93,500	769,000
Forcemain to Gravity Transition	18	18	2,018	17	34,310	10-15	105	211,915	5	4,990	24,950	Local	8.40	16,953	10,090	298,200	104,400	120,800	523,500	60%	312,500	47%	244,500	
Gravity Interceptor	18	27	18,018	17	306,310	10-15	105	1,891,914	45	4,990	224,550	Arterial	19.09	343,968	20,000	2,786,700	975,300	1,128,600	4,890,500	60%	2,919,000	53%	2,611,500	7,447,000

Project Element	Quantity	2030 Material Cost ($)	2030 Subtotal Cost ($)	2030 Engr/ Admin Cost @35% ($)	2030 Contig. @30% ($)	2030 Build-out Total ($)	2030 Growth[4] %	2030 Growth Total ($)	Alt. 2030 Growth[5] %	Alt. 2030 Growth Total ($)	Original Build-out Total ($)
US Hwy 97 Undercrossing	400	400,000	400,000	140,000	162,000	702,000	60%	419,000	52%	368,000	702,000
Railroad Undercrossing	230	230,000	230,000	80,500	93,200	403,500	60%	241,000	52%	211,500	403,500
Traffic Control/Management	1 EA	176,400	176,400	61,700	71,400	309,500	60%	184,500	52%	162,500	309,500
Erosion Control	1 EA	84,000	84,000	29,400	34,000	147,500	60%	88,000	52%	77,500	147,500
					TOTAL	7,177,000	60%	4,284,000	VARIES	3,769,000	9,779,000

NOTES FOR TABLE 14B

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the City of Bend CSMP. 2030 build-out cost estimates are for improvements for population growth to 119,009 by year 2030 in 2005 dollars. Unit Costs were taken directly from the CSMP and applied to revised improvements.

NOTE 2. Information in the CSMP for the North Interceptor Lift Station cost estimates at original build-out was limited to the total cost. Peak flow estimates in the CSMP range from 4,400 gpm to 10,800 gpm. The 2030 flow estimates at the North Interceptor Lift Station ranged from 1,400-1,500 gpm. The North Interceptor Lift Station total cost estimate for the 2030 build-out CIP was assumed as 52% of the original cost estimate using the six tenths cost rule where percent is calculated as $(Q_{2030}/Q_{build\text{-}out})^{0.6}$. This should result in a conservative 2030 build-out CIP cost.

NOTE 3. Manholes sizes are 48 inches for pipe sizes less than 24 inches and 60 inches for pipe sizes greater than or equal to 24 inches.

NOTE 4. The 2030 build-out growth share is calculated from the existing dry weather peak flow to 2030 dry weather peak flow ratio for the entire system (1-existing flow/2030 flow).

NOTE 5. The alternate 2030 build-out growth share is calculated from the existing to 2030 dry weather flow ratio for specific areas of the system where the interceptor is located (1-existing flow location specific/2030 flow location specific). Growth shares for additional items such as crossings, traffic control, erosion control, and siphon structures are length-weighted and averaged for the various sections of each interceptor.

Table 14c. 2030 Build-out Interceptor Improvements Cost Totals (all costs in 2005 dollars)[1]

Project	2030 Build-out Total ($)	2030 Growth Total[2] ($)	Alternate 2030 Growth Total[3] ($)	Original Build-out Total ($)
Plant Interceptor	6,559,000	3,915,000	3,920,000	9,405,000
North Interceptor	16,868,000	10,068,000	11,868,000	25,028,000
Southeast Interceptor	16,401,000	9,790,000	10,0833,000	19,033,000
Westside Interceptor	7,177,000	4,284,000	3,769,000	9,779,000
Total	47,005,000	28,057,000	29,640,000	63,245,000

NOTES FOR TABLES 14C

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the City of Bend CSMP. 2030 build-out cost estimates are for improvements for population growth to 119,009 by year 2030 in 2005 dollars. Unit costs were taken directly from the CSMP and applied to revised improvements.

NOTE 2. The 2030 build-out growth share is calculated from the existing dry weather peak flow to 2030 dry weather peak flow ratio for the entire system (1-existing flow/2030 flow).

NOTE 3. The alternate 2030 build-out growth share is calculated from the existing to 2030 dry weather flow ratio for specific areas of the system where the interceptor is located (1-existing flow location specific/2030 flow location specific). Growth shares for additional items such as crossings, traffic control, erosion control, and siphon structures are length-weighted and averaged for the various sections of each interceptor.

Overall Costs

The total costs for the 2030 build-out CIP and the original build-out CIP are compared in Table 15. The 2030 build-out total costs are 32% less than the original build-out total costs. The reduction in improvements and costs is primarily caused by the reduced planning densities and population estimates.

Table 15. Summary 2030 Build-out CIP Costs (all costs in 2005 dollars)[1]

Improvement Category	2030 Build-out Total ($)	Original Build-out Total ($)	Percent Reduction between Original Build-out and 2030 Build-out
Gravity and Forcemain	5,429,000	17,314,000	69%
Lift Station and Decommissioning	8,210,000	8,551,000	4%
Interceptor	47,005,000	63,245,000	26%
Total	**60,644,000**	**89,110,000**	**32%**

NOTES FOR TABLE 15

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the City of Bend CSMP. 2030 build-out cost estimates are for improvements for population growth to 119,009 by year 2030 in 2005 dollars. Unit costs were taken directly from the CSMP and applied to revised improvements.

FULL BUILD-OUT CAPITAL IMPROVEMENT PROGRAM

General

The planning density established for the full build-out CIP assumes a constant 5% growth rate through 2030 with a final population of 238,162. The full build-out CIP is divided into three sections:

1. Gravity and forcemain improvements in the 9 study areas.
2. Lift station upgrades and decommissioning in the 9 study areas.
3. Planned interceptors (Plant Interceptor, North Interceptor, Southeast Interceptor, and Westside Interceptor).

All improvements are dependent on each other unless otherwise noted. For example, an upstream improvement is sized adequately if the downstream interceptor is also constructed. At the time of project implementation, additional modeling scenarios and analysis will be required to determine whether each improvement is adequate without other applicable downstream improvements.

Gravity and Forcemain Improvements

The gravity and forcemain improvements in the nine study areas are presented in Figure 18 (E-size folded map), Table 16a, Table 16b, and Table 16c. The velocity, depth/diameter (d/D), and surcharge clearance results are included in Table 16a for each improvement. All improvements from the original build-out CIP are included in the tables and figure. Also included in Table 16a are the model results compared with the design criteria for each improvement at the next smallest pipe size unless the improvement can be eliminated from consideration.

In the original build-out CIP, all gravity improvement cost estimates used the unit costs for a 0-10 ft construction depth even though the CSMP stated that the same unit costs should be applied to both new improvements and replacement/upgrade improvements. The full build-out CIP utilizes all of the unit cost data with variation for construction depth. Because of the modified assumption, the cost differences between the original build-out CIP and the full build-out CIP are less exaggerated than if both CIPs had utilized the variation in construction depth. A "revised" original CIP cost applying variation in construction depth to the original improvements is presented in Table 16B to provide an appropriate comparison.

Additionally, the full build-out costs may be conservative since a replacement or upgrade improvement may require less excavation expense than a new improvement. It is recommended for future CIPs and master planning efforts that separate unit costs be developed for new improvements and upgrade/replacement improvements.

The detailed cost breakdown for each improvement is provided in Table 16b including a comparison to the original build-out cost and "revised" original build-out cost. A summary of the gravity improvements is provided in Table 16c. Improvements are categorized as follows:

1. No Improvement – Improvement not required for the full build-out or the existing system.

2. Reduced Improvement – Improvement required for the full build-out, but size is less than the original build-out.

3. Full Improvement – Improvement required for the full build-out and size is identical to the original build-out.

4. Additional Improvement – Improvement required for the full build-out and size is calculated to be greater than the original build-out size.

5. Improvement dependent on Interceptor – Improvement not required, unless interceptor is not completed.

6. New Improvement- Improvement not considered in the original build-out CIP.

When compared with the original build-out CIP, there is a 9% reduction in length of gravity and forcemain improvements for the full build-out CIP. The reduction is primarily caused by revisions to dry weather diurnal patterns and the wet weather model component including the selected summer-time design storm. Only 46,500 feet of the 67,300 feet of pipeline improvements identified in the original build-out CIP are required for the full build-out CIP. An additional 15,100 feet of pipeline improvements not previously identified in the original build-out CIP are also required. The 9% reduction includes the additional 15,100 feet of new improvements.

Some improvements are required to correct the existing system deficiencies as well as the full build-out deficiencies. A growth share is defined for each improvement to identify the percentage of the cost associated with growth. A zero percent growth share indicates that the improvement is entirely caused by an existing deficiency. The growth share information can be used to prioritize improvements. The gravity and forcemain growth share is calculated with the following formula:

Growth Share = 1 – (Existing Dry Weather Peak Flow location specific/Full Build-out Dry Weather Peak Flow location specific).

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
2.1	2.1a1	446	10	12	full improvement from original build-out analysis	12	0.7	>=0.5, shallow manhole	>=0.5, shallow manhole	2.7	2.5	10	>0.8	<1.5	<1.5	<10	>2	d/D
2.1	2.1a2	189	10	12	full improvement from original build-out analysis	12	0.7	>=3.5	>=1.5, shallow manhole	2.6	2.6	10	>0.8	>2.5	<2.5	<10	>2	d/D
2.1	2.1a3	128	10	12	additional improvement from original build-out analysis	15	0.5	>=3.5	>=3.5	2.2	2.2	12	>0.9	>=3.5	>=3.5	<3	>2	d/D
2.1	2.1a4	12	10	12	no improvement	10	0.7	>=3.5	>=3.5	3.1	3.0	NA	--	--	--	--	--	--
2.1	2.1b1	464	8	12	reduced improvement	10	0.8	>=3.5	>=3.5	2.9	2.9	8	>0.8	>2.5	>2.5	<10	>2	d/D
2.1	2.1c1	863	8	10	full improvement from original build-out analysis	10	0.8	>=3.5	>=3.5	3.6	2.9	8	>0.8	>=3.5	>=3.5	<10	>3	d/D
2.1	2.1c2	1,749	8	10	no improvement	8	0.8	>=1.5, shallow manhole	>=1.5, shallow manhole	5.6	1.3	NA	--	--	--	--	--	--
2.1	2.1c3	280	8	10	full improvement from original build-out analysis	10	0.5	>=3.5	>=3.5	3.6	3.6	8	>0.8	>=3.5	>=3.5	<4	>3	d/D
2.2	2.2a1	310	12	15	full improvement from original build-out analysis	15	0.8	>=3.5	>=3.5	3.0	2.9	12	>1	<0.5	>=3.5	<4	>3	d/D, surcharge clearance
2.2	2.2b1	450	10	12	additional improvement from original build-out analysis	15	0.3	>=3.5	>=3.5	3.8	3.8	12	>0.4	>=3.5	>=3.5	<4	>3	improvement required for downstream segment 2.2a1
2.3	2.3a1	425	8	12	full improvement from original build-out analysis	12	0.8	>=3.5	>=3.5	5.5	4.0	10	>1	>= 2.5	>= 2.5	<6	>5	d/D
2.4	2.4a1	252	8	10	full improvement from original build-out analysis	10	0.6	>=3.5	>=3.5	3.8	3.5	8	>1	>=3.5	>=3.5	<4	>3	d/D
2.5	2.5a1	232	8	15	reduced improvement	12	0.5	>=3.5	>= 2.5	3.2	3.2	10	>0.8	>=3.5	>= 2.5	<4	>3	d/D
2.5	2.5b1	244	8	10	full improvement from original build-out analysis	10	0.6	>= 2.5	>=3.5	4.1	4.0	8	>1	<1.5	<2.5	<4	>3	d/D, surcharge clearance
2.5	2.5c1	52	8	12	reduced improvement	10	0.6	>=3.5	>=3.5	3.7	3.7	8	>1	>=3.5	>=3.5	<4	>3	d/D
2.5	2.5d1	1,182	8	10	full improvement from original build-out analysis	10	0.6	>=3.5	>=3.5	4.4	3.9	8	>1	>=3.5	>=3.5	<5	>3	d/D

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
2.5	2.5e1	767	8	12	reduced improvement	10	0.7	>=3.5	>=3.5	4.9	3.8	8	>1	>=3.5	>=3.5	<5	>4	d/D
2.5	2.5f1	392	8	15	reduced improvement	12	0.6	>=3.5	>=3.5	3.0	3.0	10	>0.8	>2.5	>2.5	<10	>2	d/D
2.6	2.6a1	305	8	10	no improvement	8	0.2	>=3.5	>=3.5	7.6	7.5	NA	--	--	--	--	--	--
2.6	2.6a2	314	8	10	no improvement	8	0.2	>=3.5	>=3.5	7.1	7.1	NA	--	--	--	--	--	--
2.6	2.6b1	245	8	10	no improvement	8	0.1	>=3.5	>=3.5	10.0	10.0	NA	--	--	--	--	--	--
2.6	2.6c1	435	8	12	no improvement	8	0.5	>=3.5	>=3.5	9.7	6.0	NA	--	--	--	--	--	--
2.6	2.6d1	156	8	10	no improvement	8	0.2	>=3.5	>= 2.5	8.2	8.2	NA	--	--	--	--	--	--
2.6	2.6e1	372	8	18	no improvement	8	0.5	>=3.5	>=3.5	4.7	4.7	NA	--	--	--	--	--	--
2.6	2.6e2	318	8	18	no improvement	8	0.4	>= 2.5	>=3.5	6.9	6.8	NA	--	--	--	--	--	--
2.6	2.6f1	325	10	15	no improvement	10	0.6	>=3.5	>=3.5	3.2	3.2	NA	--	--	--	--	--	--
2.7	2.7a1	497	27	30	full improvement from original build-out analysis	30	0.7	>=3.5	>=3.5	3.6	3.5	27	>0.8	>=3.5	>=3.5	<4	>3	d/D
2.7	2.7a2	492	27	30	full improvement from original build-out analysis	30	0.7	>=3.5	>=3.5	3.4	3.1	27	>0.9	>=3.5	>=3.5	<4	>3	d/D
2.8	2.8a1	305	8	24	no improvement	8	0.5	>=3.5	>=3.5	1.9	1.5	NA	--	--	--	--	--	--
2.8	2.8b1	164	21	24	full improvement from original build-out analysis	24	0.7	>=3.5	>=3.5	3.3	3.2	21	>0.8	>2.5	>2.5	<10	>2	d/D
2.8	2.8b2	452	21	24	additional improvement from original build-out analysis	27	0.8	>=3.5	>=3.5	2.9	2.7	24	>1	>=3.5	>=3.5	<4	>2	d/D
2.8	2.8b3	261	21	24	no improvement	21	0.8	>=3.5	>=3.5	3.5	3.4	NA	--	--	--	--	--	--
2.8	2.8c1	954	21	27	full improvement from original build-out analysis	27	0.7	>=3.5	>=3.5	2.9	2.7	24	>0.9	>=3.5	>=3.5	<3	>2	d/D
2.8	2.8c2	300	21	27	full improvement from original build-out analysis	27	0.6	>=3.5	>=3.5	2.8	2.7	24	>0.7	>=3.5	>=3.5	<3	>2	improvement required for upstream segment 2.8c1
2.8	2.8c3	352	21	27	full improvement from original build-out analysis	27	0.8	>=3.5	>=3.5	3.0	3.0	24	>1	>=3.5	>=3.5	<3	>2	d/D

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
2.9	2.9a1	249	21	24	full improvement from original build-out analysis	24	0.7	>=3.5	>=3.5	2.9	2.8	21	>0.9	>=3.5	>=3.5	<4	>3	d/D
2.10	2.10a1	576	30	36	full improvement from original build-out analysis, assumes the West Side Interceptor is constructed	36	0.8	>=3.5	>=3.5	2.4	2.3	30	>1	>=3.5	>=3.5	<3	>2	d/D
2.10	2.10a2	162	30	36	full improvement from original build-out analysis, assumes the West Side Interceptor is constructed	36	0.6	>=3.5	>=3.5	2.5	2.5	30	>0.9	>=3.5	>=3.5	<3	>2	d/D
2.10	2.10a3	60	30	36	no improvement, assumes the West Side Interceptor is constructed	30	0.5	>=3.5	>=3.5	3.3	3.3	NA	--	--	--	--	--	--
2.11	2.11a1	294	10	15	reduced improvement, assumes the West Side Interceptor is constructed	12	0.2	>= 2.5	>= 2.5	1.2	1.2	10	<0.8	<0.5	>2.5	<10	>2	surcharge clearance
2.12	2.12a1	322	8	10	no improvement	8	0.8	>=3.5	>=3.5	2.9	2.5	NA	--	--	--	--	--	--
2.12	2.12a2	392	8	10	no improvement	8	0.8	>=3.5	>=3.5	2.8	2.5	NA	--	--	--	--	--	--
2.12	2.12a3	144	8	10	no improvement	8	0.8	>=3.5	>=3.5	2.9	2.5	NA	--	--	--	--	--	--
2.12	2.12a4	128	8	10	full improvement from original build-out analysis	10	0.5	>=3.5	>=3.5	2.6	2.4	8	>0.8	>=3.5	>=3.5	<3	>2	d/D
2.13	2.13a1	93	8	10	no improvement	8	0.8	>= 2.5	>= 2.5	2.9	2.6	NA	--	--	--	--	--	--
2.14	2.14a1	628	8	12	no improvement, assumes the Awbrey Glen Lift Station is decommissioned and North Interceptor is constructed	NA	--	--	--	--	--	NA	--	--	--	--	--	--
2.14	2.14a2	274	8	12		NA	--	--	--	--	--	NA	--	--	--	--	--	--
2.14	2.14a3	425	8	12		NA	--	--	--	--	--	NA	--	--	--	--	--	--
2.14	2.14a4	516	8	12		NA	--	--	--	--	--	NA	--	--	--	--	--	--

