Hi-Desert Water District

Sewer Master Plan

Final Report

January 2009

MWH

HI-DESERT WATER DISTRICT

MWH

BUILDING A BETTER WORLD

1342983/6-7

January 5, 2009

Hi-Desert Water District
55439 29 Palms Hwy
Yucca Valley, California 92284-2503

Attention: Mr. Ed Muzik
General Manager

Subject: Sewer Master Plan Final Report

Dear Mr. Muzik:

MWH is pleased to submit this final Sewer Master Plan to the Hi-Desert Water District (District). This Master Plan has been revised to reflect comments received in writing and in public meetings, and from the separate Value Engineering team review. The key change made from the draft report is that the Phase 1 service area has been expanded to include all areas which are likely to need to be sewered initially. As a result, the initial average connected flow is estimated to be 1.4 mgd.

We would like to thank you and your staff for the cooperation and assistance we have received on this project. If you have any comments, please feel free to contact either myself at 626-568-6299 or Alok Pandya at 626-568-6281.

Sincerely,

Jeffrey D. Mohr, P.E.
Project Manager

cc: Alok Pandya, MWH
Ajit Bhamrah, MWH

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APPENDICES

Appendix A – Land Use and Flow Projections for Parcels within Phase 1 through Phase 3 Boundaries
Appendix B – Proposed Collection System
Appendix C – Cost Estimate Assumptions for Phase 1 through Phase 3

Section 1
Introduction

This section provides an overview of the 2009 Sewer Master Plan Update (SMP, Plan, Master Plan) for the Hi-Desert Water District (District). This SMP provides an update to the 1998 Wastewater Collection and Treatment Master Plan (Montgomery Watson, 1998). A brief background on the District's sewer system planning is provided. The scope of work for the SMP, an outline of the final report, and a listing of abbreviations and definitions used in this report are included in this section.

1.1 AUTHORIZATION

This SMP is developed under Task Order No. WW-07-01 between the District and MWH Americas, Inc. (MWH) dated January 10, 2008. All the work under this Task Order is governed by the provisions of the Master Services Agreement between the District and MWH, executed on October 20, 2004.

1.2 PROJECT BACKGROUND

The District's service area primarily consists of residential areas with some typical neighborhood commercial development in the Town of Yucca Valley. The District serves potable water to a population of approximately 25,000. According to previous planning studies, the projected population for the District's service area at build-out condition is approximately 80,000. In order to protect groundwater quality in the area, the District is planning to connect the majority of its water customers to a new wastewater collection and treatment system. The intent of the SMP is to assist the District in planning the proposed sewer system.

As part of the SMP, a sewer hydraulic model is developed to identify the necessary infrastructure required for the functional operation of the proposed sewer system. The model also assists in evaluating the sewer system under projected future conditions. This SMP recommends the necessary infrastructure required to meet the near-term as well as future needs of the District's service area.

This SMP also presents a Capital Improvement Program (CIP) to help the District identify and prioritize sewer infrastructure projects required to support the growth expected to occur within the District's service area. It is recommended that the District update this SMP every five years to account for changes in the growth pattern which could impact the sewer flows, which in turn could impact the infrastructure requirements.

1.3 OBJECTIVE

The objective of the District is to plan, develop, and implement a sewer system that is cost-effective and meets the requirements of its customers. This SMP is developed to assist the District in achieving these objectives. For this SMP, a hydraulic model of the District's proposed sewer system is created. Using the hydraulic model, system elements that are

necessary to meet the near-term and the build-out service conditions are identified. The purpose of this report is to prepare a Capital Improvement Program (CIP) that includes all infrastructure facilities required to meet the District's near and long-term sewer system needs. The CIP includes a list of the recommended infrastructure, proposed phasing and cost estimates. The CIP will provide the District with a sewer system planning road map for the future.

1.4 SCOPE OF WORK

The scope of work for this Sewer Master Plan includes the following tasks:

- Task 1: Project Management and Meetings
- Task 2: Data Collection and Model Review
- Task 3: Current and Future Sewer System Flows
- Task 4: Sewer System Collection Design Basis
- Task 5: Hydraulic Model of the Sewer System
- Task 6:Capital Improvement Program
- Task 7: Sewer System Master Plan Final Report

1.5 DATA SOURCES

For the preparation of this report, the District staff supplied many reports, maps and other sources of information. In addition, material was obtained from other sources such as United States Geological Survey (USGS) and Environmental Systems Research Institute, Inc. (ESRI). In addition, multiple meetings with District staff were held to obtain a thorough understanding of the District's information and needs. Pertinent materials included historical water production and billing data, planning and development information, aerial photography and GIS information. Various reference documents including previous studies conducted by MWH for the District's system were used for the preparation of this report. A complete list of reference documents is provided in **Appendix A**.

1.6 ACKNOWLEDGEMENTS

MWH wishes to acknowledge and thank all District staff for their support and assistance in completing this project. Special thanks to Ed Muzik (General Manager), Joseph Glowitz (Project Manager), and Martha Ostrander (Associate Engineer).

1.7 PROJECT STAFF

The following MWH staff was principally involved in the preparation of this Sewer System Master Plan:

Principal-in-Charge:	Ajit Bhamrah, P.E.
Project Manager:	Jeff Mohr, P.E.
Project Engineer:	Alok Pandya, P.E.
Staff Engineers:	Joyce Lee, P.E.
	Jinny Huang
	Ganesh Krishnamurthy
Technical Review:	David Bouck, P.E.
	Geoff Carthew, P.E.

1.8 SEWER MASTER PLAN ORGANIZATION

This Sewer System Master Plan is divided into six sections. Section 2 provides a description of the District's service area. Section 3 discusses the planning and sewer system design criteria. Section 4 provides an overview of the development of the hydraulic model. Section 5 describes the proposed collection system and the evaluation of that system using the hydraulic model. Section 6 presents the recommended CIP for the District's sewer system along with the anticipated costs.

1.9 ACRONYMS AND ABBREVIATIONS

To conserve space and improve readability, abbreviations have been used in this report. Each abbreviation has been spelled out in the text the first time it is used. Subsequent usage of the term is usually identified by its abbreviation. The abbreviations used are shown in **Table 1-1**.

Table 1-1
Acronyms and Abbreviations

Name	Abbreviation
Advancement of Cost Estimating International	AACEI
Capital Improvement Program	CIP
Environmental Systems Research Institute	ESRI
feet per second	fps
gallons per capita per day	gpcd
gallons per day per acre	gpd/acre
gallons per minute	gpm
Hi-Desert Water District	District
million gallons per day	mgd
Opinion of Probable Construction Cost	OPCC
peak dry weather flow	PDWF
San Bernardino Association of Governments	SANBAG
Sewer Master Plan	SMP
Southern California Association of Governments	SCAG
United States Geological Survey	USGS
Water Duty Factors	WDF
Water Reclamation Facility	WRF

Section 2
Service Area and Phasing Description

This section presents a brief discussion of land use classifications and wastewater flow projections for the District's service area.

2.1 SERVICE AREA AND LAND USE

The District's service area contains the entire Town of Yucca Valley along with some unincorporated areas. The District is divided topographically into the Yucca Valley area in the south and the Yucca Mesa area in the north. The Yucca Valley and Yucca Mesa areas are separated by the Sawtooth Mountains which lay generally east-west through the center of the District. The Yucca Valley area ranges in elevation from about 2,800 to 3,400 feet above sea level, while the Yucca Mesa area north of the Sawtooth Mountains ranges from 3,200 to 3,600 feet above sea level. The topography within the District varies widely, ranging from a valley flood plain to steep mountains. The Yucca Valley and the Yucca Mesa comprise two major drainage basins, with several sub-basins within them. The Yucca Mesa area generally drains to the north and east, while the Yucca Valley area drains predominantly to the east. This drainage and topography is critical for configuring gravity sewers and location of the treatment facility. The area has a very dry climate with hot summers and cool winters. The District's service area receives an annual average precipitation of approximately about 4 inches.

Figure 2-1 depicts the service area boundary for the District's sewer system and the land use classifications within the service area. General Plan land use information for the Town of Yucca Valley was obtained from San Bernardino Association of Governments (SANBAG) website in Geographical Information Systems (GIS) format.

Land use categories with similar characteristics are grouped together for planning purposes. For example, land use categories such as General Commercial, Mixed Use Commercial, Neighborhood Commercial etc. are lumped into a single Commercial land use category. These consolidated land use categories are used for estimating projected water demands for the District's service area.

2.2 YUCCA VALLEY AND YUCCA MESA SERVICE AREAS

The District's service area covers two distinct drainage areas. Of these, groundwater quality is currently a concern only in the more populated Yucca Valley drainage area. Due to the low density of development and minimal use of groundwater for potable purposes in Yucca Mesa, a sewer system is not proposed there. If in the future groundwater quality impacts arise due to the use of septic tanks, a separate sewer system and treatment facility would be constructed. This Master Plan, therefore, addresses the wastewater collection requirements only for the Yucca Valley drainage area.

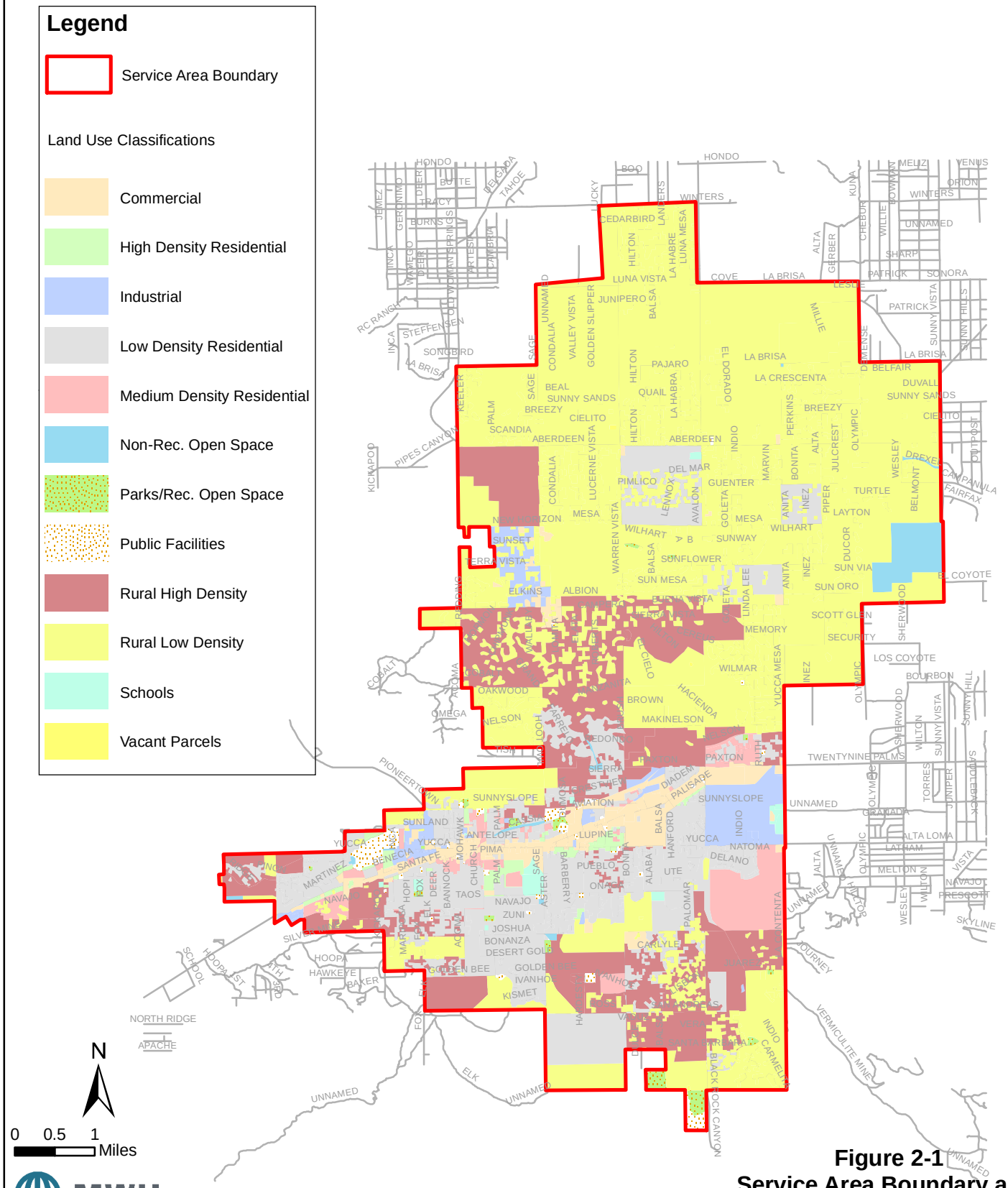


Figure 2-1
Service Area Boundary and Land Use Classifications

2.3 PHASED CONSTRUCTION OF COLLECTION SYSTEM

The construction of the wastewater collection and treatment system will occur in phases. MWH evaluated several sewer system phasing alternatives for this Sewer Master Plan. The District adopted a three-phase boundary shown in **Figure 2-2**.

