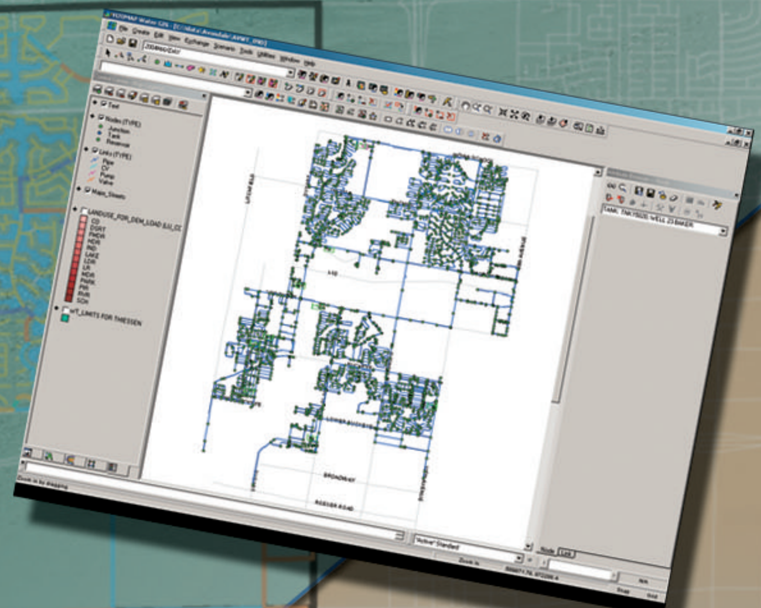
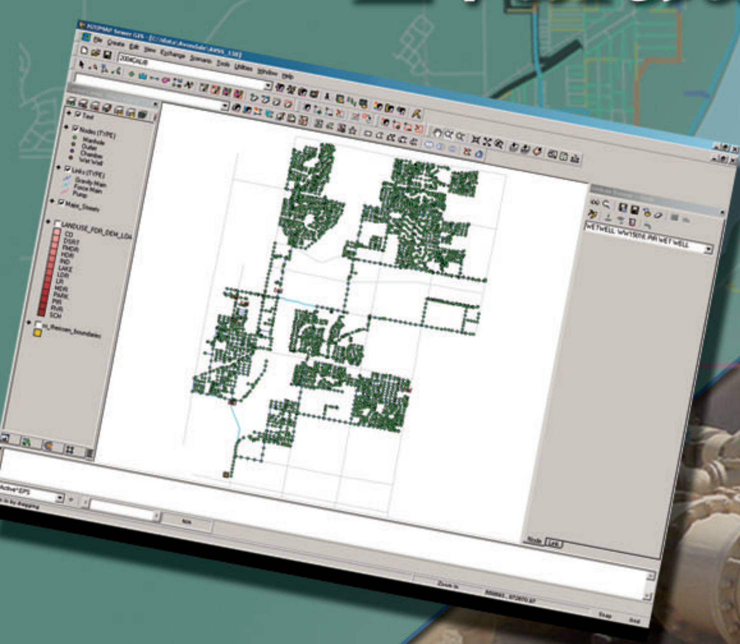
City of Avondale

FINAL

Wastewater Collection System Master Plan & Utility Systems Evaluation





August 2005

Carollo Engineers

City of Avondale

WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS

August 2005

Registered Professional Engineer (Civil)
CERTIFICATE NO.
11809
JOHN S.
PUZAUSKAS, JR
Date Signed..........
ARIZONA, U. S. A.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
14615
MARK EVERETT
COURTNEY
Date Signed..........
ARIZONA, U. S. A.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
36578
RICHARD A.
HUMPHERYS
Date Signed..........
ARIZONA, U. S. A.

carollo engineers

3033 NORTH 44TH STREET, SUITE 101 • PHOENIX, ARIZONA 85018 • (602) 263-9500 • FAX (602) 265-1422
H:\Client\Avondale_PHXW\6847A00\Rpt\Final\TOC.doc

City of Avondale, Arizona

WASTEWATER COLLECTION SYSTEM
MASTER PLAN AND UTILITY SYSTEMS ANALYSIS

TABLE OF CONTENTS

Page No.

CHAPTER 1 INTRODUCTION

CHAPTER 2 PLANNING FRAMEWORK

CHAPTER 3 MODEL DEVELOPMENT

CHAPTER 4 WASTEWATER SYSTEM MASTER PLAN

Page No.

LIST OF TABLES

Page No.

LIST OF FIGURES

Index of Abbreviations	
Description	**Application**
ADD	Average Daily Demand
BPS	Booster Pump Station
CADD	Computer Aided Drafting and Design
DES	Arizona Department of Economic Security
DU	Dwelling Unit
DU/Acre	Dwelling Units per Acre
GIS	Geographic Information System
gpad	gallons per acre per day
gpcd	gallons per capita per day
gpm	gallons per minute
HGL	Hydraulic Grade Line
I-10	Interstate 10
LPSCO	Litchfield Park Service Company
MAG	Maricopa Association of Governments
MDD	Maximum Daily Demand
MG	Million Gallons
mgd	million gallons per day
PHD	Peak Hour Demand
PRV	pressure reducing valves
psi	pounds per square inch
TAZ(s)	Traffic Analysis Zone(s)
UFW	Unaccounted for Water
WWTP	Wastewater Treatment Plant

Chapter 1

INTRODUCTION

The City of Avondale is experiencing rapid growth within its municipal planning area. This rapid growth requires improvements in the water and wastewater infrastructure to serve the growing community. In order to prepare for this growth, the City has chosen to undertake a planning study of the City's water and wastewater systems to determine how the infrastructure should grow to provide customers with an appropriate level of service without incurring unnecessary costs. One of the challenges faced by any growing city is that the new infrastructure that supports growth needs to function efficiently and effectively along with the City's existing infrastructure. A major objective of this project was to identify the infrastructure needed for the water and wastewater systems, and develop a capital improvement budget for 2005, 2010, and buildout planning periods. This study covers the land area from the north of the Avondale Municipal Planning Area south to the Estrella Mountains.

The City also wants to have access to the modeling tools that were developed as part of this project so that future additions to both systems can be modeled to allow new infrastructure to be adequately sized and integrated with the existing system. An ongoing approach to planning using hydraulic models requires that the pipe infrastructure and demands or loads be updated on an ongoing basis. The City is well positioned to have updated models because the pipe infrastructure is stored in the City's Geographic Information System (GIS) and is updated regularly. The land use plan, from which the demands/loads are derived, is also in a GIS data layer that can be easily maintained. Both the water and sewer system models utilize the H_2OMAP software, which has a common user interface for both water and sewer modeling. Using a common software simplifies the approach to maintaining an ongoing modeling program.

The City will be able to use this study as well as the models in the future to identify system needs and estimate capital improvement costs.

This report is organized into the following major sections:

- **Planning Framework** – The planning framework describes the land use plan and how this land use plan was used to define the type of development that is expected to occur throughout the City's service area. The land use plan applies equally to the water and wastewater systems, and is a key component in having an integrated plan.
- **Model Development** – This section describes how the models were created, and how the City's GIS data is to be used in maintaining the models.
- **Wastewater System Master Plan** – This section contains a discussion of the model analysis of the wastewater system, and the capital improvements that will be required for the wastewater system.
- **Water Distribution System Plan** – This section contains a discussion of the analysis of the water distribution system, with recommendations for a capital improvement plan.

PLANNING FRAMEWORK

This chapter of the report describes information in the land use plan and how it was developed. This chapter is organized into the following sections:

- **Data Sources** – Identifies the information used to create the land use plan
- **Land Use Classifications** – Defines the categories of land use in the plan
- **Land Use Plan** – Categories of land use for the Avondale service area are presented
- **Growth Projections**
- **Population Projections**

The foundation of a water or wastewater master plan is an understanding of how much water or wastewater will need to be delivered or collected throughout the service area at each planning interval. This understanding is developed by creating a land use plan.

A land use plan defines the type of land use for all areas within the service area of a water supply/wastewater collection system. The information in the land use plan is stored in a GIS data layer. To create a land use plan, information is gathered that helps to define how land areas are currently being used, and how land areas may be used at the time the City is built out. This information comes from sources such as aerial photographs, development plans, general plans, land use zoning, discussions with City planners, and other GIS data that describes how the land is to be used. Within the GIS, polygons are drawn around land areas with a homogeneous type of land use, and assigned to a pre-defined set of land use classifications. These classifications correspond to types of land use that usually have distinct water use amounts and patterns. Attributes are then assigned to each polygon to help identify not only the amount of water entering or leaving the polygon area, but also when the polygon may be developed. Attributes may include polygon identifier, acreage, land use classification, housing density, population density, subdivision name, and percent buildout in each planning year. The database of information associated with each polygon can then be used to calculate water demands and wastewater loads in each planning year. The hydraulic modeling software uses the land use plan to assign the demands or loads to the correct location in the model.

Land use plans that are created and stored in the GIS can be easily changed as development plans and growth projections change. These changes can then be reflected in the model so that the infrastructure planning can remain current with development plans.

2.1 DATA SOURCES

Table 2.1 presents data sources that were utilized in developing the land use plan for this study.

Table 2.1 Data Sources
Wastewater Master Plan and Utility System Analysis – City of Avondale

Description	Application
Zoning Ordinance	Provided existing land use of developed or soon to be developed areas
General Plan	Provided anticipated land use for undeveloped land
Aerial Photo	Provided a "reality check" when examining zoning as well as development progress information
Maricopa Association of Governments Population Projection Data	Provided total population as well as persons per household values
Avondale GIS Data	Provided alignment and configuration of water and wastewater infrastructure as well as background mapping
Avondale property parcel GIS data	Provided information on housing densities.

2.2 LAND USE CLASSIFICATIONS

The City currently classifies land use according to the City's zoning ordinance, and according to the categories in the City's General Plan. For the purposes of water and wastewater infrastructure planning, the land use classifications that are used in a land use plan should be about ten categories. It is usually not possible to distinguish meaningful differences between categories when more categories are used. Classifications in the City's zoning ordinance and the General Plan were used as a basis for developing the land use classifications. Ambiguous classifications in the zoning ordinance such as Planned Area Development were reassigned to specific land use classifications according to information in the City’s General Plan. The classifications of developed areas were assigned utilizing Avondale's zoning ordinance. Undeveloped areas received a classification according to the intended use set forth in Avondale's General Plan. The classifications were evaluated by comparison with aerial photographs to determine the accuracy of the classification.

Residential areas were divided into three categories according to housing density. Classifications within the zoning ordinance and general plan were segregated into low, medium, and high density housing uses. Medium and low density areas that were not developed were grouped into a future medium density classification, which will have a composite population density slightly higher than the existing medium density areas.

Commercial areas were divided into classifications of "Large Retail" and "Commercial/ Office" to reflect the potential for these areas to develop differing water demand and wastewater loading characteristics.

Some types of land uses do not fit neatly into the established land use classifications. For example, the Phoenix International Raceway (PIR) occupies approximately 300 acres south of the Gila River. The facility has significantly different water demand and wastewater loading patterns than other industrial or commercial facilities within Avondale. PIR has the capacity to seat approximately 100,000 motor sport enthusiasts for large events, creating peak demands and loadings during race events. Therefore, a separate land use category has been established to address demands and loads associated with PIR.

The Avondale Auto Mall is another example of a situation where the actual land use does not fit neatly into a commercial land use classification like other businesses. The auto mall has large car lots where water usage is primarily occasional car washing. Water demands and wastewater loads for this type of land use are handled individually in the model. Flow monitoring in the collection system downstream from the Auto Mall was the basis for collection system flows from the Auto Mall.

Table 2.2 presents the land use classifications that were used in the land use plan.

Table 2.2 Land Use Classifications
Wastewater Master Plan and Utility System Analysis – City of Avondale

Classification	Description
Low Density Residential	Areas with less than 2.5 dwelling units per acre
Medium Density Residential	Areas with 2.5 to 8 dwelling units per acre
High Density Residential	Areas with more than 8 dwelling units per acre
Future Medium Density Residential	Undeveloped areas classified as Medium or High Density Residential, with an average of 4.5 dwelling units per acre
Commercial/Office	Small retail centers including stores and offices
Large Retail	Large retail centers such as grocery stores and big-box stores
Industrial	Industrial areas
School	Public schools
Park	Open parks with high irrigation water requirements
PIR	Phoenix International Raceway
Lake	Water features utilizing water sources other than the potable water system
Rivers and Desert Parks	Open space requiring negligible potable water and producing negligible wastewater

2.3 LAND USE PLAN

Figure 2.1 shows the land use plan for the City of Avondale. Table 2.3 presents the acreage associated with each land use classification at buildout. Appendix A contains a D-size copy of Figure 2.1, and a table showing the attributes of each land use polygon.

Table 2.3 Total Acreages for Each Land Use Classification
Wastewater Master Plan and Utility System Analysis – City of Avondale

Classification	Acres
Low Density Residential	1,335
Medium Density Residential	4,409
High Density Residential	416
Future Medium Density Residential	6,241
Commercial/Office	1,961
Large Retail	689
Industrial	1,651
School	546
Park	821
PIR	322
Lake	107
Rivers and Desert Park	6,803
Total	25,302

The service area for the land use plan corresponds to the Avondale planning area north of the Estrella Mountains, including county areas that have not yet been annexed into the City. Several private companies serve the water and wastewater needs of portions of the City of Avondale. The Litchfield Park Service Company (LPSCO) serves water and wastewater to an area located within the section bounded by Indian School, Thomas, Old Litchfield, and Dysart Roads. The Rigby Water Company serves the southeast portions of Avondale. The area is roughly bounded by Broadway Road to the north, the Gila River to the south, 127th Avenue to the west and the Avondale service boundary to the east. Because the City of Avondale may serve these areas in the future, the land use plan includes the land area served by these private utilities. Figure 2.2 shows areas currently served by private companies.

Avondale personnel reviewed and approved the land use plan for use in this study.

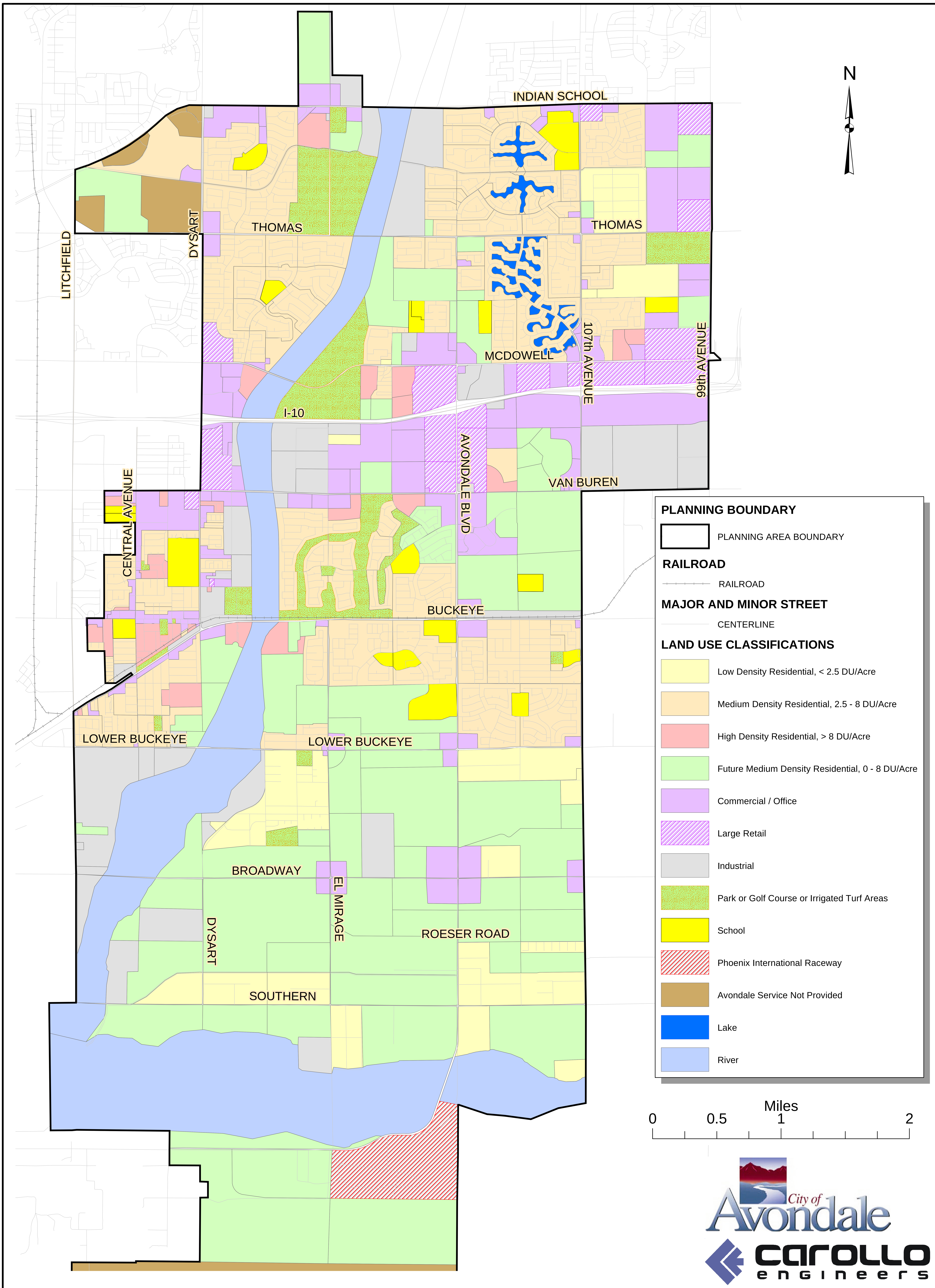


FIGURE 2.1 - CITY OF AVONDALE LAND USE PLAN
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005

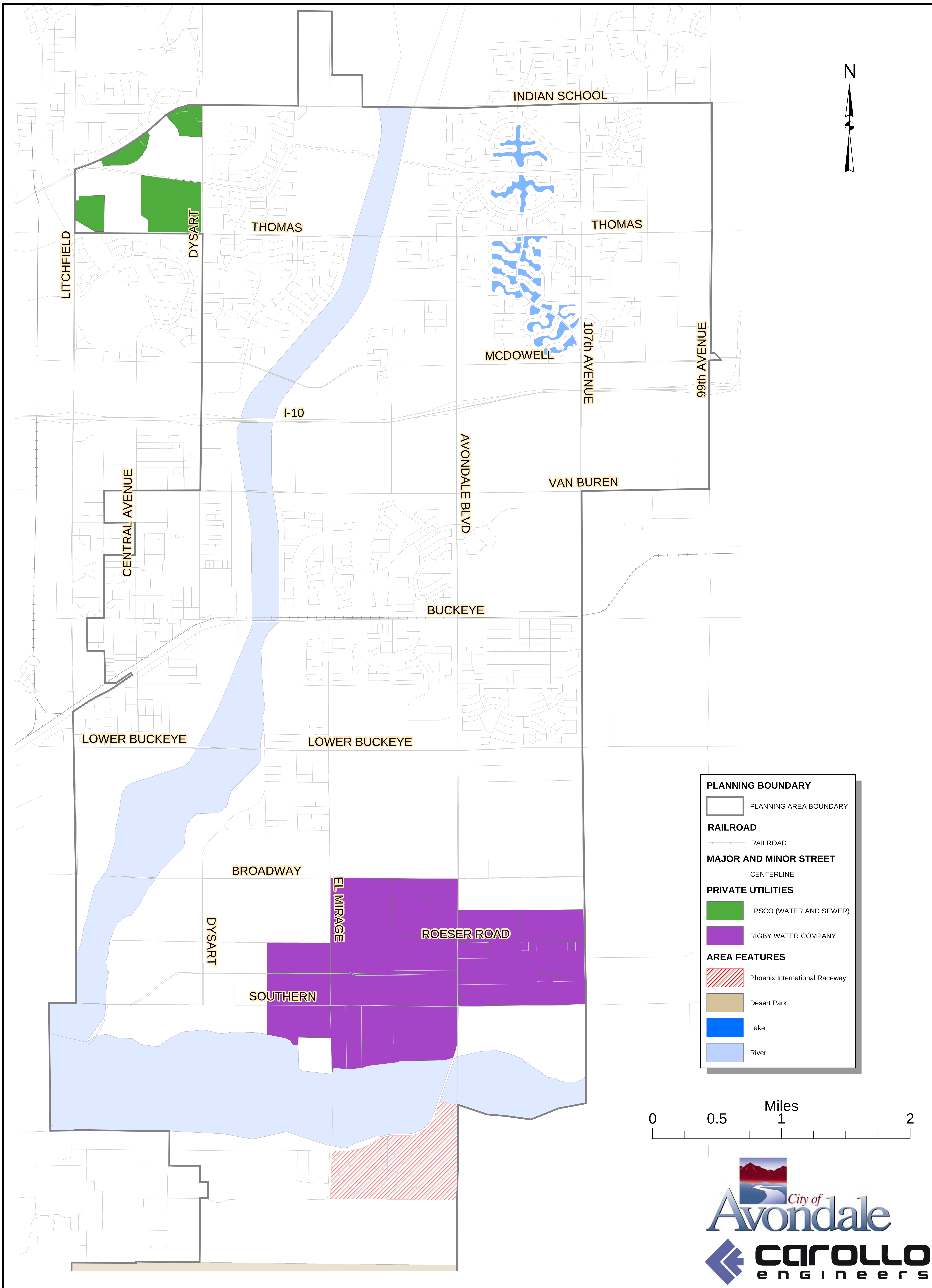


FIGURE 2.2 - PRIVATE UTILITIES WITHIN THE AVONDALE SERVICE AREA
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005

2.4 BUILDOUT PROJECTIONS

Avondale personnel worked with Carollo to assign a current day (2004) buildout percentage to each land use parcel. Completely built-out parcels received a buildout percentage of 100 percent while completely undeveloped areas received a buildout percentage of zero percent. Buildout percentages for each planning period were established based on information from aerial photos, and buildout percentages recommended by the Avondale Planning Department.

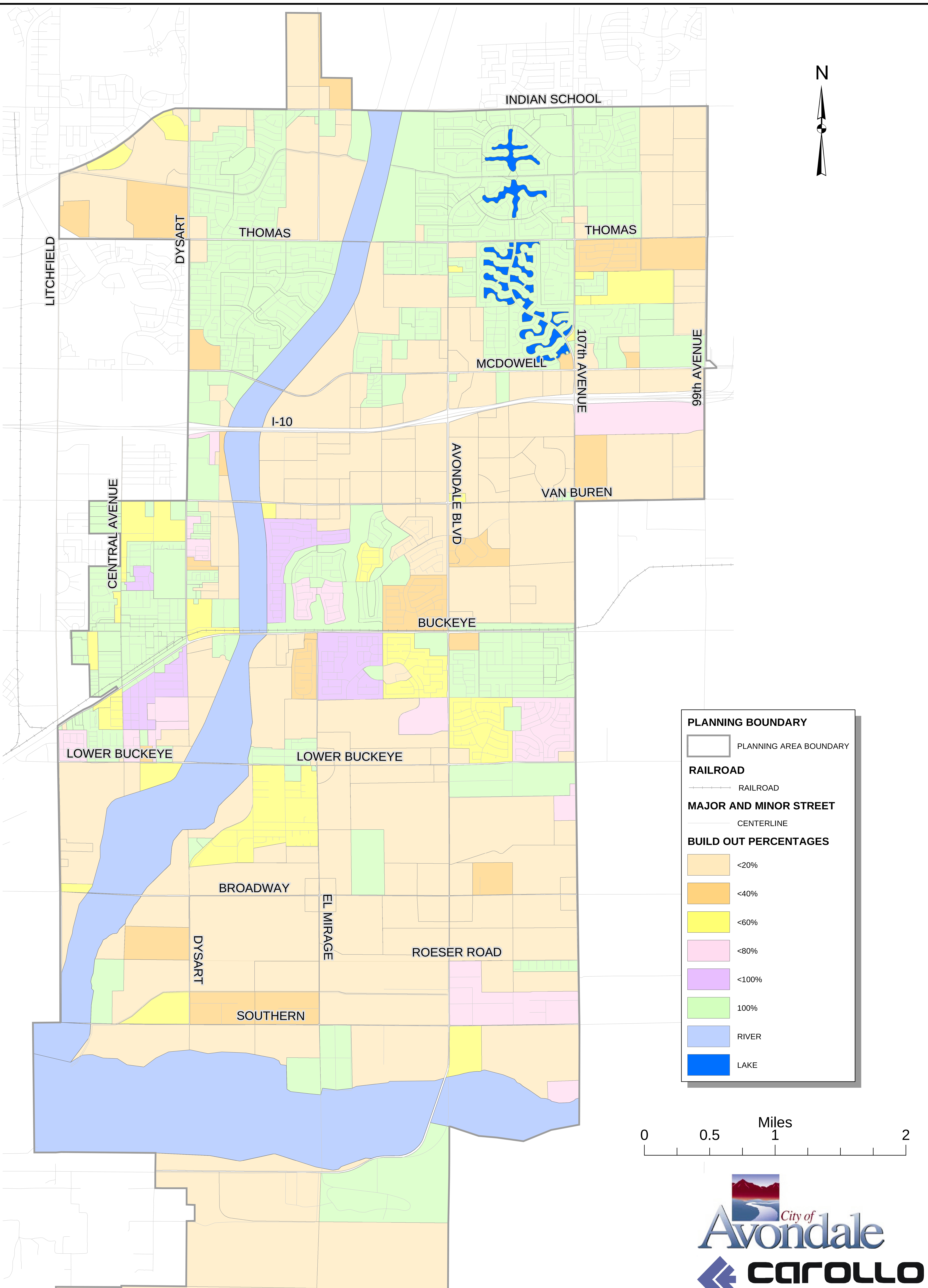
Future buildout percentages were established according to the following guidelines:

- All parcels were assigned a buildout percentage of 100 percent in the buildout planning period
- Parcels which were partially built-out in 2004 were taken to be completely built-out by the 2010 planning period.
- Undeveloped parcels north of Buckeye Road were taken as built-out by the 2010 planning period.
- Undeveloped parcels south of Buckeye Road were taken as 25 percent built-out by the 2010 planning period
- Avondale personnel made adjustments to individual parcels according to their understanding of future developments for the 2010 planning period
- 2005 buildout percentages were established through linear interpolation between the current day buildout percentage and 2010 buildout percentage.

Figures 2.3 and 2.4 show the buildout percentages utilized in the 2005 and 2010 planning periods.

2.5 POPULATION PROJECTIONS

Population projections based on the land use plan were set to be similar to population projections used by the City, which were based on the Maricopa Association of Governments (MAG) data. MAG population projections were utilized to establish total population, distribution of population among land use classifications, and persons per dwelling unit.



City of Avondale

carollo engineers

FIGURE 2.3 - 2005 BUILD OUT PERCENTAGES
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005

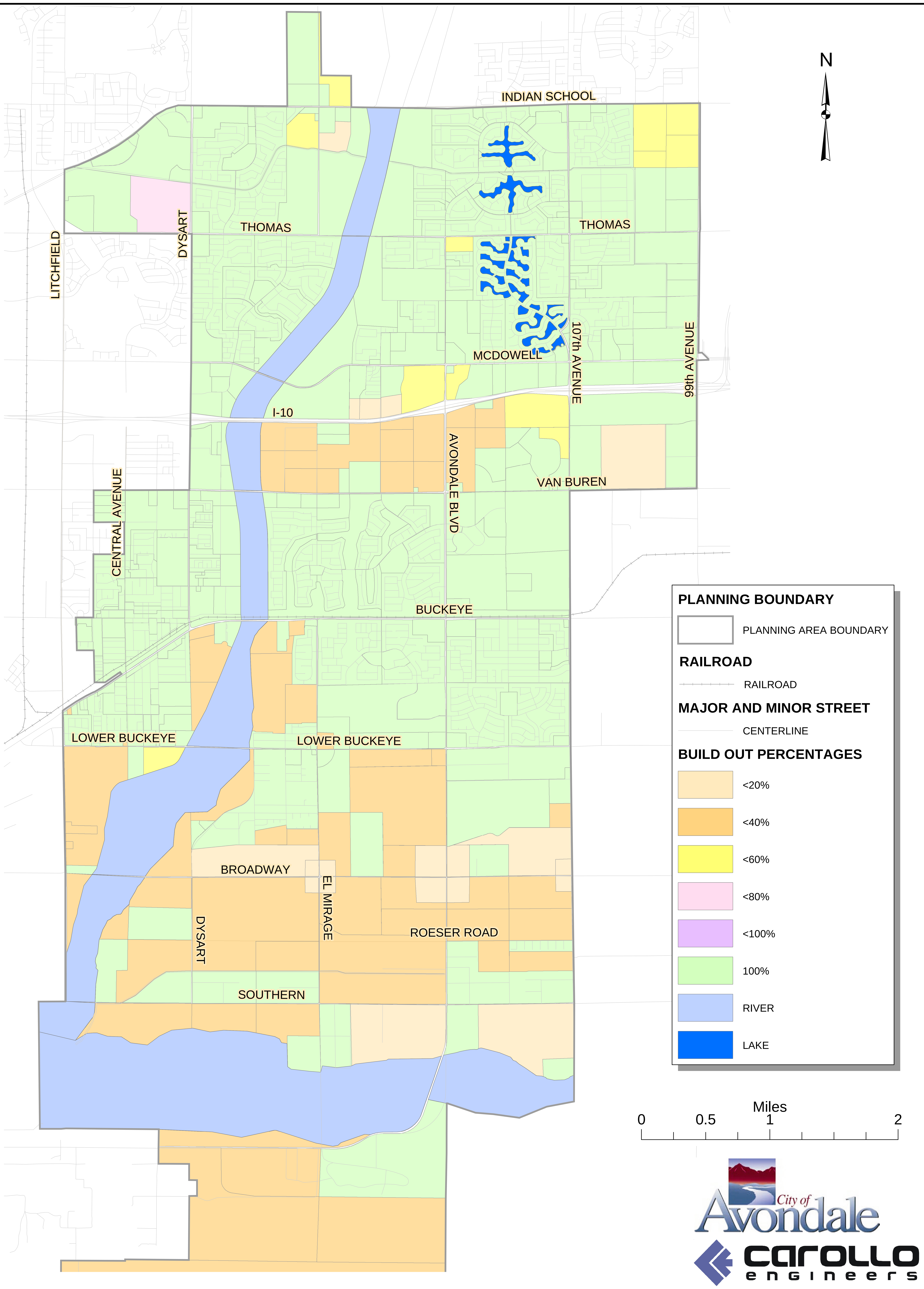


FIGURE 2.4 - 2010 BUILD OUT PERCENTAGES
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005

Avondale's water meter GIS layer was used to estimate the density of dwelling units for developed medium density residential areas. This housing density was calculated to be 3.95 DU/Acre. The housing density for other residential land use classifications was based on the MAG data. The population projection using the land use plan was obtained by multiplying the acreage of each residential land use polygon by the housing density, population density, and percent buildout in each planning year. The population of all the residential polygons was then summed to obtain the total estimated City population. In order to have a population projection at buildout that was similar to the MAG projections, the housing density of future medium density residential land areas was adjusted upwards from 3.95 to 4.5 DU/Acre. A dwelling unit density of 4.5 DU/Acre will result in a higher potable water demand and wastewater loading than the 3.95 DU/Acre, which is typical of current medium density developments within Avondale.

The land use plan describes areas outside of the boundaries of PIR as future medium density residential. This classification matches Avondale's general plan; however, future development within this area may follow a different pattern. Much of the undeveloped land serves as a parking area for PIR. A significant portion of the area is located on steep terrain, which may attract lower density residential developments. In spite of this apparent discrepancy, the classification in the City's General Plan was used in order to make population projections from the City match population projections from the land use plan.

Previous, recent master planning efforts have used several different methods of establishing population projections and a land use plan. The population projections used in this study were compared with previous projections as a check prior to using the land use plan for this study.

The City of Avondale Sewer System Master Plan Update (June 2000) analyzed three growth projections to select the most probable residential growth rate for use in the sewer model. The three residential growth projections were developed by MAG through use of Traffic Analysis Zones (TAZs), GeoSTAT Engineering, and information from Avondale's Planning Department. The Planning Department projection was selected because this projection was based upon the most recent data.

Avondale's Water Infrastructure Master Plan (February 2002) selected a population projection after analyzing three projection methodologies: the DES Housing Unit Method, 1993 TAZ studies performed by MAG, and the City of Avondale/ESI Corporation (COA-ESI) study. The COA-ESI study's results were published in Avondale's General Plan Update in March 2001. The master plan recommended using the "moderate" growth scenario presented in the COA-ESI study.

These population projections are similar to the projections proposed for this master planning effort. The projections differ slightly in the short term (2005 to 2010), but are similar near buildout. For master planning purposes, it is preferable to adopt a conservatively high buildout population projection to properly size future infrastructure. The population projection utilized in this effort is compared to previous projections in Figure 2.5. Note that the steep increase in population prior to 2010 is a reflection of the growth anticipated by the City from specific large developments just north of the Gila River.

Table 2.4 presents population projections at each planning period.

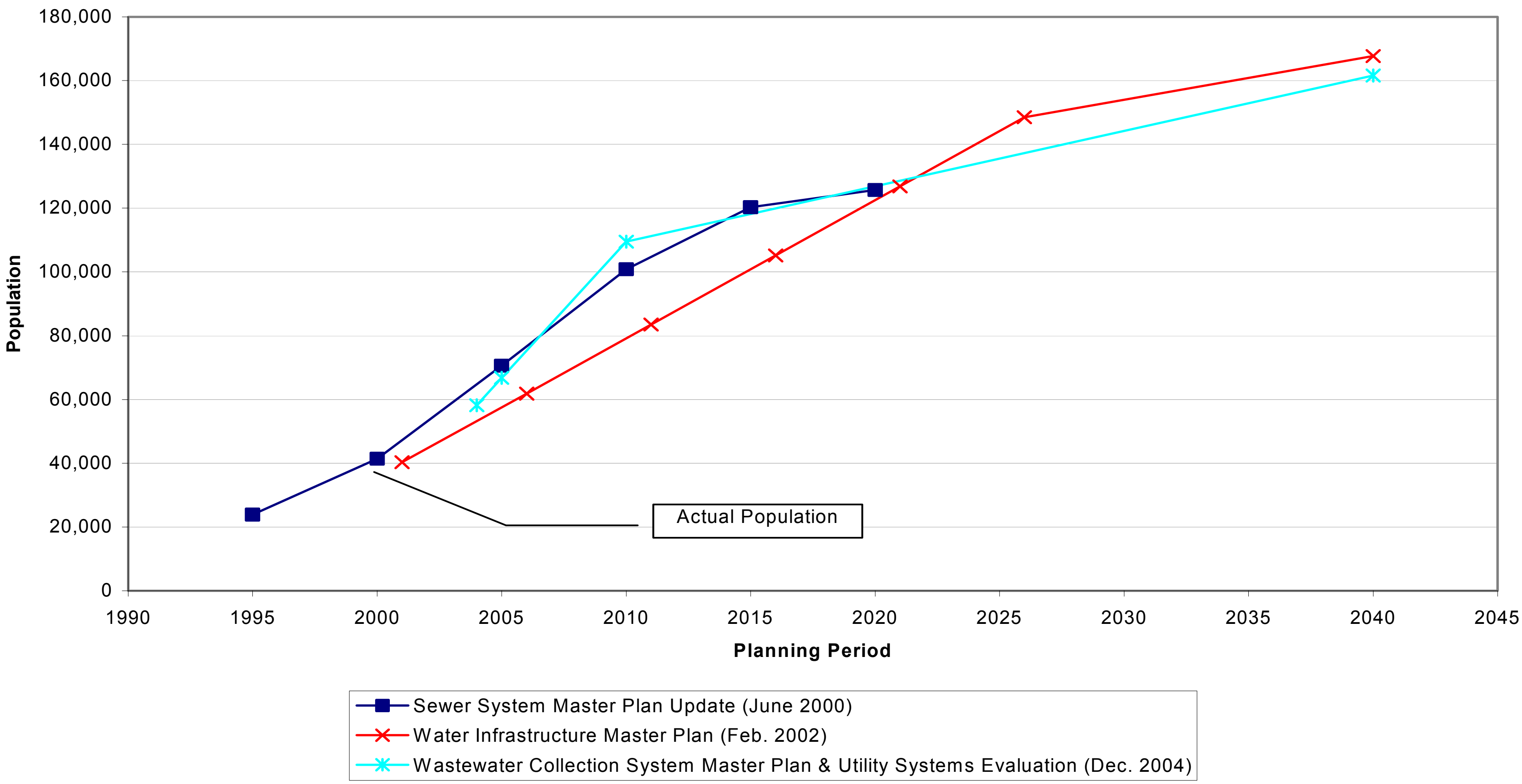


Figure 2.5 Comparison of Previous Population Projections with the Current Projection

Table 2.4 Population Projections
Wastewater Master Plan and Utility System Analysis – City of Avondale

Classification	Population Per Dwelling Unit	Dwelling Unit Density (Du / Acre)	Population Density (Capita/ Acre)	2004		2005		2010		Buildout	
				Developed Area (Acres)	Population	Developed Area (Acres)	Population	Developed Area (Acres)	Population	Developed Area (Acres)	Population
Low Density Residential	3.25	1.00	3.25	924	3,002	992	3,225	1335	4,339	1335	4,339
Medium Density Residential	3.25	3.95	12.84	3849	49,405	3942	50,605	4409	56,605	4409	56,605
High Density Residential	1.99	13.06	25.99	223	5,787	245	6,368	357	9,272	416	10,818
Future Medium Density Residential	3.20	4.50	14.40	0	0	455	6,546	2728	39,278	6241	89,870
Total				4,995	58,194	5,634	66,744	8,829	109,495	12,402	161,633

MODEL DEVELOPMENT

Hydraulic models are comprised of four major components: software, infrastructure data, demand or load data, and operating information. The data requirements and data format are dictated by the modeling software and the hydraulic equations that are solved by the software. Much of the infrastructure data can come from the GIS, but equipment data usually comes from a variety of sources and is entered manually. Demand and load data includes GIS data in the form of the land use plan and other GIS data layers that help to allocate the loads to the correct location, but also includes other components such as unit demand/load factors and diurnal patterns. Operational data includes controls for pumps and PRVs, and are usually entered manually. This section summarizes the model development process.