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
2.15	2.15a1	259	8	10	no improvement, assumes the Awbrey Glen Lift Station is decommissioned and North Interceptor is constructed	NA	--	--	--	--	--	NA	--	--	--	--	--	--
2.15	2.15a2	655	8	10		NA	--	--	--	--	--	NA	--	--	--	--	--	--
2.15	2.15b1	477	8	12		NA	--	--	--	--	--	NA	--	--	--	--	--	--
2.15	2.15c1	504	8	15		NA	--	--	--	--	--	NA	--	--	--	--	--	--
2.15	2.15d1	282	8	12		NA	--	--	--	--	--	NA	--	--	--	--	--	--
2.16	2.16a1	351	4	0	new improvement, not considered in original build-out analysis, forcemain	8	1.0	sealed manhole	>=3.5	5.1	5.1	6	>1	sealed manhole	>2.5	>6	>2	velocity
2.17	2.17a1	612	4	0	new improvement, not considered in original build-out analysis, reduced forcemain	6	1.0	sealed manhole	>=3.5	4.6	4.3	4	>1	sealed manhole	>=3.5	<11	>9	velocity
3.1	3.1a1	278	8	12	full improvement from original build-out analysis	12	0.7	>=3.5	>=3.5	2.2	2.1	10	>0.8	>2.5	>2.5	<10	>2	d/D
3.1	3.1a2	168	8	12	full improvement from original build-out analysis	12	0.8	>=3.5	>=3.5	2.0	2.0	10	>0.8	>2.5	>2.5	<10	>2	d/D
3.2	3.2a1	143	8	10	full improvement from original build-out analysis	10	0.5	>=3.5	>=3.5	2.8	2.5	8	>0.8	>=3.5	>=3.5	<4	>2	d/D
3.2	3.2a2	330	8	10	full improvement from original build-out analysis	10	0.5	>=3.5	>=3.5	2.9	2.6	8	>0.9	>=3.5	>=3.5	<4	>2	d/D
3.2	3.2b1	167	8	10	full improvement from original build-out analysis	10	0.7	>=3.5	>=3.5	2.7	2.4	8	>1	>= 2.5	>=3.5	<4	>2	d/D
3.2	3.2c1	504	8	15	full improvement from original build-out analysis	15	0.4	>= 2.5	>=0.5, shallow manhole	2.2	2.0	12	<0.8	<2.5	<1.5	<10	>2	surcharge clearance
3.3	3.3a1	288	8	10	full improvement from original build-out analysis	10	0.7	>=3.5	>=3.5	6.6	6.3	8	>1	>= 2.5	>=3.5	<8	>6	d/D
3.3	3.3a2	207	8	10	no improvement	8	0.8	>=3.5	>=3.5	8.9	8.7	NA	--	--	--	--	--	--
3.3	3.3a3	108	8	10	full improvement from original build-out analysis	10	0.5	>=3.5	>=3.5	8.0	7.9	8	>0.8	>=3.5	>=3.5	<9	>7	d/D

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

						Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						
Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	Controlling Criteria for Improvement
3.3	3.3a4	230	8	10	full improvement from original build-out analysis	10	0.5	>=3.5	>=3.5	8.7	8.3	8	>0.8	>=3.5	>=3.5	<9	>7	d/D
3.3	3.3a5	157	8	10	full improvement from original build-out analysis	10	0.5	>=3.5	>=3.5	8.7	8.3	8	>0.8	>=3.5	>=3.5	<9	>8	d/D
3.3	3.3a6	52	8	10	no improvement	8	0.7	>=3.5	>=3.5	7.9	7.8	NA	--	--	--	--	--	--
3.3	3.3a7	99	8	10	no improvement	8	0.7	>=3.5	>=3.5	8.0	7.8	NA	--	--	--	--	--	--
3.3	3.3b1	660	10	15	full improvement from original build-out analysis	15	0.4	>=1.5, shallow manhole	>=1.5, shallow manhole	4.6	3.8	12	<0.8	<0.5	<0.5	<10	>2	surcharge clearance
3.3	3.3c1	333	10	12	full improvement from original build-out analysis	12	0.6	>=3.5	>=1.5, shallow manhole	5.3	5.1	10	>1	>=3.5	>=1.5	<6	>5	d/D
3.3	3.3d1	256	8	15	full improvement from original build-out analysis	15	0.6	>= 2.5	>=3.5	3.4	3.2	12	>1	>= 2.5	>=3.5	<4	>3	d/D
3.3	3.3d2	108	8	15	reduced improvement	12	0.8	>= 2.5	>= 2.5	4.3	4.2	10	>0.8	<2.5	>2.5	<10	>2	d/D, surcharge clearance
3.3	3.3e1	903	10	15	full improvement from original build-out analysis	15	0.7	>=3.5	>=3.5	3.5	3.2	12	>0.8	>2.5	<2.5	<10	>2	d/D, surcharge clearance
3.3	3.3e2	676	10	15	full improvement from original build-out analysis	15	0.7	>=3.5	>=3.5	3.4	3.3	12	>0.8	>2.5	>2.5	<10	>2	d/D
3.3	3.3f1	663	10	15	full improvement from original build-out analysis	15	0.6	>=1.5, shallow manhole	>=3.5	4.3	3.7	12	>1	>=1.5	>=3.5	<5	>3	d/D
3.3	3.3g1	360	10	15	full improvement from original build-out analysis	15	0.6	>=3.5	>=3.5	3.9	3.5	12	>0.9	>=3.5	>=3.5	<4	>3	d/D
3.3	3.3g2	652	10	15	full improvement from original build-out analysis	15	0.6	>=1.5, shallow manhole	>=1.5, shallow manhole	4.1	3.7	12	>1	>=1.5	>=1.5	<5	>3	d/D
3.3	3.3h1	624	10	12	no improvement	10	0.7	>=3.5	>=3.5	7.4	6.9	NA	--	--	--	--	--	--
3.3	3.3h2	312	10	12	full improvement from original build-out analysis	12	0.6	>=3.5	>=3.5	6.0	5.8	10	>0.9	>=3.5	>=3.5	<6	>5	d/D
3.4	3.4a1	352	15	18	no improvement	15	0.6	>=3.5	>=3.5	3.0	2.6	NA	--	--	--	--	--	--
3.5	3.5a1	110	8	12	no improvement	8	0.3	>=3.5	>=3.5	2.9	2.7	NA	--	--	--	--	--	--
3.5	3.5b1	347	8	12	no improvement	8	0.7	>=3.5	>=3.5	2.6	2.6	NA	--	--	--	--	--	--

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
3.6	3.6a1	325	8	10	no improvement	8	0.8	>=3.5	>=3.5	3.9	3.9	NA	--	--	--	--	--	--
3.6	3.6a2	108	8	10	full improvement from original build-out analysis	10	0.6	>=3.5	>=3.5	3.3	3.2	8	>1	>=3.5	>=3.5	<4	>3	d/D
3.6	3.6a3	47	8	10	no improvement	8	0.8	>=3.5	>=3.5	4.0	3.9	NA	--	--	--	--	--	--
3.6	3.6a4	316	8	10	no improvement	8	0.8	>=3.5	>=3.5	3.9	3.9	NA	--	--	--	--	--	--
3.7	3.7a1	185	8	10	no improvement	8	0.6	>=3.5	>=3.5	5.9	5.9	NA	--	--	--	--	--	--
3.8	3.8a1	143	6	8	no improvement	6	0.7	>=3.5	>=3.5	2.0	1.7	NA	--	--	--	--	--	--
3.9	3.9a1	258	6	0	new improvement, not considered in original build-out analysis, forcemain	8	1.0	sealed manhole	sealed manhole	4.1	3.1	6	>1	sealed manhole	sealed manhole	<13	>9	velocity
3.10	3.10a1	1,846	6	0	new improvement, not considered in original build-out analysis, reduced forcemain	8	1.0	sealed manhole	>=3.5	5.9	4.9	6	>1	sealed manhole	>=3.5	<11	>10	velocity
5.1	5.1a1	425	24	30	no improvement	24	0.4	>=3.5	>=3.5	8.0	6.9	NA	--	--	--	--	--	--
5.2	5.2a1	63	12	15	no improvement	12	0.3	>=3.5	>=3.5	4.9	2.9	NA	--	--	--	--	--	--
5.2	5.2a2	189	12	15	no improvement	12	0.8	>=3.5	>=3.5	2.8	2.5	NA	--	--	--	--	--	--
5.2	5.2a3	86	12	15	no improvement	12	0.8	>=3.5	>=3.5	2.7	2.4	NA	--	--	--	--	--	--
5.2	5.2a4	1,107	12	15	full improvement from original build-out analysis	15	0.5	>=3.5	>=3.5	2.6	2.3	12	>0.9	>=3.5	>=3.5	<3	>2	d/D
5.2	5.2a5	486	12	15	full improvement from original build-out analysis	15	0.5	>=3.5	>=3.5	2.8	2.5	12	>0.9	>=3.5	>=3.5	<4	>2	d/D
5.2	5.2b1	484	12	15	full improvement from original build-out analysis	15	0.6	>=3.5	>=3.5	2.7	2.4	12	>1	>=3.5	>=3.5	<3	>2	d/D
5.2	5.2b2	167	12	15	full improvement from original build-out analysis	15	0.6	>=3.5	>=3.5	2.8	2.6	12	>1	>=3.5	>=3.5	<4	>2	d/D
5.3	5.3a1	3,586	6	10	additional improvement from original build-out analysis, reduced forcemain	12	0.8	sealed manhole	<0.5	4.8	3.7	10	>1	sealed manhole	<0.5	>6	<2	d/D, velocity

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
5.4	5.4a1	955	8	12	reduced improvement	10	0.8	>= 2.5	>= 2.5	2.9	2.1	8	>0.8	<1.5	<1.5	<10	>2	d/D, surcharge clearance
5.4	5.4b1	268	8	12	reduced improvement	10	0.8	>=3.5	>=3.5	3.1	2.0	8	>0.8	>2.5	>2.5	<10	>2	d/D
5.4	5.4c1	494	12	15	no improvement	12	0.6	>=3.5	>=3.5	3.5	2.7	NA	--	--	--	--	--	--
5.5	5.5a1	15	15	18	no improvement	15	0.5	>=3.5	>=3.5	2.3	2.1	NA	--	--	--	--	--	--
5.6	5.6a1	351	21	24	no improvement	21	0.6	>=3.5	>=3.5	2.3	2.0	NA	--	--	--	--	--	--
5.7	5.7a1	3,931	4	0	new improvement, not considered in original build-out analysis, forcemain	8	1.0	sealed manhole	sealed manhole	2.5	1.6	6	>1	sealed manhole	sealed manhole	>6	>5	velocity
5.8	5.8a1	683	8	0	new improvement, not considered in original build-out analysis	10	0.7	>= 2.5	>= 2.5	2.6	2.3	8	>0.8	>= 2.5	>= 2.5	<3	>2	d/D
5.8	5.8a2	304	8	0	new improvement, not considered in original build-out analysis	10	0.7	>=3.5	>=3.5	2.3	2.2	8	>0.8	>=3.5	>=3.5	<3	>2	d/D
5.9	5.9a1	1,566	8	0	new improvement, not considered in original build-out analysis, forcemain	10	1.0	sealed manhole	sealed manhole	5.3	5.3	8	>0.8	sealed manhole	sealed manhole	>6	>4	velocity
6.1	6.1a1	95	8	12	full improvement from original build-out analysis	12	0.7	>=3.5	>=3.5	2.9	2.6	10	>1	>=3.5	>=3.5	<4	>2	d/D
6.2	6.2a1	734	12	15	additional improvement from original build-out analysis	18	0.6	>=1.5, shallow manhole	>= 2.5	1.7	1.4	15	>1	>=1.5	>= 2.5	<2	>1	d/D
6.2	6.2a2	439	12	15	additional improvement from original build-out analysis	18	0.7	>=3.5	>=3.5	1.9	1.7	15	>1	>=3.5	>=3.5	<2	>1	d/D
6.2	6.2a3	623	12	15	full improvement from original build-out analysis	15	0.5	>=3.5	>=3.5	2.5	2.2	12	<0.8	>2.5	>2.5	<10	>2	improvement required for downstream segments 6.2a1, 6.2a2, & 6.2b1

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
6.2	6.2a4	230	12	15	full improvement from original build-out analysis	15	0.5	>=3.5	>=3.5	2.5	2.3	12	<0.8	>2.5	>2.5	<10	>2	improvement required for downstream segments 6.2a1, 6.2a2, & 6.2b1
6.2	6.2a5	209	12	15	full improvement from original build-out analysis	15	0.5	>=3.5	>=3.5	2.4	2.2	12	<0.8	>2.5	>2.5	<10	>2	
6.2	6.2b1	195	15	15	additional improvement from original build-out analysis	18	0.5	>=3.5	>=3.5	1.9	1.5	15	>0.8	>=3.5	>=3.5	<3	>1	d/D
6.3	6.3a1	499	12	0	new improvement, not considered in original build-out analysis	15	0.5	>=3.5	>=3.5	2.2	1.9	12	>0.9	>=3.5	>=3.5	<3	>2	d/D
6.3	6.3a2	544	12	0	new improvement, not considered in original build-out analysis	15	0.6	>=3.5	>=1.5, shallow manhole	2.5	2.3	12	>1	>=3.5	<0.5	<3	>2	d/D, surcharge clearance
6.4	6.4a1	470	15	0	new improvement, not considered in original build-out analysis	18	0.2	>=3.5	>=3.5	4.3	3.5	15	>0.3	<0.5	>=3.5	<5	>3	surcharge clearance
6.5	6.5a1	557	6	0	new improvement, not considered in original build-out analysis, forcemain	8	1.0	sealed manhole	>= 2.5	5.1	5.1	6	>1	sealed manhole	>= 2.5	>6	>6	velocity
8.1	8.1a1	533	8	12	full improvement from original build-out analysis	12	0.5	>=1.5, shallow manhole	>=3.5	3.6	2.9	10	>0.8	<2.5	<2.5	<10	>2	d/D, surcharge clearance
8.1	8.1a2	237	10	0	new improvement, not considered in original build-out analysis	12	0.2	>=3.5	>=3.5	4.4	4.4	10	>0.3	>=3.5	< 2.5	<6	>4	surcharge clearance
8.1	8.1b1	462	10	12	additional improvement from original build-out analysis	15	0.4	>=3.5	>=3.5	2.7	2.6	12	>0.6	<0.5	>=3.5	<3	>2	surcharge clearance
8.1	8.1b2	500	10	12	full improvement from original build-out analysis	12	0.5	>=3.5	>=3.5	3.3	2.8	10	<0.8	<2.5	<0.5	<10	>2	surcharge clearance
8.1	8.1c1	494	8	12	full improvement from original build-out analysis	12	0.7	>=3.5	>= 2.5	3.5	2.7	10	>0.8	<2.5	<2.5	<10	>2	d/D, surcharge clearance

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
8.1	8.1c2	1,666	12	0	new improvement, not considered in original build-out analysis	15	0.4	>= 2.5	>=3.5	3.9	2.7	12	>0.7	<0.5	<0.5	<5	>2	surcharge clearance
8.2	8.2a1	248	12	15	full improvement from original build-out analysis	15	0.6	>=3.5	>=3.5	2.8	2.5	12	>0.8	>2.5	>2.5	<10	>2	d/D
8.2	8.2a2	927	12	15	additional improvement from original build-out analysis	18	0.4	>= 2.5	>= 2.5	3.3	2.5	15	>0.6	<0.5	<0.5	<3	>2	surcharge clearance
8.2	8.2a3	566	12	15	full improvement from original build-out analysis	15	0.7	>=3.5	>=3.5	3.1	2.6	12	>0.8	>2.5	>2.5	<10	>2	d/D
8.2	8.2a4	360	12	0	new improvement, not considered in original build-out analysis	15	0.2	>=1.5, shallow manhole	>= 2.5	5.0	4.5	12	>0.4	<0.5	<0.5	<5	>4	surcharge clearance
8.2	8.2b1	80	15	18	no improvement	15	0.4	>=3.5	>=3.5	4.1	3.7	NA	--	--	--	--	--	--
8.2	8.2c1	1,496	12	18	full improvement from original build-out analysis	18	0.5	>=1.5, shallow manhole	>=1.5, shallow manhole	3.8	2.8	15	>0.8	<0.5	<0.5	<4	>2	d/D, surcharge clearance
8.2	8.2d1	443	12	18	reduced improvement	15	0.8	>=3.5	>=3.5	3.5	2.8	12	>1	>=3.5	>=3.5	<5	>3	d/D
8.2	8.2d2	494	12	18	reduced improvement	15	0.8	>=3.5	>=3.5	3.1	2.5	12	>1	>=3.5	>=3.5	<5	>2	d/D
8.2	8.2e1	208	12	15	no improvement	12	0.2	>=3.5	>=3.5	9.4	9.2	NA	--	--	--	--	--	--
8.3	8.3a1	589	8	10	full improvement from original build-out analysis	10	0.5	>=3.5	>=3.5	3.0	2.6	8	>0.9	>=3.5	>=3.5	<4	>2	d/D
8.3	8.3a2	51	8	10	no improvement	8	0.7	>=3.5	>=3.5	3.1	2.8	NA	--	--	--	--	--	--
8.4	8.4a1	149	12	15	full improvement from original build-out analysis	15	0.6	>=3.5	>=3.5	3.2	2.8	12	>1	>=3.5	>=3.5	<4	>2	d/D
8.4	8.4a2	217	12	15	full improvement from original build-out analysis	15	0.6	>=3.5	>=3.5	3.0	2.6	12	>1	>=3.5	>=3.5	<4	>2	d/D
8.4	8.4a3	210	12	15	no improvement	12	0.8	>=3.5	>=3.5	3.1	2.8	NA	--	--	--	--	--	--
8.4	8.4b1	161	12	15	full improvement from original build-out analysis	15	0.5	>=3.5	>=3.5	3.1	2.8	12	>0.8	>=3.5	>=3.5	<4	>2	d/D

