FINAL Report

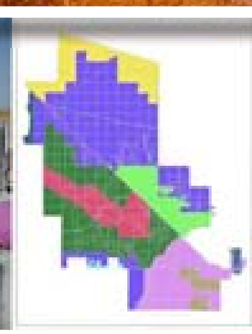
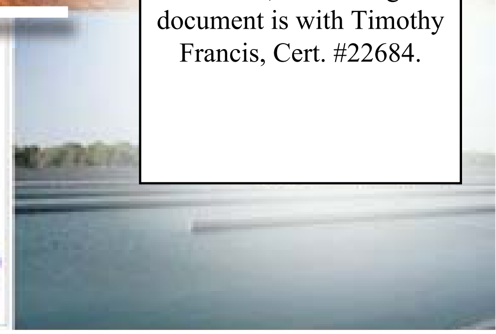
SURPRISE
ARIZONA

Integrated Water Master Plan
Water Resources

NOVEMBER 2008

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



4957-002

MALCOLM PIRNIE
INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS AND CONSULTANTS

ASU DECISION THEATER
ARIZONA STATE UNIVERSITY

City of Surprise, Arizona
Water Services Department • 12425 West Bell Road • Surprise, AZ 85374-9002

Integrated Water Master Plan

Water Resources

November 2008

Report Prepared By:

Malcolm Pirnie, Inc.

4646 East Van Buren Street
Suite 400
Phoenix, AZ 85008

4957-002

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

Contents

Tables

Figures

Appendices

A. Water Resource Demand Module

The Water Resources Demand Module was created to allow the City to dynamically simulate its existing and future water resource needs derived from GIS-based data and land use-based demand factors entered by the user. This section provides an overview of the Demand Module, the methodology that was used to create it, the demand factors that were used, and the steps that were taken to calibrate it.

A.1. General Overview

The objective of the Demand Module is to provide water (indoor, outdoor, and landscape) and wastewater flow projections in a format compatible with City water, wastewater, and reclaimed water infrastructure models. Historically, integrated water master planning relied on Microsoft Excel-based spreadsheets to calculate water resource needs, and existing/future demands were manually entered into water system models. By utilizing the City's GIS-based data in an interactive database setting, future water resource needs can be calculated quickly and easily and exported into water system models. In addition, the Demand Module allows users the opportunity to change demands, development characteristics, or demand factors that can then be used to dynamically recalculate water resource needs. For example, if the City accepts a proposal for a large development in SPA 6, the City can quickly update the Demand Module to determine the development's effect on water resource needs. Similarly, if historical data suggest that average water use in high density residential areas has decreased, the City can adjust the demand factor and rerun the Demand Module to obtain revised water resource needs.

Potable water, potential reclaimed water, and wastewater flow demand factors were incorporated into the Demand Module and applied to each polygon in a "demand map." The Demand Map was created in order to spatially allocate demands across the City's planning area and allow the City to adjust demands within its planning area. By intersecting multiple shapefiles, the Demand Map allows the City to adjust these demands by polygon attributes such as land use type, water service provider, sewer service provider, SPA, and development name. MAG population projections and the City's *Scenic Integrity Guidelines* (May 2008) were also included to refine projections over time and approximate landscape demands for parks and golf courses and other landscape area demands. By maintaining each polygon's attributes as the Demand Map is incorporated into the Demand Module, polygon attributes such as the density (du/acre), percent landscape, and type of landscape can be changed individually or on a system-wide basis.

A.2. Demand Map

The Demand Map, created from a combination of 10 shapefiles (Table A-1), was the basis for all water, wastewater, reclaimed water demand projections. Prior to intersecting the shapefiles, each shapefile was clipped using the City's municipal planning area as a reference, and common boundaries were aligned to minimize the creation of small, unnecessary polygons. Data from the shapefiles were also used to estimate residential densities, landscape characteristics, and a development timeline. After the shapefiles were intersected, unused data fields were deleted. This section describes the methodology that was used to create the Demand Map.

Table A-A-1.
Shapefiles Intersected in the Composite Map

Shapefile	Source	Description
planning_area	City of Surprise	Municipal Planning Area
spa	City of Surprise	Special Planning Areas
water_mpa	City of Surprise	Water Service Providers
sewer_mpa	City of Surprise	Sewer Service Providers
landuse_2008	City of Surprise	Updated Land Use Plan (January 2008)
parcels	City of Surprise	Parcels and Property Use Codes
landscape	City of Surprise	Percent and Type of Landscaping
developments	City of Surprise	Existing and Planned (1-3 years) Developments
TAZ_2007	MAG	MAG Traffic Analysis Zone (TAZ) 2005, 2010, 2020, and 2030 Population Projections
PLSS	City of Surprise	Public Land Survey System One-Mile Grid Section

A.2.1. Residential Densities

"Lot_count" and "area" fields found in the *developments* shapefile were used to determine the residential densities (du/acre) for each existing and planned development (Table A-2). In the event that a development's number of dwelling units was not indicated, "property_use" codes and count information from the *parcels* shapefile were used to estimate residential densities. Codes starting with "01**" (Single Family Residential) were classified as a dwelling unit. The few multiple family dwelling unit codes ("03**") were not included in the dwelling unit count because there were not sufficient data in the *parcels* shapefile to ascertain the number of dwelling units contained within an apartment or condo complex. For all other residential areas where the du/acre were unknown, the residential density was left blank. Default values used when the residential densities were unknown are described in Section 5 of the *Integrated Water Master Plan: Water Resources* Report.

Table A-A-2.
Residential Development Housing Densities

Development	Density (du/acre)	Development	Density (du/acre)	Development	Density (du/acre)
Acoma Court	2.0	Greenway Parc	3.5	Rancho Gabriela	2.9
Ana Mandera	5.9	Greer Ranch	2.8	Rancho Maria	2.6
Arizona Traditions	5.6	Happy Trails Resorts	6.2	Rancho Mercado	3.4
Asante	4.3	Heathers Place	0.7	Rio Caballo	3.0
Asante North	3.8	Hendricks Estates	0.2	Rio Rancho	4.3
Ashton Ranch	3.8	Hill View Estates	0.2	Roseview	4.2
Austin Ranch	3.7	Hollow Way Estates	0.1	Royal Ranch	3.7
Austin Ranch II	3.7	Jarvis Estates	0.1	Sarah Ann Ranch	3.0
Baergs Place	0.2	JOMAX RANCHES	0.8	Sierra Montana	3.4
Baldwin Estates	0.4	JOMAX RANCHES 2	1.0	Sierra Norte	2.4
Bear Estates	0.1	Kamaoles Retreat	0.4	Sierra Verde	4.0
Bell Pointe 1	5.5	Kenly Farms	1.0	Soleada	2.6
Bell Pointe 2	6.1	Kingswood Parke	4.6	Sonoran Trails	5.4
Bell West Ranch	3.5	Lake Pleasant 5000	2.0	Stonebrook	3.9
BNSF Commercial	0.0	Legacy Parc	4.0	Sun City Grand	3.0
Breckners Place	3.0	Legacy Village	1.8	Sun Village	6.6
Broadstone Ranch	3.0	Litchfield Manor	3.2	Sunhaven Ranch	3.8
Buena Vista Ranch	3.1	Litchfields	4.5	Sunrise Ranch	3.1
Cactus End	3.0	Marisol Ranch	3.2	Surprise Farms	4.9
Cactus Town	3.0	Marley Park	3.7	Surprise Foothills	2.8
Canyon Ridge West	4.3	Martin Acres Subdivision	0.6	Surprise Foothills East	3.1
Cielo Crossing	2.7	Maxs Corner	0.9	Surprise Ranch	3.5
Ciminski Estates	3.0	Mequite Mountain Ranch	1.6	Sycamore Farms	3.4
Clemit	3.0	Mesquite Mountain Ranch Phase	2.4	Tash	3.0
Cotton Gin	2.6	Mountain Gate	1.1	The Orchards	2.1
Countryside	4.1	Mountain Vista Ranch	4.5	Tierra Rico	2.3
Coyote Lakes	2.3	Nelson Acres	0.4	Tierra Verde	2.8
Custer Estates	3.6	Northwest Ranch	3.3	Trail of Light	0.4
Desert Moon Estates	2.7	Original Town Site	2.0	Trail of Light Phase II	0.4
Desert Oasis	4.0	OTT	0.4	Veramonte	2.2
Desert Vista Estates	0.2	Parke Row	4.3	Vistas Montanas	2.5
Esmeier Estates	0.3	Patsys Place	0.2	Waddell Ranches	0.8
Foothills 40	1.1	Patton Place Estates	1.4	Walden Ranch	3.0
Fox Hill Run	4.8	Peak View Estates	0.3	West Point Town Center	3.6
Fox Trail	2.9	Pensris Place	0.4	Yoder Estates	0.2
Grand Oasis	5.0	Pinnacle Peak Country Estates	1.5	Zenjero Trails	3.1
Grand Vista	3.1	Prasada	2.1		

A.2.2. Landscape Characterization

Using the City's *Scenic Integrity Guidelines* as a starting point, the City's Planning Department estimated the "Percent Landscape" (percent of a development's area that is landscaped), "Turf Landscape Percentage" (percent of the landscape indicative of high water use), "Xeriscape Landscape Percentage" (percent of the landscape indicative of low water use), and "Desert Landscape Percentage" (percent of the landscape with no water use) for the landscape use codes shown in Table A-3. These estimations were based on knowledge of previous developments' landscaping and developer landscape guidelines. After estimating the values for each landscape use code, the City projected these codes onto a map that was transferred into the Demand Module.

Table A-A-3.
Landscape Use Codes

Landscape Use Code	Percent Landscape	Turf Landscape Percentage	Xeriscape Landscape Percentage	Desert Landscape Percentage
South Valley Plain	13	41	12	47
Mid Valley Plain	16	20	40	40
Luke Valley Plain	10	3	46	51
West Valley Plain	14	22	33	45
Bajada	23	10	37	53
Sonoran Uplands	78	1	8	91
River Wash Corridor	78	1	8	91
Sonoran Mountain	100	0	0	100

A.2.3. Development Timeline

The City indicated that, for purposes of planning, build-out would occur around 2060. With an estimated 2.2 residents per dwelling unit, the expected population at build-out was anticipated to be around one million people. Population projections obtained from MAG were used as a surrogate to determine the percent developed of each polygon with respect to time. Using 2004 TAZ projections, the build-out population for each polygon was calculated by multiplying the build-out dwelling units by 2.2 residents per dwelling unit. Then, using the *TAZ_2007* shapefile, "TOTPOP05", "TOTPOP20", and "TOTPOP30" were divided by the build-out population to determine the percent developed for each polygon. In the event that the 2004 TAZ projections did not include areas in the City's current MPA, the rate of development was determined from polygons adjacent to the unknown polygon. For polygons where the "TOTPOP30" exceeded the build-out population, the percent developed was assumed to be 100 percent for both periods.

A.2.4. Shapefile Intersection

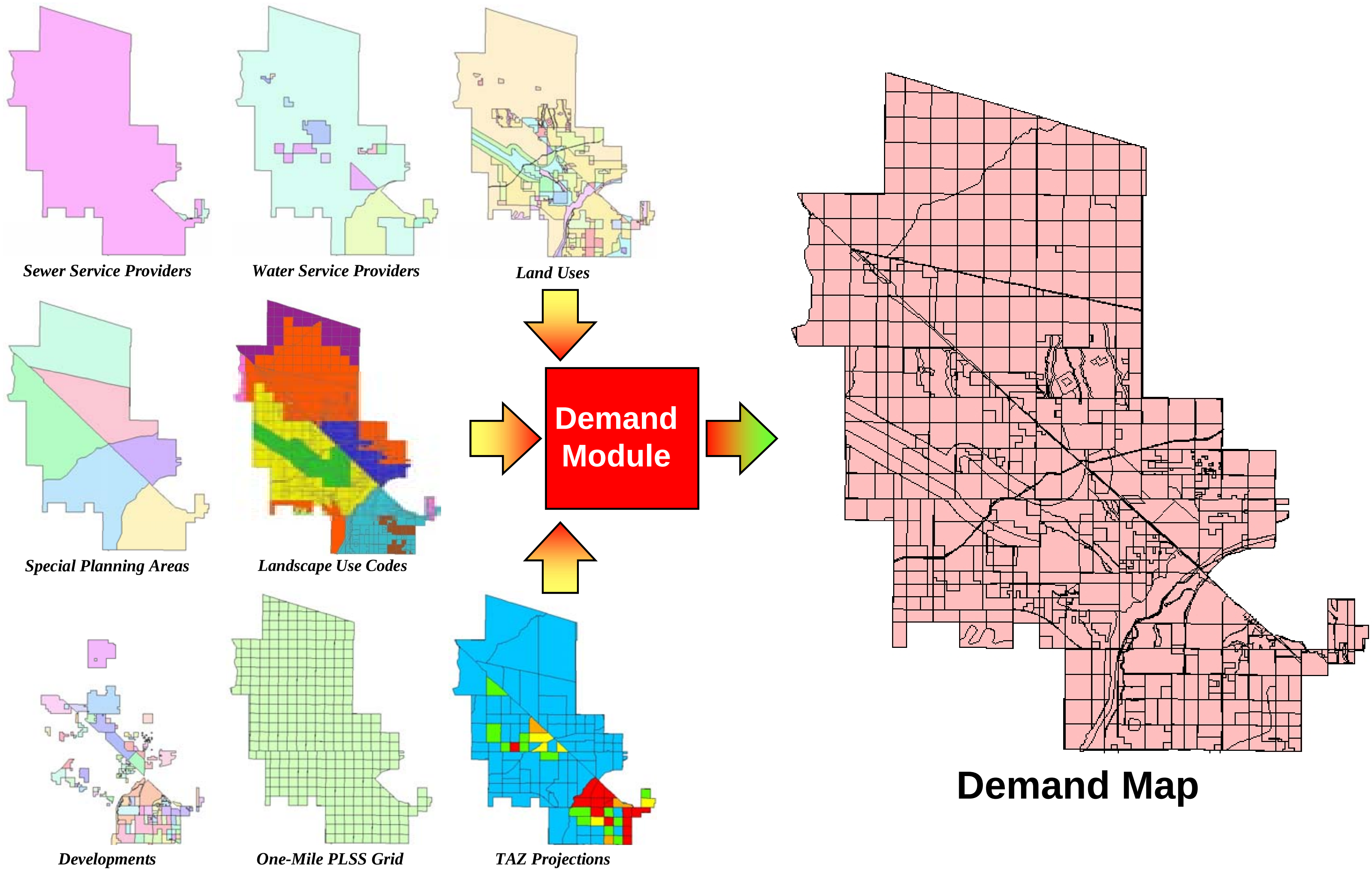
Unused fields from *TAZ_2007*, *developments,* and other shapefiles described in Table A-1 were deleted, and the shapefiles were intersected to create the Demand Map, consisting of 2,455 unique polygons (Figure A-1). Large polygons in SPAs 4, 5, and 6, where no development has occurred, were intersected with the *PLSS* shapefile to form smaller polygons, giving the City the ability to change attributes on a smaller level as new developments are planned and erected.

A.3. Demand Factors

Demand factors used in the Demand Module were developed according to the following general process and are summarized in Table A-4.

- In order to project demands for drinking water and reclaimed water separately, the water billed through irrigation meters (30 percent) was subtracted from the calculated demand factors described in Section 5 to determine non-irrigation (indoor and outdoor) demand factors for residential and commercial land uses.
- The calculated water demand factors for non-irrigation residential uses were compared to demand factors obtained from surrounding areas and from City guidelines. The calculated City residential demand factors did not follow the expected pattern of lower demand factors in higher density residential uses. However, because there was only 2 years of billing data available and because high growth in the service area makes determining the number of dwelling units each year challenging, engineering judgment was used to assign demand factors for residential areas:
  - One demand factor was calculated for all residential land use categories with less than 5 du/acre, and a second factor was calculated for categories with more than 5 du/acre. The factor for less than 5 du/acre was based on the City's billing data for Low Density Residential, and the factor for greater than 5 du/acre was based on the City's billing data for Medium Density Residential.
  - When considering all water meters in all residential land use categories, 30 percent of the billed water was for irrigation meters. This percentage was applied to the "total" demand factors, resulting in the non-irrigation factors shown in Table A-4.

  The City indicated that the Mixed-Use Gateway areas will be densely populated areas with large commercial and employment areas. For the purposes of the *Integrated Water Master Plan*, the Mixed-Use Gateway demand factor was estimated assuming a build-out residential density of 8 du/acre and the remaining area composed of commercial/employment. Based on the anticipated number of dwelling units in Sycamore Farms and Cielo Crossing (both located completely within Mixed-Use Gateway), 60 percent of the remaining area commercial (2,000 gpad), and 40 percent of the remaining area employment (1,000 gpad), the calculated demand factor for Mixed-Use Gateway was 2,200 gpad.



SURPRISE ARIZONA

CITY OF SURPRISE, ARIZONA
INTEGRATED WATER MASTER PLAN: WATER RESOURCES

MALCOLM PIRNIE — In Association With ASU Decision Theater

November 2008

Demand Map

Figure A-1

Table A-4.
Demand Module Demand Factors

Land Use Category	Units	Non-Irrigation Water			Wastewater Flow	Reclaimed Water Production
		Indoor	Outdoor	Total		
Residential						
Rural Residential (0-1 du/acre)	gpd/du	210	110	320	210	190
Suburban Residential (1-3 du/acre)	gpd/du	210	110	320	210	190
Low Density Residential (3-5 du/acre)	gpd/du	210	110	320	210	190
Medium Density Residential (5-8 du/acre)	gpd/du	190	100	290	190	170
Medium/High Density Residential (8-15 du/acre)	gpd/du	190	100	290	190	170
High Density Residential (15-21 du/acre)	gpd/du	190	100	290	190	170
Commercial/Other						
Airport Preservation (0-2 du/acre)	gpd/acre	390	210	600	390	350
Surprise Center	gpd/acre	1,300	700	2,000	1,300	1,200
Original Townsite	gpd/acre	800	400	1,200	800	720
Commercial	gpd/acre	1,300	700	2,000	1,300	1,200
Employment	gpd/acre	650	350	1,000	650	590
Mixed Use Gateway	gpd/acre	1,200	1,000	2,200	1,200	1,080
Agriculture	gpd/acre	2,600	1,400	4,000	2,600	2,340
Landfill	gpd/acre	325	175	500	325	290
Military	gpd/acre	650	350	1,000	650	590
Open Space	gpd/acre	0	0	0	0	0
Public Facilities	gpd/acre	650	350	1,000	650	590
Proving Grounds	gpd/acre	325	175	500	325	290
Landscape						
Turf	gpd/acre	0	4,000	4,000	0	0
Xeriscape	gpd/acre	0	1,300	1,300	0	0
Desert	gpd/acre	0	0	0	0	0

- Using the City's 2008 aerial images, the demand for the Original Townsite land use category assumed water demand for 450 homes and 320 acres (50 percent) of commercial development. The calculated demand factor for Original Townsite was 1,200 gpad.
- For land use categories where demands were unique to the City (Surprise Center, Landfill, Military, Proving Grounds, and Airport Preservation), engineering judgment was used to estimate these values based on values from similar land use categories (i.e. Commercial, Employment, and Mixed Use Gateway).
- Indoor uses were assumed to be 65 percent of the non-irrigation demand; the remaining 35 percent was assigned to outdoor demand, which refers to the irrigation of the individual properties (e.g., front and back yard irrigation).
- Wastewater flow was assumed to be 100 percent of the interior demand; i.e., nearly all water used within the home or business returns to the sewer system.
- For large landscaped areas, the ADWR TMP factors for turf and xeriscape were used. By definition, the City's "Open Space" land use category classifies open space as areas with natural vegetation. As such, the Open Space demand factor was assumed to be zero gpad.

A.4. Demand Module Methodology

The Map created from the intersection of City shapefiles was integrated with water demand factors and other user input tables to create the Demand Module. Because the Demand Module is entirely GIS-based, standard GIS functions can be used to change a polygon's field attributes and recalculate water resource needs. In order to make the Demand Module more user-friendly, a user interface was created to allow users to quickly and efficiently update field attributes and recalculate water resource needs. Overviews of the Demand Module's user input tables, calculation equations, and user interface are described below.

A.4.1. User Input Tables

In addition to the Demand Map, three user input tables were incorporated into the Demand Module to assist with the demand calculations and to provide default demand factors and landscape use codes for areas where no information could be obtained. Within the Demand Module, the user has the ability to change indoor and outdoor water demand factors for each land use category as well as turf and xeriscape landscaping demand factors for the City's planning area (Figures A-2 and A-3). Used for planning purposes, these values were applied to all polygons in the map and served as the basis for water resource calculations. Because non-residential demands can vary widely, the Demand Module allows users to change an individual non-residential land use polygon's demand factor. Landscape and residential demand factors cannot be changed at an individual polygon level.

Because City residential land use category definitions allow for a range of du/acre within a specific land use category, the Demand Module allows the user to modify the default du/acre value that is used in calculating residential demands (Figure A-2). In order to prevent the user from entering a value outside the range defined by the land use category, the minimum and maximum values are also given.

Attributes of LandUseCategoryDefaults

OBJECTID	LandUse	Description	Classification	DwellingUnitsPerAcre	MinDwellingUnitsPerAcre	MaxDwellingUnitsPerAcre	IndoorDemandFactor	OutdoorDemandFactor	Units
1	AG	Agriculture	Non-Residential	0	0	0	2600	1400	gpd/acre
2	AP	Airport Preservation	Non-Residential	0	0	0	650	350	gpd/acre
3	C	Commercial	Non-Residential	0	0	0	1300	700	gpd/acre
4	E	Employment	Non-Residential	0	0	0	650	350	gpd/acre
5	HDR	High Density Residential	Residential	18	15	21	190	100	gpd/du
6	LDR	Low Density Residential	Residential	4	3	5	210	110	gpd/du
7	LFP	Landfill	Non-Residential	0	0	0	325	175	gpd/acre
8	MDR	Medium Density Residential	Residential	6.5	5	8	190	100	gpd/du
9	MHDR	Medium High Density Residential	Residential	11.5	8	15	190	100	gpd/du
10	ML	Military	Non-Residential	0	0	0	650	350	gpd/acre
11	MU	Mixed Use Gateway	Non-Residential	0	0	0	1200	1000	gpd/acre
12	OS	Open Space	Non-Residential	0	0	0	0	0	gpd/acre
13	PF	Public Facilities	Non-Residential	0	0	0	650	350	gpd/acre
14	PG	Proving Grounds	Non-Residential	0	0	0	325	175	gpd/acre
15	RR	Rural Residential	Residential	0.5	0	1	210	110	gpd/du
16	SQMP	Square Mile	Non-Residential	0	0	0	800	400	gpd/acre
17	SUBP	Suburban Residential	Residential	2	1	3	210	110	gpd/du
18	SURP	Surprise Center	Non-Residential	0	0	0	1300	700	gpd/acre

Record: 1 Show: All Selected Records (0 out of 18 Selected) Options

Figure A-2: User Input: LandUseCategoryDefaults

Attributes of LandscapeDemandFactors

OBJECTID *	LandscapeType	LandscapeDemandFactor	Units
1	Xeriscape	1300	gpd/acre
2	Turf	4000	gpd/acre

Record: 1 Show: All Selected Records

Figure A-3: User Input: LandscapeDemandFactors

In Section 5 of the *Integrated Water Master Plan: Water Resources* Report, an analysis of City historical consumption data indicated that 30 percent of water use was used to irrigate open spaces including parks, schools, and HOA common areas. Landscape demand factors were created to account for the water used to irrigate large turf and xeriscape areas. All landscape demand calculations thus rely not only on landscape demand factors, but also the percent and type of landscape contained within each polygon. For all polygons, the percent and type of landscape were estimated using the landscape use codes. Eight landscape use codes were incorporated into the Demand Module (Figure A-4); however, additional landscape use codes or custom values for a specific polygon can be entered into the Demand Module at the City's discretion.

Attributes of LandscapeUseCodes

OB	LandscapeUseCode	PercentLandscape	TurfLandscapePercentage	XeriscapeLandscapePercentage
1	South Valley Plain	0.133	0.412	0.118
2	Mid Valley Plain	0.156	0.2	0.4
3	Luke Valley Plain	0.102	0.031	0.462
4	West Valley Plain	0.141	0.222	0.333
5	Bajada	0.234	0.1	0.367
6	Sonoran Uplands	0.781	0.01	0.08
7	River Wash Corridor	0.781	0.01	0.08
8	Sonoran Mountain	1	0	0

Record: 1 Show: All Selected Records (0 out of 8 Selected) Option

Figure A-4: User Input: LandscapeUseCodes

A.4.2. Module Calculations and Field Attributes

Within the GIS environment, the Demand Module is capable of calculating indoor, outdoor, and landscape water demands in addition to wastewater flows in 2007, 2020, 2030, and build-out. While indoor demands must be met with potable water, outdoor (residential and commercial water use) and landscape (parks, schools, HOA common areas, etc.) demands can be served with either potable or reclaimed water. The equations used to calculate these demands as well as other field attributes used in the equations are described in Table A-5. While all the calculations can be performed manually in the GIS environment, macros were created within the user interface to allow the user to change attributes and recalculate demands in quick, reliable, and efficient manner, without requiring extensive knowledge of GIS software.