Figure 2-2 shows the extent and the location of these phase areas within the District's service area. As shown in the figure, this master plan covers the full extent of the Yucca Valley area. For the purposes of this master plan, the total drainage area covered by the three phases (and served by the Water Reclamation Facility) is called the Yucca Valley Sewer System Boundary.

The choice of the optimum phasing strategy is affected by the required time between phases. For example, if there are long intervals between phases, then postponing major capital expenses is an effective way to reduce the present worth of the capital costs. On the other hand, with short intervals between construction, there is less incentive to delay major capital cost expenditures for future phases.

For the purposes of this evaluation, the WRP is assumed to be in operation by 2012, at which point the first customers will be connected to the sewer system. The two subsequent phases will be constructed with three year intervals between completion dates.

The phasing strategy targets the commercial corridor along Hwy 62 and high density residential areas near drinking water wells in Phase 1, followed by the higher density residential customers located south of the Yucca Wash in Phase 2, and finally captures the flows north of the wash in Phase 3.

The Phase 1 area is bounded by the Nelson Avenue to the north, Onaga Trail to the south, La Contenta Road to the east, and Rockaway Avenue to the west. It is assumed that the customers in the Phase 1 area will be connected to the sewer system by 2012.

The Phase 2 area is bounded by Onaga Trail to the north, Golden Bee Drive to the south, La Contenta Road to the east, and Kickapoo Trail to the west. Phase 2 area is assumed to be connected to the sewer system in year 2015.

The Phase 3 area covers the remaining residential customers on the west end of the District's service area along with some low to medium density residential customers located north of the Yucca Wash up to Cobalt Road. It is assumed that the Phase 3 area will be connected to the sewer system in year 2018. Densification will continue in the three phase areas and the cumulative build out wastewater flows of the three phase areas will represent the ultimate wastewater generation for the District's service area. After completion of the third phase, further increases in wastewater flow will result from development within the already-sewered area. **Table 2-1** summarizes the wastewater flow projections for the different phases. **Appendix A** lists all parcels by land use and projected wastewater flow within each phasing boundary. Wastewater flow projections are described in more detail in **Section 3**.

Table 2-1
Wastewater Flow Projections by Phase

Phase	Year 2012 Flow (mgd)	Year 2015 Flow (mgd)	Year 2018 Flow (mgd)	Build Out Flow (mgd)	Build Out Cumulative Flow (mgd)
Phase 1	1.40	1.49	1.59	3.48	3.48
Phase 2		0.41	0.44	1.20	4.68
Phase 3			0.56	1.42	6.09
Total	**1.40**	**1.90**	**2.58**	**6.09**	**-**

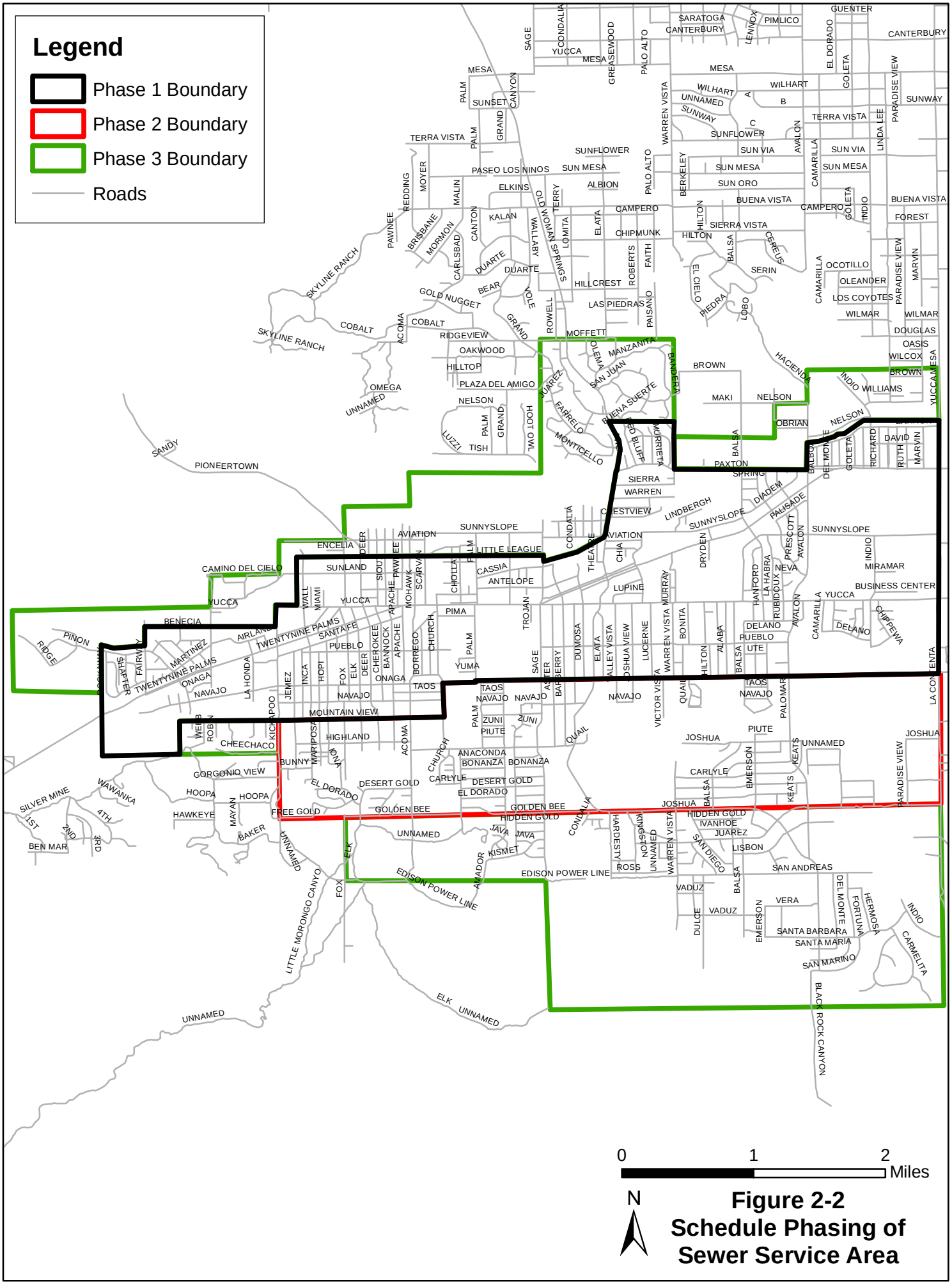


Figure 2-2
Schedule Phasing of Sewer Service Area

Section 3
Sewer System Planning Criteria

This section summarizes the District's planning and sewer system design criteria. System characteristics such as per capita flow and peaking factors are also discussed. These criteria are based on literature values, previous planning studies performed by MWH for the District's system, and the District's Standard Guidelines for Sanitary Sewer System Design and Construction (MWH, 2004). The sizing of the District's proposed sewer facilities is based on these criteria.

3.1 WASTEWATER FLOW CRITERIA

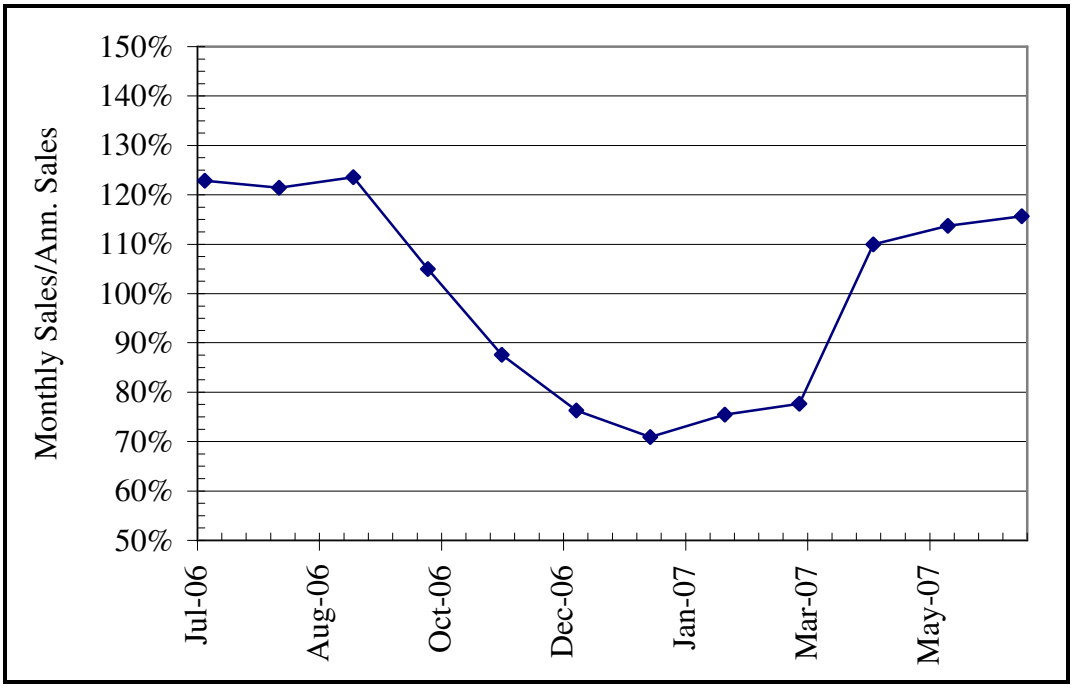
Two different approaches are used for wastewater flow projections. For near-term projections, existing water demands are used to predict wastewater flows when existing water customers are connected to the sewer system. For the longer term build-out scenarios, wastewater flows are projected on the basis of unit wastewater flow production for each type of land use.

3.1.1 Near Term Flow Projections

Because the proposed service area is not currently sewered, there is no accurate information to quantify or even estimate the actual per-capita wastewater flow production. However, potable water consumption data can be used to predict wastewater flow rates, when the water data is adjusted for uses that do not return to the sewer. In most communities, irrigation is the main use of potable water that does not return to the sewer. Because irrigation varies seasonally, the difference between average annual demands and winter demand is an indicator of irrigation demands.

Based on the District's water consumption data from July 2006 through June 2007 as shown in **Figure 3-1**, the lowest monthly winter water demand is approximately 70 percent of the average annual water demand. Because there is no data indicating how much of this difference is due to irrigation, MWH recommends assuming 80 percent of the average annual water demand will be returned as wastewater flow. For consistency, the near-term water demands are projected by using the 2.3 percent per year linear growth factor used for the District's July 2007 Water System Master Plan.

Figure 3-1
Seasonal Water Demand Variations



3.1.2 Future Flow Projections

Future wastewater flows are projected assuming that wastewater flows will be 80 percent of future water demands. Future water demands are estimated based on the Town of Yucca Valley General Plan land use information (obtained from San Bernardino County GIS) and water duty factors (WDF). WDFs for different land use classifications were developed as part of the District's Water System Master Plan (WSMP, MWH 2007).

A WDF is the average daily water use in gallons per day per acre (gpd/acre) of a given land use type. To estimate the water consumption for a particular area, the surface area expressed in acres is multiplied by the WDF. The WDF represents a typical water demand associated with a particular land use type. For example, the estimated water consumption of a 50-acre commercial area (with a WDF of 1,000 gpd/acre) is 50 acres times 1,000 gpd/acre, which equals 50,000 gpd (or 35 gpm). A sewage duty factor (SDF) can be assumed as 80 percent of the WDF. WDFs used for estimating the District's future water demands and sewage flows are shown in **Table 3-1**.

