City of Avondale

FINAL Report

Water Master Plan Update

Electronic copy of final document; sealed original document is with Timothy Francis 22684.

MAY 2013

00864027

MALCOLM PIRNIE | ARCADIS

The Water Division of ARCADIS

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May 10, 2013

Michael N. Smith, P.E., Water Resources CIP Engineer
Public Works Department, Water Resources Group
City of Avondale
399 East Lower Buckeye Road, Suite 100
Avondale, AZ 85323

Subject:
Water Master Plan Update
Final Report

Dear Mike:

Malcolm Pirnie, the Water Division of ARCADIS, is pleased to submit the *Water Master Plan Update* Final Report. The *Water Master Plan Update* builds upon and updates the recommendations made in the companion 2010 *Water Infrastructure Master Plan* by recommending water system improvements to improve service to current residents and businesses and to support future City growth. The City's water demand projection tool and water system hydraulic model were also updated to reflect current conditions.

The *Water Master Plan Update* includes brief text describing the updates made and includes only updated tables and figures. The tables and figures are numbered identical to the 2010 Water Infrastructure Master Plan for ease of comparison. The 2010 master plan should be referenced for any information or details not presented in this *Water Master Plan Update*.

We sincerely appreciate the assistance and guidance provided by the City's Water Resources Group during preparation of the *Water Master Plan Update*, and we look forward to continuing our working relationship in the future.

Sincerely,

ARCADIS U.S., Inc.

Timothy Francis, PE, BCEE
Principal Environmental Engineer
Project Manager

Enclosures
0864027.0000

City of Avondale, Arizona
399 East Lower Buckeye Road • Suite 100 • Avondale, AZ 85323

Water Master Plan Update

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Report Prepared By:

Malcolm Pirnie, *the Water Division of ARCADIS*

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Suite 1000
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Abbreviations/Acronyms

AACE	Association for the Advancement of Cost Engineering
BDL	below detection limit
CDPH	California Department of Public Health
CCI	Consumer Cost Index
CIP	Capital Improvement Plan
DBCP	Dibromochloropropane
ENR	Engineering News and Record
EPS	extended period simulation
GER	General Engineering Requirements
GIS	geographic information system
gpm	gallons per minute
IIPs	Infrastructure Improvement Plans
IRIS	Integrated Risk Information System
MCL	maximum contaminant level
MG	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
MPA	Municipal Planning Area
OEHHA	Office of Environmental Health Hazard Assessment
PHG	Public Health Goal
PIR	Phoenix International Raceway
ppb	parts per billion
ppt	parts per trillion
PRV	pressure reducing valve
psi	pounds per square inch
SRP	Salt River Project
TDS	total dissolved solids

UCMR3	Unregulated Contaminant Monitoring Rule
ug	microgram
USEPA	United States Environmental Protection Agency

Executive Summary

Abstract

The work conducted in this *Water Master Plan Update*, for the study area consisting of the City's Municipal Planning Area north of the Estrella Mountains, has identified water infrastructure improvements that the City should undertake to support existing residents and planned development through 2035. The recommended improvements include the following well projects:

- **2013 to 2017:** Additional Dibromochloropropane (DBCP) and nitrate treatment at Well #8A to increase its capacity from 2,000 gallons per minute (gpm) to 3,000 gpm, and provision of brine processing at Well #17 to address concerns related to high levels of total chromium in the backwash water.
- **2018 to 2022:** Construction of Wells #22 and #26 which are currently in the City's Capital Improvement Plan (CIP) and two additional new wells. Well #22 will be provided nitrate treatment because of nitrate levels in the nearby existing Coldwater wells.
- **2023 to 2035:** Connection of existing irrigation Well #16B to the potable distribution system, provision of total dissolved solids (TDS) treatment with pre-oxidation for Wells #21 and #28, and construction of five additional new wells.

The total capital costs for the wells and other new infrastructure (pipelines, storage reservoirs, booster station expansions, pressure reducing valves) are estimated to be $13 million for 2013 to 2017, $26.9 million for 2018 to 2022, and $60.5 million for 2023 to 2035.

Introduction

The City of Avondale last updated its *Water Resource Master Plan* and *Water Infrastructure Master Plan* in May 2010. The 2010 Master Plans included a recommended schedule of water system improvements to guide the City in improving service to current residents and businesses and to support future growth. There have been several changes in planning assumptions, as well as actual construction that has occurred, since completion of the 2010 master plans:

- A new General Plan has been adopted.
- Growth rates have changed from previous estimates.
- Well rehabilitation projects have been attempted with limited success, and groundwater quality remains a concern. Additional groundwater treatment should be incorporated into the recommended system improvements.

- Due to funding constraints and reduced demands, some new pipes have been installed with smaller diameters than those recommended in the 2010 master plans to extend service into new areas in the southern areas.

The purposes of this *Water Master Plan Update* project are to 1) incorporate changes in development and land use planning and new construction that have occurred since 2010, and 2) update the system improvement recommendations. This *Water Master Plan Update* report provides a summary update to the City's 2010 Master Plans and contains updated water demand projections, water production and distribution capacity requirements; and, updated recommendations for system improvements and capital cost opinions.

The study area for the *Water Master Plan Update* is the City's Municipal Planning Area (MPA) north of the Estrella Mountains. The City is projected to grow from a current (2012) population of approximately 80,100 to a little over 135,000 by 2035 within the project study area shown on Figure ES-1. The City has extended service to the Phoenix International Raceway (PIR) and has purchased the Rigby Water Company service area; thus, the former service areas of PIR and Rigby Water Company are included in the *Water Master Plan Update*. The City does not intend to serve the Liberty Water Company service area in the future, thus this service area is not included.

Updated Water Demand Projection Tool

The demand projection tool developed in 2010 was updated with modifications to existing and planned developments, and incorporation of the City's' 2030 General Plan land use plan. The updated land use map used for water demand projections is shown on Figure ES-2. The demand projection tool was then recalibrated to 2012 actual water production and to updated population and growth projections. The updated water demand projections, presented on Table ES-1, are nearly identical to the 2010 projections through 2022. From 2022 to 2035, the updated demand projections have a slower growth rate than the 2010 growth rate; however, the 2035 demand projections are nearly identical.

Development Build-out Projections

City estimates for development phasing and growth within the study area have not changed since 2010 and are shown on Figure ES-3. The 5-year growth area will include infill within the existing water system, generally the area north of Lower Buckeye Road. The 10-year growth area will generally include the area between Lower Buckeye Road and Roeser Road. The growth area beyond 10 years through build-out will include the remaining areas north of the Estrella Mountains.

Water Production Requirements

The City currently has 22 active and inactive wells. The active wells (currently 15 wells) are used to supply the potable water system. Two active wells (Well #5 and Well #16B) supply irrigation water and are not connected to the drinking water system. The total pumping capacity of the 15 active wells is 32.8 million gallons per day (mgd). The remaining inactive wells cannot be operated because they are currently planned and not yet constructed, have been capped, and/or because of water quality concerns. Table ES-1 compares the projected water demands against existing production capacity and summarizes the additional supply or production capacity required through 2035.

Table ES-1:
Water Demand Projections and Production Requirements

Parameters	2012	2017	2022	2035
Average Day Demand (mgd)	12.5	15.1	18.5	23.9
Maximum Day Demand (mgd)	20.6	24.9	30.5	39.4
Existing Active Well Supply (mgd)	32.8	32.8	32.8	32.8
Production Criteria				
Reliable Supply Needed (mgd)[1]	27.5	33.2	40.7	52.6
Additional Supply Required (mgd)	0	0.4	7.9	19.7

Notes:
(1) Governing criteria: system supply needed to fulfill the maximum day demand with all wells operating for 18 hours or less

Additional production capacity can be provided by improving treatment at existing wells, reactivation of existing wells that are inactive due to water quality concerns, completion of previously planned but not yet implemented wells, and with new wells identified in the 2010 master plans.

Table ES-2 presents an update of the assumptions for existing wells that were identified as inactive and/or have water quality concerns and includes the assumed use of each well, additional supply capacity to be provided, and recommended timeline for implementation.

Table ES-2:
Assumed Improvements to Existing Wells

Well No.	Current Status	Potential for Improvement	Assumption for Master Plan	Additional Supply Capacity (gpm)	Planning Period
#17	Active – Treatment Issues	- Concentrate backwash brine to minimize hazardous waste disposal	Provide brine processing	0	2013 - 2017
#8A	Active – Insufficient Treatment	- Provide additional nitrate (800 gpm) and DBCP (1,000 gpm) treatment to increase well capacity from 2,000 gpm to 3,000 gpm	Provide additional treatment	1,000	2013 - 2017
#16B	Active - Irrigation Well	- Connecting to potable system will increase well supply reliability	Connect to well transmission pipe for Coldwater Reservoir, with no treatment	650	2023 - 2035
#21	Inactive - Water Quality	- Distribution of high TDS prohibits rehabilitation - Re-drilling to target lower TDS may increase arsenic - Potential for blending with limited capacity	Treat for TDS, iron and manganese	900[1]	2023 - 2035
#28	Inactive - Under Construction	- Potential for blending with limited capacity	Treat for TDS	600[1]	2023 - 2035

Note: (1) 25 percent loss in capacity assumed for wells with TDS treatment.

The following priorities are recommended to provide additional production capacity in the future, all new wells are assumed to have a capacity of 1,200 gpm (1.7 mgd):

- **2013 to 2017:** The first priority wells are Wells #8A and #17 which currently receive treatment to reduce nitrate and DBCP to acceptable levels. Additional treatment for DBCP and nitrate is recommended to increase the capacity of Well #8A from 2,000 gpm to 3,000 gpm. To address concerns related to high levels of total chromium in the backwash water, brine processing will be provided at Well #17 (Well #17 will stay at its current capacity). These improvements will provide 1,000 gpm (1.4 mgd) of additional capacity by 2017.
- **2018 to 2022:** The next priority wells are those that have been planned previously but have not yet been implemented (Wells #22 and #26) and two new wells that were identified in the 2010 planning efforts. Because of nitrate levels in the existing Coldwater wells, nitrate treatment is assumed for Well #22. The four new wells will provide an additional production capacity of 6.8 mgd by 2022.
- **2023 to 2035:** The next priority wells are existing Wells #16B, #21 and #28; and, five new wells that were identified in the 2010 planning efforts. Well #16B is an existing irrigation well that can be connected to the potable distribution system. Wells #21 and #28 have elevated TDS and will be assumed to be provided with TDS

treatment. Oxidation prior to membrane treatment was included to aid in the removal of other constituents present in these wells including iron, manganese and arsenic. Wells #21 and #28 are required to fill the Del Rio reservoir to serve future demands in the southern areas. The added existing and new wells will provide an additional production capacity of 11.6 mgd by 2035.

It is assumed that new wells will be drilled and screened in appropriate locations such that arsenic, nitrate, and TDS levels are below the City's water quality goals and treatment will not be needed. Figure ES-4 presents all existing and recommended new wells located in areas of favorable groundwater quality developed from the hydrogeologic evaluation contained in the 2010 *Water Resource Master Plan*.

Storage Requirements

The inventory of existing storage was updated by determining the usable storage of each reservoir based on allowable operating levels. The City's existing usable system storage totals 11.3 million gallons (MG) at six water supply facilities. However, the Del Rio Reservoir is currently inactive due to deteriorated conditions and reduces the existing usable system storage capacity to 8.5 MG. Table ES-2b summarizes the projected system storage needs through 2035.

Table ES-2b:
Storage Requirements

Parameters	2012	2017	2022	2035
Average Day Demand (mgd)	12.5	15.1	18.5	23.9
Maximum Day Demand (mgd)	20.6	24.9	30.5	39.4
Peak Hour Demand (mgd)	32.4	39.1	47.9	61.9
Fire Flow (MG) - 3,500 gpm for 4 hours	0.8	0.8	0.8	0.8
Total Production Capacity (mgd)	27.5	33.2	40.7	52.6
Existing Storage Capacity (MG)	8.5	8.5	8.5	8.5
Storage Criteria				
Peak Hour Storage Needed (MG)[1]	6.2	7.5	9.2	11.9
Additional Storage Required (MG)	**0.0**	**0.0**	**0.7**	**3.4**

Notes:
(1) Governing criteria: satisfy peak hour demand for four hours with 50% source capacity and 50% storage capacity

The reservoir at Del Rio is recommended to be rehabilitated in the next five years. It is assumed that the reservoir will be rehabilitated to its current configuration and will, thus, return to service its usable storage capacity of 2.8 MG. This will provide enough storage through 2022. An additional 1.0 MG of storage is recommended in the 2023 to 2035 time period at the Coldwater site where space is available.

Booster Pumping Requirements

The inventory of booster pumping capacity was updated and the projected booster pumping requirements were reevaluated. Table ES-2c presents the updated booster pumping requirements.

Table ES-2c:
Booster Pumping Requirements

Booster Station	Firm Capacity (mgd)			
	2012	2017	2022	2035
Average Day Demand (mgd)	12.5	15.1	18.5	23.9
Existing Booster Pumping Firm Capacity (mgd)	40.2	40.2	40.2	40.2
Booster Pumping Criteria				
Peak Hour Demand (mgd)[1]	32.4	39.1	47.9	61.9
Additional Booster Pumping Required (mgd)	**0**	**0**	**7.7**	**21.7**

Notes:
(1) Governing criteria: Peak Hour = 2.59 times Average Day Demand

With the Del Rio reservoir being rehabilitated, the boosters at Del Rio (8.6 mgd firm capacity) will become available to use by 2017, which will provide sufficient booster pumping through 2022. An additional 13 mgd of firm booster pumping capacity is recommended to be added in the 2023 to 2035 time period at the Rancho Santa Fe, Northside and Coldwater booster stations.

Recommended System Improvements for 2013 - 2017

The recommended system improvements for the 5-year planning period are shown on Figure ES-5 and summarized in Table ES-3, along with capital cost opinions. The improvements are needed to increase the capacity and robustness of the existing system and to provide connections for new development:

- Completion of a 16-inch loop (P-1 and P-2) in the northwest area of the City.
- New pipes (P-3 to P-9) in the northeast area of the City to support planned commercial development assumed to occur by 2017.
- New pipes (P-10 to P-20) northwest and northeast of Avondale Boulevard and Van Buren Street to provide better fire flow for areas planned for increased commercial development.
- Improvement of pipes in the "old town" area to increase capacity by replacing existing pipes with new pipes (P-22)
- New pipes (P-24, P-25 and P-28) and a pressure reducing valve (PRV-1) north and south of Lower Buckeye Road to improve service in the area.
- Increase the capacity of the existing 8-inch pipe at the junction of El Mirage Road and Lower Buckeye Road by providing an 8-inch parallel pipe (P-30).
- Rehabilitation of the Del Rio reservoir (R-1).
- Increased DBCP and nitrate treatment at Gateway to increase the capacity of Well #8A (W-8A).
- Addition of brine processing at Well #17 (W-17).

As the Del Rio reservoir lacks a well supply, it is assumed that the Del Rio booster station will be filled with system water during non-peak hours and be operated sparingly to meet peak demands during this time period.

Table ES-3:
Recommended Infrastructure (2013-2017)

Project No.	Description		Location	Cost ($)[1,2,3]
Distribution System Pipes				
P-1	16-inch	2,556 LF	Indian School Rd from Santa Fe Trail to Dysart Rd[4]	$650,000
P-2	16-inch	1,310 LF	Dysart Rd from Fairmont Ave to Indian School Rd[4]	$333,000
P-3	12-inch	2,733 LF	103rd Ave from Orange Blossom Ln to Thomas Rd	$548,000
P-4	12-inch	2,629 LF	Osborn Rd from 99th Ave to 103rd Ave	$421,000
P-5	16-inch	5,280 LF	99th Ave from Thomas Rd to Indian School Rd	$1,140,000
P-7	16-inch	2,664 LF	99th Ave from Encanto Blvd to Thomas Rd[4]	$575,000
P-9	16-inch	1,748 LF	Indian School Rd from 99th Ave to 103rd Ave	$444,000
P-10	12-inch	960 LF	111th Ave from Roosevelt St to I -10	$154,000
P-11	16-inch	2,621 LF	Roosevelt St from 107th Ave to 111th Ave	$566,000
P-12	16-inch	788 LF	111th Ave from Pierce Pkwy to Roosevelt St	$170,000
P-13	12-inch	1,463 LF	Coldwater Sp from 113th Ave to W Civic Dr	$234,000
P-14	12-inch	600 LF	113th Ave from Coldwater Sp to Van Buren St	$96,000
P-15	12-inch	1,294 LF	117th Ave from Van Buren St to Roosevelt St	$207,000
P-16	12-inch	1,343 LF	Roosevelt St from Avondale Blvd to 117th Ave[4]	$215,000
P-17	16-inch	688 LF	117th Ave from Roosevelt St due North[4]	$149,000
P-18	12-inch	1,521 LF	119th Ave from Roosevelt St to I-10	$244,000
P-19	12-inch	1,735 LF	Roosevelt St from 120th Ave to El Mirage Rd	$278,000
P-20	16-inch	1,357 LF	Roosevelt St from 117th Ave to 119th Ave[4]	$293,000
P-22	12-inch	767 LF	4th St from E La Canada Blvd to La Vista Dr	$153,700
P-24	16-inch	2,000 LF	127th Ave from Vermeesch Rd to Lower Buckeye Rd[4]	$432,000
P-25	8-inch	1,867 LF	125th Ave from Durango Rd due South[4]	$203,000
P-28	12-inch	1,375 LF	Dysart Rd from Lower Buckeye Rd to Whyman Rd[4]	$275,500
P-29	12-inch	35 LF	Van Buren St and 10th St	$7,100
P-30	8-inch	46 LF	El Mirage Rd and Lower Buckeye Rd	$6,800
Well Transmission Mains				
W-8A	1.4 mgd	DBCP Treatment	Well #8A - 99th Ave and Encanto Blvd[4]	$1,027,000
	1.2 mgd	Nitrate Treatment	Well #8A - 99th Ave and Encanto Blvd[4]	$1,013,000
W-17	1.7 mgd	Brine Processing	Well #17 - 107th Ave and W Lakeshore Dr	$479,000
Booster Pump Stations				
None				
Pressure Reducing Valves				
PRV-1	16 inch	-	On S Vermeersch Rd near W Illini St	$100,000
Reservoirs				
R-1	3.5 MG (Usable - 2.8 MG)	Rehab Tank	Del Rio	$2,580,000
Total				**$13,000,000**

(1) February 2013 Costs (Engineering News and Record Consumer Cost Index (ENR CCI) = 9,453)
(2) Unit capital costs include engineering/design, materials of construction, installation, contractor overhead & profit, engineering & construction administration (20%) and contingencies (30%)
(3) Pipeline unit costs varied for developed and undeveloped areas

(4) Present in City's Current CIP

Recommended System Improvements for 2017 - 2022

The recommended system improvements for the 10-year planning period are shown on Figure ES-6 and summarized in Table ES-4, along with capital cost opinions. The system improvements are required to serve increased demand and to serve the development area generally between Lower Buckeye Road and Roeser Road:

- New pipe (P-31) in the northeast area of the City to support increased demand in the planned commercial development area.
- New pipes (P-32 to P-34) to serve commercial areas west of the Aqua Fria River.
- New pipes (P-35 to P-55) to serve the new developments in the southern areas.
- Two new PRVs (PRV-2 and PRV-3) to serve areas south of Lower Buckeye Rd.
- Two new wells (Well-A and Well-E) and two wells that are currently planned and in the City's CIP (Wells #22 and #26) to provide additional production capacity. New well W-A will be connected to the Northside reservoir, and new Well-E will connect to Coldwater via the transmission line near Well #16. Nitrate treatment (1,200 gpm) is assumed for Well #22 to allow greater flexibility when operating the Coldwater wells.
- New transmissions mains to transport water from the new wells (W-A and W-E) to the reservoirs at the Coldwater and Northside facilities.

The Del Rio booster station will be available as a secondary supply for emergency for peak demands and filled using system water during low demand periods.