Table A-5.

Demand Module Field Attributes and Equations

Field ID	Description	Units	Residential Polygons	Non-Residential Polygons
OBJECTID	Unique Polygon Identifier	N/A	GIS Value: Unique to Each Polygon	
Category				
SPA	Special Planning Area	N/A	User Input: Initially Populated by City GIS Data in Demand Map Construction	
WaterServiceProvider	Water Service Provider	N/A	User Input: Initially Populated by City GIS Data in Demand Map Construction	
WastewaterServiceProvider	Wastewater Service Provider	N/A	User Input: Initially Populated by City GIS Data in Demand Map Construction	
Landuse	Land Use Category	N/A	User Input: Initially Populated by City GIS Data in Demand Map Construction	
Subdivision	Development Name	N/A	User Input: Initially Populated by City GIS Data in Demand Map Construction	
Status				
Timeline	Status of Development (Existing, Proposed, 1-3 Years)	N/A	User Input: Initially Populated by City GIS Data in Demand Map Construction	
LotCount	Total Dwelling Units in the Development	N/A	User Input: Initially Populated by City GIS Data in Demand Map Construction	
DwellingUnitPerAcre	Number of Dwelling Units per Acre (Residential Polygons)	du/acre	User Input: Initially Populated by City GIS Data in Demand Map Construction	
EXISTING	Existing (E) or Proposed (P)	N/A	User Input: Initially Populated by City GIS Data in Demand Map Construction	
CustomType	Indicates Whether Polygon Values Are Custom or Default	N/A	User Input: (Default) for No Changes, (Custom) if Custom	
IndoorDemandFactor	Indoor Demand Factor for Residential and Non-Residential Polygons	gpd/du or gpad	User Input: Populated by Default Tables if Polygon is Default; If Custom, the Value is Obtained from the User	
OutdoorDemandFactor	Indoor Demand Factor for Residential and Non-Residential Polygons	gpd/du or gpad	User Input: Populated by Default Tables if Polygon is Default; If Custom, the Value is Obtained from the User	
WWFlowFactor	Percent of IndoorDemands that Become WastewaterFlows	decimal	User Input: Default value is 1	
PercentLandscape	Percent of Polygon that is Open Space (Schools, Parks, HOA Areas, etc.)	decimal	User Input: Initially Populated by City GIS Data in Demand Map Construction	
PercentLandscapeTurfLandscape	Percent of Open Space That is High Water Use	decimal	User Input: Initially Populated by City GIS Data in Demand Map Construction	
PercentLandscapeDesertLandscape	Percent of Open Space That is Low Water Use	decimal	User Input: Initially Populated by City GIS Data in Demand Map Construction	
PercentDevelopedYear1	Percent of Polygon That is Developed in 2008	decimal	User Input: Initially Populated by City GIS Data in Demand Map Construction	
PercentDevelopedYear2	Percent of Polygon That is Developed in 2020	decimal	User Input: Initially Populated by City GIS Data in Demand Map Construction	

Table A-5. (cont.)
Demand Module Field Attributes and Equations

Field ID	Description	Units	Residential Polygons	Non-Residential Polygons
PercentDevelopedYear3	Percent of Polygon That is Developed in 2030	decimal	User Input: Initially Populated by City GIS Data in Demand Map Construction	
PercentDevelopedYear4	Percent of Polygon That is Developed at Build-out	decimal	User Input: Initially Populated by City GIS Data in Demand Map Construction	
LandscapeTurfLandscapeDemand1	Average Demand for Turf Open Space in 2008	gpd	Calculated Value: PercentLandscape * PercentLandscapeTurfLandscape * PercentDevelopedYear1 * TurfOutdoorDemandFactor * Area/43,560	
LandscapeDesertLandscapeDemand1	Average Demand for Desert Landscape Open Space in 2008	gpd	Calculated Value: PercentLandscape * PercentLandscapeDesertLandscape * PercentDevelopedYear1 * TurfOutdoorDemandFactor * Area/43,560	
LandscapeDemand1	Sum of Open Space Demands in 2008	gpd	Calculated Value: LandscapeTurfLandscapeDemand1 + LandscapeDesertLandscapeDemand1	
OutdoorDemand1	Total of All Demands That Can be Served with Reclaimed Water in 2008	gpd	Calculated Value: DwellingUnitPerAcre * LandUseCategoryOutdoorDemandFactor * PercentDevelopedYear1 * Area/43,560 + LandscapeDemand1	Calculated Value: Area/43,560 * LandUseCategoryOutdoorDemandFactor * PercentDevelopedYear1 + LandscapeDemand1
IndoorDemand1	Total of All Demands That Must be Served with Potable Water in 2008	gpd	Calculated Value: DwellingUnitPerAcre * LandUseCategoryIndoorDemandFactor * PercentDevelopedYear1 * Area/43,560	Calculated Value: Area/43,560 * LandUseCategoryIndoorDemandFactor * PercentDevelopedYear1
WastewaterFlow1	Average Flow of Wastewater from the Polygon in 2008	gpd	Calculated Value: IndoorDemand1	
LandscapeTurfLandscapeDemand2	Average Demand for Turf Open Space in 2020	gpd	Calculated Value: PercentLandscape * PercentLandscapeTurfLandscape * PercentDevelopedYear2 * TurfOutdoorDemandFactor * Area/43,560	
LandscapeDesertLandscapeDemand2	Average Demand for Desert Landscape Open Space in 2020	gpd	Calculated Value: PercentLandscape * PercentLandscapeDesertLandscape * PercentDevelopedYear2 * TurfOutdoorDemandFactor * Area/43,560	
LandscapeDemand2	Sum of Open Space Demands in 2020	gpd	Calculated Value: LandscapeTurfLandscapeDemand2 + LandscapeDesertLandscapeDemand2	
OutdoorDemand2	Total of All Demands That Can be Served with Reclaimed Water in 2020	gpd	Calculated Value: DwellingUnitPerAcre * LandUseCategoryOutdoorDemandFactor * PercentDevelopedYear2 * Area/43,560 + LandscapeDemand2	Calculated Value: DwellingUnitPerAcre * LandUseCategoryOutdoorDemandFactor * PercentDevelopedYear1 * Area/43,560 + LandscapeDemand1
IndoorDemand2	Total of All Demands That Must be Served with Potable Water in 2020	gpd	Calculated Value: DwellingUnitPerAcre * LandUseCategoryIndoorDemandFactor * PercentDevelopedYear2 * Area/43,560	Calculated Value: DwellingUnitPerAcre * LandUseCategoryIndoorDemandFactor * PercentDevelopedYear1 * Area/43,560
WastewaterFlow2	Average Flow of Wastewater from the Polygon in 2020	gpd	Calculated Value: IndoorDemand2	

Table A-5. (cont.)
Demand Module Field Attributes and Equations

Field ID	Description	Units	Residential Polygons	Non-Residential Polygons
LandscapeTurfLandscapeDemand3	Average Demand for Turf Open Space in 2030	gpd	Calculated Value: PercentLandscape * PercentLandscapeTurfLandscape * PercentDevelopedYear3 * TurfOutdoorDemandFactor * Area/43,560	
LandscapeDesertLandscapeDemand3	Average Demand for Desert Landscape Open Space in 2030	gpd	Calculated Value: PercentLandscape * PercentLandscapeDesertLandscape * PercentDevelopedYear3 * TurfOutdoorDemandFactor * Area/43,560	
LandscapeDemand3	Sum of Open Space Demands in 2030	gpd	Calculated Value: LandscapeTurfLandscapeDemand3 + LandscapeDesertLandscapeDemand3	
OutdoorDemand3	Total of All Demands That Can be Served with Reclaimed Water in 2030	gpd	Calculated Value: DwellingUnitPerAcre * LandUseCategoryOutdoorDemandFactor * PercentDevelopedYear3 * Area/43,560 + LandscapeDemand3	Calculated Value: DwellingUnitPerAcre * LandUseCategoryOutdoorDemandFactor * PercentDevelopedYear2 * Area/43,560 + LandscapeDemand2
IndoorDemand3	Total of All Demands That Must be Served with Potable Water in 2030	gpd	Calculated Value: DwellingUnitPerAcre * LandUseCategoryIndoorDemandFactor * PercentDevelopedYear3 * Area/43,560	Calculated Value: DwellingUnitPerAcre * LandUseCategoryIndoorDemandFactor * PercentDevelopedYear2 * Area/43,560
WastewaterFlow3	Average Flow of Wastewater from the Polygon in 2030	gpd	Calculated Value: IndoorDemand3	
LandscapeTurfLandscapeDemand4	Average Demand for Turf Open Space at Build-out	gpd	Calculated Value: PercentLandscape * PercentLandscapeTurfLandscape * PercentDevelopedYear4 * TurfOutdoorDemandFactor * Area/43,560	
LandscapeDesertLandscapeDemand4	Average Demand for Desert Landscape Open Space at Build-out	gpd	Calculated Value: PercentLandscape * PercentLandscapeDesertLandscape * PercentDevelopedYear4 * TurfOutdoorDemandFactor * Area/43,560	
LandscapeDemand4	Sum of Open Space Demands at Build-out	gpd	Calculated Value: LandscapeTurfLandscapeDemand4 + LandscapeDesertLandscapeDemand4	
OutdoorDemand4	Total of All Demands That Can be Served with Reclaimed Water at Build-out	gpd	Calculated Value: DwellingUnitPerAcre * LandUseCategoryOutdoorDemandFactor * PercentDevelopedYear4 * Area/43,560 + LandscapeDemand4	Calculated Value: DwellingUnitPerAcre * LandUseCategoryOutdoorDemandFactor * PercentDevelopedYear1 * Area/43,560 + LandscapeDemand1
IndoorDemand4	Total of All Demands That Must be Served with Potable Water at Build-out	gpd	Calculated Value: DwellingUnitPerAcre * LandUseCategoryIndoorDemandFactor * PercentDevelopedYear4 * Area/43,560	Calculated Value: DwellingUnitPerAcre * LandUseCategoryIndoorDemandFactor * PercentDevelopedYear1 * Area/43,560
WastewaterFlow4	Average Flow of Wastewater from the Polygon at Build-out	gpd	Calculated Value: IndoorDemand4	WastewaterFlow4
Shape_Length	Perimeter of Polygon	ft	Calculated Value by GIS	Shape_Length
Shape_Area	Area of Polygon	ft^2	Calculated Value by GIS	Shape_Area

A.4.3. User Interface

The primary intent of the user interface is to allow City personnel to quickly and accurately update water resource needs as undeveloped areas take shape. Encoded within the Demand Module and presented as an icon, the user interface allows users to edit field attributes for one or more polygons at a time (Figure A-5). While all attributes can technically be changed within the GIS working environment, polygon attributes such as WaterServiceProvider, WastewaterServiceProvider, and SPA will mostly likely remain constant and have been excluded from the user interface. Attributes for an individual polygon or group of polygons that can be changed by the user using the interface are described below.

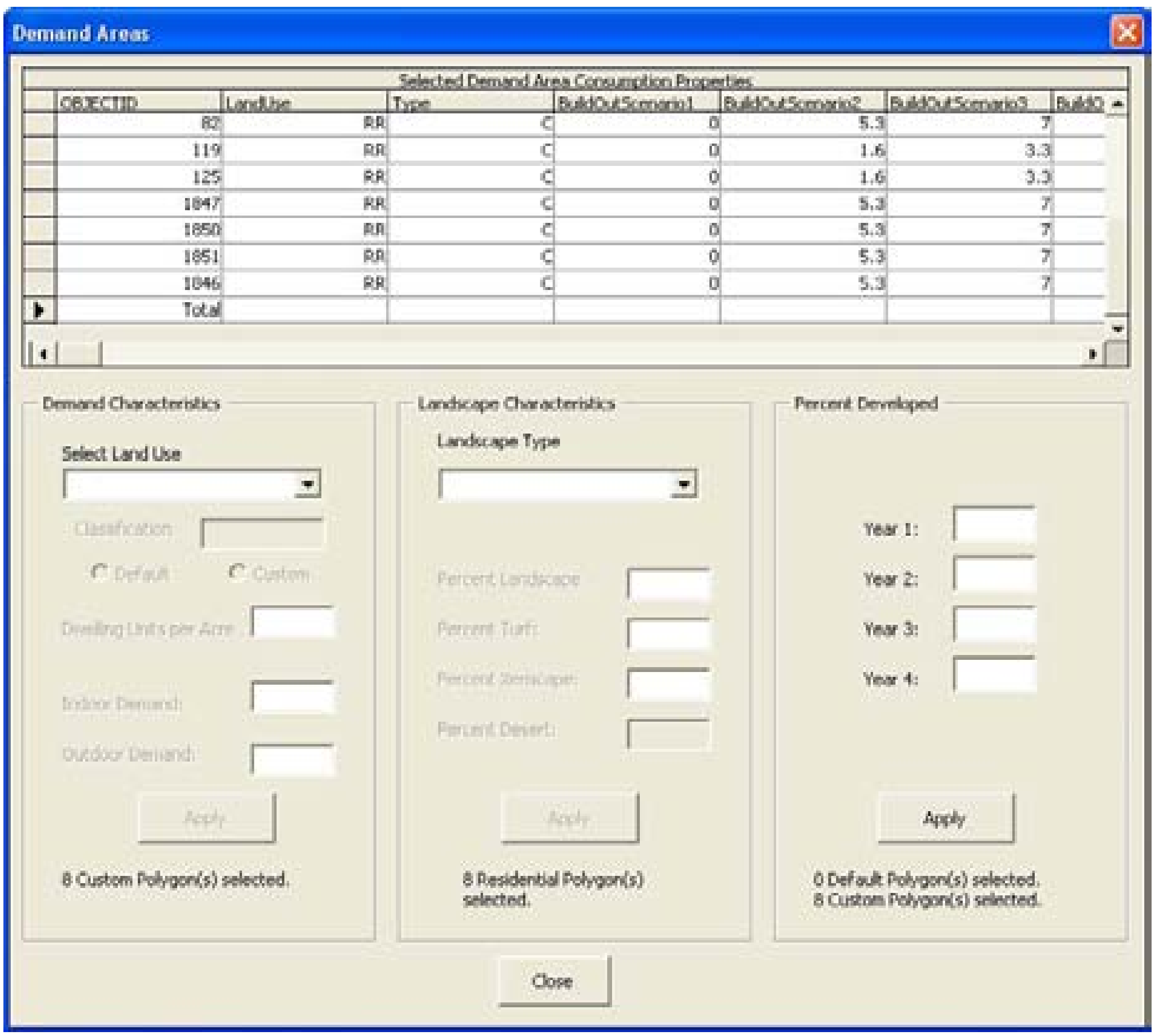


Figure A-5: Demand Module User Interface

Select Land Use – A drop down list that allows the user to change the land use type for a polygon. Only land use categories described in the City's 2020 General Plan can be selected.

Classification **–** Automatic field indicating the type of land use that was selected (residential or non-residential).

Default/Custom **–** Allows the user to select land use category "default" values obtained from the user input tables or input "custom" values characteristic of the polygon(s). "Custom" must be selected in order to change most of the attributes in the user interface. If "custom" is selected, the Module will use all values appearing in the interface to calculate water resource needs

Dwelling Units per Acre **–** Applicable only to residential land use types, the user can enter the number of dwelling units per acre for existing or planned developments if it differs from the land use category default value.

Indoor Demand **–** For non-residential polygons only, the user can enter a custom indoor demand (gpd/acre) for the polygon if it is known.

Outdoor Demand **–** For non-residential polygons only, the user can enter a custom outdoor demand (gpd/acre) for the polygon if it is known.

Landscape Type **–** If the user does not know the percent and type of open space (turf, desert landscape, desert), he/she may select a landscape use code characteristic of the area (Bajada, West Valley Plain, etc.). Additional landscape use codes can be entered in the "LandscapeUseCodes" user input table. If the user knows the specific characteristics of the polygon, "CUSTOM" may be selected.

Percent Landscape **–** The percent area of the polygon(s) that is landscaped (schools, parks, HOA common areas, golf courses, agriculture, etc.). This value is entered as a decimal.

Percent Turf **–** Percent of landscape area, entered as a decimal, that is characteristic of high water use (golf courses, parks, schools, lakes, etc.)

Percent Xeriscape **–** Percent of landscape area, entered as a decimal, that is characteristic of low water use (Xeriscape)

Percent Desert **–** Percent of landscape area, entered as a decimal, that is characteristic of no water use (natural desert, streets, parking lots, etc.). This value is calculated as the remaining landscaped portion that is not turf or Xeriscape.

Percent Developed: Year 1 **–** The percentage of the polygon that is developed in 2007, entered as a decimal.

Percent Developed: Year 2 **–** The percentage of the polygon that is developed in 2020, entered as a decimal.

Percent Developed: Year 3 **–** The percentage of the polygon that is developed in 2030, entered as a decimal.

Percent Developed: Year 4 **–** The percentage of the polygon that is developed at build-out, entered as a decimal.

Apply – Accepts changes that were made in the interface and recalculates all demands and flows based on the updated values.

Close **–** Exits the user interface.

Selected Demand Area Consumption Properties **–** A summary of individual and total water resource needs for the selected polygon(s) which includes indoor, outdoor, and landscape demands and wastewater flows.

A.5. Calibration of Demand Module

In order to calibrate the Demand Module, existing conditions were verified in the existing polygons within the City's current service area. City water meter locations were used to indicate the development status of each polygon within the City's water service area. For each development that was completely built-out, 1.00 was entered into "PercentDevelopedYear1". 0.00 was entered into areas where the City was not currently serving water, particularly in SPAs 2, 3, 4, 5, and 6. For residential areas partially developed (i.e. some water meters), the number of residential water meters in 2007 was divided by the development's "LotCount" to determine the "PercentDevelopedYear1". For non-residential areas partially-developed (Surprise Center), the total area of parcels with water meters was divided by the total area of the development. The extent of development for 2020, 2030, and build-out were not adjusted from the original estimated values unless "PercentDevelopedYear1" was already 1.00 (100 percent built-out). The development status for water service providers other than the City were kept as determined from the population data.

Once existing information had been entered for the polygons representing existing conditions, the Demand Module was run to determine existing water demands. According to historical data obtained from the City's 2007 Monthly Operation Reports (obtained from AAWC), total production in 2007 was 7,605 AFY or 6.8 million gallons per day (mgd) in the City's service area. In the same year, the Demand Module estimated demands to be 5.8 mgd, or approximately 85 percent of the existing demand. This variance was due to the landscape demand which, using the landscape use codes provided by the City, was only 15 percent of the total demand instead of 30 percent. For existing SPA 1 developments, the "*PercentLandscape*" was increased from 13.3 percent to 30 percent. When the Demand Module was run a second time, the total water demand was 6.9 mgd, or 102 percent of the existing water demand.

Demand Module calibration was only performed for water demands within the City's water service area. Because no information could be obtained from other private water company service areas, additional calibrations could not be performed.

THIS PAGE INTENTIONALLY LEFT BLANK

B. High Level Recharge Technology Cost Evaluation

In order to assess the viability of the recharge options, a high-level evaluation was performed for recharge and recovery of a specific volume of reclaimed water. Recharge followed by recovery was considered for each recharge technology. When using various recharge and recovery technologies, two types of treatment may be needed. The first treatment refers to treatment of reclaimed water prior to recharge such that the recharged water meets the water quality standards of the aquifer. This is particularly important in vadose zone, ASR, and deep well injection. The second type of treatment is treating the recovered water prior to delivery. It was assumed that recovery for the surface recharge, vadose zone injection, and deep injection would be via potable production wells that would need treatment for arsenic, including brine disposal. However, because water recovered from ASR wells can only be used for non-potable purposes, additional treatment of the recovered water is not needed.

The review of the recharge technologies reveal that recharge facility design, operation, and the need for additional reclaimed water treatment are highly dependent on local hydrogeology, groundwater quality, and reclaimed water quality conditions, and are normally not determined until site-specific studies are completed. To bracket the possible range of costs, two high level evaluations were completed. The initial evaluation considered no additional reclaimed water treatment while the second evaluation considered additional treatment to meet aquifer water quality standards necessary for sub-surface injection (vadose zone, deep injection, and ASR).

Summary of Unit Costs[1]

ITEM	COST	UNITS	NOTES	SOURCE
CAPITAL COSTS				
Land	40,000	$/acre	0.25 acres/well, brine disposal, and spreading basins	City of Surprise
Surface Spreading Basins	97,082	$/acre		Goodyear Adaman Design Concept Report
Vadose Zone Wells (20 years, 200 gpm)	$450,000	$/800 gpm	200 gpm per well, 3 wells needed to last 20 years (one initial and two replacements), 7 year expected lifetime without additional treatment	City of Surprise and City of Scottsdale telephone correspondence
Deep Well Injection (20 years, 800 gpm)	$1,500,000	$/800 gpm	900 gpm (60% average production well capacity), 20 years with RO treatment	City of Scottsdale and Fountain Hills Sanitary District telephone correspondence
ASR Well Injection and Recovery (20 years, 800 gpm injection, 1400 gpm recovery)	$2,500,000	$/800 gpm	900 gpm injection (60% average production well capacity), 1400 gpm production (average well capacity in Surprise), 20 years with RO treatment	City of Scottsdale telephone correspondence
Recovery Well (20 years, 1400 gpm)	$2,050,000	$/well site	1400 gpm, 20 years	Goodyear Adaman Design Concept Report
Advanced Pre-Treatment	$2,300,000	$/mgd	2-stage, 95% recovery	City of Avondale Surface Water Treatment Study/Water Reuse Foundation Decision Support System
Pre-Treatment Waste Disposal	$350,000	$/acre	Evaporation ponds, includes $350,000/acre construction but no land costs	City of Avondale Surface Water Treatment Study and City of Surprise

NOTES:

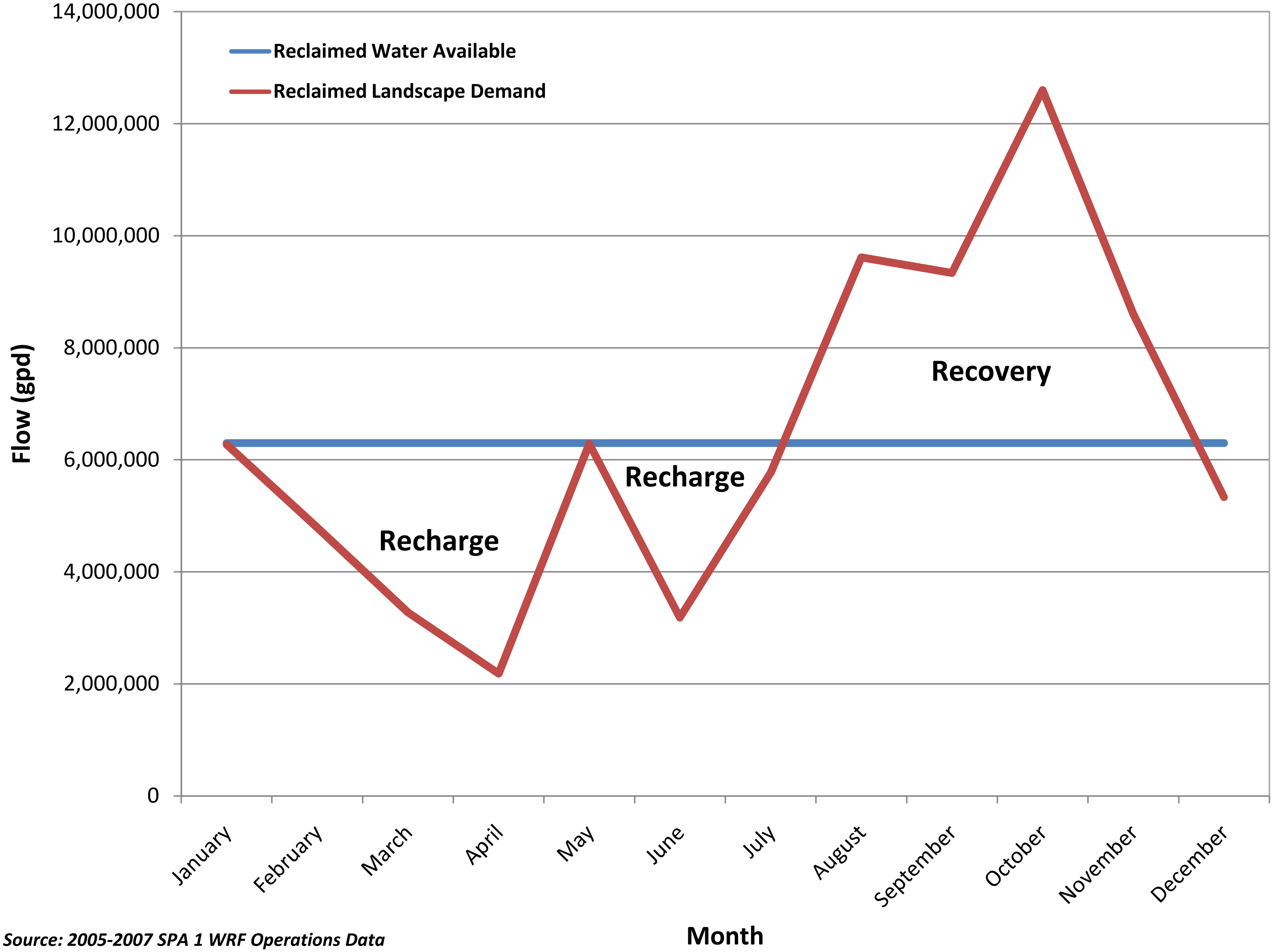
(1) June 2008 Costs (ENR CCI = 8,185). Unit capital costs include materials of construction, installation, contractor overhead and profit, and a 30% planning level contingency.