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
8.5	8.5a1	212	10	12	no improvement, assumes upgrades to Old Mill Lift Station are implemented	10	0.7	>=3.5	>=3.5	4.0	2.5	NA	--	--	--	--	--	--
8.6	8.6a1	268	8	10	no improvement	8	0.6	>=3.5	>=3.5	2.2	1.9	NA	--	--	--	--	--	--
8.6	8.6a2	259	8	10	no improvement	8	0.5	>=3.5	>=3.5	2.1	1.9	NA	--	--	--	--	--	--
8.7	8.7a1	522	8	10	full improvement from original build-out analysis, assumes some flows are re-directed through the Southeast Interceptor	10	0.5	>=3.5	>=3.5	3.1	2.4	8	>0.9	<1.5	< 1.5	<5	>2	d/D, surcharge clearance
8.8	8.8a1	412	8	0	new improvement, not considered in original build-out analysis	10	0.4	>= 2.5	>=3.5	2.5	1.2	8	>0.7	<0.5	<2.5	<4	>1	surcharge clearance
8.9	8.9a1	487	8	0	new improvement, not considered in original build-out analysis	10	0.3	>=3.5	>=3.5	3.7	1.8	8	>0.5	<1.5	< 1.5	<5	>1	surcharge clearance
8.10	8.10a1	38	10	0	new improvement, not considered in original build-out analysis	12	0.6	>=3.5	>=3.5	2.1	1.8	10	>0.9	>=3.5	>=3.5	<3	>1	d/D
9.1	9.1a1	314	8	10	no improvement, assumes some flows are re-directed through the Southeast Interceptor	8	0.5	>=3.5	>=3.5	2.6	2.2	NA	--	--	--	--	--	--
9.1	9.1a2	305	8	10		8	0.5	>=3.5	>=3.5	2.7	2.2	NA	--	--	--	--	--	--
9.1	9.1a3	84	8	10		8	0.3	>=3.5	>=3.5	1.6	0.7	NA	--	--	--	--	--	--
9.1	9.1b1	268	10	12	full improvement from original build-out analysis	12	0.4	>=3.5	>=3.5	2.3	1.9	10	>0.5	<0.5	<0.5	<3	>1	surcharge clearance
9.2	9.2a1	136	8	10	full improvement from original build-out analysis	10	0.4	>=3.5	>=3.5	5.5	4.4	8	>0.7	<0.5	>= 2.5	<8	>4	surcharge clearance
9.3	9.3a1	415	12	15	full improvement from original build-out analysis	15	0.3	>=3.5	>=3.5	3.3	2.1	12	<0.8	>2.5	>2.5	<10	>2	improvement required for downstream segments 9.3c1, c2, c3, & c4

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
9.3	9.3a2	382	12	15	full improvement from original build-out analysis	15	0.3	>=3.5	>=3.5	3.7	2.9	12	<0.8	>2.5	>2.5	<10	>2	improvement required for downstream segments 9.3c1, c2, c3, & c4
9.3	9.3a3	244	12	0	new improvement, not considered in original build-out analysis	15	0.3	>=3.5	>=3.5	3.9	3.0	12	<0.8	>2.5	>2.5	<10	>2	
9.3	9.3b1	18	8	15	full improvement from original build-out analysis	15	0.2	>=3.5	>=3.5	4.4	3.4	12	<0.8	>2.5	>2.5	<10	>2	
9.3	9.3c1	627	12	15	full improvement from original build-out analysis	15	0.5	>=1.5, shallow manhole	>=1.5, shallow manhole	3.5	2.2	12	<0.8	>2.5	>2.5	<10	>2	
9.3	9.3c2	975	12	15	full improvement from original build-out analysis	15	0.5	>=3.5	>=3.5	3.2	2.3	12	>0.8	>=3.5	>=3.5	<4	>2	d/D
9.3	9.3c3	885	12	15	full improvement from original build-out analysis	15	0.5	>=3.5	>=3.5	3.2	2.4	12	>0.8	>=3.5	>=3.5	<4	>2	d/D
9.3	9.3c4	635	12	15	full improvement from original build-out analysis	15	0.5	>=3.5	>=3.5	3.5	2.4	12	>0.8	< 2.5	< 2.5	<4	>2	d/D
9.4	9.4a1	2,918	8	10	full improvement from original build-out analysis	10	0.6	>= 2.5	>=1.5, shallow manhole	3.8	2.3	8	>1	<0.5	<0.5	<4	>2	d/D, surcharge clearance
9.4	9.4a2	1,348	8	10	full improvement from original build-out analysis	10	0.7	>=3.5	>=3.5	3.0	2.1	8	>1	< 1.5	<0.5	<4	>1	d/D, surcharge clearance
9.4	9.4a3	2,057	8	10	no improvement	8	0.6	>=3.5	>=3.5	2.7	2.1	NA	--	--	--	--	--	--
9.4	9.4a4	211	8	10	no improvement	8	0.6	>=3.5	>=3.5	3.0	2.5	NA	--	--	--	--	--	--
9.4	9.4b1	313	8	12	reduced improvement	10	0.6	>= 2.5	>= 2.5	2.9	2.3	8	>1	< 2.5	>=3.5	<4	>2	d/D, surcharge clearance
9.4	9.4c1	97	8	10	no improvement	8	0.7	>= 2.5	>=1.5, shallow manhole	5.7	3.8	NA	--	--	--	--	--	--
9.4	9.4d1	1,020	10	12	no improvement	10	0.7	>= 2.5	>= 2.5	3.8	2.6	NA	--	--	--	--	--	--
9.5	9.5a1	172	15	18	no improvement	15	0.7	>=3.5	>=3.5	4.1	3.7	NA	--	--	--	--	--	--
9.5	9.5a2	125	15	18	no improvement	15	0.7	>=3.5	>=3.5	3.4	3.1	NA	--	--	--	--	--	--
9.5	9.5b1	100	15	18	no improvement	15	0.5	>= 2.5	>=3.5	3.7	3.2	NA	--	--	--	--	--	--
9.6	9.6a1	538	10	12	full improvement from original build-out analysis	12	0.6	>=3.5	>=3.5	2.9	2.0	10	>0.9	>=3.5	>=3.5	<4	>2	d/D

Table 16a. Full Build-out Gravity and Forcemain Improvement Results and Comparison to Design Criteria

Project ID	Project ID (specific) *first number in ID indicates study area	Length (ft)	Existing Diameter (in)	Original Build-out Diameter (in)	Category (mod from original build-out to full BO)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size (not applicable to improvements which have been eliminated)						Controlling Criteria for Improvement
						Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
9.7	9.7a1	515	8	10	no improvement	8	0.7	>= 2.5	>= 2.5	1.5	1.3	NA	--	--	--	--	--	--
9.8	9.8a1	281	12	15	no improvement	12	0.7	>=3.5	>= 2.5	2.7	2.2	NA	--	--	--	--	--	--
9.8	9.8a2	78	12	15	full improvement from original build-out analysis	15	0.9	>=3.5	>=3.5	1.9	1.9	12	>1	>=3.5	>=3.5	<3	>2	minimal slopes; additional size upgrades to meet d/D criteria would have decreased scouring velocities significantly
9.8	9.8b1	515	12	18	full improvement from original build-out analysis	18	1.0	>= 2.5	>=3.5	1.9	1.5	15	>1	>= 2.5	>= 2.5	<2	>1	
9.8	9.8c1	334	12	15	full improvement from original build-out analysis	15	0.5	>=3.5	>=3.5	2.3	2.3	12	>0.8	>=3.5	>=3.5	<3	>2	d/D

NOTES FOR TABLE 16A

Note 1. The cleansing velocity criteria of 2 ft/sec was ignored if an improvement was not required. For some improvements, multiple criteria conflicted such that an improvement satisfied one criteria, but caused a deficiency in another criteria. For these improvements, the priority of the criteria was established as (1) d/D, (2) surcharging clearance, (3) maximum velocity, (4) cleansing velocity.

Table 16b. Full Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	Full BO CIP Dia. (in)	Category (mod from Original Build-out to Full BO)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	Full BO Materials ($/ft)	Full BO Installation ($/ft)	Full BO Bypass Pumping ($/ft)	Full BO Depth Range (ft)[3]	Full BO Manhole Dia.	Full BO Manhole ($/each)	Full BO Reconnect Fee ($/each)	Full BO Restore Fee ($/ft)	Full BO Easement, Crossing, Etc. ($)	Full BO Subtotal ($)	Full BO Engr/Legal Admin@35-40% ($)	Full BO Contingency @30% ($)	Full BO Build-out Total ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Revised Original Build-out Total[3] ($)	Original Build-out Total ($)
2.1	2.1a1	10	12	full improvement from original build-out analysis	446	1	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	7,600	58,500	20,500	23,700	102,500	87%	89,000	102,500	102,500
2.1	2.1a2	10	12	full improvement from original build-out analysis	189	1	12.75	90.00	11.60	10-15	48	4,990	1,000	7.35	3,200	32,200	11,300	13,100	56,500	87%	49,000	56,500	48,000
2.1	2.1a3	10	15	additional improvement from original build-out analysis	128	0	18.80	120.00	11.60	15-20	48	6,740	1,000	7.88	2,200	22,500	7,900	9,100	39,500	87%	34,500	37,000	27,000
2.1	2.1a4	10	10	no improvement	12	0	0.00	0.00	0.00	15-20	0	0	0	0.00	0	0	0	0	0	0%	0	3,500	2,500
2.1	2.1b1	8	10	reduced improvement	464	1	8.85	113.00	11.60	15-20	48	6,740	1,000	7.35	8,900	81,900	28,700	33,200	144,000	88%	126,500	148,500	108,000
2.1	2.1c1	8	10	full improvement from original build-out analysis	863	3	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	15,400	113,700	39,800	46,100	199,500	88%	175,000	199,500	199,500
2.1	2.1c2	8	8	no improvement	1,749	3	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	379,500	379,500
2.1	2.1c3	8	10	full improvement from original build-out analysis	280	1	8.85	88.00	11.60	10-15	48	4,990	1,000	7.35	5,000	43,400	15,200	17,600	76,000	88%	66,500	76,000	65,000
2.2	2.2a1	12	15	full improvement from original build-out analysis	310	1	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	4,400	44,700	15,700	18,100	78,500	55%	43,000	78,500	78,500
2.2	2.2b1	10	15	additional improvement from original build-out analysis	450	1	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	8,500	65,000	22,700	26,300	114,000	54%	61,500	105,000	105,000
2.3	2.3a1	8	12	full improvement from original build-out analysis	425	1	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	7,700	56,400	19,800	22,900	99,000	58%	57,000	99,000	99,000
2.4	2.4a1	8	10	full improvement from original build-out analysis	252	1	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	2,700	32,000	11,200	13,000	56,000	95%	53,000	56,000	56,000
2.5	2.5a1	8	12	reduced improvement	232	1	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	2,100	30,800	10,800	12,500	54,000	92%	50,000	59,000	59,000
2.5	2.5b1	8	10	full improvement from original build-out analysis	244	1	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	2,500	31,000	10,800	12,500	54,500	92%	50,000	54,500	54,500
2.5	2.5c1	8	10	reduced improvement	52	0	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	1,500	6,600	2,300	2,700	11,500	92%	10,500	12,000	12,000
2.5	2.5d1	8	10	full improvement from original build-out analysis	1,182	3	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	20,500	150,000	52,500	60,700	263,000	92%	242,500	263,000	263,000
2.5	2.5e1	8	10	reduced improvement	767	2	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	13,000	97,300	34,100	39,400	171,000	88%	150,000	179,000	179,000
2.5	2.5f1	8	12	reduced improvement	392	1	12.75	90.00	11.60	10-15	48	4,990	1,000	7.35	6,800	60,500	21,200	24,500	106,000	88%	93,000	114,000	99,500
2.6	2.6a1	8	8	no improvement	305	1	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	80,000	68,000
2.6	2.6a2	8	8	no improvement	314	1	0.00	0.00	0.00	15-20	0	0	0	0.00	0	0	0	0	0	0%	0	99,000	70,000
2.6	2.6b1	8	8	no improvement	245	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	54,500	54,500

Table 16b. Full Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	Full BO CIP Dia. (in)	Category (mod from Original Build-out to Full BO)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	Full BO Materials ($/ft)	Full BO Installation ($/ft)	Full BO Bypass Pumping ($/ft)	Full BO Depth Range (ft)[3]	Full BO Manhole Dia.	Full BO Manhole ($/each)	Full BO Reconnect Fee ($/each)	Full BO Restore Fee ($/ft)	Full BO Easement, Crossing, Etc. ($)	Full BO Subtotal ($)	Full BO Engr/Legal Admin@35 -40% ($)	Full BO Contingency @30% ($)	Full BO Build-out Total ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Revised Original Build-out Total[3] ($)	Original Build-out Total ($)
2.6	2.6c1	8	8	no improvement	435	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	101,500	101,500
2.6	2.6d1	8	8	no improvement	156	0	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	34,500	34,500
2.6	2.6e1	8	8	no improvement	372	1	0.00	0.00	0.00	20-25	0	0	0	0.00	0	0	0	0	0	0%	0	145,000	99,500
2.6	2.6e2	8	8	no improvement	318	1	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	98,500	86,000
2.6	2.6f1	10	10	no improvement	325	1	0.00	0.00	0.00	15-20	0	0	0	0.00	0	0	0	0	0	0%	0	112,500	82,500
2.7	2.7a1	27	30	full improvement from original build-out analysis	497	1	40.00	215.00	14.50	20-25	60	15,845	1,000	12.60	10,900	168,000	58,800	68,000	295,000	76%	223,000	295,000	233,500
2.7	2.7a2	27	30	full improvement from original build-out analysis	492	1	40.00	205.00	14.50	15-20	60	13,345	1,000	12.60	10,800	159,000	55,700	64,400	279,000	75%	210,500	279,000	231,500
2.8	2.8a1	8	8	no improvement	305	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	103,500	103,500
2.8	2.8b1	21	24	full improvement from original build-out analysis	164	0	22.00	107.00	14.50	0-10	60	8,345	1,000	9.45	3,200	28,300	9,900	11,500	49,500	79%	39,000	49,500	49,500
2.8	2.8b2	21	27	additional improvement from original build-out analysis	452	1	35.00	135.00	14.50	0-10	60	8,345	1,000	11.00	8,800	106,500	37,300	43,200	187,000	79%	147,500	153,000	153,000
2.8	2.8b3	21	21	no improvement	261	1	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	108,000	95,500
2.8	2.8c1	21	27	full improvement from original build-out analysis	954	2	35.00	135.00	14.50	0-10	60	8,345	1,000	11.00	13,000	218,200	76,400	88,400	383,000	79%	302,000	383,000	383,000
2.8	2.8c2	21	27	full improvement from original build-out analysis	300	1	35.00	150.00	14.50	10-15	60	10,845	1,000	11.00	4,100	79,100	27,700	32,000	139,000	79%	109,000	139,000	126,500
2.8	2.8c3	21	27	full improvement from original build-out analysis	352	1	35.00	180.00	14.50	15-20	60	13,345	1,000	11.00	4,800	103,800	36,300	42,000	182,000	79%	143,000	182,000	145,500
2.9	2.9a1	21	24	full improvement from original build-out analysis	249	1	22.00	125.00	14.50	10-15	60	10,845	1,000	9.45	800	55,200	19,300	22,400	97,000	81%	79,000	97,000	84,500
2.10	2.10a1	30	36	full improvement from original build-out analysis, assumes the West Side Interceptor is constructed	576	2	46.00	235.00	14.50	15-20	60	13,345	1,000	14.18	30,000	237,100	83,000	96,000	416,000	76%	315,000	416,000	293,500
2.10	2.10a2	30	36	full improvement from original build-out analysis, assumes the West Side Interceptor is constructed	162	1	46.00	205.00	14.50	10-15	60	10,845	1,000	14.18	8,300	65,400	22,900	26,500	115,000	76%	87,000	115,000	89,500
2.10	2.10a3	30	30	no improvement, assumes the West Side Interceptor is constructed	60	0	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	32,000	27,000