Table ES-4:
Recommended Infrastructure (2018-2022)

Project No.	Description		Location	Cost ($)[1,2,3]
Distribution System Pipes				
P-31	12-inch	2,784 LF	103rd Ave from Thomas Rd to Mulberry Dr	$558,000
P-32	16-inch	6,954 LF	West of Aqua Fria River from Broadway Rd to Lower Buckeye Rd	$1,500,000
P-33	8-inch	1,630 LF	Elwood St from Aqua Fria River to Litchfield Rd	$177,000
P-34	8-inch	989 LF	Broadway Rd from Aqua Fria River to Litchfield Rd	$108,000
P-35	12-inch	5,213 LF	Roeser Rd from El Mirage Rd to Dysart Rd	$834,000
P-36	12-inch	2,077 LF	127th Ave from Broadway Rd to Illini St	$333,000
P-37	12-inch	2,690 LF	127th Ave from Roeser Rd to Broadway Rd	$431,000
P-38	16-inch	5,209 LF	Broadway Rd from El Mirage Rd to Dysart Rd	$1,130,000
P-39	16-inch	2,680 LF	El Mirage Rd from Roeser Rd to Broadway Rd[4]	$578,000
P-40	16-inch	2,019 LF	El Mirage Rd from Broadway Rd to Illini St[4]	$436,000
P-41	12-inch	5,285 LF	Elwood Rd from Avondale Blvd to El Mirage Rd	$845,000
P-42	16-inch	5,282 LF	Broadway Rd from Avondale Blvd to El Mirage Rd	$1,140,000
P-43	12-inch	5,232 LF	119th Ave from Broadway Rd to Lower Buckeye Rd	$837,000
P-44	12-inch	2,691 LF	119th Ave from Roeser Rd to Broadway Rd	$431,000
P-46	12-inch	5,227 LF	Roeser Rd from Avondale Blvd to El Mirage Rd	$836,000

Project No.	Description		Location	Cost ($)[1,2,3]
P-48	12-inch	5,117 LF	Elwood Rd from 107th Ave to Avondale Blvd	$819,000
P-49	12-inch	1,435 LF	111th Ave from Elwood St to Miami Rd	$230,000
P-50	16-inch	1,432 LF	107th Ave from Broadway Rd Due North	$309,000
P-51	16-inch	5,098 LF	Broadway Rd from 107th Ave to Avondale Blvd	$1,300,000
P-52	16-inch	2,667 LF	107th Ave from Roeser Rd to Broadway Rd	$678,000
P-53	12-inch	2,659 LF	111th Ave from Roeser Rd to Broadway Rd	$426,000
P-55	12-inch	3,321 LF	Dysart Rd from Southern Ave to Roeser Rd [4]	$666,000
Wells and Transmission Mains				
W-A	1.7 mgd	New Well	Well A - Thomas Rd and Santa Fe Blvd	$2,420,000
	12-inch	6,965 LF	El Mirage Rd from Well W A to Northside Reservoir	$1,400,000
W-E	16-inch	1,729 LF	Aqua Fria River from Well E to Well #16 Connection	$440,000
	1.7 mgd	New Well	Well E - McDowell Rd and El Mirage Rd (Pecan Tree Trailer Park)	$2,420,000
W-22	1.7 mgd	New Well	Well W-22 - Avondale Blvd and Van Buren Blvd[4]	$1,500,000
		Nitrate Treatment	Well W-22 - Avondale Blvd and Van Buren Blvd[4]	$1,440,000
W-26	1.7 mgd	New Well	Well W-26 - I-10/Agua Fria River[4]	$2,420,000
Booster Pump Stations				
None				
Pressure Reducing Valves				
PRV-2	16 inch	-	On El Mirage Rd near W Illini St	$100,000
PRV-3	16 inch	-	On 107th Ave near W Jones Rd	$100,000
Reservoirs				
None				
Total				**$26,900,000**

Notes:

(1) February 2013 Costs (ENR CCI = 9,453)

(2) Unit capital costs include engineering/design, materials of construction, installation, contractor overhead & profit, engineering & construction administration (20%) and contingencies (30%)

(3) Pipeline unit costs varied for developed and undeveloped areas

(4) Present in City's Current CIP

Recommended System Improvements for 2023 - 2035

The recommended system improvements for 2023 to 2035 are shown on Figure ES-7 and are summarized in Table ES-5, along with capital cost opinions. The improvements are required to serve all areas north of the Estrella Mountains and to complete looping in the entire system to provide additional reliability.

- New pipes (P-57 to P-59) for the Phase II development of City Center.
- New pipes (P-61 to P-80) to serve the remaining new developments south of Roeser Road.
- Connect Well #16B to the potable system and provide TDS treatment with pre-oxidation at Wells #21 and #28 to increase production capacity.
- Five new wells (W-B, W-C, W-D, W-F, and W-G) to provide additional production capacity, and associated new and/or improved well transmissions mains from the new wells to the Coldwater, Garden Lakes, and Gateway reservoirs.

- Increased capacity at Rancho Santa Fe, Northside and Coldwater (BPS-1 to BPS-3) to meet increased demand and pressure requirements.
- Addition of a new 1 MG reservoir at Coldwater needed to provide additional system storage.

Table ES-5:
Recommended Infrastructure (2023 - 2035)

Project No.	Description		Location	Cost ($)[1,2,3]
Distribution System Pipes				
P-57	8-inch	4,607 LF	City Center	$674,000
P-58	16-inch	1,508 LF	City Center	$383,000
P-59	12-inch	1,295 LF	City Center	$260,000
P-60	6-inch	110 LF	El Mirage Rd and Elwood Rd	$13,100
P-61	12-inch	2,657 LF	Roeser Rd from Dysart Rd to Aqua Fria River	$425,000
P-62	16-inch	3,934 LF	Southern Ave from Dysart Rd to Aqua Fria River	$849,000
P-63	16-inch	1,302 LF	Southern Ave from 129th Ave to Dysart Rd[4]	$281,000
P-64	16-inch	3,946 LF	Southern Ave from El Mirage Rd to 129th Ave[4]	$851,000
P-65	12-inch	2,542 LF	127th Ave from Southern Ave to Roeser Rd	$407,000
P-66	16-inch	2,547 LF	El Mirage Rd from Southern Ave to Roeser Rd[4]	$549,000
P-67	16-inch	5,963 LF	El Mirage Rd from Indian Springs Rd to Southern Ave[4]	$1,290,000
P-69	12-inch	2,579 LF	119th Ave from Southern Ave to Roeser Rd	$413,000
P-75	16-inch	6,717 LF	Indian Springs Rd from El Mirage Rd to 143rd Ave	$1,450,000
P-76	16-inch	2,007 LF	Coyote Ln from Mountain Rd to Indian Springs Rd	$433,000
P-77	16-inch	889 LF	Coyote Ln from Mountain Rd Due South	$192,000
P-78	12-inch	5,163 LF	Mountain Rd from Coyote Ln to Dysart Rd	$826,000
Project No.	**Description**		**Location**	**Cost ($)[1,2,3]**
P-79	12-inch	3,187 LF	City of Avondale Boundary from Mountain Rd to Indian Springs Rd	$510,000
P-80	12-inch	2,915 LF	Aqua Fria River from Southern Ave to Roeser Rd	$466,000
Wells and Transmission Mains				
W- 16B	1.0 mgd	Convert to Potable	Well #16B - Friendship Park	$120,000
W-21	1.7 mgd	TDS Treatment with pre-oxidation	Well #21- El Mirage Rd and Durango Rd	$13,760,000
W-28	1.1 mgd	TDS Treatment with pre-oxidation	Well #28 - 117th Ave and Whyman Ave	$8,900,000
W-B	1.7 mgd	New Well	Well B - 119th Ave and McDowell Rd	$2,420,000
	16-inch	2,090 LF	Aqua Fria River from Coldwater Reservoir to Well #26	$531,000
	12-inch	2,560 LF	McDowell Rd from Well B to Well E	$512,800
W-C	1.7 mgd	New Well	Well C - 107th Ave and Roosevelt Rd	$2,420,000
	12-inch	2,310 LF	107th Ave from Well C to McDowell Rd	$463,000
W-D	1.7 mgd	New Well	Well D - 107th Ave and McDowell Rd[4]	$2,420,000
	16-inch	2,875 LF	McDowell Rd from 103rd Ave to 107th Ave	$731,000
	12-inch	2,600 LF	103rd Ave from McDowell Rd to Gateway Reservoir	$521,000
W-F	1.7 mgd	New Well	Well F - El Mirage Rd North of Van Buren St[4]	$2,420,000
W-G	1.7 mgd	New Well	Well G - 119th Ave and Thomas Rd	$2,420,000
	12-inch	6,980 LF	Thomas Rd from Well G to Garden Lakes Reservoir	$1,399,000

Project No.	Description		Location	Cost ($)[1,2,3]
Booster Pump Stations				
BPS-1	5.8 mgd	@ 163 ft	Rancho Santa Fe Booster Pump Station	$3,526,000
BPS-2	2.9 mgd	@ 131 ft	Northside Booster Pump Station	$1,763,000
BPS-3	5.8 mgd	@ 150 ft	Coldwater Booster Station	$3,526,000
Pressure Reducing Valves				
None				
Reservoirs				
R-2	1.0 MG	New Reservoir	Coldwater	$2,293,000
Total				**$60,500,000**

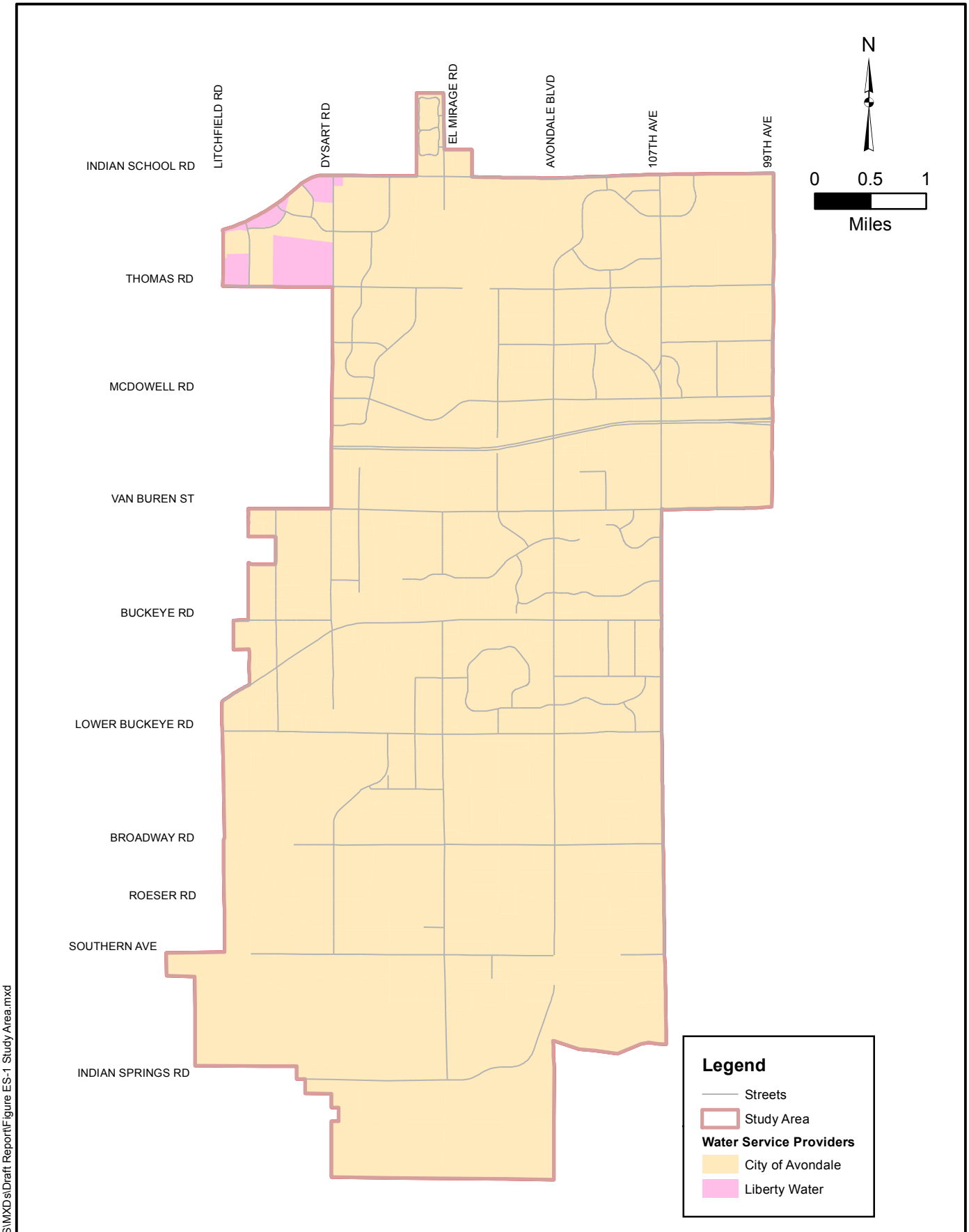
Notes:

(1) February 2013 Costs (ENR CCI = 9,453)

(2) Unit capital costs include engineering/design, materials of construction, installation, contractor overhead & profit, engineering & construction administration (20%) and contingencies (30%)

(3) Pipeline unit costs varied for developed and undeveloped areas

(4) Present in City's Current CIP



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure ES-1 Study Area.mxd

CITY OF AVONDALE, ARIZONA
WATER MASTER PLAN UPDATE

Study Area

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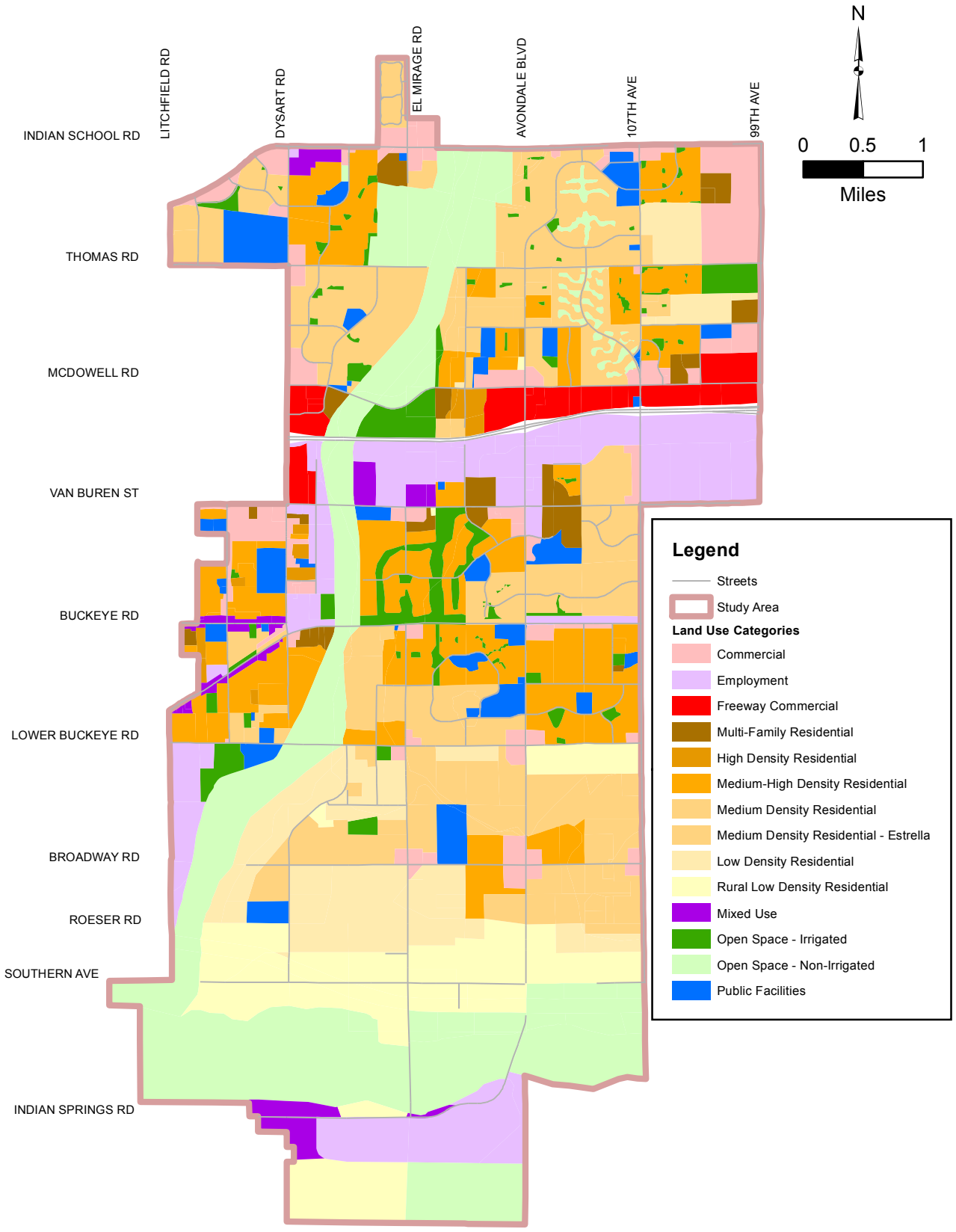
The Water Division of ARCADIS

May 2013
FIGURE ES-1



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure ES-2 Land Use Map for Study Area.mxd

City of Avondale

CITY OF AVONDALE, ARIZONA
WATER MASTER PLAN UPDATE

Land Use Map for Study Area

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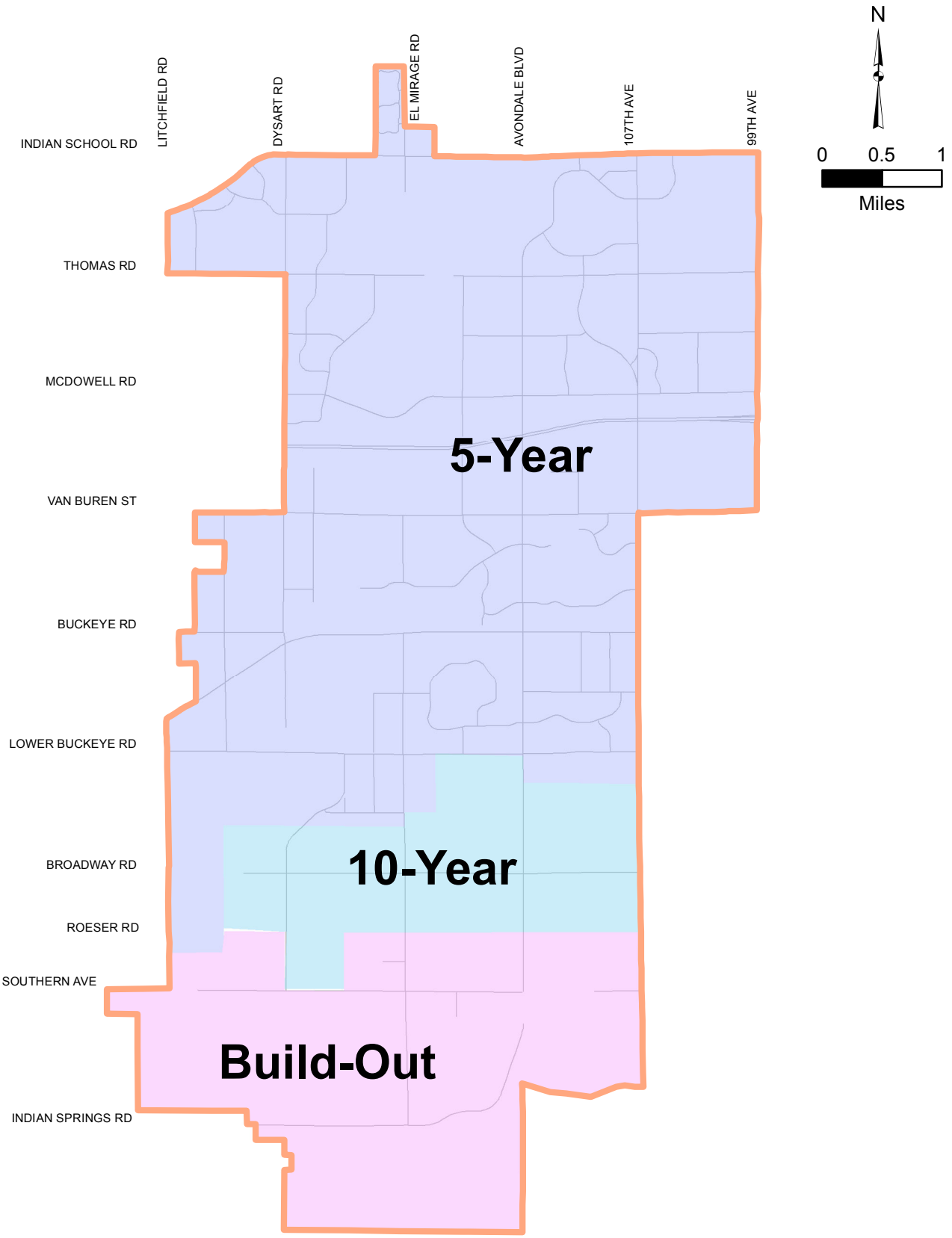
FIGURE ES-2



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure ES-3 Development and Growth Phasing.mxd

CITY OF AVONDALE, ARIZONA
WATER MASTER PLAN UPDATE

Development and Growth Phasing

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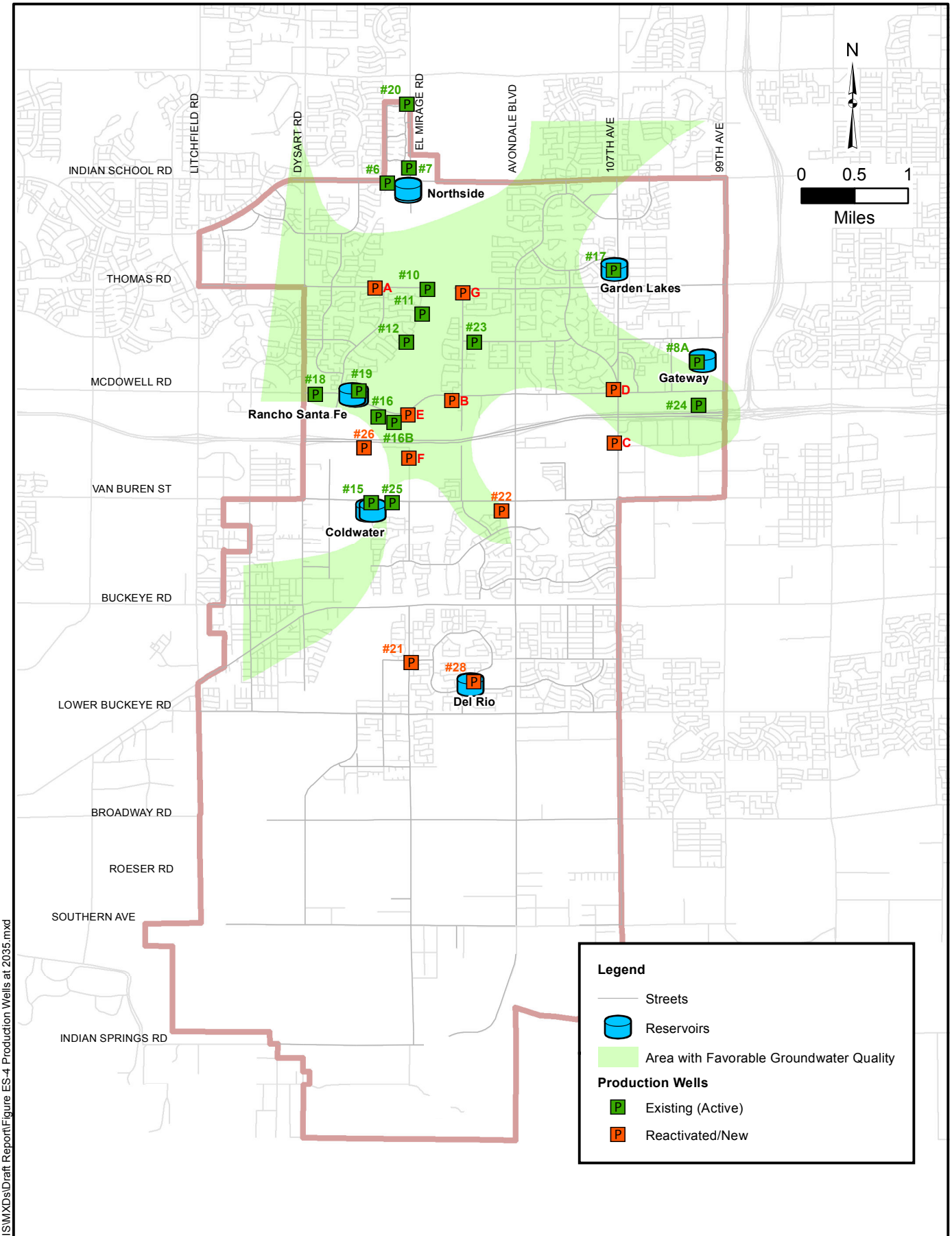
FIGURE ES-3