Summary of Unit Costs[1]

ITEM	COST	UNITS	SOURCE
O&M COSTS			
Surface Spreading Basins (20 years)	$0.03	$/1,000 gallons	Engineering Judgement, City of El Mirage
Vadose Zone Wells (20 years, 800 gpm)	$0.03	$/1,000 gallons	Engineering Judgement, City of El Mirage
Deep Well Injection (20 years, 800 gpm)	$0.05	$/1,000 gallons	Engineering Judgement, City of El Mirage
ASR Well Injection (20 years, 800 gpm injection)	$0.05	$/1,000 gallons	Engineering Judgement, City of El Mirage
ASR Well Recovery (20 years, 1400 gpm recovery)	$0.20	$/1,000 gallons	Engineering Judgement, City of Avondale
Recovery Well (20 years, 1400 gpm)	$0.20	$/1,000 gallons	City of Avondale Surface Water Treatment Study
Advanced Pre-Treatment	$0.60	$/1,000 gallons	City of Avondale Surface Water Treatment Study
Pre-Treatment Waste Disposal	$0.20	$/1,000 gallons	City of Avondale Surface Water Treatment Study

NOTES:

(1) June 2008 Costs (ENR CCI = 8,185). O&M caiptal costs include electricity, labor, chemicals, disposal, and maintenance.



Source: 2005-2007 SPA 1 WRF Operations Data

Surface Spreading Basins (No Treatment)[1]

ITEM	QUANTITY	UNITS	UNIT COST	COST[2]
CAPITAL COSTS				
Land	14.8	acres	$ 40,000	$ 593,665
Spreading Basins	14	acres	$ 97,082	$ 1,343,773
Vadose Zone Wells	0	well sites	$ 450,000	$ -
Deep Injection Wells	0	wells	$ 1,500,000	$ -
ASR Wells	0	wells	$ 2,500,000	$ -
Recovery Wells	4	wells	$ 2,050,000	$ 8,200,000
Advanced Pre-Treatment	0	mgd	$ 2,300,000	$ -
Advanced Pre-Treatment Waste Disposal	0	acres	$ 350,000	$ -
TOTAL CAPITAL COST				$ 10,137,438
O&M COSTS				
Spreading Basins	405,977	1,000 gallons	$ 0.03	$ 13,347
Vadose Zone Wells	0	1,000 gallons	$ 0.03	$ -
Deep Injection Wells	0	1,000 gallons	$ 0.05	$ -
ASR Wells				
Injection	0	1,000 gallons	$ 0.05	$ -
Recovery	0	1,000 gallons	$ 0.20	$ -
Recovery Wells	455,918	1,000 gallons	$ 0.20	$ 91,184
Advanced Pre-Treatment	0	1,000 gallons	$ 0.60	$ -
Advanced Pre-Treatment Waste Disposal	0	1,000 gallons	$ 0.20	$ -
TOTAL O&M COST				$ 104,531
NET PRESENT WORTH[3]				$ 11,244,837
$/AF				$ 46

NOTES:

(1) Analysis based on 6.3 mgd reclaimed water available and 6.3 mgd landscape demand, which results in 4.1 mgd recharge capacity and 6.3 mgd additional production capacity. Analysis does not include potable water components, distribution system infrastructure, reclaimed system infrastructure, or piping.

(2) June 2008 Costs (ENR CCI = 8,185).

(3) 20 Years, 7 Percent Interest.

Vadose Zone Wells (No Treatment)[1]

ITEM	QUANTITY	UNITS	UNIT COST	COST[2]
CAPITAL COSTS				
Land	4.8	acres	$ 40,000	$ 190,000
Spreading Basins	0	acres	$ 97,082	$ -
Vadose Zone Wells	15	well sites	$ 450,000	$ 6,750,000
Deep Injection Wells	0	wells	$ 1,500,000	$ -
ASR Wells	0	wells	$ 2,500,000	$ -
Recovery Wells	4	wells	$ 2,050,000	$ 8,200,000
Advanced Pre-Treatment	0	mgd	$ 2,300,000	$ -
Advanced Pre-Treatment Waste Disposal	0	acres	$ 350,000	$ -
TOTAL CAPITAL COST				$ 15,140,000
O&M COSTS				
Spreading Basins	0	1,000 gallons	$ 0.03	$ -
Vadose Zone Wells	405,977	1,000 gallons	$ 0.03	$ 13,347
Deep Injection Wells	0	1,000 gallons	$ 0.05	$ -
ASR Wells				
Injection	0	1,000 gallons	$ 0.05	$ -
Recovery	0	1,000 gallons	$ 0.20	$ -
Recovery Wells	455,918	1,000 gallons	$ 0.20	$ 91,184
Advanced Pre-Treatment	0	1,000 gallons	$ 0.60	$ -
Advanced Pre-Treatment Waste Disposal	0	1,000 gallons	$ 0.20	$ -
TOTAL O&M COST				$ 104,531
NET PRESENT WORTH[3]				$ 16,247,399
$/AF				$ 66

NOTES:

(1) Analysis based on 6.3 mgd reclaimed water available and 6.3 mgd landscape demand, which results in 4.1 mgd recharge capacity and 6.3 mgd additional production capacity. Analysis does not include potable water components, distribution system infrastructure, reclaimed system infrastructure, or piping.

(2) June 2008 Costs (ENR CCI = 8,185).

(3) 20 Years, 7 Percent Interest.

Vadose Zone Wells with Treatment[1]

ITEM	QUANTITY	UNITS	UNIT COST	COST[2]
CAPITAL COSTS				
Land	43.1	acres	$ 40,000	$ 1,723,919
Spreading Basins	0	acres	$ 97,082	$ -
Vadose Zone Wells	15	well sites	$ 450,000	$ 6,750,000
Deep Injection Wells	0	wells	$ 1,500,000	$ -
ASR Wells	0	wells	$ 2,500,000	$ -
Recovery Wells	4	wells	$ 2,050,000	$ 8,200,000
Advanced Pre-Treatment	4.1	mgd	$ 2,300,000	$ 9,430,000
Advanced Pre-Treatment Waste Disposal	38	acres	$ 350,000	$ 13,421,790
TOTAL CAPITAL COST				$ 39,525,709
O&M COSTS				
Spreading Basins	0	1,000 gallons	$ 0.03	$ -
Vadose Zone Wells	405,977	1,000 gallons	$ 0.03	$ 13,347
Deep Injection Wells	0	1,000 gallons	$ 0.05	$ -
ASR Wells				
Injection	0	1,000 gallons	$ 0.05	$ -
Recovery	0	1,000 gallons	$ 0.20	$ -
Recovery Wells	455,918	1,000 gallons	$ 0.20	$ 91,184
Advanced Pre-Treatment	405,977	1,000 gallons	$ 0.60	$ 243,586
Advanced Pre-Treatment Waste Disposal	405,977	1,000 gallons	$ 0.20	$ 81,195
TOTAL O&M COST				$ 429,312
NET PRESENT WORTH[3]				$ 44,073,844
$/AF				$ 179

NOTES:

(1) Analysis based on 6.3 mgd reclaimed water available and 6.3 mgd landscape demand, which results in 4.1 mgd recharge capacity and 6.3 mgd additional production capacity. Analysis does not include potable water components, distribution system infrastructure, reclaimed system infrastructure, or piping.

(2) June 2008 Costs (ENR CCI = 8,185).

(3) 20 Years, 7 Percent Interest.

Deep Injection Wells (No Treatment)[1]

ITEM	QUANTITY	UNITS	UNIT COST	COST[2]
CAPITAL COSTS				
Land	2.0	acres	$ 40,000	$ 80,000
Spreading Basins	0	acres	$ 97,082	$ -
Vadose Zone Wells	0	wells	$ 450,000	$ -
Deep Injection Wells	4	wells	$ 1,500,000	$ 6,000,000
ASR Wells	0	wells	$ 2,500,000	$ -
Recovery Wells	4	wells	$ 2,050,000	$ 8,200,000
Advanced Pre-Treatment	0	mgd	$ 2,300,000	$ -
Advanced Pre-Treatment Waste Disposal	0	acres	$ 350,000	$ -
TOTAL CAPITAL COST				$ 14,280,000
O&M COSTS				
Spreading Basins	0	1,000 gallons	$ 0.03	$ -
Vadose Zone Wells	0	1,000 gallons	$ 0.03	$ -
Deep Injection Wells	405,977	1,000 gallons	$ 0.05	$ 20,299
ASR Wells				
Injection	0	1,000 gallons	$ 0.05	$ -
Recovery	0	1,000 gallons	$ 0.20	$ -
Recovery Wells	455,918	1,000 gallons	$ 0.20	$ 91,184
Advanced Pre-Treatment	0	1,000 gallons	$ 0.60	$ -
Advanced Pre-Treatment Waste Disposal	0	1,000 gallons	$ 0.20	$ -
TOTAL O&M COST				$ 111,482
NET PRESENT WORTH[3]				$ 15,461,045
$/AF				$ 63

NOTES:

(1) Analysis based on 6.3 mgd reclaimed water available and 6.3 mgd landscape demand, which results in 4.1 mgd recharge capacity and 6.3 mgd additional production capacity. Analysis does not include potable water components, distribution system infrastructure, reclaimed system infrastructure, or piping.

(2) June 2008 Costs (ENR CCI = 8,185).

(3) 20 Years, 7 Percent Interest.

Deep Injection Wells with Treatment[1]

ITEM	QUANTITY	UNITS	UNIT COST	COST[2]
CAPITAL COSTS				
Land	40.3	acres	$ 40,000	$ 1,613,919
Spreading Basins	0	acres	$ 97,082	$ -
Vadose Zone Wells	0	wells	$ 450,000	$ -
Deep Injection Wells	4	wells	$ 1,500,000	$ 6,000,000
ASR Wells	0	wells	$ 2,500,000	$ -
Recovery Wells	4	wells	$ 2,050,000	$ 8,200,000
Advanced Pre-Treatment	4.1	mgd	$ 2,300,000	$ 9,430,000
Advanced Pre-Treatment Waste Disposal	38	acres	$ 350,000	$ 13,421,790
TOTAL CAPITAL COST				$ 38,665,709
O&M COSTS				
Spreading Basins	0	1,000 gallons	$ 0.03	$ -
Vadose Zone Wells	0	1,000 gallons	$ 0.03	$ -
Deep Injection Wells	405,977	1,000 gallons	$ 0.05	$ 20,299
ASR Wells				
Injection	0	1,000 gallons	$ 0.05	$ -
Recovery	0	1,000 gallons	$ 0.20	$ -
Recovery Wells	455,918	1,000 gallons	$ 0.20	$ 91,184
Advanced Pre-Treatment	405,977	1,000 gallons	$ 0.60	$ 243,586
Advanced Pre-Treatment Waste Disposal	405,977	1,000 gallons	$ 0.20	$ 81,195
TOTAL O&M COST				$ 436,264
NET PRESENT WORTH[3]				$ 43,287,490
$/AF				$ 176

NOTES:

(1) Analysis based on 6.3 mgd reclaimed water available and 6.3 mgd landscape demand, which results in 4.1 mgd recharge capacity and 6.3 mgd additional production capacity. Analysis does not include potable water components, distribution system infrastructure, reclaimed system infrastructure, or piping.

(2) June 2008 Costs (ENR CCI = 8,185).

(3) 20 Years, 7 Percent Interest.

ASR Wells (No Treatment)[1]

ITEM	QUANTITY	UNITS	UNIT COST	COST[2]
CAPITAL COSTS				
Land	1.0	acres	$ 40,000	$ 40,000
Spreading Basins	0	acres	$ 97,082	$ -
Vadose Zone Wells	0	wells	$ 450,000	$ -
Deep Injection Wells	0	wells	$ 1,500,000	$ -
ASR Wells	4	wells	$ 2,500,000	$ 10,000,000
Recovery Wells	0	wells	$ 2,050,000	$ -
Advanced Pre-Treatment	0	mgd	$ 2,300,000	$ -
Advanced Pre-Treatment Waste Disposal	0	acres	$ 350,000	$ -
TOTAL CAPITAL COST				$ 10,040,000
O&M COSTS				
Spreading Basins	0	1,000 gallons	$ 0.03	$ -
Vadose Zone Wells	0	1,000 gallons	$ 0.03	$ -
Deep Injection Wells	0	1,000 gallons	$ 0.05	$ -
ASR Wells				
Injection	405,977	1,000 gallons	$ 0.05	$ 20,299
Recovery	455,918	1,000 gallons	$ 0.20	$ 91,184
Recovery Wells	0	1,000 gallons	$ 0.20	$ -
Advanced Pre-Treatment	0	1,000 gallons	$ 0.60	$ -
Advanced Pre-Treatment Waste Disposal	0	1,000 gallons	$ 0.20	$ -
TOTAL O&M COST				$ 111,482
NET PRESENT WORTH[3]				$ 11,221,045
$/AF				$ 46

NOTES:

(1) Analysis based on 6.3 mgd reclaimed water available and 6.3 mgd landscape demand, which results in 4.1 mgd recharge capacity and 6.3 mgd additional production capacity. Analysis does not include potable water components, distribution system infrastructure, reclaimed system infrastructure, or piping.

(2) June 2008 Costs (ENR CCI = 8,185).

(3) 20 Years, 7 Percent Interest.

ASR Wells with Treatment[1]

ITEM	QUANTITY	UNITS	UNIT COST	COST[2]
CAPITAL COSTS				
Land	39.3	acres	$ 40,000	$ 1,573,919
Spreading Basins	0	acres	$ 97,082	$ -
Vadose Zone Wells	0	wells	$ 450,000	$ -
Deep Injection Wells	0	wells	$ 1,500,000	$ -
ASR Wells	4	wells	$ 2,500,000	$ 10,000,000
Recovery Wells	0	wells	$ 2,050,000	$ -
Advanced Pre-Treatment	4.1	mgd	$ 2,300,000	$ 9,430,000
Advanced Pre-Treatment Waste Disposal	38	acres	$ 350,000	$ 13,421,790
TOTAL CAPITAL COST				$ 34,425,709
O&M COSTS				
Spreading Basins	0	1,000 gallons	$ 0.03	$ -
Vadose Zone Wells	0	1,000 gallons	$ 0.03	$ -
Deep Injection Wells	0	1,000 gallons	$ 0.05	$ -
ASR Wells				
Injection	405,977	1,000 gallons	$ 0.05	$ 20,299
Recovery	455,918	1,000 gallons	$ 0.20	$ 91,184
Recovery Wells	0	1,000 gallons	$ 0.20	$ -
Advanced Pre-Treatment	405,977	1,000 gallons	$ 0.60	$ 243,586
Advanced Pre-Treatment Waste Disposal	405,977	1,000 gallons	$ 0.20	$ 81,195
TOTAL O&M COST				$ 436,264
NET PRESENT WORTH[3]				$ 39,047,490
$/AF				$ 158

NOTES:

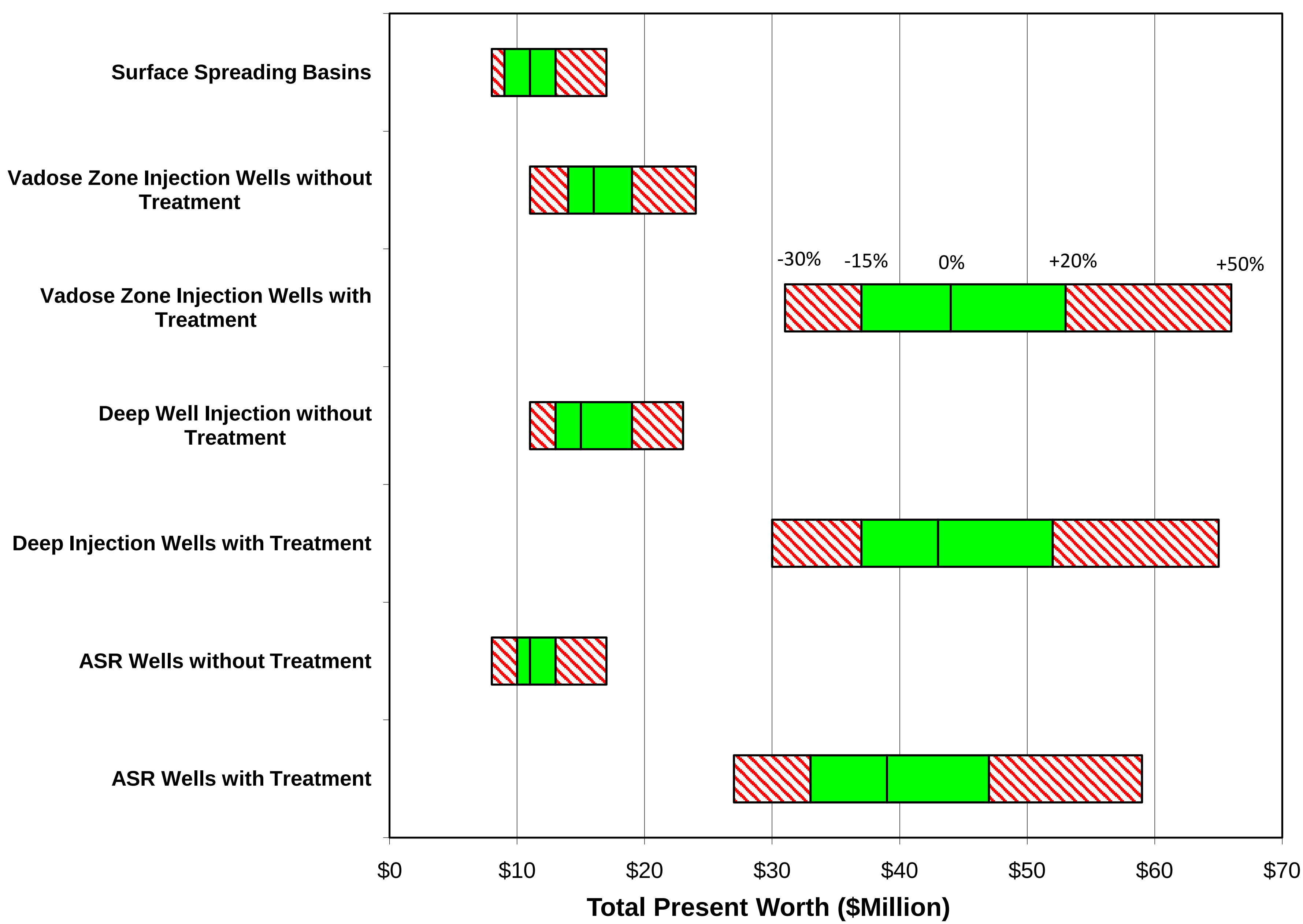
(1) Analysis based on 6.3 mgd reclaimed water available and 6.3 mgd landscape demand, which results in 4.1 mgd recharge capacity and 6.3 mgd additional production capacity. Analysis does not include potable water components, distribution system infrastructure, reclaimed system infrastructure, or piping.

(2) June 2008 Costs (ENR CCI = 8,185).

(3) 20 Years, 7 Percent Interest.

Comparison Cost Summary of Injection Technology Alternatives

	Present Value ($)						
	Surface Spreading Basins	Vadose Zone Injection Wells without Treatment	Vadose Zone Injection Wells with Treatment	Deep Well Injection without Treatment	Deep Injection Wells with Treatment	ASR Wells without Treatment	ASR Wells with Treatment
Capital							
Land	$ 593,665	$ 190,000	$ 1,723,919	$ 80,000	$ 1,613,919	$ 40,000	$ 1,573,919
Spreading Basins	$ 1,343,773	$ -	$ -	$ -	$ -	$ -	$ -
Vadose Zone Wells	$ -	$ 6,750,000	$ 6,750,000	$ -	$ -	$ -	$ -
Deep Injection Wells	$ -	$ -	$ -	$ 6,000,000	$ 6,000,000	$ -	$ -
ASR Wells	$ -	$ -	$ -	$ -	$ -	$ 10,000,000	$ 10,000,000
Recovery Wells	$ 8,200,000	$ 8,200,000	$ 8,200,000	$ 8,200,000	$ 8,200,000	$ -	$ -
Advanced Pre-Treatment	$ -	$ -	$ 9,430,000	$ -	$ 9,430,000	$ -	$ 9,430,000
Advanced Pre-Treatment Waste Disposal	$ -	$ -	$ 13,421,790	$ -	$ 13,421,790	$ -	$ 13,421,790
TOTAL CAPITAL COST ($)	**$ 10,137,438**	**$ 15,140,000**	**$ 39,525,709**	**$ 14,280,000**	**$ 38,665,709**	**$ 10,040,000**	**$ 34,425,709**
Operation and Maintenance							
Spreading Basins	$ 13,347	$ -	$ -	$ -	$ -	$ -	$ -
Vadose Zone Wells	$ -	$ 13,347	$ 13,347	$ -	$ -	$ -	$ -
Deep Injection Wells	$ -	$ -	$ -	$ 20,299	$ 20,299	$ -	$ -
ASR Wells	$ -	$ -	$ -	$ -	$ -	$ 111,482	$ 111,482
Recovery Wells	$ 91,184	$ 91,184	$ 91,184	$ 91,184	$ 91,184	$ -	$ -
Advanced Pre-Treatment	$ -	$ -	$ 243,586	$ -	$ 243,586	$ -	$ 243,586
Advanced Pre-Treatment Waste Disposal	$ -	$ -	$ 81,195	$ -	$ 81,195	$ -	$ 81,195
TOTAL O&M COST ($)	**$ 91,184**	**$ 104,531**	**$ 429,312**	**$ 111,482**	**$ 436,264**	**$ 111,482**	**$ 436,264**
PRESENT WORTH COST ($)	**$ 11,103,437**	**$ 16,247,399**	**$ 44,073,844**	**$ 15,461,045**	**$ 43,287,490**	**$ 11,221,045**	**$ 39,047,490**
$/AF	**$ 45**	**$ 66**	**$ 179**	**$ 63**	**$ 176**	**$ 46**	**$ 158**


Surface Spreading Basins
Vadose Zone Injection Wells without Treatment
Vadose Zone Injection Wells with Treatment
Deep Well Injection without Treatment
Deep Injection Wells with Treatment
ASR Wells without Treatment
ASR Wells with Treatment
-30%
-15%
0%
+20%
+50%
$0
$10
$20
$30
$40
$50
$60
$70
Total Present Worth ($Million)

THIS PAGE INTENTIONALLY LEFT BLANK

C. Reclaimed Water Program Alternatives

This appendix contains the information used to evaluate the reclaimed water program alternatives presented in Section 7. The information includes a description of the alternatives as well as the water balances used to size the infrastructure.

C.1 Alternative Descriptions

The design considerations, concept schematics, and rationale for locating the infrastructure under each reclaimed water program alternatives are further described below. All schematics are presented at the end of the appendix.

C.1.1 Recharge at City-Owned Facilities

Four recharge alternatives at City-owned facilities were considered that varied the method of recharge (spreading basins or "injection") and whether or not recharge facilities can be combined when WRFs are in close proximity to each other.

Alternative 1A: Spreading Basin Recharge by SPA

Under this alternative, the City will continue to plan and construct WRFs in each SPA. All reclaimed water produced at the WRFs will be recharged within the respective SPA boundaries using spreading basins. The recharge sites were located within each SPA based on the depth to groundwater (available aquifer storage), relative proximity to other permitted recharge facilities, potential interferences (landfills and airports), and other geographic considerations (Figure C-1).