Table 3-1
Water Duty Factors

Land use Type	WDF(Planning) (gpd/acre)(1)	SDF(Planning) (gpd/acre)(1)
Commercial	1,000	800
Industrial	850	680
Low Density Residential	440	352
Medium Density Residential	1,025	820
High Density Residential	3,520	2816
Rural Low Density Residential	130	104
Rural High Density Residential	330	264
Non-Recreational Open Space	0	0
Parks/Recreational Open Space	280	224
Public Facilities	800	640
Schools	620	496

(1) WDFs used for projecting future demands.

3.2 WASTEWATER FLOWS BY SOURCE TYPE

3.2.1 Phase 1 Residential Flows

Based on year 2007 billing information, the average residential water usage in the District is approximately 260 gpd per connection, which translates to 102 gallons per capita per day (gpcd), based on an average of 2.55 persons per connection. The 80 percent wastewater return fraction when applied to the 102 gpcd yields approximately 82 gpcd of sewer flow. MWH compared the District's proposed residential sewer flows with the residential sewer flows for Lake Havasu City (City) which has similar land use and water demands to that of the District. The City is in the process of constructing a new sewer system and has used 80 gpcd as wastewater return flow for sizing their sewer system which is comparable to the residential sewer flows computed for the District.

3.2.2 Phase 1 Commercial Flows

Commercial flows are defined as wastewater flows that are generated by commercial businesses such as restaurants, car washes, laundry facilities, etc. These flows are estimated by multiplying the employment population with the estimated employee wastewater flow. For areas such as the District's service area, commercial wastewater flows are estimated to be 80 percent of the water consumption at commercial land use classifications.

3.2.3 Industrial Flows

Industrial wastewater flows vary significantly based on factors such as the type, the size, the operational techniques, and the presence of on-site treatment facilities for wastewater. Variation

in industrial peak flows are significant because of the method of operation and work shifts. There are only a few industrial users present in the District's service area. For industrial users, the District will review the applicant's requested sewer capacity on a case-by-case basis.

3.2.4 Infiltration/Inflow

Studies have shown that for newly-constructed sewers, the infiltration component is insignificant. For the District's system, such extraneous flows have been accounted by using conservative per capita flows. In addition, taking into account the dry climate for the District's service area, it is expected that inflow will be negligible. Manholes located in low-lying areas should be watertight in their design to avoid inflow problems caused by flash-floods.

3.3 HYDRAULIC DESIGN CRITERIA

3.3.1 Peak Design Flow

Taking into account the limited precipitation and the dry weather, the District's sewer system shall be sized to accommodate the peak dry weather flow (PDWF) observed within the District's service area.

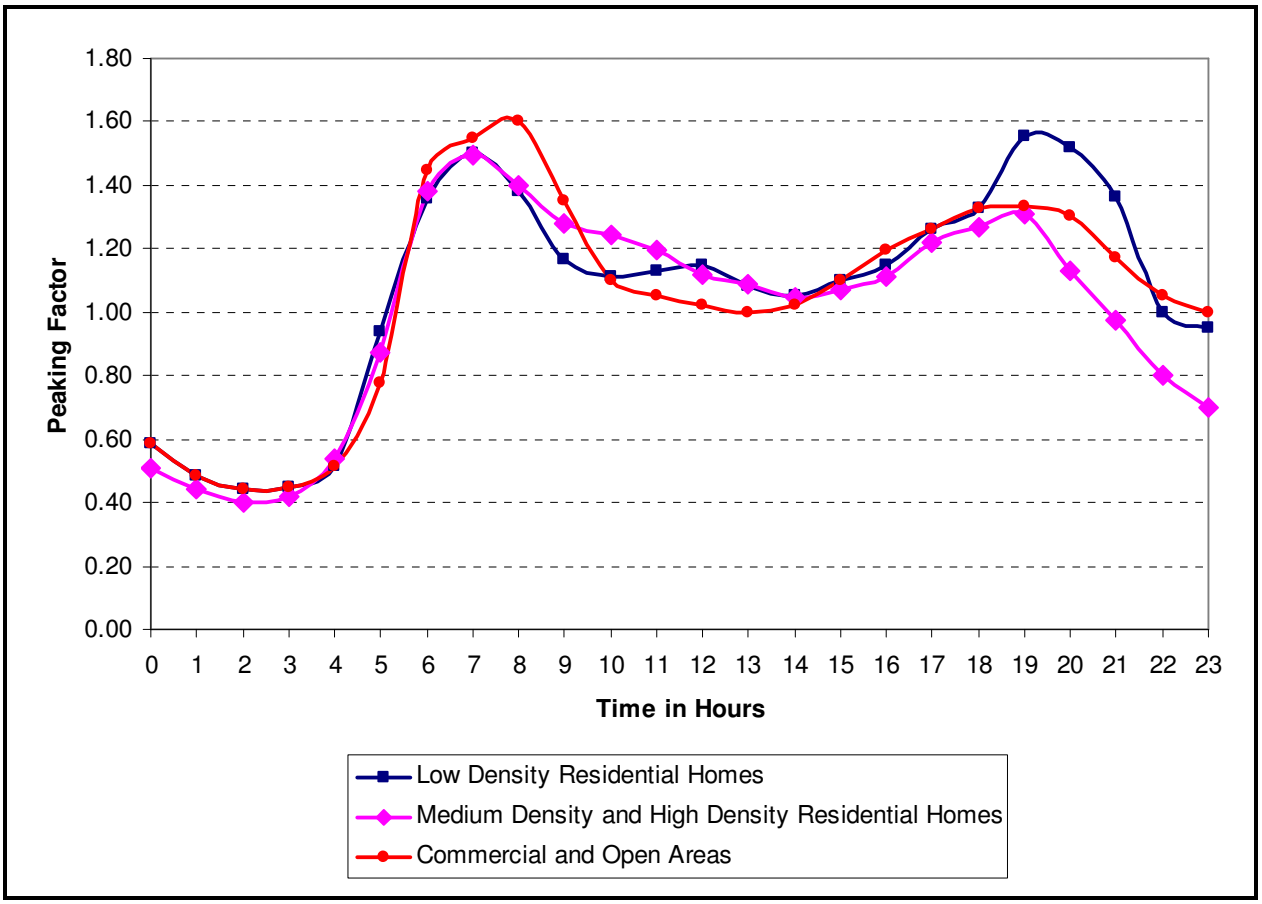
- For collector sewers up to 18-inch in diameter, the design peak flow should be equal to 3 times the average day flow.
- For trunk sewers greater than 18-inch in diameter, the design peak flow should be equal to 2.5 times the average day flow.

The District pipelines have been sized to accommodate additional wet weather flows when the design peak flows are greater than 3.0 times the average day flow. Additional pipeline capacity is accounted for in the pipeline design criteria, d/D (flow depth/sewer diameter) ratio, listed in **Section 3.3.4**.

3.3.2 Peaking Factors

Typical diurnal curves (from field monitoring data for similar agencies in southern California) for different land use classifications are presented on **Figure 3-2**. These curves represent the variation in sewer flows for each land use type during a 24-hour period. This pattern has been used in the hydraulic model along with the peaking factors above in **Section 3.3.1**.

Figure 3-2
Typical Diurnal Curves



3.3.3 Minimum Collection Sewer Size

No sewer shall be less than 8-inches in diameter except at locations authorized by the District. The minimum diameter of 8-inches is suggested for ease of cleaning and maintenance.

3.3.4 d/D Ratio

Typically, sewer systems are designed to account for extraneous flows by designing pipes to have a d/D ratio of 0.5 for PDWFs. For example, when peak dry weather flow conditions are exceeded, pipelines designed at a maximum d/D ratio of 0.5 will have 50 percent of pipeline capacity to accommodate additional flows. For the District's proposed sewer system,

- The maximum d/D ratio for all sewers that are less than or equal to 18-inch in diameter shall be 0.50.
- The maximum d/D ratio for all sewers that are greater than or equal to 18-inch in diameter shall be 0.66.

3.3.5 Slopes and Velocity

All trunk and collector sewers shall be designed with hydraulic slopes sufficient to result in mean velocities at the average day rate of flow of not less than 3 feet per second (fps). The mains shall be designed to meet the minimum slope criteria of 0.4 percent. The maximum allowable velocity in the sewer shall not be greater than 10 fps.

3.3.6 Manholes

Manholes shall be installed on sewers at all changes in slope, size of pipe, or alignment and at all intersections of main line sewers. The maximum spacing allowable between manholes is 500 feet unless otherwise approved. The system planning criteria are summarized in **Table 3-2**.

Table 3-2
System Planning Criteria

Planning Criteria	Value
Per Capita Flow	
Flow Generation Rate	Per Land Use(1)
Velocity	
Minimum	3 fps
Maximum	10 fps
d/D Ratio	
For all sewers that are less than or equal to 18-inch in diameter.	0.5
For all sewers that are greater than or equal to 18-inch in diameter.	0.66
Manning's n (gravity mains)	0.013
Hazen-Williams C-factor (force mains)	120
Average Manhole Losses	0.1 feet
Peak Manhole Losses	0.5 feet

(1) Wastewater return fraction assumed to be 80 percent of the total flow generated per land use classification.

Section 4
Sewer System Hydraulic Model

This section describes development of the hydraulic model of the proposed sewer system. The hydraulic model is one of the primary analytical tools used to determine pipe sizing, and flow distribution. The model is also used in evaluating alternative pipe configurations and flows under Phase 1 and build out conditions.

4.1 MODEL DEVELOPMENT

MWH Soft's InfoSWMM (Version 6.0, Update No. 6) is used to model District's sewer system. InfoSWMM is a fully dynamic model based upon the EPA SWMM 5 engine, and utilizes the explicit solution of the Saint Venant equations, which permits accurate analysis of reverse flows and backwater conditions as seen in complex sewer systems. InfoSWMM is an extension to ESRI ArcGIS (Version 9.2), and this brings a powerful modeling system into a fully featured Geographical Information System (GIS), which permits all the advanced GIS functions to be utilized.

4.1.1 Infrastructure Data Input

Key information that is used for the development of the master plan hydraulic model includes:

- GIS file of street centerlines and parcels
- GIS file of District boundary
- GIS file of drainage washes
- GIS file of facilities
- GIS file of 3-foot elevation contours
- GIS file of existing and projected land use parcels
- GIS file of potential water demand
- HDWD Wastewater Collection Facilities Phase 1 – Trunk Sewer Line Preliminary Construction Drawings, October 2002
- Digital aerial photography coverage within the State Plan Coordinate System, in NAD83, California Zone V
- HDWD Standard Guidelines for Sanitary Sewer System Design & Construction, September 2004

4.1.2 Model Construction

The development of the hydraulic model is based on the District Standard Guidelines for Sanitary Sewer System Design & Construction, criteria described in **Section 3**, discussions from the Value Engineering workshop (June 2008), and good sewer design practices. The alignment of pipelines and placement of manholes are based on preliminary construction drawings (for trunks) and the standard guidelines for sanitary sewer design. The network model is shown on **Figure 4-1**. Pipelines and manholes constructed outside of the Phase 1 boundary line are drawn to represent sewage flows from outside the Phase 1 boundary. Elevations, slopes and manhole spacing for the pipelines and manholes outside of the Phase 1 service area are not established as part of this project.