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure ES-4 Production Wells at 2035.mxd

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WATER MASTER PLAN UPDATE

Production Wells at 2035

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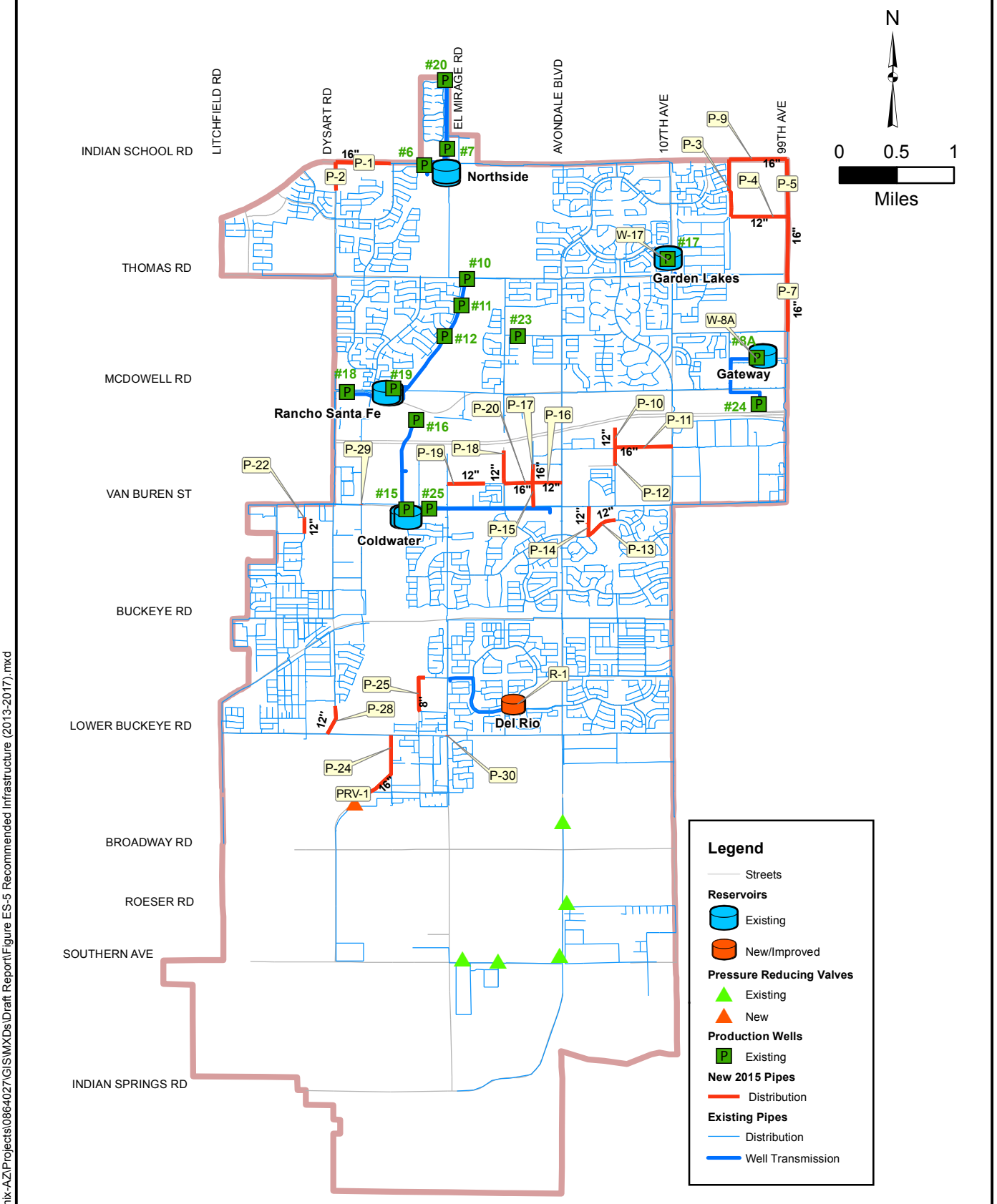
FIGURE ES-4



\\arcadis-us.com\OfficeData\Phoenix-AZ\Projects\08640027\GIS\MXDs\Draft Report\Figure ES-5 Recommended Infrastructure (2013-2017).mxd

CITY OF AVONDALE, ARIZONA
WATER MASTER PLAN UPDATE

Recommended Infrastructure (2013-2017)

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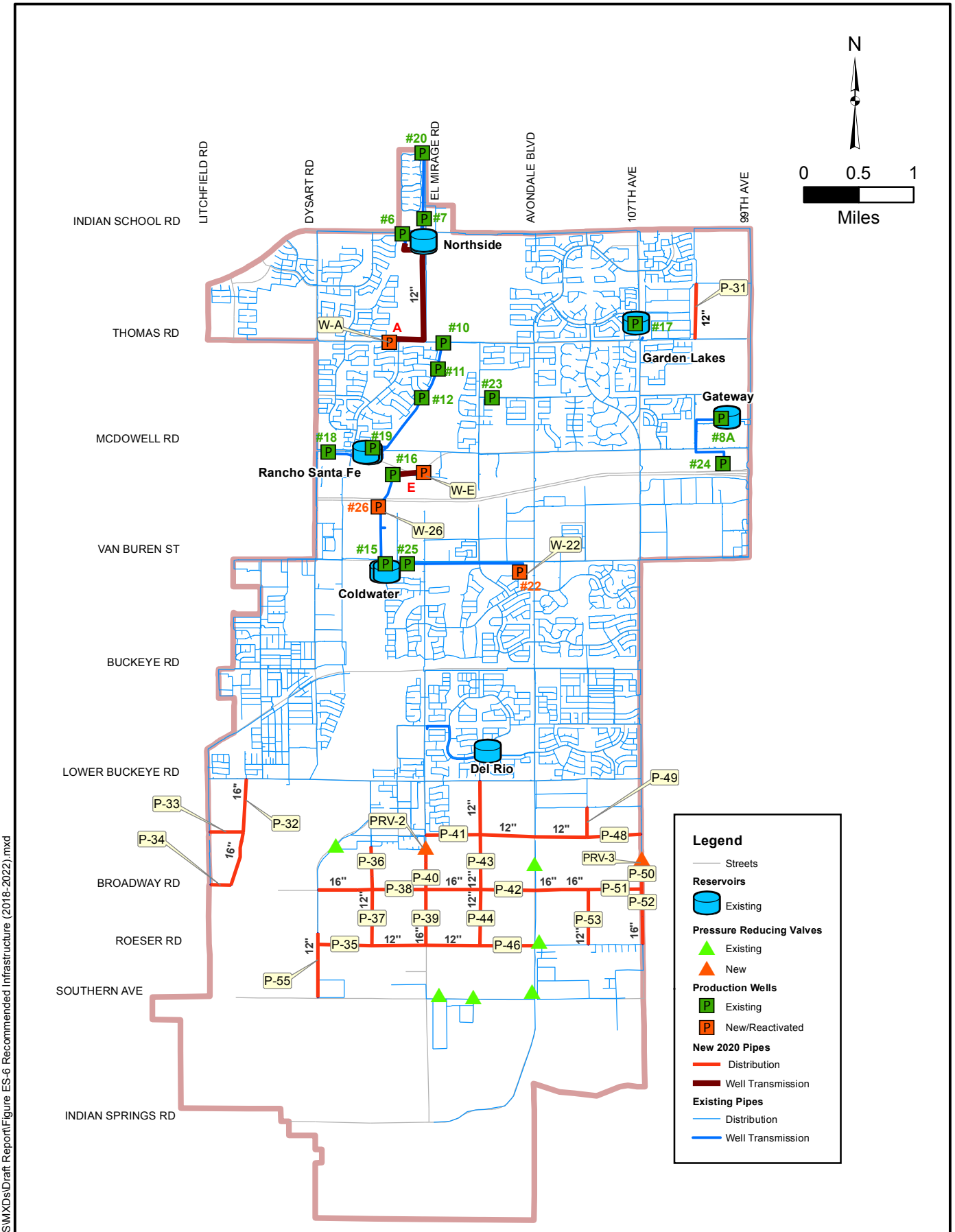
May 2013
FIGURE ES-5



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure ES-6 Recommended Infrastructure (2018-2022).mxd

CITY OF AVONDALE, ARIZONA
WATER MASTER PLAN UPDATE

Recommended Infrastructure (2018-2022)

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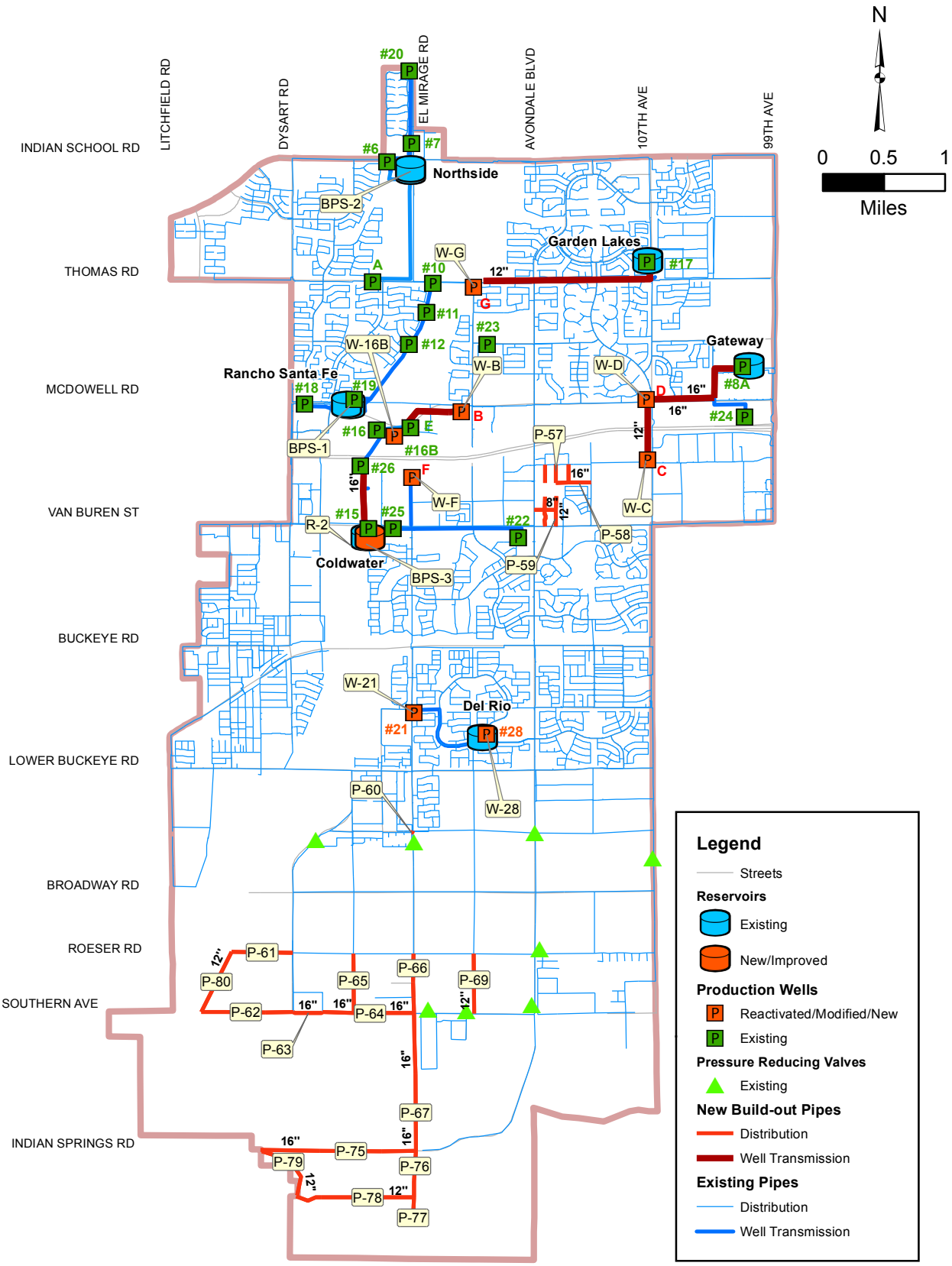
May 2013
FIGURE ES-6



\\arcadis-us.com\OfficeData\Phoenix-AZ\Projects\08640027\GIS\MXDs\Draft Report\Figure ES-7 Recommended Infrastructure (2023-2035).mxd

CITY OF AVONDALE, ARIZONA
WATER MASTER PLAN UPDATE

Recommended Infrastructure (2023 - 2035)

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May 2013
FIGURE ES-7

1. Introduction

1.1. Background and Purpose

The City of Avondale last updated its *Water Resource Master Plan* and *Water Infrastructure Master Plan* in May 2010. The Master Plans included a recommended schedule of water system improvements to help guide the City in improving service to current residents and businesses and to support future growth. There have been several changes in planning assumptions, as well as actual construction that has occurred, since completion of the 2010 master plans:

- A new General Plan has been adopted.
- Growth rates have changed from previous estimates.
- Well rehabilitation projects have been attempted with limited success. Thus, increased levels of groundwater treatment should be assumed and incorporated into the recommended system improvements and costs.
- Due to funding constraints and decreased demands, some new pipes have been installed with smaller diameters than those recommended in the 2010 master plans to extend service into new areas.

The State of Arizona has also passed new legislation regarding development fee updates which stipulate requirements for cities to update their Infrastructure Improvement Plans (IIPs) to justify development fee changes. The IIPs have specific information requirements and must be completed in accordance with the overall development fee update process. The City has recently commenced its next development fee update which is to be completed by August 2014. Updated water system improvement recommendations are needed to support the development fee update process.

The objectives of this *Water Master Plan Update* project are to 1) incorporate changes in development and land use planning and Capital Improvement Plan (CIP) achievements since 2010 and 2) update the system improvement recommendations to support the IIP and development fee update requirements. This *Water Master Plan Update* report provides a summary update to the City's *Water Resources* and *Water Infrastructure Master Plans* and contains updated water demand projections, water production and distribution capacity requirements, recommendations for system improvements, and capital improvement project cost opinions.

It should be noted that in accordance with industry-accepted practice for long-range water system planning, the *Water Master Plan Update* includes recommendations for all

facilities and infrastructure that will serve all current and future land uses identified in the City's General Plan, and within the agreed upon future service area. It is expected that many of the recommended pipelines on adjacent half-mile and mile section lines (streets) will be constructed by developers as part of their normal construction requirements. Also, some of the pipelines may not be constructed based on actual development and future changes to the General Plan. It is anticipated that the City will identify which recommended infrastructure will be constructed by developers and by the City, and which infrastructure will actually be built based on the best prevailing information.

1.2. General Methodology and Report Format

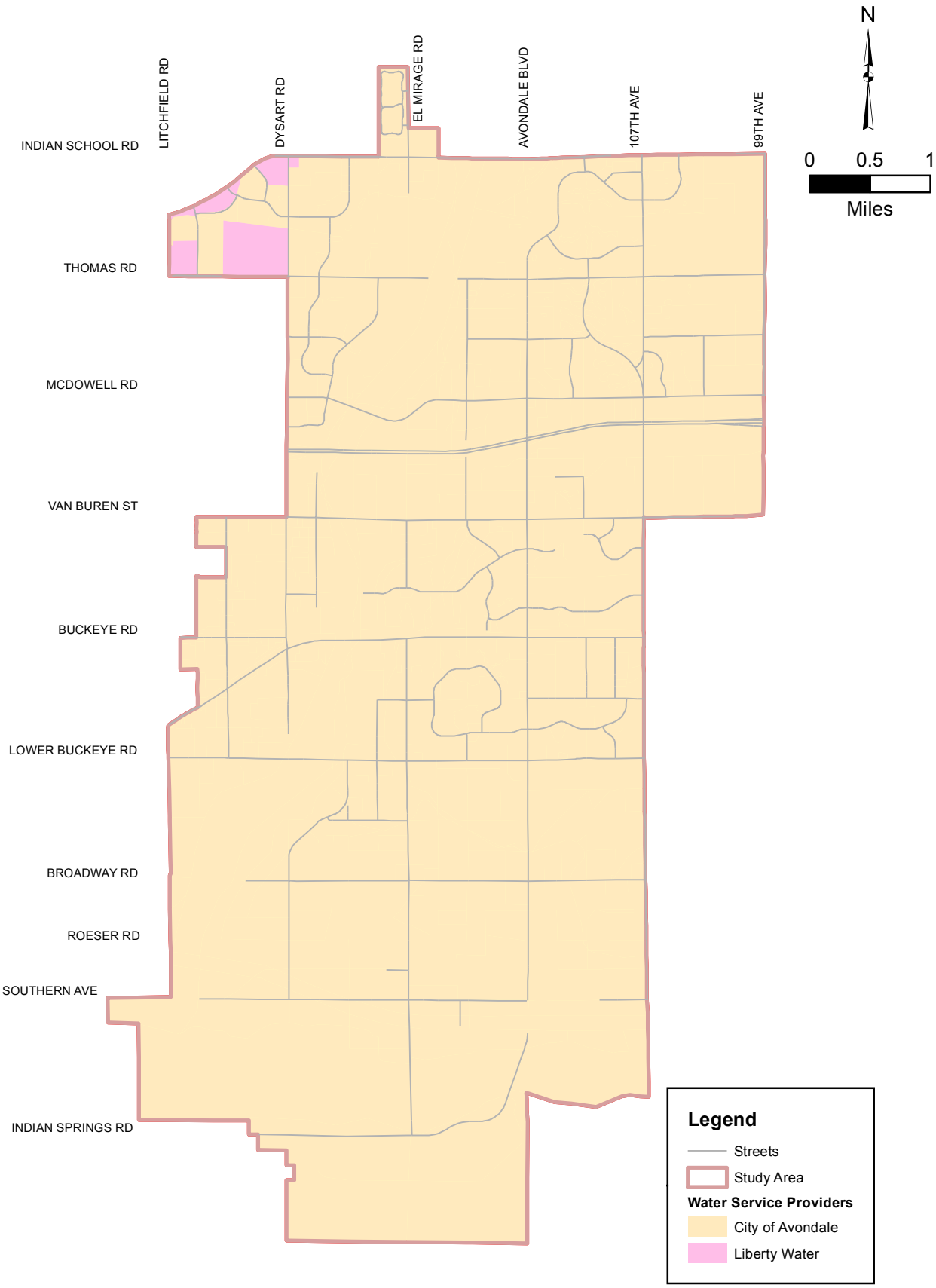
This *Water Master Plan Update* report should be considered a companion document to the 2010 *Water Resource* and *Water Infrastructure Master Plans*. This report summarizes only the changes and updates that were made, summarizes the key findings of the updates, and presents revised master plan tables and figures. For ease of comparison and unless otherwise noted, all of the updated tables and figures retain the same numbering as the 2010 *Water Infrastructure Master Plan*. For additional information, refer to the 2010 Master Plans.

1.3. Study Area

The study area for the *Water Master Plan Update* is the City's Municipal Planning Area (MPA) north of the Estrella Mountains, as illustrated on Figure 1-1. According to information provided by the City Finance Department, the City is projected to grow from a current population of approximately 80,000 to nearly 123,000 by 2035 within the study area.

Figure 1-1 also illustrates the water service providers. The City of Avondale is the water service provider for the majority of the area within the City study area except for the Liberty Water Company (formerly Litchfield Park Service Company) which serves four small areas within the area bounded by Thomas Road, Litchfield Road, Dysart Road, and Indian School Road. The customers in this area include a college, some schools, and a few commercial properties.

The City purchased the Rigby Water Company which served an area of approximately 2.5 square miles in the southeastern portion of the study area. The system is divided into two independent systems and has three wells. The City is in the process of connecting the area to the City water system and when completed, will abandon the three existing Rigby wells. The City is also in the process of extending water service to the Phoenix International Raceway (PIR) who had previously been a self-supplier with its own water source and infrastructure.



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure 1-1 Study Area.mxd

CITY OF AVONDALE, ARIZONA
WATER MASTER PLAN UPDATE

Study Area

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The Water Division of ARCADIS

May 2013
FIGURE 1-1

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2. Regulatory Framework

The applicable regulations, ordinances, and guidelines related developing and maintaining drinking water infrastructure in Arizona, and used to update recommendations for the City's water system, remain unchanged from those described in the 2010 *Water Infrastructure Master Plan*.