- In SPA 1, the City plans to construct 24 vadose zone injection wells near the South WRF and Surprise Center (12 at each location). These facilities were assumed to be in place. All additional recharge capacity will be obtained via the construction of surface spreading basins on the northwest corner of 179th Avenue and Cactus Road, distant from surrounding recharge facilities. The depth to groundwater in this area is approximately 400 feet.
- In SPA 2, the depth to groundwater near the planned WRF is approximately 400 feet. The WRF is also appears to be a reasonable distance form from two regional recharge facilities (Hieroglyphics and Agua Fria) as to not affect the area of recharge. For these reasons, all recharge capacity will be located near the planned SPA 2 WRF, south of Pinnacle Peak Road and north of the Beardsley Canal.
- In SPA 3, the depth to groundwater ranges from 400 to 500 feet. No local or regional recharge facilities are currently permitted or planned in or around SPA 3. To the west of the planned SPA 3 WRF, the Northwest Regional Landfill may present challenges

when permitting a recharge facility. As such, all recharge capacity for this evaluation will be located southwest of the SPA 3 WRF where the depth to groundwater is approximately 500 feet and where the landfill will be less likely to affect recharge activities.

- The SPA 4 depth to groundwater ranges from 400 to 600 feet. CAP's Hieroglyphics Recharge Facility is located northeast of the planned WRF, south of Lone Mountain Road. In order to take advantage of the depth to groundwater and maintain a reasonable distance from other recharge facilities, all SPA 4 recharge will be located north of Black Mountain Road and east of Grand Avenue.
- Due to the increase potential for bird strikes near water sources, surface spreading basins may be difficult to permit near Luke Air Force Base Auxiliary #1 Airfield. With spreading basins planned in the northern portion of SPA 4 and in SPAs 2 and 3, recharge may be best suited in the western region of SPA 5. For the purposes of this evaluation, all recharge facilities will be located along Pinnacle Peak Road, east of 243rd Avenue.
- Recharge capacity within SPA 6 is largely limited by mountains and shallow bedrock conditions surrounding SPA 6. In order to take advantage of the depth to groundwater and thicker alluvial (basin) deposits, the SPA 6 WRF and spreading basins will be located in the center of SPA 6, just north of SR 74.

Because site specific hydrogeologic studies have not been conducted for each planned location, infiltration rates were assumed to be 1 foot/day for all surface recharge facilities. The recharge area was increased by 10 percent to allow for basin embankments and a basin out of service. Because this alternative does not have a dual distribution system, all potential reclaimed water demands will be served with recovered groundwater treated to potable water standards.

Alternative 1B: "Injection" Recharge by SPA

Under this alternative, all build-out reclaimed water available will be recharged via injection technologies (Figure C-2). Because site specific hydrogeologic studies have not been conducted a generic "injection" technology, which is defined as the average unit costs between vadose zone (no treatment) and deep injection well (with treatment) recharge. Recharge facilities will be located in the same areas as described in Alternative 1A.

Alternative 1C: Spreading Basin Recharge by Combining SPAs

Under this alternative, all build-out reclaimed water available will be recharged via spreading basins (Figure C-3). Due to the proximity of some WRFs and the feasibility of recharging water in SPA 6, reclaimed water from some WRFs were combined:

- SPA 2 and 3 WRFs are within 4 miles of each other. A SPA 2/3 Recharge facility was located to the east of SPA 3 WRF where the depth to groundwater is between

400 and 500 feet. Reclaimed water from SPA 2 WRF will flow via gravity to the facility where it will be recharged via spreading basins.

- Due to the presence of mountains surrounding SPA 6 and generally thinner alluvial deposits and shallower groundwater table, recharge within SPA 6 boundaries may be prohibitive. Instead, reclaimed water from SPA 6 WRF will flow via gravity to the recharge facility located in SPA 4 where the depth to groundwater is currently approximately 600 feet.
- SPA 1 and 5 recharge facilities will remain the same, as described in Alternative 1A.

Alternative 1D: "Injection" Recharge by Combining SPAs

Under this alternative, all build-out reclaimed water available will be recharged via the generic "injection" technology in locations described under Alternative 1C (Figure C-4).

C.1.2 Recharge at Regional Facilities

Based on discussions with their owners, both the Hieroglyphics Recharge Facility and SROG's Agua Fria Linear Recharge Projects can potentially accommodate reclaimed water and have available capacity. Because of the uncertainty of the Agua Fria Linear Recharge Project, two regional recharge alternatives were considered.

Alternative 2A: Recharge at Hieroglyphics and Agua Fria Linear Recharge Facilities

Under Alternative 2A, all available reclaimed water from SPA 1, 2, and 3 WRFs will be recharged at the Agua Fria Linear Recharge Facility; and all available reclaimed water from SPA 4, 5, and 6 WRFs will be recharged at the Hieroglyphics Recharge Facility (Figure C-5). When appropriate, common pipelines will be used.

Alternative 2B: Recharge at Hieroglyphics Recharge Facility

Under this alternative, reclaimed water from all WRFs will be sent to the Hieroglyphics Recharge Facility (Figure C-6). When appropriate, common pipelines will be used.

C.1.3 Direct Reuse via Non-Potable Distribution System

Eight alternatives were considered direct reuse via a dual distribution system. The alternatives varied the type of customers served, number of WRFs, and whether the system was separated by SPA or was full-connected. In addition, the seasonal reclaimed water demands will require some recharge of reclaimed water during the low demand periods. Spreading basin recharge facilities were assumed when seasonal recharge was needed. Finally, during the high demand periods, reclaimed water supply will not supply all reclaimed water demands when maximizing users. It was assumed that the peak demands would be met by supplementing the reclaimed water with non-potable groundwater (i.e., from wells that are not treated for arsenic, nitrate, etc., but are plumbed directly to the reclaimed water distribution system).

Alternative 3: Serve Largest Reuse Customers by SPA

Alternative 3 assumed that reclaimed water generated in each SPA would remain within each respective SPA and be delivered to large reclaimed water users (parks, schools, HOA common areas, etc.) only. Residential outdoor demands will be met with potable water.

The reclaimed water distribution system assumes one pressure zone per SPA. Pipeline routes were based on existing street rights-of-way and transportation easements along section lines in undeveloped areas. Figure C-7 provides an illustration of the conceptual facility layout for Alternative 3. Recharge and recovery facilities were assumed to be located at a number of locations within each SPA. The size of transmission pipelines were minimized by increasing the numbers and distribution of water sources within the reclaimed water system.

Alternative 4: Maximize Direct Reuse by SPA

Under Alternative 4, reclaimed water generated in each SPA would remain within each respective SPA and be delivered to all potential reclaimed water users. In addition to the large reclaimed water users included in Alternative 3, maximum direct reuse will include residential, commercial, and industrial outdoor water demands. As previously described for Alternative 3, one pressure zone was assumed for each SPA when sizing booster stations, reservoirs, and pipelines. The layout and locations of pipelines, booster stations, and reservoirs for Alternative 4 are shown on Figure C-8.

Alternatives 5A, 5B, and 5C: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System

Under Alternatives 5A, 5B, and 5C, reclaimed water generated in each SPA would enter into a single reclaimed water system that extends over the entire City planning area and deliver reclaimed water to large water users. Outdoor water demands will be served from the potable water system. Similar to the other direct reuse alternatives, pipeline routes are based on using existing street rights-of-way and transportation easements along section lines in undeveloped areas. The number of WRFs for each alternative is as follows:

- ***Alternative 5A*** – Six WRFs: one in each SPA (Figure C-9).
- ***Alternative 5B*** – Four WRFs: one each in SPAs 1, 2, and 3, and one in SPA 5 that receives wastewater from SPAs 4, 5, and 6 (Figure C-10).
- ***Alternative 5C*** – Three WRFs: one in SPA 1, one in SPA 3 that receives wastewater from SPAs 3 and 5, and one in SPA 2 that receives wastewater from SPAs 2, 4, and 6 (Figure C-11).

Water pressure zones were set up in each of the SPAs to account for water delivery requirements for a single delivery system over a study area with large variations in ground surface elevation. The reclaimed water distribution model is based on a single distribution system for the entire planning area with variations in the number of water sources based on the number of WRFs. The numbers and locations of reservoirs and booster stations, therefore, will be based on pressure zones rather than WRF locations as in Alternatives 3 and 4. Pressure zones were modeled using pressure reducing valve stations (PRV stations), reservoirs, and booster stations. Initially, pressure zones were based on individual SPAs, but were further developed to reduce the total discharge head for pump stations by including two pressure zones across SPAs 4 and 5.

Alternatives 6A, 6B, and 6C: Maximize Direct Reuse via Fully-Connected Dual Distribution System

Under Alternatives 6A, 6B, and 6C, reclaimed water generated in each SPA would enter into a single reclaimed water system that extends over the entire City planning area and delivers reclaimed water to all potential reclaimed water users, including all outdoor and landscape demands. Similar to the other direct reuse alternatives, pipeline routes are based on using existing street rights-of-way and transportation easements along section lines in undeveloped areas. The number of WRFs for each alternative is as follows:

- ***Alternative 6A*** **–** Six WRFs: one in each SPA (Figure C-12).
- ***Alternative 6B*** **–** Four WRFs: one each in SPAs 1, 2, and 3, and one in SPA 5 that receives wastewater from SPAs 4, 5, and 6 (Figure C-13).
- ***Alternative 6C*** - Three WRFs: one in SPA 1, one in SPA 3 that receives wastewater from SPAs 3 and 5, and one in SPA 2 that receives wastewater from SPAs 2, 4, and 6 (Figure C-14).

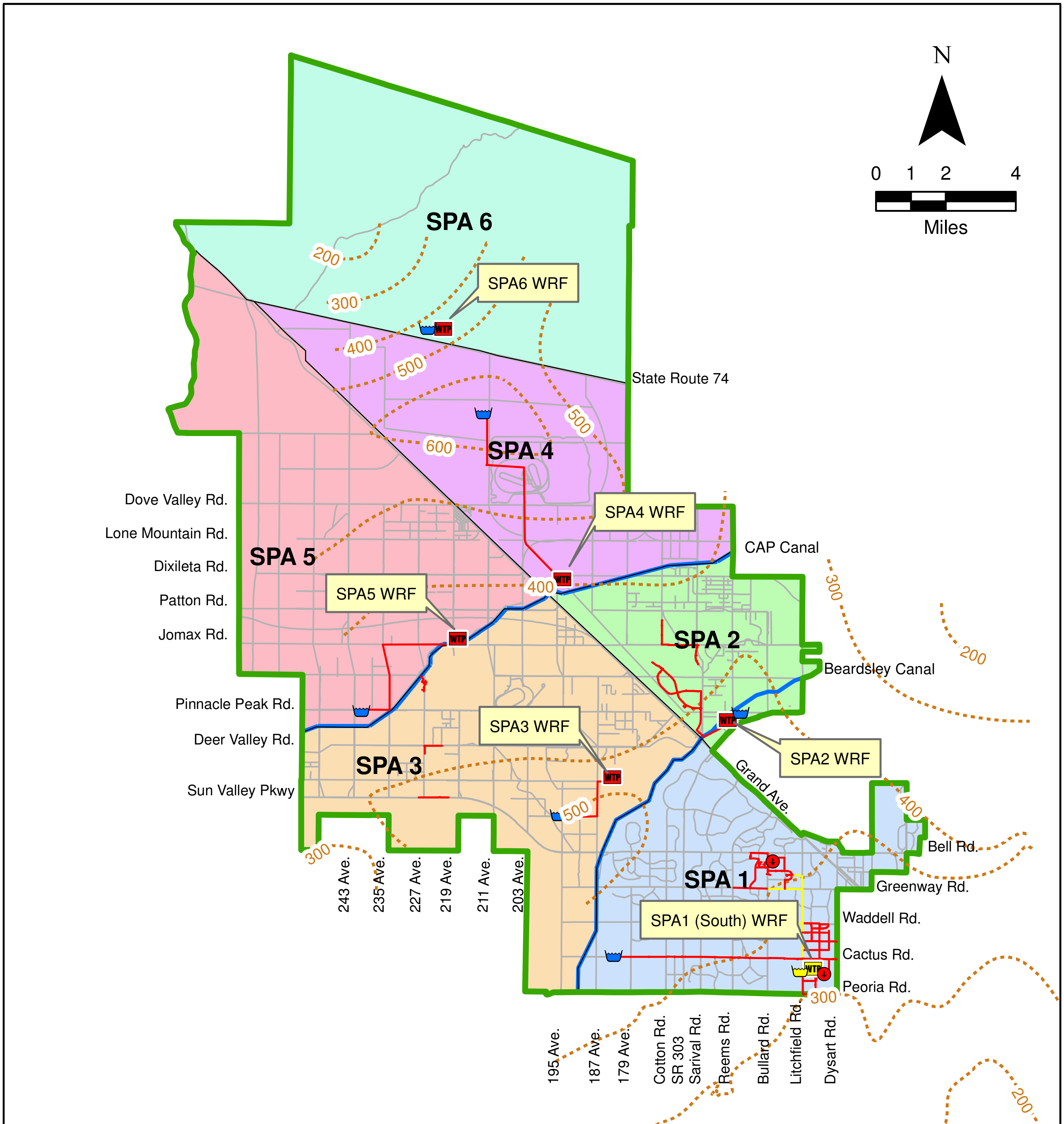
The reclaimed water distribution systems for these alternatives were developed similarly to the systems for Alternatives 5A, 5B, and 5C.

C.2 Reclaimed Water Balances and Infrastructure Sizing

Using the Demand Module previously developed and described in Section 5 and Appendix A of the *Integrated Water Master Plan: Water Resources* Report, future wastewater flows and potential reclaimed water demands (outdoor and landscape) were calculated for baseline build-out conditions. These values were used to calculate the seasonal balance of reclaimed water supply and demand and subsequently determine the necessary infrastructure sizing in each alternative. The tables and figures on the following pages show the following information:

- Schematics of each alternative evaluated
- Baseline reclaimed water projections from the Demand Module

- Figures showing the recharge and recovery balance for the reclaimed water alternatives
- Tables detailing the water balance and infrastructure sizing for each alternative
- A summary table containing a comparison of all infrastructure requirements for the alternatives



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets
- Depth to Groundwater Contour (feet)

Water Reclamation Facilities

- Existing
- Planned/Proposed

Surface Spreading Basins

- Existing
- Planned/Proposed

Vadose Zone Injection Wells

- Planned/Proposed

Reclaimed Water Pipelines

- Existing
- Planned/Proposed

SURPRISE ARIZONA

MALCOLM PIRNIE

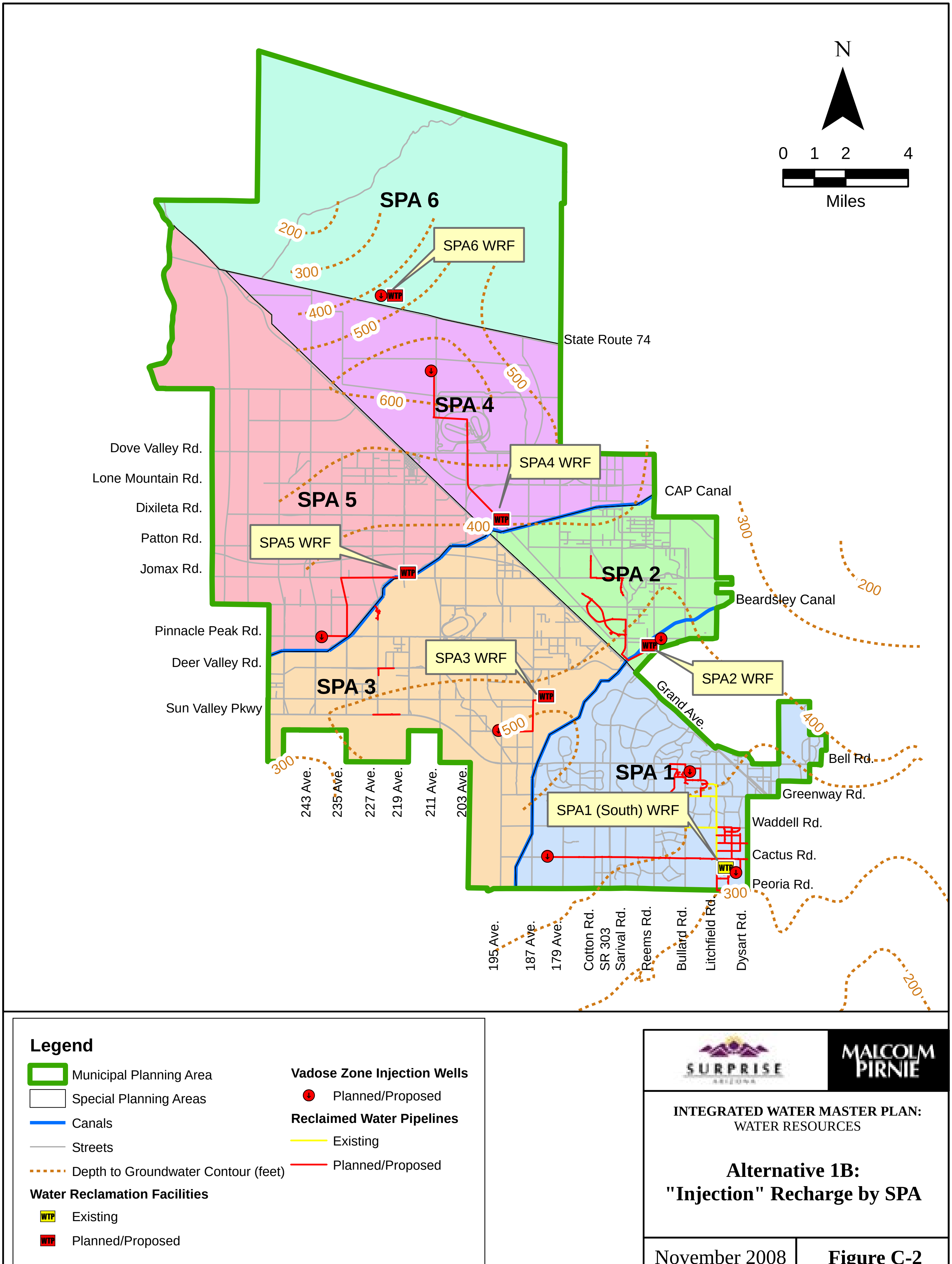
INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternative 1A: Spreading Basin Recharge by SPA

November 2008

Figure C-1

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-1 Spreading Basin Recharge by SPA.mxd



SURPRISE ARIZONA

MALCOLM PIRNIE

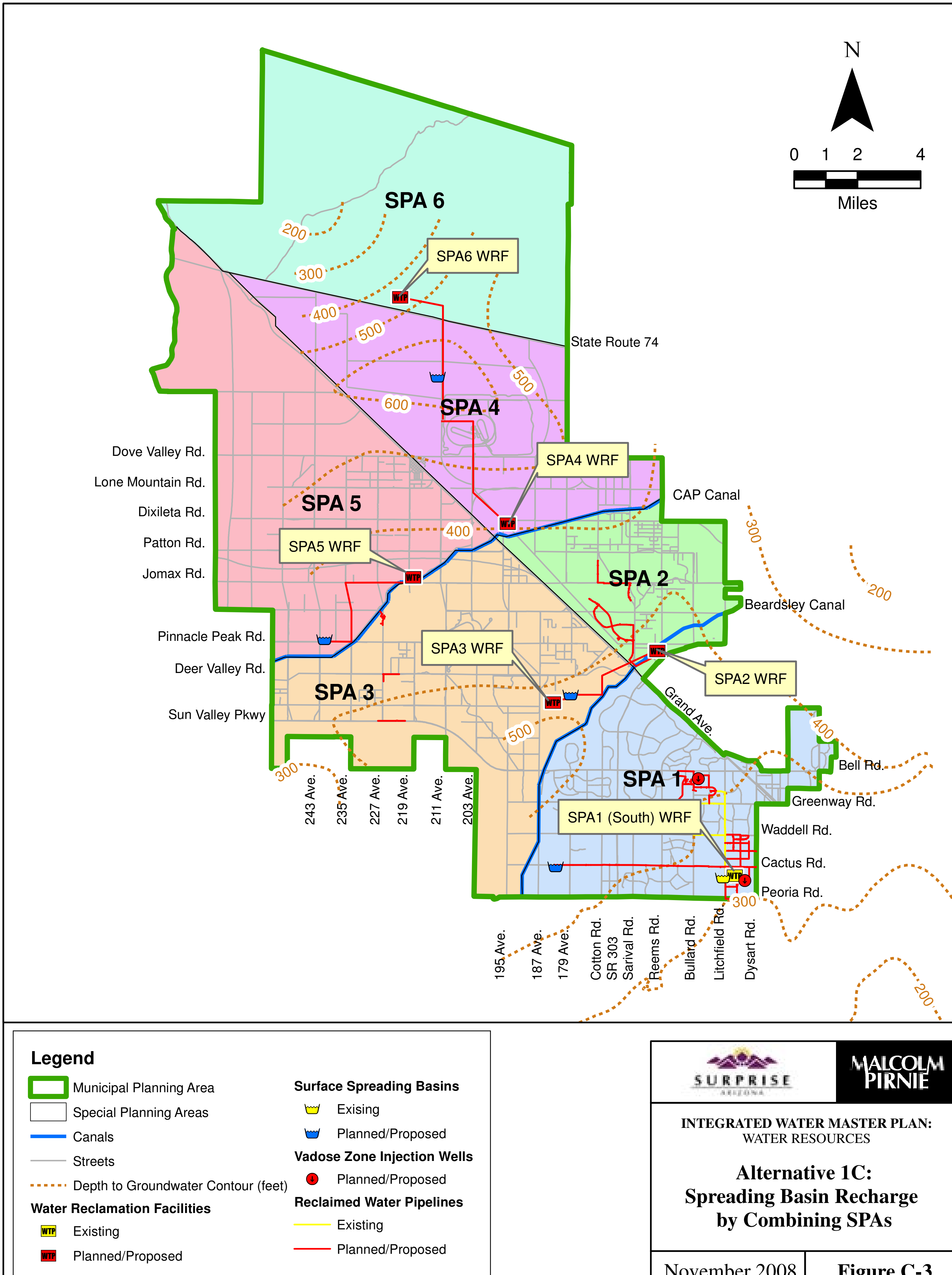
INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternative 1B: "Injection" Recharge by SPA

November 2008

Figure C-2

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-2 Injection Recharge by SPA.mxd



SURPRISE ARIZONA

MALCOLM PIRNIE

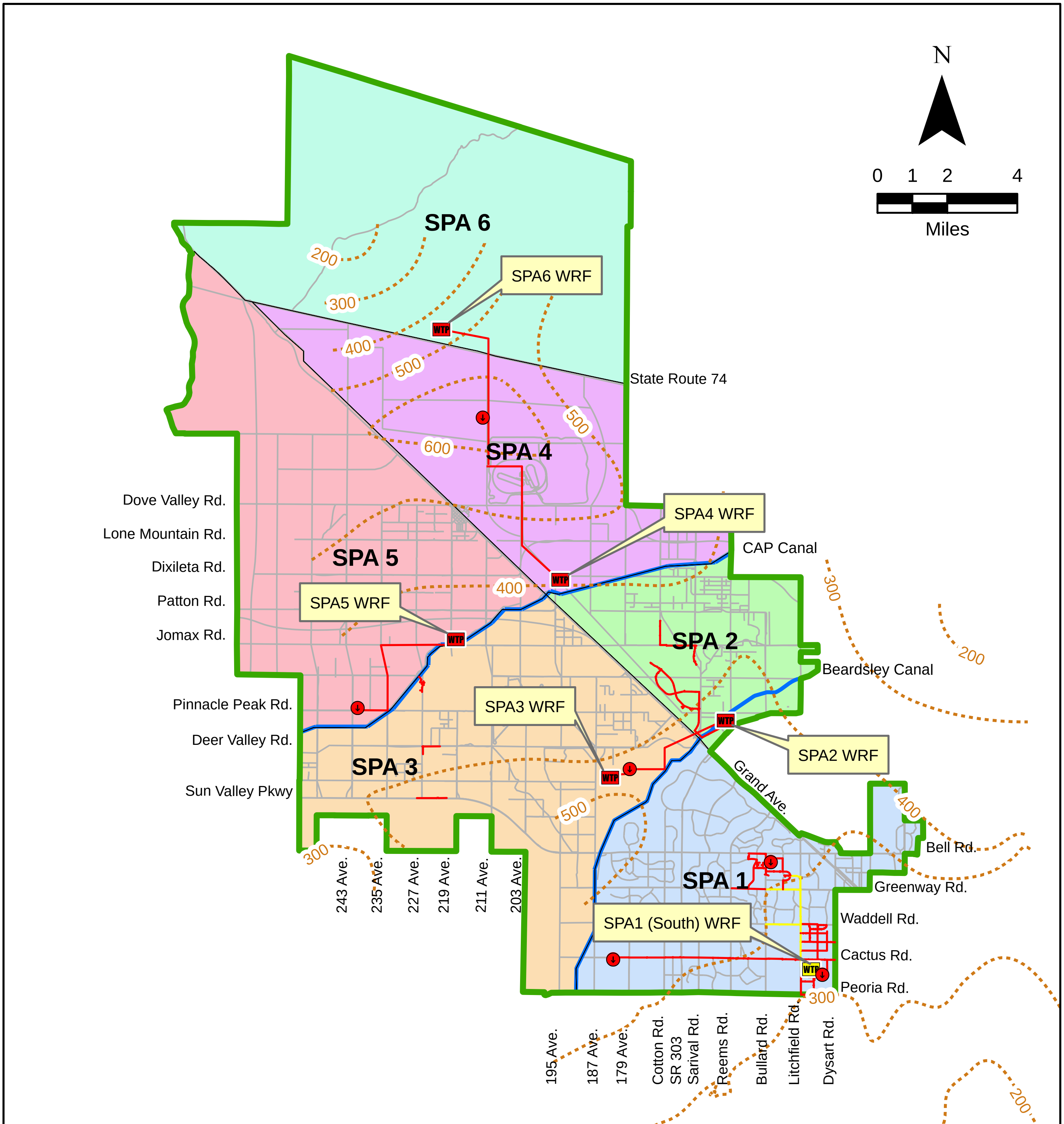
INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternative 1C: Spreading Basin Recharge by Combining SPAs