Table 16b. Full Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	Full BO CIP Dia. (in)	Category (mod from Original Build-out to Full BO)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	Full BO Materials ($/ft)	Full BO Installation ($/ft)	Full BO Bypass Pumping ($/ft)	Full BO Depth Range (ft)[3]	Full BO Manhole Dia.	Full BO Manhole ($/each)	Full BO Reconnect Fee ($/each)	Full BO Restore Fee ($/ft)	Full BO Easement, Crossing, Etc. ($)	Full BO Subtotal ($)	Full BO Engr/Legal Admin@35 -40% ($)	Full BO Contingency @30% ($)	Full BO Build-out Total ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Revised Original Build-out Total[3] ($)	Original Build-out Total ($)
2.11	2.11a1	10	12	reduced improvement, assumes the West Side Interceptor is constructed	294	1	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	3,900	39,000	13,700	15,800	68,500	72%	49,000	74,500	74,500
2.12	2.12a1	8	8	no improvement	322	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	74,500	74,500
2.12	2.12a2	8	8	no improvement	392	1	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	103,500	89,000
2.12	2.12a3	8	8	no improvement	144	0	0.00	0.00	0.00	15-20	0	0	0	0.00	0	0	0	0	0	0%	0	40,500	29,500
2.12	2.12a4	8	10	full improvement from original build-out analysis	128	0	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	2,500	15,000	5,300	6,100	26,500	75%	20,000	26,500	26,500
2.13	2.13a1	8	8	no improvement	93	0	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	20,500	20,500
2.14	2.14a1	8	8	no improvement, assumes the Awbrey Glen Lift Station is decommissioned and North Interceptor is constructed; if the North Interceptor is not constructed the Original Build-out diameters at the Revised Original Build-out cost should be implemented	628	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	141,000	141,000
2.14	2.14a2	8	8		274	2	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	87,500	74,500
2.14	2.14a3	8	8		425	1	0.00	0.00	0.00	25-30	0	0	0	0.00	0	0	0	0	0	0%	0	174,000	98,000
2.14	2.14a4	8	8		516	1	0.00	0.00	0.00	25-30	0	0	0	0.00	0	0	0	0	0	0%	0	207,000	117,500
2.15	2.15a1	8	8		259	0	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	53,000	53,000
2.15	2.15a2	8	8		655	2	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	176,000	150,500
2.15	2.15b1	8	8		477	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	111,000	111,000
2.15	2.15c1	8	8		504	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	127,500	127,500
2.15	2.15d1	8	8		282	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	65,500	65,500
2.16	2.16a1	4	8	new improvement, not considered in original build-out analysis, forcemain	351	1	5.65	67.00	11.60	0-10	48	3,640	1,000	7.35	5,300	42,100	14,700	17,100	74,000	94%	69,500	0	0
2.17	2.17a1	4	6	new improvement, not considered in original build-out analysis, reduced forcemain	612	2	5.65	0.00	11.60	0-10	48	3,640	1,000	7.35	3,500	27,900	9,800	11,300	49,000	55%	27,000	0	0
3.1	3.1a1	8	12	full improvement from original build-out analysis	278	1	12.75	160.00	11.60	25-30	48	9,440	1,000	7.35	5,200	68,900	27,600	29,000	125,500	93%	116,500	125,500	70,500
3.1	3.1a2	8	12	full improvement from original build-out analysis	168	0	12.75	145.00	11.60	20-25	48	8,090	1,000	7.35	3,100	32,800	13,100	13,800	59,500	93%	55,500	59,500	37,500
3.2	3.2a1	8	10	full improvement from original build-out analysis	143	0	8.85	88.00	11.60	10-15	48	4,990	1,000	7.35	2,800	19,300	7,700	8,100	35,000	94%	33,000	35,000	30,500
3.2	3.2a2	8	10	full improvement from original build-out analysis	330	1	8.85	113.00	11.60	15-20	48	6,740	1,000	7.35	6,400	60,600	24,200	25,400	110,000	94%	104,000	110,000	79,000

Table 16b. Full Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	Full BO CIP Dia. (in)	Category (mod from Original Build-out to Full BO)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	Full BO Materials ($/ft)	Full BO Installation ($/ft)	Full BO Bypass Pumping ($/ft)	Full BO Depth Range (ft)[3]	Full BO Manhole Dia.	Full BO Manhole ($/each)	Full BO Reconnect Fee ($/each)	Full BO Restore Fee ($/ft)	Full BO Easement, Crossing, Etc. ($)	Full BO Subtotal ($)	Full BO Engr/Legal Admin@35 -40% ($)	Full BO Contingency @30% ($)	Full BO Build-out Total ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Revised Original Build-out Total[3] ($)	Original Build-out Total ($)
3.2	3.2b1	8	10	full improvement from original build-out analysis	167	0	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	4,900	21,200	8,500	8,900	38,500	92%	35,500	38,500	38,500
3.2	3.2c1	8	15	full improvement from original build-out analysis	504	1	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	10,000	72,800	29,100	30,600	132,500	90%	119,500	132,500	132,500
3.3	3.3a1	8	10	full improvement from original build-out analysis	288	1	8.85	88.00	11.60	10-15	48	4,990	1,000	7.35	4,900	44,200	17,700	18,600	80,500	86%	69,000	80,500	68,500
3.3	3.3a2	8	8	no improvement	207	1	0.00	0.00	0.00	20-25	0	0	0	0.00	0	0	0	0	0	0%	0	88,000	51,500
3.3	3.3a3	8	10	full improvement from original build-out analysis	108	0	8.85	160.00	11.60	25-30	48	9,440	1,000	7.35	1,800	22,100	8,800	9,300	40,000	86%	34,000	40,000	22,500
3.3	3.3a4	8	10	full improvement from original build-out analysis	230	1	8.85	145.00	11.60	20-25	48	8,090	1,000	7.35	3,900	52,700	21,100	22,100	96,000	86%	82,000	96,000	56,500
3.3	3.3a5	8	10	full improvement from original build-out analysis	157	0	8.85	113.00	11.60	15-20	48	6,740	1,000	7.35	2,700	24,800	9,900	10,400	45,000	86%	38,500	45,000	33,000
3.3	3.3a6	8	8	no improvement	52	0	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	12,500	11,000
3.3	3.3a7	8	8	no improvement	99	0	0.00	0.00	0.00	15-20	0	0	0	0.00	0	0	0	0	0	0%	0	28,500	20,500
3.3	3.3b1	10	15	full improvement from original build-out analysis	660	2	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	9,900	95,300	38,100	40,000	173,500	86%	149,000	173,500	173,500
3.3	3.3c1	10	12	full improvement from original build-out analysis	333	1	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	5,000	44,200	17,700	18,600	80,500	87%	70,000	80,500	80,500
3.3	3.3d1	8	15	full improvement from original build-out analysis	256	1	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	4,200	38,300	15,300	16,100	69,500	86%	60,000	70,000	70,000
3.3	3.3d2	8	12	reduced improvement	108	0	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	1,800	13,000	5,200	5,400	23,500	86%	20,000	26,000	26,000
3.3	3.3e1	10	15	full improvement from original build-out analysis	903	2	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	15,700	129,000	51,600	54,200	235,000	87%	203,500	235,000	235,000
3.3	3.3e2	10	15	full improvement from original build-out analysis	676	2	18.80	95.00	11.60	10-15	48	4,990	1,000	7.88	11,700	113,800	45,500	47,800	207,000	87%	179,000	207,000	180,000
3.3	3.3f1	10	15	full improvement from original build-out analysis	663	2	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	10,000	95,700	38,300	40,200	174,000	87%	151,000	174,000	174,000
3.3	3.3g1	10	15	full improvement from original build-out analysis	360	1	18.80	95.00	11.60	10-15	48	4,990	1,000	7.88	5,500	59,500	23,800	25,000	108,500	87%	94,000	108,500	94,000
3.3	3.3g2	10	15	full improvement from original build-out analysis	652	2	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	10,000	94,400	37,800	39,700	172,000	80%	137,000	172,000	172,000
3.3	3.3h1	10	10	no improvement	624	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	148,000	148,000
3.3	3.3h2	10	12	full improvement from original build-out analysis	312	1	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	6,000	43,000	17,200	18,100	78,500	80%	62,500	78,000	78,000

Table 16b. Full Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	Full BO CIP Dia. (in)	Category (mod from Original Build-out to Full BO)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	Full BO Materials ($/ft)	Full BO Installation ($/ft)	Full BO Bypass Pumping ($/ft)	Full BO Depth Range (ft)[3]	Full BO Manhole Dia.	Full BO Manhole ($/each)	Full BO Reconnect Fee ($/each)	Full BO Restore Fee ($/ft)	Full BO Easement, Crossing, Etc. ($)	Full BO Subtotal ($)	Full BO Engr/Legal Admin@35 -40% ($)	Full BO Contingency @30% ($)	Full BO Build-out Total ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Revised Original Build-out Total[3] ($)	Original Build-out Total ($)
3.4	3.4a1	15	15	no improvement	352	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	98,000	98,000
3.5	3.5a1	8	8	no improvement	110	0	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	30,000	26,500
3.5	3.5b1	8	8	no improvement	347	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	84,000	84,000
3.6	3.6a1	8	8	no improvement	325	1	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	89,500	76,500
3.6	3.6a2	8	10	full improvement from original build-out analysis	108	0	8.85	113.00	11.60	15-20	48	6,740	1,000	7.35	1,900	17,100	6,800	7,200	31,000	98%	30,500	31,000	22,500
3.6	3.6a3	8	8	no improvement	47	0	0.00	0.00	0.00	15-20	0	0	0	0.00	0	0	0	0	0	0%	0	13,500	10,000
3.6	3.6a4	8	8	no improvement	316	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	74,500	74,500
3.7	3.7a1	8	8	no improvement	185	0	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	42,500	42,500
3.8	3.8a1	6	6	no improvement	143	0	0.00	0.00	0.00	25-30	0	0	0	0.00	0	0	0	0	0	0%	0	55,500	31,500
3.9	3.9a1	6	8	new improvement, not considered in original build-out analysis, forcemain	258	1	5.65	67.00	11.60	0-10	48	3,640	1,000	7.35	4,100	32,400	11,300	13,100	57,000	67%	38,000	0	0
3.10	3.10a1	6	8	new improvement, not considered in original build-out analysis, reduced forcemain	1,846	5	5.65	67.00	11.60	0-10	48	3,640	1,000	7.35	27,900	220,200	77,100	89,200	386,500	86%	333,500	0	0
5.1	5.1a1	24	24	no improvement	425	1	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	239,000	178,000
5.2	5.2a1	12	12	no improvement	63	0	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	17,000	15,000
5.2	5.2a2	12	12	no improvement	189	1	0.00	0.00	0.00	15-20	0	0	0	0.00	0	0	0	0	0	0%	0	74,500	54,000
5.2	5.2a3	12	12	no improvement	86	0	0.00	0.00	0.00	20-25	0	0	0	0.00	0	0	0	0	0	0%	0	31,500	20,500
5.2	5.2a4	12	15	full improvement from original build-out analysis	1,107	3	18.80	120.00	11.60	15-20	48	6,740	1,000	7.88	18,900	217,300	86,900	91,300	395,500	53%	211,500	395,500	292,000
5.2	5.2a5	12	15	full improvement from original build-out analysis	486	1	18.80	95.00	11.60	10-15	48	4,990	1,000	7.88	8,300	79,100	31,600	33,200	144,000	53%	77,000	144,000	125,500
5.2	5.2b1	12	15	full improvement from original build-out analysis	484	2	18.80	95.00	11.60	10-15	48	4,990	1,000	7.88	7,200	83,700	33,500	35,100	152,500	53%	81,500	152,500	131,500
5.2	5.2b2	12	15	full improvement from original build-out analysis	167	0	18.80	120.00	11.60	15-20	48	6,740	1,000	7.88	2,500	28,900	11,600	12,100	52,500	56%	29,000	52,500	39,500
5.3	5.3a1	6	12	additional improvement from original build-out analysis, reduced forcemain	3,586	9	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	62,600	476,200	190,500	200,000	866,500	73%	633,000	828,000	828,000
5.4	5.4a1	8	10	reduced improvement	955	2	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	18,500	121,200	48,500	50,900	220,500	0%	0	231,000	231,000

Table 16b. Full Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	Full BO CIP Dia. (in)	Category (mod from Original Build-out to Full BO)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	Full BO Materials ($/ft)	Full BO Installation ($/ft)	Full BO Bypass Pumping ($/ft)	Full BO Depth Range (ft)[3]	Full BO Manhole Dia.	Full BO Manhole ($/each)	Full BO Reconnect Fee ($/each)	Full BO Restore Fee ($/ft)	Full BO Easement, Crossing, Etc. ($)	Full BO Subtotal ($)	Full BO Engr/Legal Admin@35 -40% ($)	Full BO Contingency @30% ($)	Full BO Build-out Total ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Revised Original Build-out Total[3] ($)	Original Build-out Total ($)
5.4	5.4b1	8	10	reduced improvement	268	1	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	3,200	34,000	13,600	14,300	62,000	0%	0	65,000	65,000
5.4	5.4c1	12	12	no improvement	494	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	130,000	130,000
5.5	5.5a1	15	15	no improvement	15	0	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	4,000	4,000
5.6	5.6a1	21	21	no improvement	351	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	124,000	124,000
5.7	5.7a1	4	8	new improvement, not considered in original build-out analysis, forcemain	3,931	1	5.65	67.00	11.60	0-10	48	3,640	1,000	7.35	52,900	417,600	146,200	169,100	733,000	39%	289,500	0	0
5.8	5.8a1	8	10	new improvement, not considered in original build-out analysis	683	1	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	10,400	81,800	28,600	33,100	143,500	0%	0	0	0
5.8	5.8a2	8	10	new improvement, not considered in original build-out analysis	304	1	8.85	88.00	11.60	10-15	48	4,990	1,000	7.35	6,000	47,200	16,500	19,100	83,000	0%	0	0	0
5.9	5.9a1	8	10	new improvement, not considered in original build-out analysis, forcemain	1,566	2	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	23,600	186,000	65,100	75,300	326,500	48%	156,500	0	0
6.1	6.1a1	8	12	full improvement from original build-out analysis	95	0	12.75	115.00	11.60	15-20	48	6,740	1,000	7.35	2,800	16,700	6,700	7,000	30,500	45%	13,500	30,500	23,000
6.2	6.2a1	12	18	additional improvement from original build-out analysis	734	3	17.00	87.00	11.60	0-10	48	3,640	1,000	8.40	12,200	117,200	46,900	49,200	213,500	55%	116,500	201,500	201,500
6.2	6.2a2	12	18	additional improvement from original build-out analysis	439	1	17.00	105.00	11.60	10-15	48	4,990	1,000	8.40	7,300	75,600	30,300	31,800	137,500	52%	71,500	130,500	114,000
6.2	6.2a3	12	15	full improvement from original build-out analysis	623	2	18.80	120.00	11.60	15-20	48	6,740	1,000	7.88	10,400	124,500	49,800	52,300	226,500	52%	117,500	226,500	166,500
6.2	6.2a4	12	15	full improvement from original build-out analysis	230	0	18.80	95.00	11.60	10-15	48	4,990	1,000	7.88	3,800	34,500	13,800	14,500	63,000	52%	32,500	63,000	55,000
6.2	6.2a5	12	15	full improvement from original build-out analysis	209	0	18.80	145.00	11.60	20-25	48	8,090	1,000	7.88	3,500	41,800	16,700	17,500	76,000	52%	39,500	76,000	50,000
6.2	6.2b1	15	18	additional improvement from original build-out analysis	195	0	17.00	105.00	11.60	10-15	48	4,990	1,000	8.40	5,700	33,400	13,300	14,000	60,500	0%	0	57,500	51,000
6.3	6.3a1	12	15	new improvement, not considered in original build-out analysis	499	1	18.80	95.00	11.60	10-15	48	4,990	1,000	7.88	10,500	83,000	29,100	33,600	145,500	52%	75,000	0	0

Table 16b. Full Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	Full BO CIP Dia. (in)	Category (mod from Original Build-out to Full BO)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	Full BO Materials ($/ft)	Full BO Installation ($/ft)	Full BO Bypass Pumping ($/ft)	Full BO Depth Range (ft)[3]	Full BO Manhole Dia.	Full BO Manhole ($/each)	Full BO Reconnect Fee ($/each)	Full BO Restore Fee ($/ft)	Full BO Easement, Crossing, Etc. ($)	Full BO Subtotal ($)	Full BO Engr/Legal Admin@35 -40% ($)	Full BO Contingency @30% ($)	Full BO Build-out Total ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Revised Original Build-out Total[3] ($)	Original Build-out Total ($)
6.3	6.3a2	12	15	new improvement, not considered in original build-out analysis	544	2	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	10,400	82,400	28,900	33,400	144,500	54%	78,000	0	0
6.4	6.4a1	15	18	new improvement, not considered in original build-out analysis	470	1	17.00	87.00	11.60	0-10	48	3,640	1,000	8.40	9,100	72,000	25,200	29,200	126,500	59%	75,000	0	0
6.5	6.5a1	6	8	new improvement, not considered in original build-out analysis, forcemain	557	1	5.65	67.00	11.60	0-10	48	3,640	1,000	7.35	8,100	63,700	22,300	25,800	112,000	51%	57,500	0	0
8.1	8.1a1	8	12	full improvement from original build-out analysis	533	1	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	10,900	70,800	24,800	28,700	124,500	72%	89,500	124,000	124,000
8.1	8.1a2	10	12	new improvement, not considered in original build-out analysis	237	6	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	7,600	60,000	21,000	24,300	105,500	77%	81,000	0	0
8.1	8.1b1	10	15	additional improvement from original build-out analysis	462	1	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	9,000	66,900	23,400	27,100	117,500	78%	92,000	108,000	108,000
8.1	8.1b2	10	12	full improvement from original build-out analysis	500	1	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	9,700	66,200	23,200	26,800	116,000	78%	90,500	116,000	116,000
8.1	8.1c1	8	12	full improvement from original build-out analysis	494	1	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	9,700	65,600	23,000	26,600	115,000	77%	88,000	115,000	115,000
8.1	8.1c2	12	15	new improvement, not considered in original build-out analysis	1,666	6	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	31,900	251,800	88,100	102,000	442,000	77%	342,500	0	0
8.2	8.2a1	12	15	full improvement from original build-out analysis	248	1	18.80	95.00	11.60	10-15	48	4,990	1,000	7.88	4,600	43,600	15,300	17,700	76,500	70%	54,000	76,500	66,500
8.2	8.2a2	12	18	additional improvement from original build-out analysis	927	2	17.00	87.00	11.60	0-10	48	3,640	1,000	8.40	17,100	141,300	49,500	57,200	248,000	73%	181,500	234,000	234,000
8.2	8.2a3	12	15	full improvement from original build-out analysis	566	1	18.80	120.00	11.60	15-20	48	6,740	1,000	7.88	10,400	107,800	37,700	43,600	189,000	72%	135,500	189,000	141,000
8.2	8.2a4	12	15	new improvement, not considered in original build-out analysis	360	1	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	6,700	52,800	18,500	21,400	92,500	73%	67,500	0	0
8.2	8.2b1	15	15	no improvement	80	0	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	21,500	21,500
8.2	8.2c1	12	18	full improvement from original build-out analysis	1,496	4	17.00	87.00	11.60	0-10	48	3,640	1,000	8.40	25,000	229,000	80,200	92,800	402,000	71%	285,000	402,000	402,000
8.2	8.2d1	12	15	reduced improvement	443	1	18.80	95.00	11.60	10-15	48	4,990	1,000	7.88	8,500	73,500	25,700	29,800	129,000	74%	95,500	136,000	119,500