3.1 COMPUTER MODEL SOFTWARE

The H_2OMAP Sewer hydraulic modeling software produced by MWH Soft, Inc. was selected for use on this project. The City already purchased the H_2OMAP Water modeling software for the water master plan in 2002. By purchasing companion software, the City can employ a common approach to hydraulic modeling and model building for both water and wastewater systems. This simplifies the modeling processes, helping the City to obtain more value from modeling activities. This software is a good fit for the City of Avondale for the following reasons:

- The City's water and wastewater infrastructure data is stored in an ESRI shape file format that can be read directly into the H_2OMAP software so that updates to the GIS data can be imported easily into the model.
- A common user interface between the water and wastewater modeling software means that experience using one software package can be applied to the other software package.
- Model results can be saved in a shape file format so that this information can be displayed on maps along with other GIS data.
- The software does not require third party software to run, so the City can upgrade GIS or CAD software without adversely affecting use of the model software.
- The hydraulic engine of both software packages contains all the features that are needed to model the Avondale water and wastewater systems.
- A common land use plan can be used and maintained to calculate and assign demands/loads to the appropriate points in the model.

- The software has a scenario manager that makes it possible to easily generate "what if" scenarios to analyze an endless number of conditions.
- Data is not stored in a proprietary format, so data could be moved to another modeling software package if necessary.

The software comes with additional modules, some of which were not used for this project. However, the Load Allocator for the wastewater model, and the Demand Allocator for the water model were used to allocate the demands and loads to the models. These modules use the land use plan shape file to place demands and loads at the appropriate locations. The Load/Demand Allocator simplifies the process of applying demands and loads to the correct location in the model using several different techniques, including the use of catchment areas and Thiessen polygons to identify the land areas where wastewater is collected and applied to manholes in the model.

One of the City's goals for this project is to obtain the model and software that can be used on an ongoing basis to solve planning, design, and operational questions. Computer technology, software technology, modeling techniques, and methods of storing and accessing data are continually changing, so the City should maintain support for the software so that the software used remains current and viable.

3.2 MODEL DEVELOPMENT USING GIS BASED INFRASTRUCTURE DATA

The City of Avondale, or its data conversion contractor, Engineering Mapping Solutions, Inc. (EMS), updates the GIS data from as-built drawings or other sources. At present, the data is digitized using AutoCAD, and then converted to a shape file format for use with ESRI software products. Therefore, any changes that need to be made to the data should be in the original AutoCAD files to maintain the integrity of the source data. The process of creating models and performing modeling studies invariably uncovers data errors or missing information that may require an update to the source data. This information was provided to the City of Avondale and EMS so that the source data could be updated. Updates to the GIS data were then passed to Carollo for incorporation into the models. The GIS database was set up to support model creation as well as to support a variety of other applications for the asset data. The data supports model creation by establishing connectivity between pipe segments and by digitizing pipe segments in ways that are consistent with modeling requirements.

Where the information was available, attributes necessary for modeling were also included in the GIS database. When the model was created, there was some work that needed to be done to use the GIS data in the model. A model requires that every pipe attribute necessary for modeling, such as pipe diameter, be populated in the database. Models also require a complete set of invert elevations, and pipe connectivity needs to be complete so that there are no pipes or manholes that are not physically connected to the rest of the system. The models also need to include enough yard piping to connect pump stations and reservoirs. In the model, these missing values must be added even if values are assumed, so that the model will run. Existing or planned pipelines, which are not included in Avondale GIS records, were digitized into the models as required for some analyses. GIS databases will often include only the information that can be verified, to help maintain the integrity of the GIS data. GIS data may also include additional mains such as fire lines, hydrant connections, retired mains, or even service lines that will not be modeled and therefore filtered out of the model data set. Because of the differences between the requirements for the GIS data and the requirements for the model data, some data cleanup is to be expected every time that the model is to be updated with GIS data. Appendix B contains detailed information about the specific GIS data layers used to create the model.

3.3 FACILITIES DATA

3.3.1 Wastewater System

For the wastewater model, as-built information was utilized where available to establish the physical parameters of lift station wet wells. No specific information regarding diversion structure dimensions or wastewater pump curve characteristics was available.

Future lift station pumps were modeled based upon the assumption that constant speed pumps would be used. Although variable speed pumps in lift station facilities are used, this constant speed pump assumption provides a conservative estimate of lift station flow because fixed speed pumps are usually sized to deliver higher flows at discrete intervals where a variable speed pump typically pumps the flow rate that comes into the wet well.

3.3.2 Water System

Information provided by Avondale personnel and as-built records were the source of information for equipment data in the hydraulic model. Existing pumps were modeled using available pump curves or estimated operating points. Wells were modeled as fixed inflow points using flows provided by the City.

Reservoir information obtained from the previous master plan as well as as-built information was integrated into the water model. Reservoir volumes, floor elevations, and overflow elevations were included where available.

Several reservoirs have fill valves that allow water from the distribution system to fill the reservoir during off peak times so that this water can be used to meet peak demands. These valves were added to the model so that they can be used when appropriate for specific analyses.

Future facilities were developed according to the performance criteria established within this report. Avondale provided guidelines on the extent of infrastructure expected at the

2005, 2010, and buildout planning periods. It is assumed that all facilities will be in place for the buildout planning period.

3.4 DEMANDS AND LOADS

Water demands/loads for the entire City were calculated by taking the unit demands/loads for each land use classification and multiplying these values by the acreage, and percent buildout of each land use parcel. The portion of the demand/load that was allocated to each node/manhole in the model was based on the geographical area served by the node/ manhole. For the water system, this area was defined by creating Thiessen polygons that were drawn along the midpoint between each node and the surrounding nodes. For the wastewater system, a polygon was drawn around the drainage basin or drainage area associated with that manhole. To allocate demands/loads, the Thiessen polygon or drainage basin area was intersected with the land use plan to determine how many acres of each land use type should be allocated to each node or manhole.

Once demands/loads were assigned to the proper location, multipliers were used to convert from average daily conditions to maximum day or peak hour conditions. For extended period simulations where flows need to change throughout the day, a diurnal pattern was used that defined the daily variation.

3.5 CONTROLS AND OPERATIONAL INFORMATION

Pump controls for the water system were set to maintain a desired hydraulic grade line in the distribution system.

The Avondale water system has had PRV stations operating in the past, but PRVs in all but two stations have been removed.

Lift station pump controls were set to turn on and off based on wet well level. Actual level setpoints were not known, so approximations were made to simulate a reasonable lift station operation. The 4th Street station has variable frequency drives, so the pumps in this station were set to pump at the same rate as the wastewater inflow.

3.6 ONGOING MODEL APPLICATION FOR FUTURE PLANNING

3.6.1 GIS Interface

The H_2OMAP modeling software includes a "scenario manager" that manages multiple versions of all model data, so that versions of the model can be created to simulate different infrastructure alternatives, demand/load conditions, and phases of network development at different points in time. The infrastructure that is in place in each planning year is presented later in the report.

The models can also output model results in a shape file format for use by the City. These shape files would not be joined with source data, but could be used with other data layers in the GIS to communicate the results of model simulations.

3.6.2 Model Updates

Hydraulic models contain large amounts of data from a variety of sources. The following is a summary of the data required for a model, and the sources of this data.

- **Mains, Manholes, Fire Hydrants, and Valves**

  These infrastructure components are contained within Avondale's GIS databases, and can be updated at regular intervals directly from the GIS. Updates and additions can be handled by updating the entire model, particular geographical areas where mains have been added or updated, or by selecting entities that have been modified or added after a certain date. The modeler can take each specific data layer, and select the specific entities that need to be added to the model. Update intervals depend on the amount and significance of changes, but the models should be updated on an annual basis, and at intervals where specific analyses require new mains.

- **Land Use Plan**

  The land use plan is created and maintained in an ESRI shape file form. It can be easily updated in Arc View, and then applied to the models using the H_2OMAP software. The land use plan should be updated annually and whenever a specific study requires the improved accuracy of an update.

- **Pumps, Reservoirs, Wells, Lift Stations, and Junction Chambers**

  These infrastructure components require information describing both the physical and operational characteristics. This information is entered and updated manually, and comes from utility operations staff, SCADA systems, and field measurements. This information should be updated when a new site comes online.

- **Demand/Load Information**

  Demand/load information consists of unit demand/load factors based on categories of land use, demand/load multipliers to adjust to specific demand conditions, and water/wastewater usage/load information for specific customers. This information is calculated from customer billing records, SCADA data, and water production information. This information is entered manually into the models. Demand information should be updated with each addition to mains or change in the land use plan.

- **Water Quality Information**

  For water quality studies, water quality data would need to be added manually from field tests or other sources to address the needs of a particular analysis. Water quality information is not typically updated on an ongoing basis due to the changing nature of this data.

- **Future, Proposed Infrastructure**

  Hydraulic models will often contain pipes and other infrastructure that is proposed or planned that does not exist in the GIS database. These entities were created manually in the models, often in schematic form. Usually, there are different variations of this infrastructure data that is used for different scenarios that are analyzed in the models. This information can be replaced with the actual infrastructure after the preferred alternative has been selected, constructed, and digitized precisely into the GIS database.

Avondale has an established system of assigning unique identifiers to elements in the GIS database. The hydraulic models also utilize the unique identifier for facilities generated from the GIS database. This is the key to updating the models with GIS information. The H_2OMAP software will read or load in ESRI shape file data directly. Once a model has been created, new entities can be added by asking the program to read in only those entities that do not currently exist in the model. Therefore, the model can be updated at any desired frequency by adding these new entities. If there is a need for updates to entities that already exist in the models, the H_2OMAP software can update attributes of existing entities as well.

WASTEWATER SYSTEM MASTER PLAN

4.1 BACKGROUND

This wastewater collection system master plan has been developed to provide a framework for development of a collection system to serve all areas within the City of Avondale municipal planning area. As of 2004, approximately 56,000 people were served by the existing system. At buildout, approximately 162,000 people will be served by the collection system.

The wastewater service area comprises the entirety of the northern municipal planning area. Currently, several portions of the system are served by private on-site or septic systems, LPSCO, and a private system maintained by PIR. The City of Avondale has determined that the collection system should be planned with the capacity to receive flows from all land areas within the City north of the Estrella Mountains, even if some areas are not currently being served by the Avondale Collection System. Figure 4.1 shows the existing collection system.

4.2 OVERVIEW

This report is organized into the following sections:

- **Field Tests and Calibration –** This section describes the field testing that was completed, and summarizes field testing results.
- **Wastewater Loads** – This section describes the loads and diurnal patterns that were estimated for the collection system, and the load projections that were used for the analyses
- **Performance Criteria** – Performance criteria describes the standards by which the wastewater collection system was evaluated to determine its adequacy.
- **Collection System Evaluation –** This section describes the results of the model study for both existing and future conditions, and the implications of the study.
- **Capital Improvement Plan –** Opinion of Costs for improvements and the timing of those improvements is given in this section.

4.3 FIELD TESTS

Flow metering tests were performed to help determine unit loads and to obtain information to calibrate the model. Flowmeters were placed at strategic locations throughout Avondale to measure flow at locations that would yield useful information for calibration of the model. Meters were placed at the locations noted in Figure 4.2 for 2-week periods running from August through October 2004. Appendix C contains the field test data.

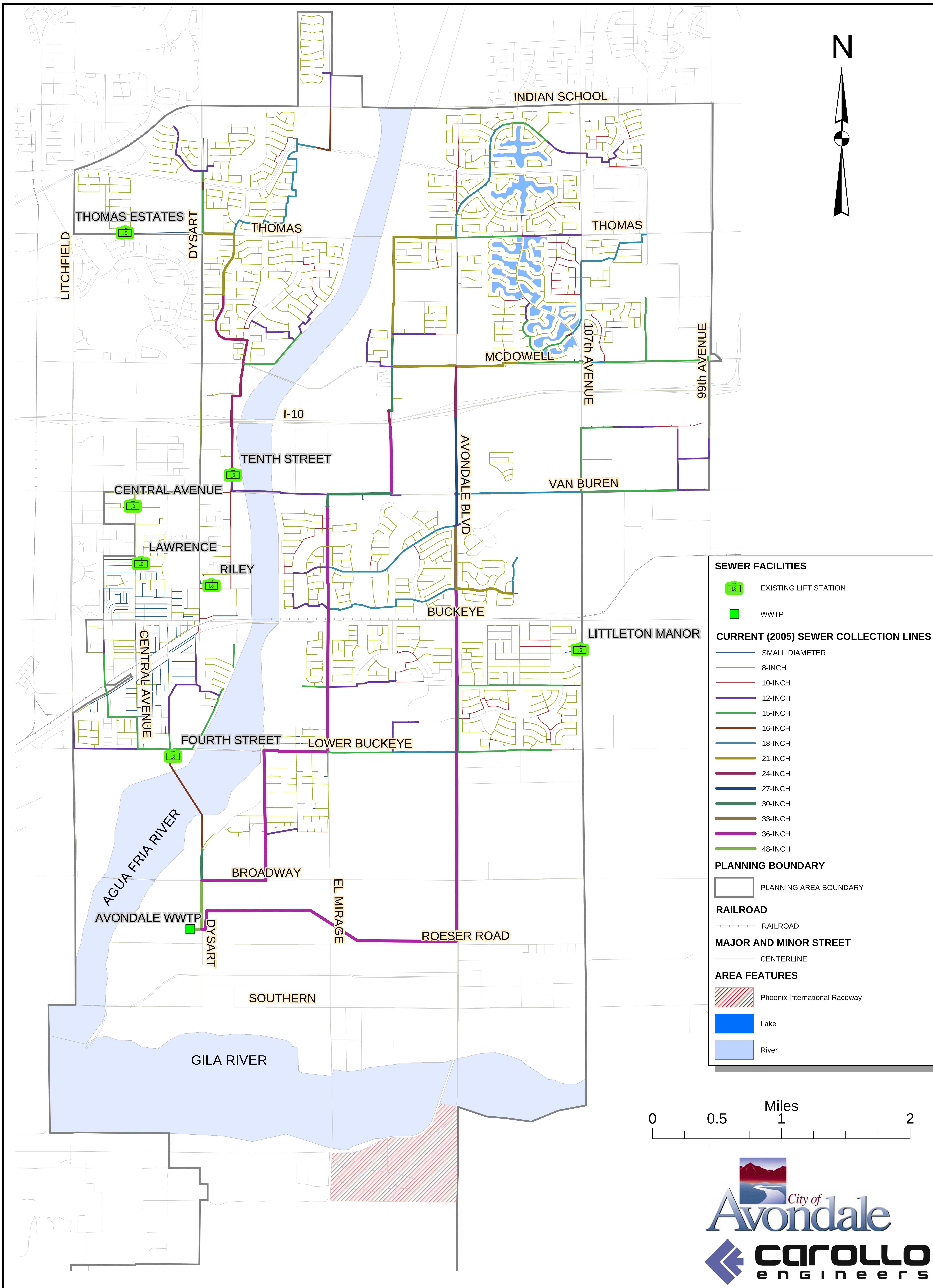


FIGURE 4.1 - CURRENT (2005) WASTEWATER COLLECTION SYSTEM
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005

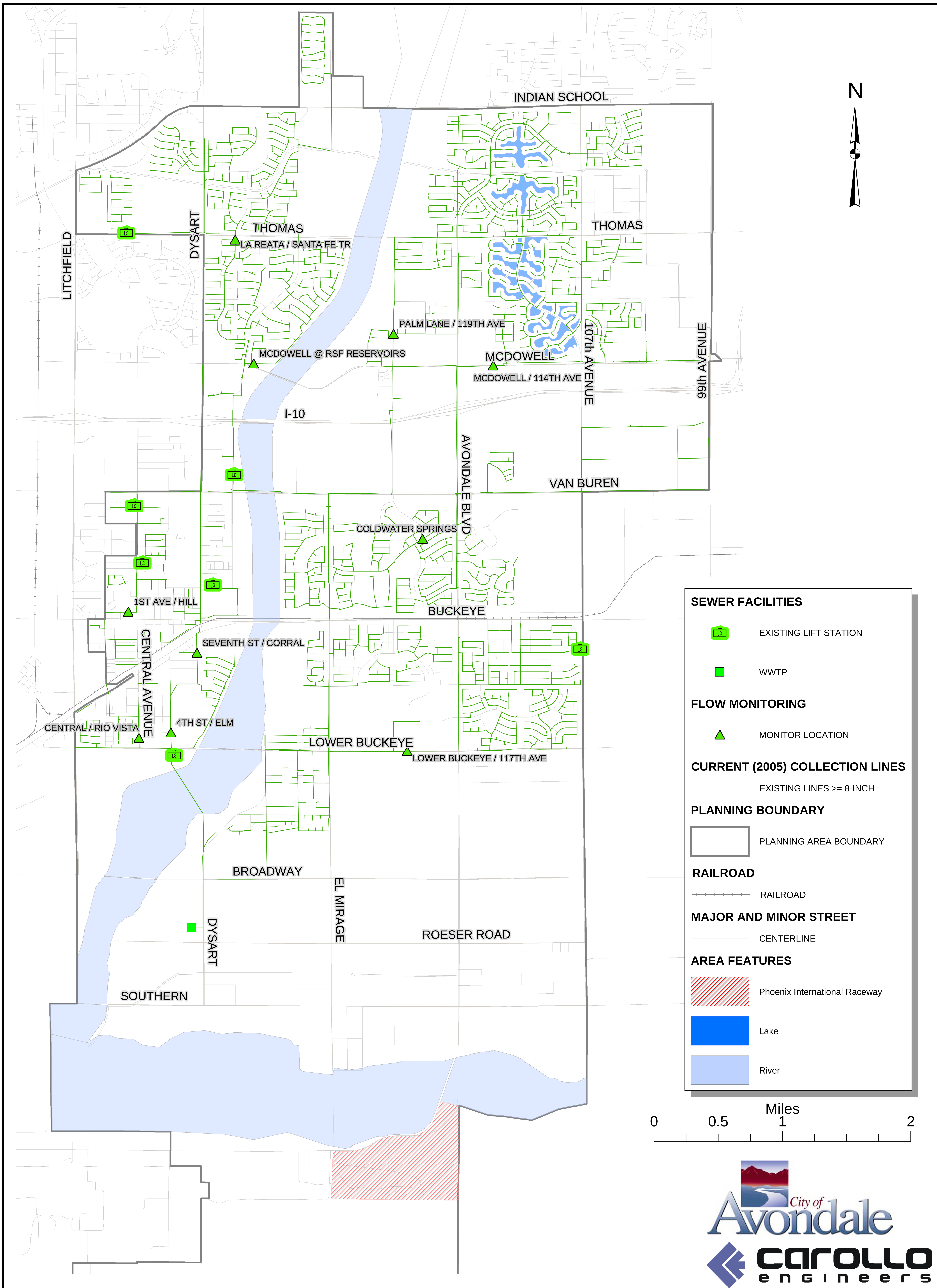


FIGURE 4.2 - FLOW METERING LOCATIONS
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005

Flow metering tests provide a calibration mechanism for the wastewater hydraulic model. Small adjustments are made to the model during calibration to demonstrate that the model can provide a reasonable representation of events that occured in the field. Once confidence in the model was established, the model was used to model future conditions and perform "what if" analyses.

Under ideal circumstances, flowmeters would have been installed at each location to record data for the same time period. However, flow metering occurred at several different times, so records from similar days were used to develop the unit loads and to calibrate the model. Table 4.1 lists the days that were used in calibrating the model.

Table 4.1 Flow Metering Recording Locations and Days Used for Model Calibration
Wastewater Master Plan and Utility System Analysis – City of Avondale

Flowmeter Location	Date that Field Data was Compared with the Model
Avondale WWTP Influent	August 21, 2004
114th Avenue and McDowell	September 11, 2004 and September 18, 2004
119th Avenue and Palm Lane	September 11, 2004 and September 18, 2004
4th Street and Elm	August 21, 2004
7th Street and Corral	August 21, 2004
Central and Rio Vista	September 11, 2004 and September 18, 2004
Coldwater Springs	October 02, 2004
Hill and 1st Avenue	September 11, 2004 and September 18, 2004
Lower Buckeye and 117th Avenue	September 11, 2004 and September 18, 2004
McDowell at Rancho Santa Fe Reservoirs	October 02, 2004
Rancho Santa Fe Trail and La Reata	October 02, 2004

Appendix D contains graphs that compare model results with field measured flows. The graphs show that the model provides a reasonable approximation of collection system flows. Once the diurnal flow patterns were established as described in the next section, the model calibrated well, except for the flowmeter at 1st Street and Hill, where flows did not match well. Subsequent flow monitoring showed that the problem was a meter reading error.

4.4 WASTEWATER LOADS

4.4.1 Unit Loads

This section discusses unit loads in the Avondale System that were estimated from field test data and from an overall mass balance of collection system flows. Avondale may choose to use more conservative unit loads to account for uncertainties in future loads. Unit loads are an estimate of the average daily loads on a per acre basis for each land use classification in the land use plan. A first approximation of unit loads was initially obtained by using a mass balance to estimate the unit loads that would result in a load prediction that matched a high daily flow. The high weekend average daily flow on August 21, 2004 was used for this mass balance. This type of mass balance identifies reasonable unit load values that add up to the total daily flow when multiplied by the total acreage of the land use category. Therefore, any error in one unit load value is compensated for by a corresponding error in one or more other unit load values. Figure 4.3 shows the treatment plant flows on August 21, 2004 that were used to calculate unit loads.

The initial unit loads were estimated using ranges of reasonable values that are typical of unit loads in Arizona. The unit loading of residential areas can typically be obtained from population density. Wastewater loading generally ranges from 55 to 75 gpcd for residential areas. Retirement communities tend to have unit loads near 55 or 60 gpcd. Unit loads for designing mains may need to be set higher than the loads that the City is experiencing.

The commercial / office and large retail land use classifications generally produce unit loads ranging from 700 to 1,500 gpad.

Industrial unit loadings generally range from 500 to 1,000 gpad for light industry typical of business and industrial parks.

The school land use classification includes educational facilities characterized by large buildings containing multiple classrooms and associated open field facilities. Wastewater loading for educational facilities can vary significantly.

A unit load was estimated for PIR. Based on an analysis of anticipated flows from plumbing fixtures, the water supply was estimated to be 1.0 mgd under peak conditions or 2,370 gpad under high flow conditions. The analysis was based upon the 2000 Uniform Plumbing Code. Wastewater flows were not expected to be higher than water supply to PIR.

Table 4.2 lists the unit loads that were estimated using the mass balance.

Table 4.2 Wastewater Unit Loads
Wastewater Master Plan and Utility System Analysis – City of Avondale

Land Use Type	Average Population Density (person/Ac)	Unit Load, gpcd	Unit Load, gpad
Low Density Residential	3.25	65	211
High Density Residential	25.99	65	1689
Medium Density Residential	12.84	65	834
Future Medium Density Residential	14.40	65	936
Commercial / Office			757
Large Retail			757
Industrial			698
Schools			174
PIR			2,370

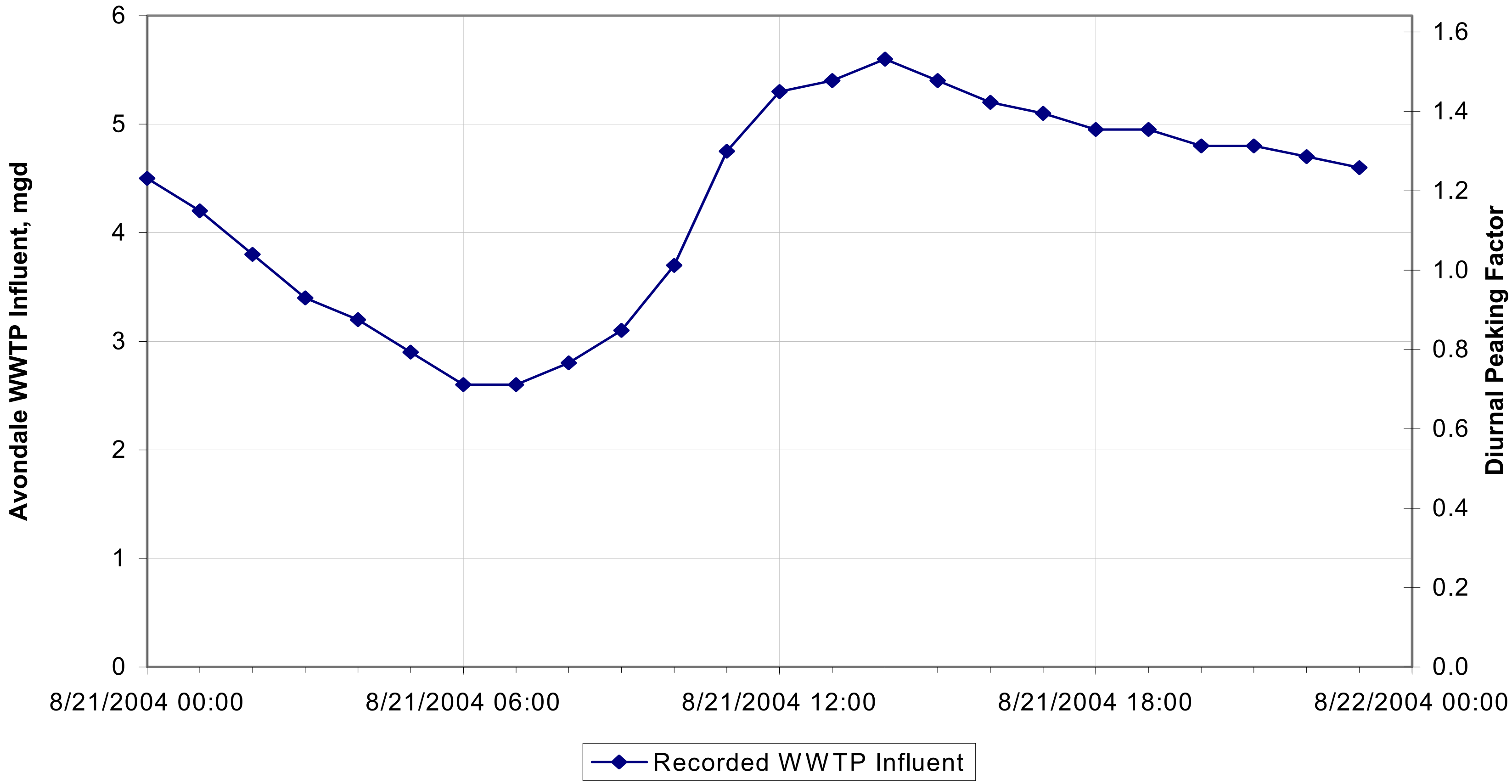


Figure 4.3 Avondale Wastewater Treatment Plant Flows

Unit loads for specific land use classifications are broad averages of the actual unit loads within the land use classification. Actual unit loads for a specific area may vary from the average load. For example, older areas generally have higher wastewater loads caused by the use of less efficient fixtures and appliances. Sometimes affluent areas or areas with children have higher unit loads. Commercial and industrial users can have significantly different unit loads depending on the type of business. Therefore, unit loads were adjusted to match field data collected from the specific areas where flows were monitored. Table 4.3 presents unit loads modified to match the flows recorded by the flowmeters.

Unit loadings for the flowmeters located at the intersections of 114th Avenue / McDowell and Rancho Santa Fe Trail / La Reata (South of Thomas) were not adjusted.

Residential unit loadings were reduced to better characterize flows measured by flowmeters at 119th Avenue / Palm Lane, 117th Avenue / Lower Buckeye, and the Rancho Santa Fe Reservoirs (along McDowell Road). The majority of the collection area served by these meters is newer residential development. Therefore, the reduction in unit loads may be due to water saving plumbing fixtures.

The flowmeters located at 4th Street / Elm and 7th Street / Corral are connected in a series type arrangement. All flow measured by the 7th Street / Corral meter continue through the collection system to the 4th Street / Elm location. A significant portion of the collection area served by the 7th Street / Corral meter is of commercial / office, large retail, and industrial land use. A slight adjustment to unit loads for these land uses was required to match metered flows.

In a similar fashion, the flowmeter at 1st Avenue / Hill flows down gradient to the flowmeter located at Central / Rio Vista. The flows recorded at 1st Avenue / Hill were higher on a per acre basis than any other flowmeter. To understand the cause of this discrepancy, a flowmeter was reinstalled at the Central/Rio Vista location February 2005. The second set of flow data was more consistent with the 1st Avenue / Hill. Therefore, the cause of the discrepancy was assumed to be a metering error.

The flowmeter located on Coldwater Springs Boulevard metered flow generated almost exclusively by the car dealerships located south of Interstate 10 between 99th Avenue and 107th Avenue. These facilities generate significantly less wastewater than other commercial and industrial areas.

A review of the mass balance used to generate the unit loads suggest that un-metered areas may have a higher unit load when compared with other areas. However, several other factors may be influencing this phenomenon. Since the flowmeter records were not collected on a single day, temporal variations may influence the mass balance. Additionally, limitations in the accuracy of the flowmeters themselves may affect flows in the mass balance.

Table 4.3 Unit Load Adjustments Made Based on Temporary Meter Data
Wastewater Master Plan and Utility System Analysis – City of Avondale

Loading (gpad)	Low Density Residential	High Density Residential	Medium Density Residential	Future Medium Density Residential	Commercial / Office	Large Retail	Industrial	School	Comparison with Metered Flow (% of Metered Flow)
Unit Loads	211	1,689	834	936	757	757	698	174	-
114th Avenue and McDowell	211	1,689	834	936	757	757	698	174	106%
Rancho Santa Fe Trail and La Reata	211	1,689	834	936	757	757	698	174	99%
119th Avenue and Palm Lane	166	1,325	654	734	757	757	698	174	108%
Lower Buckeye and 117th Avenue	166	1,325	654	734	757	757	698	174	102%
McDowell at Rancho Santa Fe Reservoirs	166	1,325	654	734	757	757	698	174	112%
4th Street and Elm	211	1,689	834	936	845	845	779	174	101%
7th Street and Corral	211	1,689	834	936	845	845	779	174	101%
Central and Rio Vista	243	1,944	960	1,077	1,152	1,152	892	174	100%
Hill and 1st Avenue	243	1,944	960	1,077	1,200	1,200	1,000	288	60%
Coldwater Springs	211	1,689	834	936	216	757	199	174	100%
Unmetered Areas	243	1,944	960	1,077	1,195	1,195	1,102	288	92%
Avondale WWTP Loading	-	-	-	-	-	-	-	-	98%

Notes:

- Cells shaded in green represent the unit loads as developed previously. These values serve as comparison values.
- Cells shaded in yellow represent modifications to the unit loads to adjust unit loads to match flowmeter records.

4.4.2 Unit Load Comparison with Other Studies

Unit loading factors and peaking factors were developed in previous master plans. This section presents the results of previous master plans in contrast to this study.

As with this master planning effort, previous studies have used unit load factors to establish wastewater flows. The unit loading factors used in previous studies have consistently been higher than those used in this study. Table 4.4 lists the unit loads utilized in previous studies.

Table 4.4 Comparison of Unit Loading Factors
Wastewater Master Plan and Utility System Analysis – City of Avondale

Land Use Type	Unit Load, gpcd	Unit Load, gpad	Source
Residential	100		City of Avondale Design Standards, June 1997
Residential	85*		City of Avondale Sewer System Master Plan Update, June 2000
Commercial		3,000	City of Avondale Design Standards, June 1997
Commercial	30		City of Avondale Sewer System Master Plan Update, June 2000

* Includes 19 GPCD inflow and infiltration

The Sewer System Master Plan Update, June 2000, utilized some field-testing for both the residential and commercial land use types. However, the Update utilized a residential flow adjusted for inflow and infiltration, and a commercial flow consistent with the standard MAG unit load.

In contrast to these values, this study utilized unit loadings of 65 gpcd and commercial unit loadings of less than 1,000 gpad according to current flow metering records. The mass balance using current influent flows at the Avondale WWTP showed that actual flows are less than those that would be predicted using the unit loads in the City of Avondale Design Standards. Design values should be followed for new development because there is a degree of uncertainty regarding the actual flows that will occur. However, after the development has already occurred, the City does not need to upsize mains for flows other than the ones that actually occur, so lower unit values are justified when evaluating existing mains. In addition, major trunk mains and interceptors may be oversized if the conservative design values are used because the sum of the predicted loads based on design unit loads may be significantly greater than the flows that actually occur.

4.4.3 Diurnal Loading Patterns

Diurnal loading patterns were developed to provide representative time varying distribution of the flows that is consistent with flow monitoring data. Diurnal patterns are multipliers for each hour of the day. These patterns are multiplied by the average daily flow to obtain the flow for each hour of the day. Diurnal patterns were developed such that predicted flows in the model correspond to the distribution of flows throughout the day. These patterns were developed separately for each flowmeter, with the exception of flowmeters located in Old Avondale. Just as the flowmeters located at 4th Street / Elm and 7th Street / Corral shared adjusted unit loadings, these stations exhibited common loading patterns.

The diurnal flow variation recorded at the 1st Street / Hill flowmeter could not be matched to the flows measured at the Central / Rio Vista flowmeter, which was downstream of the 1st Street / Hill flowmeter. The cause of inconsistency has been attributed to a flow metering problem.

The loading patterns are presented in Table 4.5, which lists the diurnal patterns used for each flow metering location. Figure 4.4 shows each of the diurnal patterns.

Table 4.5 Applicable Diurnal Loading Patterns
Wastewater Master Plan and Utility System Analysis – City of Avondale

Flowmeter Location	Applicable Pattern
114th Avenue and McDowell	Pattern – A
McDowell at Rancho Santa Fe Reservoirs	Pattern – B
Rancho Santa Fe at La Reata	Pattern – B
Lower Buckeye at 117th Ave	Pattern – C
Coldwater Springs	Pattern – D
119th Avenue and Palm Lane	Pattern – E
Central and Rio Vista	Pattern – F
Hill and 1st Avenue	Pattern – F
Unmetered Areas	Pattern – G
4th Street and Elm	Pattern – H
7th and Corral	Pattern – H

4.4.4 Comparison with Previous Studies

Previous planning studies utilized more conservative peaking factors than were used in this study. For example, the East Avondale Sewer System Master Plan (July 2003) utilized a peaking factor (average day to peak hour) of 4.0 in pipes less than 12 inches in diameter, and 2.5 in pipes greater than or equal to 12 inches in diameter. These values were taken from Avondale's Engineering Design Standards. The peaking factor for small diameter pipes is larger than typically recommended, while the factor of 2.5 is typical of industry recommendations. The "10-States" Recommended Standards for Wastewater Facilities indicates that facilities serving approximately 200 people should be designed with a peaking factor of 4.0, while facilities serving approximately 28,000 should be designed using a peaking factor of 2.5. These peaking factors are generally higher than recorded in the desert southwest because the "10-States" standards were developed for areas with significant infiltration and inflow.