November 2008

Figure C-3

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-3 Spreading Basin by Combining SPAs.mxd

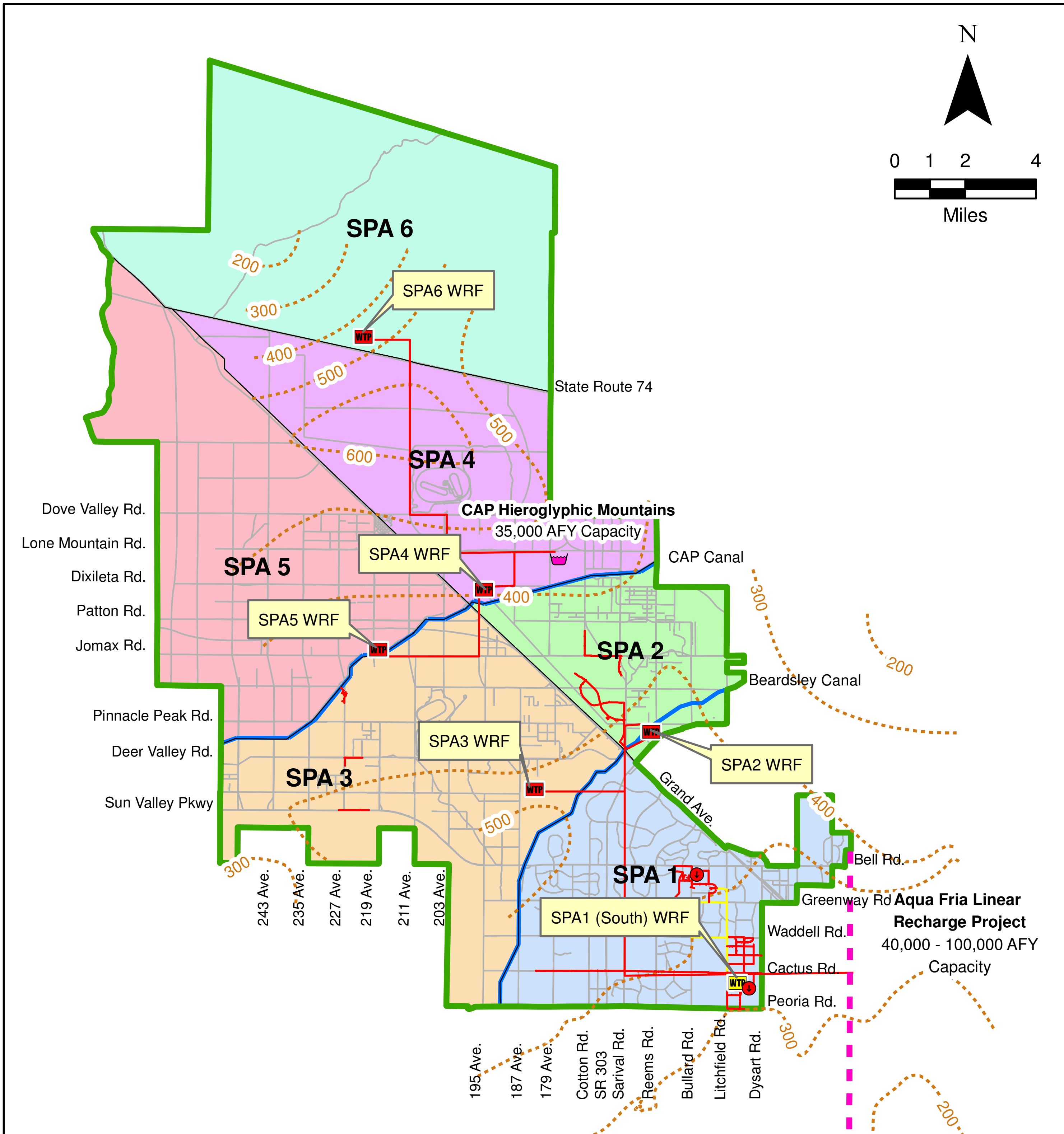


INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternative 1D: "Injection" Recharge by Combining SPAs

November 2008 | **Figure C-4**

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-4 Injection Recharge by Combining SPAs.mxd



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets
- Depth to Groundwater Contour (feet)

Water Reclamation Facilities

- Existing
- Planned/Proposed

Permitted Recharge Facilites

- CAP Hieroglyphics
- Linear Recharge Project

Vadose Zone Injection Wells

- Planned/Proposed

Reclaimed Water Pipelines

- Existing
- Planned/Proposed

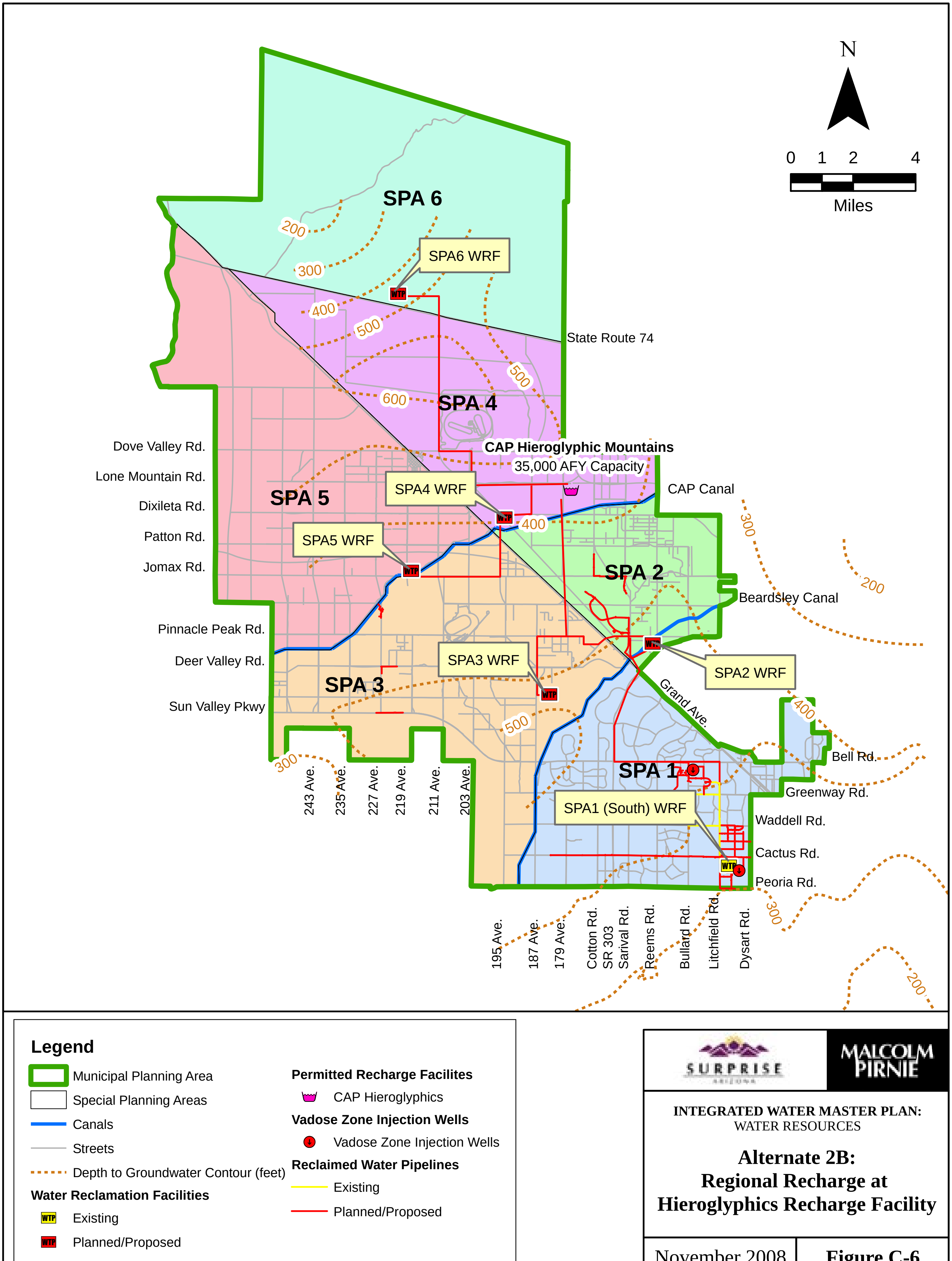
SURPRISE ARIZONA | MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternative 2A: Regional Recharge at Hieroglyphics and Agua Fria Linear Recharge Facilities

November 2008 | **Figure C-5**

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-5 Hieroglyphic and Linear Recharge.mxd



SURPRISE ARIZONA

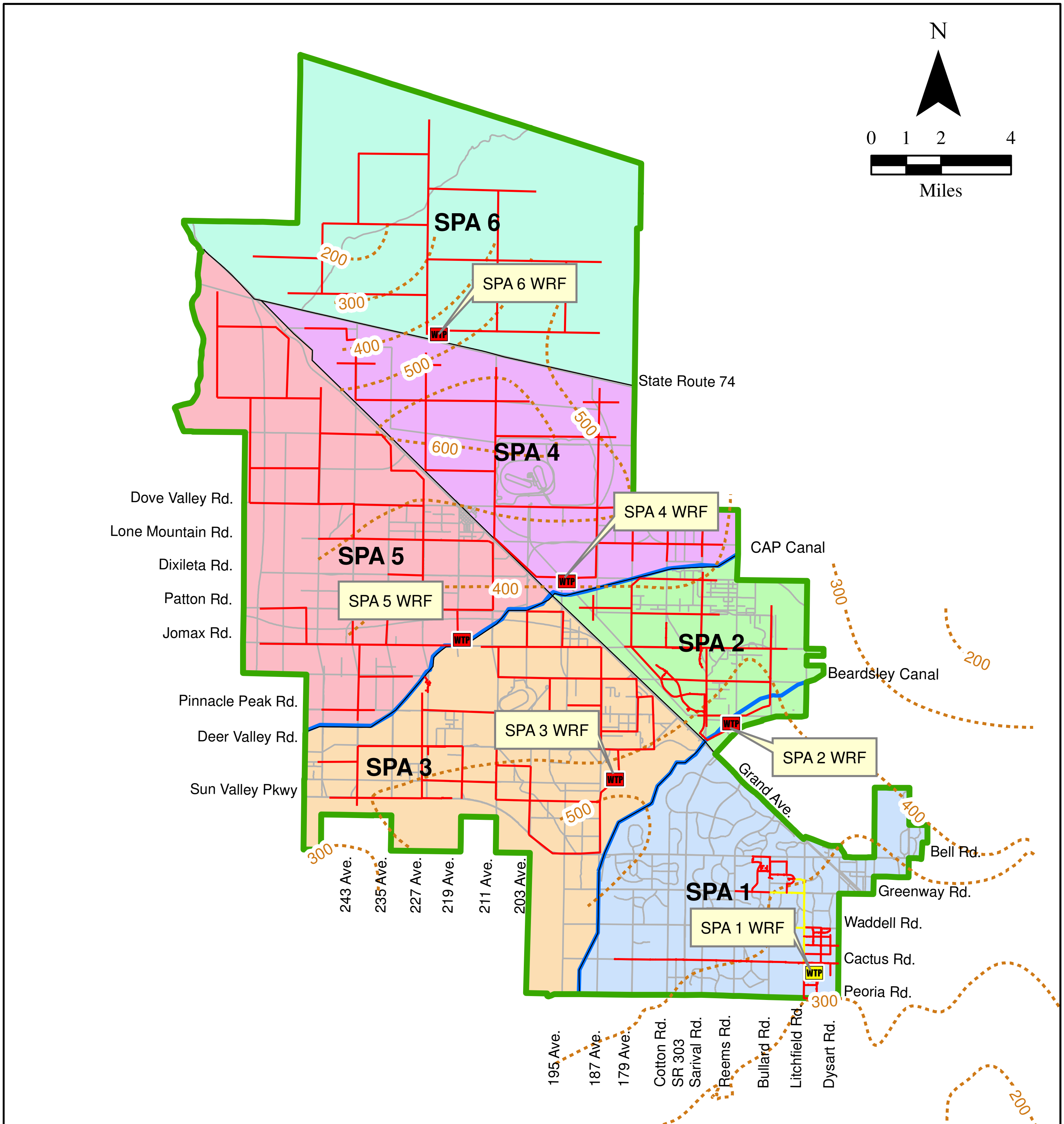
MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternate 2B:
Regional Recharge at Hieroglyphics Recharge Facility

November 2008	**Figure C-6**

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-6 Recharge at Hieroglyphics.mxd



Legend

Municipal Planning Area
Special Planning Areas
Canals
Streets
Depth to Groundwater Contour (feet)

Water Reclamation Facilities
WTP Existing
WTP Planned/Proposed

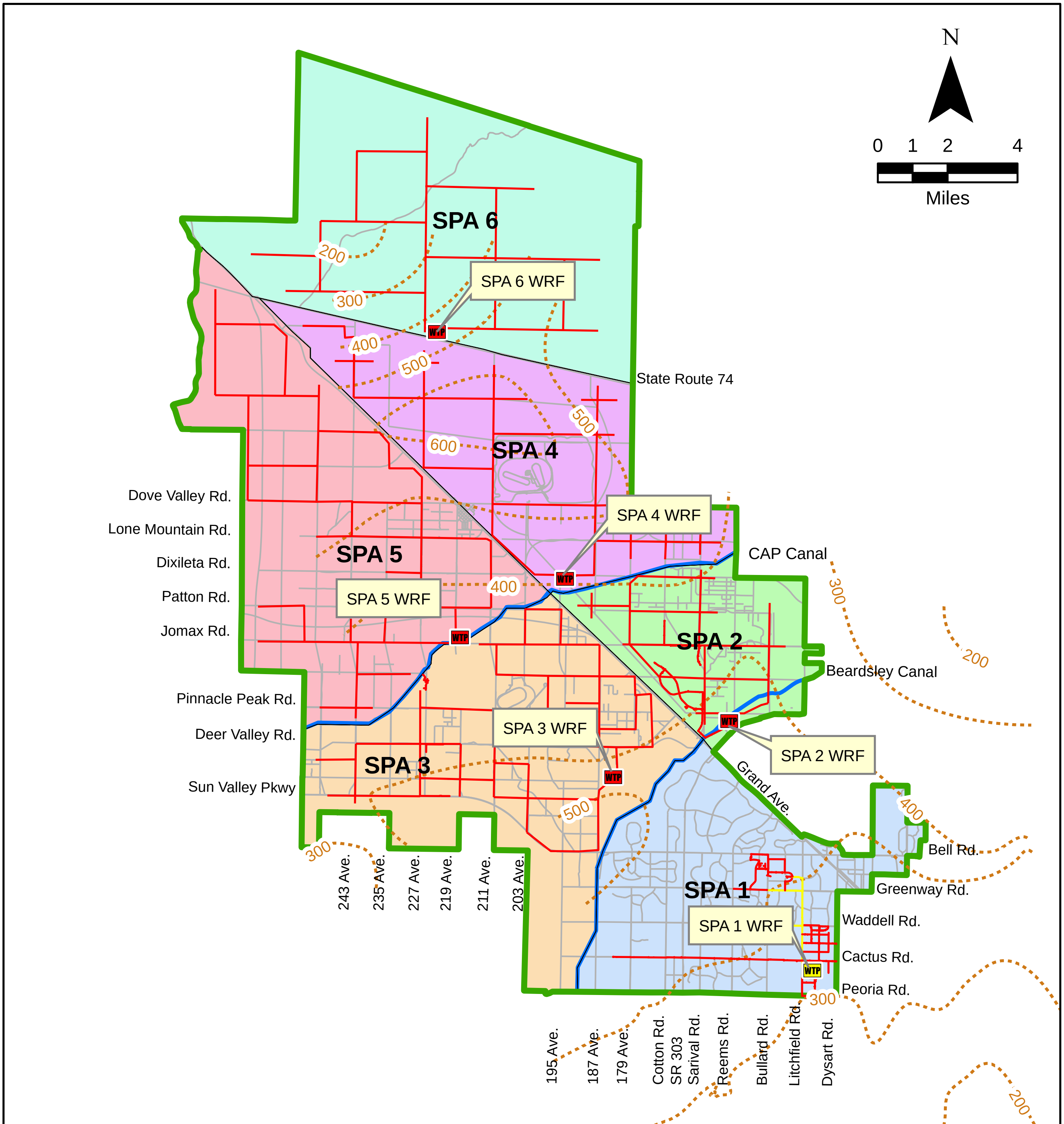
Reclaimed Water Pipelines
Existing
Planned/Proposed

SURPRISE ARIZONA
MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternative 3: Serve Largest Reuse Customers by SPA

November 2008 | **Figure C-7**



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets
- Depth to Groundwater Contour (feet)

Water Reclamation Facilities

- WTP Existing
- WTP Planned/Proposed

Reclaimed Water Pipelines

- Existing
- Planned/Proposed

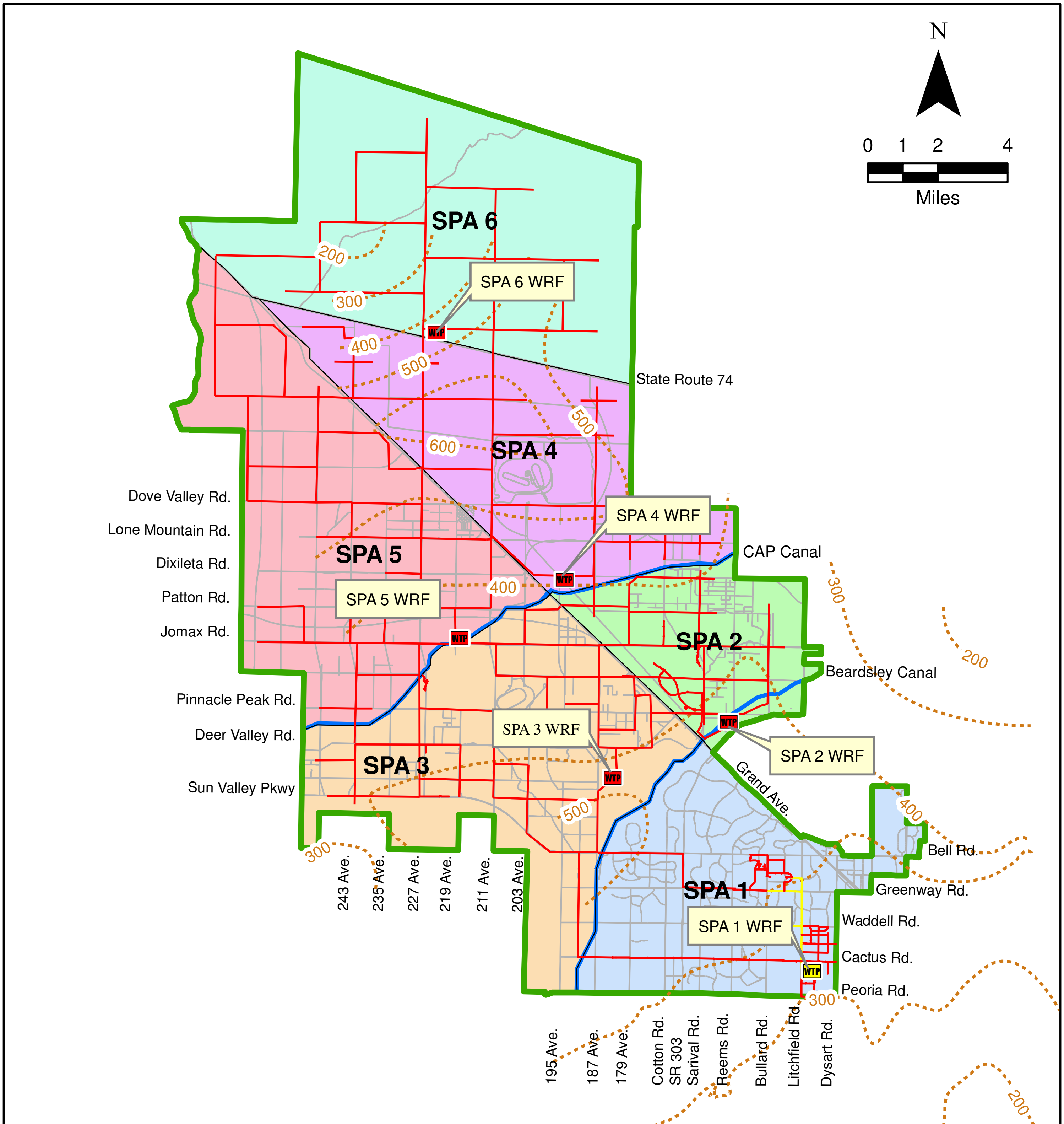
SURPRISE ARIZONA | MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternative 4:
Maximize Direct Reuse by SPA

November 2008 | **Figure C-8**

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-8 Maximize Direct Reuse by SPA.mxd



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets
- Depth to Groundwater Contour (feet)

Water Reclamation Facilities

- WTP Existing
- WTP Planned/Proposed

Reclaimed Water Pipelines

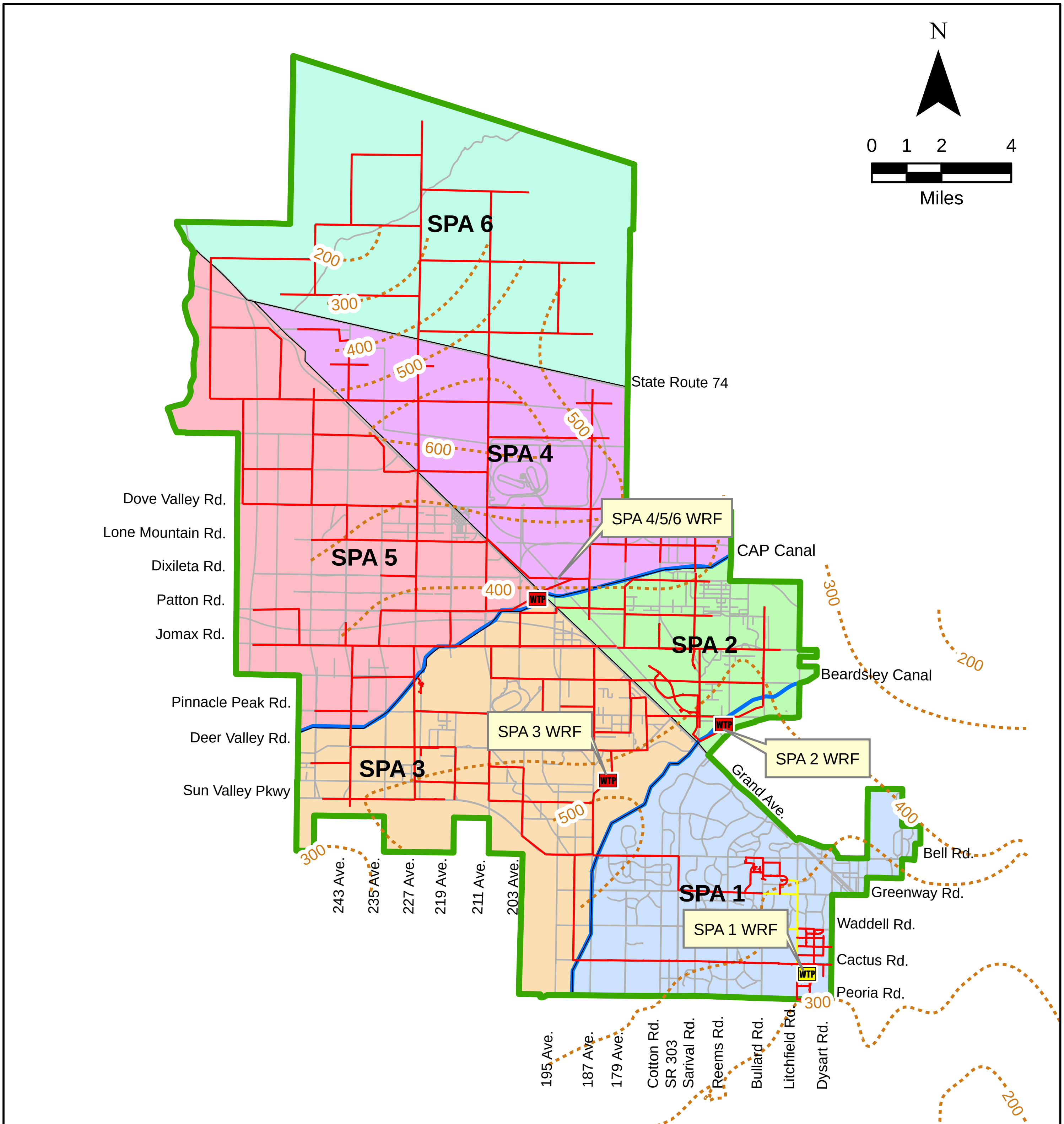
- Existing
- Planned/Proposed

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternative 5A:
Serve Largest Reuse Customers from 6 WRFs via Fully-Connected Dual Distribution System