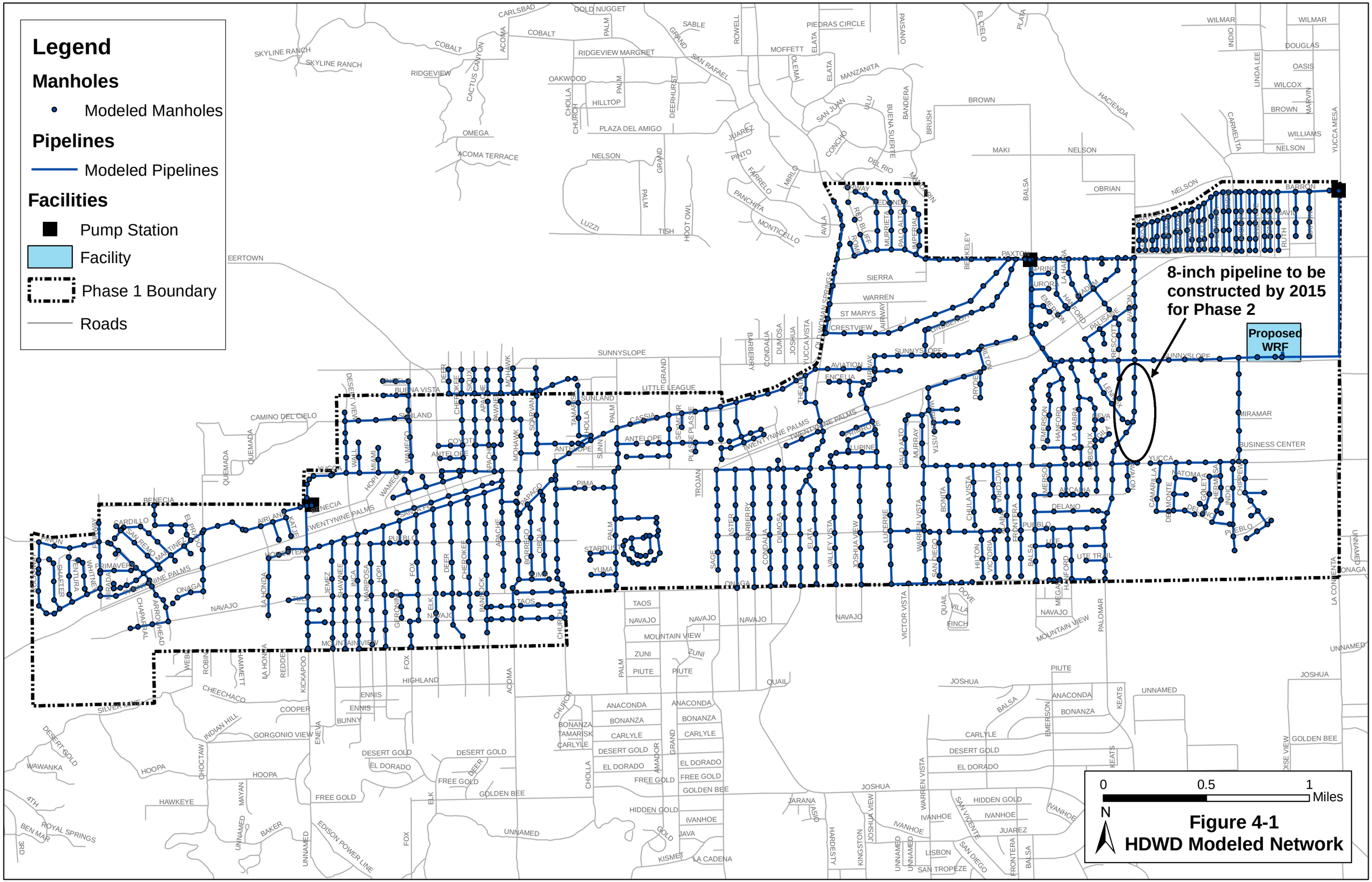


Figure 4-1
HDWD Modeled Network

Pipelines

Pipeline nomenclature in the District's sewer system is based on the diameter of the pipes. The sewer pipelines are grouped in one of the following three categories:

- **Mains**. Mains are 8-inch sewers that receive wastewater from individual service laterals.
- **Collectors**. Collectors are sewers up to 18-inches in diameter that receive wastewater from mains.
- **Trunks**. Trunks are sewers larger than 18-inches in diameter, that receive flow from mains or collectors.

The collector and main alignments are configured to follow the topography and utilize the public right of ways wherever possible. A number of collectors throughout the sewer system discharges flow into trunks that run west to east through the sewer service area. In October 2002, MWH and Warner Engineering prepared draft design drawings for a trunk sewer extending from Acoma Trail south of Highway 62 to the intersection of Balsa Avenue and Paxton Road. Wherever possible, that design was followed.

The model was constructed only for the Phase 1 area, although the ultimate build out flows from areas outside Phase 1 were included in the simulation to size the collectors and the trunks such that they are able to handle the higher flows under build out conditions.

Manholes

The pipelines are connected by manholes spaced no more than 500 feet apart. Based on MWH experience in sewer system design and the availability of commonly used cleaning equipment with the ability to clean pipelines up to 500 feet in single pass, manholes have been constructed in the model at a distance no greater than 500 feet apart.

4.1.3 Sewer Facilities

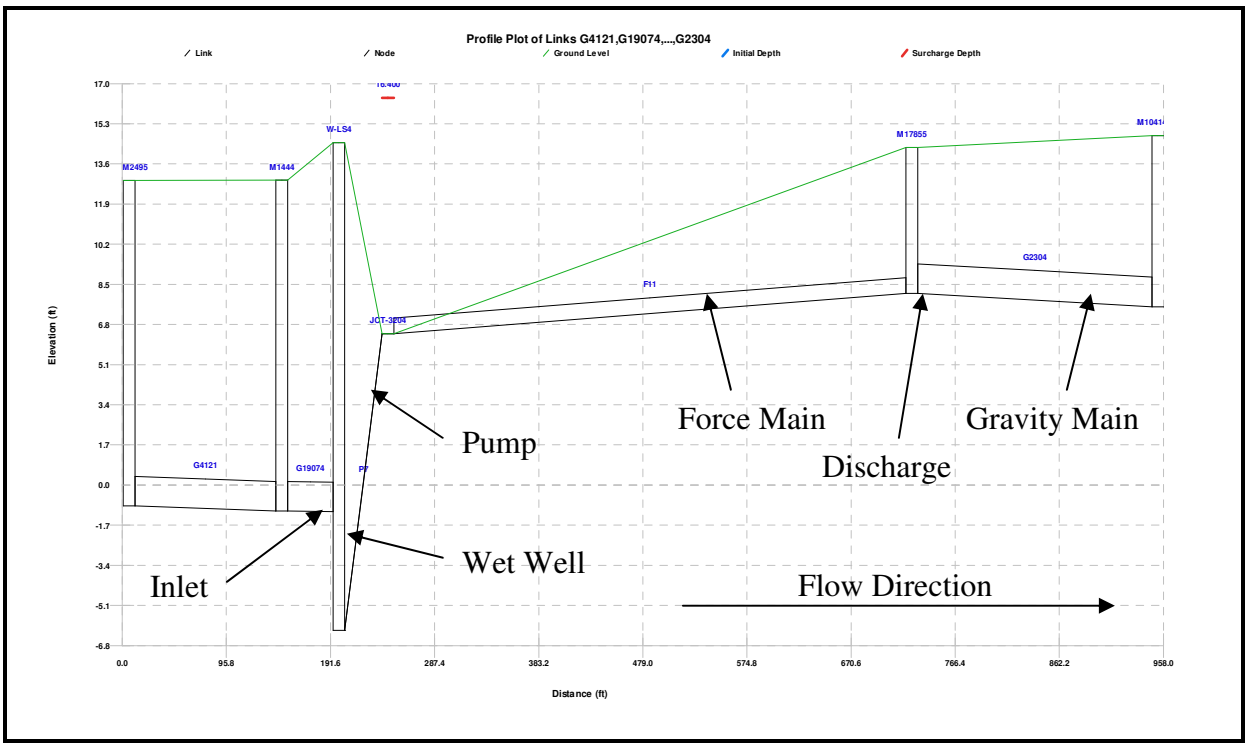
Pump stations have been included in the model to carry flow from a lower elevation to a higher elevation. Siphons have been modeled in place to help carry gravity-fed sewer across obstacles such as drainage washes or existing conduits.

Pump Stations and Wet Wells

An example of a modeled pump station and wet well is presented in **Figure 4-2**. Each lift station is modeled with a wet well, a pump and a discharge node. Information needed to model a wet well includes the area of the wet well, the invert elevation (bottom elevation) of the well, and the maximum depth (difference of the ground elevation and invert elevation). Invert elevations of the incoming and outgoing pipe of the lift station needs to be known to calculate the downstream and upstream offset information to be included in the pipes. Attached to the wet well is the pumping unit. Each pump unit in the model includes the pump's start up depth and shutoff depth, as well as its pump curve. The pump curve is modeled with a multi-point curve. For the District model, a pump has not been sized, therefore the curve is a vertical line on the pump curve, where flow on the x-axis and the head on the y-axis, which designates a fixed value of flow and head pressure.

Flow is then pumped into force mains. Force mains are pressurized pipes that carry flow from a lift station to a discharge point, which then flows downstream by gravity.

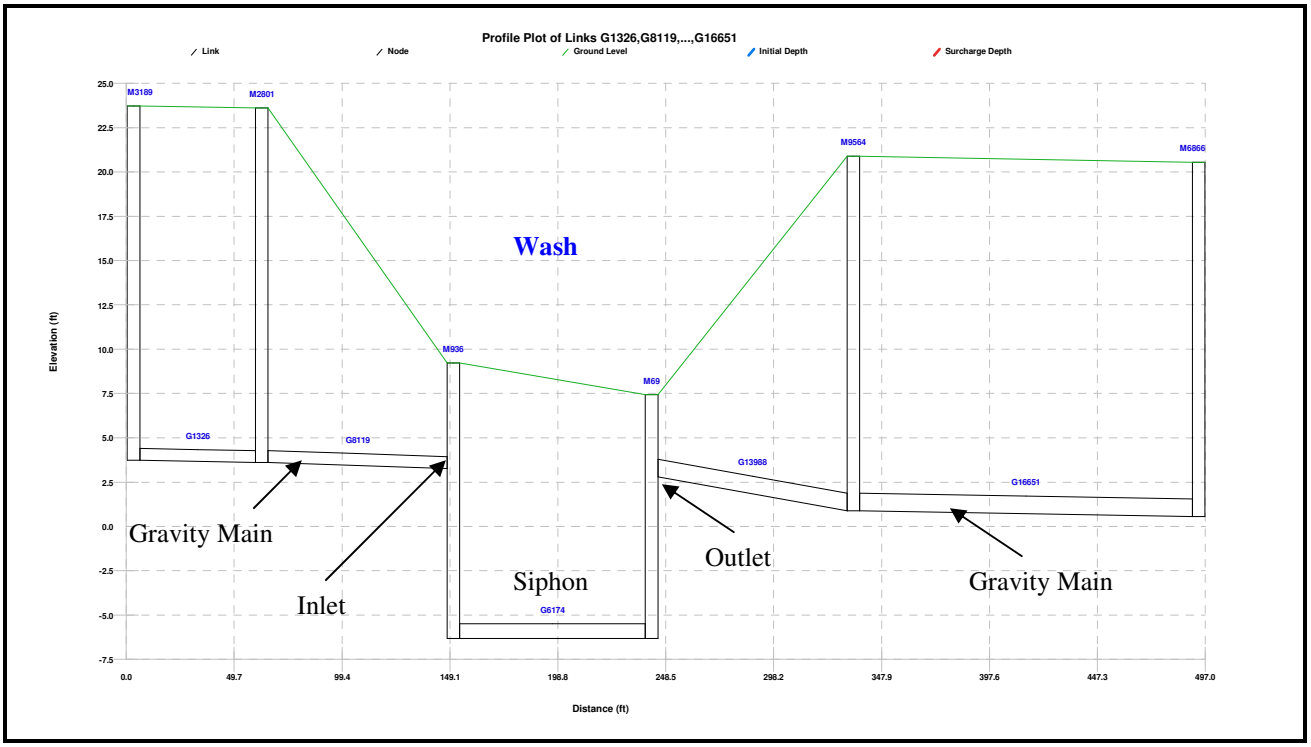
Figure 4-2
Profile of Pump Station



Siphons

The proposed collection system has three inverted siphons as described in detail in **Section 5**. Inverted siphons are gravity pipes that transport flow under a river or an existing interfering structure, such as the two washes that run through the District service area. For the proposed sewer system, the inverted siphons help carry flow under the wash. Gravity flow is maintained when there is enough flow at one end of the siphon to force flow to come out of the other end. Siphons are cleaned by lowering a pump at the downstream section of the siphon and flushing any stagnant debris that have collected in the siphon over time. The model includes three single barrel invert siphons. The profile of a siphon modeled for the sewer system is show on **Figure 4-3**.

Figure 4-3
Profile of Modeled Siphon



Outfalls

For modeling purposes, outfall is defined as a point at which flows exit the system. Typically, this point would be at a hydraulic cut off, such as a treatment facility. In the District model, it is the point where the flows leave the sewer collection system and enters the water reclamation facility (WRF), east of the sewer service area. Information needed to model an outfall in InfoSWMM is its invert elevation, which has been assumed to be the lowest point of the pipe network. The District sewer system has two outfalls modeled; one for flows leaving the Phase 1 area and another one for the build out flows.