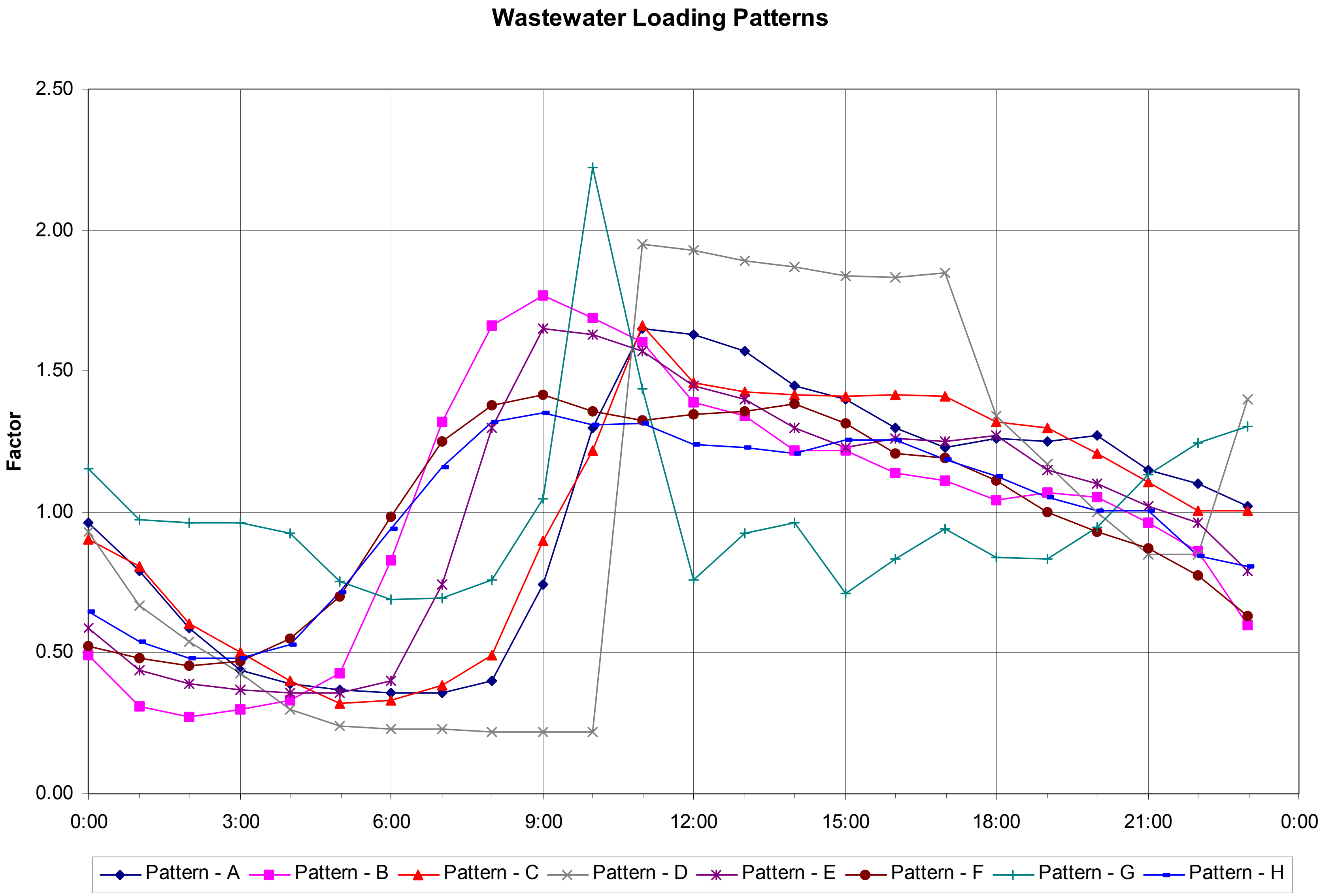


Figure 4.4 Diurnal Flow Patterns

The Sewer System Master Plan Update (June 2000) reported a Peak Day flow of 1.6 times the Average Daily Flow and a Peak Hour flow of 2.0 times the Average Daily flow. These values are similar to the peaking factors utilized in this analysis.

A typical peaking factor at the Avondale Wastewater Treatment Plant on a weekend day is 1.3. Peaking factors at flow monitoring points upstream of the treatment plant were usually between 1.4 and 1.7. Peaking factors in the smaller mains would be higher as aggregation and attenuation within the smaller collection mains would not have occurred.

For design purposes, the peaking factors contained in the Arizona Revised Statute would be appropriate for future development where the actual peaking factor is not known.

4.4.5 Projected Wastewater Flow

Projected wastewater flows were developed by multiplying the unit loads for each land use classification by the developed or connected acreage in each planning period. The loads for each land use category were then summed to obtain a total projected load for each planning period. Table 4.6 shows the projected wastewater loads for each planning year of this study. Avondale requested that an infiltration and inflow factor of 10 percent be included in the analysis in addition to the normal flows. This factor was added onto the loads that are listed in the table.

Loading patterns developed for areas metered during the calibration portion of this project were applied to those same areas in future scenarios. A typical, diurnal loading pattern was applied to un-metered and future areas. Note that a peak time of 9:00 a.m. corresponds to a weekend flow pattern when loads are greater. Weekday peak flow times occur closer to 7:00 a.m. in the Avondale Collection system. Figure 4.5 shows this loading pattern.

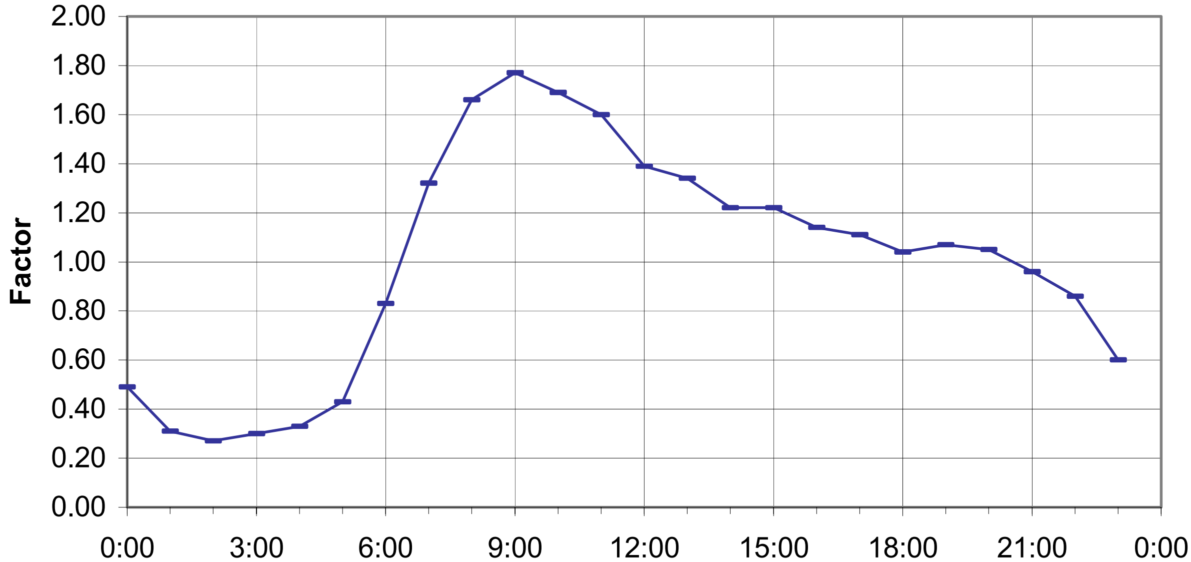


Figure 4.5 Unmetered and Future Areas Loading Pattern

Table 4.6 Wastewater Loading Per Planning Period
Wastewater Master Plan and Utility System Analysis – City of Avondale

Land Use Type	Current (2004)			2005			2010			Buildout		
	Acres	Population	High Day, gpm	Acres	Population	High Day, gpm	Acres	Population	High Day, gpm	Acres	Population	High Day, gpm
Low Density Residential	304	989	45	328	1,066	48	1,199	3,897	176	1,335	4,339	196
High Density Residential	223	5,787	261	244	6,340	286	357	9,272	419	416	10,818	488
Medium Density Residential	3,849	49,405	2,230	3,935	50,509	2,280	4,409	56,605	2,555	4,409	56,605	2,555
Future Medium Density Residential	0	0	0	271	3,907	176	2,728	39,278	1,773	6,241	89,870	4,057
Commercial / Office	441	-	232	593	-	312	1,505	-	791	1,961	-	1,031
Large Retail	182	-	96	229	-	120	468	-	246	689	-	362
Industrial	369	-	179	429	-	208	1,111	-	539	1,651	-	800
Schools	365	-	44	375	-	45	516	-	63	546	-	66
Phoenix International Raceway	0	-	0	0	-	0	0	-	0	322	-	530
Total	5,733	56,182	3,087	6,403	61,823	3,476	12,294	109,053	6,561	17,571	161,633	10,085
Avondale WWTP Influent	-	-	4.4 mgd	-	-	5.0 mgd	-	-	9.4 mgd	-	-	14.5 mgd

4.5 PERFORMANCE CRITERIA

This section describes the measurement standards that were used to evaluate the suitability of the existing wastewater collection system, as well as the capacity requirements of future improvements. The capacities of gravity pipes, force mains, and pump stations are based on the criteria described below.

4.5.1 Pipe Capacities

Sewer pipe capacities are dependent on many factors. These include roughness of pipe, maximum allowable depth of flow, and limiting velocity and slope. The Continuity Equation and the Manning Equation were used for steady-flow hydraulic calculations. The Manning coefficient 'n' is a friction coefficient that varies with respect to pipe material, size of pipe, depth of flow, smoothness of joints, root intrusion, and other factors. For gravity sewer pipes, the Manning Coefficient typically ranges between 0.011 and 0.017. A typical value used for planning purposes is 0.013.

4.5.2 Flow Depth Criteria (d/D)

When designing sewer pipelines, it is common practice to adopt variable flow depth criteria for various pipe sizes. This criterion is expressed as a maximum depth of flow to pipe diameter ratio (d/D). Design d/D ratios typically range from 0.5 to 1.0, with the lower values typically used for smaller pipes that may experience flow peaks greater than planned or may experience blockages from debris, paper, or rags.

The flow depth criterion for new mains with diameters less than 12 inches is 0.5. A typical flow depth criteria for the design of new pipes with diameters 12 inches and greater is 0.75. However, existing mains will be evaluated based on flow depth criteria of 0.85 because there are fewer unknowns, especially in established, built out areas, and because there is no need to replace an existing pipe until flows are close to the pipe capacity. The hydraulic criteria used for sizing the proposed gravity sewers will have a greater factor of safety than the criteria used to evaluate the capacity of the existing system due to the uncertainties in making projections of future flows. The proposed difference between the design criteria and the existing system criteria allows full use of the existing sewer capacities and prevents unnecessary pipe replacements. This approach avoids the problem of replacing or upgrading existing mains prematurely.

In order to minimize the settlement of sewage solids, it is standard practice in the design of gravity sewers to specify that a minimum velocity of 2 feet per second be maintained when the pipe is flowing half full. At this velocity, the sewer flow will typically provide self-cleaning for the pipe. Due to the hydraulics of a circular conduit, velocity for half full flow in pipes approaches the velocity of nearly full flow in pipes. Table 4.7 lists the minimum slopes for maintaining self-cleaning full flow velocities with d/D = 0.5. The minimum slope listed in the table is 0.0008 ft/ft, which is the minimum practical slope for gravity sewer construction. Greater slopes are desirable if they are compatible with existing topography, as long as the water velocity does not exceed 8 feet per second.

Table 4.7 Recommended Minimum Slopes for Circular Pipes Wastewater Master Plan and Utility System Analysis – City of Avondale

Pipe Size (inches)	Minimum Slope(1) (ft/ft)	Pipe Capacity(2) (mgd)	(cfs)
8	0.0034	0.45	0.70
10	0.0025	0.70	1.09
12	0.0020	1.02	1.57
14	0.0016	1.38	2.14
15	0.0015	1.59	2.45
16	0.0014	1.80	2.79
18	0.0012	2.28	3.53
20	0.0010	2.82	4.36
21	0.0010	3.11	4.81
24	0.0008	4.06	6.28

Note:
1. Mains larger than 24 inches should still have a slope no less than 0.0008.
2. Pipe Capacity presented based on full capacity flow.
3. Table assumes Manning's N coefficient of 0.013.

4.5.3 Changes in Pipe Size

When a smaller sewer joins a large sewer, the invert of the larger sewer will be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation. For master planning purposes, and in the absence of field data, sewer crowns will be matched at the manholes.

4.5.4 Lift Stations

A firm capacity equal to three times the high-daily flow is often used to determine the size of lift stations. The firm capacity concept calls for the pumps in the lift station to be sized to allow the lift station to operate at its design capacity with the largest pump out of service.

4.5.4.1 Normal Operation

The fill time, based on average flows, and minimum pump cycle time, are usually considered in sizing the lift station wet well. The effective volume of the wet well shall provide a holding period not to exceed thirty minutes for the design average flow. When selecting the minimum cycle time, the pump manufacturer's duty cycle recommendations shall be utilized. Start and stop times higher than seven (7) times an hour for any one pump are not recommended.

4.5.4.2 Emergency Operation

The objective of emergency operation is to protect public health by preventing back-up of wastewater and subsequent discharge into streets and other public or private property. Emergency pumping capability in Avondale for some of the lift stations is provided with back up generators.

4.5.5 Force Mains

Force mains should have a minimum diameter of 6 inches and a water velocity between 3 and 7 feet per second.

4.5.6 Gravity Main Planning Guidelines

Gravity mains should be planned and installed to have a minimum of 5 feet of cover or sufficient depth to serve the ultimate drainage area.

Gravity mains should be planned and installed with a minimum of 4 feet of separation between the flowline of irrigation ditches and the crown of the sewer main.

Gravity and force mains should have a minimum separation of 6 feet from potable water lines unless concrete encased according to Arizona Department of Environmental Quality requirements.

Manholes with pipelines intersecting at 90-degree (or greater) angles should provide 0.2 feet of invert drop through the manhole. Other manholes should provide a minimum 0.1 feet of invert drop

4.5.7 Performance Criteria Summary

Table 4.8 summarizes the system performance criteria used to evaluate the collection system.

Table 4.8 Planning and Design Criteria Summary
Wastewater Master Plan and Utility System Analysis – City of Avondale

Minimum Slopes for New Circular Pipes(1)

Slopes were calculated using Manning's formula for pipes flowing full with a minimum velocity of 2 fps, using a Manning's N of 0.013.

Pipe Size (inches)	Minimum Slope(1) (ft/ft)	Pipe Capacity (mgd)	Pipe Capacity (cfs)
8	0.0034	0.45	0.70
10	0.0025	0.70	1.09
12	0.0020	1.02	1.57
14	0.0016	1.38	2.14
15	0.0015	1.59	2.45
16	0.0014	1.80	2.79
18	0.0012	2.28	3.53
20	0.0010	2.82	4.36
21	0.0010	3.11	4.81
24	0.0008	4.06	6.28

Note:
(1) Mains larger than 24 inches should still have a slope no less than 0.0008.

Maximum Velocity

Maximum velocity should not exceed 7 feet per second.

Flow Depth, d/D

The following flow depth will be used in the analysis:

d/D for New Sewer Pipes with Diameters less than 12 inches	=	0.5
d/D for Designing New Sewer Pipes 12 inches and Higher	=	0.75
d/D for Evaluating Existing Mains	=	0.85

Headloss in Existing Pipes

Headloss in existing sewer pipes shall be calculated based on the following:

Gravity Pipes	Manning's n	=	0.013
Pressure Pipes	Hazen William's C	=	120

Changes in Pipe Size

When a smaller sewer joins a larger one, sewer crowns will be matched.

Headloss at Manholes

Manholes with pipelines intersecting at 90 degrees or greater	Provide 0.2' Invert Drop
Manholes with pipelines intersecting at less than 90 degrees	Provide 0.1' Invert Drop

4.6 WASTEWATER COLLECTION SYSTEM EVALUATION

The model was used to evaluate the existing wastewater collection system to determine if deficiencies exist, and to evaluate the unused capacity that remains in the collection system. Appendix E contains maps of the wastewater collection system and the water system that summarize key model results.

4.6.1 Existing Wastewater Collection System

The existing collection system conveys wastewater to the City of Avondale WWTP located west of the Dysart Road alignment between Broadway and Southern Avenues. The WWTP has a rated capacity of 6.4 mgd. As the WWTP is located on the east side of the Agua Fria River, two lift stations are used to pump wastewater generated on the west side of the Agua Fria River to gravity mains that eventually lead to the WWTP. Additional lift stations serve isolated areas of the collection system.

The wastewater GIS database, maintained by the City of Avondale Engineering Department, provided information regarding the diameter and slope of existing pipelines. However, limited data was available describing existing diversion structures and lift stations. Table 4.9 lists the available information on the existing lift stations.

Table 4.9 Existing Lift Station Details
Wastewater Master Plan and Utility System Analysis – City of Avondale

Lift Station	Bottom Elevation (ft)	Maximum Water Level (ft)	Existing Pumps	Total Future Pumps	Usable Wet Well Volume (cf)	Pumping Capacity
Lawrence	955.69	960.97	2	2	66	Not Available
Central Avenue	951.3	957.8	2	2	184	Not Available
Littleton Manor	966.27	972.27	2	2	170	Not Available
Riley	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available
10th Street	947.95	956.45	3	3	635	Not Available
4th Street	924	931	3	4	1026	Not Available

The 10th Street and 4th Street lift stations are the two major lift stations in the collection system. The 10th Street station is in good condition but the pumping capacity of this station is not known, and the 4th Street station is scheduled for an upgrade to address deficiencies.

4.6.1.1 Pipeline Capacity

The existing collection system has no known capacity limitations, based on information from operations personnel. The model also indicated that there are no mains that are near or at capacity.

4.6.1.2 Insufficient Pipe Slopes

Many pipes within the Avondale collection system have flatter slopes than are recommended by the performance criteria assuming that a Manning's N of 0.013 is used to calculate friction losses. Since flatter slopes increase the likelihood of sedimentation, these pipelines are more likely to have deposition problems or capacity problems than pipes with more slope. Figure 4.6 shows pipelines with slopes that are less than the slopes recommended in the performance criteria.

4.6.2 Future Wastewater Collection System

4.6.2.1 Collection Mains

The model was used to size gravity and force mains along major streets that will provide a backbone for the wastewater collection system. Specific mains that may be at capacity in the future are discussed below. Figure 4.7 shows the new mains and lift stations that were modeled and sized during this study. Figure 4.8 shows the estimated planning time period when the City will need to provide service to each area that is not currently served.

Two critical force mains cross the Agua Fria River. These force mains are essential to the collection of wastewater from western Avondale. However, the Agua Fria River could flood, which can place the force mains at risk. Therefore, the costs for providing an additional, redundant force main across the river for the 10th Street and 4th Street lift stations is included within the cost summary. It is proposed that the 10th Street force main be attached to the street bridge across the river near the lift station. If a factor of three is used to size pumps for the 10th Street Lift Station, there is a possibility that one section of main along El Mirage Road south of Van Buren Street would be under-sized. However, the area served by the 10th Street Lift Station is close to buildout, and the capacity of the existing pumps in the lift station is not known. Therefore, additional flow monitoring of flows into the lift station and along El Mirage Road is recommended before drawing any conclusions regarding the flows produced by the lift station and the potential capacity limitations downstream of this lift station.

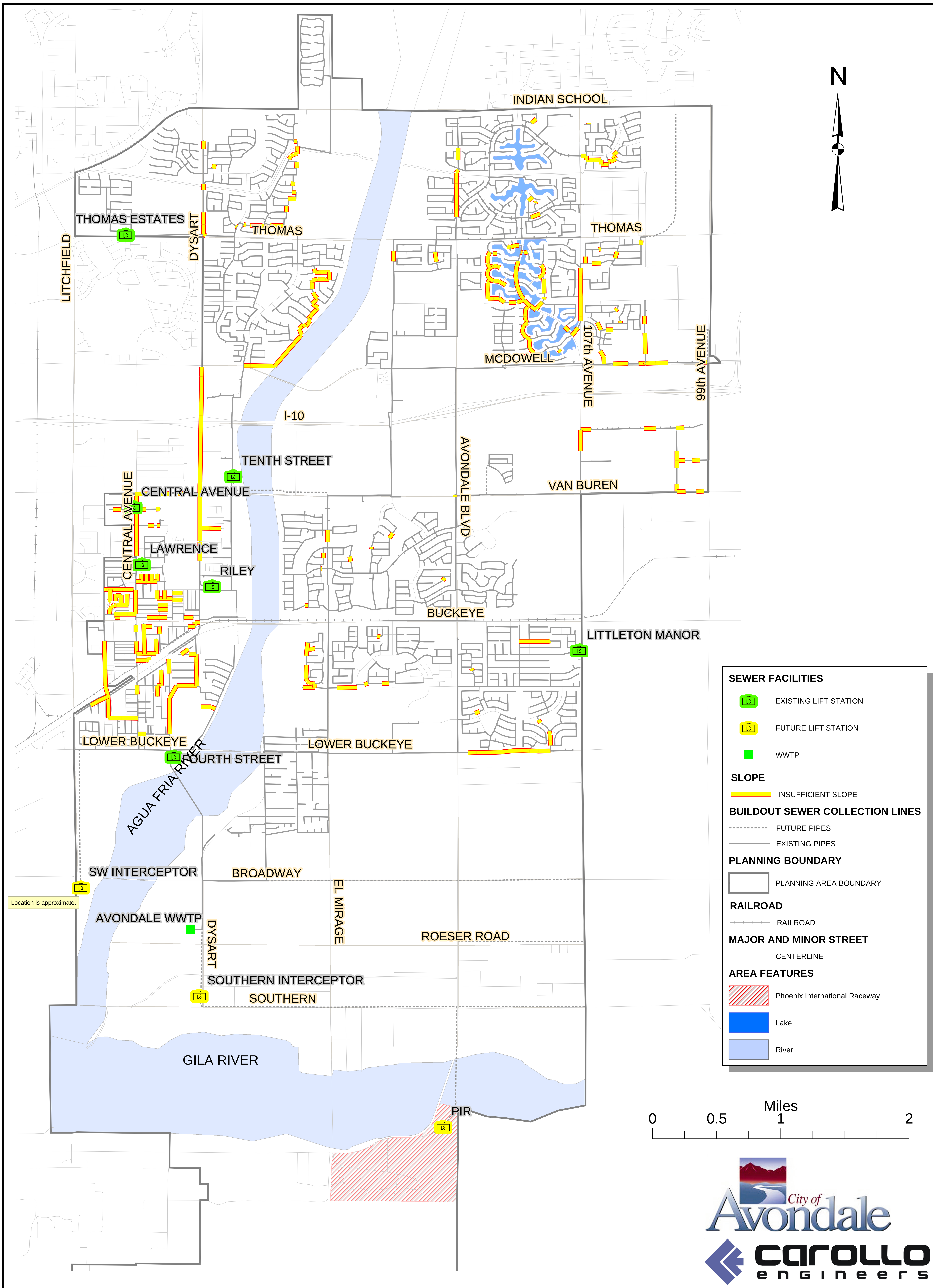


FIGURE 4.6 - PIPELINES WITH AN INSUFFICIENT SLOPE
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005

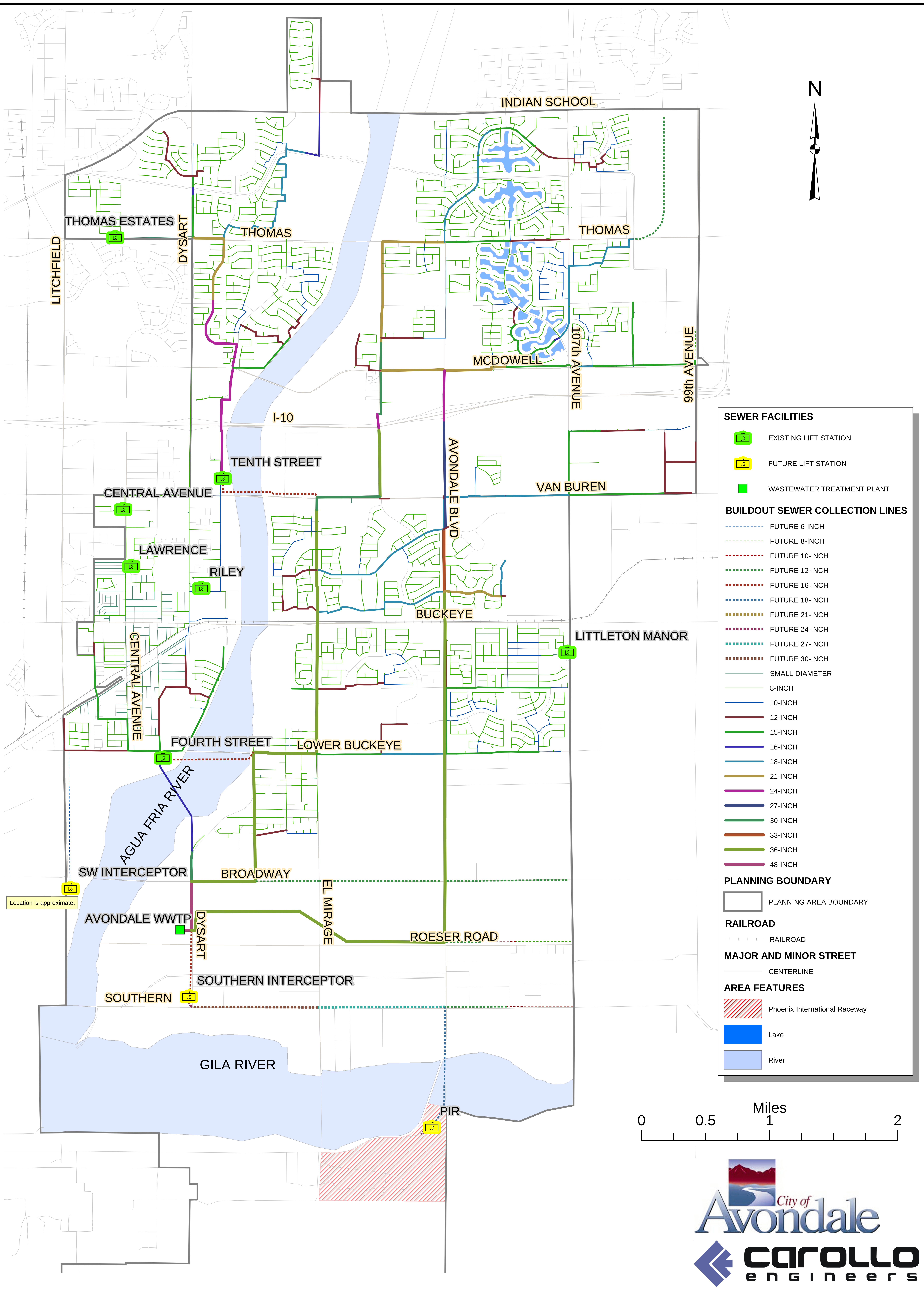


FIGURE 4.7 - BUILDOUT WASTEWATER COLLECTION SYSTEM
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005

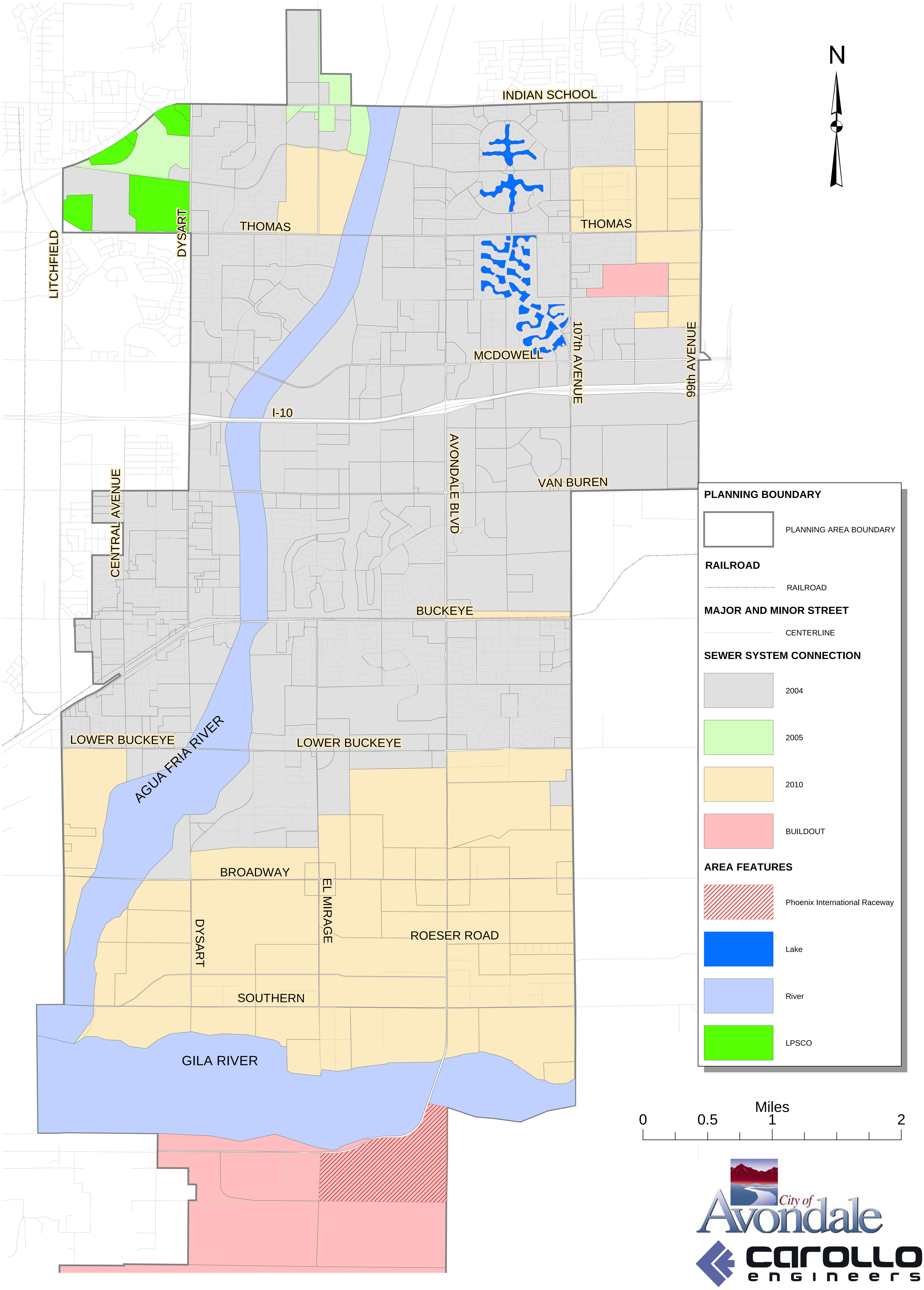


FIGURE 4.8 - ESTIMATED WASTEWATER COLLECTION SYSTEM CONNECTION PERIOD
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005

The Western Interceptor is a proposed main along the west side of the Agua Fria River. This interceptor was recommended in previous master plans as a means to convey wastewater currently handled by the 10th Street Lift Station to the 4th Street Lift Station for conveyance across the Agua Fria River. The Western Interceptor was originally intended to take flows that are currently pumped by the 10th Street station and convey the flow by gravity along the west side of the river to limit the loading of the gravity interceptor between the intersection of Van Buren / El Mirage and Dysart / Broadway. The analysis of unit loads performed as a part of this study revealed that earlier, higher load projections did not accurately represent Avondale's actual wastewater flows. Based on the model results of this study, overloading of the gravity main should not occur and therefore, the Western Interceptor is not required. This main is not included in the CIP recommendations in this report.

During this study, the diversion structures in Avondale Boulevard were assumed to direct all flow south along the Avondale Boulevard Interceptor, after this interceptor is constructed completely, instead of using the interceptor along El Mirage Road. These diversion structures currently move wastewater west to El Mirage Road, but are expected to be removed when the Avondale Interceptor is in place.

Analysis of the collection system at buildout revealed that there is a stretch of gravity main that may have d/D ratios greater than 0.9. These pipelines appear to provide adequate conveyance for the 2005 planning period. However, these pipes should be included in a "watch list" for future flow monitoring. While reasonable, conservative assumptions were used to develop future model scenarios, future scenarios inherently include assumptions regarding factors such as future wastewater routing, wastewater loading patterns, and application of unit loading factors according to the land use plan. The City has the ability to monitor flows in mains that may be flowing near capacity to confirm the need to upsize mains where necessary. The 8-inch main that should be monitored runs south along Central Avenue, beginning at Madden Drive, turns west along Hill Street, than south on 4th Avenue. The stretch ends at Norton Drive.

4.6.3 Lift Station Evaluations

The lift stations were evaluated to determine the required capacities at buildout. The lift stations should have a firm capacity (i.e., capacity with one pump out of service) that exceeds the maximum flow into the lift station. A listing of lift stations and predicted inflows at buildout is included in Table 4.10. In this table, force main sizes are based on the assumption that the main is sized for three times the predicted inflow. If a different factor is used to size pumps, or if variable speed drives are used, force main diameter recommendations could change.

Table 4.10 Ultimate Lift Station Capacities Wastewater Master Plan and Utility System Analysis – City of Avondale		
Lift Station	**Max Loading w/Inflow (gpm)**	**Required Force Main Diameter (in)**
Lawrence	37	6
Central Avenue	31	6
Riley	6	6
Littleton Manor	22	6
10th Street	1,075	16
4th Street	976	16
Southern Interceptor	2,111	24
PIR	1,178	18
Southwest Interceptor	82	6

4.6.4 Wastewater Treatment Plant Capacity

The wastewater treatment plant has a current capacity of 6.4 mgd. The site has been master planned for an ultimate capacity of 20 mgd. The wastewater flow projections in this study predict a buildout flow rate of 14.5 mgd on a high flow weekend day, not including a factor of 10 percent for storm flow. The treatment plant will need to have an increased capacity to handle the projected flow of 9.4 mgd in 2009.

4.7 CAPITAL IMPROVEMENT PROGRAM

A capital improvement program that includes the infrastructure necessary to complete the City's wastewater collection system is provided. Table 4.11 lists the unit costs used to calculate estimated project costs. Table 4.12 presents a summary of the phased capital improvements proposed within this master plan. The existing collection system satisfies the d/D requirements in the performance criteria, so the gravity mains and lift stations in Table 4.12 are to serve planned growth.

Table 4.11 Wastewater Collection System Unit Costs
Wastewater Master Plan and Utility System Analysis – City of Avondale

Force Main Diameter, in	Construction Costs ($/LF)
6	$72
8	$77
10	$80
12	$118
18	$140
24	$165
Gravity Main Diameter, in	Construction Costs ($/LF)
8	$56
10	$62
12	$69
15	$84
18	$99
21	$120
24	$141
27	$157
30	$174
33	$246
36	$284
Lift Station Capacity, mgd	Total Construction Cost
1	$700,000
5	$1,330,000
8	$1,690,000
10	$2,090,000
12	$2,270,000
15	$2,830,000
Manhole Diameter, in	Construction Costs, each
48	$3,300
60	$5,800
Wastewater treatment plant	Cost per gallon of capacity
	$10
Project costs are based on the assumption that engineering design, contract management, inspection, and contingency are an additional 40% of the construction cost	
ENR CCI = 7312 (20 Cities Index, November 2004)	

Table 4.12 Wastewater Collection System Wastewater Master Plan and Utility System Analysis – City of Avondale					
	Diameter (in) or LS Capacity (mgd)	**Length (ft)**	**Project Costs**		
			2005	**2010**	**Buildout**
Roeser Road Trunk Line	8	2,640	-	$272,000	-
Roeser Road Trunk Line	10	1,320	-	$152,000	-
Roeser Road Trunk Line	12	1,320	-	$165,000	-
Broadway Interceptor	12	13,200	-	$1,616,000	-
Eastern Half of T-2N, R-1E, Section 29	12	5,280	-	$649,000	-
Southern Interceptor	10	2,640	-	-	$298,000
Southern Interceptor	12	2,640	-	-	$325,000
Southern Interceptor	27	5,280	-	-	$1,443,000
Southern Interceptor	30	5,280	-	-	$1,574,000
Southern Interceptor Force Main	24	2,640	-	-	$671,000
Southern Interceptor Lift Station	10.00	-	-	-	$3,215,000
PIR Force Main	18	5,280	-	-	$1,150,000
PIR Lift Station	6.00	-	-	-	$2,234,000
Southwest Interceptor Force Main	6	5,280	-	-	$584,000
Southwest Interceptor Lift Station	0.35	-	-	-	$500,000
4th Street Lift Station Upgrades	5.00	-	-	-	$2,050,000
4th Street Parallel Force Main	16	4,000	-	-	$823,000
10th Street Lift Station Upgrades	5.00	-	-	-	$2,050,000
10th Street Force Main Capacity Increase	12	4,500	-	-	$817,000
10th Street Parallel Force Main	16	4,500	-	-	$926,000
Wastewater Treatment Plant Capacity Increase 2006-2010				$36,000,000	
Wastewater Treatment Plant Capacity Increase Buildout					$45,000,000
Total	-	-	-	$38,854,000	$63,660,000
Note: Pipeline costs include manholes every 500 feet.					
Project costs are based on the assumption that engineering design, contract management, inspection, and contingency are an additional 40% of the construction cost					
ENR CCI = 7312 (20 Cities Index, November 2004)					

WATER SYSTEM UTILITY ANALYSIS

5.1 BACKGROUND

The City of Avondale requested that the water system utility analysis be conducted to help the City obtain a detailed model that can be used for future modeling analysis to help plan growth, and to evaluate a wide variety of operational considerations. This model was to be made compatible with the City's GIS system so that it could be readily updated. The model was to be set up so that demands could be modified according to changes in the GIS based land use plan that is described in the planning framework portion of this report. Then the model was to be used to evaluate existing and future conditions to determine required infrastructure changes that would meet demands and satisfy performance criteria in the 2005, 2010, and buildout time periods. The results of this study will be used to develop a capital improvement plan.

This portion of the report is divided into the following sections:

Demand Projections – This section describes the demands and peaking factors that were developed and used in this study.

Performance Criteria – The performance criteria provides the standard of measurement against which existing and new infrastructure is measured.

Network Evaluation – This section contains recommendations for improvements to the existing system and identifies future infrastructure that would be needed to serve additional customers while still meeting the performance criteria.