November 2008	**Figure C-9**

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-9 Serve from 6 WRFs.mxd



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets
- Depth to Groundwater Contour (feet)

Water Reclamation Facilities

- WTP Existing
- WTP Planned/Proposed

Reclaimed Water Pipelines

- Existing
- Planned/Proposed

SURPRISE ARIZONA

MALCOLM PIRNIE

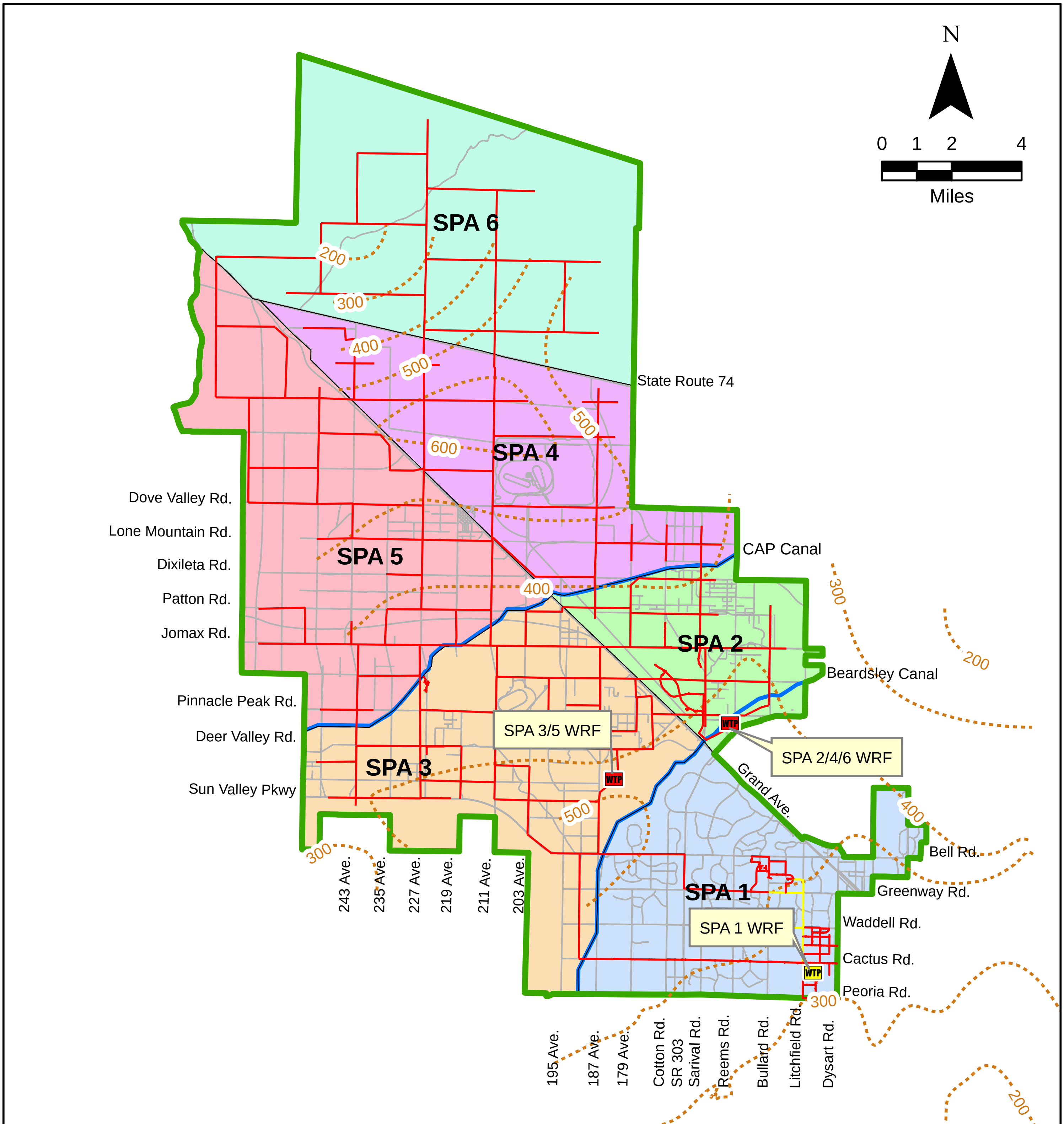
INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternative 5B: Serve Largest Reuse Customers from 4 WRFs via Fully-Connected Dual Distribution System

November 2008

Figure C-10

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-10 Serve from 4 WRFs.mxd



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets
- Depth to Groundwater Contour (feet)

Water Reclamation Facilities

- WTP Existing
- WTP Planned/Proposed

Reclaimed Water Pipelines

- Existing
- Planned/Proposed

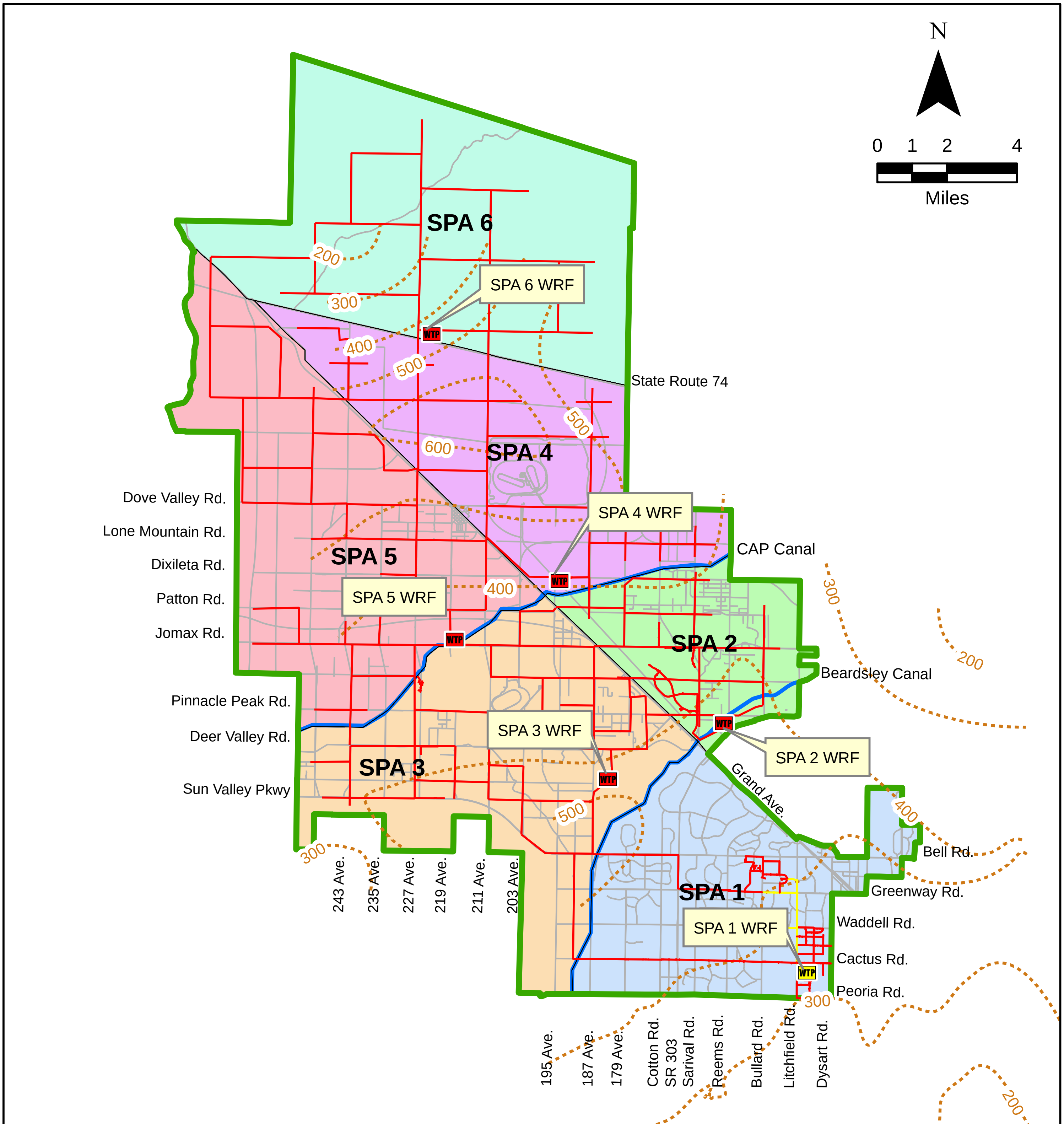
SURPRISE ARIZONA | MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternative 5C:
Serve Largest Reuse Customers from 3 WRFs via Fully-Connected Dual Distribution System

November 2008 | **Figure C-11**

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-11 Serve from 3 WRFs.mxd



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets
- Depth to Groundwater Contour (feet)

Water Reclamation Facilities

- WTP Existing
- WTP Planned/Proposed

Reclaimed Water Pipelines

- Planned/Proposed
- Existing

SURPRISE ARIZONA

MALCOLM PIRNIE

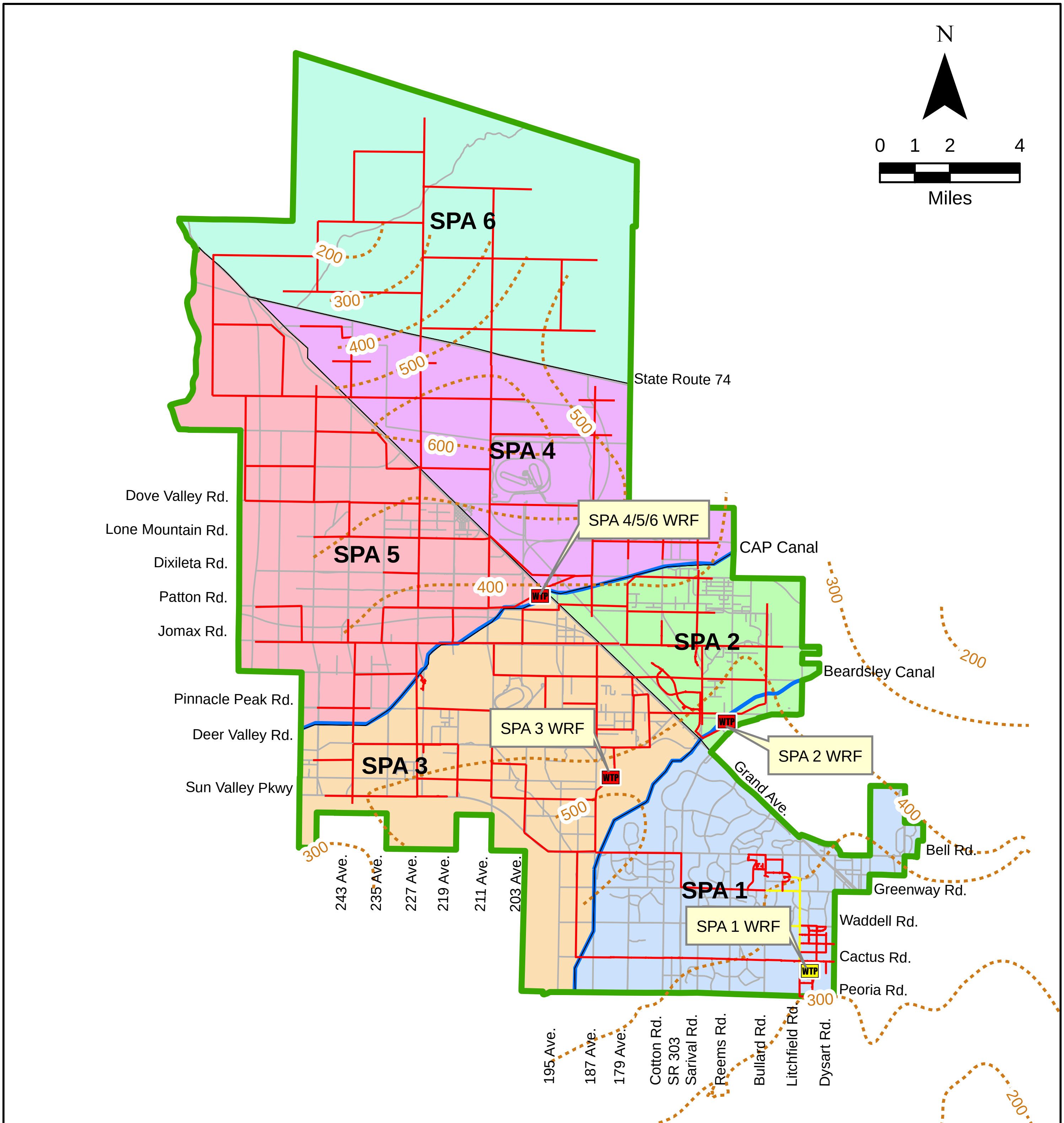
INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternative 6A: Maximize Direct Reuse from 6 WRFs via Fully-Connected Dual Distribution System

November 2008

Figure C-12

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-12 Maximize from 6 WRFs.mxd



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets
- Depth to Groundwater Contour (feet)

Water Reclamation Facilities

- WTP Existing
- WTP Planned/Proposed

Reclaimed Water Pipelines

- Existing
- Planned/Proposed

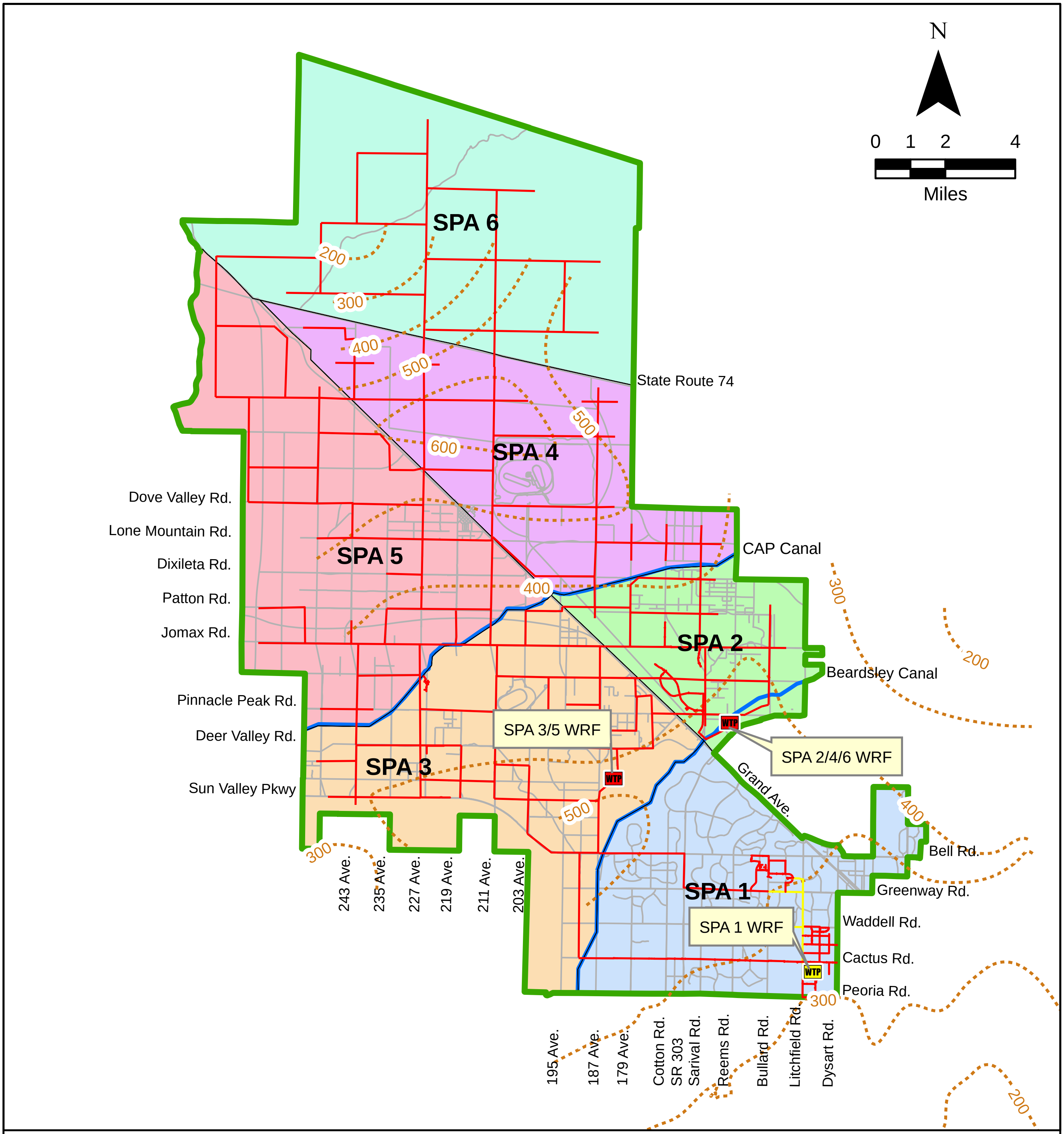
SURPRISE ARIZONA | MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

**Alternate 6B:
Maximize Direct Reuse from
4 WRFs via Fully-Connected
Dual Distribution System**

November 2008 | **Figure C-13**

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-13 Maximize from 4 WRFs.mxd



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets
- Depth to Groundwater Contour (feet)

Water Reclamation Facilities

- WTP Existing
- WTP Planned/Proposed

Reclaimed Water Pipelines

- Existing
- Planned/Proposed

SURPRISE ARIZONA | MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Alternate 6C: Maximize Direct Reuse from 3 WRFs via Fully-Connected Dual Distribution System

November 2008 | **Figure C-14**

M:\4957002\GIS\Project_MXDs\Final Report\Figure C-14 Maximize from 3 WRFs.mxd

Demand Module Output Used in Preliminary Evaluation of Reclaimed Water Program Alternatives

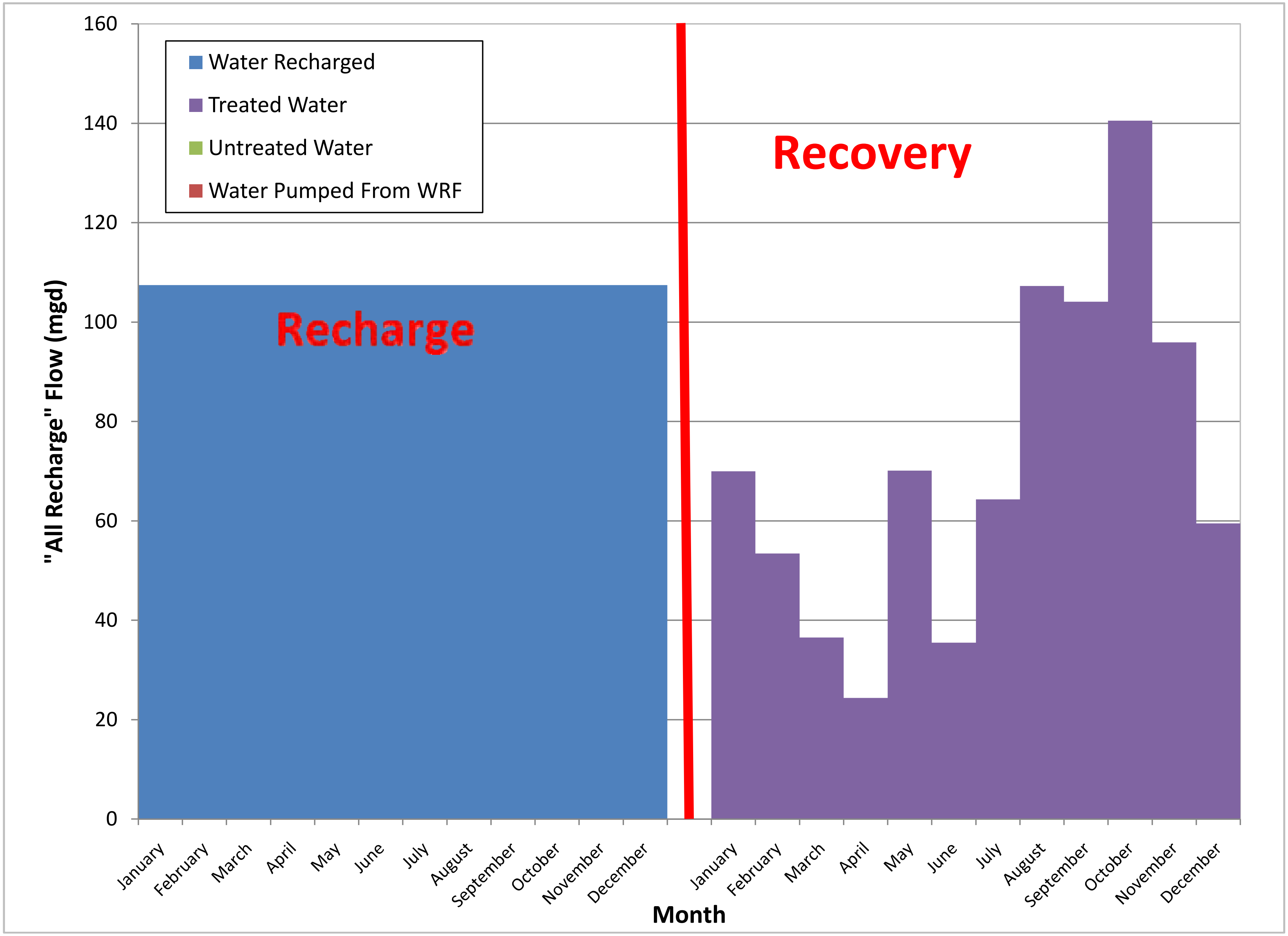
	Indoor Demand (gpd)	Outdoor Demand (gpd)	Landscape Demand (gpd)	Total Reclaimed Demand (gpd)	Total Water Demand (gpd)	Wastewater Flow (gpd)	Reclaimed Water Available (gpd)
SPA 1	5,735,179	3,038,269	2,180,125	5,218,394	10,953,574	20,718,159	18,646,343
SPA 2	10,551,899	5,603,495	1,573,179	7,176,674	17,728,573	10,710,579	9,639,521
SPA 3	22,122,661	11,705,305	2,381,510	14,086,815	36,209,476	23,016,846	20,715,161
SPA 4	19,344,657	10,618,144	2,523,377	13,141,521	32,486,179	19,344,657	17,410,192
SPA 5	26,239,916	13,898,646	3,540,566	17,439,213	43,679,128	26,239,916	23,615,924
SPA 6	19,342,227	10,131,672	3,072,635	13,204,307	32,546,534	19,342,227	17,408,004
TOTAL	103,336,539	54,995,532	15,271,392	70,266,924	173,603,463	119,372,384	107,435,145