Table 16b. Full Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	Full BO CIP Dia. (in)	Category (mod from Original Build-out to Full BO)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	Full BO Materials ($/ft)	Full BO Installation ($/ft)	Full BO Bypass Pumping ($/ft)	Full BO Depth Range (ft)[3]	Full BO Manhole Dia.	Full BO Manhole ($/each)	Full BO Reconnect Fee ($/each)	Full BO Restore Fee ($/ft)	Full BO Easement, Crossing, Etc. ($)	Full BO Subtotal ($)	Full BO Engr/Legal Admin@35-40% ($)	Full BO Contingency @30% ($)	Full BO Build-out Total ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Revised Original Build-out Total[3] ($)	Original Build-out Total ($)
8.2	8.2d2	12	15	reduced improvement	494	1	18.80	120.00	11.60	15-20	48	6,740	1,000	7.88	9,500	95,400	33,400	38,600	167,500	74%	124,000	175,000	132,500
8.2	8.2e1	12	12	no improvement	208	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	52,500	52,500
8.3	8.3a1	8	10	full improvement from original build-out analysis	589	2	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	8,600	75,500	26,400	30,600	132,500	99%	130,500	132,500	132,500
8.3	8.3a2	8	8	no improvement	51	0	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	10,000	10,000
8.4	8.4a1	12	15	full improvement from original build-out analysis	149	0	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	3,100	20,300	7,100	8,200	35,500	80%	28,500	35,500	35,500
8.4	8.4a2	12	15	full improvement from original build-out analysis	217	0	18.80	95.00	11.60	10-15	48	4,990	1,000	7.88	4,600	33,500	11,700	13,600	59,000	80%	47,500	59,000	52,000
8.4	8.4a3	12	12	no improvement	210	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	58,500	58,500
8.4	8.4b1	12	15	full improvement from original build-out analysis	161	0	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	4,700	23,200	8,100	9,400	40,500	80%	32,500	41,000	41,000
8.5	8.5a1	10	10	no improvement, assumes upgrades to Old Mill Lift Station are implemented	212	1	0.00	0.00	0.00	15-20	0	0	0	0.00	0	0	0	0	0	0%	0	73,000	51,500
8.6	8.6a1	8	8	no improvement	268	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	63,500	63,500
8.6	8.6a2	8	8	no improvement	259	0	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	62,000	53,500
8.7	8.7a1	8	10	full improvement from original build-out analysis, assumes some flows are re-directed through the Southeast Interceptor	522	1	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	10,600	66,200	23,200	26,800	116,000	23%	27,000	116,500	116,500
8.8	8.8a1	8	10	new improvement, not considered in original build-out analysis	412	1	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	6,500	51,500	18,000	20,800	90,500	76%	69,000	0	0
8.9	8.9a1	8	10	new improvement, not considered in original build-out analysis	487	1	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	7,600	59,800	20,900	24,200	105,000	93%	97,500	0	0
8.10	8.10a1	10	12	new improvement, not considered in original build-out analysis	38	1	12.75	90.00	11.60	10-15	48	4,990	1,000	7.35	1,500	12,200	4,300	4,900	21,500	68%	14,500	0	0

Table 16b. Full Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	Full BO CIP Dia. (in)	Category (mod from Original Build-out to Full BO)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	Full BO Materials ($/ft)	Full BO Installation ($/ft)	Full BO Bypass Pumping ($/ft)	Full BO Depth Range (ft)[3]	Full BO Manhole Dia.	Full BO Manhole ($/each)	Full BO Reconnect Fee ($/each)	Full BO Restore Fee ($/ft)	Full BO Easement, Crossing, Etc. ($)	Full BO Subtotal ($)	Full BO Engr/Legal Admin@35-40% ($)	Full BO Contingency @30% ($)	Full BO Build-out Total ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Revised Original Build-out Total[3] ($)	Original Build-out Total ($)
9.1	9.1a1	8	8	no improvement, assumes some flows are re-directed through the Southeast Interceptor	314	1	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	86,000	73,500
9.1	9.1a2	8	8		305	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	71,500	71,500
9.1	9.1a3	8	8		84	0	0.00	0.00	0.00	15-20	0	0	0	0.00	0	0	0	0	0	0%	0	24,000	17,500
9.1	9.1b1	10	12	full imprement from original build-out analysis	268	1	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	3,200	35,600	14,200	14,900	64,500	75%	48,500	65,000	65,000
9.2	9.2a1	8	10	full improvement from original build-out analysis	136	0	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	4,000	17,300	6,900	7,200	31,500	65%	20,500	31,500	31,500
9.3	9.3a1	12	15	full improvement from original build-out analysis	415	1	18.80	95.00	11.60	10-15	48	4,990	1,000	7.88	7,200	68,500	27,400	28,800	124,500	63%	78,000	125,000	108,500
9.3	9.3a2	12	15	full improvement from original build-out analysis	382	1	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	6,700	55,300	22,100	23,200	100,500	64%	64,000	100,500	100,500
9.3	9.3a3	12	15	new improvement, not considered in original build-out analysis	244	1	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	4,800	37,500	15,000	15,800	68,500	64%	43,500	0	0
9.3	9.3b1	8	15	full improvement from original build-out analysis	18	0	18.80	120.00	11.60	15-20	48	6,740	1,000	7.88	500	3,400	1,300	1,400	6,000	63%	4,000	6,000	4,500
9.3	9.3c1	12	15	full improvement from original build-out analysis	627	2	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	10,800	92,400	36,900	38,800	168,000	63%	106,000	168,000	168,000
9.3	9.3c2	12	15	full improvement from original build-out analysis	975	2	18.80	145.00	11.60	20-25	48	8,090	1,000	7.88	16,800	213,700	85,500	89,700	389,000	63%	246,000	389,000	252,000
9.3	9.3c3	12	15	full improvement from original build-out analysis	885	2	18.80	120.00	11.60	15-20	48	6,740	1,000	7.88	15,200	170,800	68,300	71,700	311,000	63%	196,500	311,000	230,500
9.3	9.3c4	12	15	full improvement from original build-out analysis	635	2	18.80	95.00	11.60	10-15	48	4,990	1,000	7.88	10,900	107,500	43,000	45,200	195,500	63%	124,000	195,500	170,000
9.4	9.4a1	8	10	full improvement from original build-out analysis	2,918	7	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	51,800	369,600	147,800	155,200	672,500	75%	505,500	672,500	672,500
9.4	9.4a2	8	10	full improvement from original build-out analysis	1,348	4	8.85	88.00	11.60	10-15	48	4,990	1,000	7.35	23,900	204,000	81,600	85,700	371,500	75%	279,500	371,000	317,000
9.4	9.4a3	8	8	no improvement	2,057	5	0.00	0.00	0.00	15-20	0	0	0	0.00	0	0	0	0	0	0%	0	664,000	475,000
9.4	9.4a4	8	8	no improvement	211	0	0.00	0.00	0.00	10-15	0	0	0	0.00	0	0	0	0	0	0%	0	51,500	44,500
9.4	9.4b1	8	10	reduced improvement	313	1	8.85	70.00	11.60	0-10	48	3,640	1,000	7.35	4,500	39,700	15,900	16,700	72,500	75%	54,500	75,500	75,500
9.4	9.4c1	8	8	no improvement	97	0	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	22,500	22,500
9.4	9.4d1	10	10	no improvement	1,020	3	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	246,500	246,500

Table 16b. Full Build-out Gravity and Forcemain Cost Specifics[1]

Proj ID	Project ID (specific)	Existing Dia. (in)	Full BO CIP Dia. (in)	Category (mod from Original Build-out to Full BO)	Length (ft)	Manholes (# @ 400 ft max spacing)[2]	Full BO Materials ($/ft)	Full BO Installation ($/ft)	Full BO Bypass Pumping ($/ft)	Full BO Depth Range (ft)[3]	Full BO Manhole Dia.	Full BO Manhole ($/each)	Full BO Reconnect Fee ($/each)	Full BO Restore Fee ($/ft)	Full BO Easement, Crossing, Etc. ($)	Full BO Subtotal ($)	Full BO Engr/Legal Admin@35 -40% ($)	Full BO Contingency @30% ($)	Full BO Build-out Total ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Revised Original Build-out Total[3] ($)	Original Build-out Total ($)
9.5	9.5a1	15	15	no improvement	172	1	0.00	0.00	0.00	25-30	0	0	0	0.00	0	0	0	0	0	0%	0	85,000	51,500
9.5	9.5a2	15	15	no improvement	125	0	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	31,500	31,500
9.5	9.5b1	15	15	no improvement	100	0	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	28,000	28,000
9.6	9.6a1	10	12	full improvement from original build-out analysis	538	1	12.75	72.00	11.60	0-10	48	3,640	1,000	7.35	11,000	71,400	28,600	30,000	130,000	69%	89,500	130,000	130,000
9.7	9.7a1	8	8	no improvement	515	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	103,000	103,000
9.8	9.8a1	12	12	no improvement	281	1	0.00	0.00	0.00	0-10	0	0	0	0.00	0	0	0	0	0	0%	0	75,500	75,500
9.8	9.8a2	12	15	full improvement from original build-out analysis	78	0	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	1,300	10,300	4,100	4,300	18,500	54%	10,000	18,500	18,500
9.8	9.8b1	12	18	full improvement from original build-out analysis	515	1	17.00	87.00	11.60	0-10	48	3,640	1,000	8.40	10,300	78,800	31,500	33,100	143,500	55%	79,500	143,500	143,500
9.8	9.8c1	12	15	full improvement from original build-out analysis	334	1	18.80	77.00	11.60	0-10	48	3,640	1,000	7.88	5,100	48,200	19,300	20,300	88,000	55%	49,000	88,000	88,000
TOTAL															1,075,000	9,495,000	3,537,000	3,910,000	16,942,000		11,714,000	19,520,000	17,314,000

NOTES FOR TABLE 16B

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the CSMP. Full build-out cost estimates are for improvements for population growth to 238,162 by year 2030 in 2005 dollars. The first number of each project ID indicates the study area where the improvement is located. For example project 2.1 is located in study area 2. Unit costs were taken directly from the CSMP and applied to the revised improvements.

NOTE 2. In the original CIP, the number of manholes for each improvement was calculated by dividing the total length of the improvement by a maximum 400 ft spacing. This method is adequate for new interceptor improvements; however, it may underestimate the number of manholes for gravity improvements in the existing system. The existing system manholes are often spaced at less than 400 ft to account for grade changes and alignment changes. To maintain consistency between the original build-out CIP and the full build-out CIP, the method for calculating the numbers of manholes was NOT modified for the full build-out CIP. The cost discrepancy from the underestimation of manhole numbers is expected to be less than 3% of the overall gravity and forcemain CIP cost.

NOTE 3. In the original CIP, all gravity improvement cost estimates used the unit costs for a 0-10 ft construction depth even though the CSMP stated that the same unit costs should be applied to both new improvements and replacement/upgrade improvements. The full build-out CIP utilizes all of the unit cost data for the gravity improvements with variation for construction depth. Because of the modified assumption, the cost differences between the original build-out CIP and the full build-out CIP are less exaggerated than if both CIPs had utilized the variation in construction depth. A "revised" original CIP cost applying variation in construction depth to the original improvements is presented in Table 16B to provide an appropriate comparison. The full build-out costs may be conservative since a replacement or upgrade improvement may require less excavation expense than a new improvement. It is recommended for future CIPs and master planning efforts that separate unit costs be developed for new improvements and upgrade/replacement improvements.

NOTE 4. The full build-out growth share is calculated from the existing dry weather peak flow to full build-out dry weather flow ratio at the location of the improvement (1-existing flow location specific/full build-out flow location specific).

Table 16c. Full Build-out Gravity and Forcemain Cost Summary[1]

Project ID *first number in ID indicates study area	Full Build-out Cost ($)	Full Build-out Growth Cost[2] ($)	Revised Original Build-out Cost[3] ($)	Original Build-out Total ($)
2.1	618,000	540,500	1,003,000	932,000
2.2	192,500	104,500	183,500	183,500
2.3	99,000	57,000	99,000	99,000
2.4	56,000	53,000	56,000	56,000
2.5	660,000	596,000	681,500	667,000
2.6	0	0	725,500	596,500
2.7	574,000	433,500	574,000	465,000
2.8	940,500	740,500	1,118,000	1,056,500
2.9	97,000	79,000	97,000	84,500
2.10	531,000	402,000	563,000	410,000
2.11	68,500	49,000	74,500	74,500
2.12	26,500	20,000	245,000	219,500
2.13	0	0	20,500	20,500
2.14	0	0	609,500	431,000
2.15	0	0	533,000	507,500
2.16	74,000	69,500	0	0
2.17	49,000	27,000	0	0
3.1	185,000	172,000	185,000	108,000
3.2	316,000	292,000	316,000	280,500
3.3	1,583,500	1,349,500	1,863,000	1,694,500
3.4	0	0	98,000	98,000
3.5	0	0	114,000	110,500
3.6	31,000	30,500	208,500	183,500
3.7	0	0	42,500	42,500
3.8	0	0	55,500	31,500
3.9	57,000	38,000	0	0
3.10	386,500	333,500	0	0
5.1	0	0	239,000	178,000
5.2	744,500	399,000	867,500	678,000
5.3	866,500	633,000	828,000	828,000
5.4	282,500	0	426,000	426,000
5.5	0	0	4,000	4,000
5.6	0	0	124,000	124,000
5.7	733,000	289,500	0	0
5.8	226,500	0	0	0
5.9	326,500	156,500	0	0
6.1	30,500	13,500	30,500	23,000
6.2	777,000	377,500	755,000	638,000
6.3	290,000	153,000	0	0
6.4	126,500	75,000	0	0
6.5	112,000	57,500	0	0
8.1	1,020,500	783,500	463,000	463,000
8.2	1,304,500	943,000	1,286,500	1,169,500
8.3	132,500	130,500	142,500	142,500
8.4	135,000	108,500	194,000	187,000
8.5	0	0	73,000	51,500
8.6	0	0	125,500	117,000
8.7	116,000	27,000	116,500	116,500
8.8	90,500	69,000	0	0
8.9	105,000	97,500	0	0
8.10	21,500	14,500	0	0
9.1	64,500	48,500	246,500	227,500
9.2	31,500	20,500	31,500	31,500
9.3	1,363,000	862,000	1,295,000	1,034,000
9.4	1,116,500	839,500	2,103,500	1,853,500
9.5	0	0	144,500	111,000
9.6	130,000	89,500	130,000	130,000
9.7	0	0	103,000	103,000
9.8	250,000	138,500	325,500	325,500
TOTAL	16,942,000	11,714,000	19,520,000	17,314,000

NOTES FOR TABLES 16C

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the CSMP. Full build-out cost estimates are for improvements for population growth to 238,162 by year 2030 in 2005 dollars. Unit costs were taken directly from the CSMP and applied to revised improvements. Improvements with costs shown as $0 in the original build-out CIP column indicate additional improvements not previously considered.

NOTE 2. The full build-out growth share is calculated from the existing dry weather peak flow to full build-out dry weather flow ratio at the location of the improvement (1-existing flow location specific/full build-out flow location specific).

NOTE 3. In the original CIP, all gravity improvements assumed unit costs for a 0-10 ft construction depth. This assumption underestimates gravity improvements costs. The full build-out CIP utilizes all of the unit cost data with variation for construction depth. Because of the modified assumption, the cost differences between the original build-out CIP and the full build-out CIP are less exaggerated than if both CIPs had utilized the variation in construction depth. A "revised" original CIP cost applying variation in construction depth to the original improvements is presented in Table 16C to provide an appropriate comparison.

Lift Station and Decommissioning Improvements

The lift station improvements and decommissioning in the nine study areas are presented in Figure 18 (E-size folded map), Table 17a, and Table 17b. Tables 17a and 17b list all of the lift station and decommissioning improvements identified in the original build-out CIP. The improvements are categorized as follows:

1. No Improvement – Improvement not required for the full build-out or the existing system.

2. Reduced Improvement – Improvement required for the full build-out, but capacity is less than the original build-out.

3. Full Improvement – Improvement required for the full build-out and capacity is identical to the original build-out.

4. Additional Improvement – Improvement required for the full build-out and capacity is estimated to be greater than the original build-out estimate.

4. Improvement dependent on Interceptor – Improvement not required, unless interceptor is not completed. These improvements are described in Table 17b.

5. New Improvement- Improvement not considered in the original build-out CIP.

Some lift stations are being decommissioned to allow gravity service into new interceptor improvements. Other lift stations should be decommissioned in conjunction with identified gravity improvements. Decommissioning typically requires abandoning the lift station and constructing additional gravity pipeline to a collection system trunkline. Tables 17a and 17b include comments to describe the decommissioning activity.

Table 17b highlights lift stations that will need to be improved if the interceptor improvements are not implemented. The costs for these lift stations includes the cost of upgrading the lift station ONLY and does NOT include costs for all downstream pipeline improvements. Additional modeling scenarios and improvements analysis are required to determine whether or not lift station upgrades and additional downstream pipeline improvements provide feasible alternatives to the planned interceptors.

Lift station upgrades are determined by available firm capacity and peak hour flows into the lift station wet well. Where full build-out peak hour flows exceed existing firm capacity, an upgrade is recommended. The firm capacity and peak hour flows for each lift station are presented in Tables 17a and 17b. Firm capacity information for each lift station was found in the CSMP. Peak hour flows into the wet well were extracted from the wet weather model when possible. For lift stations that were not modeled, the peak hour flows were extracted from the CSMP or 2030 build-out CIP, whichever predicted higher flows. The 2030 build-out CIP applied a 2.5 peak hour factor to average flows to determine peak hour flows.