Capital Improvement Plan – This section identifies the costs and timing of recommended improvements.

5.2 DEMAND PROJECTIONS

The purpose of water demand projections is to understand how much water will be required and where that water will need to be delivered in the distribution system during each of the planning periods in this study. Demand projections were based on existing demands in the water system, categorized by each of the land use classifications in the land use plan. Water production records and customer billing data were also used to estimate the demands. Demands are expressed in terms of an average annual unit demand that is applied on a per acre basis.

Peaking factors were used to adjust the average annual demand to the demand that corresponds to a maximum annual day or a peak hour. Peaking factors were derived from water production data.

Demand projections form a critical piece of the model study because infrastructure requirements are sized based on these demands.

5.2.1 Unit Demands

Production records provided by the City of Avondale Utilities Department were used to establish average annual demands for the current (2004) planning period. Water production records from 2001 to the present were utilized to establish an anticipated 2004 average annual production. Projected production values were used to complete unavailable 2004 production records. The estimated annual average water production for 2004 was estimated to be 10.3 mgd.

Unaccounted for Water (UFW) was conservatively assumed to be 10 percent of Avondale's total production for planning purposes. Actual UFW in 2003 was 7 percent and 8 percent in 2004. UFW is the difference between total water production and total water billings. UFW consists of water that is lost through leaks, under-reporting meters, fire flows, main flushing, and other un-metered losses. This value for UFW was provided by Utilities ADWR Annual Report.

A system wide mass balance was used to develop potable water unit demands for the City of Avondale potable water system. Demands were assigned to the land use classifications to establish a demand per unit area, or unit demand, for each land use classification. The unit loads were adjusted to match the total potable water demand for 2004.

Water demand projections use the assumption that future development will exhibit similar potable water demand characteristics to existing facilities. This concept holds true when examining developments that have occurred in the last 10 to 15 years. These residential developments were established under planning and conservation guidelines similar to current regulations. However, older areas may have higher demands caused by the use of less efficient fixtures and appliances. Water demands are also influenced by the amount of landscaping, swimming pools, and number of people in a household, so the broad averages of a unit demand may not always match the demand of a specific area.

The unit per capita demand of residential areas generally ranges from 90 to 120 gpcd.

The commercial / office and large retail land use classifications generally exhibit unit demands ranging from 1500 to 2500 gpad. When actual billing data is available, the unit demands could be adjusted individually to better reflect potable water demands.

Industrial unit demands generally range from 1,000 to 1,500 gpad for light industry typical of business and industrial parks.

Parks includes large grassy playfields for public use. These areas are assumed to consist primarily of irrigated grassy areas. Recreational areas that utilize native vegetation (requiring little or no additional water) are not classified as parks.

The Phoenix International Raceway utilizes potable water according to the number of spectators, or seating capacity, at a given event. An analysis of anticipated demands from plumbing fixtures produced an estimate of 1.0 mgd under peak conditions or 979 gpad under average daily demand conditions. The analysis was based upon the 2000 Uniform Plumbing Code. These demand estimates should be verified with field measurements before connecting P/R to the South Pump Station.

The unit demand estimates provide a reasonable estimate of system wide potable water demand. It is anticipated that different areas of Avondale may vary from the unit demands, but the unit demands provide a good basis for projecting future potable water demand on a system-wide basis. Table 5.1 lists the unit demands used in this study.

Table 5.1 Potable Water Unit Demands
Wastewater Master Plan and Utility System Analysis – City of Avondale

Land Use Type	Average Population Density (person/Ac)	Unit Demand, gpcd	Unit Demand, gpad
Low Density Residential	3.25	105	341
High Density Residential	25.99	105	2,729
Medium Density Residential	12.84	105	1,348
Future Medium Density Residential	14.40	105	1,512
Commercial / Office	-	-	2,232
Large Retail	-	-	2,232
Industrial	-	-	1,152
Parks	-	-	2,304
Schools	-	-	1,152
PIR	-	-	979

5.2.2 Peaking Factors

Potable water production will vary according to seasonal and daily, or diurnal variations in demand. Seasonal variations can be caused by increased irrigation in the summertime, variations in industrial demands, and by seasonal variations in population, particularly in retirement communities.

Figure 5.1 shows the seasonal variation in water demand, measured on a weekly basis. The maximum weekly production of Avondale facilities is approximately 1.5 times larger than the average annual production. Daily flows in the maximum week show that the maximum daily demand is 1.65 times the average annual daily production. A peaking factor of 1.65 was used in this study to convert from an average annual day demand to a maximum day demand.

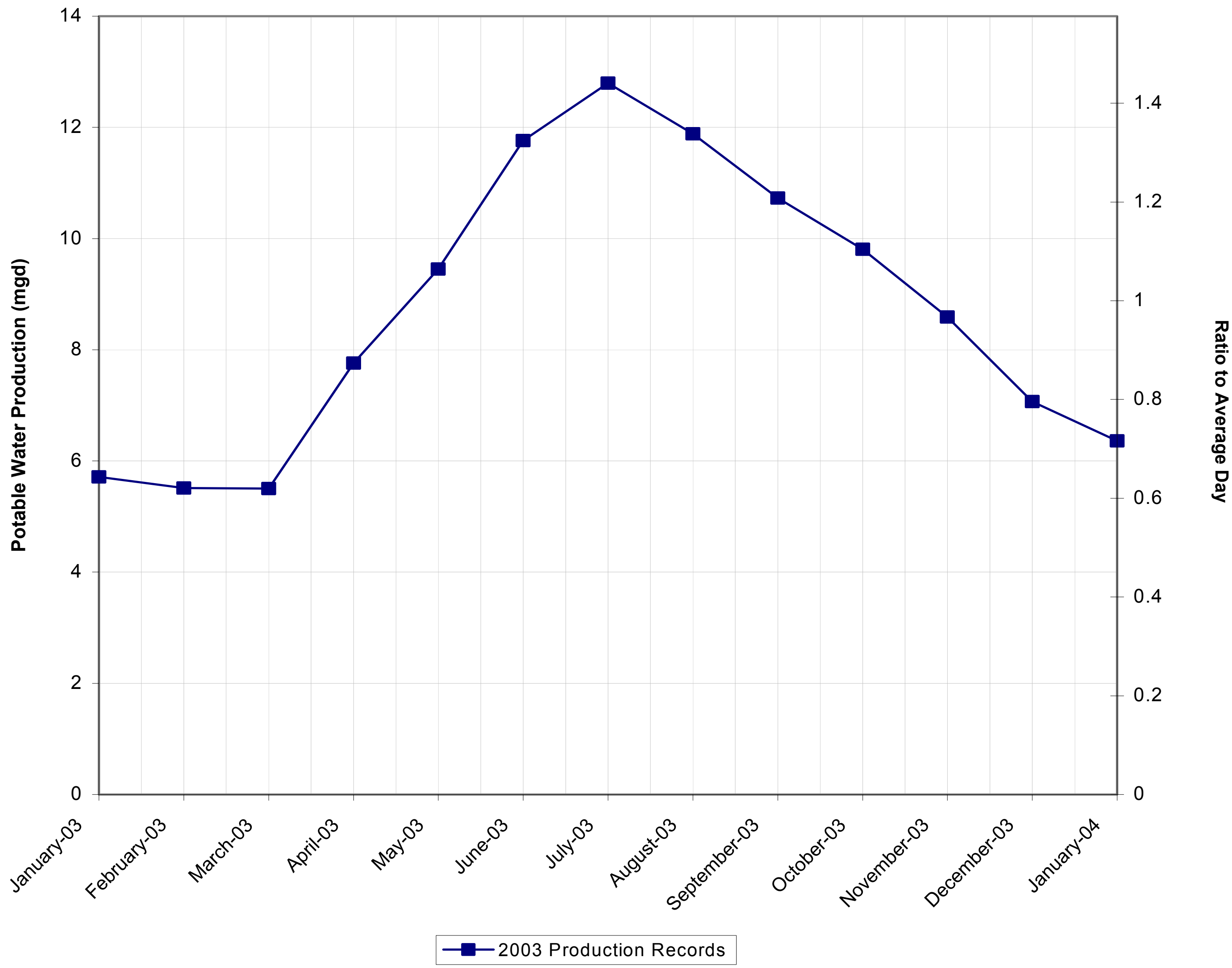


Figure 5.1 City of Avondale Seasonal Water Production Pattern

The majority of Avondale water production is consumed by residential water users, so the overall diurnal pattern for the City is primarily a residential water use pattern. A typical weekday diurnal demand will have a peak in the morning as a significant portion of the population wakes up and prepares for the day. A secondary peak occurs as the people return home from work and school. The nighttime demand is often influenced by irrigation from automatic sprinklers, so in Avondale's case, minimum daily demands actually occur in the afternoon. Weekend water usage is also characterized by a high morning peak (although not as early as the weekday pattern), and a secondary peak in the late afternoon or evening.

Avondale provided production data on an hourly basis for a limited period in the late summer of 2004. A mass balance was performed using this data to develop a diurnal curve to use in the modeling efforts associated with this utility analysis. Figure 5.2 shows the diurnal pattern developed for the Avondale potable water system. The daily peaking factor from this data is 1.92 times the average demand for the day. This factor is multiplied by the maximum day peaking factor of 1.65 to obtain an average day to peak hour multiplier of 3.17. As the City grows, this peaking factor may decrease because a larger population usually has more diverse water usage patterns. In this study, the overall peaking factors were applied to demands from all land use classifications. With additional demand information, separate peaking factors could be developed for each land use classification. Table 5.2 summarizes the peaking factors used in this study.

Table 5.2 Potable Water Peaking Factors
Wastewater Master Plan and Utility System Analysis – City of Avondale

Element	ADD	MDD	PHD
Peaking Factor	1.0	1.65	3.17
2004 Production	10.3 mgd	17.0 mgd	32.7 mgd

5.2.3 Comparison with Previous Studies

The 2002 RBF Water Infrastructure Master Plan evaluated historical water use trends as well as the relative distribution of demands to residential and commercial uses. The recommendation from that study was to establish commercial and residential demands for the distribution system according to total population. A value of 200 gpcd was selected as an overall demand value. The RBF plan also noted that some level of conservation would be required to limit consumption to this level.

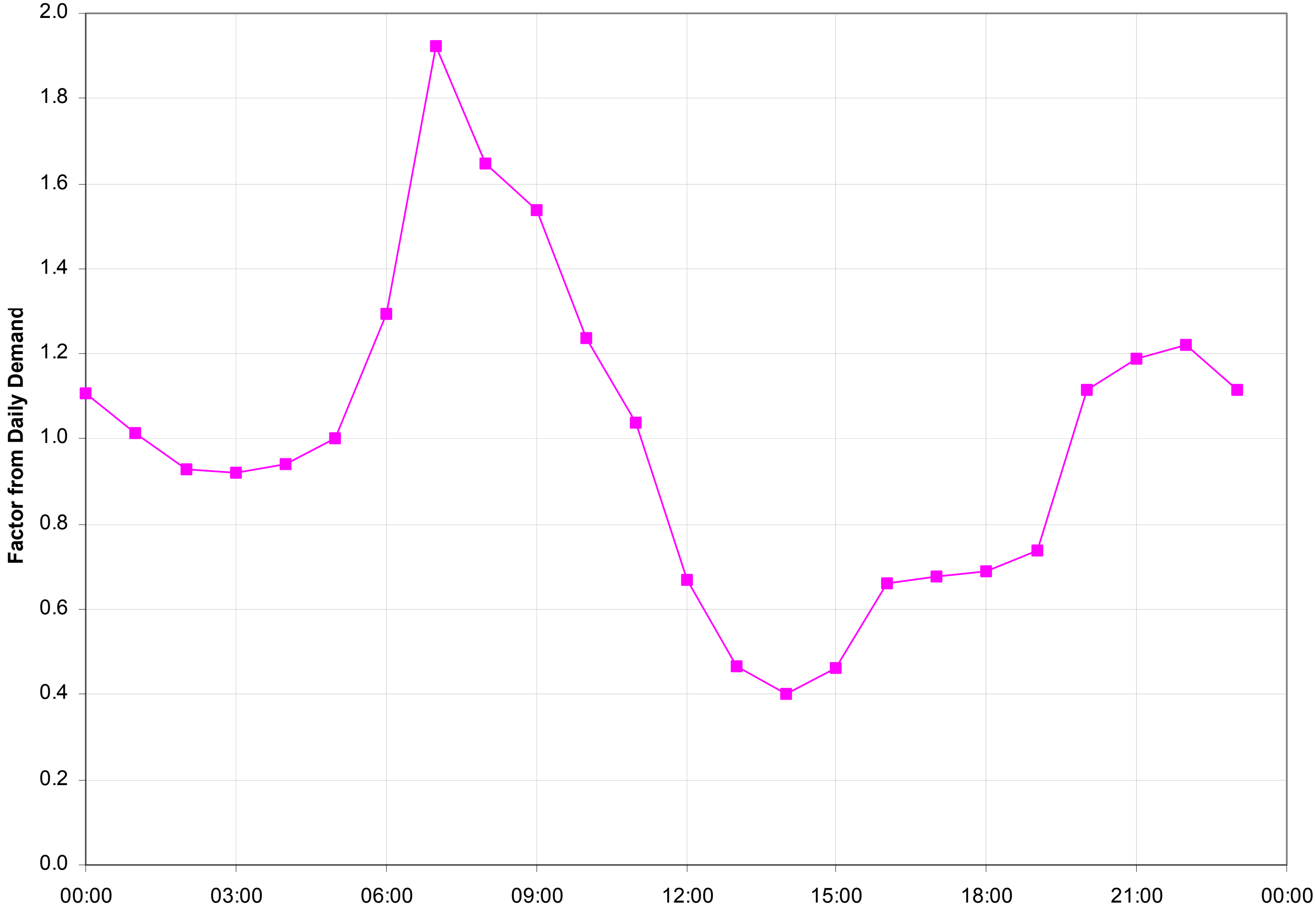


Figure 5.2 Avondale Diurnal Demand Pattern

The overall demand proposed within this study is similar, although the spatial distribution of the demand will vary according to the land use plan. The overall demand projected by this study ranges from 180 to 202 gpcd as presented in Table 5.3. This variation in total gpcd is influenced primarily by the proportion of residential to non-residential demands in each planning year.

Table 5.3 Distribution of Demands to Total Population
Wastewater Master Plan and Utility System Analysis – City of Avondale

Planning Period	Population	Demand (mgd)	Per Capita Demand (gpcd)
Current (2004)	60,000	10.31	180
2005	65,000	11.99	186
2010	106,000	21.39	202
Buildout	162,000	30.66	190

5.2.4 Demand Projections

The unit demands were multiplied by the developed acreage connected to the water system in each planning year to develop the total projected potable water demands for each planning period. Many of the rural areas within the southern portion of Avondale are currently served by private wells. The areas served by LPSCO are not expected to be served by Avondale. Areas served by the Rigby Water Company and most private wells were assigned a connection date of 2010. PIR was assumed to be connected only at build out. Figure 5.3 shows the estimated connection dates of areas within Avondale's potable water service area.

Table 5.4 lists the projected potable water demand in each planning period.

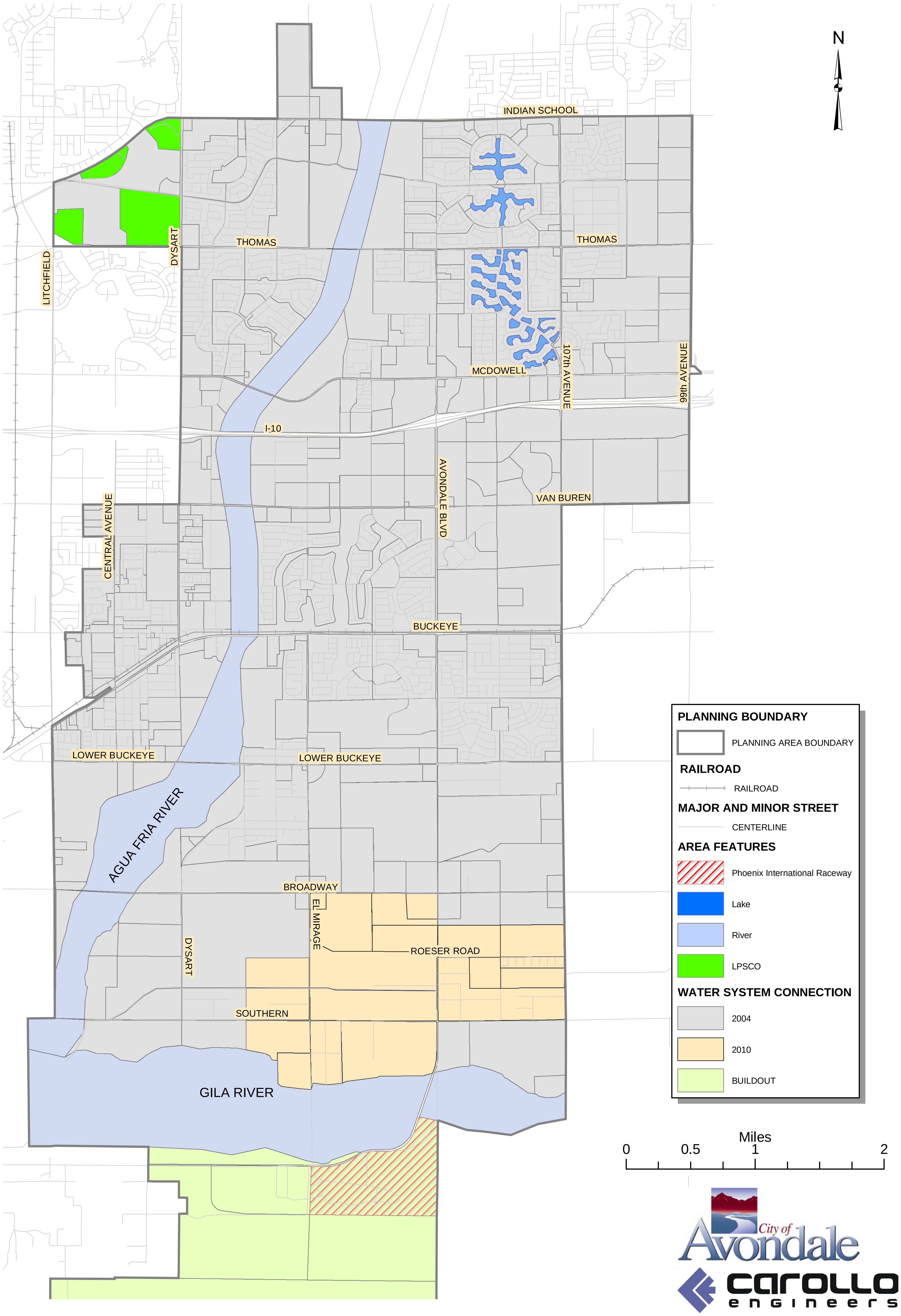


FIGURE 5.3 - ESTIMATED POTABLE WATER SYSTEM CONNECTION PLANNING PERIOD
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005

Table 5.4 Potable Water Average Annual Demand Projections
Wastewater Master Plan and Utility System Analysis – City of Avondale

Land Use Type	Current (2004)			2005			2010			Buildout		
	Acres	Population	mgd	Acres	Population	mgd	Acres	Population	mgd	Acres	Population	mgd
Low Density Residential	633	2,057	0.22	687	2,234	0.23	1,335	4,339	0.46	1,335	4,339	0.46
High Density Residential	223	5,787	0.61	245	6,368	0.67	357	9,272	0.97	416	10,818	1.14
Medium Density Residential	3,849	49,405	5.19	3,942	50,605	5.31	4,409	56,605	5.94	4,409	56,605	5.94
Future Medium Density Residential	-	-	0.00	372	5,362	0.56	2,479	35,691	3.75	6,241	89,870	9.44
Commercial / Office	462	-	1.03	619	-	1.38	1,505	-	3.36	1,961	-	4.38
Large Retail	182	-	0.41	230	-	0.51	468	-	1.05	689	-	1.54
Industrial	587	-	0.68	667	-	0.77	1,111	-	1.28	1,651	-	1.90
Parks	318	-	0.73	399	-	0.92	805	-	1.85	821	-	1.89
Schools	365	-	0.42	375	-	0.43	516	-	0.59	546	-	0.63
Phoenix International Raceway	-	-	0.00	-	-	0.00	-	-	0.00	322	-	0.32
Unaccounted for Water	-	-	1.03	-	-	1.20	-	-	2.14	-	-	3.03
Totals	6,618	57,250	10.3	7,537	64,569	12.0	12,986	105,908	21.4	18,392	161,633	30.7

5.3 PERFORMANCE CRITERIA

5.3.1 Background

The water distribution infrastructure for the City of Avondale will need to provide acceptable levels of performance and reliability, while being sensitive to the cost of new infrastructure. As new infrastructure is being planned and analyzed with the use of a hydraulic model, "standards of measurement" agreed upon by the City are necessary to evaluate the adequacy of the infrastructure. The "standards of measurement" are the performance criteria that are contained in this document. This performance criteria is based on common industry standards, accepted standards of practice in Arizona, and the desires of the City of Avondale.

Performance criteria include water supply redundancy, water system reliability, and system operational requirements.

5.3.2 Water System Reliability

The City's water system reliability is dependent on the reliability of all the components within the system and the reliability of the energy sources that supply the pump stations. The level of reliability provided is usually based on historic operational experience and judgment, which results in confidence that the system can deliver water under a variety of normal and emergency conditions. The City utilizes a reliability criteria developed as part of the 2002 water system master plan. Table 5.5 presents these criteria.

Table 5.5 Potable Water System Reliability Criteria
Wastewater Master Plan and Utility System Analysis – City of Avondale

Criteria	Demand	Description
Ultimate Source	Maximum Day	Satisfy demand with largest well out of service
Reliable Source	Maximum Day	Satisfy demand with all wells operating 18 hours or less
Peak Hour Storage	Peak Hour	Satisfy demand for 4 hours with 50 percent of storage capacity and 50 percent of source capacity
Fire Flow	Maximum Day and Fire Flow	Satisfy demand utilizing all sources and 80 percent of total storage
Operating Storage	Maximum Day	Total storage should be equal to or greater than 20 percent of demand
Emergency Supply	Average Day	Satisfy demand with 80 percent of storage volume and 50 percent of well supply operated no more than 18 hours
Booster Pump Capacity	Maximum Day Demand plus Fire Flow OR Peak Hour Demand	Satisfy the maximum of the listed demands with the single largest pump out of service.

5.3.3 Storage Facilities

Because production facilities are designed to operate at a steady rate over an extended period of time, storage reservoirs are planned to accommodate fluctuating demands. The factors included in designing reservoir capacity are diurnal demand fluctuations, fire demand, and emergency reserve storage. Storage facilities should be designed and operated to meet these conditions, while achieving storage turnover to minimize water quality degradation. The design criteria listed in Table 5.5 provides the basis for sizing storage infrastructure.

5.3.4 System Operational Requirements

System operational requirements refer to the level of service provided by a utility to the customer. Levels of service include many parameters, such as maximum and minimum pressures, maximum flow velocities, storage, redundancy, and provisions for emergency conditions. Adequate pressure is usually defined in terms of a minimum pressure under certain demand conditions, such as peak hour (40 psia) or fire flow (20 psig). Adequate fire protection refers to providing adequate flow to meet firefighting demands. The water system is considered to be adequate when system demand conditions are satisfied while meeting system performance criteria, such as system pressure, velocity, and head loss.

5.3.5 Fire Flow

Fire flow requirements are usually determined by the local fire department. However, codes such as the International Building Code, the Uniform Fire Code (see Division III, Fire Protection, Appendix III-A, Fire-Flow Requirements for Buildings), or American Insurance Association serve as guidelines. Minimum required fire-flow rates and flow durations are specified in the Uniform Building Code (UBC) for building area according to construction type.

For one- and two-family dwellings, the Fire Code is specific for the minimum required fire flow as follows:

< 3,600 square foot fire area = 1,000 gpm for 2 hours duration.

≥ 3,600 square foot fire area (refer to Uniform Fire Code Appendix III-A, Table A III A 1).

Depending on the type of use, construction, and fire area, the required fire flow and duration ranges from 1,500 gpm for 2 hours to 8,000 gpm for 4 hours.

The codes describe fire flow requirements with a minimum residual pressure of 20 psi at the hydrant. It is assumed that a major fire will occur under maximum day demand conditions as there is low probability that a major fire will occur during higher, peak hour demand conditions.

Near the end of this study, the City of Avondale initiated a change in fire protection requirements that requires all new housing to install sprinklers. Fire hydrants may be spaced at 1,000 feet, and residential fire flow from a hydrant is set at 500 gpm. However, this study was completed using the original requirements.

5.3.6 Pump Stations

Usually pumping stations are the most critical components in a distribution system with respect to meeting reliability/redundancy criteria, because these facilities are subject to disruption by the following conditions:

- Power outage.
- Mechanical failure.
- Line breaks of critical transmission mains.

Table 5.6 summarizes these conditions and the criteria to be employed for reliability.

Table 5.6 Booster Station Reliability Criteria
Wastewater Master Plan and Utility System Analysis – City of Avondale

Condition	Result	Criteria
Power Outage	Creates loss of pumping capacity at one or more pumping facilities.	Provide emergency backup power supply generation or dual power feed to critical facilities. All major BPS facilities within Avondale have been equipped with back up power supply.
Mechanical Failure	Creates loss of pumping capacity due to one or more pumps at a facility being out of service.	Provide sufficient pumping capacity at each booster pumping station to meet maximum day demands with any one pump or the largest pump out of service (referred to as “firm capacity” of the station). This allows for pumps to be out of service due to mechanical failure or unscheduled maintenance.
Line Break	Occurs at or near the booster station, creating a loss of all or a portion of the pumping capacity at the facility.	A line break at or near a booster station disrupting supply is usually mitigated through multiple pumping facilities, and storage facilities.

The firm capacity of booster stations that pump from reservoirs is often set so that half of the reservoir can be emptied in a six-hour period. These booster stations should also have a pumping capacity that exceeds the well capacity feeding the storage reservoir.

5.3.7 Transmission/Distribution Mains

Water system piping serves three basic purposes:

- To distribute water from the source to the consumer.

- To transfer water from the source of production to storage.
- To provide a conduit for firefighting water.

Transmission and distribution mains are sized for the greater of the following two demand conditions:

- Maximum day demand plus fire flow, or
- Peak hour demand.

The following pressure criteria were used to assess the adequacy of the water transmission/distribution system under the two demand conditions:

- <u>Peak Hour Demand</u>: The City of Avondale has established 40 psi as the minimum operating pressure under peak hour operational conditions. Since the portion of Avondale north of the Gila River will be operated as a single pressure zone, pressures are likely to exceed 100 psi in low areas. (Note: Uniform Plumbing Code requires a PRV on private plumbing when tap pressures exceed 80 psi).
- <u>Maximum Day Demand plus Fire-Flow Condition</u>: A minimum of 20 psi at the point of maximum fire draft and throughout the system were used to establish the maximum fire draft.

The above system pressure criteria were achieved using the following velocity guidelines Water velocity criteria under maximum day demand conditions is as follows:

- Velocity ≤ 5 feet per second (fps) for pipes < 36 inches diameter
  (Head loss, HL = 2 to 7 feet/1,000 feet).
- Velocity ≤ 6 fps for pipes ≥ 36 inches diameter
  (Head loss, HL = 1 to 2.5 feet/1,000 feet).

Velocity criteria under peak hour demand conditions is as follows:

- Velocity ≤ 7 fps (HL < 10 feet/1,000 feet).

Velocity criteria under fire demand conditions is as follows:

- Velocity ≤ 10 fps.

Water distribution mains should be looped and interconnected wherever possible so that in the event of a fire, failure of a portion of the distribution system, or another emergency, there is more than one path for water to flow to supply customer demands and fire flows.

In order to meet the criteria for maximum flow and velocity, it is a common practice to have 16-inch mains on major (mile) arterials, 12-inch mains on minor (half-mile) arterials, and 8-inch mains in residential areas.

5.3.8 Performance Criteria Summary

Table 5.7 summarizes the system performance criteria used to determine the adequacy of the modeled system, and planning for infrastructure improvements.

Table 5.7 Water System Performance Criteria Summary
Wastewater Master Plan and Utility System Analysis – City of Avondale

Criteria	Demand Condition	Description
Ultimate Source	Maximum Day	Satisfy demand with largest well out of service
Reliable Source	Maximum Day	Satisfy demand with all wells operating 18 hours or less
Peak Hour Storage	Peak Hour	Satisfy demand for 4 hours with 50 percent of storage capacity and 50 percent of source capacity
Fire Flow	Maximum Day and Fire Flow	Satisfy demand utilizing all sources and 80 percent of total storage
Operating Storage	Maximum Day	Total storage should be equal to or greater than 20 percent of demand
Emergency Supply	Average Day	Satisfy demand with 80-percent of storage volume and 50percent of well supply operated no more than 18 hours
Booster Pump Capacity	Maximum Day and Fire Flow OR Peak Hour	Satisfy the maximum of the listed demands without the single largest pump in service.

Description	Criteria
Water Production	Maximum Day plus 10% Reserve
Transmission/Distribution – Velocity/Head Loss (HL) Criteria:	
Maximum Day (MD)	
Pipe <36"	<5 feet per second (fps)
Pipe ≥36"	<6 fps
Peak Hour (PH)	≤7 fps (HL <10 feet/1,000 feet)
Fire Flow Condition at maximum day demand condition	<10 fps, ≥20 psi
System Pressure Criteria, all demand conditions	≥40 psi

Fire Demand Criteria:

Fire demand requires a determination of both the rate of flow and the total amount of water that must be applied.

Fire Flow Demand:

1. Residential = 2 hours at 1,000 gpm
2. Low Risk Commercial/Industrial = 4 hours at 3,500 gpm

5.4 MODEL ANALYSIS

The existing water distribution system is shown in Figure 5.4. Appendix E contains maps of the existing water and wastewater systems that summarize key model results.

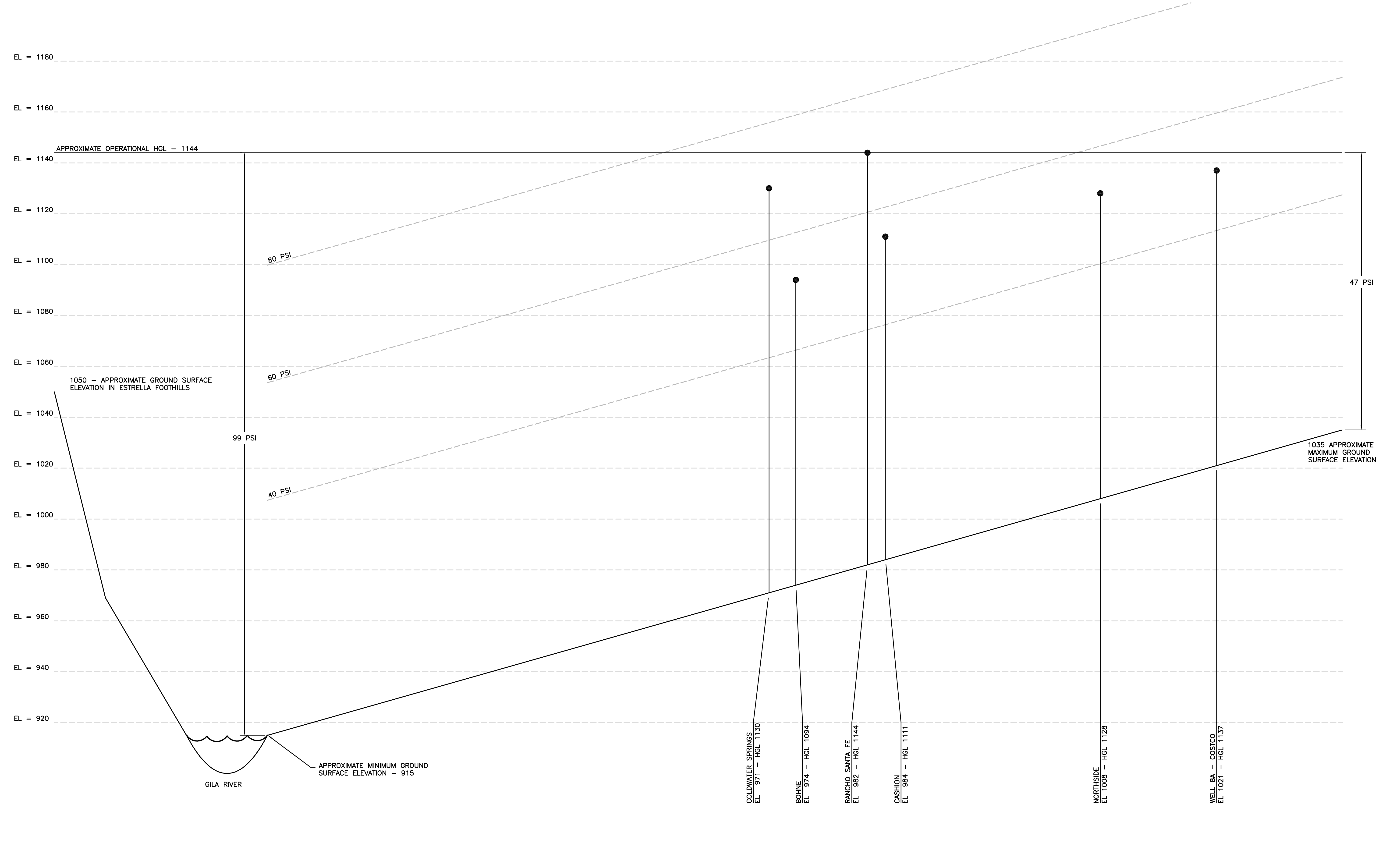
The Avondale water distribution system was originally supplied by wells that were constructed to serve customers in areas near the wells. Wells were located near customers so there was no need for a transmission system to move water greater distances. As the City developed and development fills open spaces, it became more advantageous to interconnect the separate water distribution systems so that water can be more easily moved from sources to more distant customers. This improves water supply reliability and operational flexibility. A 24-inch transmission main that currently runs along part of Avondale Boulevard has become the backbone of the water system. As the City develops to the south, this main will be extended towards the river. Water sources that are developed for the City can potentially serve any part of the City as long as mains from the source are connected into the transmission main. The larger Rancho Santa Fe and Del Rio Booster Stations also have the ability to pump into the transmission main.

The backbone system also includes a 36-inch transmission main from Avondale Boulevard to the Coldwater Booster Station. The Coldwater BPS has been developed as a facility to meet daily peaking demands. The site was master planned for a significant amount of storage, and a booster station that can deliver this water into the distribution system.

Recent water quality regulations such as the new Arsenic limit require additional wellhead treatment that can be expensive. By locating several wells in a cluster near a storage tank and booster station, water treatment costs are usually lower than individual wellhead treatment, particularly when blending schemes can be used. Avondale has clustered some wells so that groups of wells will feed to a common facility for blending or water treatment as necessary.

The Avondale water system currently operates as one pressure zone with the exception of the small areas served by the Las Liegos and Dysart PRVs south of the WWTP. The elevation range within the City north of the Gila River is 120 feet, so there is no need to create a pressure zone. Ground surface elevations within the Avondale water service area range from approximately 915 feet above mean sea level near the Gila River to approximately 1,035 feet in the areas north of Indian School Road. An average operational hydraulic grade of 1,144 feet above mean sea level was selected to provide adequate pressures across the City of Avondale. The pressure range of 47 to 99 psi under static conditions provides a buffer of 7 psi above the 40-psi minimum that the City desires to maintain in the distribution system. Figure 5.5 shows a schematic view of the proposed hydraulic grade line and the corresponding operating points of wells and booster stations, where these operating points are known. If the City wanted to reduce pressures near the river, a second zone could be created by installing PRV stations on each north-south main, possibly south of Broadway Road. Adding a second zone would eliminate the need for

FIGURE 5.4 - CURRENT (2005) POTABLE WATER DISTRIBUTION SYSTEM
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005



CITY OF AVONDALE – WASTEWATER MASTER PLAN AND UTILITY SYSTEM ANALYSIS

carollo engineers

PROPOSED AVERAGE HYDRAULIC GRADE LINE

Figure 5.5

service line PRVs where water pressure exceeds 80 psi. However, any future water supply wells in the Zone 2 service area would not be able to supply the main pressure zone without a booster station.

As the distribution system develops to become an integrated system, some upgrades may be required for existing pumps. Wells feeding directly into the distribution system and some booster stations may need to be upgraded to deliver water efficiently at the target hydraulic grade line. The hydraulic grade line at the booster station sites will need to be slightly higher than 1,144 feet so that the grade line at the transmission mains is 1,144 feet. Detailed pump characteristic data was not available for all booster stations operated by the City, so pump testing at some sites may be needed to determine if the pumps can pump efficiently at the new hydraulic grade line.

Undeveloped areas in the foothills of the Estrella Mountains (south of the Gila River) may require a separate pressure zone to provide adequate pressures, depending on the elevation of the upper end of the development. Details of development that could occur in the Estrella Mountains was undefined for this study.