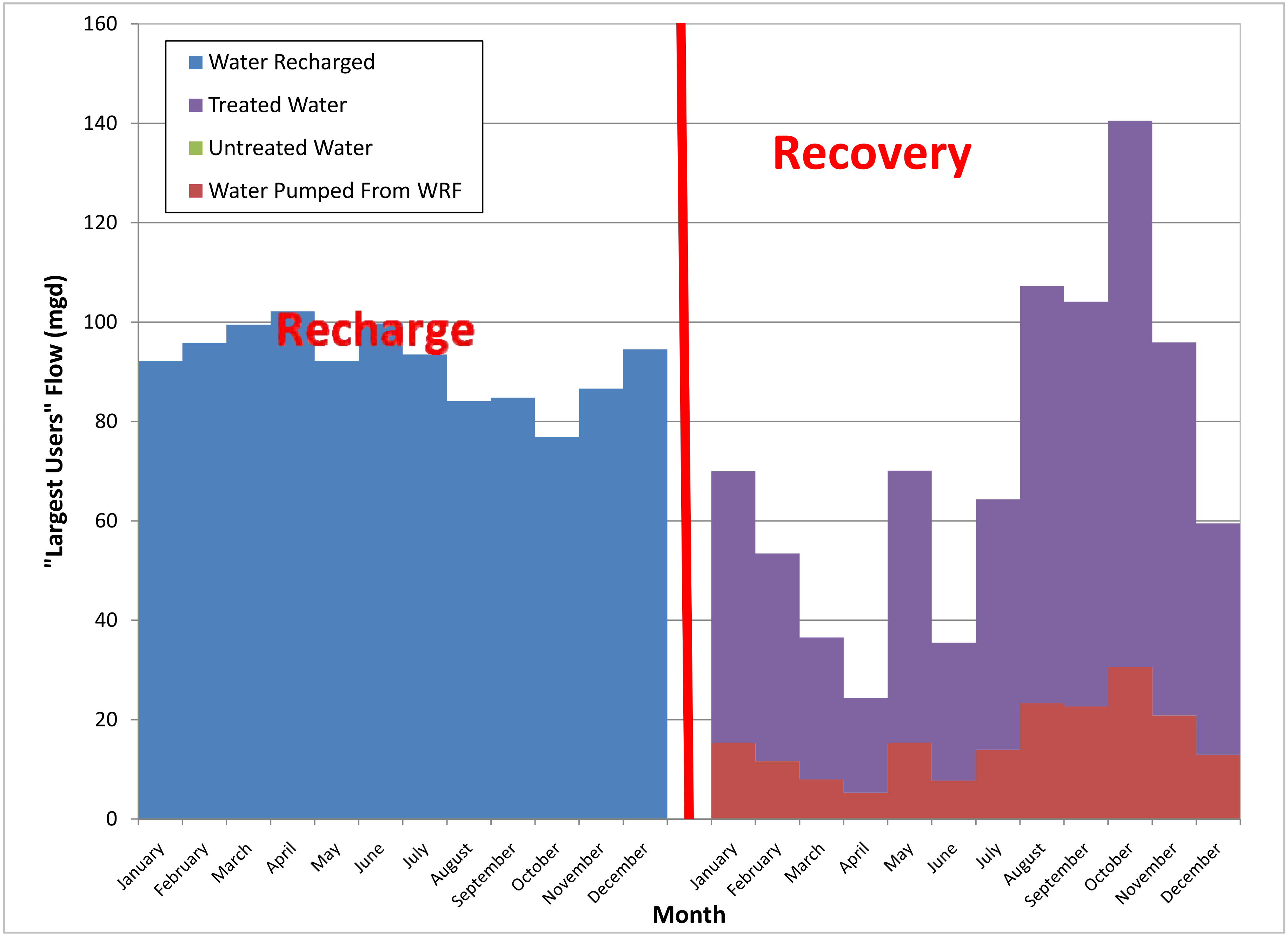
Preliminary Reclaimed Water Program Alternatives: Infrastructure and Flow Summary

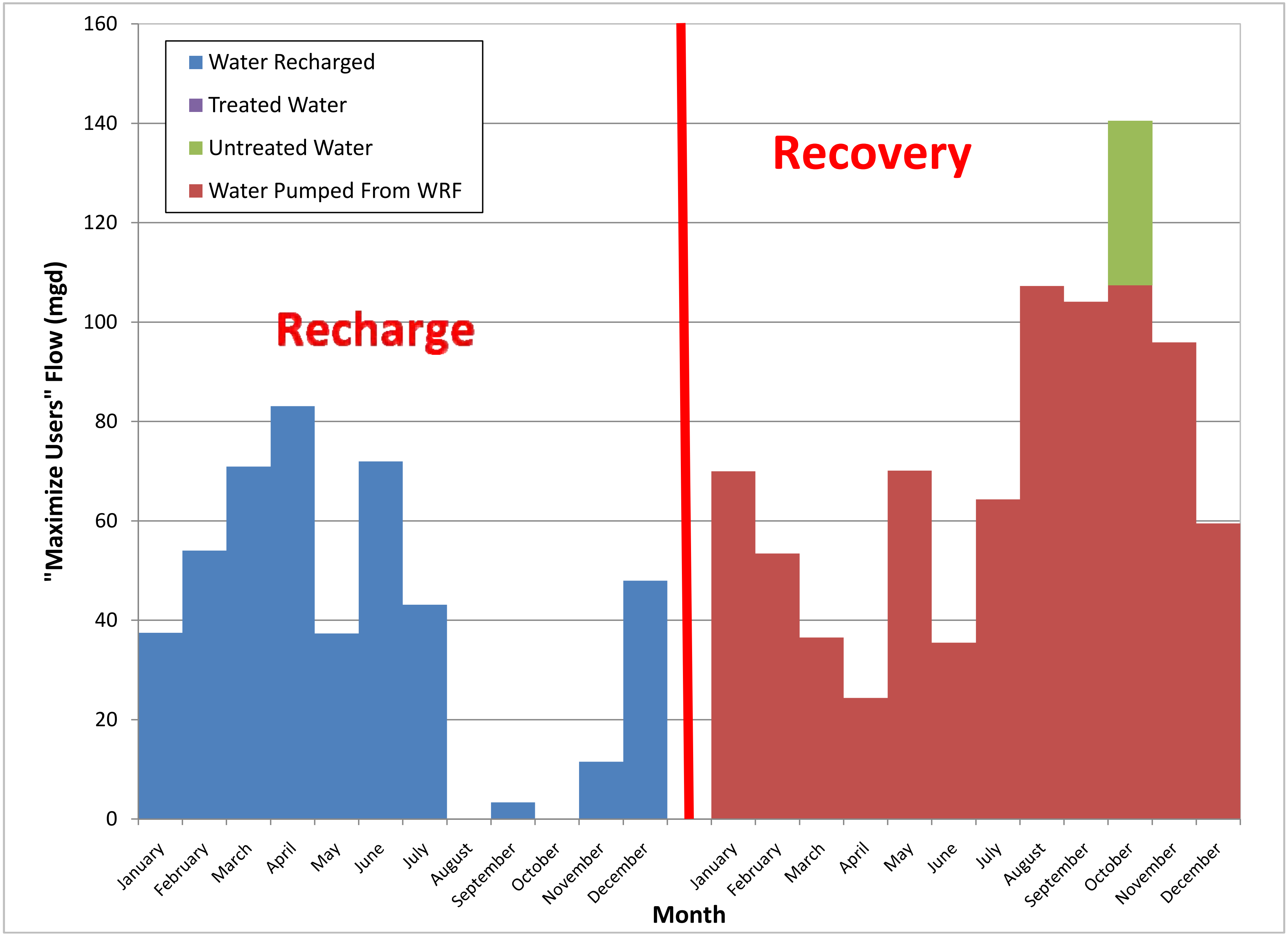
Alternative	Recharge Capacity (mgd)[1]	Injection (mgd)[2]	Speading Basins (acres)[3]	General Recharge (mgd)[4]	No. Reclaimed Production Wells[5]	No. Potable Production Wells[6]	Reclaimed Storage (MG)[7]	Potable Storage (MG)[8]	Treatment Capacity (mgd)[9]	Annual Water Recharged (MG)[10]	Annual Water Recovered (MG)[11]	Annual Water Treated (MG)[12]	Annual Water Evaporated (MG)[13]
1A	100.5	0.0	341	0.0	0	96	0	169	98.4	36,691	25,647	17,953	1,101
1B	100.5	100.5	0	0.0	0	96	0	169	98.4	36,691	25,647	17,953	0
1C	100.5	0.0	341	0.0	0	93	0	169	98.4	36,691	25,647	17,953	1,101
1D	100.5	100.5	0	0.0	0	93	0	169	98.4	36,691	25,647	17,953	0
2A	100.5	0.0	0	0.0	0	90	0	169	98.4	36,691	25,647	17,953	1,101
2B	100.5	0.0	0	0.0	0	90	0	169	98.4	36,691	25,647	17,953	1,101
3	95.2	0.0	325	95.2	0	64	31	132	77.0	33,611	20,073	14,051	1,008
4	75.9	0.0	261	75.9	23	0	141	0	0.0	14,056	1,010	0	422
5A	95.2	0.0	322	95.2	0	56	31	132	77.0	33,611	20,073	14,051	1,008
5B	95.2	0.0	322	95.2	0	56	31	132	77.0	33,611	20,073	14,051	1,008
5C	95.2	0.0	322	95.2	0	56	31	132	77.0	33,611	20,073	14,051	1,008
6A	75.9	0.0	257	75.9	17	0	141	0	0.0	14,056	1,010	0	422
6B	75.9	0.0	257	75.9	17	0	141	0	0.0	14,056	1,010	0	422
6C	75.9	0.0	257	75.9	17	0	141	0	0.0	14,056	1,010	0	422

NOTES:

(1) Recharge Capacity = Annual Average Reclaimed Water Available - 0.35(Annual Average Reclaimed Water Demand)
(2) Injection (vadose or deep) = Recharge Capacity (For Recharge via Injection Technology Alternatives Only)
(3) Spreading Basins = Recharge Capacity / (7.48 ft^3/gallon) / (1.0 ft/day) / (43,560 ft^2/acre) + 10%
(4) General Recharge (spreading or injection) = Recharge Capacity (For Direct Reuse Alternatives Only)
(5) No. Reclaimed Production Wells = 2(Annual Average Reclaimed Water Demand) / (1,400 gpm/well)
(6) No. Potable Production Wells = Outdoor Demand Not Served With Reclaimed Water / (1,400 gpm/well) / (0.80 firm capacity)
(7) Reclaimed Storage = Max Day Outdoor Demand Served With Reclaimed Water
(8) Potable Storage = 1.2(Max Day Outdoor Demand Not Served With Reclaimed Water)
(9) Arsenic Treatment = 70 Percent of Max Day Demand Not Served With Reclaimed Water
(10) Annual Water Recharged = Water Recharged When Reclaimed Water Available Exceeds Reclaimed Water Demand
(11) Annual Water Recovered = Water Recovered To Meet Reclaimed Water Demand
(12) Annual Water Treated = Total Outdoor Demand Served via Potable Water Distribution System
(13) Annual Water Evaporated = Annual Water Recharged * 0.03


160
140
120
100
80
60
40
20
0
"All Recharge" Flow (mgd)
Water Recharged
Treated Water
Untreated Water
Water Pumped From WRF
Recharge
Recovery
January
February
March
April
May
June
July
August
September
October
November
December
January
February
March
April
May
June
July
August
September
October
November
December
Month

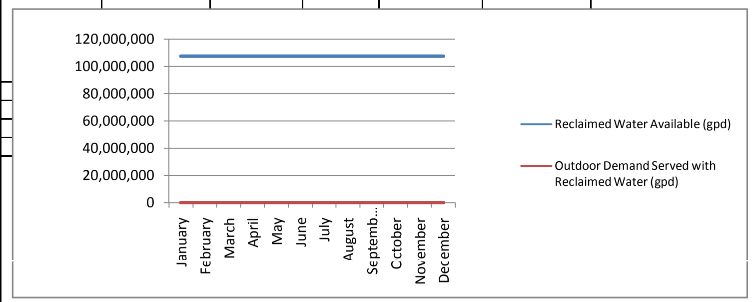

160
140
120
100
80
60
40
20
0
"Largest Users" Flow (mgd)
Water Recharged
Treated Water
Untreated Water
Water Pumped From WRF
Recharge
Recovery
January
February
March
April
May
June
July
August
September
October
November
December
January
February
March
April
May
June
July
August
September
October
November
December
Month


Water Recharged
Treated Water
Untreated Water
Water Pumped From WRF
Recharge
Recovery
"Maximize Users" Flow (mgd)
0
20
40
60
80
100
120
140
160
January
February
March
April
May
June
July
August
September
October
November
December
January
February
March
April
May
June
July
August
September
October
November
December
Month

Alternatives 1A and 1B Water Balance and Infrastructure Sizing

	Reclaimed Water Available (gpd)	Minimum Reclaimed Demand (gpd)	Maximum Reclaimed Demand (gpd)	Recharge Capacity (gpd)	Reclaimed Well Capacity (gpd)	Production Well Capacity (gpd)	Reclaimed Wells (#)	Production Wells (#)	Reclaimed Storage (MG)	Potable Storage (MG)	Injection Technology (mgd)	Spreading Basins (acres)	Arsenic Treatment Capacity (gpd)	Yearly Reclaimed Well Production (1,000 gallons)	Yearly Reclaimed System Movement (1,000 gallons)	Yearly Production Well (1,000 gallons)
SPA 1	18,646,343	0	0	11,734,343	0	10,436,788	0	8	0.0	12.5	11.7	40	7,305,752		0	1,904,714
SPA 2	9,639,521	0	0	9,639,521	0	14,353,347	0	10	0.0	17.2	9.6	33	10,047,343		0	2,619,486
SPA 3	20,715,161	0	0	20,715,161	0	28,173,629	0	19	0.0	33.8	20.7	70	19,721,541		0	5,141,687
SPA 4	17,410,192	0	0	17,410,192	0	26,283,042	0	18	0.0	31.5	17.4	59	18,398,130		0	4,796,655
SPA 5	23,615,924	0	0	23,615,924	0	34,878,425	0	23	0.0	41.9	23.6	80	24,414,898		0	6,365,313
SPA 6	17,408,004	0	0	17,408,004	0	26,408,615	0	18	0.0	31.7	17.4	59	18,486,030		0	4,819,572
TOTAL							**0**	**96**	**0**	**169**	**101**	**341**	**98,373,693**	**0**	**0**	**25,647,427**

Month	Effluent Factor	Reclaimed Water Available (gpd)	Reclaimed Factor	Outdoor Demand Served with Reclaimed Water (gpd)	Reclaimed Well Production (1,000 gallons)	Outdoor Demand Served with Potable Water (gpd)
January	1.00	107,435,145	1.00	0	0	69986970.98
February	1.00	107,435,145	0.76	0	0	53420363.76
March	1.00	107,435,145	0.52	0	0	36507956.6
April	1.00	107,435,145	0.35	0	0	24350321.26
May	1.00	107,435,145	1.00	0	0	70117095.88
June	1.00	107,435,145	0.50	0	0	35473268.37
July	1.00	107,435,145	0.92	0	0	64311933.22
August	1.00	107,435,145	1.53	0	0	107236196.7
September	1.00	107,435,145	1.48	0	0	104107112
October	1.00	107,435,145	2.00	0	0	140533847.4
November	1.00	107,435,145	1.37	0	0	95914400.03
December	1.00	107,435,145	0.85	0	0	59499403.45
				TOTAL	**0**	



Percentage of Total Reclaimed Demand Served with Groundwater	**100%**

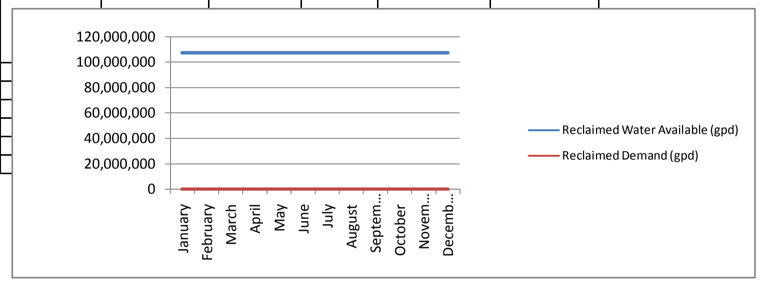
	Calculated Diameter (in)	Rounded Diameter (in)	Length (ft)	Elevation (ft)	Change in Pressure (psi)	Booster Pump Capacity (gpm)	TDH (feet)	Pump Horsepower (hp)	Velocity (ft/sec)	
SPA 1	24.6	30	1,320	160	0	8,149	165	533	5.8	11.734343
SPA 2	22.3	24	1,320	80	0	6,694	85	225	5.0	9.6395215
SPA 3	32.7	36	13,200	30	0	14,386	70	399	5.8	20.715161
SPA 4	30.0	30	31,680	210	0	12,090	320	1,533	5.5	17.410192
SPA 5	34.9	36	26,400	10	0	16,400	80	520	5.4	23.615924
SPA 6	30.0	30	1,320	10	0	12,089	15	72	5.8	17.408004

Does not include standby pumps

Alternatives 1C and 1D Water Balance and Infrastructure Sizing

	Reclaimed Water Available (gpd)	Minimum Reclaimed Demand (gpd)	Maximum Reclaimed Demand (gpd)	Recharge Capacity (gpd)	Reclaimed Well Capacity (gpd)	Production Well Capacity (gpd)	Reclaimed Wells (#)	Production Wells (#)	Reclaimed Storage (MG)	Potable Storage (MG)	Injection Technology (mgd)	Spreading Basins (acres)	Arsenic Treatment Capacity (gpd)	Yearly Reclaimed Well Production (1,000 gallons)	Yearly Reclaimed System Movement (1,000 gallons)	Yearly Production Well (1,000 gallons)
SPA 1	18,646,343	0	0	11,734,343	0	10,436,788	0	8	0.0	12.5	11.7	40	7,305,752		0	1,904,714
SPAs 2&3	30,354,682	0	0	30,354,682	0	42,526,977	0	28	0.0	51.0	30.4	103	29,768,884		0	7,761,173
SPAs 4&6	34,818,196	0	0	34,818,196	0	52,691,657	0	34	0.0	63.2	34.8	118	36,884,160		0	9,616,227
SPA 5	23,615,924	0	0	23,615,924	0	34,878,425	0	23	0.0	41.9	23.6	80	24,414,898		0	6,365,313
TOTAL							**0**	**93**	**0**	**169**	**100.5**	**341.0**	**98,373,693**	**0**	**0**	**25,647,427**

Month	Effluent Factor	Reclaimed Water Available (gpd)	Reclaimed Factor	Reclaimed Demand (gpd)	Reclaimed Well Production (1,000 gallons)
January	1.00	107,435,145	1.00	0	0
February	1.00	107,435,145	0.76	0	0
March	1.00	107,435,145	0.52	0	0
April	1.00	107,435,145	0.35	0	0
May	1.00	107,435,145	1.00	0	0
June	1.00	107,435,145	0.50	0	0
July	1.00	107,435,145	0.92	0	0
August	1.00	107,435,145	1.53	0	0
September	1.00	107,435,145	1.48	0	0
October	1.00	107,435,145	2.00	0	0
November	1.00	107,435,145	1.37	0	0
December	1.00	107,435,145	0.85	0	0
				TOTAL	**0**



Percentage of Total Reclaimed Demand Served with Groundwater	**100%**

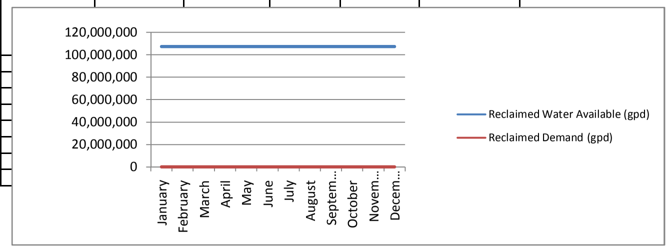
	Calculated Diameter (in)	Rounded Diameter (in)	Length (ft)	Elevation (ft)	Change in Pressure (psi)	Booster Pump Capacity (gpm)	TDH (feet)	Pump Horsepower (hp)	Velocity (ft/sec)	
SPA 1	24.6	30	1,320	160	0	8,149	165	533	5.8	11.734343
SPA 2	22.3	24	19,800	0	0	6,694	80	212	5.2	9.6395215
SPA 3	32.7	36	2,640	0	0	14,386	10	57	6.5	20.715161
SPA 4	30.0	30	31,680	210	0	12,090	300	1,437	5.0	17.410192
SPA 5	34.9	36	26,400	10	0	16,400	80	520	5.4	23.615924
SPA 6	30.0	30	23,760	-320	0	12,089	0	0	11.5	17.408004
SPAs 4&6	42.4	48	5,280	0	0	0	0	0	0.0	0

Does not include standby pumps

Alternative 2A Water Balance and Infrastructure Sizing

	Reclaimed Water Available (gpd)	Minimum Reclaimed Demand (gpd)	Maximum Reclaimed Demand (gpd)	Recharge Capacity (gpd)	Reclaimed Well Capacity (gpd)	Production Well Capacity (gpd)	Reclaimed Wells (#)	Production Wells (#)	Reclaimed Storage (MG)	Potable Storage (MG)	Injection Wells (#)	Spreading Basins (acres)	Arsenic Treatment Capacity (gpd)	Yearly Reclaimed Well Production (1,000 gallons)	Yearly Reclaimed System Movement (1,000 gallons)	Yearly Production Well (1,000 gallons)	Hieroglyphics/ Agua Fria Recharge (1,000 gallons)
SPAs 1,2,&3	49,001,025	0	0	42,089,025	0	52,963,765	0	34	0.0	63.6	0	0	37,074,636		0	9,665,887	15,362,494
SPAs 4,5,&6	58,434,120	0	0	58,434,120	0	87,570,082	0	56	0.0	105.1	0	0	61,299,058		0	15,981,540	21,328,454
TOTAL							**0**	**90**	**0**	**169**	**0**	**0**	**98,373,693**	**0**	**0**	**25,647,427**	**36,690,948**

Month	Effluent Factor	Reclaimed Water Available (gpd)	Reclaimed Factor	Reclaimed Demand (gpd)	Reclaimed Well Production (1,000 gallons)
January	1.00	107,435,145	1.00	0	0
February	1.00	107,435,145	0.76	0	0
March	1.00	107,435,145	0.52	0	0
April	1.00	107,435,145	0.35	0	0
May	1.00	107,435,145	1.00	0	0
June	1.00	107,435,145	0.50	0	0
July	1.00	107,435,145	0.92	0	0
August	1.00	107,435,145	1.53	0	0
September	1.00	107,435,145	1.48	0	0
October	1.00	107,435,145	2.00	0	0
November	1.00	107,435,145	1.37	0	0
December	1.00	107,435,145	0.85	0	0
				TOTAL	**0**



Percentage of Total Reclaimed Demand Served with Groundwater	**100%**

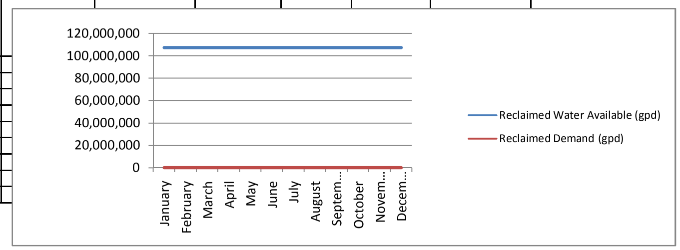
	Calculated Diameter (in)	Rounded Diameter (in)	Length (ft)	Elevation (ft)	Change in Pressure (psi)	Booster Pump Capacity (gpm)	TDH (feet)	Pump Horsepower (hp)	Velocity (ft/sec)	
SPA 1	24.6	30	1,320	160	0	8,149	165	533	5.8	11.73434
SPA 2	22.3	24	13,200	-30	0	6,694	30	80	5.6	9.639521
SPA 3	32.7	36	15,840	-60	0	14,386	0	0	6.5	20.71516
SPA 4&5	46.0	48	15,840	50	0	28,490	80	903	5.4	41.02612
SPA 5	34.9	36	26,400	10	0	16,400	80	520	5.4	23.61592
SPA 6	30.0	30	52,800	-500	0	12,089	0	0	9.5	17.408
SPAs 4,5,&6	54.9	60	7,920	0	0	0	0	0	0.0	0
SPAs 2&3	39.6	42	47,520	-190	0	0	0	0	7.4	0
SPAs 1,2,&3	46.6	48	18,480	-40	0	0	0	0	5.8	0

Does not include standby pumps

Alternative 2B Water Balance and Infrastructure Sizing

	Reclaimed Water Available (gpd)	Minimum Reclaimed Demand (gpd)	Maximum Reclaimed Demand (gpd)	Recharge Capacity (gpd)	Reclaimed Well Capacity (gpd)	Production Well Capacity (gpd)	Reclaimed Wells (#)	Production Wells (#)	Reclaimed Storage (MG)	Potable Storage (MG)	Injection Wells (#)	Spreading Basins (acres)	Arsenic Treatment Capacity (gpd)	Yearly Reclaimed Well Production (1,000 gallons)	Yearly Reclaimed System Movement (1,000 gallons)	Yearly Production Well (1,000 gallons)	Hieroglyphics/ Agua Fria Recharge (1,000 gallons)
All SPAs	107,435,145	0	0	100,523,145	0	140,533,847	0	89	0.0	168.6	0	0	98,373,693		0	25,647,427	36,690,948
TOTAL							**0**	**89**	**0**	**169**	**0**	**0**	**98,373,693**	**0**	**0**	**25,647,427**	**36,690,948**

Month	Effluent Factor	Reclaimed Water Available (gpd)	Reclaimed Factor	Reclaimed Demand (gpd)	Reclaimed Well Production (1,000 gallons)
January	1.00	107,435,145	1.00	0	0
February	1.00	107,435,145	0.76	0	0
March	1.00	107,435,145	0.52	0	0
April	1.00	107,435,145	0.35	0	0
May	1.00	107,435,145	1.00	0	0
June	1.00	107,435,145	0.50	0	0
July	1.00	107,435,145	0.92	0	0
August	1.00	107,435,145	1.53	0	0
September	1.00	107,435,145	1.48	0	0
October	1.00	107,435,145	2.00	0	0
November	1.00	107,435,145	1.37	0	0
December	1.00	107,435,145	0.85	0	0
				TOTAL	**0**