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3. Existing Water Infrastructure

The City's drinking water infrastructure includes production wells, storage reservoirs, booster pumps, transmission pipelines, and distribution pipelines (Figure 3-1). This chapter summarizes the City's water infrastructure as of March 2013. Planned infrastructure includes facilities and pipelines that are "in-progress" (either under design or in construction) but have not yet been completed. Only the updates made to the water system inventory are discussed in this chapter.

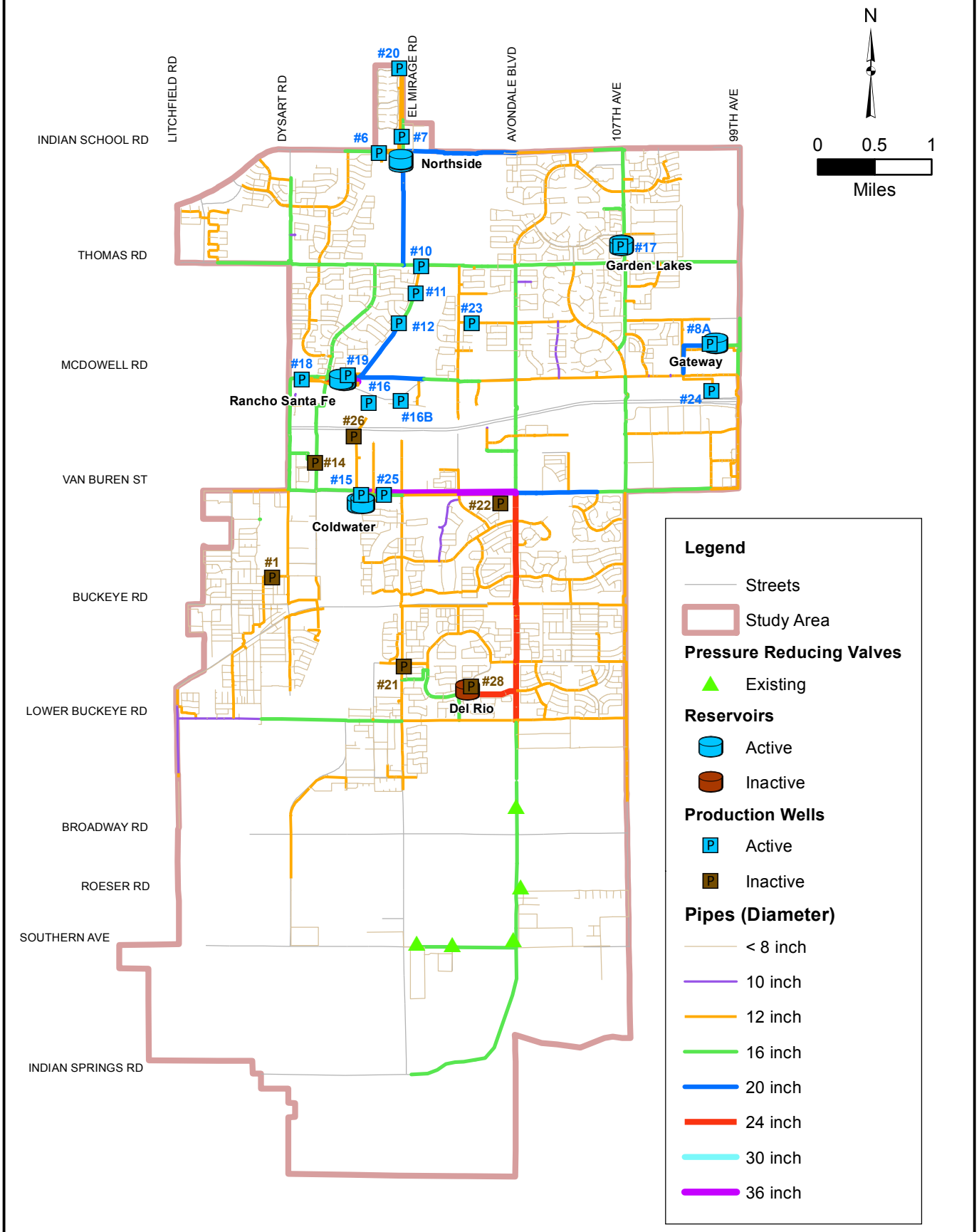
3.1. Production Wells

The City currently relies on 15 "active" production wells to meet the drinking water needs of residents and businesses (Table 3-1). Two additional wells (Wells #5 and #16B) supply water for irrigation needs and are not connected to the rest of the City's drinking water distribution system. The total pumping capacity of the City's active wells serving the main distribution system (excluding irrigation wells) is 32.8 million gallons per day (mgd). The remaining wells owned by the City (termed "inactive) cannot be operated in their current state because they are under construction or have water quality issues. The Rigby Water Company that the City has purchased had three wells within their service area. These are low volume wells and are generally in poor condition. The City will abandon these wells and serve the former Rigby service area through the distribution system.

3.1.1. Water Quality

Table 3-2 summarizes the updated water quality data available for City production wells. The City has arsenic treatment at the Northside reservoir location (Wells #6, #7, and #20) and nitrate treatment facilities at Gateway and Garden Lakes reservoirs (Wells #8A and #17). The City owns the Garden Lakes treatment facility, operating it as needed for peak demands because chromium loading on the resin increases the likelihood of classifying the backwash brine as a hazardous waste. To reduce cost associated with disposing the brine as a hazardous waste, brine processing could be installed to precipitate the chromium, thereby reducing the amount of hazardous waste.

The City also plans to purchase the Gateway treatment facility when the lease expires and intends on expanding dibromochloropropane (DBCP) treatment at Well #8A by 1,000 gallons per minute (gpm). Existing Well #8A is limited to 2,000 gpm by the treatment facilities; its capacity can be increased by expanding DBCP and nitrate treatment. Based on nitrate levels, an estimated additional nitrate treatment capacity of 800 gpm is needed to bring nitrate levels below the City's goal of 7 milligrams per liter (mg/L).



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure 3-1 Existing Water Infrastructure.mxd

CITY OF AVONDALE, ARIZONA
WATER MASTER PLAN UPDATE

Existing Water Infrastructure

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The Water Division of ARCADIS

May 2013
FIGURE 3-1

Table 3-1:
Existing Production Wells

Well Registration Number	Well Number	Operation Status	Feed Point	Pumping Capacity (gpm)[1]
55-608731	1	Inactive - Capped	None	-
55-608733	5	Irrigation	Mountain View[3]	250
55-501247	6	Active	Northside	1,700
55-501288	7	Active	Northside	1,550
55-599019	8A	Active	Gateway	2,000[5]
55-608792	10	Active	Rancho Santa Fe	2,200
55-608791	11	Active	Rancho Santa Fe	1,500
55-608793	12	Active	Rancho Santa Fe	2,000
55-583017	14	Inactive – Water Quality	Distribution System	400
55-578749	15	Active	Coldwater	650
55-200566	16	Active	Coldwater	2,200
55-807953	16B[6]	Irrigation	Friendship Park Lake	650
55-201730	17	Active	Garden Lakes	1,200
55-607157	18	Active	Rancho Santa Fe	2,100
55-588631	19	Active	Rancho Santa Fe	1,450
55-208099	20	Active	Northside	1,150
55-203924	21	Inactive – Water Quality	Del Rio	1,200[4]
55-217002	22	Inactive – Under Construction	Coldwater	1,200[2]
55-202404	23	Active	Distribution System	1,260
55-210430	24	Active	Gateway	650
55-217001	25	Active	Coldwater	1,200
55-618650	26	Inactive – Under Construction	Coldwater	1,200[2]
SRP well	28	Inactive – Water Quality	Del Rio	800[4]
Total Capacity (mgd)				41.6
Total Active Capacity (mgd)				32.8

Notes:
(1) Pumping capacity was determined by the City using 2009 well pumping records during maximum day and updated in January 2013.
(2) Well capacity has not been determined. Assumed to be 1,200 gpm for the purposes of this report.
(3) Water from the Mountain View Reservoir is used for irrigation uses only.
(4) Estimated capacity provided by the City.
(5) Treatment capacity (2,000 gpm) limits well (3,000 gpm) production.
(6) Well #16B is used for irrigation uses only.

Table 3-2:
Water Quality Data

	No. Samples	Arsenic (mg/L)	Fluoride (mg/L)	Nitrate as Nitrogen (mg/L)	TDS (mg/L)
MCL	**NA**	**0.010**	**4.0**	**10**	**NA**
Secondary Standard	**NA**	**NA**	**2.0**	**NA**	**500**
Well #1	1	0.005	0.19	6.43	**648**
Well #5	-	-	-	-	-
Well #6	2	**0.0219**	0.885	3.095	319
Well #7	2	**0.0328**	1.29	2.02	248
Well #8A	2	0.0026	0.165	**14.8**	**855**
Well #10	2	0.0051	0.28	6.325	**543**
Well #11	2	0.00475	0.255	5.615	**505**
Well #12	2	0.004	0.225	3.97	**549**
Well #14	-	-	-	-	-
Well #15	1	**0.015**	0.52	3.22	394
Well #16	-	-	-	-	-
Well #16B	1	0.002	0.17	6.06	**752**
Well #17	1	0.003	0.17	**13.1**	**660**
Well #18	1	0.006	0.18	4.88	**531**
Well #19	1	0.005	0.18	4.45	474
Well #20	1	**0.015**	1.2	4.7	330
Well #21	1	<0.002	0.13	9.34	**1450**
Well #22	1	0.0031	BDL	**10**	**890**
Well #23	1	0.003	0.1	8.67	**824**
Well #24	1	0.0025	<0.4	6.9	**780**
Well #25	1	0.0039	BDL	**10**	**1,100**
Well #26	-	-	-	-	-
Well #28	-	-	-	-	-

Notes: NA – Not Applicable
BDL – Below Detection Limit
Red text signifies values are above the MCL or secondary standard.

Because of elevated nitrate levels, wells #15, #16, and #25 are currently blended. Additionally, elevated nitrate levels in Well #22 and the anticipated nitrate levels in Well #26 could limit supplies at the Coldwater facility in the future. While approximately 760 gpm of treatment capacity is needed to get nitrate below the City's 7 mg/L goal, 1,200 gpm of nitrate treatment should be provided to account for possible nitrate fluctuations in

the future. Nitrate treatment is assumed to utilize a similar technology as Gateway and Garden Lakes.

Wells #21 and #28 are not currently operational due to total dissolved solids (TDS) levels above the City's 700 mg/L target. In order to operate these wells, 2.0 mgd of TDS treatment capacity is needed assuming an influent TDS concentration of 1,500 mg/L for Well #28. A recent study completed for the City evaluated potential TDS treatment at the Del Rio site (Wilson Engineers, 2008). While TDS treatment could be located at the Del Rio storage reservoir, brine processing via evaporation ponds would need to be pumped to an offsite location as described in the study. Well #21 also has elevated iron and manganese concentrations of 1.1 mg/L and 0.15 mg/L, respectively. An oxidation step prior to TDS treatment could be provided to reduce the concentrations of iron and manganese.

The City has also expressed a concern about levels of chromium in its wells with regards to current activities at the federal level and in California. Chromium III is a required nutrient for adults with a recommended daily intake of 50 to 200 ug. Total chromium (sum of chromium III and chromium VI) is regulated by the United States Environmental Protection Agency (USEPA) with a maximum contaminant level (MCL) of 0.1 mg/L or 100 parts per billion (ppb), and by the California Department of Public Health (CDPH) with an MCL of 50 ppb. The presence of hexavalent chromium (chromium VI) in drinking water captured the attention of many drinking water consumers when the movie "Erin Brockovich" was released in 2001. Chromium VI may cause cancer in laboratory animals, but the evidence of carcinogenicity via ingestion is not compelling. The National Toxicological Program has been conducting toxicity studies on chromium VI which may lead to future regulation, but no specific limit has currently been set for chromium VI.

CDPH is in the process of developing an MCL for chromium VI that is expected to be released as a draft regulation by July 1, 2013. In July 2011, the California Office of Environmental Health Hazard Assessment (OEHHA) finalized a Public Health Goal (PHG) of 0.020 ppb or 20 parts per trillion (ppt) for chromium VI. OEHHA's assessment is based on a one in one million cancer risk endpoint, and will form the baseline for CDPH's cost-benefit risk assessment of the chromium VI MCL. The low PHG concentration has fueled a number of studies to determine the technological ability and costs of treating to these low levels.

On the Federal level, the USEPA considered whether to regulate chromium VI following a controversial 2010 draft Integrated Risk Information System (IRIS) assessment which labeled the metal a human carcinogen when ingested. A subsequent 2011 peer review recommended that USEPA delay their assessment and await the results of ongoing industry-funded research intended to determine how chromium VI causes cancer when

ingested. USEPA has indicated that a revised draft assessment of chromium VI toxicology is expected in 2013. Chromium VI and total chromium are also part of the third Unregulated Contaminant Monitoring Rule (UCMR3), which together with the toxicology assessment and cost-benefit analysis will set the stage for a potential MCL. However, USEPA's formal regulatory determination process on whether to regulate chromium VI will be delayed until the agency can resolve questions related to the contaminants' pathways and the monitoring data under UCMR3 can be analyzed.

Studies to refine chromium VI removal technologies and costs are currently on-going. The primary technologies being studied are ion exchange with weak-based anion resin or strong-based anion resin, and a reduction-coagulation-filtration process. Other technologies such as iron-based media are starting to emerge, but have not been widely proven yet. It is also anticipated that as the technologies are better defined and the market competition increases, the cost of these technologies should become more competitive as well.

3.1.2. Blending Plans

The City uses one approved blending plan: high arsenic water from Well #15 is blended with Well #16 and supplied to the Coldwater reservoir. Loss of Well #16 would result in the loss of Well #15, for a total capacity loss of 2,850 gpm.

3.2. Storage Reservoirs

In this *Water Master Plan Update*, inlet and overflow heights were taken into account in order to estimate the "usable" volume in the storage reservoirs (Table 3-3). Because of the maintenance needed on the Del Rio storage tank, it was assumed to be inactive. The total usable drinking water storage with Del Rio out of service is 8.5 million gallons (MG). The City also maintains a small, 0.3 MG storage reservoir at Mountain View for storage of water used to irrigate Festival Fields.

Table 3-3:
Existing Storage Reservoirs

Reservoir Name	Construction Type	Status	Elevation (feet)	Tank Height (feet)	Number of Tanks	Total Volume (MG)	Usable Volume (MG)
Rancho Santa Fe	Above-ground steel	Active	982	16	2	2.8	2.1
Northside	Above-ground steel	Active	1,012	16	2	1.2	1.1
Garden Lakes	Below-grade concrete	Active	1,016	22	1	2.0	1.4
Gateway	Below-grade concrete	Active	1,021	20	1	1.0	0.8
Coldwater	Above-ground steel	Active	971	20	2	5.0	3.2
Del Rio	Above-ground steel	Inactive	984	32	1	3.5	2.8
Total Storage Capacity						**15.5**	**11.3**
Total Usable Storage Capacity (with Del Rio Out-of-Service)						**12.0**	**8.5**

3.3. Booster Pump Stations

The booster pump station capacities were updated based on discussions with the City (Table 3-4). Three of the five pumps at the Northside reservoir are out-of-service. Accounting for this loss of pumping, the system's total firm capacity is 48.8 mgd. With the reservoir at Del Rio inactive and requiring maintenance, the boosters at Del Rio are currently unusable. This reduces the firm capacity in the system to 40.2 mgd.

Table 3-4:
Existing Booster Pumps

Description	Number of Pumps	Type	Design Flow (gpm)	Design Head (feet)	Status	Total Capacity (mgd)	Firm Capacity (mgd)
Rancho Santa Fe	4	VFD	2,000	162.37	Active	12.1	8.93
			2,000	162.37	Active		
			2,200	162.37	Active		
			2,200	162.37	Active		
Coldwater	4	VFD	2,000	173.3	Active	20.2	14.40
			4,000	173.3	Active		
			4,000	173.3	Active		
			4,000	173.3	Active		
Northside	5	Constant Speed	1,200	131.7	Inactive	5	1.73
			1,200	131.7	Active		
			1,800	131.7	Inactive		
			1,200	131.7	Inactive		
		VFD	2,000	131.7	Active		
Gateway	4	VFD	2,000	164	Active	11.5	8.64
			2,000	164	Active		
			2,000	164	Active		
			2,000	164	Active		
Garden Lakes	4	Constant Speed	1,500	164	Active	8.6	6.48
			1,500	164	Active		
			1,500	164	Active		
			1,500	164	Active		
Del Rio	3	VFD	4,000	166	Inactive	14	8.64
			4,000	166	Inactive		
			2,000	166	Inactive		
Total						**71.4**	**48.8**
Total (with Del Rio Out of Service)						57.0	40.2

Source: Carollo 2009 Water Model Update Memorandum; updated based on City comments in January 2013.

3.4. System Piping and Pressure Zones

The City's water distribution system includes production well transmission mains, transmission mains, distribution mains, and service connections. According to the City's water infrastructure geographic information system (GIS) database (January 2013), the water system consists of approximately 333 miles of pipeline (Table 3-5). The City's distribution system network is primarily one pressure zone except for the areas south of

Broadway Road, including the recently assimilated Rigby System and PIR that are served by pressure reducing valves (PRVs), previously shown on Figure 3-1.

Table 3-5:
Existing Distribution System Pipes

Type	Diameter (inches)	Total Length (feet)
Service Connections[1]	0.75	149
	1	3,584
	1.5	55
	2	19,772
	3	4,281
	4	61,520
	6	267,460
Distribution Mains	8	887,549
	10	16,692
	12	309,475
Transmission Mains	16	138,745
	20	26,992
	24	14,292
	30	520
	36	7,006

Source: 2013 City water infrastructure GIS database.
Note: (1) Older parts of Avondale contain 4- and 6-inch pipes classified as distribution mains.

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4. Historical Water Demands and Peaking Factors

This chapter presents updates to the City's historical drinking water production data and water demand peaking factors.

4.1. Historical Drinking Water Demand

Annual drinking water production data for the City's wells from 2005 to 2012 are summarized in Table 4-1. Total production continued to decrease through 2010 and then increased to 12.2 mgd in 2012. Since 2010, the City has purchased the Rigby Water Company and has assumed control over the Rigby system. The water demands of the former Rigby service area have been incorporated in this update. The drinking water hydraulic model was evaluated against the peak water demand conditions of 2012.

4.2. Maximum Day Peaking Factor

As in the 2010 Water Infrastructure Master Plan, this Water Master Plan Update uses a maximum day to average day peaking factor of 1.65.

4.3. Peak Hour Peaking Factor

As in the 2010 Water Infrastructure Master Plan, this Water Master Plan Update uses a peak hour to average day peaking factor of 3.17.

Table 4-1:
Average Daily Drinking Water Production

Facility Name	Well	2005 (mgd)	2006 (mgd)	2007 (mgd)	2008 (mgd)	2009 (mgd)	2010 (mgd)	2011 (mgd)	2012[1] (mgd)
Rancho Santa Fe	#10	1.9	2.2	1.6	1.6	1.9	1.7	1.5	1.7
	#11	0.7	1.1	1.5	1.1	1.2	0.8	1.4	1.3
	#12	1.9	1.3	1.8	1.8	1.6	1.3	1.7	1.7
	#18	0.8	1.9	2.0	1.8	0.8	1.2	1.6	1.7
	#19	0.9	0.9	1.3	1.1	1.3	0.7	0.6	0.8
Northside	#6	0.8	0.8	0.6	0.6	0.7	0.6	0.3	0.3
	#7	0.7	0.8	0.5	0.3	0.6	0.3	0.3	0.2
	#20	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2
Garden Lakes	#17	0.0	0.0	0.3	0.4	0.4	0.0	0.3	0.1
Coldwater	#15	0.3	0.3	0.5	0.4	0.5	0.6	0.4	0.4
	#16	1.4	1.8	2.0	1.9	1.7	2.1	1.3	1.7
	#25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Gateway	#8A	0.7	0.7	0.7	0.7	0.4	0.1	0.5	0.8
	#24	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1
Distribution System	#23	0.0	0.0	0.0	0.0	0.6	1.8	1.4	1.0
	#14	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rigby Wells	#29	No Data						0.01	0.1
	#30	No Data							0.03
	#31	No Data							0.01
Total Annual Production		10.3	12.0	12.7	11.8	11.8	11.1	11.8	12.3

NOTES:
Source: 2005 – 2009 Well Production Reports.
(1) January 1, 2012 to October 31, 2012. November and December assumed from 2007 data

5. Model Update and Design Criteria

The City's water distribution system hydraulic model was last calibrated in February 2009, using MWHSoft H2OMAP Water. That model was used in the 2010 *Water Infrastructure Master Plan* and was used again for this *Water Master Plan Update*. This chapter presents updates to the hydraulic model to reflect additional construction that has taken place since 2010, and updates to allocation of existing and projected water demands within the modeled system.

5.1. Model Updates

The infrastructure and operations information in the hydraulic model was verified against the City's latest water infrastructure GIS database, record drawings, and other information provided by the City. The following is a list of updates that were made to the hydraulic model based on updated information:

- Maximum and minimum levels for the storage reservoirs were updated based on the inlet and overflow elevations (previously shown in Table 3-2).
- A half-mile of 16-inch transmission main was added along Thomas Road, between 99th Avenue and 103rd Avenue.
- A quarter-mile of 12-inch distribution main replaces along Riley Road, between 5th Street and Dysart Road.
- A 0.75-mile section of 8-inch distribution man replaced a 6-inch along Central Avenue from Western Avenue to E La Canada Boulevard
- A 3.2-mile section of 16-inch transmission main was added along Avondale Boulevard, between Lower Buckeye Road and Indian Springs Road.
- A 0.6-mile section of 16-inch transmission main was added along Indian Springs Road, between Avondale Boulevard and El Mirage Road.
- A 0.9-mile section of 16-inch transmission main was added along Southern Avenue, between Avondale Boulevard and 122nd Avenue
- All the pipes in the former Rigby system, ranging from 2-inch to 8-inch were added to the model.
- Booster Pumps #1, #3 and #4 were inactivated at the Northside booster station.
- Four 8-inch PRVs serving the former Rigby system were added at Roeser Road and Avondale Boulevard, Southern Avenue and Avondale Boulevard, Southern Avenue and 119th Drive, and Southern Avenue and 122nd Ave.