To assess the adequacy of the water system for a maximum day plus fire flow demand condition, the model was used to evaluate fire flows at hydrants throughout the City. This fire flow simulation showed that the water distribution system should be capable of handling fire flows of 1,000 gpm at all hydrants except for the hydrant at Rose Lane and 2nd Street. This hydrant is connected to three 2-inch mains that cannot deliver an adequate fire flow until one or more of the mains is replaced with a larger main. Commercial or industrial sites that require more than a 1,000 gpm fire flow were assumed to get the flow from multiple hydrants.

The model was also used to evaluate maximum day and peak hour demands. The model showed that the network performs satisfactorily except for the main going west from the Rancho Santa Fe booster station and the main going east of the Rancho Santa Fe booster station along McDowell Road, west of Avondale Boulevard. Parallel mains will need to be added along these pipe sections.

The mains in Old Avondale west of the Agua Fria River are small, and this portion of the network has not been well connected to the rest of the system. However, a new 16-inch main has been added along Lower Buckeye Road that will improve connectivity to this area. Additional 12-inch mains to connect the Old Avondale system to the mains along Western Road and Lower Buckeye Road have been recommended to improve connectivity in this area.

Figure 5.6 shows the proposed potable water distribution system at buildout.

Using the performance criteria, the water supply, storage, and booster station capacities are required in each planning year are given in Table 5.8. The specific locations of the infrastructure are provided in the capital improvement plan.

Table 5.8 lists the capacities and flow rates required by these criteria.

FIGURE 5.6 - BUILDOUT POTABLE WATER SYSTEM
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005

Table 5.8	Required Capacities and Flow Rates Wastewater Master Plan and Utility System Analysis – City of Avondale		
Element	**Water Supply**	**Required Storage**	**Firm Booster Station Capacity**
Units	mgd	MG	mgd
2004	22.7	7.1	35.9
2005	26.4	8.3	41.8
2010	47.1	14.8	74.6
Buildout	67.5	21.2	106.9
Note: 2004 water supply is equal to the capacity of existing wells.			

5.5 CAPITAL IMPROVEMENT PLAN

The proposed CIP presented in this section was developed to provide necessary infrastructure to meet the performance criteria presented within this report. Table 5.9 lists the unit construction costs that were used to develop the estimated costs for each capital improvement item.

Table 5.9	Unit Construction Costs for Water System Infrastructure Wastewater Master Plan and Utility System Analysis – City of Avondale
Pipeline Diameter, in	**Construction Costs ($/LF)**
8	$71
10	$81
12	$89
16	$112
24	$165
30	$205
36	$242
Number of New Wells	**Construction Cost**
1	$1,990,000
2	$2,260,000
3	$3,380,000
4	$4,510,000
Reservoir Capacity, MG	**Construction Cost**
1	$1,890,000
1.5	$2,220,000
2	$2,540,000
2.5	$2,780,000
3	$3,020,000
3.5	$3,260,000
4	$3,510,000
5	$3,680,000
6	$4,109,000

Table 5.9 Unit Construction Costs for Water System Infrastructure Wastewater Master Plan and Utility System Analysis – City of Avondale	
BPS Capacity, MGD	**Construction Cost**
5	$1,400,000
6	$1,530,000
10	$2,060,000
15	$2,740,000
20	$3,180,000
30	$4,120,000
40	$5,560,000
Project costs are based on the assumption that engineering design, contract management, inspection, and contingency are an additional 40% of the construction cost	
ENR CCI = 7312 (20 Cities Index, November 2004)	

5.5.1 Recommended Water System Improvements

Capital improvements to the potable water system were developed according to the performance criteria presented within this report. The phasing of capital improvements within this section is set forth to match the requirements presented within the performance criteria. The improvements are all based on the assumption that Avondale continues to be supplied by wells and not a surface water supply. If the City obtains water from Phoenix or from a regional water treatment plant, then transmission mains, pump stations, and even storage requirements may be different.

5.5.2 Transmission Pipelines

Proposed transmission pipelines are categorized according to pipelines required to strengthen the existing distribution network and pipelines required for expansion of the distribution network. Table 5.10 lists pipelines required to strengthen the distribution network. Some of these pipelines are parallel lines that provide additional conveyance capacity to meet the velocity based performance criteria of the maximum day or peak hour conditions.

Table 5.10 Proposed Water Pipeline Improvements to Strengthen Network Wastewater Master Plan and Utility System Analysis – City of Avondale

Description	Diameter (in)	Length (ft)	Project Cost		
			2006	2010	Buildout
119th Cross Street Connection at Virginia	8	29	$3,000	-	-
Grid Connection at McDowell and Rancho Santa Fe	16	67	$12,000	-	-

Table 5.10 Proposed Water Pipeline Improvements to Strengthen Network Wastewater Master Plan and Utility System Analysis – City of Avondale					
Description	**Diameter (in)**	**Length (ft)**	**Project Cost**		
			2006	**2010**	**Buildout**
McDowell from Avondale to El Mirage	12	2,780	$384,000	-	-
McDowell from Santa Fe BPS to Rancho Santa Fe	24	1,043	$266,000	-	-
Dysart North of Broadway Looping	12	2,634	-	$364,000	-
Network Strengthening In Rancho Santa Fe	8	169	-	$18,000	-
Network Strengthening In Rancho Santa Fe	12	584	-	$81,000	-
Across the Street Connection at Van Buren and 10th Street	12	35	-	$5,000	-
Rose Street Fire Hydrant	8	200	-	17,000	-
Subtotal			$665,000	$485,000	-
Project costs are based on the assumption that engineering design, contract management, inspection, and contingency are an additional 40% of the construction cost					
ENR CCI = 7312 (20 Cities Index, November 2004)					

Table 5.11 lists pipelines necessary to provide a reasonable distribution network within Old Avondale. Much of Old Avondale was developed under performance criteria that did not consider today's fire flow and pressure requirements. As a result, it is recommended that the improvements presented in Table 5.11 be implemented to provide a distribution backbone within Old Avondale. It is also recommended that all small diameter pipelines (<6 inches) be replaced with pipelines six inches in diameter that can serve fire hydrants.

Table 5.11 Proposed Water Pipeline Improvements to Old Avondale Wastewater Master Plan and Utility System Analysis – City of Avondale					
Description	**Diameter (in)**	**Length (ft)**	**Project Cost**		
			2006	**2010**	**Buildout**
4th St from RR to Lower Buckeye	8	3,014	$330,000	-	-
4th St from RR to Lower Buckeye	12	61	$8,000	-	-
4th St from RR to Lower Buckeye	16	781	$135,000	-	-
4th Street from Van Buren to Well 1	12	4,507	$623,000	-	-
Central from RR to Lower Buckeye	12	2,941	$407,000	-	-

Table 5.11 Proposed Water Pipeline Improvements to Old Avondale Wastewater Master Plan and Utility System Analysis – City of Avondale					
Description	**Diameter (in)**	**Length (ft)**	**Project Cost**		
			2006	**2010**	**Buildout**
Central from Van Buren to Main	8	5,786	$633,000	-	-
Dysart from Van Buren to RR	12	5,417	$749,000	-	-
Old Avondale Connect 4th/Elm to 8th St	12	1,967	$272,000	-	-
Old Avondale North of RR	12	2,315	$320,000	-	-
Old Avondale South of RR	12	3,232	$447,000	-	-
Van Buren from Dysart to Palo Verde	12	1,425	$197,000	-	-
Parallel – Lower Buckeye from Agua Fria to Central	8	1,371	$150,000	-	-
Subtotal	-	-	$3,175,000	$-	$-
Project costs are based on the assumption that engineering design, contract management, inspection, and contingency are an additional 40% of the construction cost					
ENR CCI = 7312 (20 Cities Index, November 2004)					

Table 5.12 lists pipelines necessary to complete the distribution network. It should be noted that the pipeline projects labeled “Indian School from Dysart to Litchfield” and “Litchfield and Thomas Looping” would not be needed unless Avondale chooses to serve potable water customers currently served by LPSCO.

Table 5.12 Proposed Future Water Distribution System Mains Wastewater Master Plan and Utility System Analysis – City of Avondale					
Description	**Diameter (in)**	**Length (ft)**	**Project Cost**		
			2006	**2010**	**Buildout**
103rd from Indian School to Thomas	12	5,516	$762,000	-	-
99th Avenue from Indian School to Thomas	16	5,262	$912,000	-	-
99th Avenue from Thomas to McDowell	16	2,664	$462,000	-	-
Encanto from 11th to Avondale	12	1,420	$196,000	-	-
Indian School from 99th to 103rd	16	2,702	$468,000	-	-
Osborn from 99th to 103rd	12	2,628	$363,000	-	-

Table 5.12 Proposed Future Water Distribution System Mains Wastewater Master Plan and Utility System Analysis – City of Avondale					
Description	**Diameter (in)**	**Length (ft)**	**Project Cost**		
			2006	**2010**	**Buildout**
Thomas from 99th Avenue to 107th Ave	16	2,659	$461,000	-	-
107th from Lower Buckeye to Broadway	16	1,437	-	$249,000	-
107th from Van Buren to Buckeye	12	2,833	-	$392,000	-
111th Ave from Van Buren to RR	12	4,082	-	$564,000	-
111th from I-10 to Van Buren	12	1,748	-	$242,000	-
111th from Lower Buckeye to Elwood	12	1,450	-	$200,000	-
119th Ave from I-10 to Van Buren	12	2,628	-	$363,000	-
119th from Del Rio BPS to Lower Buckeye	16	1,145	-	$199,000	-
119th from Lower Buckeye to Broadway	12	5,176	-	$716,000	-
125th from Durango to Lower Buckeye	12	3,026	-	$418,000	-
127th from Lower Buckeye to Broadway	12	4,796	-	$663,000	-
Avondale from Lower Buckeye to Broadway	24	5,163	-	$1,316,000	-
Broadway from 107th to Avondale	16	5,098	-	$884,000	-
Broadway from Avondale to El Mirage	16	5,282	-	$915,000	-
Broadway from El Mirage to Dysart	16	5,232	-	$907,000	-
Coldwater Sp from 111th to Avondale	12	1,463	-	$202,000	-
Dysart from Indian School to Thomas	16	1,310	-	$227,000	-
El Mirage from I-10 to Van Buren	12	2,617	-	$362,000	-
El Mirage Lower Buckeye to Broadway	16	2,019	-	$350,000	-
Elwood from 107th to Avondale	12	5,341	-	$738,000	-

Table 5.12 Proposed Future Water Distribution System Mains Wastewater Master Plan and Utility System Analysis – City of Avondale					
Description	**Diameter (in)**	**Length (ft)**	**Project Cost**		
			2006	**2010**	**Buildout**
Elwood from Avondale to El Mirage	12	5,273	-	$729,000	-
Elwood West of El Mirage Looping	12	1,962	-	$271,000	-
Harrison from 107th to 111th	12	2,625	-	$363,000	-
Indian School from Dysart to Litchfield	16	6,022	-	$1,044,000	-
Indian School from Santa Fe Trail to Dysart	16	2,578	-	$447,000	-
Litchfield and Thomas Looping	16	4,155	-	$720,000	-
Looping for S of L. Buckeye W of Agua Fria	12	7,605	-	$1,051,000	-
Roosevelt from 107th to 115th	12	5,059	-	$699,000	-
Van Buren from 99th to 107th	16	2,699	-	$468,000	-
Whyman from Avondale to Del Rio BPS	24	2,800	-	$714,000	-
Whyman from El Mirage to Del Rio BPS	16	2,779	-	$482,000	-
107th from Broadway to Southern	16	5,248	-	-	$909,000
110th from Broadway to Southern	12	10,502	-	-	$1,452,000
111th from Broadway to Roeser	12	2,659	-	-	$368,000
111th South of Southern	12	837	-	-	$116,000
119th South of Southern	12	1,339	-	-	$185,000
127th South of Southern	12	738	-	-	$102,000
Avondale from Broadway to Southern	24	5,275	-	-	$1,344,000
Avondale from Southern to PIR	16	4,007	-	-	$695,000
Dysart from Broadway to Southern	16	5,326	-	$923,000	-
Dysart South of Southern	12	698	-	-	$96,000
El Mirage from Broadway to Southern	16	5,227	-	-	$906,000

Table 5.12 Proposed Future Water Distribution System Mains Wastewater Master Plan and Utility System Analysis – City of Avondale					
Description	Diameter (in)	Length (ft)	Project Cost		
			2006	2010	Buildout
El Mirage from Southern to Indian Springs	16	5,963	-	-	$1,034,000
El Mirage South of Indian Springs	12	2,897	-	-	$400,000
Indian Springs from Avondale to El Mirage	16	5,785	-	-	$1,003,000
Indian Springs from El Mirage to 143rd Ave	12	6,717	-	-	$928,000
Old Baseline El Mirage to Goodyear	12	5,163	-	-	$714,000
Roeser from 107th to Avondale	12	5,249	-	-	$726,000
Roeser from Avondale to El Mirage	12	5,227	-	-	$723,000
Roeser from El Mirage to Dysart	12	5,213	-	-	$721,000
Roeser West of Dysart	12	2,657	-	-	$367,000
Southern from 107th to Avondale	16	5,254	-	-	$911,000
Southern from Avondale to El Mirage	16	5,212	-	-	$903,000
Southern from El Mirage to Dysart	16	5,271	-	$228,000	$685,000
Sunland West of Dysart	12	4,333	-	-	$599,000
Subtotal	-	-	$3,624,000	$180,460,000	$15,887,000
Project costs are based on the assumption that engineering design, contract management, inspection, and contingency are an additional 40% of the construction cost					
ENR CCI = 7312 (20 Cities Index, November 2004)					

5.5.3 Potable Water Sources

Table 5.13 lists the potable water sources that would be required by buildout. The table also presents the estimated timing and project costs for proposed potable water sources. The actual number of wells that may be required at buildout will depend on the pumping capacity of each well. The storage capacity of reservoirs is most effectively utilized when the wells that pump to the reservoir can provide sufficient flow to fill the reservoir each day to provide sufficient storage for peak daily demands. The Rancho Santa Fe reservoirs are actually undersized relative to the well capacity at that site. The Coldwater Reservoir site has more storage planned for the site than wells pumping to the reservoirs can utilize, so the Coldwater IV Reservoir may not be needed. The Del Rio site currently does not have wells identified that could fully utilize the storage at that site, so the Del Rio area may be a good location for new wells.

Table 5.13 Existing and Proposed Potable Water Wells / Sources
Wastewater Master Plan and Utility System Analysis – City of Avondale

Cluster / Well	Anticipated Maximum Day Capacity		Project Cost				
	Capacity (gpm)	Capacity (mgd)	Existing	2005	2006	2010	Buildout
Unclustered Wells							
Well 01	0	0.0	Existing	-	Out of Service		
Well 14	400	0.6	Existing	-	Out of Service		
Well 23	600	0.9	-	X	-	-	-
Rose Park	1,200	1.7	-	X	-	-	-
2010 Source	2,300	3.3	-	-	-	$3,474,000	-
Additional Source	4,500	6.5	-	-	-	-	$6,949,000
Well 8a – Costco	2,000	2.9	-	X	-	-	-
Well 17 – NE BPS	1,200	1.7	-	X	-	-	-
Northside Wells							
Well 06	1,200	1.7	Existing	-	-	-	-
Well 07	1,200	1.7	Existing	-	-	-	-
Well 20	1,200	1.7	-	-	X	-	-
Rancho Santa Fe Wells							
Well 10	1,600	2.3	Existing	-	-	-	-
Well 11	1,500	2.2	Existing	-	-	-	-
Well 12	1,500	2.2	Existing	-	-	-	-
Well 18	1,800	2.6	Existing	-	-	-	-
Well 19	2,420	3.5	Existing	-	-	-	-
Coldwater Wells							
Well 15	600	0.9	Existing	-	-	-	-
Well 16	2,200	3.2	-	X	-	-	-
Nelson Well	1,200	1.7	-	X	-	-	-
2010 Source	3,200	4.6	-	-	-	$5,212,000	-
Additional Source	4,000	5.8	-	-	-	-	$5,212,000

Table 5.13 Existing and Proposed Potable Water Wells / Sources Wastewater Master Plan and Utility System Analysis – City of Avondale							
	Anticipated Maximum Day Capacity		**Project Cost**				
Cluster / Well	**Capacity (gpm)**	**Capacity (mgd)**	**Existing**	**2005**	**2006**	**2010**	**Buildout**
Del Rio Wells							
Del Rio Site 1	1,200	1.7	-	-	-	X	-
Del Rio Site 2	1,200	1.7	-	-	-	X	-
Well 21	800	1.2	-	-	-	X	-
119th and Lower Buckeye	600	0.9	-	-	-	X	-
Roeser BPS							
Lakin (N of Broadway)	1,000	1.4	-	X	-	-	-
Lakin (S of Broadway)	1,000	1.4	-	X	-	-	-
Additional Water Source	2,000	2.9	-	-	-	-	$3,474,0000
PIR BPS	2,000	2.9	-	-	-	-	$3,474,000
Additional Well Source	1,600	2-3	-	-	-	$8,686,000	$22,583,000
Required Capacity	46,806	67.4	-	-	-	-	-

Notes:
Well 01 yield of 1,068 gpm limited to 0 due to water quality concerns.
Well 14 reported to be retired in 2010 planning period.
Well 23 production limited to 600 gpm by water quality concerns.
Assumed production of new wells is approximately 1,200 gpm.
Stated costs do not include cost of pipelines to connect wells to reservoir because the location of future wells is not known.
Stated costs do not include cost of treatment facilities.

Existing wells that are to be purchased and rehabilitated are not priced as part of this analysis because the expense is already budgeted, or because a developer has committed to pay for the improvement. These facilities are denoted with an “X”.

Project costs are based on the assumption that engineering design, contract management, inspection, and contingency are an additional 40% of the construction cost

ENR CCI = 7312 (20 Cities Index, November 2004)

The City is currently planning to serve the entire area by wells. However, purchasing surface water from the City of Phoenix has also been considered. Avondale may also be able to buy into a west valley regional water treatment facility. If the City chooses to follow one of these options, then the infrastructure needed to supply this water could be planned at that time. Any water supply source outside of Avondale would need to tie into the water transmission main along Avondale Boulevard. Even the transmission main along Avondale Boulevard may not be sized for a major surface water supply.

5.5.4 Storage

Table 5.14 lists the storage facilities that would be required for build-out. The estimated timing and project costs for potable water storage facilities are also presented within this table. Note that the City currently has plans for more storage capacity than may actually be required. The Coldwater Springs IV and Del Rio II Reservoirs may not be needed.

Table 5.14 Existing and Proposed Potable Water Storage
Wastewater Master Plan and Utility System Analysis – City of Avondale

Description	Capacity (MG)	Project Cost				
		Existing	2005	2006	2010	Buildout
Well 1	0.20	Existing	-	-	-	-
Well 2	0.30	Existing	-	-	-	-
Well 5	0.30	Existing	-	-	-	-
Well 6a (or 6)	0.60	Existing	-	-	-	-
Well 6b (or 7)	0.60	Existing	-	-	-	-
Cashion	0.11	Existing	-	-	-	-
Bohne	0.15	Existing	-	-	-	-
Rancho Santa Fe I	1.00	Existing	-	-	-	-
Rancho Santa Fe II	1.75	Existing	-	-	-	-
Well 8A – Costco	1.00	-	X	-	-	-
Coldwater Springs I	2.50	Existing	-	-	-	-
Coldwater Springs II	2.50	-	$4,280,000	-	-	-
Coldwater Springs III	2.50	-	-	-	$4,280,000	-
Coldwater Springs IV	2.50	-	-	-	-	$4,280,000
Del Rio I	3.50	-	-	-	$5,026,000	-
Del Rio II	3.50	-	-	-	-	$5,026,000
Roeser Reservoir	2.50	-	-	-	-	$4,280,000
Well 17 – NE BPS / SRP Well I	2.00	-	X	-	-	-
Well 17 – NE BPS / SRP Well II	2.00	-	-	-	$3,906,000	-
PIR Reservoir	1.00	-	-	-	-	$2,914,000

Table 5.14 Existing and Proposed Potable Water Storage Wastewater Master Plan and Utility System Analysis – City of Avondale						
		Project Cost				
Description	Capacity (MG)	Existing	2005	2006	2010	Buildout
Total Cost	-	$-	$4,280,000	$-	$13,212,000	$16,500,000
Total Storage (MG)	29.5	-	-	-	-	-
Required Storage (MG)	21.2	-	-	-	-	-
Surplus (MG)	8.3	-	-	-	-	-
Notes: Reservoirs 2 and 5 to be retired. Well 8A – Costco under construction or completed by this writing. Well 17 – NE BPS / SRP Well under construction or completed by this writing. Cashion, Bohne and Well 1 Reservoirs are not essential according to storage analysis. These facilities are not considered in the buildout condition. 2005 reservoir capacity is less than Carollo standard recommendation. Cost estimate not included for phase 2005 reservoirs because these funds have already been budgeted. Reservoir sites that are in Avondale's plan but are not required to satisfy the performance criteria include: - Coldwater IV - Rose Park - Del Rio II						
Project costs are based on the assumption that engineering design, contract management, inspection, and contingency are an additional 40% of the construction cost						
ENR CCI = 7312 (20 Cities Index, November 2004)						

5.5.5 Booster Pump Capacity

Table 5.15 presents the required BPS capacity at buildout, as well as required improvements and estimated project costs at the selected planning periods.

5.5.6 Summary

Table 5.16 summarizes the estimated costs for the recommended water distribution system improvements. In the near term, some main additions are recommended to strengthen the network and help provide a more reliable water supply. Additional storage reservoirs, wells, and booster station capacity are required to serve projected growth. The City's existing water system is in good condition, so the vast majority of recommended improvements are to support the planned growth.

Table 5.15 Existing and Proposed Potable Water Wells / Sources
Wastewater Master Plan and Utility System Analysis – City of Avondale

Station Name	Firm Capacity		Project Cost			
	(gpm)	(mgd)	2,004	2,005	2,010	Buildout
Well 1 BPS Firm Capacity	0	0.0	Existing	-	-	-
Well 2 BPS Firm Capacity	0	0.0	Existing	-	-	-
Well 5 BPS Firm Capacity	0	0.0	Existing	-	-	-
Well 8a BPS Firm Capacity	6,000	8.6	-	X	-	-
Well 17 BPS Firm Capacity	10,000	14.4	-	X	-	-
Bohne BPS Firm Capacity	0	0.0	Existing	-	-	-
Cashion BPS Firm Capacity	0	0.0	Existing	-	-	-
Coldwater Springs BPS Firm Capacity	22,000	31.7	Existing	$2,353,000	$2,353,000	$2,353,000
Del Rio BPS Firm Capacity	12,000	17.3	-	-	$4,218,000	$2,353,000
Northside BPS Firm Capacity	5,400	7.8	Existing	-	-	-
Rancho SF BPS Firm Capacity	10,200	14.7	Existing	-	$2,353,000	-
Roeser BPS Firm Capacity	6,000	8.6	-	-	-	$3,170,000
PIR BPS Firm Capacity	2,500	3.6	-	-	-	$2,149,000
Total Cost	-	-	$-	$2,353,000	$8,924,000	$10,025,000

Notes:
BPS associated with Wells 2 and 5 to be abandoned.
Costs do not include upgrading existing pumps to match anticipated hydraulic grade line.

Project costs are based on the assumption that engineering design, contract management, inspection, and contingency are an additional 40% of the construction cost

ENR CCI = 7312 (20 Cities Index, November 2004)

Table 5.16 Water Distribution System Improvements Cost Summary Wastewater Master Plan and Utility System Analysis – City of Avondale				
Description	**2006**	**2010**	**Buildout**	**Total**
Strengthen Existing Network	$665,000	$468,000		$1,133,000
Reinforcements in Old Avondale	$3,175,000			$3,175,000
Future Main Additions	$3,624,000	$16,895,000	$17,038,000	$37,557,000
Additional Wells		$8,686,000	$22,583,000	$31,269,000
Water Storage	$4,280,000	$13,212,000	$16,500,000	$33,992,000
Booster Pump Stations	$2,353,000	$3,924,000	$10,025,000	$21,302,000
Total	$14,097,000	$48,185,000	$66,146,000	$128,428,000
Project costs are based on the assumption that engineering design, contract management, inspection, and contingency are an additional 40% of the construction cost				
ENR CCI = 7312 (20 Cities Index, November 2004)				

Appendix A

LAND USE PLAN INFORMATION

Land Use Polygon Listing
Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	Land Use Type	Description	Acres	2004	2005	2010	Buildout	Sewer	Water
1	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	3.15	100	100	100	100	2004	2004
2	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	3.40	100	100	100	100	2004	2004
3	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	7.72	100	100	100	100	2004	2004
4	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	1.35	100	100	100	100	2004	2004
5	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	5.78	100	100	100	100	2004	2004
6	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	2.71	100	100	100	100	2004	2004
7	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	2.87	100	100	100	100	2004	2004
8	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	1.55	100	100	100	100	2004	2004
9	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	4.77	100	100	100	100	2004	2004
10	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	5.69	100	100	100	100	2004	2004
11	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	1.92	100	100	100	100	2004	2004
12	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	2.17	100	100	100	100	2004	2004
13	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	2.60	100	100	100	100	2004	2004
14	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	2.45	100	100	100	100	2004	2004
15	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	4.90	100	100	100	100	2004	2004
16	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	4.66	100	100	100	100	2004	2004
17	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	1.90	100	100	100	100	2004	2004
18	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	5.19	100	100	100	100	2004	2004
19	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	0.66	100	100	100	100	2004	2004
20	LAKES AND WATER FEATURES	CRYSTAL GARDENS I & II	3.88	100	100	100	100	2004	2004
21	SCHOOL	ESTRELLA MTN CC - LPSCO	119.43	35	42	75	100	2010	2010
22	COMMERCIAL/OFFICE	LPSCO	26.18	50	58	100	100	2010	2010
23	COMMERCIAL/OFFICE	LPSCO	6.31	0	17	100	100	2010	2010
24	COMMERCIAL/OFFICE	LUTHERAN CHURCH - LPSCO	26.92	50	58	100	100	2010	2010
25	MED DENSITY RES	RESIDENTIAL	84.13	100	100	100	100	2004	2004
26	SCHOOL	CRITTENDON SCHOOL	22.94	100	100	100	100	2004	2004
27	COMMERCIAL/OFFICE	OPEN SPACE IN GEN PLAN BUT OWNED BY PRIVATE	5.08	0	17	100	100	2004	2004
28	MED DENSITY RES	RESIDENTIAL	96.44	100	100	100	100	2004	2004
29	COMMERCIAL/OFFICE		4.19	100	100	100	100	2005	2004
30	MED DENSITY RES		22.16	100	100	100	100	2004	2004
31	HIGH DENSITY RES		14.36	50	58	100	100	2004	2004
32	COMMERCIAL/OFFICE		5.52	0	17	100	100	2004	2004
33	COMMERCIAL/OFFICE	CO PER GEN PLAN	14.35	0	17	100	100	2004	2004
34	MED DENSITY RES	RESIDENTIAL	57.75	100	100	100	100	2004	2004
35	PARK	CALMAT PROPERTY	116.38	0	17	100	100	2010	2004
36	MED DENSITY RES	RESIDENTIAL	117.96	100	100	100	100	2004	2004
37	COMMERCIAL/OFFICE		6.23	100	100	100	100	2005	2004
38	INDUSTRIAL		35.22	100	100	100	100	2005	2004
39	PARK	DRIVING RANGE	15.90	100	100	100	100	2005	2004
40	PARK	GRAVEL PIT AND FACILITIES - CALMAT	115.23	0	17	100	100	2010	2004
41	AGUA FRIA RIVER	AGUA FRIA RIVER	129.84	100	100	100	100	2004	2004

Land Use Polygon Listing
Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	Land Use Type	Description	Acres	2004	2005	2010	Buildout	Sewer	Water
42	SCHOOL	WESTVIEW HIGH SCHOOL	48.27	100	100	100	100	2004	2004
43	SCHOOL	GARDEN LAKES ELEMENTARY	17.33	100	100	100	100	2004	2004
44	COMMERCIAL/OFFICE	CHURCH	6.09	100	100	100	100	2004	2004
45	COMMERCIAL/OFFICE		12.63	100	100	100	100	2004	2004
46	LAKES AND WATER FEATURES	LAKE	18.70	100	100	100	100	2004	2004
47	LAKES AND WATER FEATURES	LAKE	19.23	100	100	100	100	2004	2004
48	MED DENSITY RES		13.83	100	100	100	100	2004	2004
49	MED DENSITY RES		13.76	100	100	100	100	2004	2004
50	COMMERCIAL/OFFICE	CORNERSTONE CHRISTIAN CENTER	3.94	100	100	100	100	2004	2004
51	INDUSTRIAL		81.94	100	100	100	100	2004	2004
52	MED DENSITY RES		34.61	100	100	100	100	2004	2004
53	MED DENSITY RES		33.82	100	100	100	100	2004	2004
54	MED DENSITY RES		48.76	100	100	100	100	2004	2004
55	MED DENSITY RES	PARK???	0.85	100	100	100	100	2004	2004
56	MED DENSITY RES		15.95	100	100	100	100	2004	2004
57	MED DENSITY RES	PARK???	1.40	100	100	100	100	2004	2004
58	MED DENSITY RES		23.86	100	100	100	100	2004	2004
59	MED DENSITY RES		25.03	100	100	100	100	2004	2004
60	MED DENSITY RES		20.39	100	100	100	100	2004	2004
61	MED DENSITY RES	PARK???	0.69	100	100	100	100	2004	2004
62	MED DENSITY RES		31.55	100	100	100	100	2004	2004
63	MED DENSITY RES		22.40	100	100	100	100	2004	2004
64	INDUSTRIAL		95.97	100	100	100	100	2004	2004
65	FUTURE MED DENSITY RES	MDR PER GEN PLAN	5.31	0	17	100	100	2004	2004
66	COMMERCIAL/OFFICE		10.72	0	17	100	100	2004	2004
67	INDUSTRIAL		10.50	25	38	100	100	2004	2004
68	MED DENSITY RES		29.24	100	100	100	100	2004	2004
69	MED DENSITY RES		46.95	100	100	100	100	2004	2004
70	MED DENSITY RES		14.83	100	100	100	100	2004	2004
71	MED DENSITY RES	PARK???	0.98	100	100	100	100	2004	2004
72	MED DENSITY RES		22.48	100	100	100	100	2004	2004
73	MED DENSITY RES		21.14	100	100	100	100	2004	2004
74	MED DENSITY RES		3.92	100	100	100	100	2004	2004
75	MED DENSITY RES		15.75	100	100	100	100	2004	2004
76	MED DENSITY RES		25.50	100	100	100	100	2004	2004
77	MED DENSITY RES	PARK???	0.42	100	100	100	100	2004	2004
78	MED DENSITY RES		14.72	100	100	100	100	2004	2004
79	MED DENSITY RES		31.42	100	100	100	100	2004	2004
80	MED DENSITY RES		22.75	100	100	100	100	2004	2004
81	MED DENSITY RES	PARK???	5.78	100	100	100	100	2004	2004
82	MED DENSITY RES		17.54	100	100	100	100	2004	2004

Land Use Polygon Listing
Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	**Land Use Type**	**Description**	**Acres**	**2004**	**2005**	**2010**	**Buildout**	**Sewer**	**Water**
83	MED DENSITY RES	PARK???	1.54	100	100	100	100	2004	2004
84	MED DENSITY RES		13.09	100	100	100	100	2004	2004
85	MED DENSITY RES		14.49	100	100	100	100	2004	2004
86	COMMERCIAL/OFFICE	CITY OF AVONDALE PROPERTY	2.60	0	17	100	100	2004	2004
87	COMMERCIAL/OFFICE		5.32	100	100	100	100	2004	2004
88	LARGE RETAIL		14.54	100	100	100	100	2004	2004
89	MED DENSITY RES	WESTWIND	138.75	100	100	100	100	2004	2004
90	LOW DENSITY RES	WILHOIT WATER - GLEN ARM FARMS	150.72	100	100	100	100	2010	2004
91	COMMERCIAL/OFFICE		76.98	0	17	100	100	2010	2004
92	PARK	ROMAN CATHOLIC CHURCH PROPERTY	77.08	25	38	100	100	2010	2004
93	MED DENSITY RES	LOS ARVOLITOS	78.34	30	42	100	100	2004	2004
94	MED DENSITY RES	FIRST BAPTIST CHURCH	5.23	50	58	100	100	2004	2004
95	MED DENSITY RES	PECAN GROVES	21.33	100	100	100	100	2004	2004
96	COMMERCIAL/OFFICE		2.27	50	58	100	100	2004	2004
97	COMMERCIAL/OFFICE		2.22	100	100	100	100	2004	2004
98	COMMERCIAL/OFFICE	SAFEWAY CENTER	19.82	0	17	100	100	2004	2004
99	MED DENSITY RES	HARBOR SHORES	96.11	100	100	100	100	2004	2004
100	COMMERCIAL/OFFICE	GATEWAY OFFICE PARK	8.28	25	38	100	100	2004	2004
101	COMMERCIAL/OFFICE	MIX IN GEN PLAN	60.43	0	8	50	100	2010	2004
102	INDUSTRIAL		20.24	0	10	60	100	2004	2004
103	HIGH DENSITY RES	AVENTURA APTS.	18.56	100	100	100	100	2004	2004
104	HIGH DENSITY RES	103RD AVENUE APRTS	11.57	0	17	100	100	2004	2004
105	LARGE RETAIL	GATEWAY PAVILLIONS	77.54	100	100	100	100	2004	2004
106	COMMERCIAL/OFFICE	DESERT LAKES OFFICE	7.40	25	38	100	100	2004	2004
107	COMMERCIAL/OFFICE	ALBERTSONS	2.33	100	100	100	100	2004	2004
108	FUTURE MED DENSITY RES		15.88	0	8	50	100	2004	2004
109	MED DENSITY RES	CRYSTAL RIDGE	25.59	100	100	100	100	2004	2004
110	MED DENSITY RES	UPLAND PARK	76.90	100	100	100	100	2004	2004
111	MED DENSITY RES	CRYSTAL GARDENS I & II	230.59	100	100	100	100	2004	2004
112	MED DENSITY RES	CRYSTAL POINT	61.22	100	100	100	100	2004	2004
113	FUTURE MED DENSITY RES		11.00	0	17	100	100	2004	2004
114	SCHOOL	RIO VISTA ELEMENTARY	20.12	100	100	100	100	2004	2004
115	COMMERCIAL/OFFICE		20.83	100	100	100	100	2010	2004
116	FUTURE MED DENSITY RES		37.69	0	17	100	100	2010	2004
117	AGUA FRIA RIVER	AGUA FRIA RIVER	175.45	100	100	100	100	2004	2004
118	FUTURE MED DENSITY RES		8.28	0	17	100	100	2004	2004
119	MED DENSITY RES	PALM GARDENS	31.11	100	100	100	100	2004	2004
120	COMMERCIAL/OFFICE	HORSE PROPERTY	5.68	0	17	100	100	2004	2004
121	LOW DENSITY RES	SINGLE HOUSE	2.14	100	100	100	100	2004	2004
122	MED DENSITY RES	PALM MEADOWS	42.00	100	100	100	100	2004	2004
123	LARGE RETAIL	ALAMEDA CROSSING	37.95	40	50	100	100	2004	2004