The CSMP analyzes all of the lift stations in the City of Bend Collection System and evaluates the firm capacity requirements at full build-out with the exception of the Parrell Lift Station. It was assumed that the original build-out peak hour flows used in the CSMP were as conservative as or more conservative than the full build-out peak hour flows. Because of this assumption, the full build-out analysis only considered lift stations that were identified for improvement in the original build-out CIP and any modeled lift stations such as the Parrell Lift Station and Sawyer Park Lift Station.

Some lift station improvements are required to correct existing system deficiencies as well as full build-out deficiencies. Three alternatives for calculating growth share are defined for each improvement to identify the percentage of the cost associated with growth. A zero percent growth share indicates that the improvement is entirely caused by an existing deficiency. The growth share information can be used to prioritize improvements. The growth share alternatives are described below:

> Alternative 1 – The growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to full build-out dry weather peak flow for the entire system (1-existing flow/full build-out flow). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.
>
> Alternative 2 - The growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to full build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/full build-out flow location specific). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.
>
> Alternative 3 - The growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to full build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/full build-out flow location specific) unless the existing firm capacity exceeds the full build-out capacity requirement. If the existing firm capacity exceeds the full build-out capacity requirement then the growth share for lift station decommissioning is 100%. The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

Table 17a. Full Build-out Lift Station and Decommissioning Cost Specifics (All costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action	Original Build-out Activity[2]	Original Build-out Total ($)	Full Build-out Loading Estimate (gpm, Peak Hour)	Source of Full Build-out Loading	Full BO Firm Pump Capacity (gpm)	Full BO Firm Capacity Comment	Full Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[3]	Full Build-out Cost ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Alt 2 Full BO Growth[5] (%)	Alt 2 Full BO Growth Total ($)	Alt 3 Full BO Growth[6] (%)	Alt 3 Full BO Growth Total ($)
Shevlin Commons 1.PS03	118	52	Model	202	Decommission	380-foot gravity sewer to North Interceptor	$72,500	202	Master Plan	NA		Decommission	100%	$72,500	73%	$53,000	74%	$54,000	74%	$54,000
Shevlin Commons 1.PS04	118	52	Model	202	Decommission	Removal of Pump Station	$25,000	202	Master Plan	NA		Decommission	100%	$25,000	73%	$18,500	74%	$18,500	74%	$18,500
Shevlin Meadows 2.PS04	145	130	Model	464	Upgrade	New Pumps with Increased Capacity	$66,500	370	Model	370	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	87%	$58,000	65%	$37,500	65%	$37,500	65%	$37,500
Shevlin Meadows 2.PS05	145	130	Model	464	Upgrade	Activated Carbon Odor Scrubber	$25,000	370	Model	370	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	87%	$22,000	65%	$14,500	65%	$14,500	65%	$14,500
Awbrey Glen 2.PS06	450	440	Model	1,747	Decommission	8350-foot Gravity Sewer	$1,433,000	1,747	Master Plan	NA		Decommission	100%	$1,433,000	73%	$1,051,000	75%	$1,072,000	75%	$1,072,000
Awbrey Glen 2.PS07	450	440	Model	1,747	Decommission	Remove the Pump station	$50,000	1,747	Master Plan	NA		Decommission	100%	$50,000	73%	$36,500	75%	$37,500	75%	$37,500
Sunrise Village #1 3.PS01	250	73	Model	660	Upgrade	New Pumps with Increased Capacity	$80,000	573	Model	573	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	92%	$73,500	87%	$64,000	87%	$64,000	87%	$64,000
Widgi Creek 3.PS02	297	61	Model	420	Flow Testing and Further Evaluation	A flow test performed by City staff showed station not able to pump design capacity of 450 gpm. The problem is likely caused by conficting HGL from Sunrise Village pump station. Additional flow testing and evaluation recommended.	$15,000	301	Model	301	Use Existing Station Firm Capacity and Improve Performance	Flow Testing	100%	$15,000	0%	$0	80%	$12,000	80%	$12,000
Boyd Acres 4.PS01	65	17	Master Plan	31	Decommission	New 460-ft 8" Sewer	$72,000	31	Master Plan	NA		Decommission	100%	$72,000	73%	$53,000	45%	$32,500	100%	$72,000
Boyd Acres 4.PS02	65	17	Master Plan	31	Decommission	Removal of Pump Station	$25,000	31	Master Plan	NA		Decommission	100%	$25,000	73%	$18,500	45%	$11,500	100%	$25,000
Highlands 4.PS03	250	27	Master Plan	196	Decommission	New 2512-ft 8" Sewer	$393,000	196	Master Plan	NA		Decommission	100%	$393,000	73%	$288,000	86%	$339,000	100%	$393,000
Highlands 4.PS04	250	27	Master Plan	196	Decommission	Removal of Pump Station	$25,000	196	Master Plan	NA		Decommission	100%	$25,000	73%	$18,500	86%	$21,500	100%	$25,000
Holiday Inn 4.PS05	Unknown	Unknown	Master Plan	Unknown	Decommission	New 382-ft 8" Sewer	$60,000	NA	NA	NA		Decommission	100%	$60,000	73%	$44,000	73%	$44,000	100%	$60,000
Holiday Inn 4.PS06	Unknown	Unknown	Master Plan	Unknown	Decommission	Removal of Pump Station	$10,000	NA	NA	NA		Decommission	100%	$10,000	73%	$7,500	73%	$7,500	100%	$10,000
Northpointe 4.PS07	265	58	Model	157	Decommission	New 350-ft 8" Sewer	$55,000	157	Master Plan	NA		Decommission	100%	$55,000	73%	$40,500	63%	$35,000	100%	$55,000
Northpointe 4.PS08	265	58	Model	157	Decommission	Removal of Pump Station	$25,000	157	Master Plan	NA		Decommission	100%	$25,000	73%	$18,500	63%	$16,000	100%	$25,000

Table 17a. Full Build-out Lift Station and Decommissioning Cost Specifics (All costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action	Original Build-out Activity[2]	Original Build-out Total ($)	Full Build-out Loading Estimate (gpm, Peak Hour)	Source of Full Build-out Loading	Full BO Firm Pump Capacity (gpm)	Full BO Firm Capacity Comment	Full Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[3]	Full Build-out Cost ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Alt 2 Full BO Growth[5] (%)	Alt 2 Full BO Growth Total ($)	Alt 3 Full BO Growth[6] (%)	Alt 3 Full BO Growth Total ($)
North Wind 4.PS09	270	16	Model	34	Decommission	New400-ft 8" Sewer	$63,000	34	Master Plan	NA		Decommission	100%	$63,000	73%	$46,000	52%	$33,000	100%	$63,000
North Wind 4.PS10	270	16	Model	34	Decommission	Removal of Pump Station	$25,000	34	Master Plan	NA		Decommission	100%	$25,000	73%	$18,500	52%	$13,000	100%	$25,000
Phoenix 4.PS11	228	85	Model	44	Decommission	Removal of pump station including the inter-tie between Phoenix and Northpointe Pump station basin	$41,000	85	Equal to Existing Loading	NA		Decommission	100%	$41,000	73%	$30,000	0%	$0	100%	$41,000
Summer Meadows 4.PS12	125	11	Master Plan	31	Decommission	New 450-ft 8" Sewer	$70,000	31	Master Plan	NA		Decommission	100%	$70,000	73%	$51,500	65%	$45,000	100%	$70,000
Summer Meadows 4.PS13	125	11	Master Plan	31	Decommission	Removal of Pump Station	$25,000	31	Master Plan	NA		Decommission	100%	$25,000	73%	$18,500	65%	$16,000	100%	$25,000
Empire 5.PS02	50	22	Model	96	Upgrade	Installation of New Pumps	$25,500	60	Model	60	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Reduced Upgrade**	75%	$19,000	63%	$12,000	63%	$12,000	63%	$12,000
Deschutes County Jail 5.PS03 ***SEE Table 17b and NOTE 2***	115	41	Master Plan	129	Decommission	8" Gravity Sewers discharging to the North Interceptor, no cost identified	$0	129	Master Plan	NA		**No improvement currently identified, evaluate decommissioning as part of future development, *SEE Table 17b and NOTE 2***	100%	$0	73%	$0	68%	$0	68%	$0
Majestic 5.PS04	265	102	Model	170	Decommission	New 1800-ft 8" Sewer	$281,000	170	Master Plan	NA		Decommission	100%	$281,000	73%	$206,000	40%	$112,500	100%	$281,000
Majestic 5.PS05	265	102	Model	170	Decommission	Removal of the Pump Station	$25,000	170	Master Plan	NA		Decommission	100%	$25,000	73%	$18,500	40%	$10,000	100%	$25,000
North Fire Station 5.PS06 ***SEE NOTE 2***	Unknown	Unknown	Master Plan	Unknown	Decommission	8" Gravity Sewers discharging to the North Interceptor, no cost identified	$0	NA	NA	NA		**No improvement currently identified, evaluate decommissioning as part of future development, *SEE NOTE 2***	100%	$0	73%	$0	73%	$0	100%	$0
Drake Pump Station 6.PS01	650	233	Model	446	Replacement	Replace Drake Pump Station with new station	$363,000	475	Model	475	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Replacement @ less than existing capacity**	104%	$377,000	51%	$192,000	51%	$192,000	100%	$377,000
Addison Pump Station 6.PS02 (previously 6.3) ***SEE NOTE 7***	100	61	Master Plan	88	Replacement	Correct grade problem at 4th and Addison	$575,000	380	Model	380	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Replacement @ greater than full-buildout *SEE NOTE 7***	241%	$1,383,000	84%	$1,161,000	84%	$1,161,000	84%	$1,161,000

Table 17a. Full Build-out Lift Station and Decommissioning Cost Specifics (All costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action	Original Build-out Activity[2]	Original Build-out Total ($)	Full Build-out Loading Estimate (gpm, Peak Hour)	Source of Full Build-out Loading	Full BO Firm Pump Capacity (gpm)	Full BO Firm Capacity Comment	Full Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[3]	Full Build-out Cost ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Alt 2 Full BO Growth[5] (%)	Alt 2 Full BO Growth Total ($)	Alt 3 Full BO Growth[6] (%)	Alt 3 Full BO Growth Total ($)
Nottingham #2 7.PS02	55	81	Master Plan	202	Upgrade	Replace with new 200gpm pumps	$30,500	202	Master Plan	202	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Full Upgrade**	100%	$30,500	60%	$18,500	60%	$18,500	60%	$18,500
Blue Ridge 7.PS03	70	28	Master Plan	39	Decommission	Installation of inter-tie to new gravity sewers	$16,000	39	Master Plan	NA		Decommission	100%	$16,000	73%	$11,500	28%	$4,500	100%	$16,000
Blue Ridge 7.PS04	70	28	Master Plan	39	Decommission	Removal of Pump Station	$25,000	39	Master Plan	NA		Decommission	100%	$25,000	73%	$18,500	28%	$7,000	100%	$25,000
Darnell Estates 7.PS05	170	100	Model	98	Decommission	Construction of a 300-foot 8" Sewer	$49,000	100	Equal to Existing Loading	NA		Decommission	100%	$49,000	73%	$36,000	0%	$0	100%	$49,000
Darnell Estates 7.PS06	170	100	Model	98	Decommission	Removal of Pump Station	$25,000	100	Equal to Existing Loading	NA		Decommission	100%	$25,000	73%	$18,500	0%	$0	100%	$25,000
Desert Skies 7.PS07	95	65	Model	176	Decommission	Construction of a 550-ft 8" Sewer	$86,000	176	Master Plan	NA		Decommission	100%	$86,000	73%	$63,000	63%	$54,000	63%	$54,000
Desert Skies 7.PS08	95	65	Model	176	Model	Removal of Pump Station	$25,000	176	Master Plan	NA		Decommission	100%	$25,000	73%	$18,500	63%	$15,500	63%	$15,500
Ridgewater #1 7.PS09	118	32	Model	26	Decommission	Construction of 250-foot 8" Sewer	$39,000	32	Equal to Existing Loading	NA		Decommission	100%	$39,000	73%	$28,500	0%	$0	100%	$39,000
Ridgewater #1 7.PS10	118	32	Model	26	Decommission	Removal of Pump Station	$25,000	32	Equal to Existing Loading	NA		Decommission	100%	$25,000	73%	$18,500	0%	$0	100%	$25,000
Sun Meadows 7.PS11	380	90	Master Plan	196	Decommission	Construction of 1500-foot 8" Sewer	$204,000	196	Master Plan	NA		Decommission	100%	$204,000	73%	$149,500	54%	$110,500	100%	$204,000
Sun Meadows 7.PS12	380	90	Master Plan	196	Decommission	Removal of Pump Station	$25,000	196	Master Plan	NA		Decommission	100%	$25,000	73%	$18,500	54%	$13,500	100%	$25,000
Deschutes River X-ing 8.PS01 ***SEE NOTE 2***	148	12	Master Plan	19	Reduce Pumping Capacity	Reduce pumping capacity to 100-gpm when pumps are replaced	0	26	Estimated from 2030 Build-out Average Load x Peak Hour Factor of 2.5	148	Use Existing Station Firm Capacity	**No Upgrade, *SEE NOTE 2***	0%	$0	0%	$0	54%	$0	100%	$0
Old Mill 8.PS02	300	264	Model	600	Upgrade	Installation of 2 new 600-gpm VFD pumps	$60,000	745	Model	745	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Greater than Full Build-out Upgrade**	114%	$68,500	65%	$44,500	65%	$44,500	65%	$44,500
River Rim 8.PS03	150	66	Master Plan	200	Upgrade	Installation of new 200-gpm pumps	$40,000	227	Estimated from 2030 Build-out Average Load x Peak Hour Factor of 2.5	227	Use 2030 Build-out Peak Hour Flow as Station Firm Capacity; 2030 Build-out flow estimate exceeds Full Build-out flow estimate	**Greater than Full Build-out Upgrade**	108%	$43,000	71%	$30,500	71%	$30,500	71%	$30,500
Tri-Peaks 8.PS05	120	45	Master Plan	150	Upgrade	Installation of 2 new 150-gpm pumps	$25,000	150	Master Plan	150	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Full Upgrade**	100%	$25,000	70%	$17,500	70%	$17,500	70%	$17,500

Table 17a. Full Build-out Lift Station and Decommissioning Cost Specifics (All costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action	Original Build-out Activity[2]	Original Build-out Total ($)	Full Build-out Loading Estimate (gpm, Peak Hour)	Source of Full Build-out Loading	Full BO Firm Pump Capacity (gpm)	Full BO Firm Capacity Comment	Full Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[3]	Full Build-out Cost ($)	Full BO Growth Share[4]	Full BO Growth Cost ($)	Alt 2 Full BO Growth[5] (%)	Alt 2 Full BO Growth Total ($)	Alt 3 Full BO Growth[6] (%)	Alt 3 Full BO Growth Total ($)
South Village 8.PS06	265	19	Model	330	Decommission	Construction of 400-ft 8" trunk Sewer	$63,000	420	Estimated from 2030 Build-out Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$63,000	73%	$46,000	96%	$60,000	96%	$60,000
South Village 8.PS07	265	19	Model	330	Decommission	Removal of Pump Station	$25,000	420	Estimated from 2030 Build-out Average Load x Peak Hour Factor of 2.5	NA		Decommission	100%	$25,000	73%	$18,500	96%	$24,000	96%	$24,000
Parrell (new 8.PS08)	150	76	Model	NA	Not identified in Pump Station Master Plan. Full build-out condition requires pump station upgrade.		$0	454	Model	454	Use 2030 Build-out Peak Hour Flow as Station Firm Capacity; 2030 Build-out flow estimate exceeds Full Build-out flow estimate	**Upgrade** (cost assumed similar to the other pump upgrades)	NA	$50,000	83%	$41,500	83%	$41,500	83%	$41,500
Summit Park 9.PS01	125	14	Master Plan	50	Decommission	Construction of new 500-ft 8" gravity sewer	$78,500	50	Master Plan	NA		Decommission	100%	$78,500	73%	$57,500	72%	$56,500	100%	$78,500
Summit Park 9.PS02	125	14	Master Plan	50	Decommission	Removal of Pump Station	$15,000	50	Master Plan	NA		Decommission	100%	$15,000	73%	$11,000	72%	$11,000	100%	$15,000
Westside (no id) ***SEE NOTE 7***	3,600	2,191	Model	4,500	Replacement	Replace Westside Pump Station with new station	$3,770,000	6,426	Model	6,426	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Greater than Full Build-out Upgrade** ***SEE NOTE 7***	124%	$4,668,500	66%	$3,077,000	66%	$3,077,000	66%	$3,077,000
Wyndemere (no id)	240	85	Model	214	Wyndemere Pump Station is currently being re-built. No Build-out action recommended in the Pump Station Master Plan.		$0	345	Model	345	Use Full Build-out Peak Hour Flow as Station Firm Capacity	Wyndemere Pump Station is currently being re-built.	NA	$0	0%	$0	75%	$0	75%	$0
Total							$8,551,000							$10,309,000 ***SEE NOTE 7***		$7,261,000		$6,998,000		$7,940,000

NOTES FOR TABLE 17A

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the City of Bend CSMP. Full build-out cost estimates are for improvements for population growth to 238,162 by year 2030 in 2005 dollars. The first number of each project ID indicates the study areas. For example project 2.PS04 is located in study area 2.

NOTE 2. The CSMP identifies the North Fire Lift Station and Deschutes County Jail Lift Station as decommissioning improvements; however, no cost is provided. The CSMP suggests that the lift stations should be considered for decommissioning with gravity conveyance to the North Interceptor when growth occurs in the area. The City may elect to have cost estimates provided for these lift stations and added to the CIP. If the Deschutes County Jail Lift Station is not decommissioned, the lift station upgrades described in Table 17b should be implemented.