- A 16-inch PRV serving the former Rigby system and the PIR was added along Avondale Boulevard.
- The delivery pressure setting for the PRVs downstream of the booster pump stations were set at pressure values shown in Table 5-1

Table 5-1:
Booster Station Pressure Model Settings

Booster Station	Pressure (psi)
Rancho Santa Fe	66
Northside	55
Gateway	47
Del Rio	65
Garden Lakes	47
Coldwater	68
Well #23	63

5.2. Demand Allocation

Before allocating water demands to the hydraulic model, the GIS-based demand projection Tool developed as part of the 2010 *Water Resource Master Plan* was updated. The tool utilizes the City's land use map, land use demand factors, and development growth projections in order to spatially allocate drinking water demands. The updates made to the demand projection Tool are described in Appendix A.

A summary of the study area drinking water demands that were used for the existing system evaluation and to develop 2017, 2022, and build-out recommended infrastructure are shown in Table 5-4 and on Figure 5-1.

Table 5-2:
Drinking Water Demand Projections[1]

	2012	2017	2022	Build-out (2035)
SRP On-Project Areas (mgd)	7.5	9.3	11.9	14.4
SRP Off-Project Areas (mgd)	5.0	5.8	6.6	9.5
Total Drinking Water Demand (mgd)	12.5	15.1	18.5	23.9

Note: (1) Projections for the City's MPA north of the Estrella Mountains obtained from demand projection tool updated as part of the *Water Master Plan Update*. Demands do not include Coldwater Gold Course. Friendship Park demands and well (#16B) will be connected to the main distribution system between 2031 and 2035.

Similar to 2010 planning efforts, demands for the Coldwater Golf Course, which receives Salt River Project (SRP) irrigation water and tail water, were not included in the model.

Similarly, Friendship Park demands, currently served by a separate irrigation well, were incorporated into the model starting in 2035. It is assumed that Friendship Park (and its well) will be connected to the City's main distribution system network between 2031 and 2035.

The annual average drinking water demands for each planning year were allocated to the hydraulic model network nodes using the Demand Allocator tool, a built-in feature of the H2OMap software.

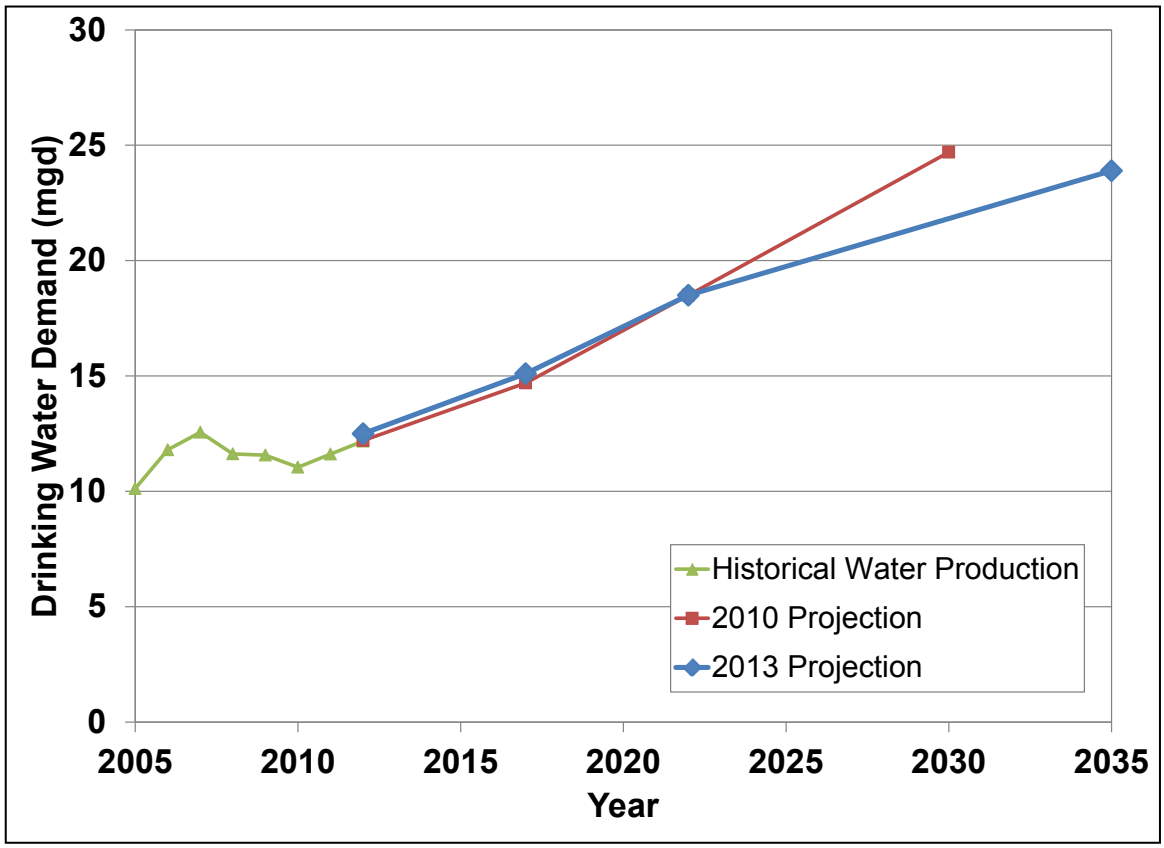

Figure 5-1: Drinking Water Demand Projections

5.3. System Performance and Design Criteria

This Water Master Plan Update utilizes the same water system performance and design criteria that were developed and used in the 2010 *Water Infrastructure Master Plan*.

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6. Existing System Evaluation

This chapter presents updates to the evaluation of the existing water system using the updated water system hydraulic model. The hydraulic model developed in H2OMAP and the system performance and design criteria were used to evaluate the existing system for a 24-hour extended period simulation (EPS) during average day, maximum day, and maximum day plus fire flow demand conditions to assess existing system adequacy. Only the information that has been updated is presented in this chapter; refer to the 2010 *Water Infrastructure Master Plan* for additional information.

6.1. Existing Production Well and Storage Analysis

According to the City's General Engineering Requirements (GER) Manual (2008), the existing active production wells need to meet two criteria: *reliable supply* and *total supply*. *Reliable supply* is defined as meeting maximum day demands with all wells operating no more than 18 hours per day. *Total supply* is defined as meeting maximum day demands with the largest well out of service. Table 6-1 summarizes the production requirements analysis and shows that the City currently meets both criteria.

Table 6-1:
Existing System Production Well Capacity Analysis

	Existing
Average Day Demand (mgd)	12.5
Maximum Day Demand (mgd)	20.6
Reliable Supply Needed (mgd)[1]	27.5
Existing Total Pumping Capacity (mgd)	32.8
Deficit (mgd)	0
Reliable Supply Criterion Met?	Yes
Total Supply Needed with Largest Well Out of Service (mgd)[2]	25.5
Total Supply Criterion Met?	Yes

Notes:
(1) Reliable supply needed = 12.5 mgd (average day) times 1.65 (maximum day peaking factor) divided by 0.75 (wells operating 18 hours per day) = 27.5 mgd.
(2) Largest production well out of service accounting for blending is Well #16 (2,200 gpm) because it also prevents blending with Well #25 (1,200 gpm), for a total pumping capacity loss of 4.9 mgd (3,400 gpm).

An analysis was also performed to determine the adequacy of the existing system storage based on the requirements of the City's 2008 GER Manual. The analysis is summarized in Table 6-2. The GER requirements are related to peak hour, fire flow, operating storage, and emergency supply (see notes in Table 6-2). Based on the GER requirements, the City's existing system storage is adequate for existing demands.

Table 6-2:
Existing System Storage Capacity Analysis

Storage Capacity Criteria	Storage Needed	Existing (2012) Storage Available	Criterion Met?
Peak Hour Storage[1]	6.2 MG	8.5 MG	Yes
Fire Flow[2]	0.0 MG	8.5 MG	Yes
Operating Storage[3]	4.1 MG	8.5 MG	Yes
Emergency Supply[4]	2.7 MG	8.5 MG	Yes

Notes:
(1) Satisfy peak hour demand for 4 hours with 50 percent of storage capacity and 50 percent source capacity.
(2) Satisfy maximum day plus fire flow utilizing all sources and 80 percent of total storage.
(3) Total storage should be equal to or greater than 20 percent of maximum day demand.
(4) Satisfy average day demand with 80 percent of storage volume and 50 percent of well supply operated no more than 18 hours.

6.2. Average Day Demand Analysis

As a part of its updated operations, the City does not regularly use water from the Gateway and Garden Lakes water supply facilities because of production well water quality and treatment issues. The reservoirs at these facilities are used occasionally to satisfy peak demands, especially during the summer months. With the Del Rio reservoir being inactive, its boosters are not currently being used. The updated hydraulic model was used to evaluate system performance during average day demand conditions (12.5 mgd) under the current water system operational practices. No system deficiencies were noted under the average day demand conditions. Velocity, headloss, and system pressures were all within the system performance criteria ranges (thus, Figures 6-1 through 6-4 are not provided in this *Water Master Plan Update*).

6.3. Maximum Day Demand Analysis

The distribution system was also analyzed for a maximum day demand of 20.6 mgd (average day demand of 12.5 mgd and maximum day to average day peaking factor of 1.65). Operational conditions, similar to the average day demand analysis, were simulated to evaluate the system during maximum day demand conditions, which include the following:

- Gateway and Garden Lakes operating during peak demand period
- Del Rio booster pumps not in operation

The 24-hour EPS analysis for maximum day demand conditions showed pressures lower than 40 pounds per square inch (psi) in the former Rigby Water Company system under peak hour demands (Figure 6-5). The low pressures are a result of older and smaller diameter (2-inch to 6-inch) pipes in the former Rigby system. In addition, the PRVs installed as part of connecting to this system have low settings (50 psi). For the remainder of the existing water system, no system pressure, headloss or velocity violations were identified under the maximum day demand analysis (Figures 6-5, 6-7 and 6-8).

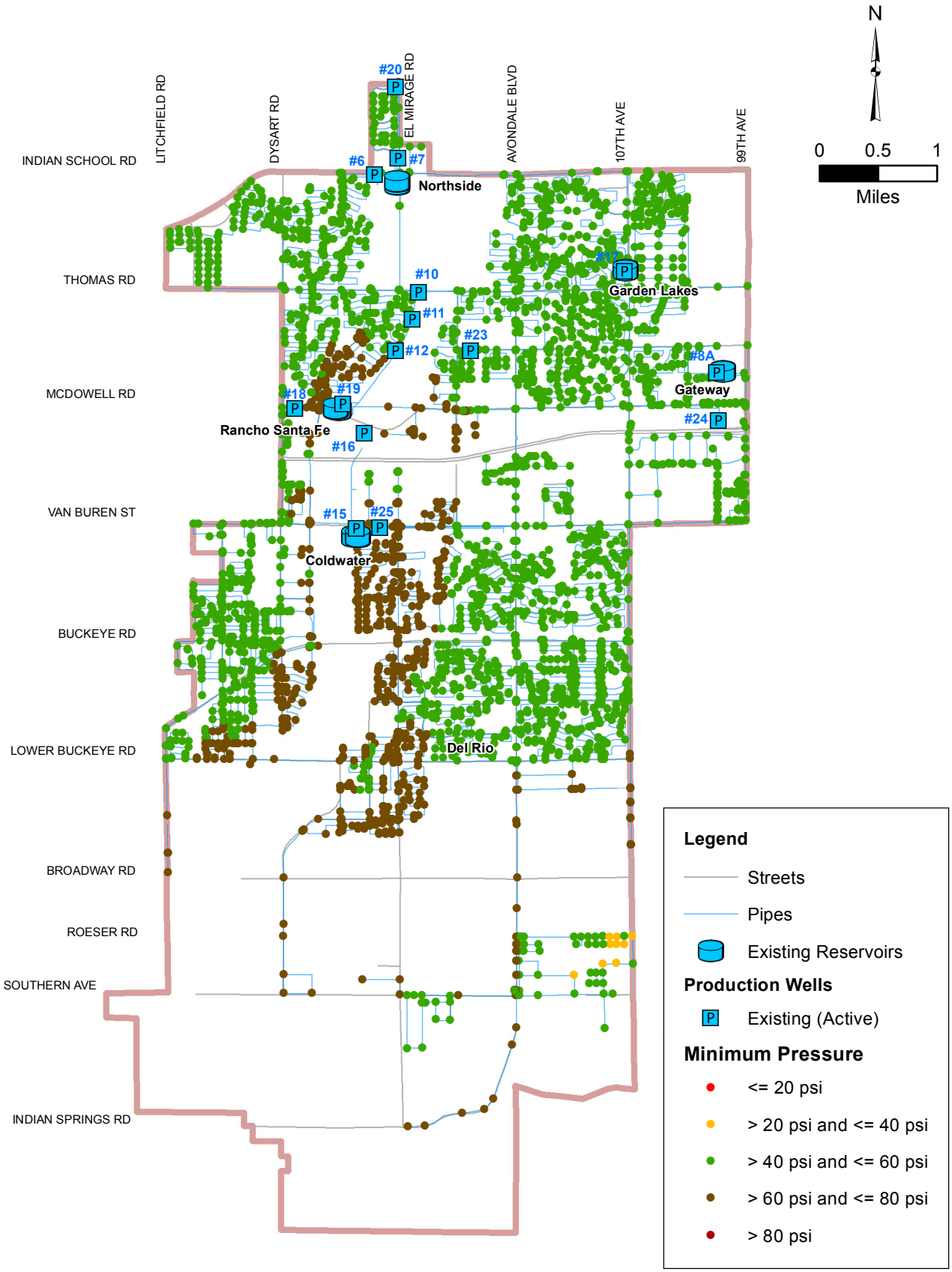
6.4. Fire Flow Analysis

The updated hydraulic model was used to evaluate the system's ability to meet the residential and commercial fire flow demands during existing maximum day demand conditions. The steady-state fire flow modeling option was used to identify network nodes where instantaneously available fire flow did not meet the system design and performance criteria.

Similar to the previous master plan, the fire flow modeling analysis revealed that most of the nodes in the system were able to meet the residential fire flow of 1,000 gpm while maintaining residual pressures of 20 psi (Figure 6-9) and all nodes within commercial zones are able to provide fire flows above 3,500 gpm. However, there are a few nodes in the system that did not meet the minimum residential fire flow criteria. These nodes are located at the dead ends of residential neighborhood piping, on small diameter pipes (less than 4 inches). The fire flow simulation was carried out at all nodes in the system instead of at fire hydrant locations only. Since the fire hydrants in these residential neighborhoods are typically located on larger diameter pipe, it is likely that all hydrant locations satisfy the fire flow requirements.

The analysis also revealed that many of the nodes in the former Rigby service area did not meet the minimum residential fire flow criteria; the minimum fire flows at these nodes ranged from 400 gpm to 950 gpm. This is also likely a result of the small diameter piping (2-inch to 6-inch) within the former Rigby service area.

Individual commercial fire flow (3,500 gpm for 4 hours) was also evaluated for two select locations under EPS modeling for an existing maximum day demand condition, the locations are the same locations analyzed in the 2010 master plan and area shown on Figure 6-9. The evaluation at these two high commercial demand locations did not show any fire flow deficiencies.



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure 6-5 Minimum Existing Peak Hour Pressures.mxd

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Minimum Peak Hour Pressures

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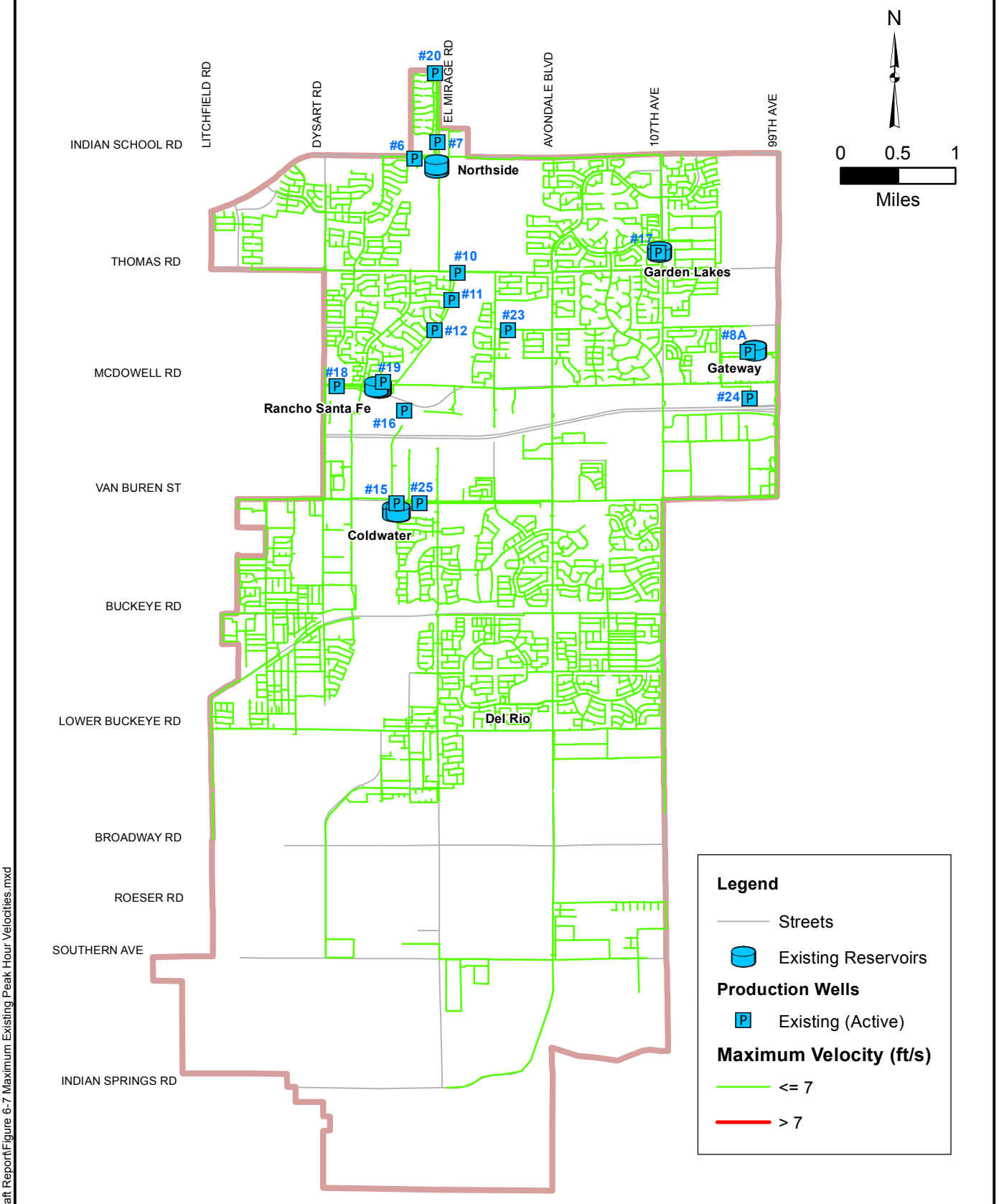
FIGURE 6-5



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure 6-7 Maximum Existing Peak Hour Velocities.mxd

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Maximum Peak Hour Velocities

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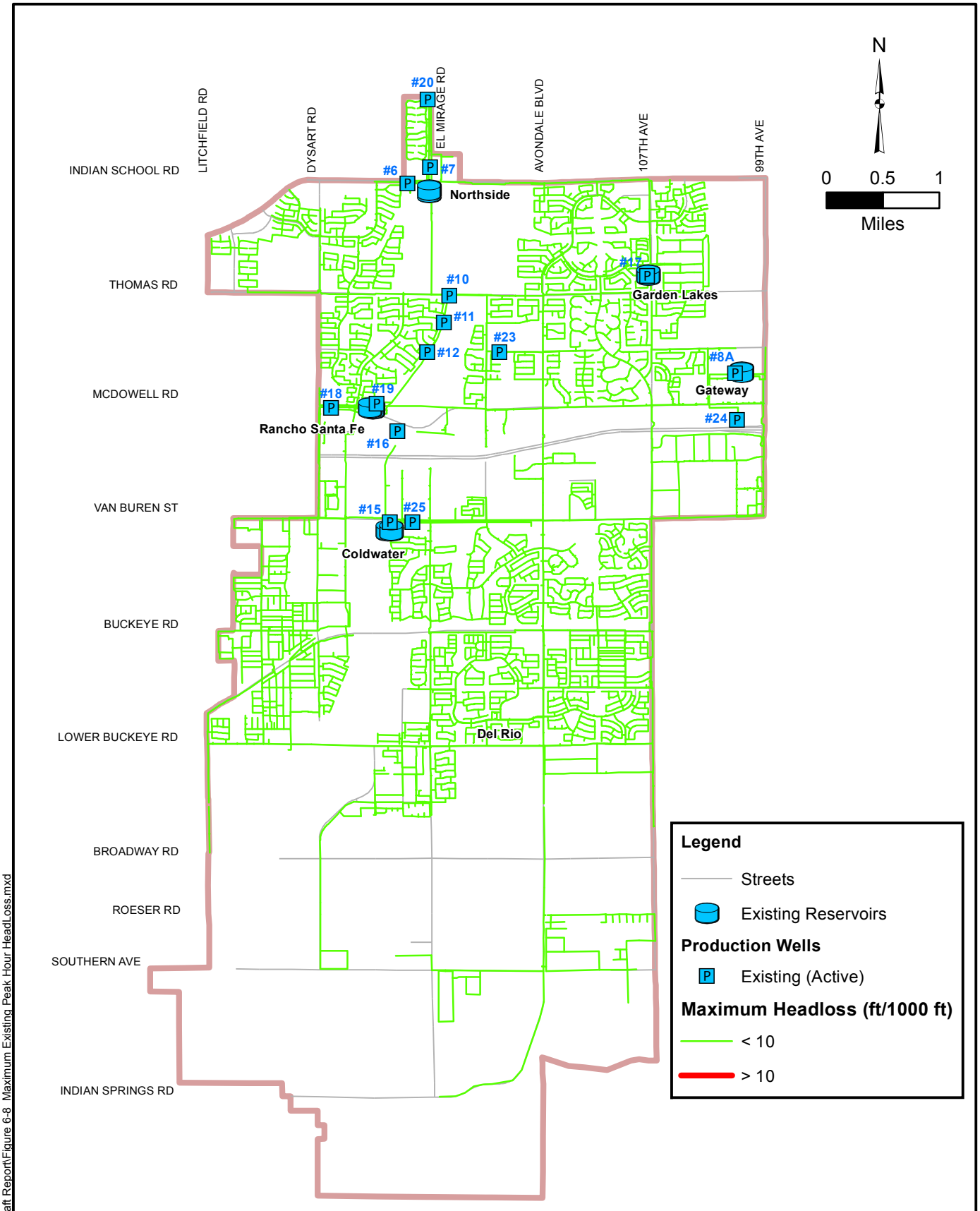
FIGURE 6-7