Land Use Polygon Listing

Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	**Land Use Type**	**Description**	**Acres**	**2004**	**2005**	**2010**	**Buildout**	**Sewer**	**Water**
124	COMMERCIAL/OFFICE	UNDEVELOPED SUNCOR PROPERTY	14.37	0	17	100	100	2004	2004
125	MED DENSITY RES	RANCHO SANTE FE	154.95	100	100	100	100	2004	2004
126	MED DENSITY RES	RANCHO SANTE FE	27.54	100	100	100	100	2004	2004
127	MED DENSITY RES	RANCHO SANTE FE	61.93	100	100	100	100	2004	2004
128	HIGH DENSITY RES	APARTMENTS	20.09	100	100	100	100	2004	2004
129	MED DENSITY RES	RANCHO SANTE FE	38.46	100	100	100	100	2004	2004
130	MED DENSITY RES	RANCHO SANTE FE	38.95	100	100	100	100	2004	2004
131	SCHOOL	RANCHO SANTE FE ELEMENTARY	14.70	100	100	100	100	2004	2004
132	MED DENSITY RES	RANCHO SANTE FE	18.36	100	100	100	100	2004	2004
133	MED DENSITY RES	RANCHO SANTE FE	52.67	100	100	100	100	2004	2004
134	MED DENSITY RES	RANCHO SANTE FE	55.33	100	100	100	100	2004	2004
135	MED DENSITY RES	RANCHO SANTE FE	22.29	100	100	100	100	2004	2004
136	SCHOOL	CANYON BREEZE ELEMENTARY	8.58	100	100	100	100	2004	2004
137	FUTURE MED DENSITY RES		78.87	0	17	100	100	2004	2004
138	COMMERCIAL/OFFICE		2.17	100	100	100	100	2004	2004
139	COMMERCIAL/OFFICE		14.94	100	100	100	100	2004	2004
140	COMMERCIAL/OFFICE	PALMILLA SHOPPING CENTER	49.20	100	100	100	100	2004	2004
141	COMMERCIAL/OFFICE	RANCHO SANTE FE MEDICAL CENTER	11.12	100	100	100	100	2004	2004
142	COMMERCIAL/OFFICE		20.89	0	17	100	100	2004	2004
143	HIGH DENSITY RES	RANCHO SANTE FE	20.80	100	100	100	100	2004	2004
144	AGUA FRIA RIVER	AGUA FRIA RIVER	54.44	100	100	100	100	2004	2004
145	PARK	FRIENDSHIP PARK YOUTH SPORTS COMPLEX	115.47	10	25	100	100	2004	2004
146	HIGH DENSITY RES	CRYSTAL SPRINGS APPARTMENTS	24.89	100	100	100	100	2004	2004
147	LARGE RETAIL	COLDWATER PLAZA	63.12	100	100	100	100	2004	2004
148	COMMERCIAL/OFFICE		2.03	0	17	100	100	2004	2004
149	COMMERCIAL/OFFICE		13.43	75	79	100	100	2004	2004
150	AGUA FRIA RIVER	AGUA FRIA RIVER	83.35	100	100	100	100	2004	2004
151	COMMERCIAL/OFFICE	CO PER GEN PLAN	3.80	100	100	100	100	2004	2004
152	COMMERCIAL/OFFICE	CO PER GEN PLAN	1.63	100	100	100	100	2004	2004
153	MED DENSITY RES	GARDEN TRAILS	37.57	100	100	100	100	2004	2004
154	MED DENSITY RES	GARDEN PARK	37.92	100	100	100	100	2004	2004
155	COMMERCIAL/OFFICE	AVONDALE AUTOMALL	150.54	75	79	100	100	2004	2004
156	INDUSTRIAL	AVONDALE COMMERCE PARK	77.93	30	42	100	100	2004	2004
157	LARGE RETAIL	FREEWAY COMMERCIAL	55.06	0	12	70	100	2004	2004
158	MED DENSITY RES	CRYSTAL SPRINGS APTS.	20.39	100	100	100	100	2004	2004
159	HIGH DENSITY RES	WATERFORD SQUARE MULTI-FAMILY	20.03	0	17	100	100	2004	2004
160	MED DENSITY RES	WATERFORD SQUARE	31.42	3	19	100	100	2004	2004
161	COMMERCIAL/OFFICE	FREEWAY COM FROM GEN PLAN	0.82	0	17	100	100	2004	2004
162	INDUSTRIAL		160.85	0	0	0	100	2004	2004
163	LARGE RETAIL		57.02	0	13	80	100	2004	2004
164	LARGE RETAIL		10.43	100	100	100	100	2004	2004

Land Use Polygon Listing
Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	Land Use Type	Description	Acres	2004	2005	2010	Buildout	Sewer	Water
165	LOW DENSITY RES		5.41	50	58	100	100	2004	2004
166	COMMERCIAL/OFFICE	CHURCH PER AVONDALE REVIEW	2.16	100	100	100	100	2004	2004
167	INDUSTRIAL	INTERSTATE COMMERCE CENTER	76.65	20	33	100	100	2004	2004
168	INDUSTRIAL		36.31	100	100	100	100	2010	2004
169	COMMERCIAL/OFFICE	AVONDALE CORPORATE CENTER	10.63	40	50	100	100	2004	2004
170	FUTURE MED DENSITY RES	MDR PER GEN PLAN	150.23	0	17	100	100	2004	2004
171	INDUSTRIAL		6.00	0	17	100	100	2004	2004
172	INDUSTRIAL		25.15	0	17	100	100	2004	2004
173	AGUA FRIA RIVER	AGUA FRIA RIVER	135.53	100	100	100	100	2004	2004
174	PARK		29.36	100	100	100	100	2004	2004
175	INDUSTRIAL		41.62	50	58	100	100	2004	2004
176	HIGH DENSITY RES		0.90	100	100	100	100	2004	2004
177	COMMERCIAL/OFFICE		5.32	0	17	100	100	2004	2004
178	LARGE RETAIL		1.51	100	100	100	100	2004	2004
179	COMMERCIAL/OFFICE		4.98	100	100	100	100	2004	2004
180	COMMERCIAL/OFFICE		0.35	100	100	100	100	2004	2004
181	MED DENSITY RES		15.60	100	100	100	100	2004	2004
182	COMMERCIAL/OFFICE		10.69	30	42	100	100	2004	2004
183	MED DENSITY RES		18.12	70	75	100	100	2004	2004
184	MED DENSITY RES		4.05	100	100	100	100	2004	2004
185	COMMERCIAL/OFFICE		6.85	80	83	100	100	2004	2004
186	SCHOOL	COLLIER ELEMENTARY	24.22	100	100	100	100	2004	2004
187	MED DENSITY RES	GLENHURST	124.53	25	38	100	100	2004	2004
188	SCHOOL	GARDEN LAKES ELEMENTARY	11.35	100	100	100	100	2004	2004
189	SCHOOL	AVONDALE JUNIOR HIGH	8.86	100	100	100	100	2004	2004
190	SCHOOL	AGUA FRIA HIGH SCHOOL	58.50	100	100	100	100	2004	2004
191	COMMERCIAL/OFFICE		5.13	100	100	100	100	2004	2004
192	HIGH DENSITY RES		10.33	100	100	100	100	2004	2004
193	MED DENSITY RES		5.24	100	100	100	100	2004	2004
194	INDUSTRIAL		11.86	100	100	100	100	2004	2004
195	MED DENSITY RES	COLDWATER SPRINGS	128.69	95	96	100	100	2004	2004
196	MED DENSITY RES		3.92	100	100	100	100	2004	2004
197	MED DENSITY RES		5.42	100	100	100	100	2004	2004
198	SCHOOL	AVONDALE ELEMENTARY	17.43	100	100	100	100	2004	2004
199	COMMERCIAL/OFFICE		89.93	50	58	100	100	2004	2004
200	COMMERCIAL/OFFICE		1.54	100	100	100	100	2004	2004
201	FUTURE MED DENSITY RES		8.42	0	17	100	100	2010	2004
202	HIGH DENSITY RES		10.85	100	100	100	100	2004	2004
203	COMMERCIAL/OFFICE		7.64	100	100	100	100	2004	2004
204	HIGH DENSITY RES		5.11	100	100	100	100	2004	2004
205	MED DENSITY RES		9.27	100	100	100	100	2004	2004

Land Use Polygon Listing

Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	Land Use Type	Description	Acres	2004	2005	2010	Buildout	Sewer	Water
206	MED DENSITY RES		27.39	100	100	100	100	2004	2004
207	COMMERCIAL/OFFICE		1.57	100	100	100	100	2004	2004
208	COMMERCIAL/OFFICE		7.21	60	67	100	100	2004	2004
209	MED DENSITY RES		59.73	100	100	100	100	2004	2004
210	HIGH DENSITY RES		1.85	100	100	100	100	2004	2004
211	PARK		2.24	100	100	100	100	2004	2004
212	HIGH DENSITY RES		19.94	90	92	100	100	2004	2004
213	COMMERCIAL/OFFICE		4.75	100	100	100	100	2004	2004
214	MED DENSITY RES		1.26	100	100	100	100	2004	2004
215	HIGH DENSITY RES		47.44	100	100	100	100	2004	2004
216	PARK		4.95	100	100	100	100	2004	2004
217	HIGH DENSITY RES		2.03	100	100	100	100	2004	2004
218	MED DENSITY RES		62.31	100	100	100	100	2004	2004
219	MED DENSITY RES		10.52	100	100	100	100	2004	2004
220	PARK		6.25	100	100	100	100	2004	2004
221	COMMERCIAL/OFFICE		8.34	100	100	100	100	2004	2004
222	COMMERCIAL/OFFICE		1.57	100	100	100	100	2004	2004
223	INDUSTRIAL		6.48	100	100	100	100	2004	2004
224	COMMERCIAL/OFFICE		23.62	100	100	100	100	2004	2004
225	PARK		0.57	100	100	100	100	2004	2004
226	MED DENSITY RES	AVONDALE SENIOR VILLAGE	3.24	100	100	100	100	2004	2004
227	SCHOOL	QUENTIN ELEMENTARY	15.35	100	100	100	100	2004	2004
228	SCHOOL	UNDER DOWN JUNIOR HIGH	9.34	100	100	100	100	2004	2004
229	PARK		6.04	100	100	100	100	2004	2004
230	MED DENSITY RES	CASHION	185.42	100	100	100	100	2004	2004
231	SCHOOL	LA JOYA HIGH SCHOOL	55.62	80	83	100	100	2004	2004
232	SCHOOL	LITTLETON ELEMENTARY SCHOOL	24.44	100	100	100	100	2004	2004
233	MED DENSITY RES	LITCHFIELD MOUNTAIN VIEW	32.68	75	79	100	100	2004	2004
234	COMMERCIAL/OFFICE		7.06	60	67	100	100	2004	2004
235	MED DENSITY RES	DIAMOND RIDGE	50.30	40	50	100	100	2004	2004
236	FUTURE MED DENSITY RES	MDR PER GEN PLAN	8.89	0	4	25	100	2004	2004
237	COMMERCIAL/OFFICE		2.90	40	50	100	100	2004	2004
238	FUTURE MED DENSITY RES		12.83	0	17	100	100	2004	2004
239	AGUA FRIA RIVER	AGUA FRIA RIVER	391.94	100	100	100	100	2004	2004
240	FUTURE MED DENSITY RES	LOW DENSITY RESIDENTIAL	58.37	0	4	25	100	2004	2004
241	PARK		9.54	100	100	100	100	2004	2004
242	INDUSTRIAL		8.01	100	100	100	100	2004	2004
243	LOW DENSITY RES		3.33	100	100	100	100	2004	2004
244	INDUSTRIAL		57.98	0	4	25	100	2004	2004
245	LOW DENSITY RES		22.48	80	83	100	100	2004	2004
246	INDUSTRIAL		32.62	0	4	25	100	2010	2004

Land Use Polygon Listing
Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	**Land Use Type**	**Description**	**Acres**	**2004**	**2005**	**2010**	**Buildout**	**Sewer**	**Water**
247	AGUA FRIA RIVER	AGUA FRIA RIVER	178.81	100	100	100	100	2004	2004
248	AGUA FRIA RIVER	GILA RIVER	257.04	100	100	100	100	2004	2004
249	AGUA FRIA RIVER	GILA RIVER	1316.48	100	100	100	100	2004	2004
250	FUTURE MED DENSITY RES		88.86	0	4	25	100	2020	2020
251	MED DENSITY RES	SANCTUARY	133.84	73	78	100	100	2004	2004
252	AGUA FRIA RIVER	AGUA FRIA RIVER	67.92	100	100	100	100	2004	2004
253	INDUSTRIAL		34.90	25	29	50	100	2005	2004
254	COMMERCIAL/OFFICE		8.52	0	17	100	100	2004	2004
255	COMMERCIAL/OFFICE	AVONDALE FIESTA PLAZA	19.27	40	50	100	100	2004	2004
256	MED DENSITY RES	FIELDCREST	52.52	100	100	100	100	2004	2004
257	MED DENSITY RES		24.37	60	67	100	100	2004	2004
258	INDUSTRIAL		13.65	0	17	100	100	2004	2004
259	LOW DENSITY RES		12.47	0	17	100	100	2004	2004
260	FUTURE MED DENSITY RES	ROY'S PLACE	124.92	0	17	100	100	2004	2004
261	COMMERCIAL/OFFICE		0.66	0	4	25	100	2004	2004
262	MED DENSITY RES		7.52	25	38	100	100	2004	2004
263	MED DENSITY RES		20.34	80	83	100	100	2004	2004
264	PARK		4.92	100	100	100	100	2004	2004
265	FUTURE MED DENSITY RES		18.31	0	17	100	100	2004	2004
266	HIGH DENSITY RES		34.92	80	83	100	100	2004	2004
267	MED DENSITY RES		19.19	80	83	100	100	2004	2004
268	COMMERCIAL/OFFICE		6.30	100	100	100	100	2004	2004
269	MED DENSITY RES		95.85	85	88	100	100	2004	2004
270	COMMERCIAL/OFFICE		8.17	100	100	100	100	2004	2004
271	HIGH DENSITY RES		1.07	0	4	25	100	2004	2004
272	MED DENSITY RES		2.24	100	100	100	100	2004	2004
273	COMMERCIAL/OFFICE		2.77	100	100	100	100	2004	2004
274	MED DENSITY RES		3.05	100	100	100	100	2004	2004
275	MED DENSITY RES		55.03	100	100	100	100	2004	2004
276	COMMERCIAL/OFFICE		0.50	100	100	100	100	2004	2004
277	AGUA FRIA RIVER	AGUA FRIA RIVER	179.29	100	100	100	100	2004	2004
278	MED DENSITY RES	RIO VISTA	52.26	100	100	100	100	2004	2004
279	COMMERCIAL/OFFICE		1.34	0	17	100	100	2004	2004
280	INDUSTRIAL	CITY PROPERTY	79.37	30	42	100	100	2010	2004
281	LOW DENSITY RES		57.09	60	67	100	100	2010	2004
282	FUTURE MED DENSITY RES		113.92	0	4	25	100	2010	2004
283	INDUSTRIAL		61.64	100	100	100	100	2010	2004
284	FUTURE MED DENSITY RES		130.73	0	4	25	100	2010	2004
285	INDUSTRIAL	RIGBY WATER COMPANY - GRAVEL PIT	44.29	100	100	100	100	2010	2010
286	FUTURE MED DENSITY RES		323.99	0	4	25	100	2020	2020
287	PHOENIX INTERNATIONAL RACEWAY	PHOENIX INTERNATIONAL RACEWAY	322.24	100	100	100	100	2020	2020

Land Use Polygon Listing

Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	**Land Use Type**	**Description**	**Acres**	**2004**	**2005**	**2010**	**Buildout**	**Sewer**	**Water**
288	DESERT PARK	DESERT SOUTH OF PIR	3833.25	0	4	25	100	2020	2020
289	FUTURE MED DENSITY RES		402.95	0	4	25	100	2020	2020
290	FUTURE MED DENSITY RES		180.84	0	4	25	100	2020	2020
291	COMMERCIAL/OFFICE	RANCHO SANTE FE RESERVOIR AND WELL SITE	4.31	100	100	100	100	2004	2004
292	MED DENSITY RES	RANCHO SANTE FE	34.36	100	100	100	100	2004	2004
293	MED DENSITY RES	RANCHO SANTE FE OPEN SPACE	29.86	100	100	100	100	2004	2004
294	FUTURE MED DENSITY RES	COLDWATER SPRINGS	48.31	0	17	100	100	2004	2004
295	PARK	COLDWATER SPRINGS GOLF COURSE	24.41	100	100	100	100	2004	2004
296	FUTURE MED DENSITY RES	COLDWATER SPRINGS MEDIUM DENSITY PER GEN PLAN	13.63	0	17	100	100	2004	2004
297	MED DENSITY RES	COLDWATER SPRINGS	22.18	100	100	100	100	2004	2004
298	MED DENSITY RES	COLDWATER SPRINGS	27.60	60	67	100	100	2004	2004
299	MED DENSITY RES	COLDWATER SPRINGS	20.82	100	100	100	100	2004	2004
300	FUTURE MED DENSITY RES	MDR PER GEN PLAN	119.75	0	17	100	100	2004	2004
301	COMMERCIAL/OFFICE	CHURCH / SCHOOL - LPSCO	34.86	35	46	100	100	2010	2010
302	PARK		98.25	10	25	100	100	2004	2004
303	FUTURE MED DENSITY RES		92.12	0	17	100	100	2004	2004
304	SCHOOL		10.98	100	100	100	100	2004	2004
305	INDUSTRIAL	ELECTRICAL SUBSTATION	10.88	100	100	100	100	2004	2004
306	COMMERCIAL/OFFICE		51.08	0	17	100	100	2004	2004
307	FUTURE MED DENSITY RES		12.13	0	17	100	100	2004	2004
308	COMMERCIAL/OFFICE		13.55	0	17	100	100	2004	2004
309	SCHOOL		16.58	0	17	100	100	2004	2004
310	FUTURE MED DENSITY RES		54.21	0	17	100	100	2004	2004
311	COMMERCIAL/OFFICE		8.40	0	17	100	100	2004	2004
312	FUTURE MED DENSITY RES		27.75	0	0	0	100	2004	2004
313	LOW DENSITY RES	HORSE PROPERTY	88.07	50	58	100	100	2020	2004
314	COMMERCIAL/OFFICE		19.88	0	17	100	100	2010	2004
315	COMMERCIAL/OFFICE	OPEN FIELD WITH ONE HOUSE	19.44	0	17	100	100	2010	2004
316	LARGE RETAIL	FREEWAY COMMERCIAL	39.32	0	8	50	100	2010	2004
317	FUTURE MED DENSITY RES	MIX IN GEN PLAN	40.95	0	8	50	100	2010	2004
318	FUTURE MED DENSITY RES		8.27	0	0	0	100	2004	2004
319	FUTURE MED DENSITY RES		16.62	0	0	0	100	2004	2004
320	HIGH DENSITY RES		19.67	0	17	100	100	2004	2004
321	COMMERCIAL/OFFICE		81.47	0	8	50	100	2004	2004
322	INDUSTRIAL		5.52	60	67	100	100	2004	2004
323	LARGE RETAIL		66.21	0	5	30	100	2004	2004
324	COMMERCIAL/OFFICE		23.86	0	4	25	100	2004	2004
325	INDUSTRIAL		5.01	0	17	100	100	2004	2004
326	LARGE RETAIL	FREEWAY COM FROM GEN PLAN	35.43	0	5	30	100	2004	2004
327	COMMERCIAL/OFFICE		13.05	0	5	30	100	2004	2004
328	COMMERCIAL/OFFICE		40.88	0	17	100	100	2010	2004

Land Use Polygon Listing

Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	**Land Use Type**	**Description**	**Acres**	**2004**	**2005**	**2010**	**Buildout**	**Sewer**	**Water**
329	LARGE RETAIL		55.34	0	5	30	100	2004	2004
330	COMMERCIAL/OFFICE		40.91	0	5	30	100	2004	2004
331	COMMERCIAL/OFFICE	GEN PLAN MIX	39.96	0	5	30	100	2004	2004
332	FUTURE MED DENSITY RES	GEN PLAN MIX	37.71	0	17	100	100	2004	2004
333	COMMERCIAL/OFFICE		9.64	0	17	100	100	2004	2004
334	COMMERCIAL/OFFICE	GEN PLAN =- MIX	20.80	0	5	30	100	2004	2004
335	COMMERCIAL/OFFICE		76.87	0	5	30	100	2004	2004
336	INDUSTRIAL		30.00	0	5	30	100	2004	2004
337	INDUSTRIAL	GEN PLAN =- MIX	60.31	0	5	30	100	2004	2004
338	INDUSTRIAL		60.95	0	5	30	100	2004	2004
339	COMMERCIAL/OFFICE		48.76	30	42	100	100	2004	2004
340	FUTURE MED DENSITY RES		47.42	0	17	100	100	2004	2004
341	COMMERCIAL/OFFICE		36.81	0	17	100	100	2004	2004
342	FUTURE MED DENSITY RES		47.46	0	4	25	100	2004	2004
343	FUTURE MED DENSITY RES		110.48	0	4	25	100	2004	2004
344	HIGH DENSITY RES		31.25	0	4	25	100	2004	2004
345	COMMERCIAL/OFFICE		10.71	0	4	25	100	2004	2004
346	FUTURE MED DENSITY RES		49.75	0	17	100	100	2004	2004
347	COMMERCIAL/OFFICE		11.02	0	17	100	100	2004	2004
348	FUTURE MED DENSITY RES		165.23	0	17	100	100	2004	2004
349	FUTURE MED DENSITY RES		30.03	0	17	100	100	2004	2004
350	FUTURE MED DENSITY RES		68.24	0	4	25	100	2010	2004
351	INDUSTRIAL	ELECTRICAL SUBSTATION	80.60	100	100	100	100	2010	2004
352	FUTURE MED DENSITY RES		39.01	0	4	25	100	2010	2004
353	FUTURE MED DENSITY RES		253.90	0	4	25	100	2010	2004
354	FUTURE MED DENSITY RES		54.52	0	4	25	100	2004	2004
355	COMMERCIAL/OFFICE		9.85	0	0	0	100	2010	2004
356	COMMERCIAL/OFFICE		38.05	0	0	0	100	2010	2004
357	COMMERCIAL/OFFICE		9.32	0	4	25	100	2004	2004
358	LOW DENSITY RES		152.01	100	100	100	100	2010	2004
359	LOW DENSITY RES		47.97	40	50	100	100	2010	2004
360	COMMERCIAL/OFFICE		9.94	0	0	0	100	2010	2004
361	COMMERCIAL/OFFICE		27.66	0	0	0	100	2010	2004
362	FUTURE MED DENSITY RES		123.29	0	0	0	100	2010	2004
363	LOW DENSITY RES	RIGBY WATER COMPANY	195.16	80	83	100	100	2010	2010
364	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	37.54	0	4	25	100	2010	2010
365	COMMERCIAL/OFFICE		21.89	0	0	0	100	2010	2004
366	COMMERCIAL/OFFICE		9.48	0	0	0	100	2010	2004
367	COMMERCIAL/OFFICE	RIGBY WATER COMPANY	29.71	0	0	0	100	2010	2010
368	COMMERCIAL/OFFICE	RIGBY WATER COMPANY	10.00	0	0	0	100	2010	2010
369	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	66.18	0	4	25	100	2010	2010

Land Use Polygon Listing
Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	**Land Use Type**	**Description**	**Acres**	**2004**	**2005**	**2010**	**Buildout**	**Sewer**	**Water**
370	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	50.14	0	4	25	100	2010	2010
371	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	192.29	0	4	25	100	2010	2010
372	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	123.33	0	4	25	100	2010	2010
373	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	151.03	0	4	25	100	2010	2010
374	COMMERCIAL/OFFICE		8.04	0	0	0	100	2010	2004
375	FUTURE MED DENSITY RES	MEDIUM DENSITY RESIDENTIAL	144.57	0	0	0	100	2010	2004
376	COMMERCIAL/OFFICE		8.54	0	0	0	100	2010	2004
377	PARK	OPEN SPACE	21.17	0	4	25	100	2004	2004
378	FUTURE MED DENSITY RES		19.88	0	4	25	100	2004	2004
379	INDUSTRIAL	EMPLOYMENT AREA	18.61	0	17	100	100	2004	2004
380	INDUSTRIAL	AVONDALE FACILITIES	31.51	50	50	50	100	2004	2004
381	INDUSTRIAL	EMPLOYMENT AREA	206.78	5	8	25	100	2010	2004
382	INDUSTRIAL	EMPLOYMENT AREA	9.34	50	58	100	100	2010	2004
383	INDUSTRIAL	EMPLOYMENT AREA	2.06	0	4	25	100	2010	2004
384	FUTURE MED DENSITY RES	EMPLOYMENT AREA	10.74	0	4	25	100	2010	2004
385	FUTURE MED DENSITY RES		23.92	0	4	25	100	2010	2004
386	FUTURE MED DENSITY RES		65.33	0	4	25	100	2010	2004
387	MED DENSITY RES	COLDWATER SPRINGS	29.76	100	100	100	100	2004	2004
388	PARK	COLDWATER SPRINGS PARK	5.06	100	100	100	100	2004	2004
389	MED DENSITY RES	COLDWATER SPRINGS	28.66	65	71	100	100	2004	2004
390	MED DENSITY RES	COLDWATER SPRINGS	32.95	65	71	100	100	2004	2004
391	PARK	COLDWATER SPRINGS GOLF COURSE	157.84	100	100	100	100	2004	2004
392	PARK	COLDWATER SPRING GOLF COURSE	9.95	100	100	100	100	2004	2004
393	MED DENSITY RES	COLDWATER SPRINGS	27.99	100	100	100	100	2004	2004
394	MED DENSITY RES	CRYSTAL PARK ESTATES	12.04	100	100	100	100	2004	2004
395	COMMERCIAL/OFFICE	CHURCH OF GOD	3.20	50	58	100	100	2004	2004
396	COMMERCIAL/OFFICE	COMMERCIAL IN GEN PLAN	10.61	0	4	25	100	2004	2004
397	FUTURE MED DENSITY RES	APARTMENTS PLANNED	59.17	0	4	25	100	2004	2004
398	FUTURE MED DENSITY RES	HIGH DENSITY PER GEN PLAN	29.63	0	4	25	100	2004	2004
399	FUTURE MED DENSITY RES	COLDWATER SPRINGS MDR PER GEN PLAN	24.11	0	17	100	100	2004	2004
400	HIGH DENSITY RES	COLDWATER SPRINGS HDR PER GEN PLAN	19.61	0	17	100	100	2004	2004
401	MED DENSITY RES	DURANGO PARK	136.07	55	63	100	100	2004	2004
402	COMMERCIAL/OFFICE	DURANGO PARK	11.30	0	17	100	100	2004	2004
403	COMMERCIAL/OFFICE	COLDWATER SPRINGS CO PER GEN PLAN	25.26	0	17	100	100	2004	2004
404	COMMERCIAL/OFFICE	CO PER GEN PLAN	8.52	0	17	100	100	2004	2004
405	COMMERCIAL/OFFICE	CO PER GEN PLAN	11.81	0	17	100	100	2004	2004
406	HIGH DENSITY RES	MULTI FAM PER GEN PLAN	19.74	0	17	100	100	2004	2004
407	FUTURE MED DENSITY RES	TOWNHOMES PER PLANNING CHART	17.84	0	17	100	100	2004	2004
408	FUTURE MED DENSITY RES	TOWNHOMES PER PLANNING CHART	12.58	0	17	100	100	2004	2004
409	COMMERCIAL/OFFICE	MIX PER GEN PLAN	20.84	0	8	50	100	2004	2004
410	COMMERCIAL/OFFICE	CO PER GEN PLAN	13.55	0	17	100	100	2004	2004

Land Use Polygon Listing

Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	Land Use Type	Description	Acres	2004	2005	2010	Buildout	Sewer	Water
411	FUTURE MED DENSITY RES	HDR PER GEN PLAN	54.25	0	17	100	100	2004	2004
412	FUTURE MED DENSITY RES	MDER PER GEN PLAN	30.92	0	17	100	100	2004	2004
413	COMMERCIAL/OFFICE	CO PER GEN PLAN	26.77	0	17	100	100	2004	2004
414	FUTURE MED DENSITY RES	MDR PER GEN PLAN	89.19	0	17	100	100	2004	2004
415	LARGE RETAIL	FREEWAY COMMERCIAL PER GEN PLAN	69.42	0	8	50	100	2004	2004
416	HIGH DENSITY RES		16.00	0	0	0	100	2004	2004
417	COMMERCIAL/OFFICE		27.01	0	4	25	100	2004	2004
418	LARGE RETAIL		21.68	0	5	30	100	2004	2004
419	FUTURE MED DENSITY RES	EL MIRAGE ESTATES	68.76	0	17	100	100	2004	2004
420	FUTURE MED DENSITY RES	EL MIRAGE ESTATES	9.08	0	17	100	100	2004	2004
421	HIGH DENSITY RES		6.76	100	100	100	100	2004	2004
422	MED DENSITY RES		6.58	100	100	100	100	2004	2004
423	SCHOOL	SCHOOL PER PLANNING MAP	16.54	0	17	100	100	2004	2004
424	MED DENSITY RES	COLDWATER RIDGE	115.90	48	57	100	100	2004	2004
425	SCHOOL	SCHOOL PER PLANNING MAP	8.19	100	100	100	100	2004	2004
426	MED DENSITY RES	CAMBRIDGE ESTATES	154.39	98	98	100	100	2004	2004
427	LOW DENSITY RES	RIGBY WATER COMPANY	27.25	100	100	100	100	2010	2010
428	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	48.58	0	4	25	100	2010	2010
429	COMMERCIAL/OFFICE	LPSCO	4.00	0	17	100	100	2010	2010
430	INDUSTRIAL	LPSCO TANK	4.26	100	100	100	100	2004	2004
431	COMMERCIAL/OFFICE	CO PER GEN PLAN	44.76	15	29	100	100	2004	2004
432	COMMERCIAL/OFFICE	DYSART RANCH	10.64	0	17	100	100	2004	2004
433	MED DENSITY RES	DYSART RANCH	118.42	17	31	100	100	2005	2004
434	INDUSTRIAL		1.01	100	100	100	100	2005	2004
435	HIGH DENSITY RES		38.48	0	8	50	100	2004	2004
436	COMMERCIAL/OFFICE		4.33	100	100	100	100	2004	2004
437	COMMERCIAL/OFFICE		17.42	0	17	100	100	2004	2004
438	INDUSTRIAL		50.35	20	33	100	100	2004	2004
439	FUTURE MED DENSITY RES		9.12	0	17	100	100	2004	2004
440	INDUSTRIAL		9.78	100	100	100	100	2004	2004
441	COMMERCIAL/OFFICE		13.47	0	17	100	100	2004	2004
442	INDUSTRIAL	COLDWATER RES AND BPS	7.66	50	58	100	100	2004	2004
443	COMMERCIAL/OFFICE	LOW DENSITY RESIDENTIAL	0.89	100	100	100	100	2004	2004
444	LOW DENSITY RES	LOW DENSITY RESIDENTIAL	255.09	50	58	100	100	2004	2004
445	COMMERCIAL/OFFICE	SANCTUARY	6.08	0	17	100	100	2004	2004
446	FUTURE MED DENSITY RES	MDR PER GEN PLAN	117.96	0	17	100	100	2004	2004
447	COMMERCIAL/OFFICE	MDR PER GEN PLAN	10.23	0	17	100	100	2004	2004
448	MED DENSITY RES		25.03	100	100	100	100	2004	2004
449	SCHOOL	SCHOOL PER AVONDALE REVIEW	17.05	0	17	100	100	2004	2004
450	LARGE RETAIL		11.29	0	12	70	100	2004	2004
451	COMMERCIAL/OFFICE		16.73	0	12	70	100	2004	2004

Land Use Polygon Listing

Wastewater Collection System Master Plan and Utility Systems Evaluation Appendix
City of Avondale

	Land Use Information			Percent Buildout				Connection Date	
Polygon ID	Land Use Type	Description	Acres	2004	2005	2010	Buildout	Sewer	Water
452	LARGE RETAIL		33.62	0	12	70	100	2004	2004
453	COMMERCIAL/OFFICE		7.49	0	17	100	100	2010	2004
454	LARGE RETAIL		39.74	0	17	100	100	2010	2004
455	FUTURE MED DENSITY RES	MIX IN GEN PLAN	20.94	0	8	50	100	2010	2004
456	INDUSTRIAL		37.69	0	13	80	100	2004	2004
457	FUTURE MED DENSITY RES		19.90	0	4	25	100	2010	2004
458	FUTURE MED DENSITY RES		214.04	0	17	100	100	2010	2004
459	FUTURE MED DENSITY RES		69.43	0	4	25	100	2010	2004
460	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	77.87	0	4	25	100	2010	2010
461	FUTURE MED DENSITY RES		54.77	0	4	25	100	2010	2004
462	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	77.05	0	4	25	100	2010	2010
463	LOW DENSITY RES	RIGBY WATER COMPANY	78.28	40	50	100	100	2010	2010
464	LOW DENSITY RES		79.77	40	50	100	100	2010	2004
465	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	80.48	0	4	25	100	2010	2010
466	FUTURE MED DENSITY RES		67.58	0	4	25	100	2010	2004
467	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	72.89	0	4	25	100	2010	2010
468	FUTURE MED DENSITY RES		379.41	0	4	25	100	2010	2004
469	LOW DENSITY RES		57.62	50	58	100	100	2010	2004
470	FUTURE MED DENSITY RES		206.75	0	0	0	100	2010	2004
471	LOW DENSITY RES		24.49	75	79	100	100	2010	2004
472	LOW DENSITY RES	RIGBY WATER COMPANY	75.87	100	100	100	100	2010	2010
473	FUTURE MED DENSITY RES	RIGBY WATER COMPANY	202.73	0	0	0	100	2010	2010

GIS INFRASTRUCTURE DATA

APPENDIX B – GIS INFRASTRUCTURE DATA

INTRODUCTION

The City of Avondale has implemented a hydraulic modeling program for both the water and wastewater systems that uses the City's GIS data. This modeling program allows the City to perform "what if" analyses using hydraulic models. These analyses can be used to plan capital infrastructure improvements as the City grows, solve operational problems, and evaluate water quality. These models were built using the City's GIS data because this is the most cost effective way to create the models, and because the City's GIS data is the best source of good data for the models. Information in the City's GIS system will change as new infrastructure data is added to the GIS, and this information will also need to be added to the models so that the model data will remain current.

The purpose of this document is to document the use of GIS shapefiles in the development of the existing water and wastewater system models. It also provides documentation of the tools used to further develop these models for future investigations.

The hydraulic model requires that essential attributes such as pipe diameter or manhole rim elevation be populated for all entities. Therefore, when the actual data is missing, assumptions will need to be made for the model. The following guidelines apply to using GIS data in the model.

1. The OBJECTID field will be the unique identifier field.
2. Pipes that are classified as abandoned or as fire lines will not be added to the model.
3. Pipes that do not have node points that cannot be snapped will not be included.
4. Node points that are not snapped to pipe ends will not be included.
5. Pipe segments that could be snapped, but are not, will be snapped together.
6. Pipe segments that are not connected and cannot be connected will not be included in the model.
7. Where sewer manhole invert elevations are not available, manhole elevations will be approximated using pipe slopes and known invert elevations.

The following is a listing of the attributes in each shape file that contains information for the model. The specific model application and data quality issues are also given.

WT_Lines

Table B.1 shows the Water Line data layer, and its applicability to the model.

Table B.1	Water Line Attributes Wastewater Master Plan and Utility System Analysis – City of Avondale		
Attribute	**Useful for Modeling?**	**Modeling Application**	**Data Quality Issues**
FID	No		
Shape	Yes	Spatial location	
EHANDLE	No		No
LAYER	Yes	Can be used to eliminate pipelines to fire hydrants, abandoned mains, or other mains from model if desired	Some pipelines from the fire layer also provide water to meters
LENGTH	Possible	Length can be input from this field or calculated in the model	
TIMESTAMP	Yes	Can be used to identify changes to GIS since last model update	
DIAM	Yes	Specifies pipe diameter	• Diameter should include only decimal fractions • Approximately 380 pipes without diameter
MATR	Yes	Pipe material can be used to develop pipe roughness characteristics	Approximately half of pipes do not have designated material
PLANREF	Possible	Could be used for referencing as-built drawings	
COMMENT	No		
OBJECTID	Yes	Identifier	Must be unique and non-changing

WT-FIREHYD

Table B.2 shows the attributes of the fire hydrant data layer as they apply to the hydraulic model.

Table B.2	Fire Hydrant Attributes Wastewater Master Plan and Utility System Analysis – City of Avondale		
Attribute	**Useful for Modeling?**	**Modeling Application**	**Data Quality Issues**
FID	No		
Shape	Yes		
BLOCKNAME	No		
EHANDLE	No		
LAYER	No		
ROTATION	No		

Table B.2	Fire Hydrant Attributes Wastewater Master Plan and Utility System Analysis – City of Avondale		
Attribute	**Useful for Modeling?**	**Modeling Application**	**Data Quality Issues**
TIMESTAMP	Yes	Can be used to identify changes to GIS since last model update	
PLANREF	Possible	Could be used for referencing as-built drawings	
COMMENT	No		
OBJECTID	No	Identifier	

WT-METER

Table B.3 shows the attributes of the water meter data layer that applies to the hydraulic model.

Table B.3	Water Meter Attributes Wastewater Master Plan and Utility System Analysis – City of Avondale		
Attribute	**Useful for Modeling?**	**Modeling Application**	**Data Quality Issues**
FID	No		
Shape	Yes		
BLOCKNAME	No		
EHANDLE	No		
LAYER	No		
ROTATION	No		
ACCOUNT	Yes	Can be used to connect meters to Billing Records	Incomplete records prevent 100% match to Billing Records
ADDRESS	Yes	Can be used to connect meters to Billing Records	Incomplete records and format issues prevent 100% match to Billing Records
HNUM	Yes	Can be used to connect meters to Billing Records	Format issues prevent 100% match to Billing Records
METERID	Yes	Identifier	Must be unique and non-changing

WT-NODE

Table B.4 shows the attributes of the water junctions and facilities data layer that apply to the hydraulic model.

Table B.4	Water Junctions and Facilities Attributes Wastewater Master Plan and Utility System Analysis – City of Avondale		
Attribute	**Useful for Modeling?**	**Modeling Application**	**Data Quality Issues**
FID	No		
Shape	Yes		
BLOCKNAME	No		
EHANDLE	No		
LAYER	No		
ROTATION	No		
TIMESTAMP	Yes	Can be used to identify changes to GIS since last model update	
PLANREF	Possible	Could be used for referencing as-built drawings	
COMMENT	No		
OBJECTID	Yes	Identifier	Must be unique and non-changing

The WT-Node data layer would be more useful if it contained elevation attribute information. For this project, a separate nodes shapefile was provided with elevations for existing nodes. The elevations of future nodes were estimated from examination of USGS topographical data.

WT-VALVE

Table B.5 shows the attributes of the water valves data layer that apply to the hydraulic model.