Likewise, the CSMP identifies the Deschutes River X-ing Lift Station as a potential "downgrade" or pump capacity reduction improvement, but does not provide costs for new pumps. The City may elect to have cost estimates provided for this lift station improvement.

NOTE 3. Information in the CSMP for all lift station cost estimates for the original build-out are limited. Where only reduced or additional improvements are required for pumping capacity under full conditions, lift station cost estimates were calculated as a percent of the original build-out cost. The percentage was calculated using the six-tenths rule $(Q_{\text{full build-out}}/Q_{\text{original build-out}})^{0.6}$.

NOTE 4. The growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to full build-out dry weather peak flow for the entire system (1-existing flow/full build-out flow). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

NOTE 5. The alternative 2 growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to full build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/full build-out flow location specific). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

NOTE 6. The alternative 3 growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to full build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/full build-out flow location specific) unless the existing firm capacity exceeds the full build-out capacity requirement. If the existing firm capacity exceeds the full build-out capacity requirement then the alternative 3 growth share for lift station decommissioning is 100%. The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

NOTE 7. The Addison and Westside Lift Station flow estimates for full build-out represent a significant increase over flow estimates for the original build-out (241% and 124% respectively). The full build-out total cost increase for lift stations over the original build-out is approximately $1.8 million due to the increased cost of these two lift stations. The six-tenths rule described in Note 2 was used to estimate costs for these lift stations. The City may want to request more precise estimation methods to revise the costs for these two lift stations.

Table 17b. Full Build-out Lift Station and Decommissioning Cost Specifics (improvements that are required only if interceptors are not installed, all costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action	Original Build-out Activity	Original Build-out Total ($)	Full Build-out Loading Estimate (gpm, Peak Hour)	Source of Full BO Loading	Full BO Firm Pump Capacity (gpm)	Full BO Firm Capacity Comment	Full Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[2]	Full Build-out Cost ($)	Full BO Growth Share[3]	Full BO Growth Cost ($)	Alt 2 Full BO Growth[4] (%)	Alt 2 Full BO Growth Total ($)	Alt 3 Full BO Growth[5] (%)	Alt 3 Full BO Growth Total ($)	Priority Comment[6]
Shevlin Commons 1.PS01	118	52	Model	202	Upgrade	New Pumps with increased capacity	$80,000	202	Master Plan	202	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Full Upgrade**	100%	$80,000	74%	$59,500	74%	$59,500	74%	$59,500	If western portion of North Interceptor is not constructed
Shevlin Commons 1.PS02	118	52	Model	202	Upgrade	New 6" force main	$809,000	202	Master Plan	202	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Full Upgrade**	100%	$809,000	74%	$601,500	74%	$601,500	74%	$601,500	If western portion of North Interceptor is not consructed
Awbrey Glen 2.PS01	450	440	Model	1747	Upgrade	New Pumps with Increased Capacity	$561,000	1747	Master Plan	1747	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Full Upgrade**	100%	$561,000	75%	$419,500	75%	$419,500	75%	$419,500	When capacity is reached
Awbrey Glen 2.PS02	450	440	Model	1747	Upgrade	Replace Force Main (8-inch to 12-inch)	$1,970,500	1747	Master Plan	1747	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Full Upgrade**	100%	$1,970,500	75%	$1,474,000	75%	$1,474,000	75%	$1,474,000	When capacity is reached
Awbrey Glen 2.PS03	450	440	Model	1747	Upgrade	Gravity System at the Station Discharge	$452,000	1747	Master Plan	1747	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Full Upgrade**	100%	$452,000	75%	$338,000	75%	$338,000	75%	$338,000	If western portion of North Interceptor is not constructed and station must be expanded beyond current capacity
Deschutes County Jail 5.PS01	115	41	Master Plan	129	Upgrade	Installation of New Pumps	$25,300	129	Master Plan	129	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Full Upgrade**	100%	$25,500	68%	$17,500	68%	$17,500	68%	$17,500	When capacity is reached
Desert Skies 7.PS01	95	65	Model	176	Upgrade	Replace with new 180-gpm pumps	$30,500	176	Master Plan	176	Use Full Build-out Peak Hour Flow as Station Firm Capacity	**Full Upgrade**	100%	$30,500	63%	$19,000	63%	$19,000	63%	$19,000	When capacity is reached

Table 17b. Full Build-out Lift Station and Decommissioning Cost Specifics (improvements that are required only if interceptors are not installed, all costs in 2005 dollars)[1]

Proj ID & Lift Station Name *first number in ID indicates study area	Existing Firm Cap. (2005-gpm)	Existing Loading (2005-gpm, Peak Hour)	Source of Existing Loading	Original Build-out Peak Flow Estimate (gpm)	Original Build-out Action	Original Build-out Activity	Original Build-out Total ($)	Full Build-out Loading Estimate (gpm, Peak Hour)	Source of Full BO Loading	Full BO Firm Pump Capacity (gpm)	Full BO Firm Capacity Comment	Full Build-out Action (Bold indicates change from Original Build-out)	Cost Adjust from Original Build-out[2]	Full Build-out Cost ($)	Full BO Growth Share[3]	Full BO Growth Cost ($)	Alt 2 Full BO Growth[4] (%)	Alt 2 Full BO Growth Total ($)	Alt 3 Full BO Growth[5] (%)	Alt 3 Full BO Growth Total ($)	Priority Comment[6]
South Village 8.PS04	265	19	Model	330	Upgrade	Installation of 2 new 330-gpm pumps	$25,500	420	Estimated from 2030 Build-out Average Load x Peak Hour Factor of 2.5	420	Use 2030 Build-out Peak Hour Flow as Station Firm Capacity; 2030 Build-out flow estimate exceeds Full Build-out flow estimate	**Greater than Full Build-out Upgrade**	116%	$29,000	96%	$27,500	96%	$27,500	96%	$27,500	When capacity is reached
TOTAL							$3,954,000							$3,958,000		$2,957,000		$2,957,000		$2,957,000	

NOTES FOR TABLE 17B

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the City of Bend CSMP. Full build-out cost estimates are for improvements for population growth to 238,162 by year 2030 in 2005 dollars. The first number of each project ID indicates the study areas. For example project 2.1 is located in study area 2.

NOTE 2. Information in the CSMP for all Lift Station cost estimates for the original build-out are limited. Where only reduced or additional improvements are required for pumping capacity under full build-out conditions, lift station cost estimates were calculated as a percent of the original build-out cost. The percentage was calculated using the six-tenths rule $(Q_{\text{full build-out}}/Q_{\text{original build-out}})^{0.6}$.

NOTE 3. The growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to full build-out dry weather peak flow for the entire system (1-existing flow/full build-out flow). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

NOTE 4. The alternative 2 growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to full build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/full build-out flow location specific). The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

NOTE 5. The alternative 3 growth share for lift station decommissioning is equal to the ratio of existing system dry weather peak flow to full build-out dry weather peak flow at the location of each improvement (1-existing flow location specific/full build-out flow location specific) unless the existing firm capacity exceeds the full build-out capacity requirement. If the existing firm capacity exceeds the full build-out capacity requirement, then the alternative 3 growth share for lift station decommissioning is 100%. The growth share for reduced and full upgrade improvements is calculated from similar flow ratios at the location of each improvement.

NOTE 6. Table 17b highlights lift stations that will need to be improved if the interceptor improvements are not implemented. The costs for these lift stations includes the cost of upgrading the lift station ONLY and does NOT include costs for all downstream pipeline improvements. Additional modeling scenarios and improvements analysis are required to determine whether or not lift station upgrades and additional downstream pipeline improvements provide feasible alternatives to the planned interceptors.

Interceptor Improvements

The interceptor improvements are presented in Figure 18 (E-size folded map), Table 18a, Table 18b, and Table 18c. The velocity, depth/diameter (d/D), and surcharge clearance results are included in Table 18a for each interceptor segment. Also, included in Table 18a are the model results compared to the design criteria for each interceptor segment at the next smallest pipe size. The detailed cost breakdown for each improvement is provided in Table 18b including a comparison to the original build-out cost and information on the North Interceptor Lift Station. A summary of the interceptor costs is provided in Table 18c.

The alignments and slopes for each of the interceptor segments were not modified from the original build-out CIP. Additional interceptor alternatives were not considered with the reduced flows. Only the pipe sizes and North Interceptor Lift Station capacity were revised. When compared with the original build-out CIP, there is a 3-inch length weighted average pipe size reduction for the interceptor improvements. The reduction is primarily caused by revisions to dry weather diurnal patterns and the wet weather model component including the selected summer-time design storm.

The interceptor improvements are required to correct for existing system deficiencies as well as the full build-out deficiencies. Two alternatives for calculating growth share are defined for each interceptor improvement segment to identify the percentage of the cost associated with growth. The growth share information can be used to prioritize improvements. The growth share alternatives are described below:

> Alternative 1 - The growth share is calculated from the existing dry weather peak flow to full build-out dry weather peak flow ratio for the entire system (1-existing flow/full build-out flow).
>
> Alternative 2 - The growth share is calculated from the existing to full build-out dry weather flow ratio for specific areas of the system where the interceptor is located (1-existing flow location specific/full build-out flow location specific). Growth shares for additional items such as crossings, traffic control, erosion control, and siphon structures are length-weighted and averaged for the various sections of each interceptor.

Table 18a. Full Build-out Interceptor Improvement Results and Comparison to Design Criteria

Project Element	Original Build-out Diameter (in)	Length (ft)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size						Controlling Criteria for Improvement
			Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
Plant Interceptor															
WWTP Siphon															
0-10' depth	48	4,962	42	1.0	sealed	sealed	4.7	2.9	36	1.0	sealed	sealed	see note 2	3.4	see Note 2
10-15' depth	48	42	42	1.0	sealed	>=3.5	4.7	2.9	36	1.0	sealed	>=2.5	see note 2	3.4	see Note 2
North Trunk Junction to Siphon	48	8,302	42	0.8	>=3.5	>=3.5	7.9	4.7	36	>0.8	>=3.5	>=3.5	<10	>2	d/D
North Interceptor															
Plant Interceptor to Hwy 97	48	11,786	42	0.8	>=3.5	<0.5, near inlet to Plant Interceptor Siphon	3.7	3.1	36	>0.8	>=3.5	>=3.5	<10	>2	d/D
Juniper Ridge to Hwy 97	42	2,538	36	0.7	>=3.5	>=3.5	4.9	4.5	30	>0.8	>=3.5	>=3.5	<10	>2	d/D
Hwy 97 to Deschutes River															
30" segment	30	6,850	30	0.8	sealed	<0.5	3.0	2.2	27	>0.8	sealed	<0.5	<10	>2	d/D, surcharge clearance
24" segment	30	7,474	24	0.6	>=3.5	>=3.5	4.5	3.7	21	>0.8	>=3.5	>=3.5	<10	>2	d/D
Deschutes River Force main	15	1,050	15	1.0	sealed	sealed	6.0	5.1	12	1.0	sealed	sealed	>6	>2	velocity
Deschutes River to Shevlin Park															
24" segment	27	550	24	0.2	>= 2.5	>= 2.5	7.9	7.0	21	<0.8	<0.5	<0.5	<10	>2	d/D, surcharge clearance
18" segment	15	10,476	18	0.2	>=3.5	>= 2.5	3.5	2.6	15	<0.8	<0.5	<0.5	<10	>2	d/D, surcharge clearance
10" segment (steep slope, design for high velocity)[3]	10	474	10	0.4	>=3.5	>=3.5	12.8	11.5	8	<0.8	<0.5	<0.5	11.8	10.4	d/D, surcharge clearance, velocity
8" segment	8	11,259	8	0.8	>=3.5	>=3.5	9.0	2.0	6	>0.8	>2.5	>2.5	<10	>2	d/D

Table 18a. Full Build-out Interceptor Improvement Results and Comparison to Design Criteria

Project Element	Original Build-out Diameter (in)	Length (ft)	Full BO Final Model Results for CIP Diameter						Comparison Full BO Model Results for CIP at next smallest Pipe Size						Controlling Criteria for Improvement
			Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)[1]	One Pipe Size Smaller than Full BO CIP Diameter (in)	Depth/ Diameter (d/D, dry weather)	Upstream Manhole Surcharge Clearance (ft, wet weather)	Downstream Manhole Surcharge Clearance (ft, wet weather)	Max Velocity (ft/sec)	Daily Cleansing Velocity (ft/sec)	
Southeast Interceptor															
North Trunk Junction to JD Estates Drive	36	3,702	30	0.5	>=3.5	>= 2.5	3.9	3.7	27	>0.8	>=3.5	<0.5	<10	>2	d/D
JD Estates Drive to Hwy 20 (24" segment)	24	10,413	24	0.6	>=3.5	>=3.5	6.6	6.2	21	>0.8	>=3.5	>=3.5	<10	>2	d/D
JD Estates Drive to Hwy 20 (21" segment)	24	8,280	21	0.6	>=3.5	>=3.5	8.3	7.5	18	>0.8	<0.5	<0.5	<10	>2	d/D, surcharge clearance
Hwy 20 to Reed Market Rd (15-20' depth)	24	3,856	21	0.5	>=3.5	>=3.5	8.4	7.9	18	>0.8	>=3.5	<0.5	<10	>2	d/D
Hwy 20 to Reed Market Rd (10-15' depth)	24	3,291	21	0.5	>=3.5	>=3.5	6.6	6.1	18	>0.8	>=3.5	>=3.5	<10	>2	d/D
Reed Market Rd to SE 15th St	24	8,985	21	0.7	>=3.5	>=3.5	5.1	3.9	18	>0.8	<0.5	>=3.5	<10	>2	d/D, surcharge clearance
SE 15th to Murphy Rd LS	24	5,505	21	0.4	>=3.5	>=3.5	3.4	2.9	18	>0.8	>=3.5	<0.5	<10	>2	d/D
Murphy Rd LS to Hwy 97	18	6,008	15	0.5	>=3.5	>=3.5	6.9	3.9	12	>0.8	<0.5	>=3.5	<10	>2	d/D, surcharge clearance
Westside Interceptor															
Westside Forcemain															
21" segment	18	980	21	1.0	sealed	sealed	6.0	5.3	18	1.0	sealed	sealed	8.2	6.8	velocity
24" segment (partial gravity)	18	2,018	24	0.8	sealed	>=3.5	5.7	5.5	21	>0.8	sealed	>=3.5	<10	>2	d/D
Gravity Interceptor	27	18,018	24	0.6	>=3.5	>=3.5	7.1	5.8	21	>0.8	>=3.5	>=3.5	<10	>2	d/D

NOTES FOR TABLE 18A

NOTE 1. For several segments of pipeline, the daily cleansing velocity and d/D criteria could not be met simultaneously. For these pipelines, the d/D criteria was given priority.

NOTE 2. The siphon size was adjusted until the upstream pipelines met the surcharge clearance criteria and the siphon and parallel siphon into the WWTP met the maximum velocity criteria.

NOTE 3. The slope of this pipeline is steep resulting in velocities exceeding 10 ft/sec. Design consideration should be given for high velocities including additional pipe anchoring.