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure 6-8 Maximum Existing Peak Hour HeadLoss.mxd

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Maximum Peak Hour Head Loss

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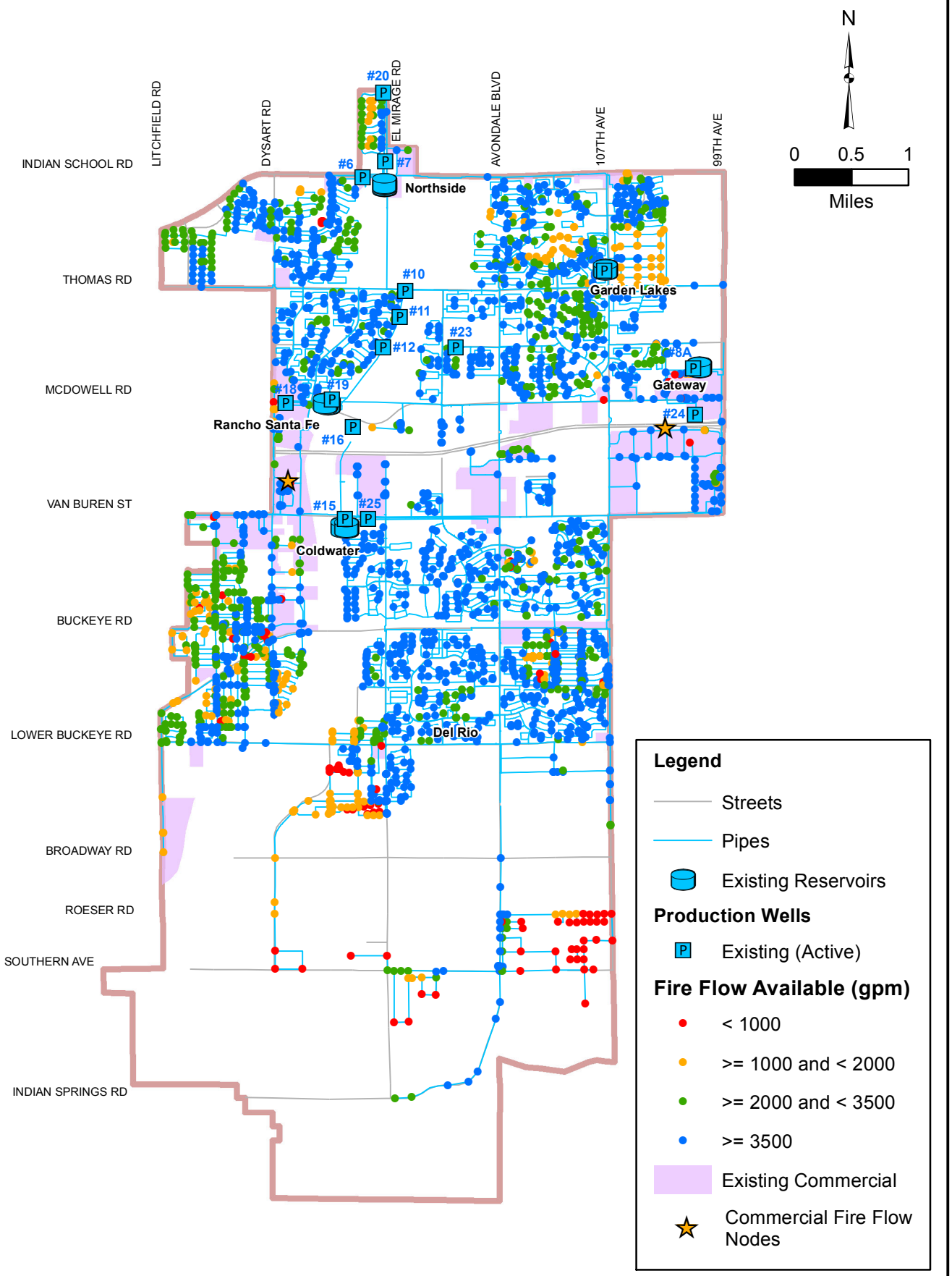
FIGURE 6-8



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure 6-9 Available Fire Flow During Maximum Day Demand.mxd

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Available Fire Flow During Maximum Day Demand

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FIGURE 6-9

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7. Recommended System Improvements

This chapter presents updates to the recommended water system improvements to enhance existing system operations and to support planned future growth. Recommended system improvements are identified for three planning periods: 5-year (2012 to 2017), 10-year (2018 to 2022), and build-out (2023 to 2035). The assumptions and updates that were made to develop the recommended system improvements and cost updates are described in this chapter.

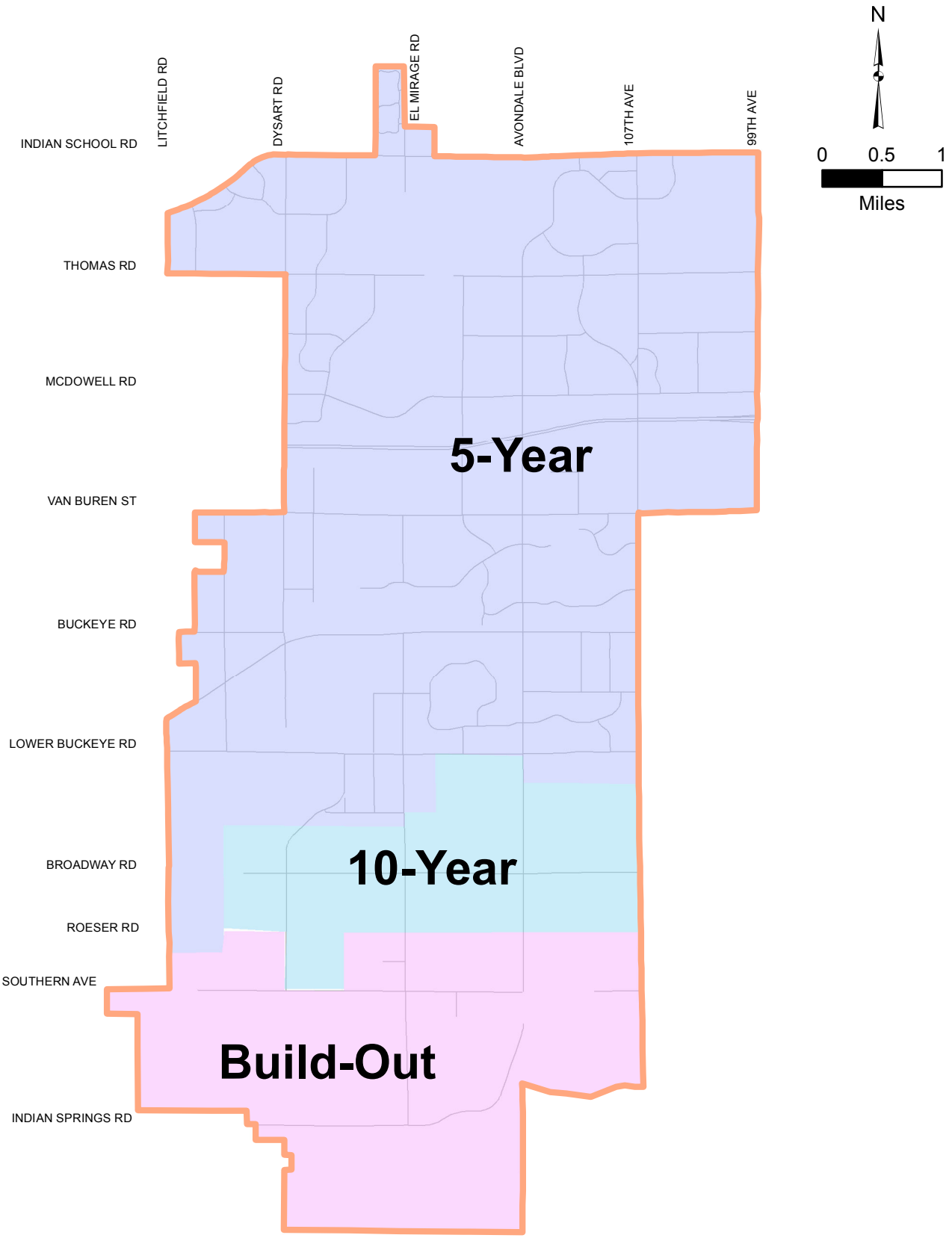
7.1. Future Water Supply Strategy

As described in the 2010 Water Resource Master Plan, the City plans to 'continue to build wells' to meet increasing water supply needs. The recommendations in this *Water Master Plan Update* are, thus, based on continuing to build wells. However, the evaluations and recommendations herein consider accommodating a future surface water treatment plant at locations investigated in the 2010 master plans.

7.2. Master Plan Assumptions

The following assumptions were made in further defining and refining the water supply strategy and in hydraulic modeling evaluations to identify recommended system improvements and expansions:

- There were no updates to the development phasing and growth phasing used in the 2010 master plan. Figure 7-1 shows the development and growth phasing used to develop the updated system improvement recommendations.
- The southern pressure zone concept was eliminated at the City's request because new construction since 2010 had not followed the 2010 master plan recommendations (due to budget limitations). The southern area is now assumed to be served from the distribution system with PRVs installed where necessary to regulate pressures. Appendix B provides details of the new PRVs that were assumed.
- The 24-inch transmission loop in the southern area was also eliminated at the City's request because new construction did not follow the 2010 master plan (due to budget limitations). The City's standard 16-inch distribution system looping was found to be adequate to serve the updated water demand projections.



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure 7-1 Development and Growth Phasing.mxd

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Development and Growth Phasing

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FIGURE 7-1

7.3. Production, Storage, and Booster Pumping Requirements

Water production, storage, and booster pumping requirements for the updated water demand projections (Chapter 5) are described in the following subsections.

7.3.1. Production Requirements

Table 7-1 presents the updated analysis of water production requirements through 2035. The analysis assumes that only existing and active wells constitute the existing well supply.

Table 7-1:
System Demand and Production Requirements

Parameters	2012	2017	2022	2035
Average Day Demand (mgd)	12.5	15.1	18.5	23.9
Maximum Day Demand (mgd)	20.6	24.9	30.5	39.4
Existing Well Supply (mgd)[1]	32.8	32.8	32.8	32.8
Production Criteria				
Reliable Supply Needed (mgd)[2]	27.5	33.2	40.7	52.6
Total Supply Needed (mgd)[3]	25.5	29.8	35.4	44.3
Additional Supply Required (mgd)	**0.0**	**0.4**	**7.9**	**19.7**

Notes:
(1) Existing well supply was calculated based on the pumping information provided by the City (Section 3.1).
(2) System supply needed to fulfill the maximum day demand with all wells operating for 18 hours or less.
(3) System supply needed to fulfill the maximum day demand with largest well out of service. The capacity of largest well is determined by Wells #16 and #25. As both wells are operate to blend water, loss of Well #16 would result in the loss of Well #25, for a total capacity loss of 3,400 gpm.

7.3.2. Recommended Additional Production Capacity

Options to provide additional production capacity in the future include improving treatment at existing wells, reactivation of existing wells that are inactive due to water quality concerns, completion of previously planned but not yet implemented wells, and new wells identified in the 2010 master plans. All new wells are assumed to have a capacity of 1,200 gpm (1.7 mgd).

Table 7-2 presents an update of the assumptions for existing wells that were identified as inactive and/or have water quality concerns. Included in Table 7-2 is the assumed use of each well for the *Water Master Plan Update*, additional supply capacity to be provided, and recommended timeline for implementation.

Table 7-2:
Assumed Improvements to Existing Wells

Well No.	Current Status	Potential for Improvement	Assumption for Master Plan	Additional Supply Capacity (gpm)	Planning Period
#17	Active – Treatment Issues	- Concentrate backwash brine to minimize hazardous waste disposal	Provide brine processing	0	2013 - 2017
#8A	Active – Insufficient Treatment	- Provide additional nitrate (800 gpm) and DBCP (1,000 gpm) treatment to increase well capacity from 2,000 gpm to 3,000 gpm	Provide additional treatment	1,000	2013 - 2017
#16B	Active - Irrigation Well	- Connecting to potable system will increase well supply reliability	Connect to well transmission pipe for Coldwater Reservoir, with no treatment	650	2023 - 2035
#21	Inactive - Water Quality	- Distribution of high TDS prohibits rehabilitation - Re-drilling to target lower TDS may increase arsenic - Potential for blending with limited capacity	Treat for TDS, iron and manganese	900[1]	2023 - 2035
#28	Inactive - Under Construction	- Potential for blending with limited capacity	Treat for TDS	600[1]	2023 - 2035

Note: (1) 25 percent loss in capacity assumed for wells with TDS treatment (see Appendix C).

In order to meet the *reliable supply* criterion in the future, the following priorities are recommended to provide additional production capacity in the future:

- **2013 to 2017:** The first priority wells are Wells #8A and #17 which currently receive treatment to reduce nitrate and DBCP to acceptable levels. Additional treatment for DBCP and nitrate is needed to increase the capacity of Well #8A from 2,000 gpm to 3,000 gpm (See Appendix C for treatment assumptions). To address the concern about high levels of total chromium in the backwash water, brine processing will be provided at Well #17 (Well #17 will stay at its current capacity). These improvements will provide 1,000 gpm (1.4 mgd) of additional production capacity by 2017.
- **2018 to 2022:** The next priority wells are those that have been planned previously but have not yet been implemented (Wells #22 and #26) and two new wells that were identified in the 2010 planning efforts. Because of the levels of nitrate in the existing Coldwater wells, nitrate treatment was assumed at the Coldwater facility (see Appendix C). The four new wells will provide an additional production capacity of 6.8 mgd by 2022.
- **2023 to 2035:** The next priority wells are existing Wells #16B, #21 and #28; and, five new wells that were identified in the 2010 planning efforts. Well #16B is an existing irrigation well that can be connected to the potable distribution system.

Wells #21 and #28 have elevated TDS and will be assumed to be provided with TDS treatment. In addition, because of elevated iron and manganese levels in Well #21, an oxidation step was assumed prior to TDS treatment to reduce the concentrations of iron and manganese, this step will also help to remove any arsenic in the water. A chlorine feed system and contact tank were included for removal of iron, manganese, and/or arsenic from Wells #21 and #28. Wells #21 and #28 are required to fill the Del Rio reservoir to serve future demands in the southern areas. The added existing and new wells will provide an additional production capacity of 11.6 mgd by 2035.

Figure 7-2 shows the recommended wells that will be in the system at 2035. Unless otherwise noted above, it is assumed that all new wells will be drilled and screened in appropriate locations such that arsenic, nitrate, and TDS levels are below the City's water quality goals. The hydrogeologic evaluation performed as part of the 2010 *Water Resource Master Plan* developed a map of favorable groundwater quality. All new wells are assumed to be located in areas with favorable groundwater quality and will not need treatment.

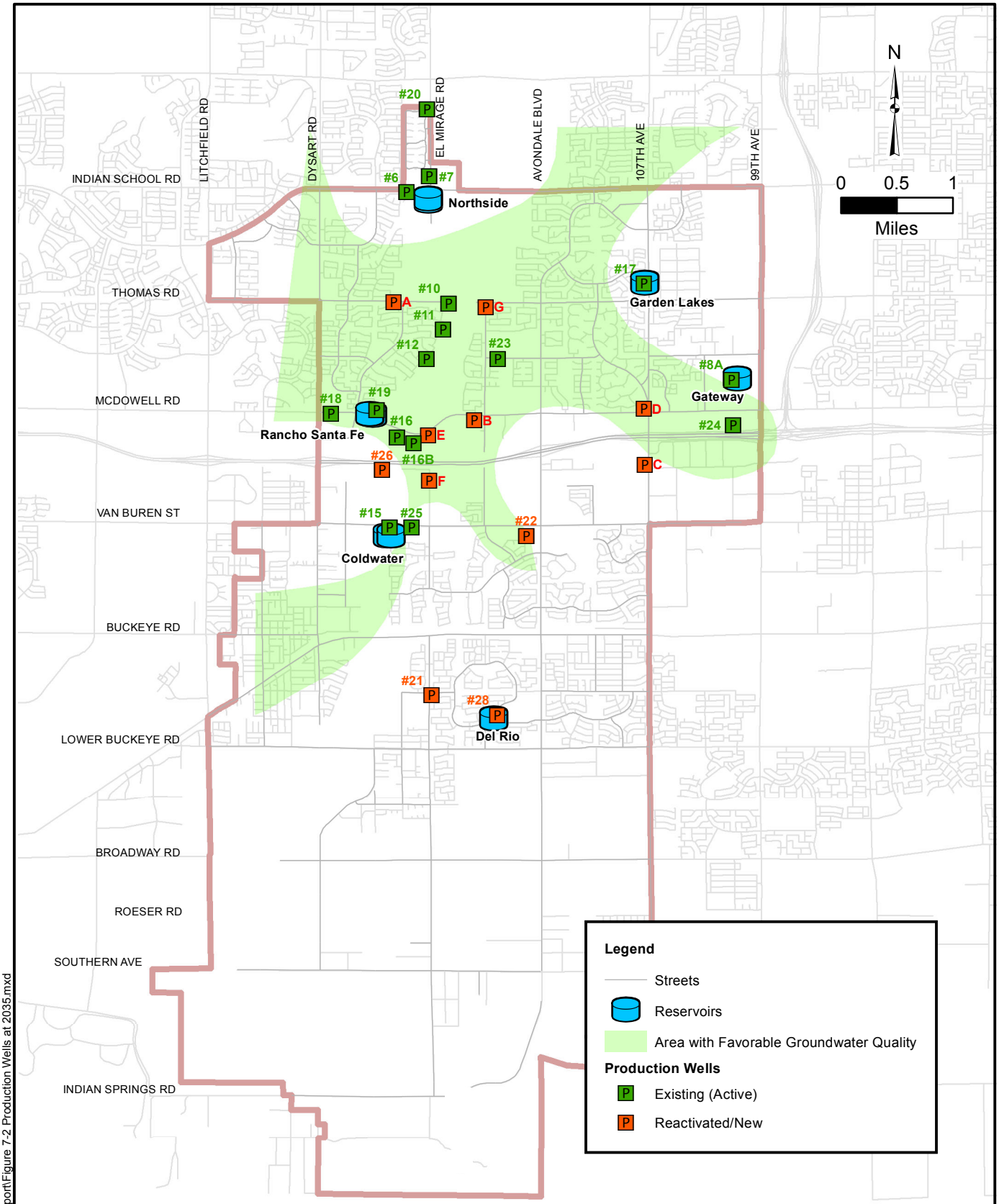
7.3.3. Storage Requirements

Table 7-3 presents the updated storage requirements through 2035. The Del Rio reservoir was assumed to be inactive, and only usable storage was assumed to comprise the existing storage capacity.

Table 7-3:
Storage Requirements

Parameters	2012	2017	2022	2035
Average Day Demand (mgd)	12.5	15.1	18.5	23.9
Maximum Day Demand (mgd)	20.6	24.9	30.5	39.4
Peak Hour Demand (mgd)	32.4	39.1	47.9	61.9
Fire Flow (MG) - 3,500 gpm for 4 hours	0.8	0.8	0.8	0.8
Total Production Capacity (mgd)	27.5	33.2	40.7	52.6
Existing Storage Capacity (MG)	8.5	8.5	8.5	8.5
Storage Criteria				
Peak Hour Storage Needed (MG)[1]	6.2	7.5	9.2	11.9
Fire Flow Storage Needed (MG)[2]	0.0	0.0	0.0	0.0
Operating Storage Needed (MG)[3]	4.1	5.0	6.1	7.9
Emergency Supply Storage Needed (MG)[4]	2.7	3.3	4.0	5.2
Additional Storage Required (MG)	**0.0**	**0.0**	**0.7**	**3.4**

Notes:
(1) Satisfy peak hour demand for four hours with 50% source capacity and 50% storage capacity
(2) Satisfy maximum day and fire flow demand with 80% total storage and all sources
(3) Operating storage should be equal to or greater than 20% of maximum day demand
(4) Satisfy average day demand with 80% storage volume and 50 % of well supply operated no more than 18 hours



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure 7-2 Production Wells at 2035.mxd

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Production Wells at 2035

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FIGURE 7-2

According to the City, the reservoir at Del Rio will be rehabilitated in the next five years. It is assumed that the reservoir will be rehabilitated to its current configuration and will thus return to service its usable storage capacity of 2.8 MG. This provides the City with enough storage through year 2022. An additional 1.0 MG of storage is recommended to be added in the 2023 to 2035 time period, it is assumed that this storage will be provided at the Coldwater site where space is available.