Table B.5	Water Valve Attributes Wastewater Master Plan and Utility System Analysis – City of Avondale		
Attribute	**Useful for Modeling?**	**Modeling Application**	**Data Quality Issues**
FID	No		
Shape	Yes		
BLOCKNAME	No		
EHANDLE	No		
LAYER	No		
ROTATION	No		
TIMESTAMP	Yes	Can be used to identify changes to GIS since last model update	
PLANREF	Possible	Could be used for referencing as-built drawings	
COMMENT	No		

Table B.5	Water Valve Attributes Wastewater Master Plan and Utility System Analysis – City of Avondale		
Attribute	**Useful for Modeling?**	**Modeling Application**	**Data Quality Issues**
OBJECTID	Yes	Identifier	Must be unique and non-changing

SS-NODE

Table B.6 shows the attributes of the sewer connections and facilities data layer that apply to the sewer model.

Table B.6	Sewer Connections and Facilities Attribute Data Wastewater Master Plan and Utility System Analysis – City of Avondale		
Attribute	**Useful for Modeling?**	**Modeling Application**	**Data Quality Issues**
FID	No		
SHAPE	Yes		
BLOCKNAME	No		
EHANDLE	No		
LAYER	No		
TIMESTAMP	Yes	Can be used to identify changes to GIS since last model update (1)	Should be complete
RIMELEV	Yes	Surcharge calculations	Best if fully populated
INVELEV	Yes	Hydraulic calculations	Best if fully populated
PLANREF	Possible	Could be used for referencing as-built drawings	Should be complete
COMMENT	No		
OBJECTID	Yes	Identifier	Must be unique and non-changing

SS_Line

Table B.7 shows the Sewer Lines data layer, and its applicability to the model.

Table B.7	Sewer Line Attributes Wastewater Master Plan and Utility System Analysis – City of Avondale		
Attribute	**Useful for Modeling?**	**Modeling Application**	**Data Quality Issues**
FID	No		
Shape	Yes		
HANDLE	No		

Table B.7	Sewer Line Attributes Wastewater Master Plan and Utility System Analysis – City of Avondale		
Attribute	**Useful for Modeling?**	**Modeling Application**	**Data Quality Issues**
LAYER	Yes	Can be used to distinguish between gravity and pressurized piping	
LENGTH	Optional	Length can be input from this field or calculated in the model	
TIMESTAMP	Yes	Can be used to identify changes to GIS since last model update	
DIAM	Yes	Specifies pipe diameter	• Diameter should include only decimal fractions • Approximately 35 pipes without diameter
MATR	Yes	Pipe material can be used to develop pipe roughness characteristics	Approximately 30% of pipes do not have designated pipe material
ABLENGTH	Optional	Length can be input from this field or calculated in the model	
SLOPE	Yes	The model can calculate the slope from the inverts on either end of the pipe. In situations where the pipe invert is not the same as the manhole invert, it is useful to know the invert in addition to the slope in order to correctly represent drops inside the manhole.	Slope field is not completely populated. Pipelines without a slope are assigned a typical minimum slope value.
PLANREF	Possible	Could be used for referencing as-built drawings	
COMMENT	No		
OBJECTID	Yes	Identifier	Must be unique and non-changing

LAND USE PLANNING DATA IN THE GIS

The land use shapefile was developed as a part of this project. Table B.8 shows the generalized land use data layer attributes, and their applicability to the model.

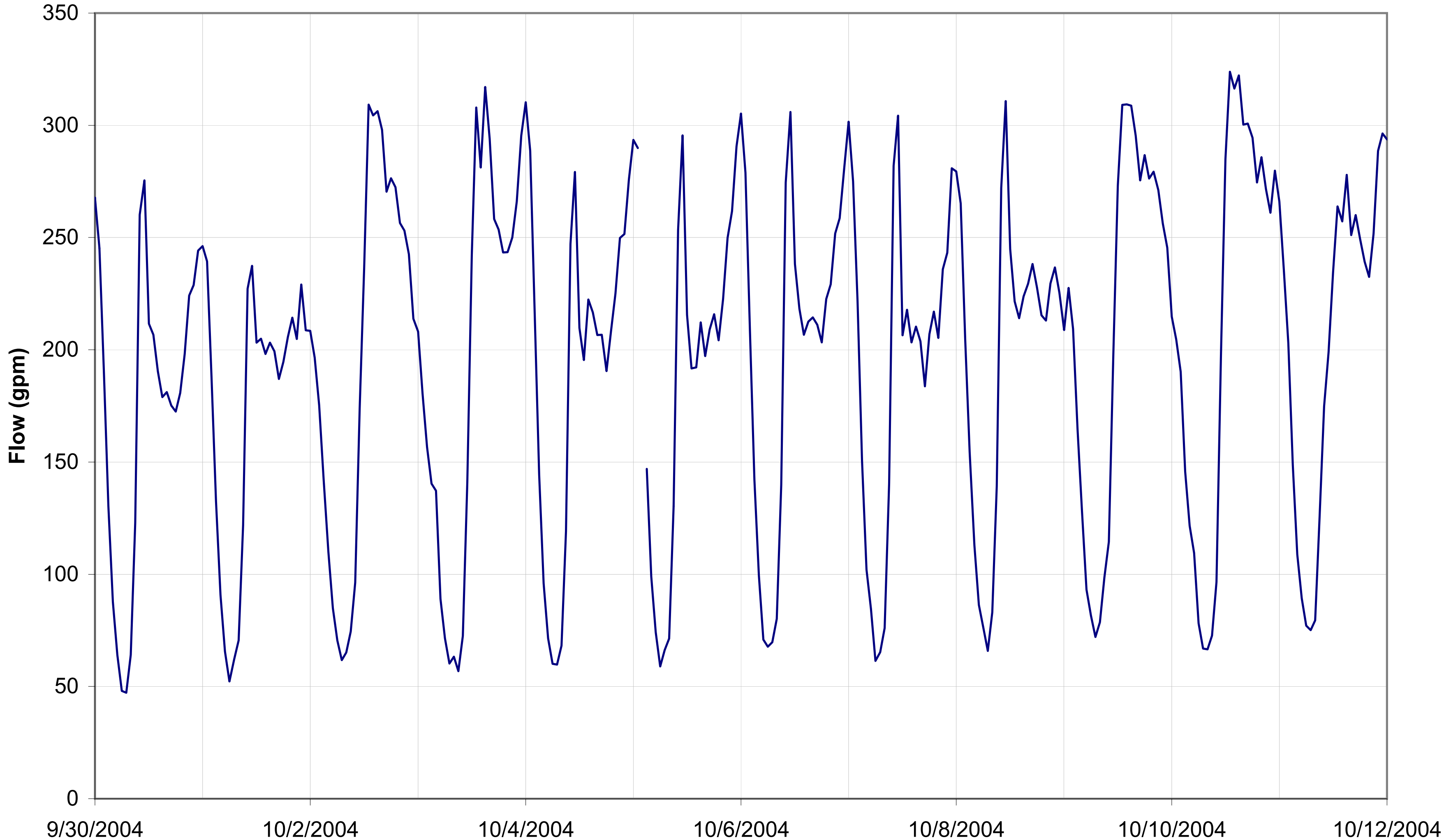
Table B.8	Land Use Attributes Wastewater Master Plan and Utility System Analysis – City of Avondale		
Attribute	**Useful for Modeling?**	**Modeling Application**	**Data Quality Issues**
FID	No		
Shape	Yes		
LU_CODE	Yes	Designates land use for	

Table B.8 Land Use Attributes
Wastewater Master Plan and Utility System Analysis – City of Avondale

Attribute	Useful for Modeling?	Modeling Application	Data Quality Issues
		developing sewer loadings and water demands	
Descript	Possible	Provides description or note regarding property or source of data	
BLD2004PCT	Yes	Records existing build out as a percent	
BLD2010PCT	Yes	Describes anticipated build-out conditions for future condition	
BLDOUTPCT	Yes	Describes anticipated, ultimate build out condition	
SSYEAR	Yes	Designates anticipated year of connection to Avondale sanitary sewer	
WTYEAR	Yes	Designates anticipated year of connection to Avondale water system	
Shape_Area	No	Calculated area in square feet of each shape is calculated automatically by modeling packages	Area must be recalculated following revisions to the shapefile
WT_04	Yes	Fractional development of object for water demand calculations at this planning period	
WT_05	Yes	Fractional development of object for water demand calculations at this planning period	
WT_10	Yes	Fractional development of object for water demand calculations at this planning period	
SS_04	Yes	Fractional development of object for sewer loading calculations at this planning period	
SS_05	Yes	Fractional development of object for sewer loading calculations at this planning period	
SS_10	Yes	Fractional development of object for sewer loading calculations at this planning period	
BLD_FRAC	Yes	Fractional development of object for water demand and sewer loading calculations at this planning period	
PRIVATE_CO	No	Designates service area of private water and sewer providers	

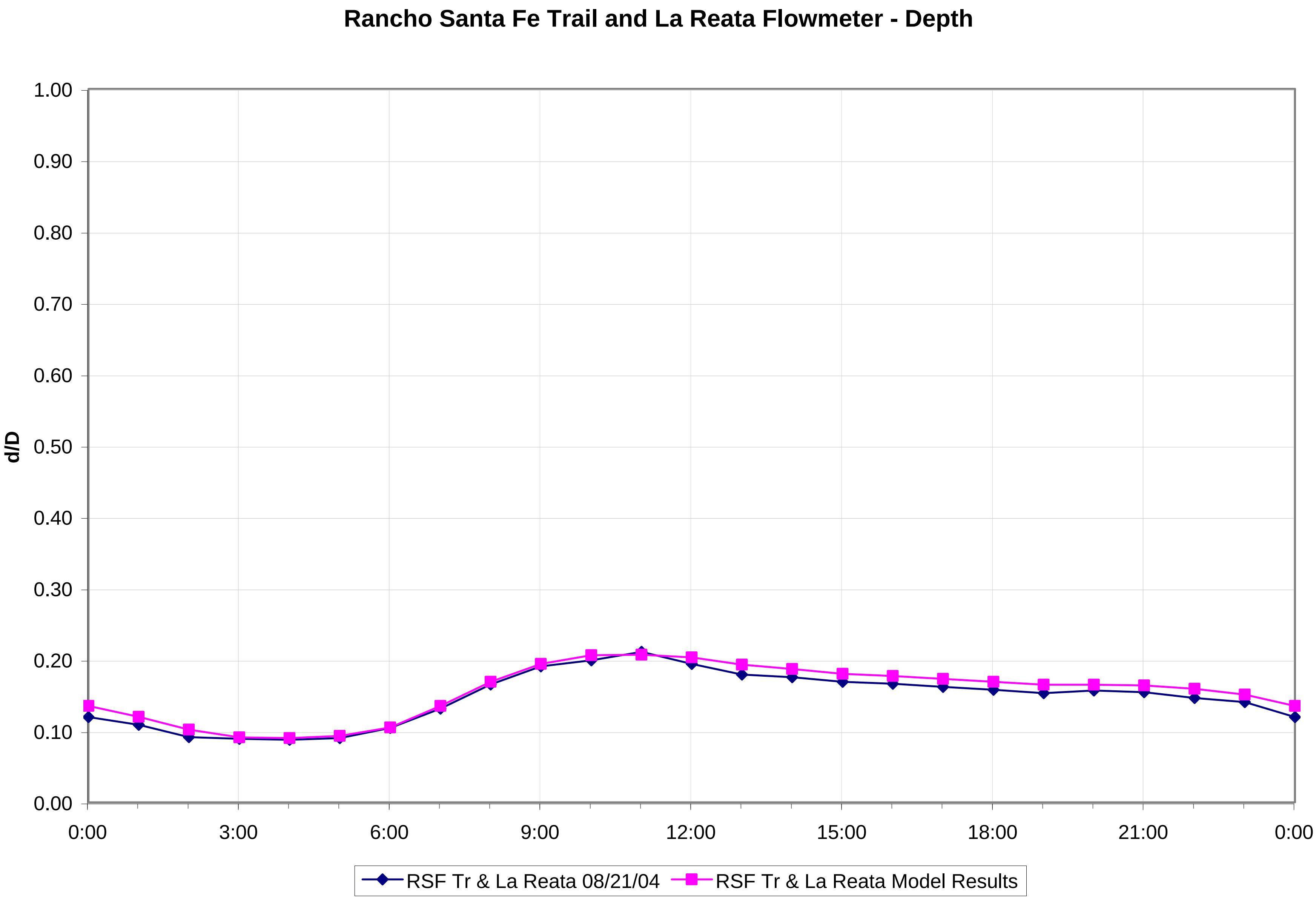
FIELD TEST DATA

Flowmeter Record
Lower Buckeye & El Mirage - 18-inch



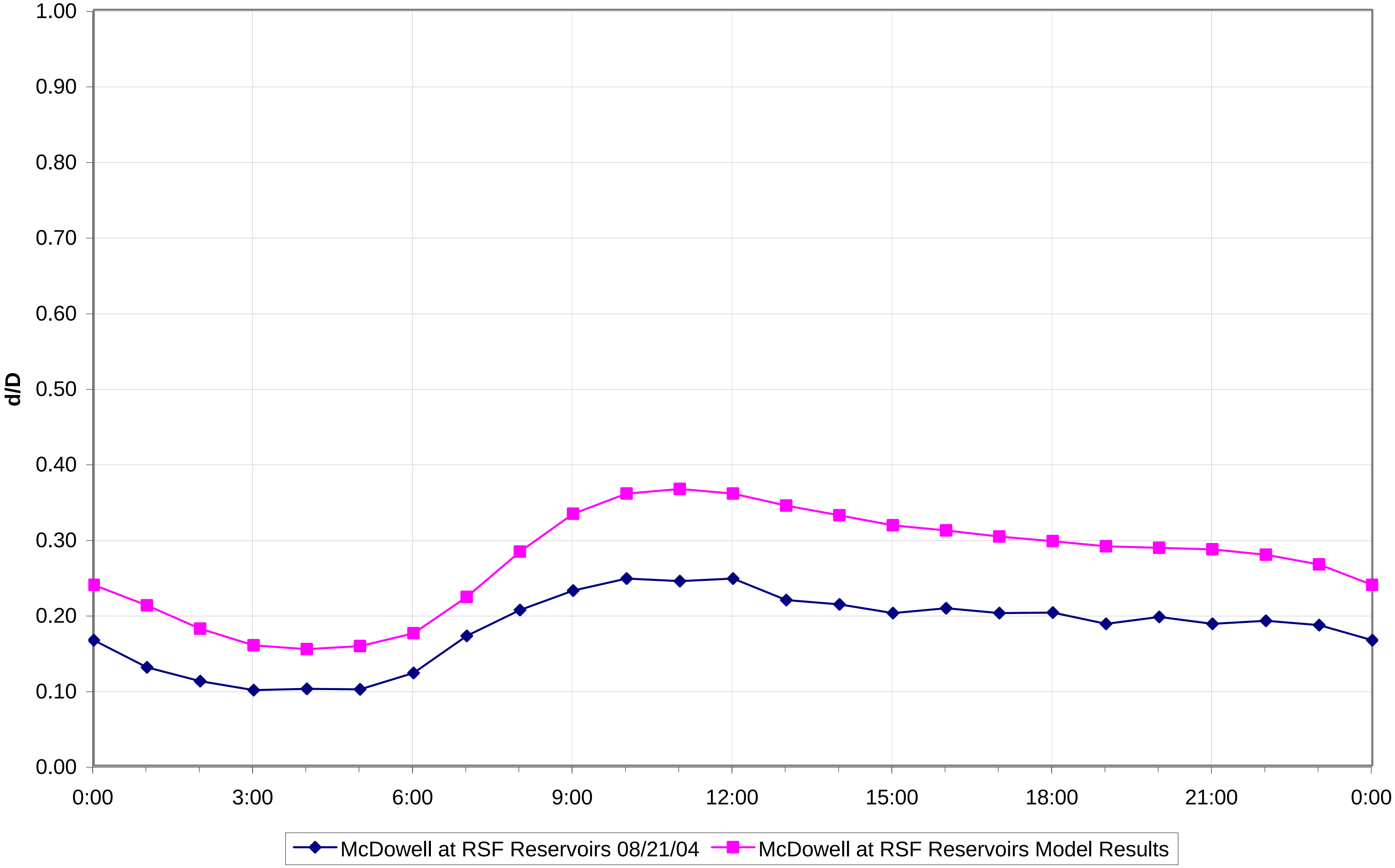
FLOWMETER DATA FOR PRESENTATION - 1a.xls
2/11/2005

MODEL CALIBRATION RESULTS

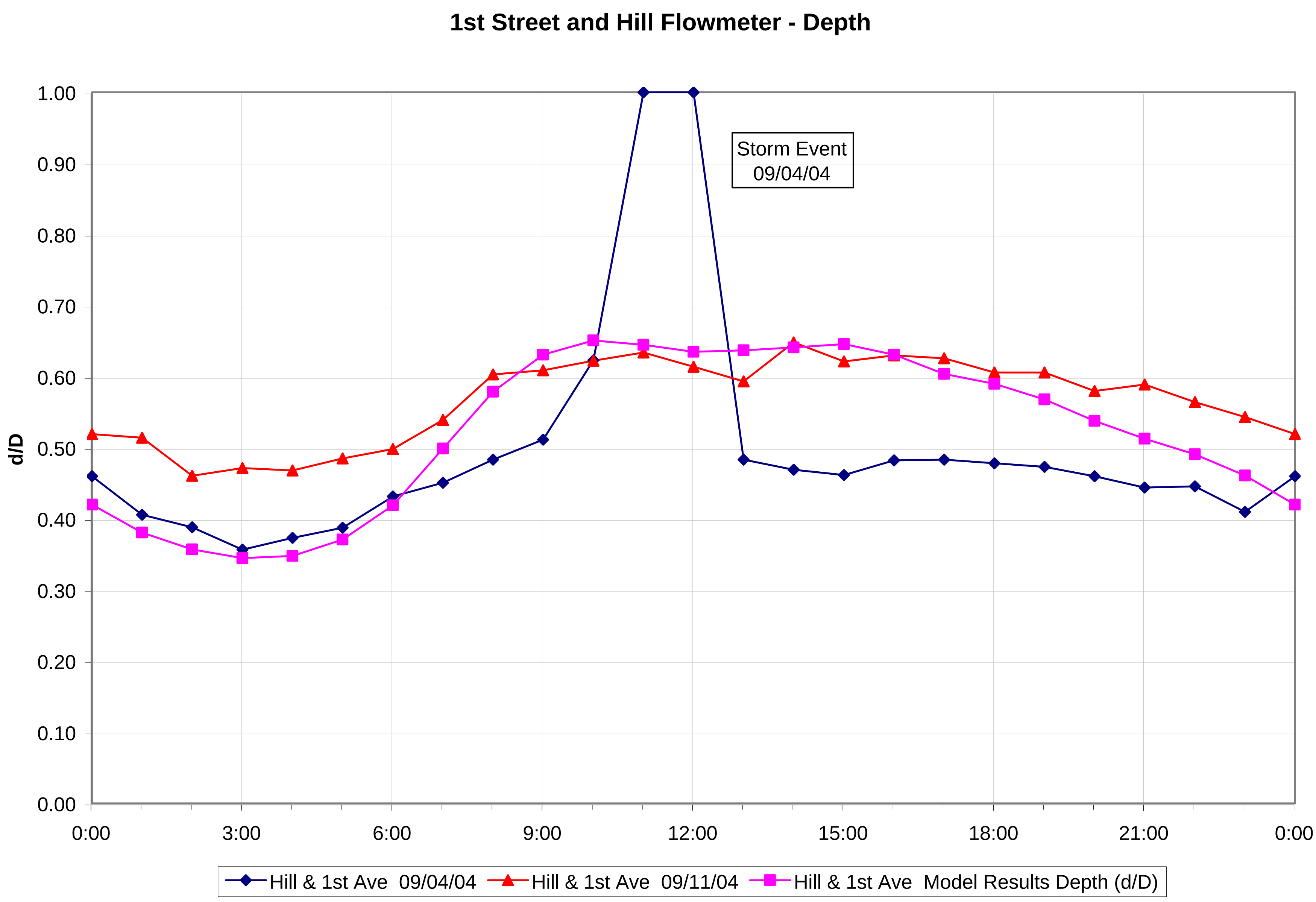


calibration graphs_1
2/18/2005

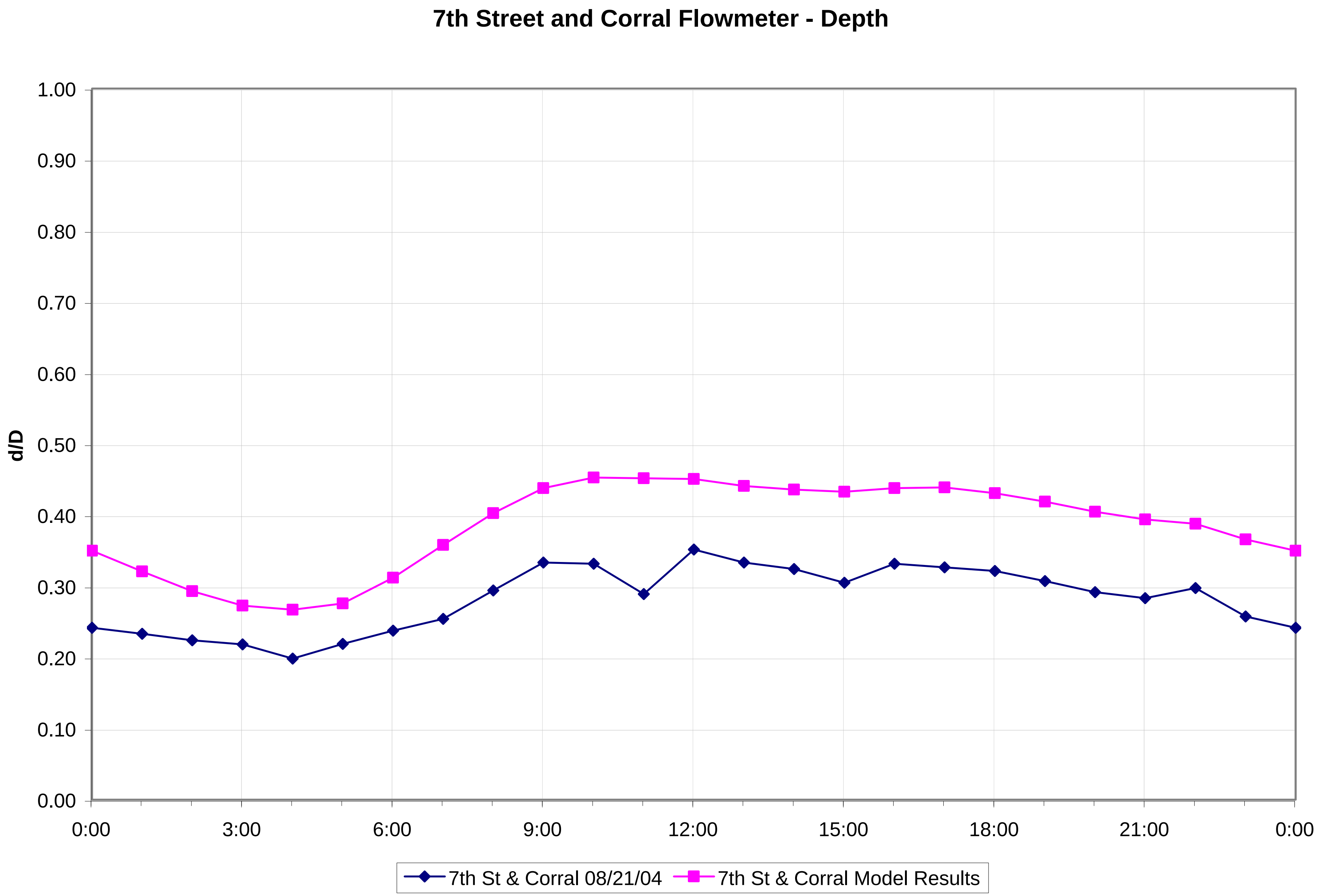
McDowell at Rancho Santa Fe Reservoir Flowmeter - Depth