Section 5
Proposed Sewer System

Using the service area information described in **Section 2**, the design criteria described in **Section 3**, and the hydraulic model described in **Section 4**, MWH developed a proposed sewage collection system for analysis. This section describes how the model is used to plan the proposed sewer system.

5.1 SYSTEM MODELING EVALUATION

The collection system hydraulic model was created in InfoSWMM as described in **Section 4** and was used to size and evaluate the sewer system performance under various scenarios.

5.1.1 Model Scenarios

MWH prepared the hydraulic model to include all pipelines within the Phase 1 boundary, as well as a few pipelines outside of the Phase 1 boundary that simulate future flows in the Phase 2 and Phase 3 areas. The modeled pipelines within the Phase 1 boundary are sized according to future flow conditions, which attempts to model the maximum potential flow that will be generated within the service area.

Initial Flow Scenario

The initial flow scenario is used to verify that the collectors and trunks will satisfy the minimum velocity criterion of three feet per second (3 fps) following commissioning of the initial Phase 1 system. The initial average wastewater flow is approximately 1,000 gpm (1.40 mgd).

Build Out Model Scenario

The total average wastewater flow for the build out scenario is approximately 4,200 gpm (6.09 mgd). The build out flows are generated for the sewer service area using the land use classifications and water duty factors as described in **Section 3**. The sizing of the facilities are done based on build out diurnal patterns and build out peak flows as described in **Section 3**.

5.2 PROPOSED COLLECTION SYSTEM

The proposed collection system is shown in **Figure 5-1**. In general, the gravity-flow collection system follows the sloping topography from west to east and from south to north and eventually terminates at the proposed water reclamation facility (WRF) located to the west of La Contenta Avenue and north of Sunnyslope Drive at the eastern end of the sewershed area. Two pump stations are included for Phase 1 and a third for Phase 3. There are a number of specific design issues discussed below that warrant further investigation and confirmation in detailed design.

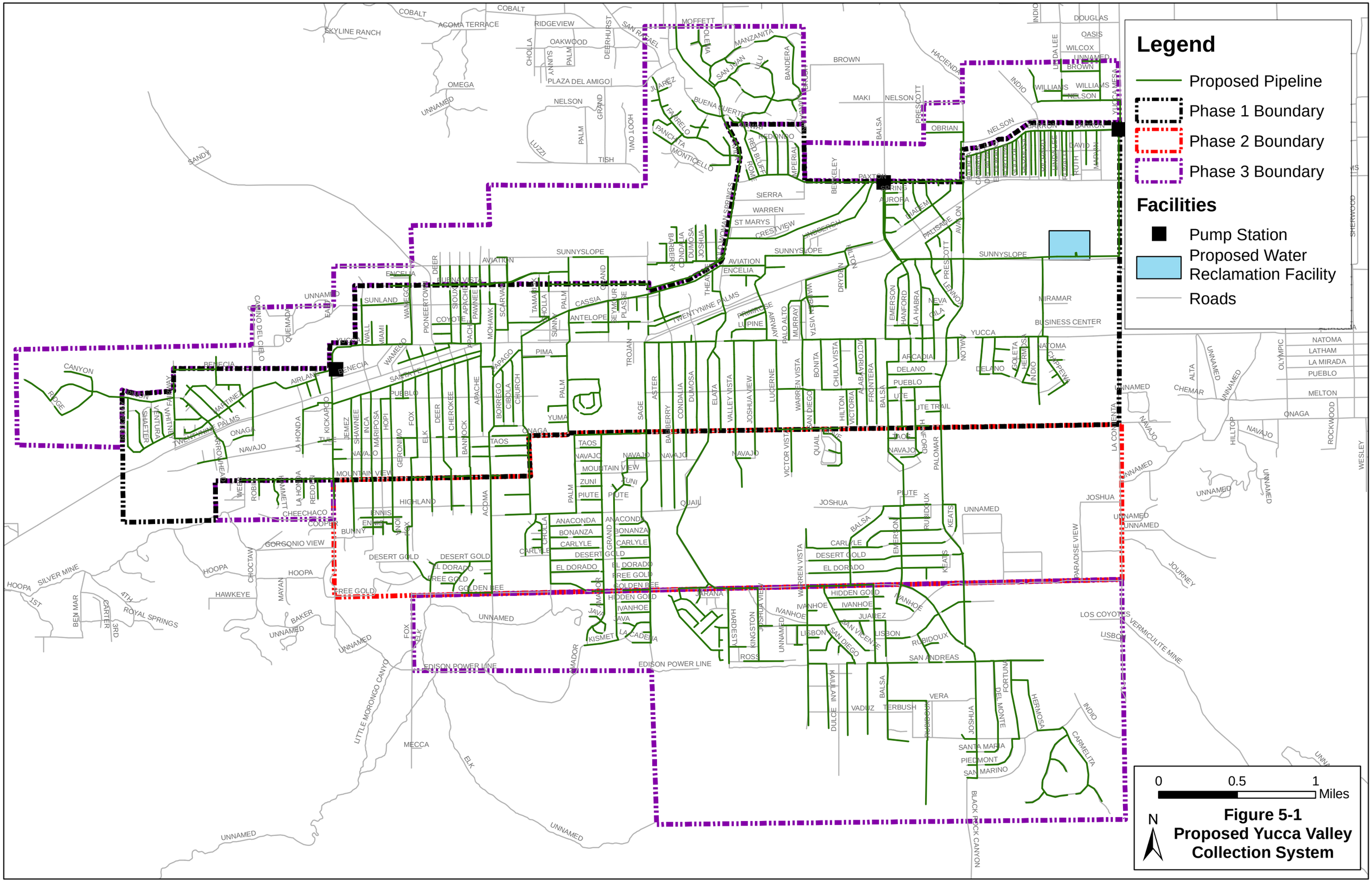


Figure 5-1
Proposed Yucca Valley Collection System

5.2.1 Pipelines and Manholes

Approximately 77 miles of pipeline and 1,153 manholes have been designed using the model in accordance with the criteria discussed in **Section 3**. The collection system includes two trunk lines, consisting of one portion generally along the south side of Yucca Wash upstream of a proposed pump station at Paxton Road and Balsa Avenue, and one in Sunnyslope Drive immediately upstream of the treatment plant.

Table 5-1 provides the average velocities for collectors and trunks as evaluated by the hydraulic model. Average velocities in these pipelines are shown in **Figure 5-2** and the maximum d/D for these pipelines are shown in **Figure 5-3.**

Table 5-1
Summary of Velocity at Average Flow Rate

Average Velocity, V	No. of Collector Pipeline Segments				No. of Trunk Pipeline Segments		
	10-inch	12-inch	15-inch	18-inch	24-inch	30-inch	36-inch
V < 2 fps	3*	4*	0	0	0	0	0
2 fps ≤ V < 3 fps	13	2	2	1	5	1	0
3 fps ≤ V < 4 fps	4	5	27	7	0	2	5
4 fps ≤ V < 5 fps	1	11	7	8	6	4	6
V ≥ 5 fps	9	22	19	6	10	13	3

* - average velocity in these pipelines is approximately 1.96 fps (no special design consideration recommended)

A summary of pipeline lengths by size is presented in **Table 5-2**. **Appendix B** shows the proposed collection system by size.

Yucca Wash Trunk Sewer

The Yucca Wash Trunk sewer begins as a 24-inch pipeline on Cholla Avenue just south of the wash and run northeast along the wash until it reaches Theatre Road, 330 feet east of Old Woman Springs Road and 140 feet south of Aviation Drive, at which the sewer becomes a 30-inch pipeline. The trunk sewer increases in size again at Airway Avenue and Sunnyslope Drive to a 36-inch pipeline until it ends at the Paxton Pump Station located near the intersection of Balsa Avenue and Paxton Road. During future conditions, the Yucca Wash Trunk sewer will collect the additional flow at Paxton Road, between Berkeley Avenue and Balsa Avenue.

Sunnyslope Trunk

The Sunnyslope Trunk is a 30-inch diameter double-barrel pipeline that begins at the discharge point of the Paxton Pump Station force main located at Avalon Avenue and Sunnyslope Drive. The first barrel of this pipeline will be constructed as part of Phase 1. The second barrel will be required by 2015. The trunk extends approximately 4,000 feet to the water reclamation facility (WRF) and picks up gravity flow from areas east of Avalon Avenue and south of Sunnyslope Drive.