Table 18b. Full Build-out Interceptor Improvements Cost Specifics (all costs in 2005 dollars)[1]

Project Element	Full BO Dia. (in)	Original BO Dia. (in)	Total Length (ft)	Full BO Pipe Unit Cost ($/ft)	Full BO Pipe Material ($)	Full BO Depth Category (ft)	Full BO Pipe Install. Unit Cost ($/ft)	Full BO Install. ($)	Manhole Count (400 ft max spacing)	Full BO Manhole Unit Cost ($/each)[3]	Full BO Manhole Cost ($)	Full BO Surface Catetgory	Full BO Restore Unit Cost ($/ft)	Full BO Restore Cost ($)	Easement Cost ($)	Full BO Subtotal Cost ($)	Full BO Engr/ Admin Cost @35% ($)	Full BO Contig. @30% ($)	Full Build-out Total ($)	Full BO Growth[4] %	Full BO Growth Total ($)	Alt. Full BO Growth[5] %	Alt. Full BO Growth Total ($)	Original Build-out Total ($)
Plant Interceptor																								
WWTP to Siphon																								
0-10' depth	42	48	4,962	57	282,806	0-10	220	1,091,530	13	8345	108,485	Dirt	8.33	41,329	99,166	1,623,300	568,200	657,500	2,849,000	73%	2,089,500	73%	2,089,500	3,132,000
10-15' depth	42	48	42	57	2,379	10-15	235	9,809	0	0	0	Dirt	8.33	348	834	13,400	4,700	5,400	23,500	73%	17,000	73%	17,000	
North Trunk Junction to Siphon																								
42” segment	42	48	8,302	57	473,209	0-10	220	1,826,420	21	8345	175,245	Local	15.75	130,755	150,000	2,755,600	964,500	1,116,000	4,836,000	73%	3,546,500	73%	3,546,500	5,492,000

Project Element	Quantity	Full BO Material Cost ($)	Full BO Subtotal Cost ($)	Full BO Engr/ Admin Cost @35% ($)	Full BO Contig. @30% ($)	Full Build-out Total ($)	Full BO Growth[4] %	Full BO Growth Total ($)	Alt. Full BO Growth[5] %	Alt. Full BO Growth Total ($)	Original Build-out Total ($)
Canal Crossings	100	75,000	75,000	26,300	30,400	131,500	73%	96,500	73%	96,500	132,000
Traffic Control/Management	1 EA	20,000	20,000	7,000	8,100	35,000	73%	25,500	73%	25,500	35,000
Erosion Control	1 EA	200,000	200,000	70,000	81,000	351,000	73%	257,500	73%	257,500	351,000
Siphon Structure	1 EA	150,000	150,000	52,500	60,800	263,500	73%	193,000	73%	193,000	263,000
					TOTAL	8,490,000	73%	6,226,000	VARIES	6,226,000	9,405,000

Table 18b. Full Build-out Interceptor Improvements Cost Specifics (all costs in 2005 dollars)[1]

Project Element	Full BO Dia. (in)	Original BO Dia. (in)	Total Length (ft)	Full BO Pipe Unit Cost ($/ft)	Full BO Pipe Material ($)	Full BO Depth Category (ft)	Full BO Pipe Install. Unit Cost ($/ft)	Full BO Install. ($)	Manhole Count (400 ft max spacing)	Full BO Manhole Unit Cost ($/each)[3]	Full BO Manhole Cost ($)	Full BO Surface Catetgory	Full BO Restore Unit Cost ($/ft)	Full BO Restore Cost ($)	Easement Cost ($)	Full BO Subtotal Cost ($)	Full BO Engr/ Admin Cost @35% ($)	Full BO Contig. @30% ($)	Full Build-out Total ($)	Full BO Growth[4] %	Full BO Growth Total ($)	Alt. Full BO Growth[5] %	Alt. Full BO Growth Total ($)	Original Build-out Total ($)
North Interceptor																								
Plant Interceptor to Hwy 97																								
42" segment	42	48	11,786	57	671,780	10-15	235	2,769,618	29	10845	314,505	Local/Dirt	12.04	141,899	0	3,897,800	1,364,200	1,578,600	6,840,500	73%	5,016,500	77%	5,290,000	8,810,000
Juniper Ridge to Hwy 97																								
36" segment	36	42	2,538	46	116,766	10-15	205	520,372	6	10845	65,070	Local/Dirt	10.84	27,516	0	729,700	255,400	295,500	1,280,500	73%	939,000	72%	925,000	1,543,500
Hwy 97 to Deschutes River																								
30" segment	30	30	6,850	40	274,000	10-15	175	1,198,750	17	10845	184,365	Local/Dirt	9.64	66,000	68,577	1,791,700	627,100	725,600	3,144,500	73%	2,306,000	89%	2,813,000	6,553,000
24" segment	24	30	7,474	22	164,425	10-15	125	934,235	19	10845	206,055	Local/Dirt	7.23	53,999	74,823	1,433,500	501,700	580,600	2,516,000	73%	1,845,000	91%	2,277,500	
Deschutes River Force main																								
15" segment	15	15	1,050	26.33	27,647	0-10	77	80,850	0	0	0	Local	7.88	8,274	0	116,800	40,900	47,300	205,000	73%	150,500	87%	177,500	278,000
North Interceptor Pump Station[2]																			1,153,000	73%	845,500	87%	998,500	1,226,500
Deschutes River to Shevlin Park																								
24" segment	24	27	550	22	12,100	0-10	107	58,850	1	8345	8,345	Local	9.45	5,198	5,756	90,200	31,600	36,500	158,500	73%	116,000	87%	137,000	5,058,000
18" segment	18	15	10,476	17	178,092	0-10	87	911,412	27	3640	98,280	Local	8.40	87,998	109,644	1,385,400	484,900	561,100	2,431,500	73%	1,783,000	71%	1,717,000	
10" segment	10	10	474	8.85	4,195	0-10	70	33,180	1	3640	3,640	Local	7.35	3,484	4,961	49,500	17,300	20,000	87,000	73%	64,000	99%	86,000	
8" segment	8	8	11,259	5.65	63,613	0-10	67	754,353	28	3640	101,920	Local	7.35	82,754	117,839	1,120,500	392,200	453,800	1,966,500	73%	1,442,000	99%	1,945,000	

Project Element	Quantity	Full BO Material Cost ($)	Full BO Subtotal Cost ($)	Full BO Engr/ Admin Cost @35% ($)	Full BO Contig. @30% ($)	Full Build-out Total ($)	Full BO Growth[4] %	Full BO Growth Total ($)	Alt. Full BO Growth[5] %	Alt. Full BO Growth Total ($)	Original Build-out Total ($)
Canal Crossings(3)	300	225,000	225,000	78,800	91,100	395,000	73%	289,500	84%	333,000	395,000
Traffic Control/Management	1 EA	50,000	50,000	17,500	20,300	88,000	73%	64,500	84%	74,000	88,000
Erosion Control	1 EA	212,640	212,640	74,400	86,100	373,000	73%	273,500	84%	314,500	373,000
Hwy 97 and Hwy 20 Bores	250	250,000	250,000	87,500	101,300	439,000	73%	322,000	84%	370,000	439,000
Railroad Undercrossing	150	150,000	150,000	52,500	60,800	263,500	73%	193,000	84%	222,000	263,500
					TOTAL	21,342,000	73%	15,650,000	VARIES	17,680,000	25,028,000

Table 18b. Full Build-out Interceptor Improvements Cost Specifics (all costs in 2005 dollars)[1]

Project Element	Full BO Dia. (in)	Original BO Dia. (in)	Total Length (ft)	Full BO Pipe Unit Cost ($/ft)	Full BO Pipe Material ($)	Full BO Depth Category (ft)	Full BO Pipe Install. Unit Cost ($/ft)	Full BO Install. ($)	Manhole Count (400 ft max spacing)	Full BO Manhole Unit Cost ($/each)[3]	Full BO Manhole Cost ($)	Full BO Surface Catetgory	Full BO Restore Unit Cost ($/ft)	Full BO Restore Cost ($)	Easement Cost ($)	Full BO Subtotal Cost ($)	Full BO Engr/ Admin Cost @35% ($)	Full BO Contig. @30% ($)	Full Build-out Total ($)	Full BO Growth[4] %	Full BO Growth Total ($)	Alt. Full BO Growth[5] %	Alt. Full BO Growth Total ($)	Original Build-out Total ($)
Southeast Interceptor																								
North Trunk Junction to JD Estates Drive	30	36	3,702	40	148,083	0-10	160	592,331	9	8345	75,105	Local	12.60	46,646	0	862,200	301,800	349,200	1,513,000	73%	1,109,500	77%	1,163,500	1,862,000
JD Estates Drive to hwy 20 (24" segment)	24	24	10,413	22	229,076	10-15	125	1,301,569	26	10845	281,970	Arterial	21.48	223,662	0	2,036,300	712,700	824,700	3,573,500	73%	2,620,500	74%	2,656,000	6,748,500
JD Estates Drive to hwy 20 (21" segment)	21	24	8,280	18.5	153,188	15-20	140	1,159,264	21	6740	141,540	Arterial	21.48	177,864	0	1,631,900	571,200	660,900	2,864,000	73%	2,100,500	74%	2,117,500	
Hwy 20 to Reed Market Rd (15-20' depth)	21	24	3,856	18.5	71,339	15-20	140	539,859	10	6740	67,400	Arterial	21.48	82,830	0	761,400	266,500	308,400	1,336,500	73%	980,000	75%	999,500	2,089,000
Hwy 20 to Reed Market Rd (10-15' depth)	21	24	3,291	18.5	60,882	10-15	115	378,455	8	4990	39,920	Arterial	21.48	70,689	0	549,900	192,500	222,700	965,000	73%	707,500	69%	665,500	
Reed Market Rd to SE 15th St	21	24	8,985	18.5	166,215	10-15	115	1,033,226	22	4990	109,780	Local	9.45	84,904	0	1,394,100	487,900	564,600	2,446,500	73%	1,794,000	76%	1,853,000	2,279,500
SE 15th to Murphy Rd LS	21	24	5,505	18.5	101,843	0-10	97	533,985	14	3640	50,960	Local	9.45	52,022	10,000	748,800	262,100	303,300	1,314,000	73%	963,500	63%	831,000	1,301,500
Murphy Rd LS to Hwy 97	15	18	6,008	18.8	112,957	10-15	95	570,795	15	4990	74,850	Arterial	17.90	107,550	0	866,200	303,200	350,800	1,520,000	73%	1,114,500	51%	770,000	1,811,500

Project Element	Quantity	Full BO Material Cost ($)	Full BO Subtotal Cost ($)	Full BO Engr/ Admin Cost @35% ($)	Full BO Contig. @30% ($)	Full Build-out Total ($)	Full BO Growth[4] %	Full BO Growth Total ($)	Alt. Full BO Growth[5] %	Alt. Full BO Growth Total ($)	Original Build-out Total ($)
Canal Crossings(2)	200	150,000	150,000	52,500	60,800	263,500	73%	193,000	70%	185,500	263,500
Railroad Undercrossing	230	230,000	230,000	80,500	93,200	403,500	73%	296,000	70%	284,000	404,000
Intertie Structures	2 EA	400,000	400,000	140,000	162,000	702,000	73%	515,000	70%	493,500	702,000
Traffic Control/Management	1 EA	450,000	450,000	157,500	182,300	790,000	73%	579,500	70%	555,500	790,000
Erosion Control	1 EA	195,200	195,200	68,300	79,100	342,500	73%	251,000	70%	241,000	342,500
US Hwy 20 Undercrossing	250	250,000	250,000	87,500	101,300	439,000	73%	322,000	70%	309,000	439,000
					TOTAL	18,473,000	73%	13,547,000	VARIES	13,125,000	19,033,000

Table 18b. Full Build-out Interceptor Improvements Cost Specifics (all costs in 2005 dollars)[1]

Project Element	Full BO Dia. (in)	Original BO Dia. (in)	Total Length (ft)	Full BO Pipe Unit Cost ($/ft)	Full BO Pipe Material ($)	Full BO Depth Category (ft)	Full BO Pipe Install. Unit Cost ($/ft)	Full BO Install. ($)	Manhole Count (400 ft max spacing)	Full BO Manhole Unit Cost ($/each)[3]	Full BO Manhole Cost ($)	Full BO Surface Catetgory	Full BO Restore Unit Cost ($/ft)	Full BO Restore Cost ($)	Easement Cost ($)	Full BO Subtotal Cost ($)	Full BO Engr/ Admin Cost @35% ($)	Full BO Contig. @30% ($)	Full Build-out Total ($)	Full BO Growth[4] %	Full BO Growth Total ($)	Alt. Full BO Growth[5] %	Alt. Full BO Growth Total ($)	Original Build-out Total ($)
Westside Interceptor																								
Westside Forcemain	21	18	980	69.85	68,453	0-10	97	95,060	0	0	0	Local	9.45	9,261	4,900	177,700	62,200	72,000	312,000	73%	229,000	69%	215,500	769,000
Forcemain to Gravity Transition	24	18	2,018	22	44,401	10-15	125	252,280	5	10845	54,225	Local	9.45	19,072	10,090	380,100	133,000	153,900	667,000	73%	489,000	69%	461,000	
Gravity Interceptor	24	27	18,018	22	396,401	10-15	125	2,252,278	45	10845	488,025	Arterial	21.48	387,031	20,000	3,543,700	1,240,300	1,435,200	6,219,000	73%	4,560,500	73%	4,548,000	7,447,000

Project Element	Quantity	Full BO Material Cost ($)	Full BO Subtotal Cost ($)	Full BO Engr/ Admin Cost @35% ($)	Full BO Contig. @30% ($)	Full Build-out Total ($)	Full BO Growth[4] %	Full BO Growth Total ($)	Alt. Full BO Growth[5] %	Alt. Full BO Growth Total ($)	Original Build-out Total ($)
US Hwy 97 Undercrossing	400	400,000	400,000	140,000	162,000	702,000	73%	515,000	73%	509,500	702,000
Railroad Undercrossing	230	230,000	230,000	80,500	93,200	403,500	73%	296,000	73%	293,000	403,500
Traffic Control/Management	1 EA	176,400	176,400	61,700	71,400	309,500	73%	227,000	73%	224,500	309,500
Erosion Control	1 EA	84,000	84,000	29,400	34,000	147,500	73%	108,000	73%	107,000	147,500
					TOTAL	8,761,000	73%	6,425,000	VARIES	6,359,000	9,779,000

NOTES FOR TABLE 18B

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the City of Bend CSMP. Full build-out cost estimates are for improvements for population growth to 238,162 by year 2030 in 2005 dollars. Unit costs were taken directly from the CSMP and applied to the revised improvements.

NOTE 2. Information in the CSMP for the North Interceptor Lift Station cost estimates at original build-out was limited to the total cost. Peak flow estimates in the CSMP range from 4,400 gpm to 10,800 gpm. The full build-out flow estimate at the North Interceptor Lift Station is 4,000 gpm. The North Interceptor Lift Station total cost estimate for the full build-out CIP was assumed as 94% of the original cost estimate using the six tenths cost rule where percent is calculated as $(Q_{full\ build\text{-}out}/Q_{original\ build\text{-}out})^{0.6}$.

NOTE 3. Manholes sizes are 48 inches for pipe sizes less than 24 inches and 60 inches for pipe sizes greater than or equal to 24 inches.

NOTE 4. The full build-out growth share is calculated from the existing dry weather peak flow to full build-out dry weather peak flow ratio for the entire system (1-existing flow/full build-out flow).

NOTE 5. The alternate full build-out growth share is calculated from the existing to full build-out dry weather flow ratio for specific areas of the system where the interceptor is located (1-existing flow location specific/full build-out flow location specific). Growth shares for additional items such as crossings, traffic control, erosion control, and siphon structures are length-weighted and averaged for the various sections of each interceptor.

Table 18c. Full Build-out Interceptor Improvements Cost Totals (all costs in 2005 dollars)[1]

Project	Full Build-out Total ($)	Full Build-out Growth Total[2] ($)	Alternate Full Build-out Growth Total[3] ($)	Original Build-out Total ($)
Plant Interceptor	8,490,000	6,226,000	6,226,000	9,405,000
North Interceptor	21,342,000	15,650,000	17,680,000	25,028,000
Southeast Interceptor	18,473,000	13,547,000	13,125,000	19,033,000
Westside Interceptor	8,761,000	6,425,000	6,359,000	9,779,000
Total	57,066,000	41,848,000	43,390,000	63,245,000

<u>NOTES FOR TABLES 18C</u>

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the City of Bend CSMP. Full build-out cost estimates are for improvements for population growth to 238,162 by year 2030 in 2005 dollars. Unit costs were taken directly from the CSMP and applied to the revised improvements.

NOTE 2. The full build-out growth share is calculated from the existing dry weather peak flow to full build-out dry weather peak flow ratio for the entire system (1-existing flow/full build-out flow).

NOTE 3. The alternate full build-out growth share is calculated from the existing to full build-out dry weather flow ratio for specific areas of the system where the interceptor is located (1-existing flow location specific/full build-out flow location specific). Growth shares for additional items such as crossings, traffic control, erosion control, and siphon structures are length-weighted and averaged for the various sections of each interceptor.

Overall Costs

The total costs for the full build-out CIP and the original build-out CIP are compared in Table 19. The full build-out total costs are 8% less than the original build-out total costs. The overall reduction in cost appears minimal; however, the following considerations should be remembered for the comparison:

- The design criteria requires 2.5 ft of surcharge clearance during a wet weather event in the full build-out model which is more conservative than the original build-out model (no overflows).
- The full build-out model design storm is larger and has greater peak intensity than the original build-out model. However, the wet weather component of the full build-out model is less conservative than the original build-out model because of the multiplication of wet weather flow patterns in the original build-out model.
- The full build-out model considers peak day diurnal patterns and the original build-out model considered average day diurnal patterns. However, the dry weather component of the full build-out model is less conservative than the original build-out model because of the multiplication of dry weather diurnal patterns in the original build-out model.
- Because of the revised distribution of wet weather flows and revised diurnal patterns in the full build-out model, some additional deficiencies were identified for improvement which had not been considered in the original build-out CIP. Other improvements were completely eliminated.
- Full build-out gravity/forcemain improvements represent a 13% reduction in cost from the original build-out CIP.
- Full build-out interceptor costs represent a 10% reduction in cost from the original build-out CIP
- Full build-out lift station and decommissioning costs represent a 21% cost increase from the original build-out CIP. This increase is primarily caused by higher peak hour flow estimates at the Addison and Westside Lift Stations.

Table 19. Summary of Full Build-out CIP Costs (all costs in 2005 dollars)[1 & 2]

Improvement Category	Full Build-out Total ($)	Revised Original Build-out Total ($)	Original Build-out Total ($)	Percent Reduction between Revised Original Build-out and Full Build-out
Gravity & Forcemain	16,975,000	19,520,000	17,314,000	13%
Lift Station & Decommissioning	10,309,000	8,551,000	8,551,000	21% (increase)
Interceptor	57,066,000	63,245,000	63,245,000	10%
Total	**84,350,000**	**91,316,000**	**89,110,000**	**8%**

<u>NOTES FOR TABLE 19</u>

NOTE 1. All costs estimates are order-of-magnitude (+30% to -20%) in 2005 dollars as described in the City of Bend CSMP. Full build-out cost estimates are for improvements for population growth to 238,162 by year 2030 in 2005 dollars. Unit costs were taken directly from the CSMP and applied to the revised improvements.

NOTE 2. In the original CIP, all gravity improvement cost estimates used the unit costs for a 0-10 ft construction depth even though the CSMP stated that the same unit costs should be applied to both new improvements and replacement/upgrade improvements. The full build-out CIP utilizes all of the unit cost data for the gravity improvements with variation for construction depth. Because of the modified assumption, the cost differences between the original build-out CIP and the full build-out CIP are less exaggerated than if both CIPs had utilized the variation in construction depth. A “revised” original CIP cost applying variation in construction depth to the original improvements is presented in Table 19 to provide an appropriate comparison. The full build-out costs may be conservative since a replacement or upgrade improvement may require less excavation expense than a new improvement. It is recommended for future CIPs and master planning efforts that separate unit costs be developed for new improvements and upgrade/replacement improvements.

APPENDIX A: V&A FLOW MONITORING REPORT

APPENDIX B: MWH UNIT COST CRITERIA MEMO