7.3.4. Pumping Requirements

Table 7-4 presents the updated booster pumping requirements.

Table 7-4:
Booster Pumping Requirements

Booster Station	Firm Capacity (mgd)			
	2012	2017	2022	2035
Average Day Demand (mgd)	12.5	15.1	18.5	23.9
Existing Booster Pumping Firm Capacity (mgd)	40.2	40.2	40.2	40.2
Booster Pumping Criteria				
Maximum Day Demand plus Fire Flow (mgd)[1]	25.7	30.0	35.6	44.5
Peak Hour Demand (mgd)[2]	32.4	39.1	47.9	61.9
Additional Booster Pumping Required (mgd)	**0**	**0**	**7.7**	**21.7**

Notes:
(1) Maximum Day + Fire Flow = 1.65 times Average Day Demand + 3500 gpm of Fire Flow
(2) Peak Hour = 2.59 times Average Day Demand

With the Del Rio reservoir being rehabilitated in the next 5 years, the boosters at Del Rio (8.6 mgd firm capacity) will become available to use by 2017, which will provide sufficient booster pumping through 2022. An additional 13 mgd of firm booster pumping capacity is needed in the 2023 to 2035 time period. The required additional booster pumping capacity is recommended to be added at the Rancho Santa Fe, Northside and Coldwater booster stations.

7.3.5. Distribution System Requirements

The projected future water demand conditions were evaluated with the updated water system hydraulic model to identify needed distribution system piping improvements. The modeling incorporated the recommended production, storage and booster pumping recommendations in the previous sections.

The recommended water system improvements and capital cost opinions are presented in the Executive Summary of this *Water Master Plan Update* on Figures ES-5, ES-6 and ES-7; and, in Tables ES-3, ES-4 and ES-5.

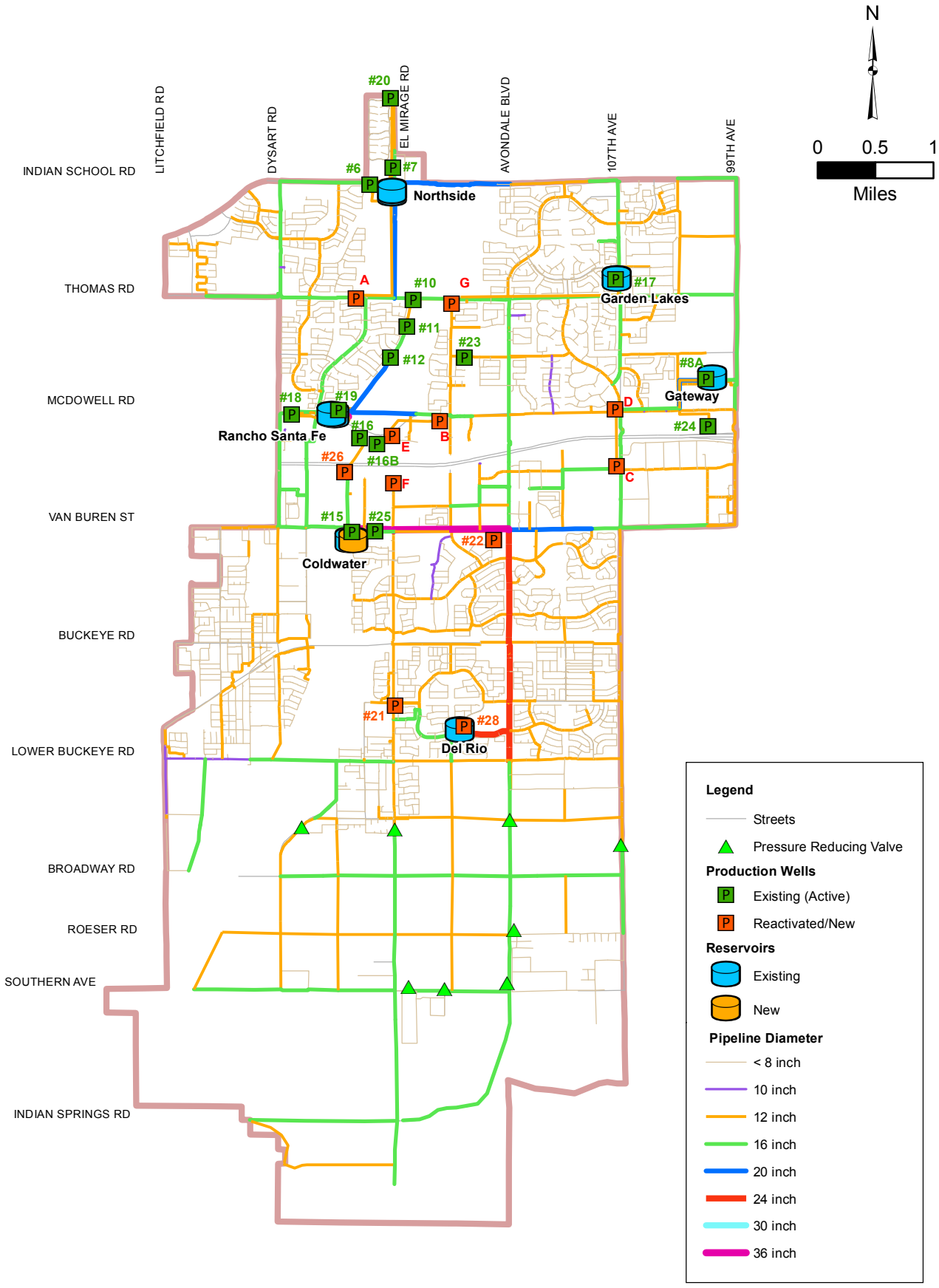
An updated complete system map of the recommended water system at 2035 is shown on Figure 7-6. This map shows the existing system (Figure 3-1) and the entire new infrastructure that is recommended in this *Water Master Plan Update*.

It should be noted that in accordance with industry-accepted practice for long-range water system planning, the *Water Master Plan Update* includes recommendations for all facilities and infrastructure that will serve all current and future land uses identified in the City's General Plan, and within the agreed upon future service area. It is expected that many of the recommended pipelines on adjacent half-mile and mile section lines (streets) will be constructed by developers as part of their normal construction requirements. Also, some of the pipelines may not be constructed based on actual development and future changes to the General Plan. It is anticipated that the City will identify which recommended infrastructure will be constructed by developers and by the City, and which infrastructure will actually be built based on the best prevailing information.

7.4. Basis for Capital Cost Opinions

Opinions of capital costs were developed for the recommended system improvements based on available existing studies, recent projects with similar components, manufacturer's budget estimates, standard construction cost estimating manuals, and engineering judgment. The level of accuracy for the cost estimates corresponds to the Class 4 estimate as defined by the Association for the Advancement of Cost Engineering (AACE) International. This level of engineering cost estimating is approximate and generally made without detailed engineering data and site layouts, but is appropriate for preliminary budget-level estimating. The accuracy range of a Class 4 estimate is minus 15 percent to plus 20 percent in the best case and minus 30 percent to plus 50 percent in the worst case.

Appendix C contains updated unit cost information and other assumptions used for estimating costs. Unit capital costs include materials of construction, installation, and contractor costs (overhead, profit, bonding, mobilization). Different unit cost values were used for pipes that were located in developed and undeveloped areas. Pipes located in developed areas have higher unit costs to account for additional costs associated with pavement resurfacing, traffic management in developed areas, etc. All costs also include a 20 percent factor for engineering and construction administration and 30 percent for project contingencies. All costs are in February 2013 dollars referenced to an Engineering News Record Construction Cost Index (ENR CCI) of 9,453.



\arcadis-us.com\OfficeData\Phoenix-AZ\Projects\0864027\GIS\MXDs\Draft Report\Figure 7-6 Water Infrastructure at Build-out.mxd

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Water Infrastructure at 2030

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FIGURE 7-6

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8. References

Avondale, City of. 2008. General Engineering Requirements Manual. City of Avondale Arizona.

Wilson Engineers. 2008. Del Rio Wellhead Treatment Summary Report. City of Avondale, Arizona (August).

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A. Water Demand Projection Tool Update

The water resource demand projection tool (Tool) developed in the 2010 Water Resource Master Plan was updated for this Water Master Plan Update. This appendix summarizes the updates made to the Tool.

A.1. General Overview

The Tool is a GIS-based tool that utilizes the City's GIS data in an interactive database setting to project future water resource needs quickly and easily and produces geospatial output that can be exported into infrastructure hydraulic models. The Water Master Plan Update focused on updating the drinking water demand projections. Water supply, wastewater flow projections and reclaimed water projections were not included in the scope of the Update project.

A.2. Data Sources

Table A-1 provides a summary of the data sources that were used to update the Tool.

Table A-1:
Projection Tool Data Sources

File/Report Name	Description
2012 Avondale Development Progress shapefiles (*commercial, developments_under_const, multifam_dev, school_public, parks, zoning_applications)*	Existing and planned developments in the City's planning area
2012 Google aerial images	Used to confirm development progress
Avondale General Plan 2030	Land use classifications and definitions
Recent (2012) City population projections and vacancy rates	Used to confirm calibration of the Tool

A.3. Tool Update and Calibration

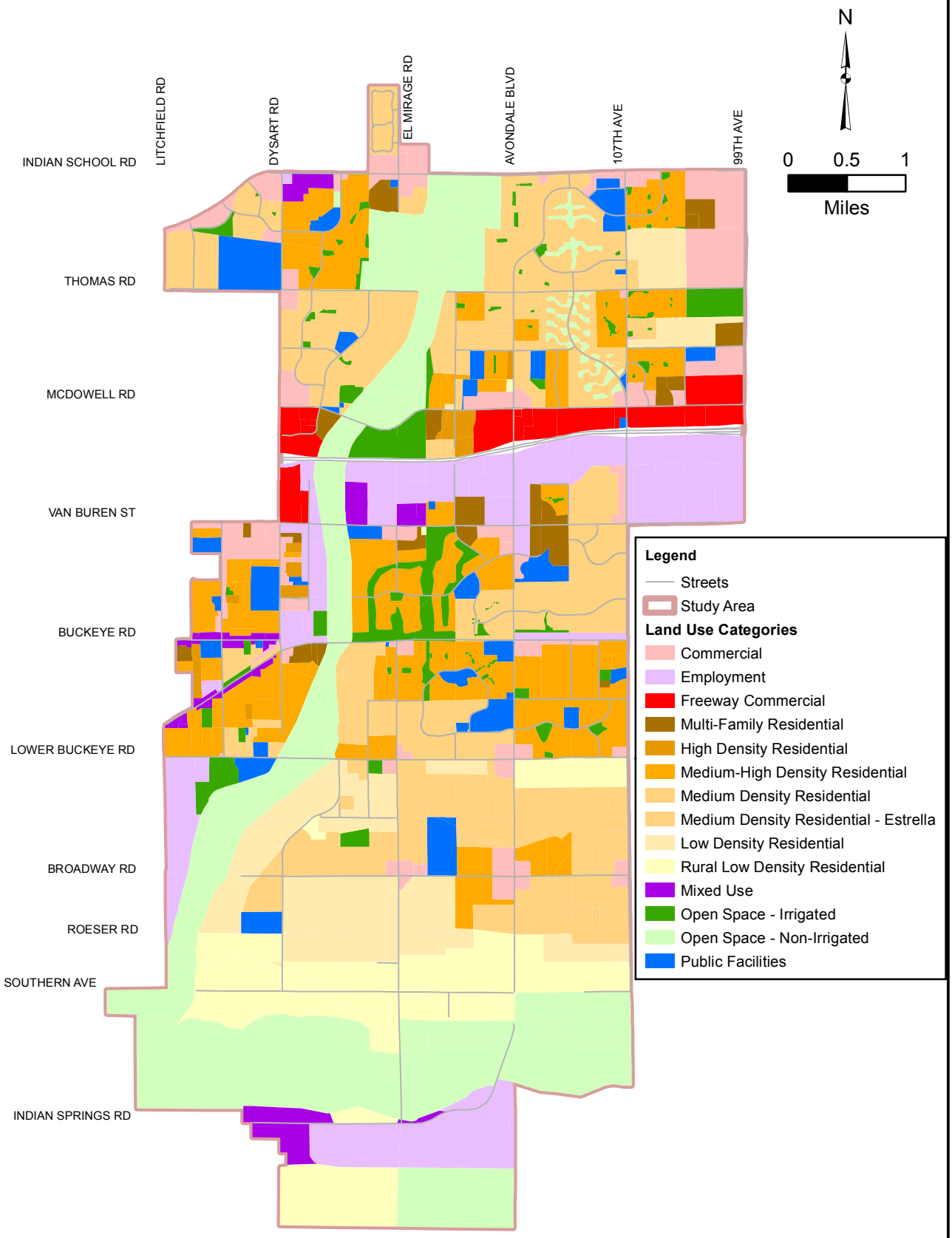
The Tool was updated to reflect changes that have been made to existing developments and planned land uses since 2010. The Tool demand map was updated (see Figure A-2) and calibrated as follows:

- The City's existing/planned developments were compared against the developments in the 2010 Tool. The percent developed for Ashton Pointe and Mirabella Apartment communities was changed from 0% to 100%.

- Land uses in the Avondale General Plan 2030 were compared against land uses in the 2010 Tool. Changes were only made if the polygon was not custom and there was not a known development in the area. Changes were largely made south of Lower Buckeye Road.
- The updated Tool calculated the existing demand as 13.3 mgd based on the changes noted above. The Tool was calibrated to existing 2012 drinking water production (12.3 mgd in the City service area, 0.1 mgd in the former Rigby service area) by adjusting the residential percent developed for year 1 (existing, 2012) from 100% to 93%. The difference in calculated demand and actual production is presumed to be due to vacancies (7%). The vacancy rate assumption was confirmed by the City's planning department who estimated the current vacancy rate to be 10.2%.
- The rate of growth between Year1 (2012), Year2 (2017), Year3 (2022), and Year4 (2035) was compared to updated population growth rates provided by the City as shown in Table A-2. The dwelling unit growth in the Tool compares well with the City's updated population projections through 2035.

Table A-2:
Growth Rate Comparison: Tool Dwelling Units vs. City Population Projections

	2012	2017	2022	2035
Dwelling Units (Tool)	25,568	29,787	34,201	41,500
Percent Change (Tool)	-	17%	15%	21%
Population (Updated City Data)	80,096	93,754	110,249	135,763
Percent Change (Updated City Data)	-	17%	18%	21%



G:\Projects\0864027\GIS\MXDs\Draft Report\Figure A-2 Land Use Map for Study Area.mxd

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Demand Map

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FIGURE A-2

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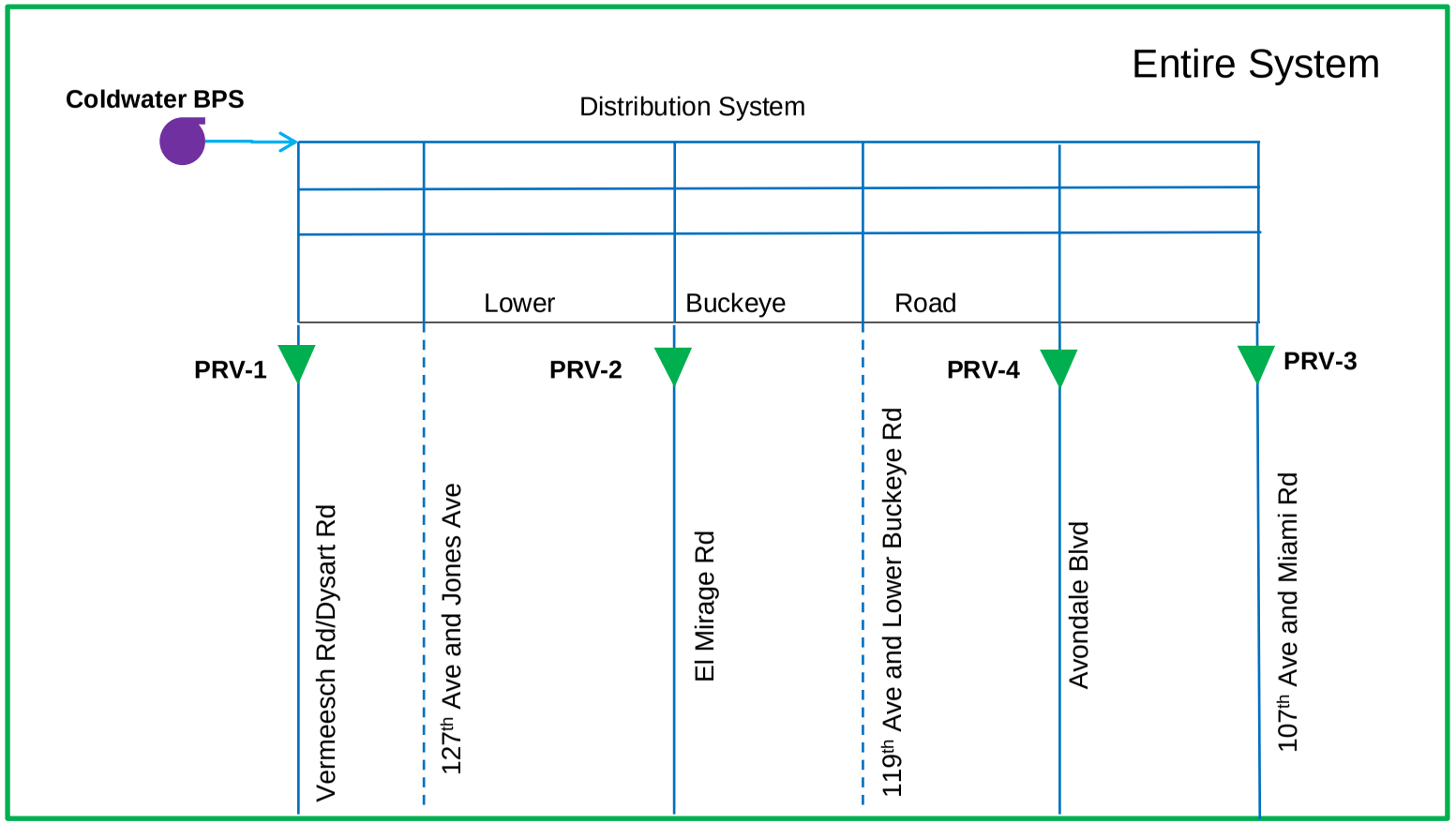
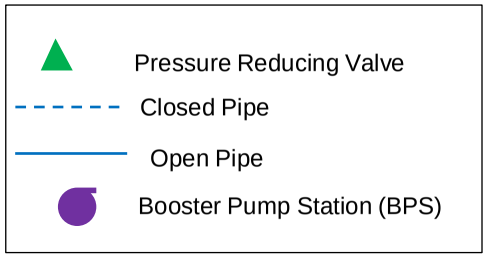
B. New Pressure Zone Schematics



PRV1, PRV-2, PRV-3, and PRV-4: These three PRVs can be used to regulate the high pressure from the existing system, to the users in the south,



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Schematic of Pressure Zone Setup

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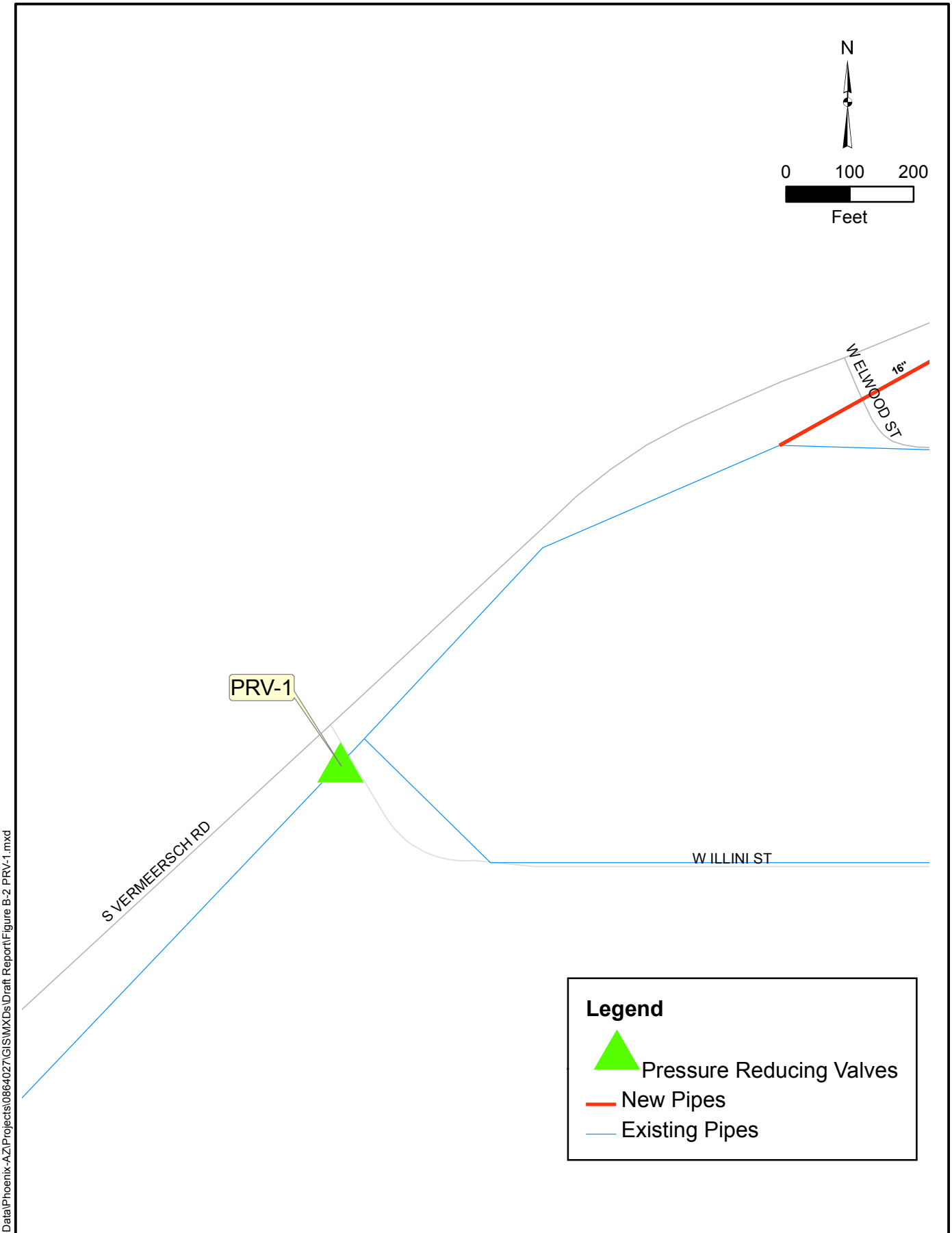
Figure B-1