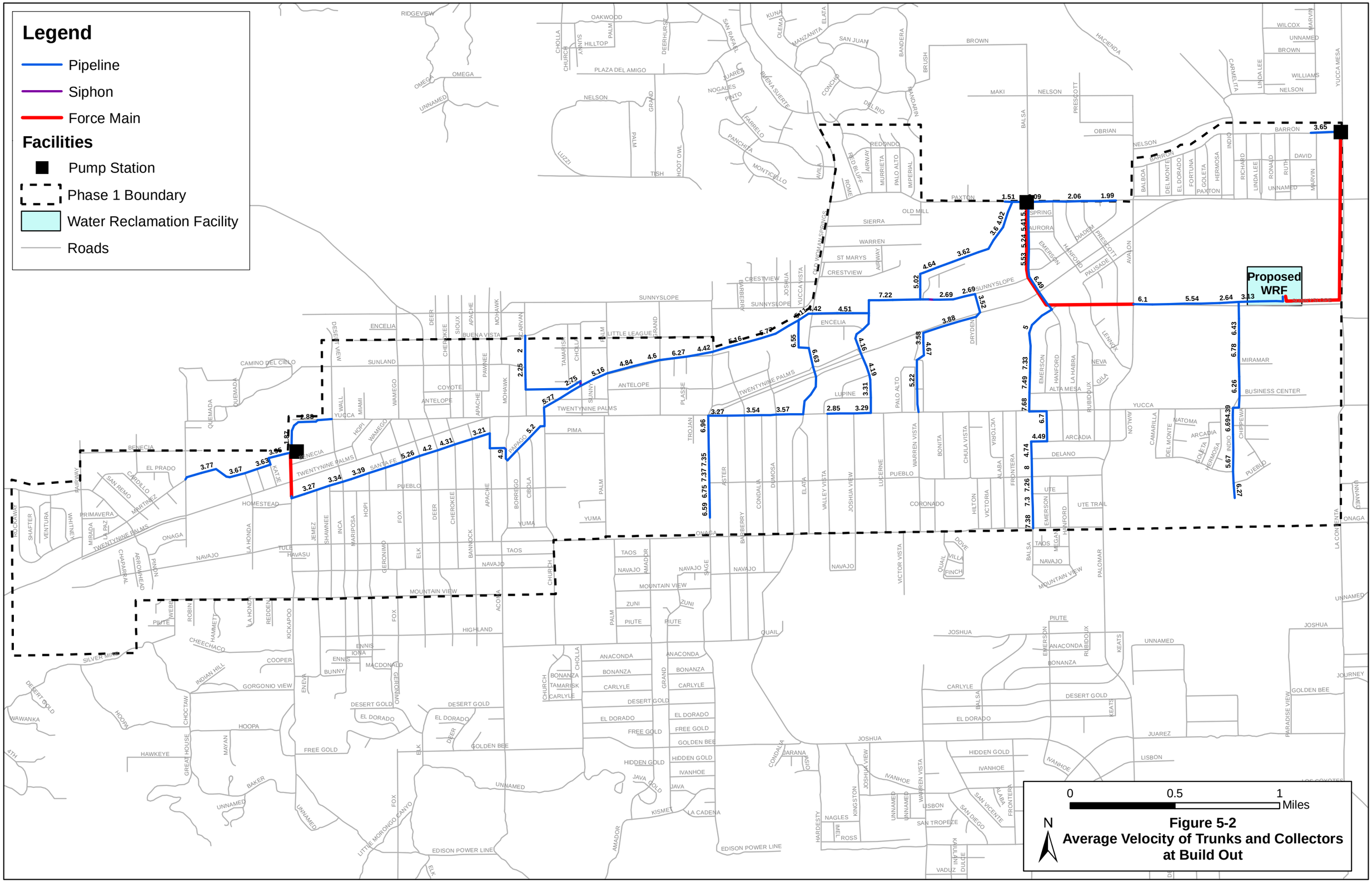


Figure 5-2
Average Velocity of Trunks and Collectors at Build Out

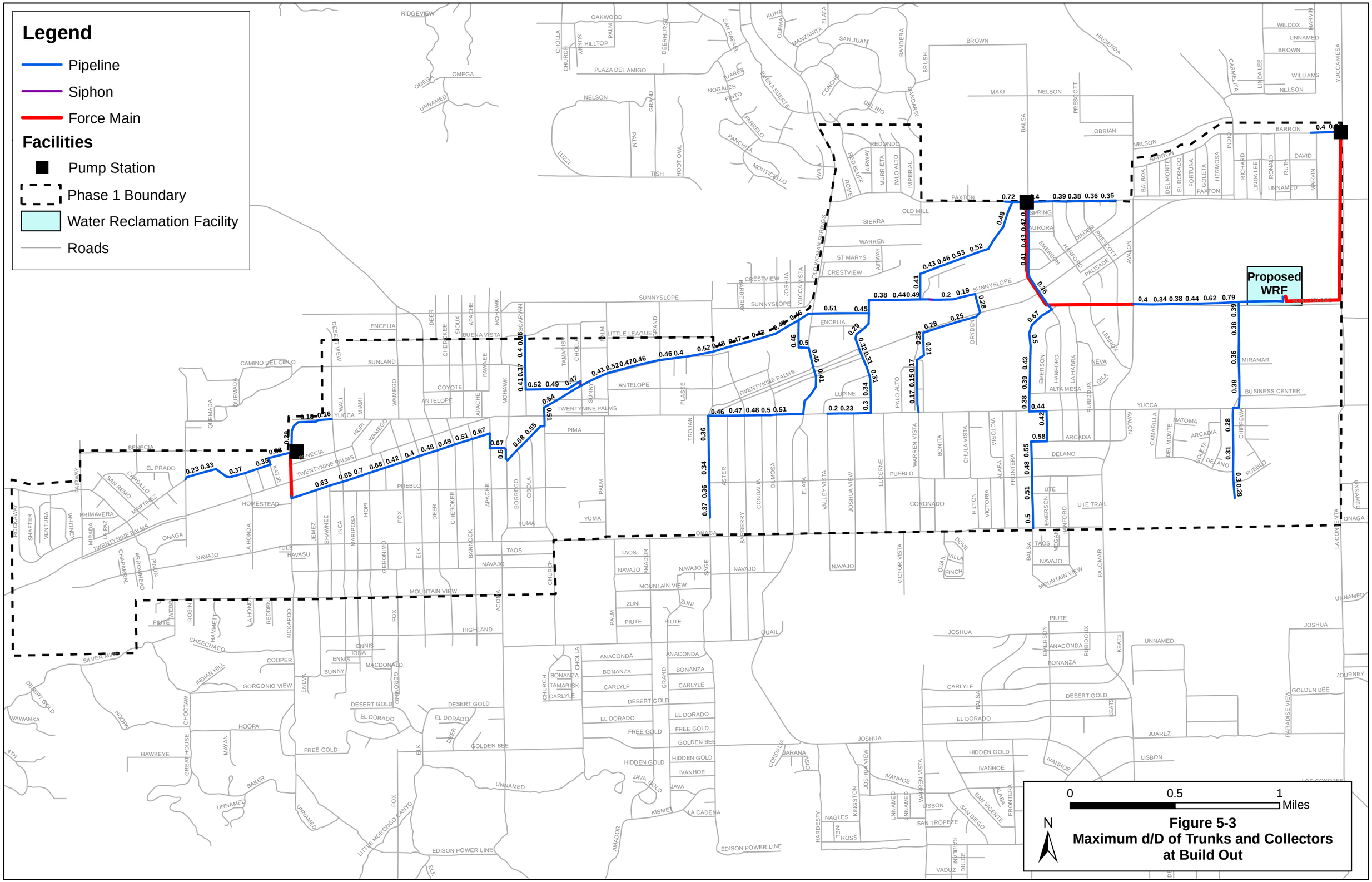


Figure 5-3
Maximum d/D of Trunks and Collectors at Build Out

Table 5-2
Phase 1 Pipelines

Diameter (in)	Gravity Sewers Length (ft)	Force Mains Length (ft)	Total Pipe Lengths Length (ft)
8	325,300	1,200	326,500
10	11,000	0	11,000
12	14,600	5,800	20,400
15	17,600	0	17,600
16	0	4,900	4,900
18	6,800	0	6,800
24	7,100	0	7,100
30	7,300	0	7,300
36	4,200	0	4,200
Total	**393,900**	11,900	405,800

A summary of manholes by depth is presented in **Table 5-3**.

Table 5-3
Phase 1 Manholes

Depth Category	Number of Manholes
depth ≤ 6	815
6 < depth ≤ 10	174
10 < depth ≤16	137
16 < depth ≤ 20	19
20 < depth ≤ 25	8
Total	**1153**

5.2.2 Pump Station, Wet Wells and Force Mains

The collection system requires three pump stations, as described below and summarized in **Table 5-4**.

Kickapoo Pump Station

The Kickapoo Pump Station is located at the northeast corner of Benicia Trail and Kickapoo Trail. The station receives flows primarily from residential neighborhoods west and northeast of the pump station, as well as from the Blue Skies Golf and Country Club. The pump station consists of a single below-grade wet well with submersible, non clog pumps. Only the motor control center will extend above grade. The discharge force main extends approximately 1,200 feet from the Kickapoo Pump Station to a gravity sewer at the intersection of Kickapoo Trail and Sante Fe Trail.

Paxton Pump Station

The Paxton Pump Station is located near Paxton Road and Balsa Avenue. The pump station conveys most of the service area flow. The double-barrel discharge force main extends

approximately 5,000 feet south on Balsa Avenue from the Paxton Pump Station and then east on Sunnyslope Drive to Avalon Avenue, where it discharges to a gravity sewer. Only one of the two pipes will be constructed with Phase 1. The additional capacity of the second force main will not be needed until Phase 3, although construction of the second pipe would add redundancy and reliability to the operation.

Paradise Valley Pump Station

The Paradise Valley Pump Station will be located near Yucca Mesa Road and Barron Avenue. The discharge force main will extend approximately 5,700 feet running south from the Paradise Valley Pump Station on La Contenta Road and then west on Sunny slope Drive to the WRF.

Table 5-4
Pump Station Summary

Pump Station	Initial Scenario		Buildout Scenario	
	Average Flow (gpm)	Peak flow (gpm)	Average Flow (gpm)	Peak flow (gpm)
Kickaoo Trail	200	600	800	2,400
Paxton & Balsa	1,600	4,800	6,900	20,700
Paradise Valley	100	300	300	900

5.2.3 Siphons

Three single barrel siphons are modeled in the system. A summary of the modeled siphons are shown in **Table 5-5**.

Table 5-5
Summary of Modeled Siphons

Location	Diameter (in.)
Sunnyslope Drive, approximately 200 feet east of Warren Vista Avenue	15
Acoma Trail, approximately 300 feet north of Papago Trail	18
Cholla Avenue and Coyote Trail	8

5.2.4 Specific Design Concerns

Easement for Antelope Main between Scarvan and Cholla

Residential flows collected by the 8-inch pipelines along Buena Vista Drive and Mohawk Trail are joined at Scarvan Road approximately 650 feet north of 29 Palms Highway. In order to avoid the construction of deep pipelines, the 8-inch pipeline that collects flow from the upstream residential areas is proposed to run east through private property south of the Apache Mobile Park.

The pipeline will continue east along the unpaved road until it reaches the wash and then run parallel to the wash until it joins another pipeline at Coyote Trail and Cholla Ave. **Figure 5-4** shows the proposed configuration. Further investigation may be required to confirm the feasibility of obtaining easements through private property.

Easements along 29 Palms Highway between Warren Vista and Dryden

Approximately 1,400 feet of a 15-inch diameter pipeline is proposed to run along 29 Palms Highway between Warren Vista Avenue and Dryden Avenue. Construction of a collector pipeline running south to north on Warren Vista Avenue would require an easement through a large commercial center, and rerouting of the collector to avoid an existing building. The proposed collector pipeline will run northeast parallel to the 29 Palms Highway, which will require a 700 foot easement along an existing parking lot south of the highway. The collector will continue northeast along the highway through approximately 700 feet of undeveloped property until it crosses the highway at Dryden Avenue. **Figure 5-5** shows the proposed alignment along the highway.

Table 5-6 includes a list of parcel numbers through which the alignments of the proposed sewer pipelines discussed above will pass.

Table 5-6
Easement Requirements for Proposed Alignments

Alignment	Assessor Parcel Number
Antelope Valley Main between Scarvan Road and Cholla Avenue	059504302
	059501339
	059533135
	059504301
	059504306
	059501341
	059504305
	059501340
Along 29 Palms Highway between Warren Vista Avenue and Dryden Road	060160125
	060160119

Avalon Avenue between Yucca Trail and Sunnyslope

The collection system piping installed in the area around Yucca Trail and Palomar Avenue/Avalon Avenue will be developed in two phases (Phase 1 and Phase 2). The proposed initial configuration is to install an 8-inch pipeline along Yucca Trail from Palomar Avenue to Rubidoux Avenue, which will collect flow from the network of pipelines south of the Yucca Trail and a few of the pipelines east of the Yucca and Palomar intersection. In Phase 2, the network of pipelines on Palomar Avenue just south of Yucca Trail will expand south, thus collecting a greater amount of flow. At that time, the 8-inch pipeline on Yucca Trail from Palomar Avenue and Rubidoux Avenue will be abandoned, and flows will then be diverted to a new pipeline that will run North along Palomar Avenue/Avalon Avenue from Yucca Trail to Sunnyslope Drive. This reduces the amount of flow to be pumped at the Paxton Pump Station, but delays the cost of the sewer in Avalon until Phase 2.