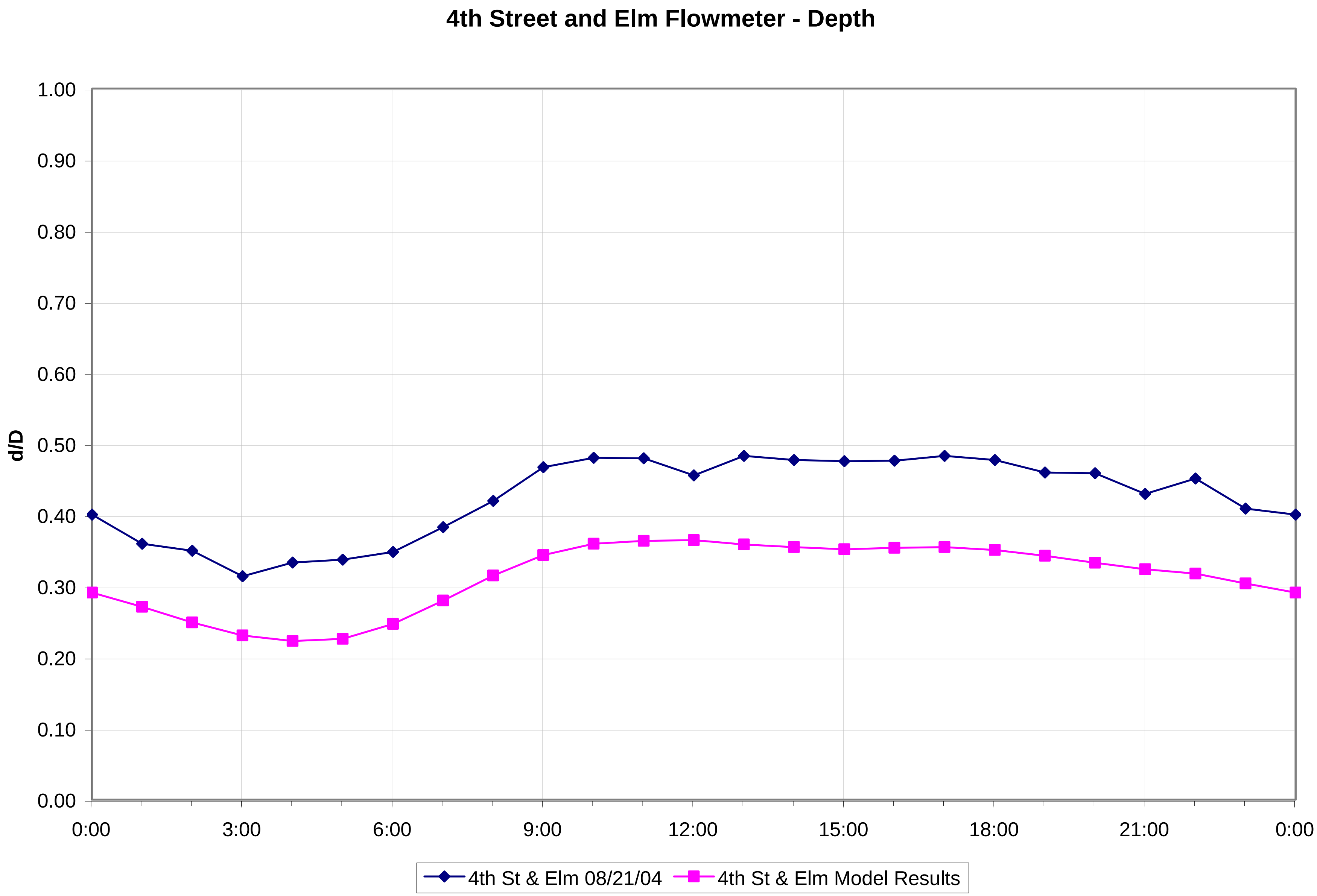
calibration graphs_1
2/18/2005



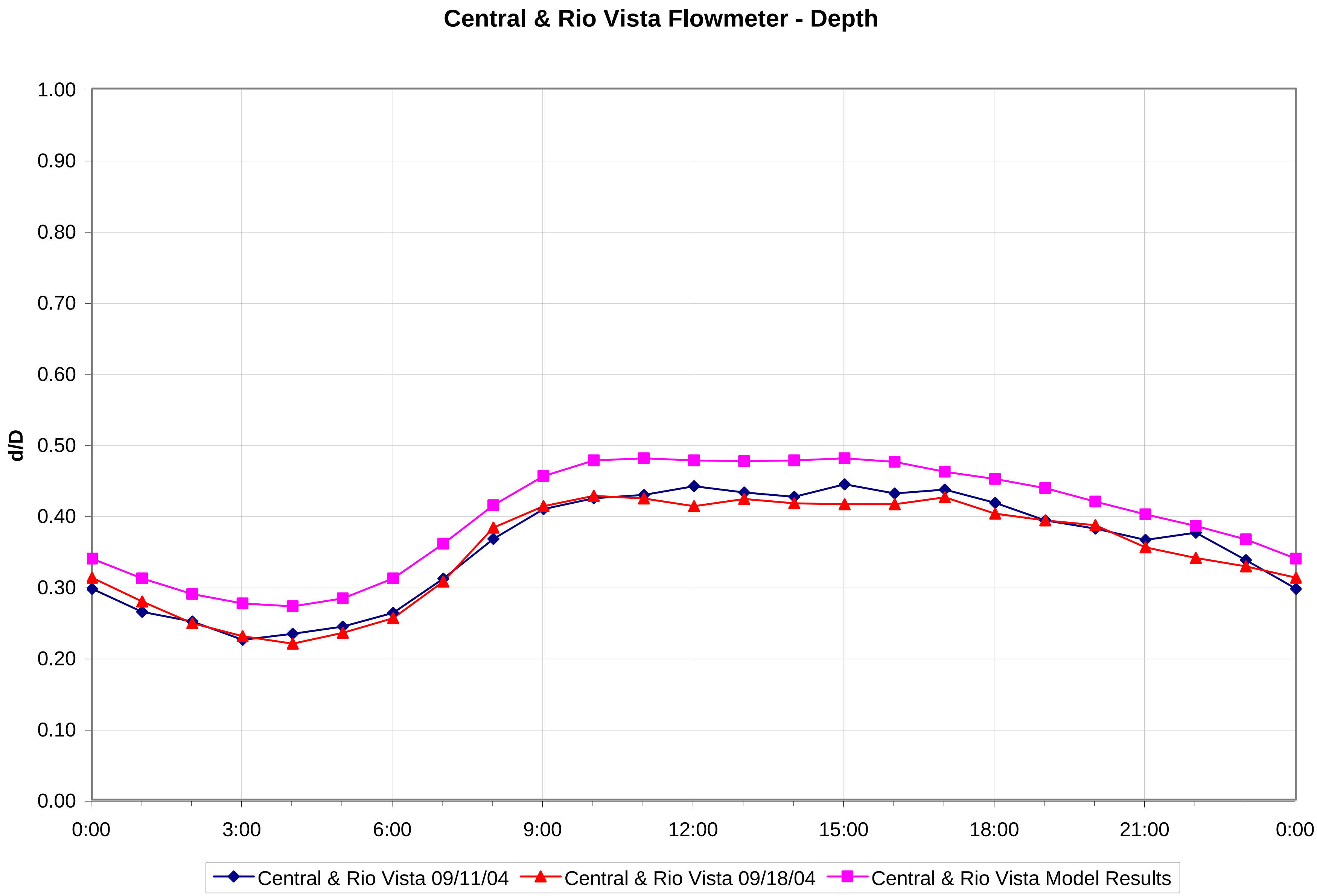
calibration graphs_1
2/18/2005



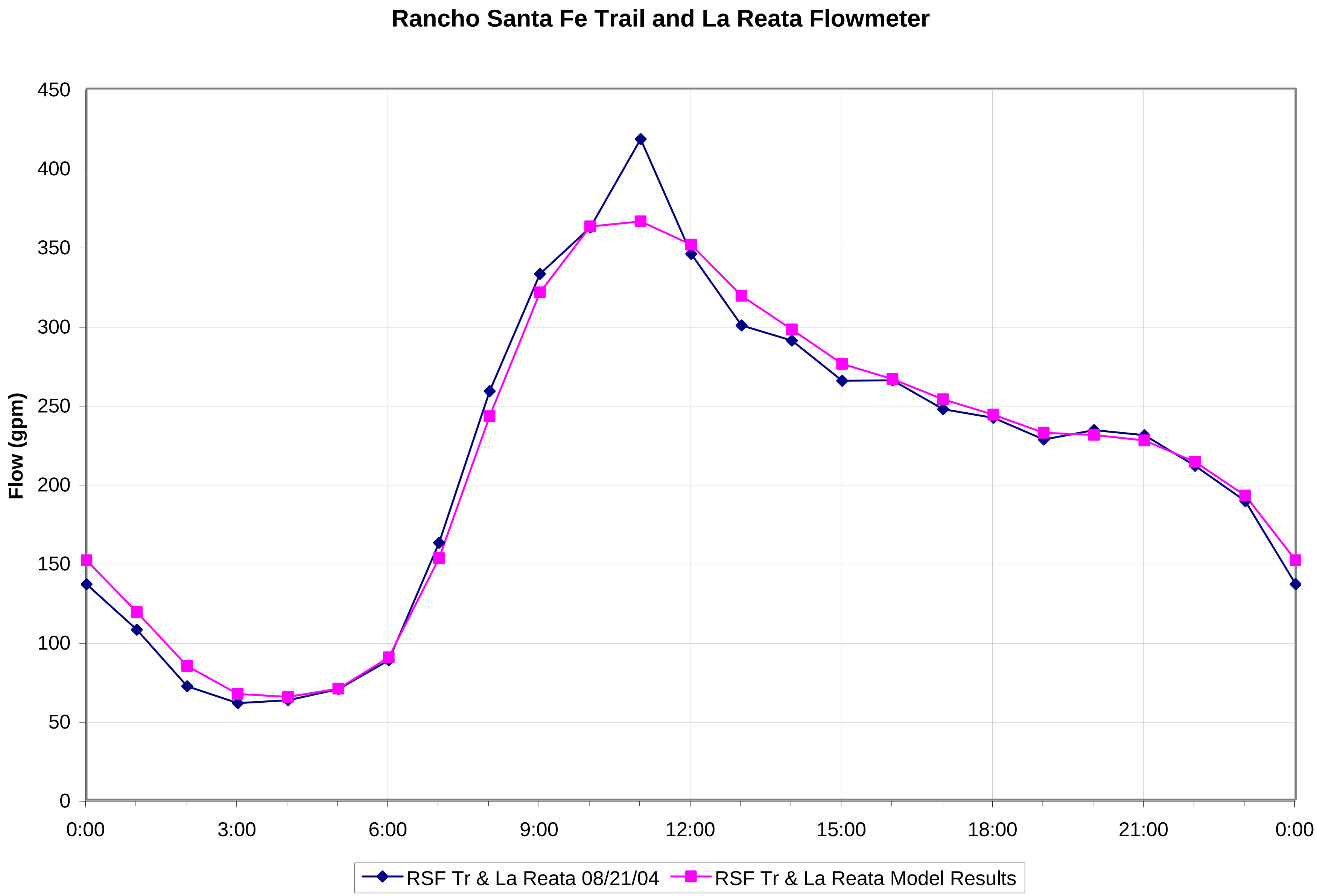
calibration graphs_1
2/18/2005



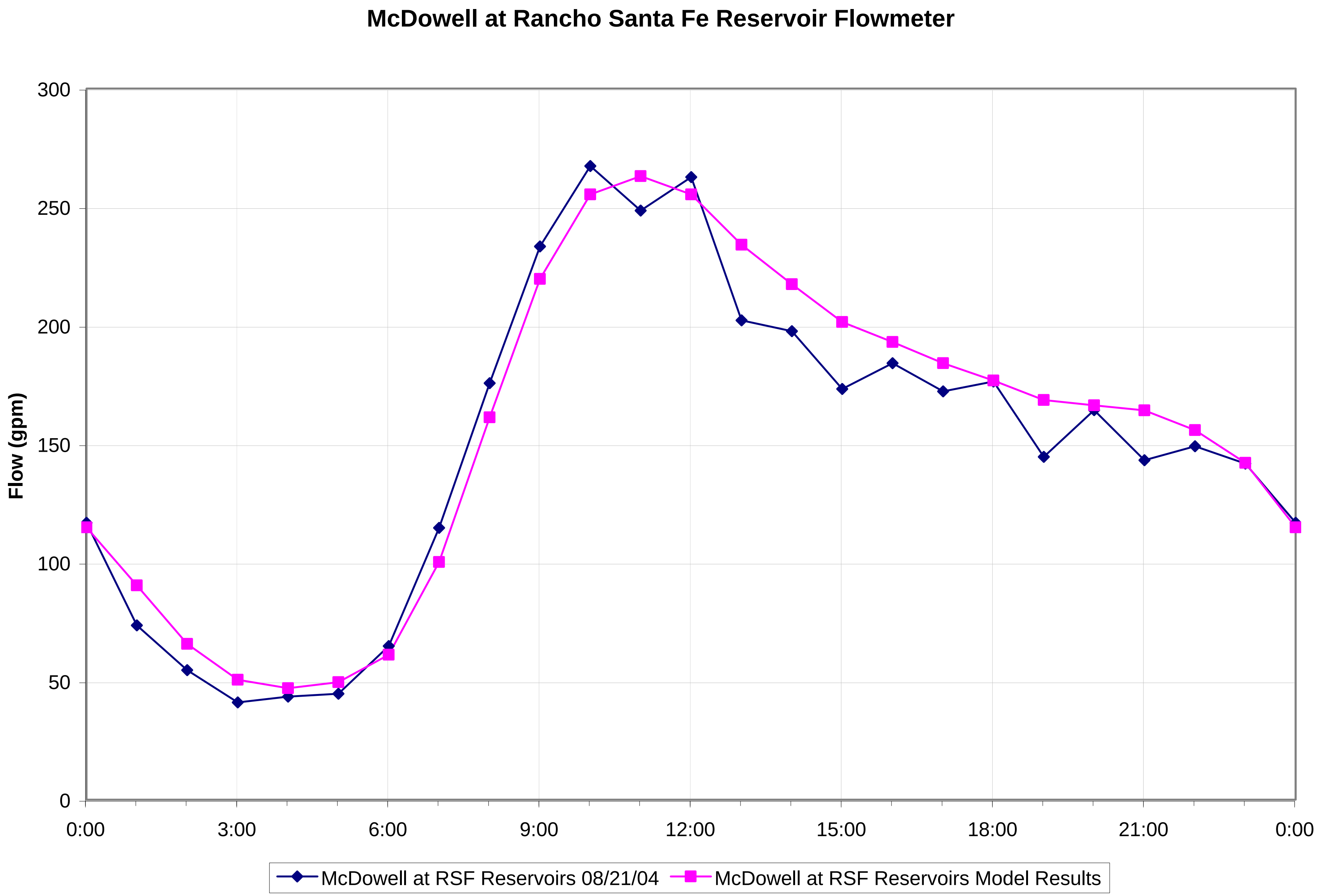
calibration graphs_1
2/18/2005



calibration graphs_1
2/18/2005

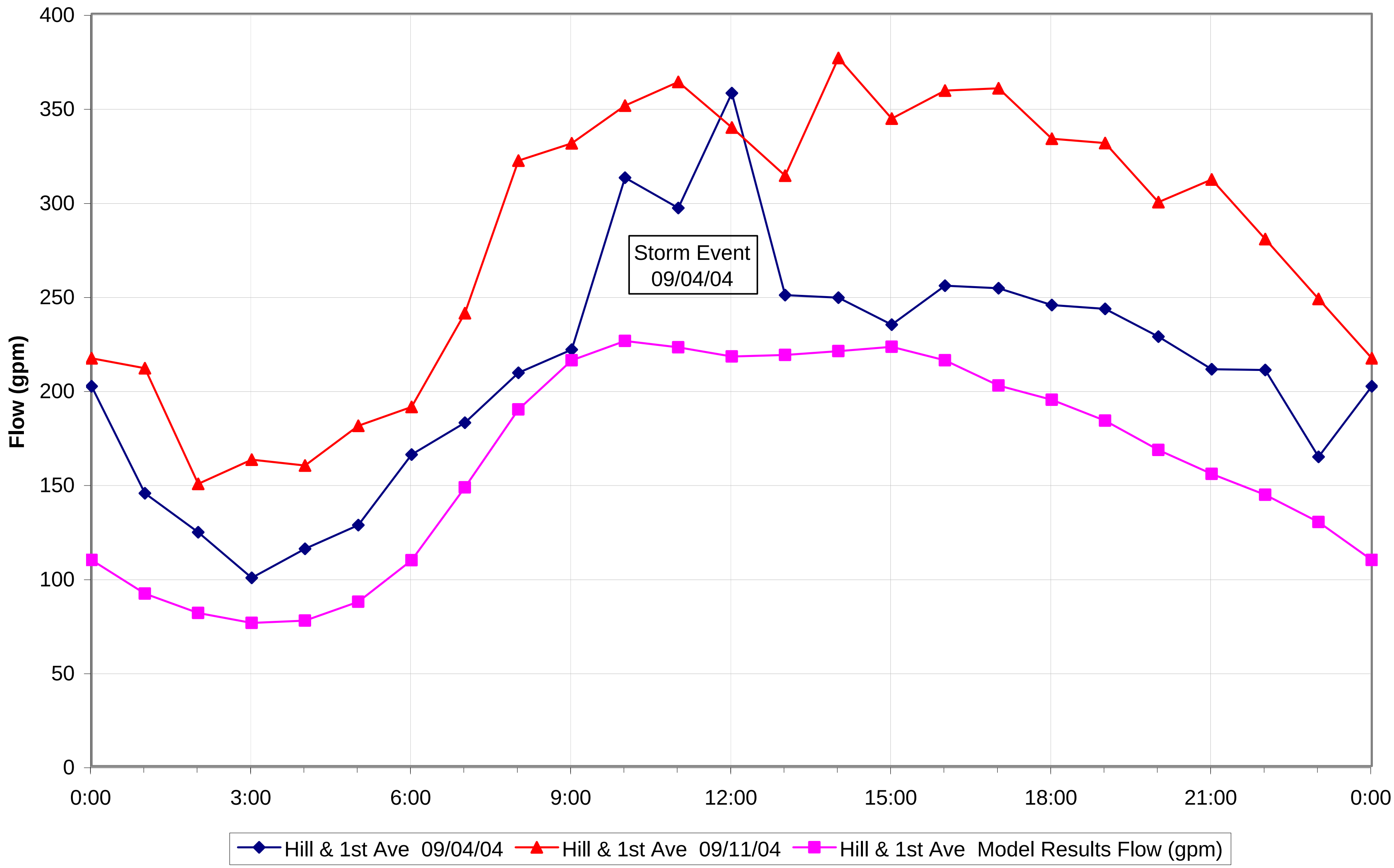


calibration graphs_1
2/18/2005

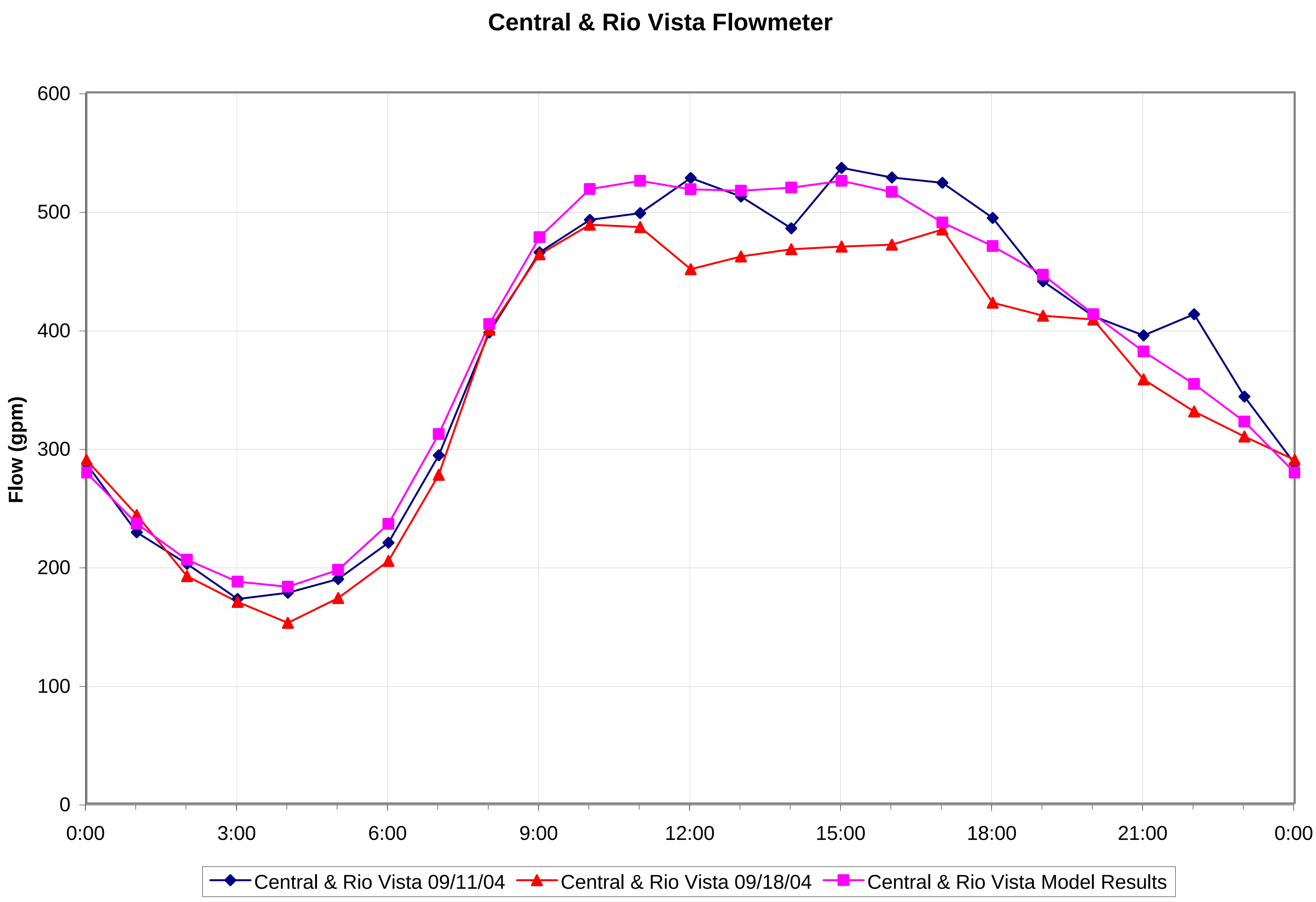


calibration graphs_1
2/18/2005

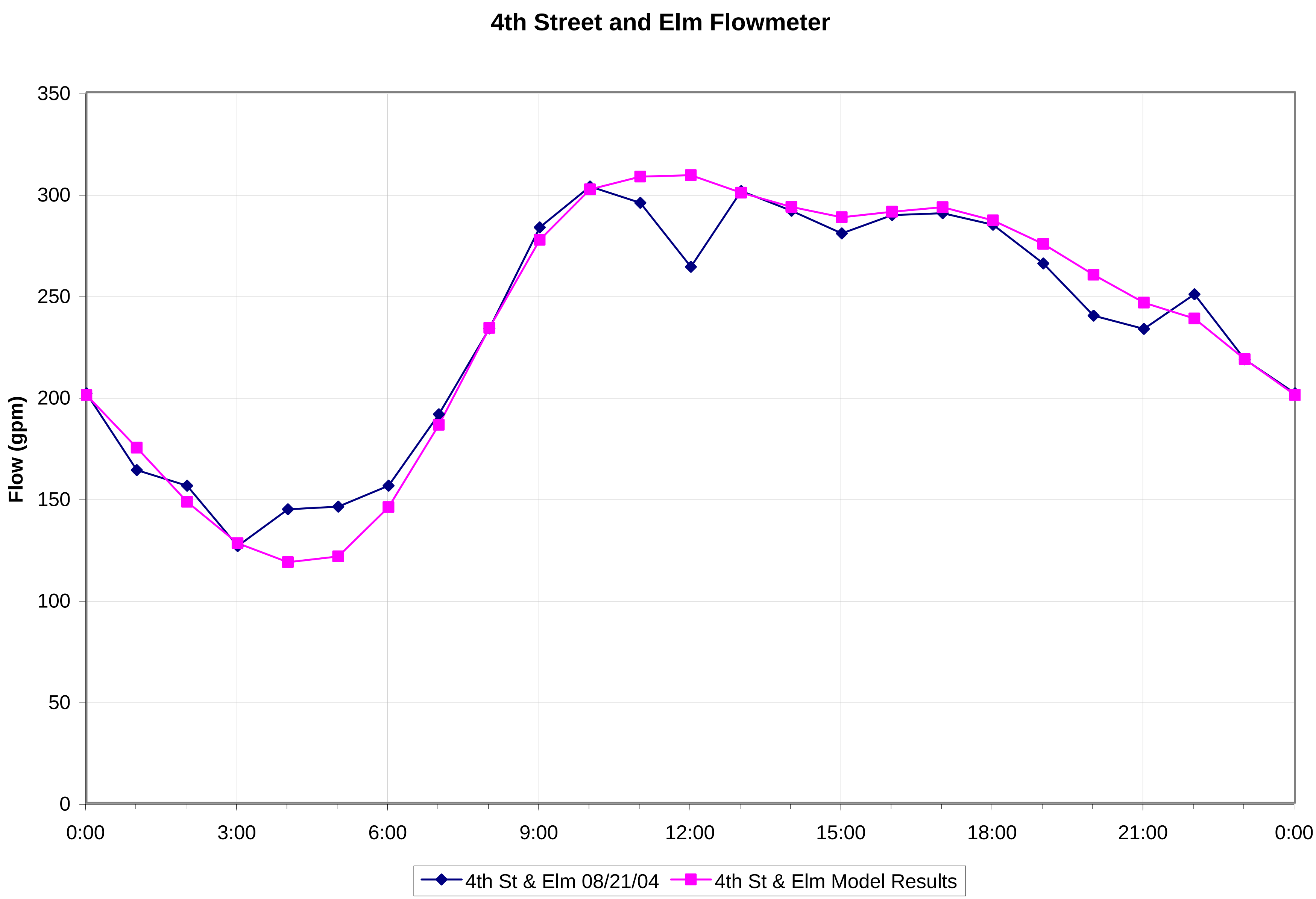
1st Street and Hill Flowmeter



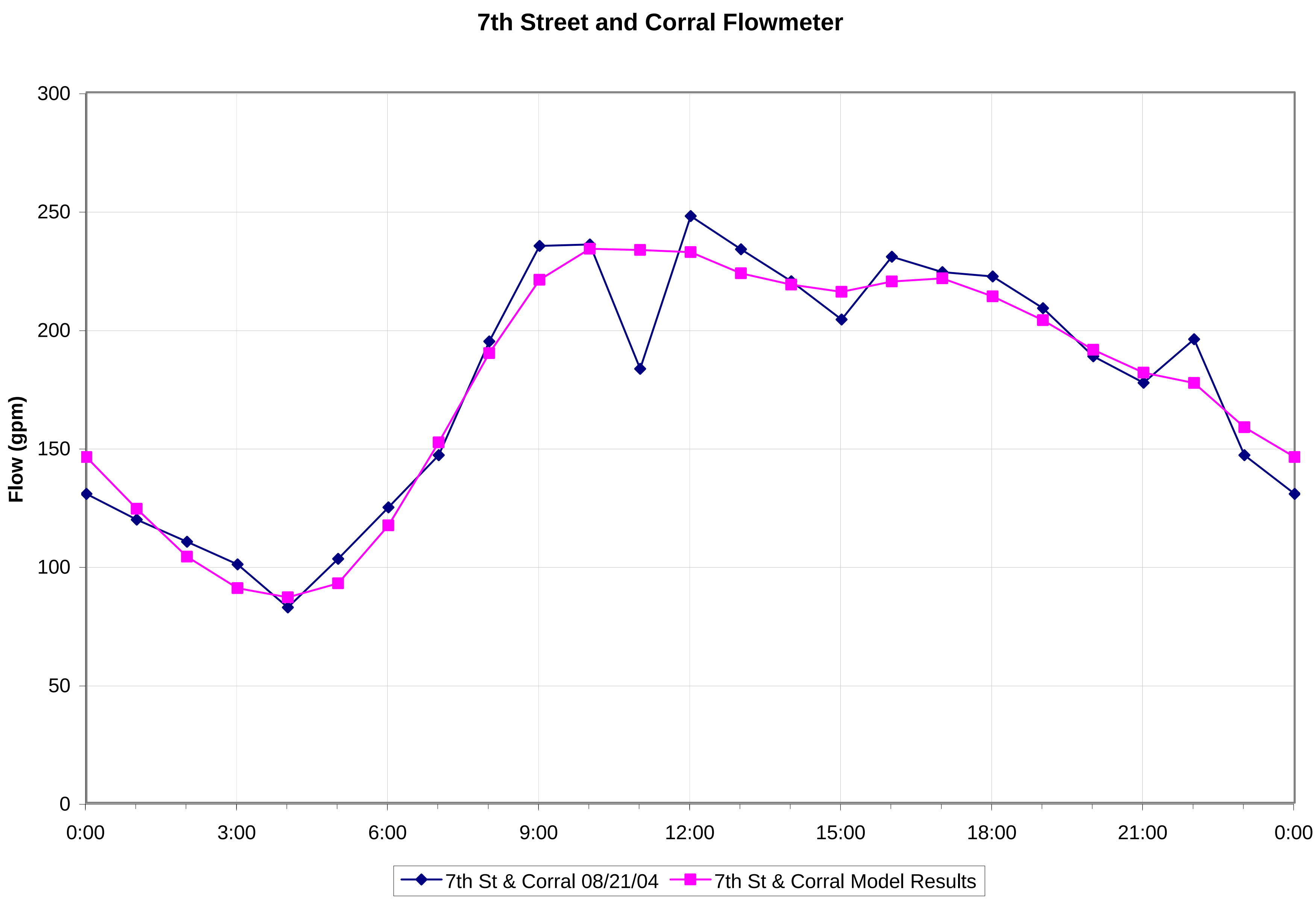
calibration graphs_1
2/18/2005



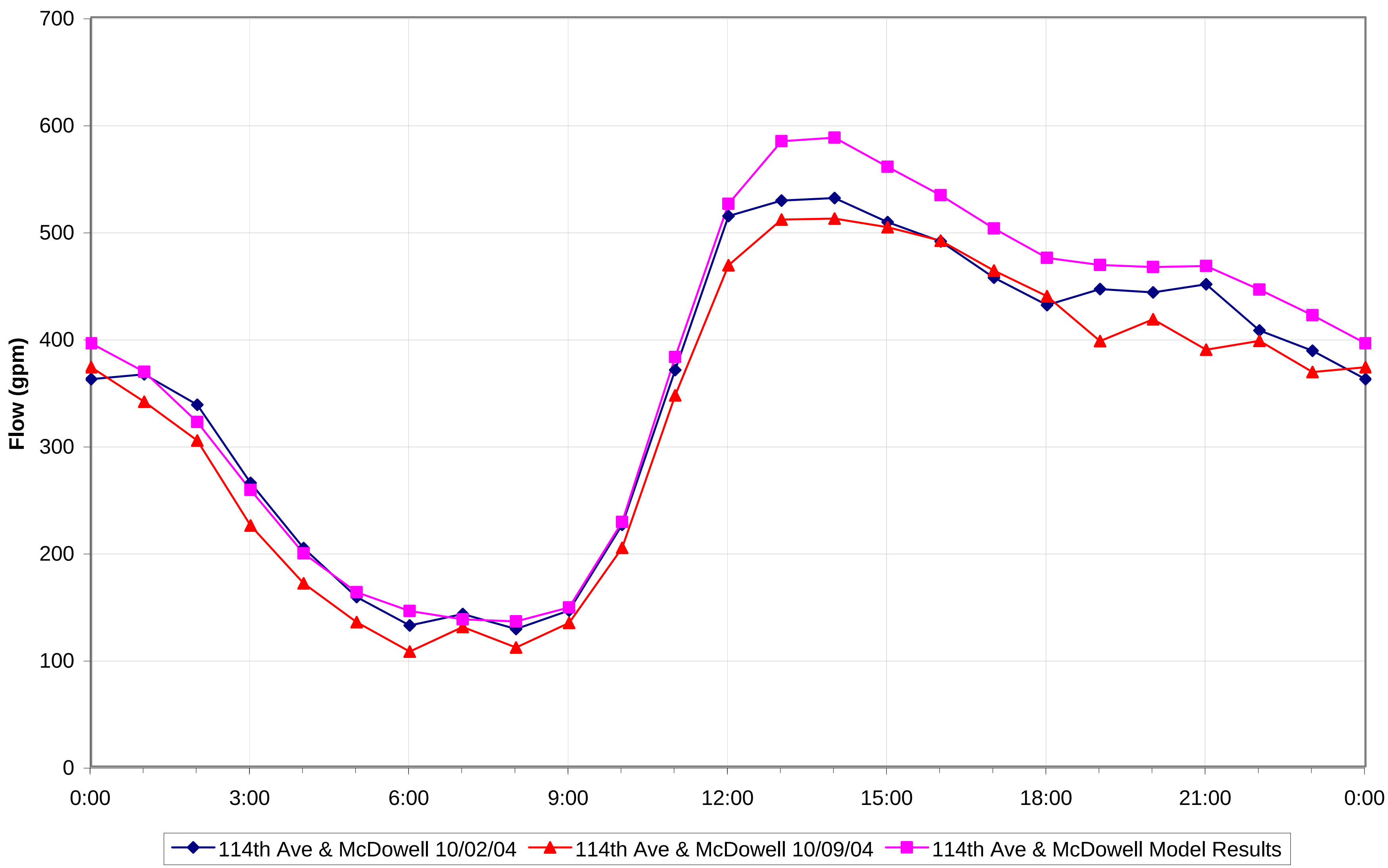
calibration graphs_1
2/18/2005



calibration graphs_1
2/18/2005

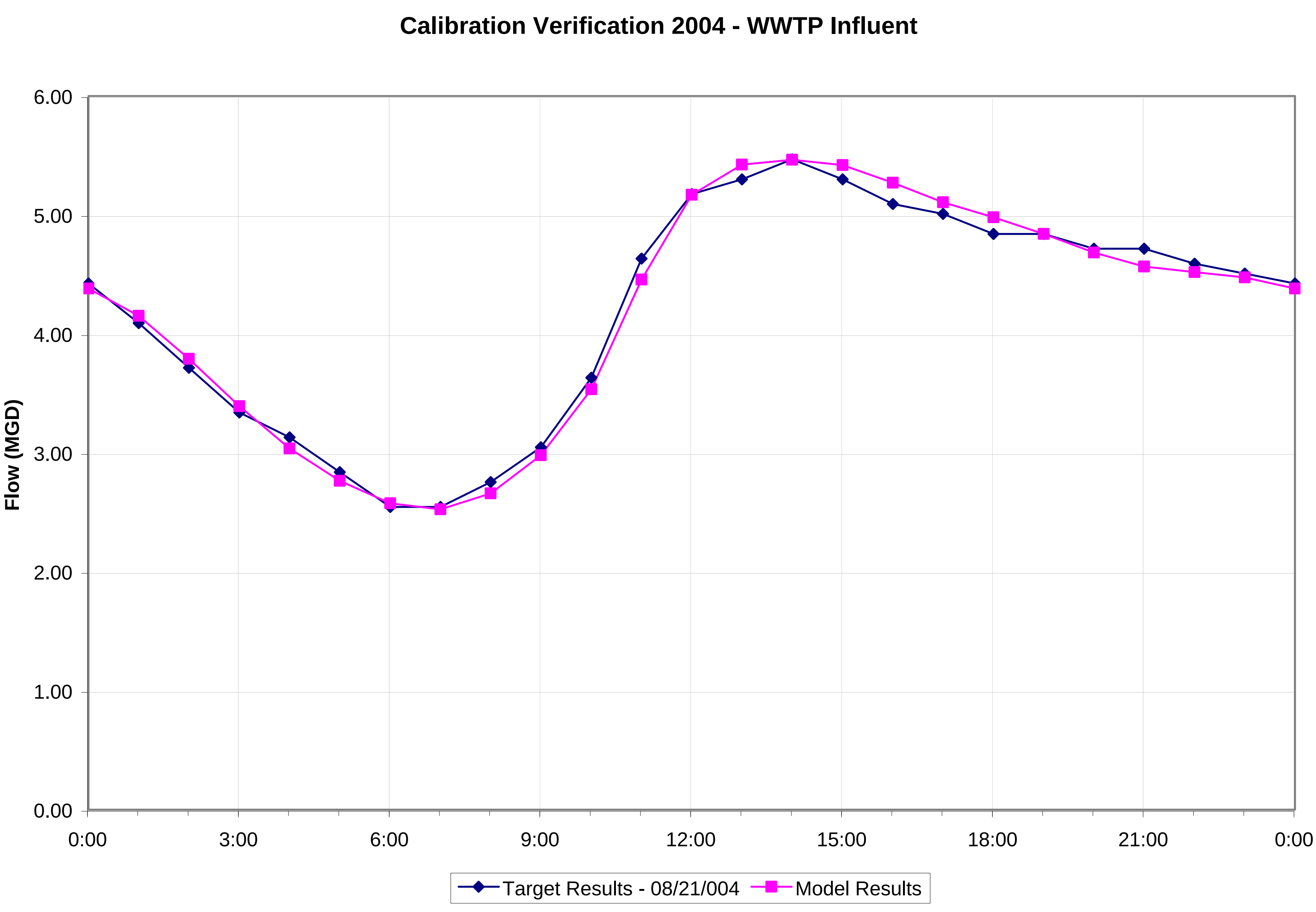

7th Street and Corral Flowmeter
Flow (gpm)
300
250
200
150
100
50
0
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
7th St & Corral 08/21/04
7th St & Corral Model Results

114th Avenue and McDowell Flowmeter

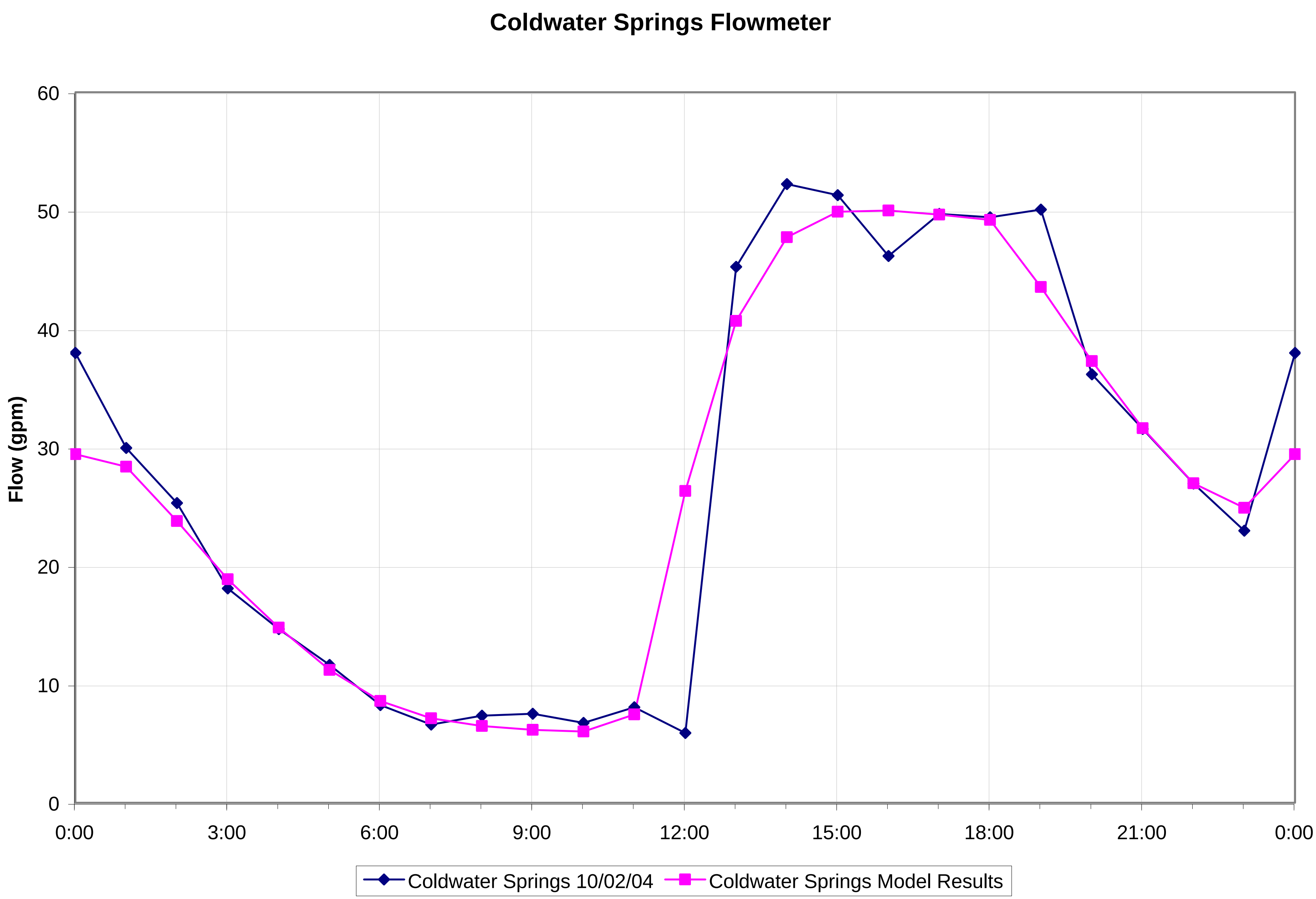


calibration graphs_1
2/18/2005

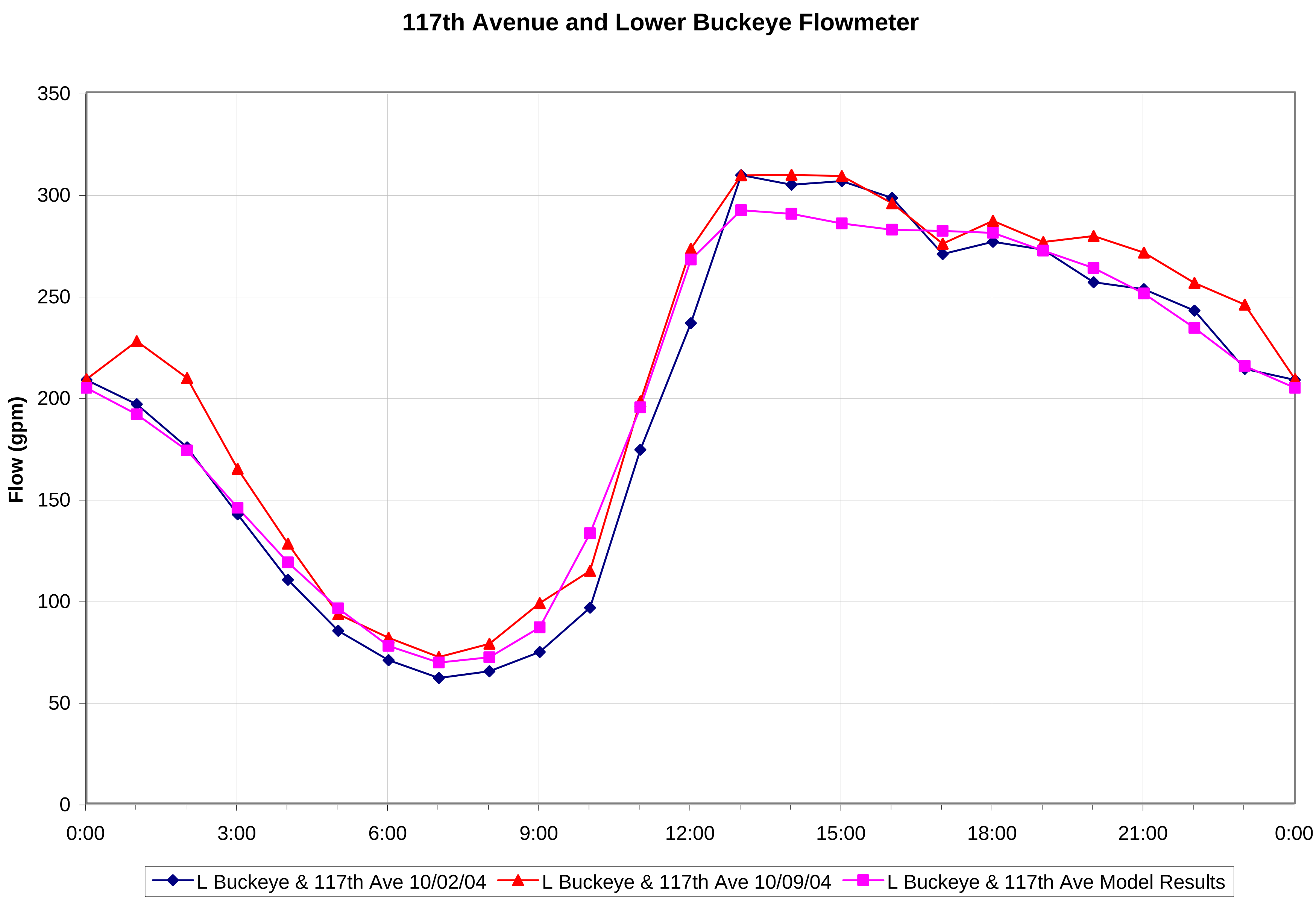
Calibration Verification 2004 - WWTP Influent



calibration graphs_1
2/18/2005

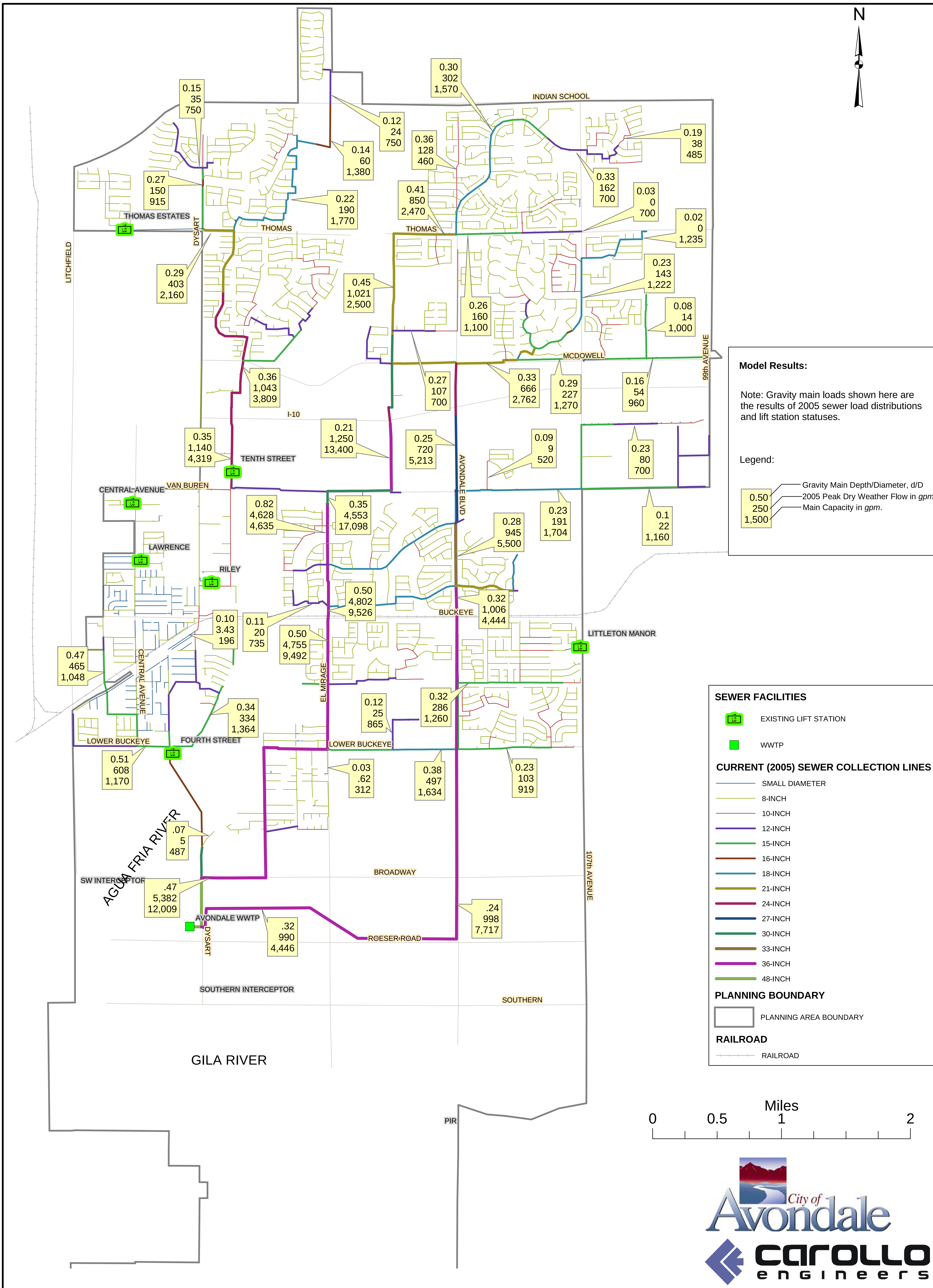


calibration graphs_1
2/18/2005


117th Avenue and Lower Buckeye Flowmeter
Flow (gpm)
350
300
250
200
150
100
50
0
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
L Buckeye & 117th Ave 10/02/04
L Buckeye & 117th Ave 10/09/04
L Buckeye & 117th Ave Model Results

MODEL SIMULATION RESULT FIGURES

APPENDIX E - KEY PRESSURES AND FIREFLOWS IN CURRENT (2005) POTABLE WATER DISTRIBUTION SYSTEM
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005



APPENDIX E - KEY GRAVITY MAIN LOADS IN CURRENT (2005) WASTEWATER COLLECTION SYSTEM
WASTEWATER COLLECTION SYSTEM MASTER PLAN AND UTILITY SYSTEMS ANALYSIS
FINAL REPORT, AUGUST 2005