\\arcadis-us.com\OfficeData\Phoenix-AZ\Projects\08640027\GIS\MXDs\Draft Report\Figure B-2 PRV-1.mxd

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PRV at Vermeersch Road near Illini Street

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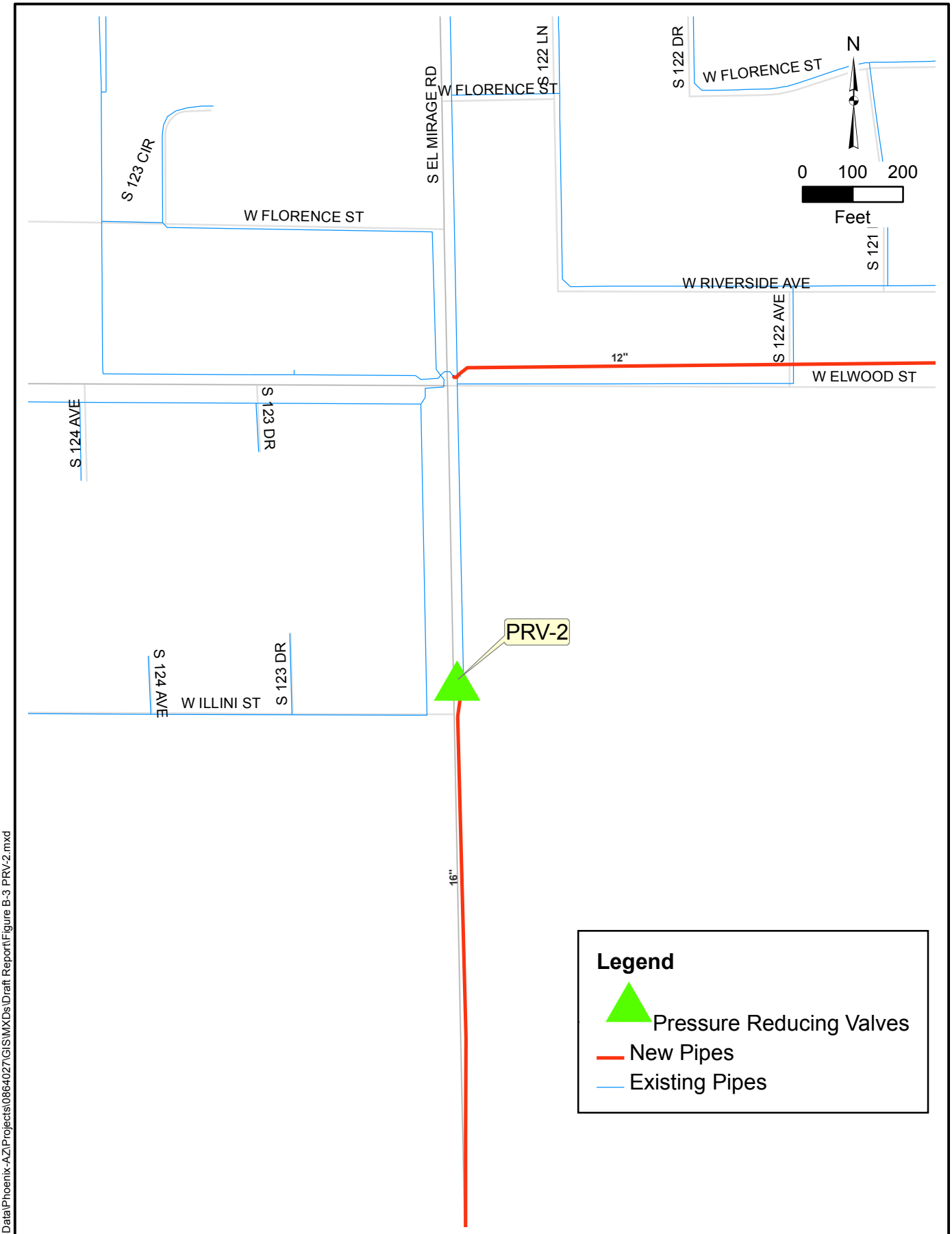
FIGURE B-2



\\arcadis-us.com\OfficeData\Phoenix-AZ\Projects\08640027\GIS\MXDs\Draft Report\Figure B-3 PRV-2.mxd

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PRV at El Mirage Road near Illini Street

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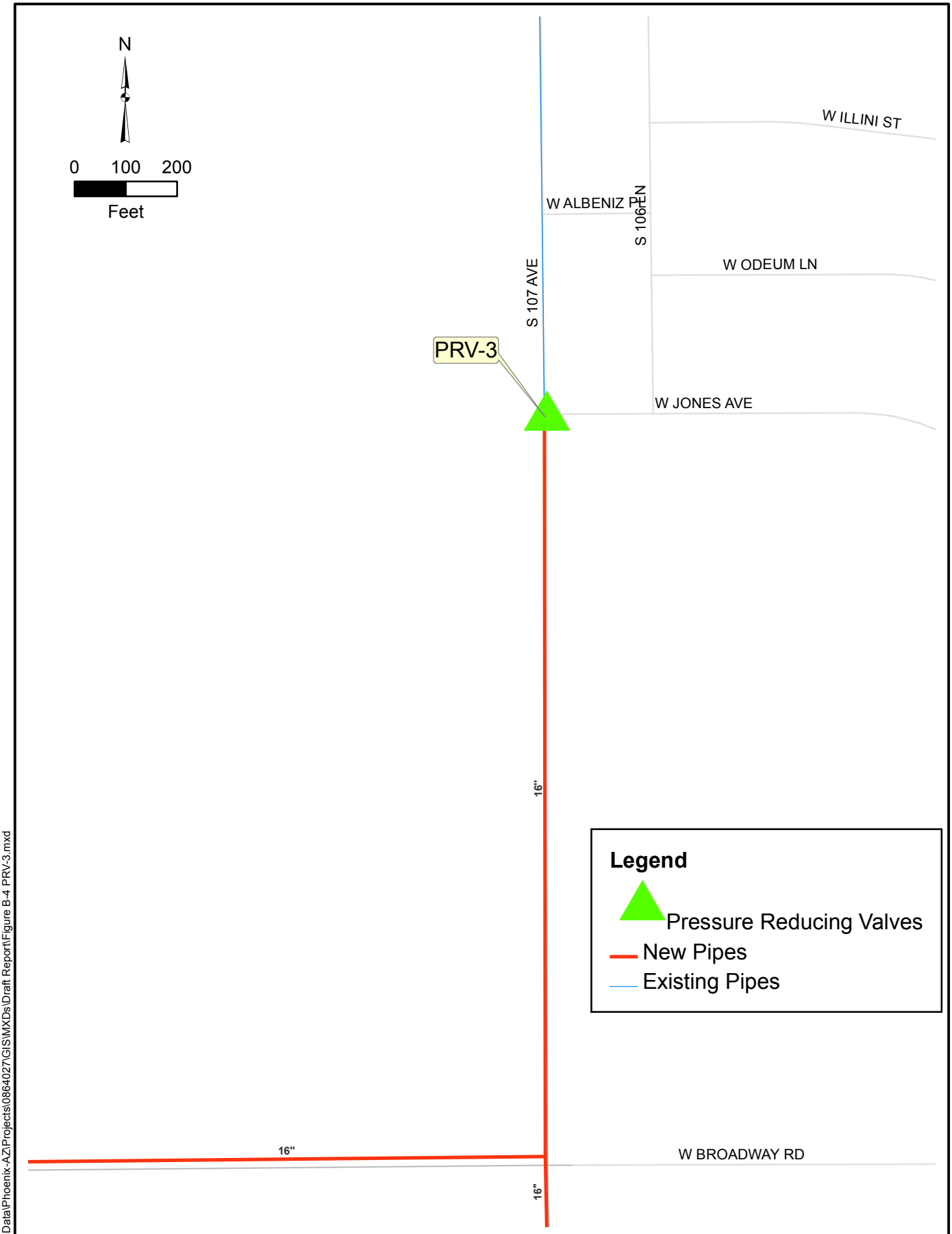
FIGURE B-3



\\arcadis-us.com\OfficeData\Phoenix-AZ\Projects\08640027\GIS\MXDs\Draft Report\Figure B-4 PRV-3.mxd

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PRV at 107th Avenue near Jones Ave

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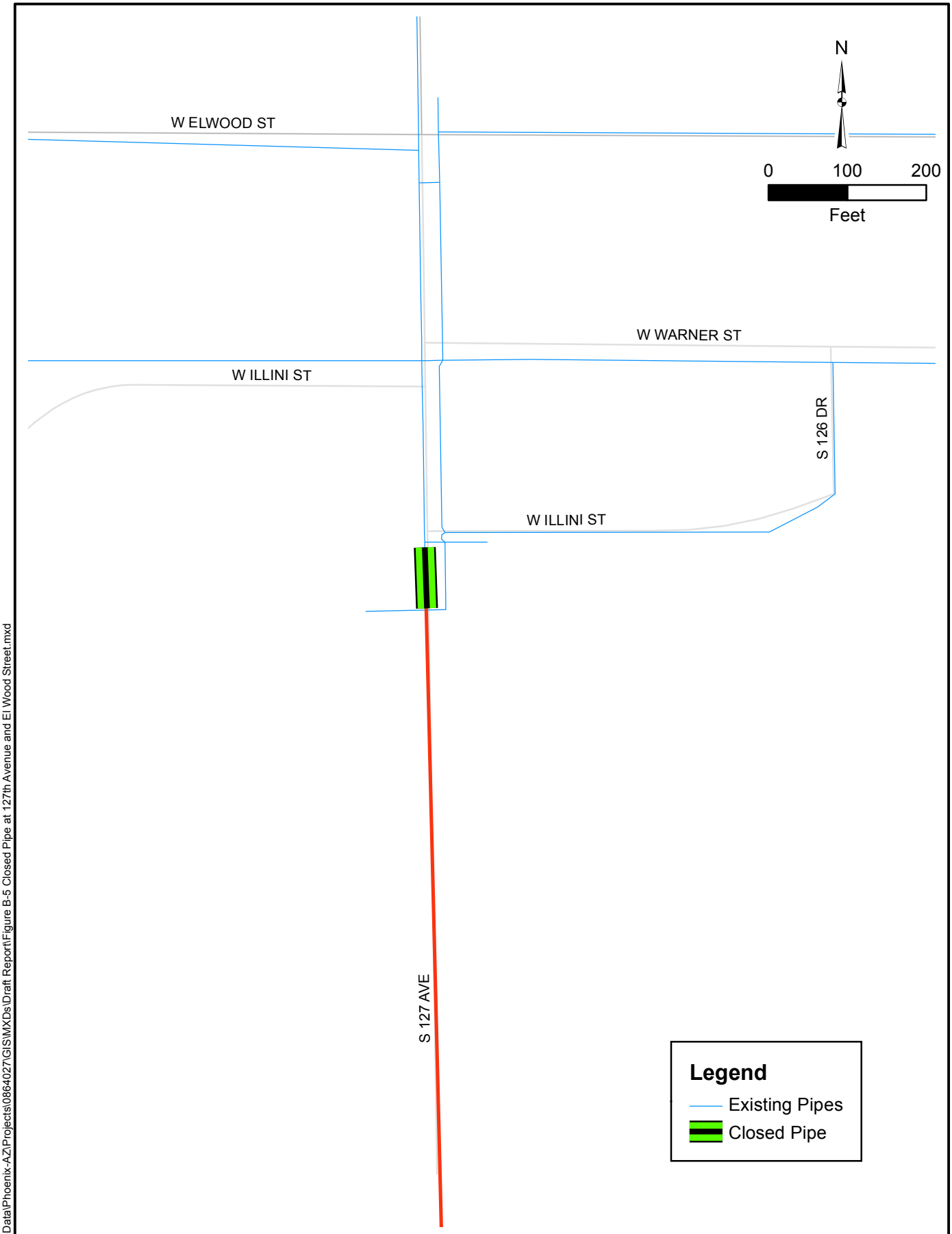
FIGURE B-4



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Closed Pipe at 127th Avenue and Illini Street

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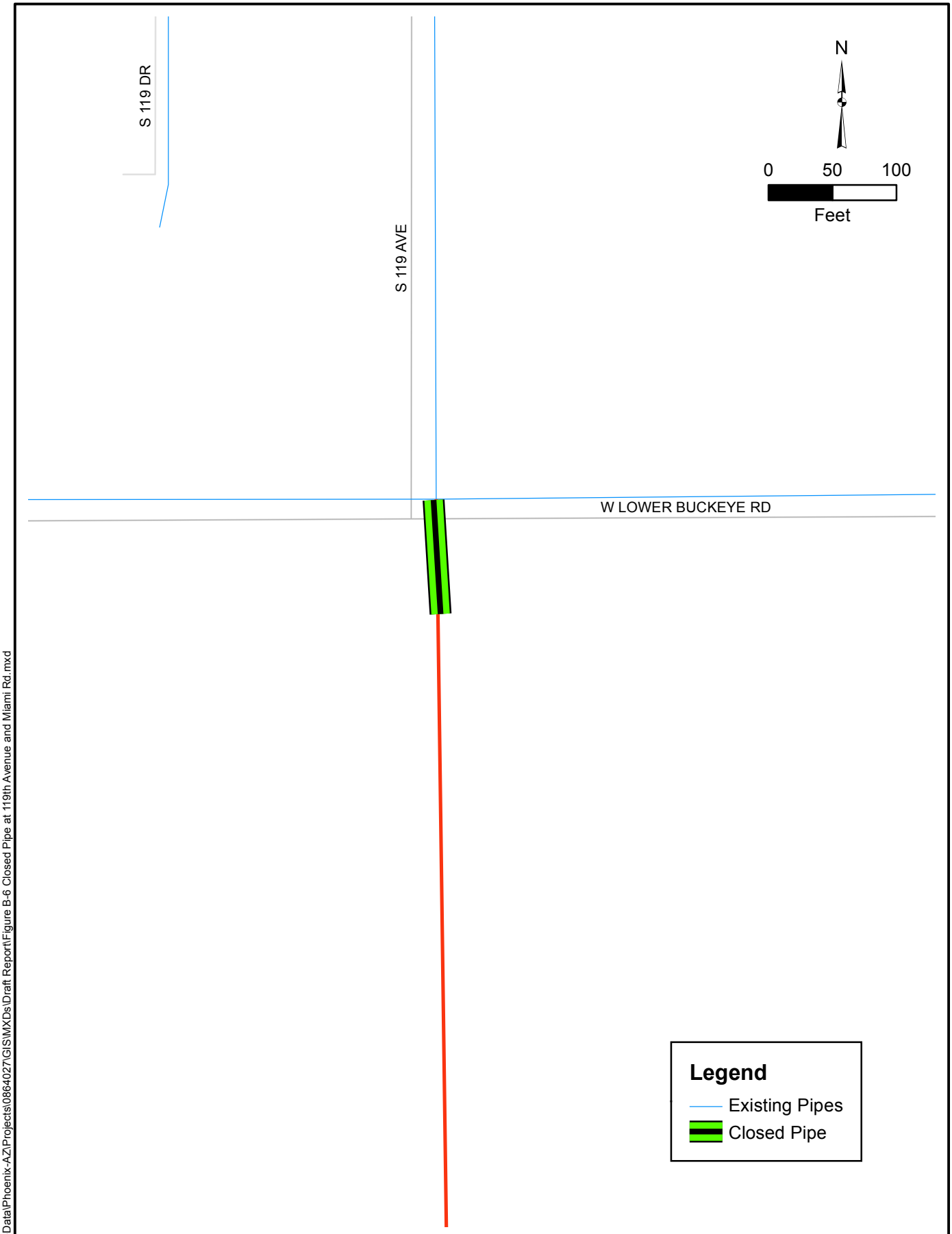
FIGURE B-5

\\arcadis-us.com\OfficeData\Phoenix-AZ\Projects\08644027\GIS\MXDs\Draft Report\Figure B-5 Closed Pipe at 127th Avenue and El Wood Street.mxd



\\arcadis-us.com\OfficeData\Phoenix-AZ\Projects\08640027\GIS\MXDs\Draft Report\Figure B-6 Closed Pipe at 119th Avenue and Miami Rd.mxd

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Closed Pipe at 119th Avenue and Lower Buckeye Rd

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FIGURE B-6

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C. Updated Capital Unit Costs

Table C-1
Summary of Capital Unit Costs[1,2,3]

ITEM	UNITS	COST (Feb. 2013)	Included in Unit Cost
CAPITAL COSTS			
Pipelines			
Ductile Iron Pipe (developed areas)			
6"	$/LF	$119	Ductile iron pipe with excavation, asphalt removal and replacement, five feet of cover, backfill, bedding
8"	$/LF	$146	
10"	$/LF	$174	
12"	$/LF	$200	
14"	$/LF	$228	
16"	$/LF	$254	
18"	$/LF	$289	
20"	$/LF	$324	
24"	$/LF	$394	
30"	$/LF	$499	
36"	$/LF	$603	
Ductile Iron Pipe (undeveloped areas)			
6"	$/LF	$83	Ductile iron pipe with excavation, five feet of cover, backfill, bedding
8"	$/LF	$109	
10"	$/LF	$135	
12"	$/LF	$160	
14"	$/LF	$187	
16"	$/LF	$216	
18"	$/LF	$251	
20"	$/LF	$286	
24"	$/LF	$357	
30"	$/LF	$463	
36"	$/LF	$570	
Reservoirs (covered)			
0.0 to < 2.5 MG	$/MG	$2,292,904	
2.5 to < 4.0 MG	$/MG	$1,859,126	
Reservoir Rehabilitation (3.5 MGD)	$/EA	$2,574,000	
Booster Pump Stations			
0 to < 7 mgd	$/MGD	$607,915	Includes fencing and access gates, site paving, landscaping, earth and concrete work, electrical, mechanical, instrumentation and SCADA
Pressure Reducing Valves			
16 inch	$/EA	$ 91,096	
New Production Wells/Redrilling	$/well	$2,411,759	
Wellhead Rehabilitation	$/well	$1,100,209	
Nitrate Treatment	$/MGD	$ 844,022	
Brine Processing Unit	$/MGD	$ 281,371	
DCBP Treatment	$/MGD	$ 733,473	
Oxidation + TDS Treatment + Evap Ponds	$/MGD	$8,089,586	

NOTES:
(1) February 2013 Costs (ENR CCI = 9,453).
(2) Unit capital costs include engineering/design, materials of construction, installation and contractor overhead and profit.
(3) Unit capital costs include engineering & construction administration (20 percent) and contingency (30 percent).

Table C-2
Water Quality Treatment Summary

Well	Flow (gpm)	TDS (mg/L)	Nitrate (mg/L)	Arsenic (µg/L)	DBCP (mg/L)	Treatment Process	Treated Flow (MGD)	Assumptions
21	1,200	1,450	9.34	ND	-	Oxidation + TDS treatment + evaporation ponds	2.2	Assume treatment at Del Rio storage reservoir; Includes associated piping to offsite evaporation ponds. Oxidation step includes chlorine feed system and contact tank for iron, manganese, and/or arsenic removal. City's target TDS concentration is 700 mg/L.
28	800	1,500	36	11	-			
8A	3,000	-	14.8	-	present	DBCP treatment (GAC)	1.5	Add additional 1,000 gpm DBCP treatment capacity.
8A	3,000	-	14.8	-	present	Nitrate treatment	1.2	Can currently treat 1,300 gpm for nitrate and 2,000 gpm for DBCP; assumes blending #8A with #24; City's target nitrate concentration is 7 mg/L.
24	650	-	9.28	-	-			
24	650	-	9.28	-	-	Brine processing unit	1.2	Assume chromium in backwash brine is an issue.
17	1,200	-	-	-	-	Brine processing unit	1.8	Entire flow is currently treated; assume chromium in backwash brine is an issue; add brine concentration; assume brine and solids will be hauled offsite; City's target nitrate concentration is 7 mg/L.
15	650	-	3.2	-	-	Nitrate treatment at Coldwater Facility	1.8	Assuming a nitrate concentration of 8 mg/L for well #26; wells #15, #16, #25 are blended together and do not require treatment; treating wells #22 and #26 requires 760 gpm of treatment capacity; to be more conservative, assume 1,200 gpm of treatment.
16	2,200	-	6.1	-	-			
22	1,200	-	10	-	-			
25	1,200	-	10	-	-			
26	1200	-	8	-	-			

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City of Avondale

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