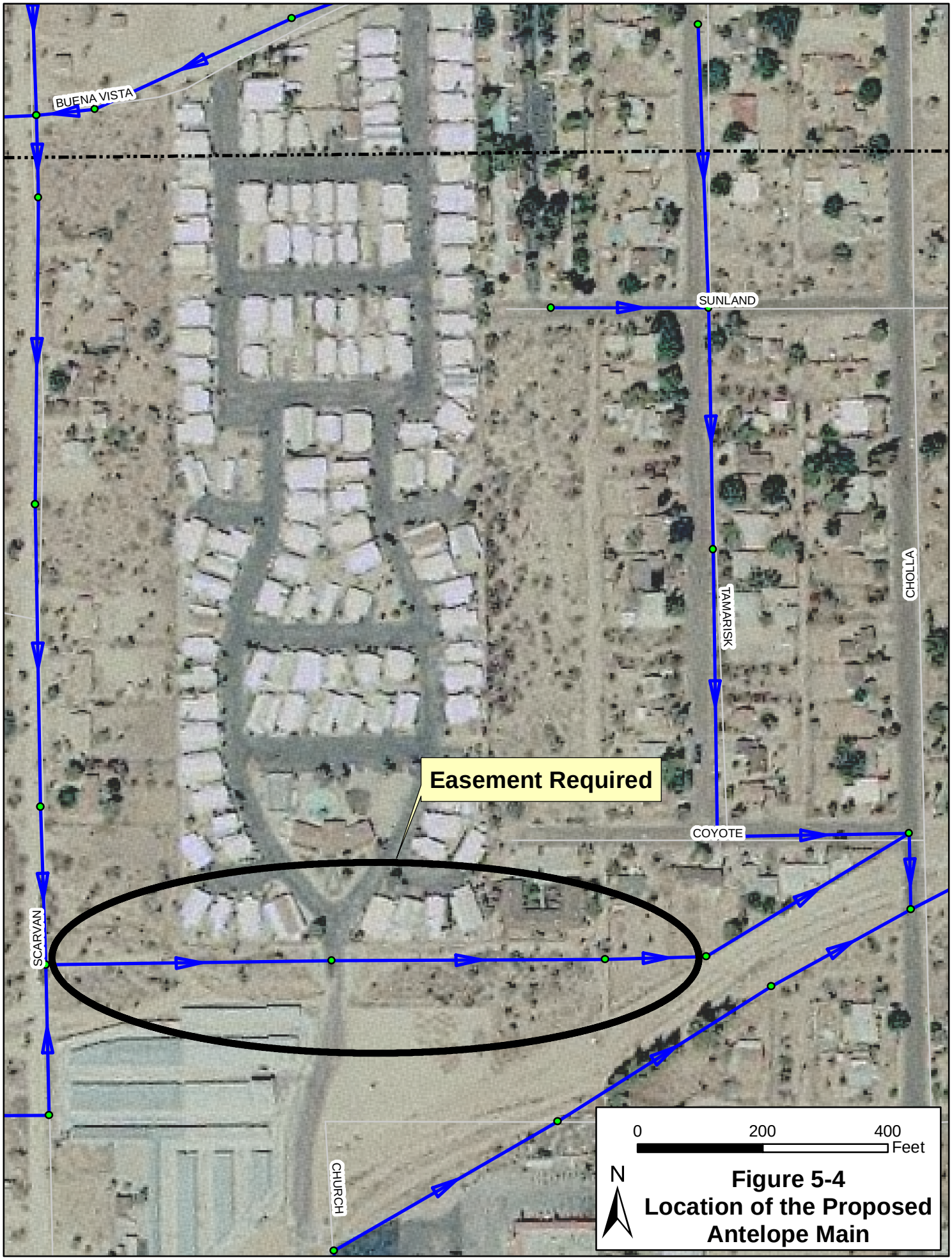


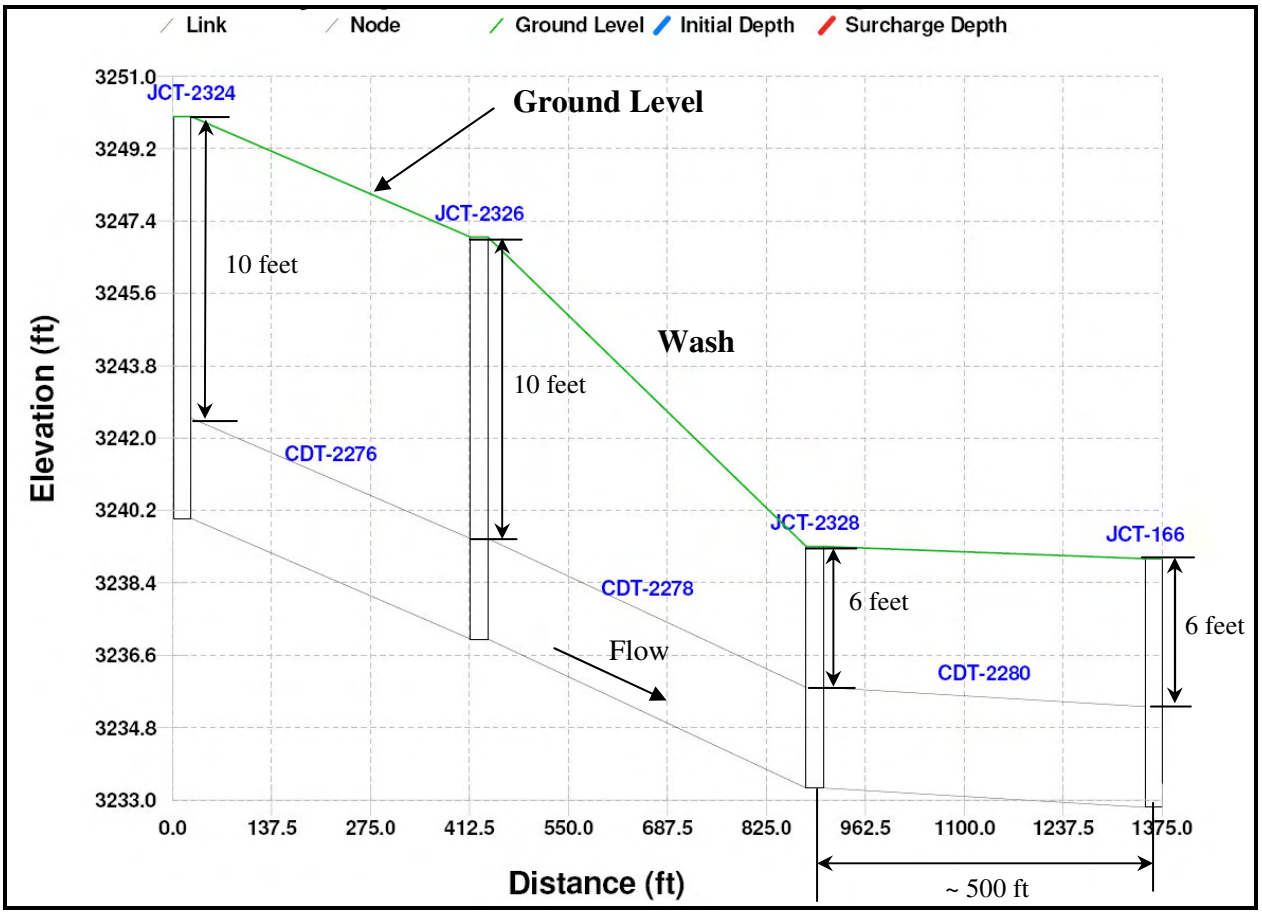
Figure 5-4
Location of the Proposed Antelope Main

Figure 5-5
Location of Proposed Collector along 29 Palms Highway between Warren Vista and Dryden

Shallow Cover at the Sunnyslope Trunk Sewer

The 30-inch trunk lines running west to east on Sunnyslope Drive will slope slightly against the grade just east of the wash that crosses Sunnyslope west of Indio Ave. Based on the HDWD Standard Guidelines for Sanitary Sewers, the minimum depth of the pipeline invert to the ground level must be at least 10 feet. In order to maintain sufficient flushing velocities and to maximize the available head into the WRF, the invert of the pipeline is only 6 feet from the ground elevation for approximately 500 feet. **Figure 5-6** shows the profile of the trunk pipeline with shallow manhole depths, and a section of pipeline that will be crossing the wash. Additional protection may be needed to the trunk pipeline that runs under the wash between Modeled Junctions 2326 and 2328.

Figure 5-6
Sunnyslope Trunk Sewer Wash Crossing



Section 6
Capital Improvement Program

The Capital Improvement Program (CIP) describes the elements of the proposed collection system and provides an implementation plan for the proposed facilities along with the associated costs.

6.1 COST ESTIMATING BASIS

The Opinion of Probable Construction Costs (OPCC) developed for this Sewer Master Plan (SMP) are suitable only for planning purposes. The estimate is developed in general accordance with guidelines established by the Association for the Advancement of Cost Estimating International (AACEI) and is most accurately described as a Class 5 cost estimate[1]. A list of assumptions made for developing this OPCC is listed in **Appendix C**.

6.2 PHASING OF THE PROPOSED SEWER SYSTEM AND ASSOCIATED COSTS

Section 2 describes how the wastewater collection service area will be expanded in three phases. This CIP is based on that phasing plan. Most of the core collection system will be built in Phase 1, with the system extended to cover additional areas in Phases 2 and 3.

6.2.1 PHASE 1 FACILITIES AND ASSOCIATED COSTS

Construction of facilities for Phase 1 of the District's proposed sewer system will begin in year 2010 and will be completed by 2012. Sewer flows for the Phase 1 region are estimated to be 1.40 mgd in year 2012. At build out, the sewer flows for the Phase 1 region are estimated to be 3.48 mgd. Complete length of the trunk mains required to collect and convey sewage to the proposed wastewater treatment plant is constructed during Phase 1. A summary of the collection system facilities to be constructed in Phase 1 is presented in **Table 6-1**. The breakdown of the capital costs by facility type is shown on **Figure 6-1**.

A detailed breakdown the proposed facilities by type and the associated costs is presented in **Appendix C**.

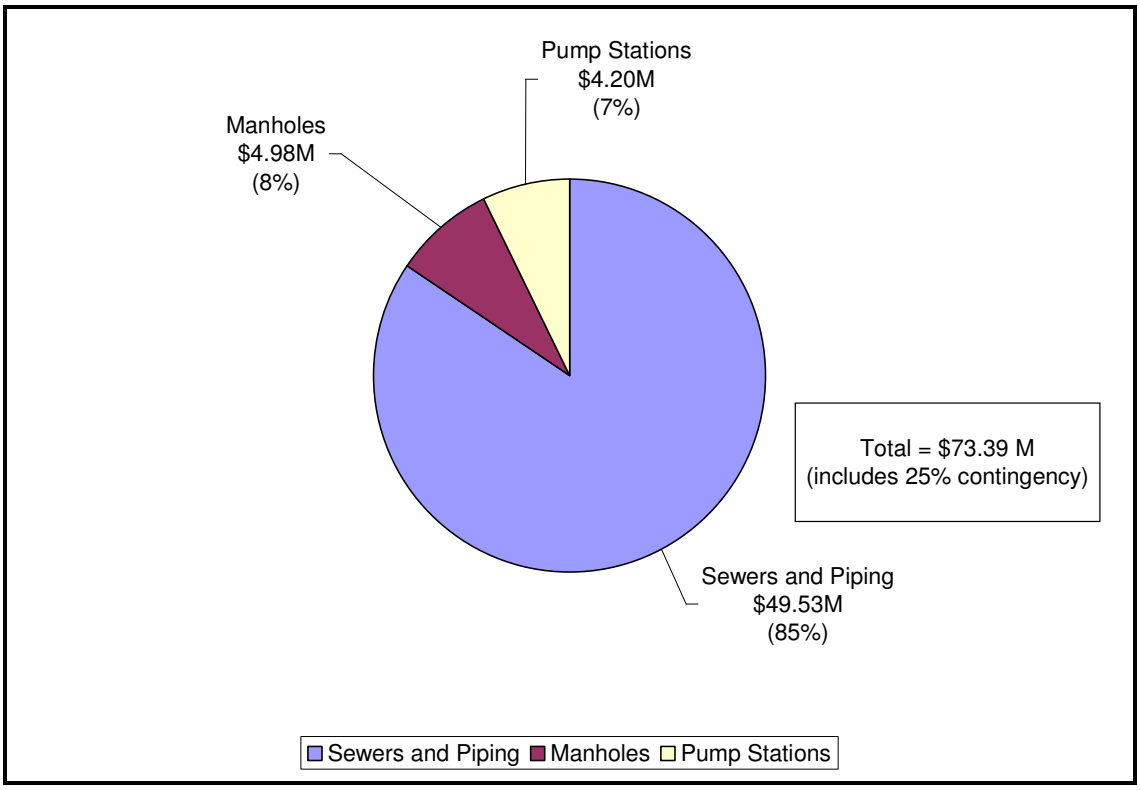
[1] *AACE International CLASS 5 Cost Estimate – Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. Typically, engineering is from 2% to 10% complete. They are often prepared for strategic planning purposes, market studies, assessment of viability, project location studies, and long range capital planning. Virtually all Class 5 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric techniques. Expected accuracy ranges are from –20% to –50% on the low side and +30% to 100% on the high side, depending on technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 1 hr or less to perhaps more than 200 hours may be spent preparing the estimate based on the project and estimating methodology (AACE International Recommended Practices and Standards).*

Table 6-1
Phase 1 CIP Costs

Facility	Cost ($)
Sewers and Piping	$49,530,000
Manholes	$4,980,000
Pump Stations	
Paxton Pump Station[1]	$0
Kickapoo Pump Station	$1,600,000
Paradise Valley Pump Station	$2,600,000
Subtotal	**$58,710,000**
Contingency (25 percent)	$14,680,000
Total Cost Phase 1	**$73,390,000**[2]

1) Costs for the Paxton Pump Station are included in the total costs for the wastewater treatment plant
2) Costs represent year 2008 costs. Actual construction costs may vary based on the timing of construction and other market factors

Figure 6-1
Phase 1 CIP Costs by Facility Type



6.2.2 PHASE 2 FACILITIES AND ASSOCIATED COSTS

Construction of facilities for Phase 2 of the District's proposed sewer system will begin in year 2013 and will be completed by 2015. Sewer flows for the Phase 2 region are estimated to be 0.41 mgd in year 2015. At build out, the sewer flows for the Phase 2 region are estimated to be 1.20 mgd. A summary of the collection system facilities to be constructed in Phase 2 is presented in **Table 6-2**. The breakdown of the capital costs by facility type is shown on **Figure 6-2**. No pump stations are proposed to be constructed in Phase 2.

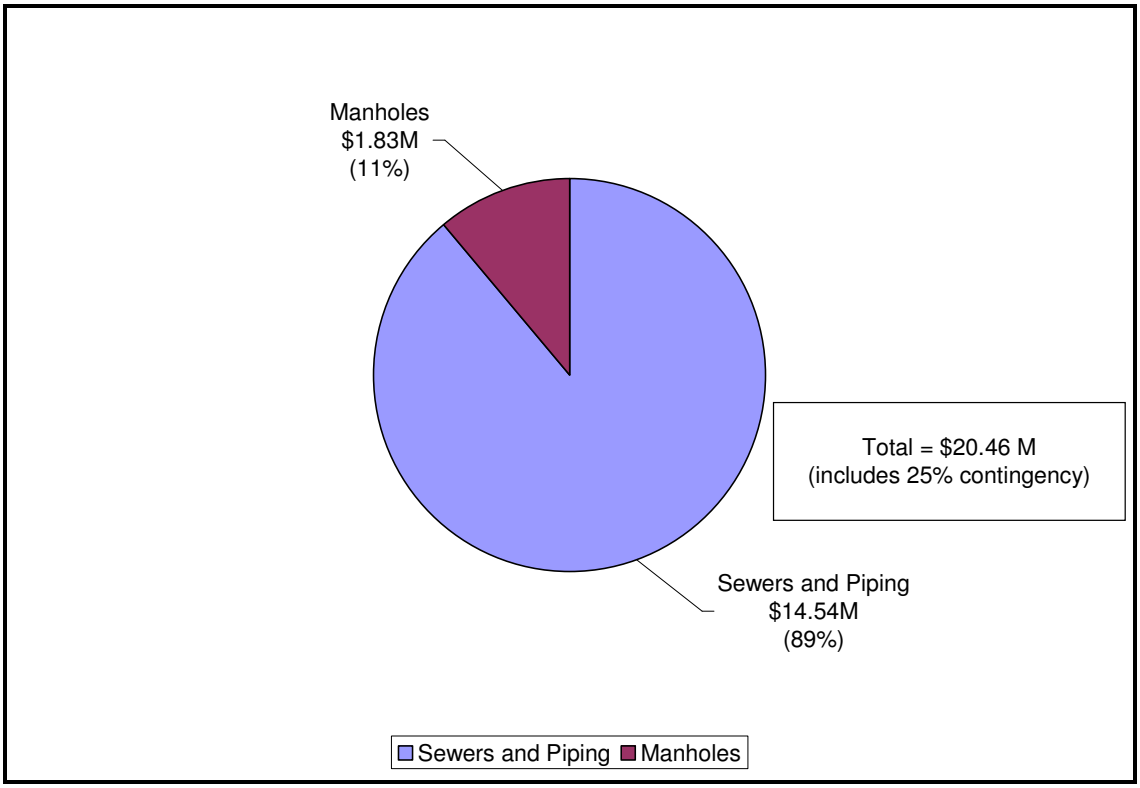
A detailed breakdown the proposed facilities by type and the associated costs is presented in **Appendix C**.

Table 6-2
Phase 2 CIP Costs

Facility	Cost ($)
Sewers and Piping	14,540,000
Manholes	1,830,000
Subtotal	**$16,370,000**
Contingency (25 percent)	$4,090,000
Total Cost Phase 2	**$20,460,000**[1]

1) Costs represent year 2008 costs. Actual construction costs may vary based on the timing of construction and other market factors

Figure 6-2
Phase 2 CIP Costs by Facility Type



6.2.3 PHASE 3 FACILITIES AND ASSOCIATED COSTS

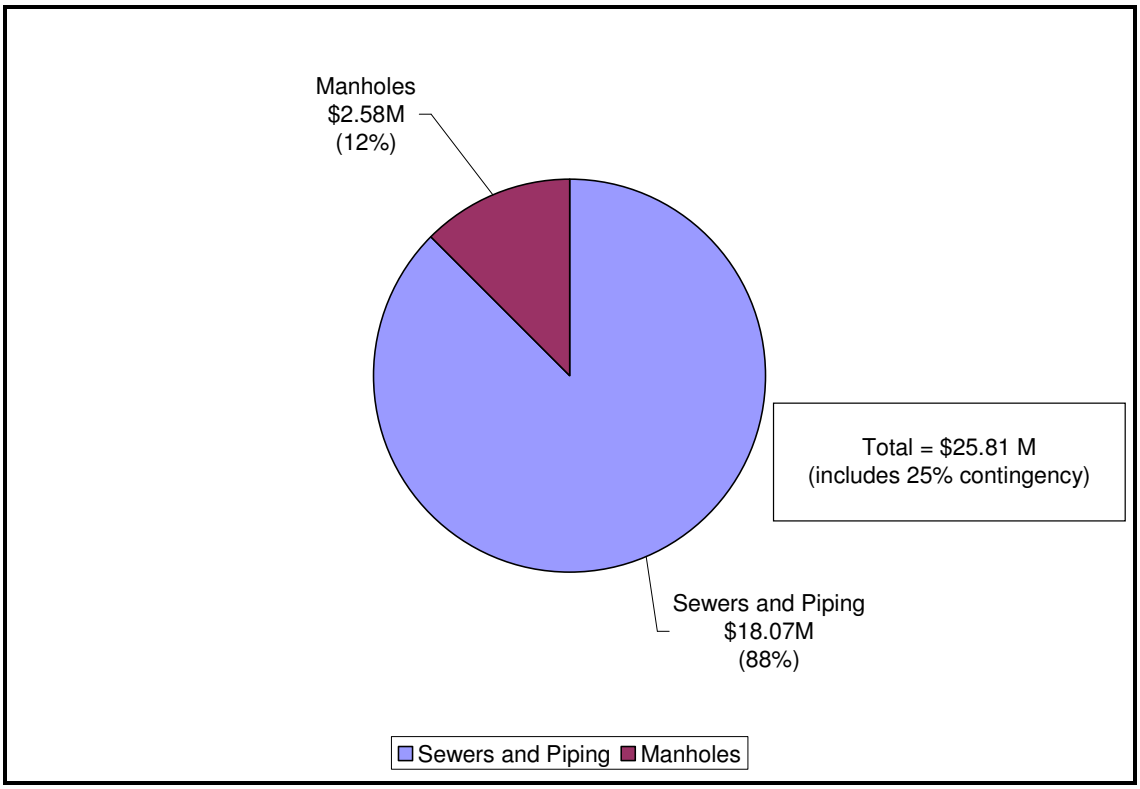
Construction of facilities for Phase 3 of the District's proposed sewer system will begin in year 2016. Sewer flows for the Phase 3 region are estimated to be 0.56 mgd in year 2018. At build out, the sewer flows for the Phase 3 region are estimated to be 1.42 mgd. A summary of the collection system facilities to be constructed in Phase 3 is presented in **Table 6-3**. The breakdown of the capital costs by facility type is shown on **Figure 6-3**. A detailed breakdown the proposed facilities by type and the associated costs is presented in **Appendix C**.

Table 6-3
Phase 3 CIP Costs

Facility	Cost ($)
Sewers and Piping	$18,070,000
Manholes	$2,580,000
Subtotal	**$20,650,000**
Contingency (25 percent)	$5,160,000
Total Cost Phase 3	**$25,810,000**[1]

1) Costs represent year 2008 costs. Actual construction costs may vary based on the timing of construction and other market factors

Figure 6-3
Phase 3 CIP Costs by Facility Type



6.3 SUMMARY OF OVERALL CIP

A summary of the District's sewer system CIP including the facilities and the associated costs for Phases 1, 2, and 3 is presented in **Table 6-4**. The breakdown of the capital costs by facility type is shown on **Figure 6-4**. The estimated capital cost for the combined CIP is $119.7 million. Approximately, 86 percent of this cost is allocated for the construction of the sewer pipelines. The configuration of the sewer system follows the topography of the District's service area and where flow cannot be accomplished by gravity, pump stations are recommended. The estimated capital costs for the construction of the pump stations is $4.2 million, approximately four percent of the total CIP. Manholes account for the remaining 10 percent of the total CIP.

The total costs for Phase 1 are higher as compared to the costs for Phases 2 and 3 as all trunk mains required to collect and convey sewage to the proposed wastewater treatment plant are constructed during Phase 1.

Table 6-4
Combined CIP Costs

Facility	Phase			Total
	Phase 1	Phase 2	Phase 3	
Sewers and Piping	$49,530,000	$14,540,000	$18,070,000	$82,140,000
Manholes	$4,980,000	$1,830,000	$2,580,000	$9,390,000
Pump Stations				
Paxton Pump Station[1]	-	-	-	-
Kickapoo Pump Station	$1,600,000	-	-	$1,600,000
Paradise Valley Pump Station	$2,600,000	-	-	$2,600,000
Subtotal	**58,710,000**	**16,370,000**	**20,650,000**	**$95,730,000**
Contingency (25 percent)	14,680,000	4,090,000	5,160,000	$23,930,000
Total[2]	**73,390,000**	**20,460,000**	**25,810,000**	**$119,660,000**

1) Costs for the Paxton Pump Station are included in the total costs for the wastewater treatment plant
2) Costs represent year 2008 costs. Actual construction costs may vary based on the timing of construction and other market factors

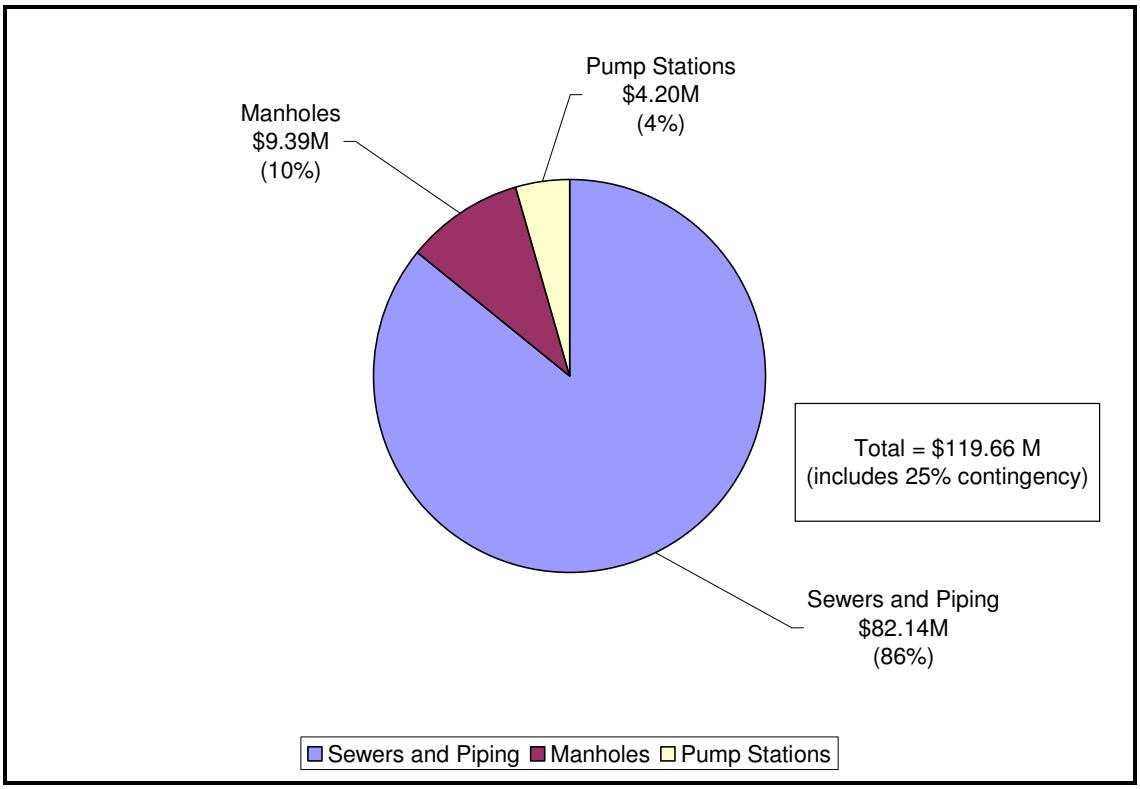



Figure 6-4
Combined CIP by Facility Type