Percentage of Total Reclaimed Demand Served with Groundwater	100%

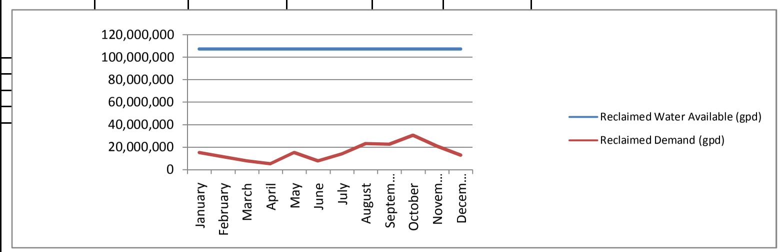
	Calculated Diameter (in)	Rounded Diameter (in)	Length (ft)	Elevation (ft)	Change in Pressure (psi)	Booster Pump Capacity (gpm)	TDH (feet)	Pump Horsepower (hp)	Velocity (ft/sec)	
SPA 1	24.6	30	58,080	320	0	8,149	500	1,614	5.2	11.73434
SPA 2	22.3	24	13,200	40	0	6,694	100	265	5.6	9.639521
SPA 3	32.7	36	15,840	40	0	14,386	80	456	5.2	20.71516
SPA 1,2,&3	46.6	48	23,760	260	0	29,228	300	3,473	5.0	42.08903
SPA 4&5	46.0	48	15,840	50	0	28,490	80	903	5.4	41.02612
SPA 5	34.9	36	26,400	10	0	16,400	80	520	5.4	23.61592
SPA 6	34.9	36	52,800	-500	0	16,400	0	0	10.7	23.61592
SPAs 4,5,&6	72.0	78	7,920	0	0	12,089	0	0	0.0	17.408

Does not include standby pumps

Alternative 3 Water Balance and Infrastructure Sizing

	Reclaimed Water Available (gpd)	Minimum Reclaimed Demand (gpd)	Maximum Reclaimed Demand (gpd)	Recharge Capacity (gpd)	Reclaimed Well Capacity (gpd)	Production Well Capacity (gpd)	Recharge (mgd)	Additional Production Wells for Reclaimed (#)	Potable Production Wells (#)	Reclaimed Storage (MG)	Potable Storage (MG)	Additional Injection (mgd)	Spreading Basins (acres)	Arsenic Treatment Capacity (gpd)	Yearly Reclaimed Well Production (1,000 gallons)	Yearly Reclaimed System Movement (1,000 gallons)	Yearly Production Well (1,000 gallons)
SPA 1	18,646,343	763,044	4,360,250	10,971,299	0	6,076,538	11.0	0	5	4.4	7.3	0.0	38	4,253,577		795,746	1,108,968
SPA 2	9,639,521	550,613	3,146,358	9,088,909	0	11,206,989	9.1	0	7	3.1	13.4	0.0	31	7,844,892		574,210	2,045,276
SPA 3	20,715,161	833,528	4,763,019	19,881,633	0	23,410,610	19.9	0	13	4.8	28.1	0.0	68	16,387,427		869,251	4,272,436
SPA 4	17,410,192	883,182	5,046,754	16,527,010	0	21,236,289	16.5	0	12	5.0	25.5	0.0	56	14,865,402		921,033	3,875,623
SPA 5	23,615,924	1,239,198	7,081,133	22,376,726	0	27,797,292	22.4	0	15	7.1	33.4	0.0	76	19,458,105		1,292,307	5,073,006
SPA 6	17,408,004	1,075,422	6,145,270	16,332,582	0	20,263,345	16.3	0	12	6.1	24.3	0.0	56	14,184,341		1,121,512	3,698,060
TOTAL							**95.2**	**0**	**64**	**31**	**132**	**0**	**325**	**76,993,744**	**0**	**5,574,058**	**20,073,369**
												0					
												14051358.33					

Month	Effluent Factor	Reclaimed Water Available (gpd)	Reclaimed Factor	Reclaimed Demand (gpd)	Reclaimed Well Production (1,000 gallons)	Recharged (1,000 gallons)
January	1.00	107,435,145	1.00	15,210,549	0	2,812,850
February	1.00	107,435,145	0.76	11,610,062	0	2,922,665
March	1.00	107,435,145	0.52	7,934,420	0	3,034,772
April	1.00	107,435,145	0.35	5,292,153	0	3,115,361
May	1.00	107,435,145	1.00	15,238,829	0	2,811,988
June	1.00	107,435,145	0.50	7,709,548	0	3,041,631
July	1.00	107,435,145	0.92	13,977,170	0	2,850,468
August	1.00	107,435,145	1.53	23,306,072	0	2,565,937
September	1.00	107,435,145	1.48	22,626,016	0	2,586,678
October	1.00	107,435,145	2.00	30,542,784	0	2,345,217
November	1.00	107,435,145	1.37	20,845,461	0	2,640,985
December	1.00	107,435,145	0.85	12,931,244	0	2,882,369
				TOTAL	**0**	**33,610,922**



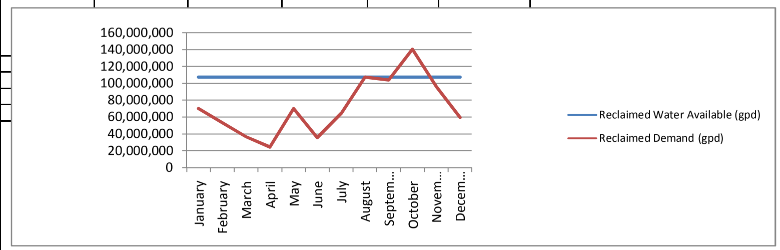
Percentage of Total Reclaimed Demand Served with Groundwater	**78%**

RECLAIMED DISTRIBUTION PIPING SIZED IN WATERGEMS MODEI

Alternative 4 Water Balance and Infrastructure Sizing

	Reclaimed Water Available (gpd)	Minimum Reclaimed Demand (gpd)	Maximum Reclaimed Demand (gpd)	Recharge Capacity (gpd)	Reclaimed Well Capacity (gpd)	Production Well Capacity (gpd)	Recharge (mgd)	Additional Production Wells for Reclaimed (#)	Potable Production Wells (#)	Reclaimed Storage (MG)	Potable Storage (MG)	Additional Injection (mgd)	Spreading Basins (acres)	Arsenic Treatment Capacity (gpd)	Yearly Reclaimed Well Production (1,000 gallons)	Yearly Reclaimed System Movement (1,000 gallons)	Yearly Production Well (1,000 gallons)
SPA 1	18,646,343	1,826,438	10,436,788	9,907,905	0	0	9.9	0	0	10.4	0.0	0.0	34	0		1,904,714	0
SPA 2	9,639,521	2,511,836	14,353,347	7,127,686	4,713,826	0	7.1	3	0	14.4	0.0	0.0	25	0		2,619,486	0
SPA 3	20,715,161	4,930,385	28,173,629	15,784,776	7,458,468	0	15.8	4	0	28.2	0.0	0.0	54	0		5,141,687	0
SPA 4	17,410,192	4,599,532	26,283,042	12,810,659	8,872,851	0	12.8	5	0	26.3	0.0	0.0	44	0		4,796,655	0
SPA 5	23,615,924	6,103,724	34,878,425	17,512,200	11,262,501	0	17.5	6	0	34.9	0.0	0.0	60	0		6,365,313	0
SPA 6	17,408,004	4,621,508	26,408,615	12,786,496	9,000,611	0	12.8	5	0	26.4	0.0	0.0	44	0		4,819,572	0
TOTAL							**75.9**	**23**	**0**	**141**	**0**	**0**	**261**	**0**	**1,009,510**	**25,647,427**	**0**
												0					
												14051358.33					

Month	Effluent Factor	Reclaimed Water Available (gpd)	Reclaimed Factor	Reclaimed Demand (gpd)	Reclaimed Well Production (1,000 gallons)	Recharged (1,000 gallons)
January	1.00	107,435,145	1.00	69,986,971	0	1,142,169
February	1.00	107,435,145	0.76	53,420,364	0	1,647,451
March	1.00	107,435,145	0.52	36,507,957	0	2,163,279
April	1.00	107,435,145	0.35	24,350,321	0	2,534,087
May	1.00	107,435,145	1.00	70,117,096	0	1,138,201
June	1.00	107,435,145	0.50	35,473,268	0	2,194,837
July	1.00	107,435,145	0.92	64,311,933	0	1,315,258
August	1.00	107,435,145	1.53	107,236,197	0	6,068
September	1.00	107,435,145	1.48	104,107,112	0	101,505
October	1.00	107,435,145	2.00	140,533,847	1,009,510	0
November	1.00	107,435,145	1.37	95,914,400	0	351,383
December	1.00	107,435,145	0.85	59,499,403	0	1,462,040
				TOTAL	**1,009,510**	**14,056,278**



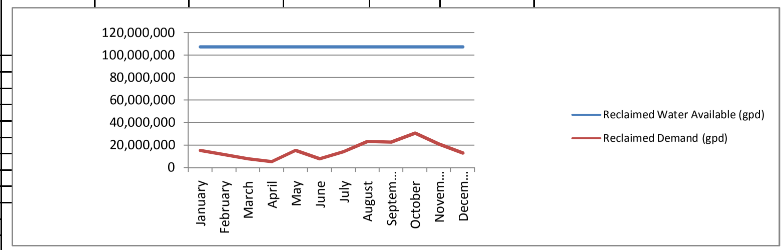
Percentage of Total Reclaimed Demand Served with Groundwater	**0%**

RECLAIMED DISTRIBUTION PIPING SIZED IN WATERGEMS MODEl

Alternatives 5A, 5B, and 5C Water Balance and Infrastructure Sizing

	Reclaimed Water Available (gpd)	Minimum Reclaimed Demand (gpd)	Maximum Reclaimed Demand (gpd)	Recharge Capacity (gpd)	Reclaimed Well Capacity (gpd)	Production Well Capacity (gpd)	Recharge (mgd)	Additional Production Wells for Reclaimed (#)	Potable Production Wells (#)	Reclaimed Storage (MG)	Potable Storage (MG)	Additional Injection (mgd)	Spreading Basins (acres)	Arsenic Treatment Capacity (gpd)	Yearly Reclaimed Well Production (1,000 gallons)	Yearly Reclaimed System Movement (1,000 gallons)	Yearly Production Well (1,000 gallons)
All SPAs	107,435,145	5,344,987	30,542,784	95,178,158	0	109,991,063	95.2	0	56	30.5	132.0	0.0	322	76,993,744		5,574,058	20,073,369
TOTAL							**95.2**	**0**	**56**	**31**	**132**	**0**	**322**	**76,993,744**	**0**	**5,574,058**	**20,073,369**
												17953199					
												17953199					

Month	Effluent Factor	Reclaimed Water Available (gpd)	Reclaimed Factor	Reclaimed Demand (gpd)	Reclaimed Well Production (1,000 gallons)	Recharged (1,000 gallons)
January	1.00	107,435,145	1.00	15,210,549	0	2,812,850
February	1.00	107,435,145	0.76	11,610,062	0	2,922,665
March	1.00	107,435,145	0.52	7,934,420	0	3,034,772
April	1.00	107,435,145	0.35	5,292,153	0	3,115,361
May	1.00	107,435,145	1.00	15,238,829	0	2,811,988
June	1.00	107,435,145	0.50	7,709,548	0	3,041,631
July	1.00	107,435,145	0.92	13,977,170	0	2,850,468
August	1.00	107,435,145	1.53	23,306,072	0	2,565,937
September	1.00	107,435,145	1.48	22,626,016	0	2,586,678
October	1.00	107,435,145	2.00	30,542,784	0	2,345,217
November	1.00	107,435,145	1.37	20,845,461	0	2,640,985
December	1.00	107,435,145	0.85	12,931,244	0	2,882,369
				TOTAL	**0**	**33,610,922**



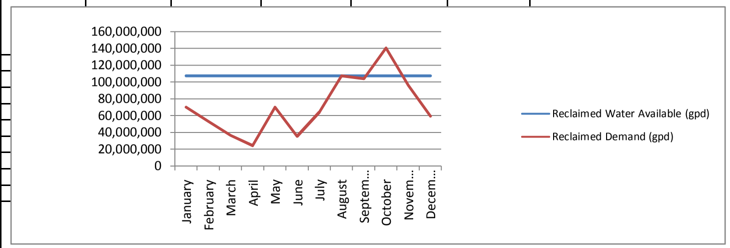
Percentage of Total Reclaimed Demand Served with Groundwater	78%

RECLAIMED DISTRIBUTION PIPING SIZED IN WATERGEMS MODEI

Alternatives 6A, 6B, and 6C Water Balance and Infrastructure Sizing

	Reclaimed Water Available (gpd)	Minimum Reclaimed Demand (gpd)	Maximum Reclaimed Demand (gpd)	Recharge Capacity (gpd)	Reclaimed Well Capacity (gpd)	Production Well Capacity (gpd)	Recharge (mgd)	Additional Production Wells for Reclaimed (#)	Potable Production Wells (#)	Reclaimed Storage (MG)	Potable Storage (MG)	Additional Injection (mgd)	Injection Wells (#)	Spreading Basins (acres)	Arsenic Treatment Capacity (gpd)	Yearly Reclaimed Well Production (1,000 gallons)	Yearly Reclaimed System Movement (1,000 gallons)	Yearly Production Well (1,000 gallons)
All SPAs	107,435,145	24,593,423	140,533,847	75,929,722	33,098,702	0	75.9	17	0	140.5	0.0	0.0	0	257	0		25,647,427	0
TOTAL							**76**	**17**	**0**	**141**	**0**	**0**	**0**	**257**	**0**	**1,009,510**	**25,647,427**	**0**
												17953199						
												17953199						

Month	Effluent Factor	Reclaimed Water Available (gpd)	Reclaimed Factor	Reclaimed Demand (gpd)	Reclaimed Well Production (1,000 gallons)	Recharged (1,000 gallons)
January	1.00	107,435,145	1.00	69,986,971	0	1,142,169
February	1.00	107,435,145	0.76	53,420,364	0	1,647,451
March	1.00	107,435,145	0.52	36,507,957	0	2,163,279
April	1.00	107,435,145	0.35	24,350,321	0	2,534,087
May	1.00	107,435,145	1.00	70,117,096	0	1,138,201
June	1.00	107,435,145	0.50	35,473,268	0	2,194,837
July	1.00	107,435,145	0.92	64,311,933	0	1,315,258
August	1.00	107,435,145	1.53	107,236,197	0	6,068
September	1.00	107,435,145	1.48	104,107,112	0	101,505
October	1.00	107,435,145	2.00	140,533,847	1,009,510	0
November	1.00	107,435,145	1.37	95,914,400	0	351,383
December	1.00	107,435,145	0.85	59,499,403	0	1,462,040
				TOTAL	**1,009,510**	**14,056,278**



Percentage of Total Reclaimed Demand Served with Groundwater	**0%**

RECLAIMED DISTRIBUTION PIPING SIZED IN WATERGEMS MODEL

Alternative Infrastructure Summary

Infrastructure	Units	Alternative													
		1A	1B	1C	1D	2A	2B	3	4	5A	5B	5C	6A	6B	6C
Land	acres	365	49	365	49	23	23	340	267	336	336	336	262	262	262
Pipelines															
6"	feet	0	0	0	0	0	0	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
8"	feet	0	0	0	0	0	0	131,200	26,600	7,100	7,100	7,100	7,100	7,100	7,100
10"	feet	0	0	0	0	0	0	0	0	0	0	0	195,800	195,800	195,800
12"	feet	0	0	0	0	0	0	982,100	197,200	574,700	574,700	574,700	383,000	383,000	383,000
16"	feet	0	0	0	0	0	0	205,000	749,400	284,200	284,200	284,200	159,400	159,400	159,400
20"	feet	0	0	0	0	0	0	91,700	320,000	66,800	66,800	166,800	233,100	233,100	223,100
24"	feet	1,300	1,300	19,800	19,800	13,200	13,300	33,800	94,700	258,200	258,200	121,600	175,500	175,500	179,500
30"	feet	34,300	34,300	56,800	56,800	54,100	58,100	300	34,200	160,300	160,300	150,900	212,800	205,200	195,200
36"	feet	39,600	39,600	29,000	29,000	42,200	95,000	3,800	24,000	107,900	98,700	112,200	68,900	63,000	62,800
42"	feet	0	0	0	0	47,500	0	0	1,600	2,000	2,500	15,800	38,800	43,700	43,700
48"	feet	0	0	5,300	5,300	34,300	39,600	0	0	900	1,100	7,700	1,100	9,700	10,300
54"	feet	0	0	0	0	0	7,900	0	0	1,000	9,700	17,400	0	0	12,900
60"	feet	0	0	0	0	7,900	7,900	0	0	0	0	4,800	0	0	2,700
20" PRV Station	each	0	0	0	0	0	0	0	0	15	15	21	15	15	28
Recharge Basins	acres	341	0	341	0	0	0	324	261	322	322	322	257	257	257
"Injection" Recharge	mgd	0	101	0	101	0	0	0	0	0	0	0	0	0	0
Total Reservoir Capacity	MG	169	169	169	169	169	169	163	141	163	163	163	141	141	141
Booster Pump Stations															
50 TDH	mgd	17	17	21	21	10	0	0	0	0	0	0	0	0	0
100 TDH	mgd	54	54	33	33	65	95	0	0	0	0	0	0	26	86
150 TDH	mgd	0	0	0	0	0	0	0	0	0	8	18	0	0	0
200 TDH	mgd	12	12	12	12	12	0	7	16	0	0	0	47	47	47
300 TDH	mgd	0	0	17	17	0	42	5	34	8	8	8	51	51	51
400 TDH	mgd	17	17	0	0	0	12	34	63	49	49	49	18	18	18
Potable Booster Pump Station	mgd	141	141	141	141	141	141	111	0	111	111	111	0	0	0
Recovery/Production Wells	each	96	96	93	93	90	89	64	23	56	56	56	17	17	17
Arsenic Treatment	mgd	98	98	98	98	98	98	77	0	77	77	77	0	0	0

D. Reclaimed Water Alternative Cost Opinions

This section contains information related to developing the cost opinions for the reclaimed water program alternatives presented in Section 7 and Appendix C. Unit cost tables as well as tables summarizing the cost for each alternative are presented. The sensitivity to changes in water quality (i.e., changing the amount of water that needs to be treated in the split stream to achieve the City's arsenic goal of 7 µg/L in the treated water) is also included.

The unit capital costs include materials of construction, installation, and contractor costs (overhead, profit, bonding, mobilization). All costs include a 20 percent factor for engineering and construction administration and 30 percent for project contingencies. The unit O&M costs include labor, power, chemicals, maintenance, and materials. All costs are in June 2008 dollars referenced to an Engineering News Record Construction Cost Index (ENR CCI) of 8,185.

The cost estimates are 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. The accuracy range of a Class 4 estimate is minus 15 to plus 20 percent in the best case and minus 30 percent to plus 50 percent in the worst case.

Summary of Capital Unit Costs[1]

ITEM	COST	UNITS	CCI	Total (June 2008)	Included in Unit Cost	SOURCE
CAPITAL COSTS						
Land	$40,000	$/acre	8090	$40,470	Land purchase	2008 land appraisal for SPA 5 WRF
Pipelines						
6"	$55	Linear Feet	8185	$55	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
8"	$71	Linear Feet	8185	$71	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
10"	$89	Linear Feet	8185	$89	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
12"	$107	Linear Feet	8185	$107	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
14"	$125	Linear Feet	8185	$125	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
16"	$152	Linear Feet	8185	$152	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
18"	$170	Linear Feet	8185	$170	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
20"	$194	Linear Feet	8185	$194	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
24"	$242	Linear Feet	8185	$242	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
30"	$286	Linear Feet	8185	$286	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
36"	$380	Linear Feet	8185	$380	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
42"	$473	Linear Feet	8185	$473	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
48"	$602	Linear Feet	8185	$602	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
54"	$726	Linear Feet	8185	$726	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
60"	$866	Linear Feet	8185	$866	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
Recharge Basin	$96,667	$/acre	8090	$97,802		Goodyear Adaman Design Concept Report
Alternatives 1B and 1D Recharge Capital Cost	$4,300,000	$/MGD	8185	$4,300,000	Assumes the average cost per MGD of spreading basin costs (Min) to Injection Wells with RO treatment for aquifer water quality standards (Max)	Current evaluation of recharge costs escalated from El Mirage for recharge basins and injection well costs. RO treatment costs based on City of Phoenix Master Plan
Alternatives 3, 4, 5, and 6 Recharge Capital Cost	$3,900,000	$/MGD	8185	$3,900,000	Assumes the average cost per MGD of vadose zone injection costs (Min) to Injection Wells with RO treatment for aquifer water quality standards (Max)	Current evaluation of recharge costs escalated from El Mirage for recharge basins and injection well costs. RO treatment costs based on City of Phoenix Water System Master Plan
Regional Recharge Capital Cost Agua Fria Linear	$200	$/AF	8185	$200		
Vadose Zone Well Injection (20 years, 200 gpm well)	$450,000	$/well site	8090	$455,284	Equipment, electrical, drilling, development	Engineering Judgment (3 wells lasting 7 years each)
Reservoirs	$1,107,475	$/MG	7398	$1,225,289	Includes fencing and access gates, site paving, landscaping, earth and concrete work, electrical, mechanical, instrumentation and SCADA	City of Phoenix Water System Master Plan
Booster Pump Stations					Includes fencing and access gates, site paving, landscaping, earth and concrete work, electrical, mechanical, instrumentation and SCADA	City of Phoenix Water System Master Plan
50 TDH	$ 51,872	$/MGD	8185	$51,872		
100 TDH	$ 78,493	$/MGD	8185	$78,493		
150 TDH	$ 101,849	$/MGD	8185	$101,849		
200 TDH	$ 129,088	$/MGD	8185	$129,088		
300 TDH	$ 155,300	$/MGD	8185	$155,300		
400 TDH	$ 189,447	$/MGD	8185	$189,447		
Production Well (1,400 gpm)	$1,000,000	$/well	8090	$1,011,743		Hard Bid for City of El Mirage, Canterbury Drive and Dietz Crane Phase II, October 2005
Arsenic Treatment	$1,225,000	$/MGD	8090	$1,239,385		Evaluation of Lease or Purchase of Skid-mounted Arsenic Treatment for Dietz Crane and Canterbury Drive Wells, City of El Mirage (June 2005)

NOTES:
(1) June 2008 Costs (ENR CCI = 8,185).
(2) Unit capital costs include materials of construction, installation and contractor overhead and profit.

Summary of Operations and Maintenance Unit Costs[1]

ITEM	COST	UNITS	CCI	Total (June 2008)	Included in Unit Cost	SOURCE
O&M COSTS						
Pipelines	$3,200	$/mile/year	7355	$3,561	Labor, materials	Peoria Water Reuse Master Plan
Recharge Basin	$0.05	$/1000	7355	$0.05	Labor, materials	Peoria Water Reuse Master Plan
Recharge Capital Costs Operations (basins/injection)	$0.44	$/1000	8185	$0.44	Labor, materials (average of no treatment needed and treatment required)	City of Avondale Surface Water Treatment Study
Recharge Capital Costs Operations (vadose zone/injection)	$0.44	$/1000	8185	$0.44	Labor, materials (average of no treatment needed and treatment required)	City of Avondale Surface Water Treatment Study
Recharge O&M Hieroglyphics	$8.00	$/AF	8185	$8.00	Labor, power, materials	Central Arizona Water Conservation District
Recharge Agua Fria Linear	$13.00	$/AF	8185	$13.00	Labor, power, materials	New River-Agua Fria River Underground Storage Project
CAGRD Recharge	$281.00	$/AF	8185	$281.00		CAGRD 2008/09 Published Rate
Reservoir	$6,400.00	$/yr-each	7355	$7,122.23	Labor, chemicals, power, materials	Peoria Water Reuse Master Plan
Booster Pump Station						
Power	$0.08	$/kWh	8185	$0.08		Engineering Judgment
Maintenance	3% of capital					Engineering Judgment
Vadose Zone Well Injection (200 gpm well)	$0.03	$/1,000 gallons	8090	$0.03	Labor, chemicals, power	Engineering Judgment (employing one additional operator)
Production Well (1,400 gpm)	$0.20	$/yr-each	8090	$0.20		Avondale Surface Water Treatment Plant Investigation (Wilson and Company)
Arsenic Treatment	$0.52	$/1000 gal	8090	$0.53		Evaluation of Lease or Purchase of Skid-mounted Arsenic Treatment for Dietz Crane and Canterbury Drive Wells, City of El Mirage (June 2005)

NOTES:
(1) June 2008 Costs (ENR CCI = 8,185).

Alternative 1A: Spreading Basin Recharge by SPA (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	365	acres	$ 40,470	$14,771,446
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	1,320	LF	$ 242.39	$319,951
30"	34,320	LF	$ 286.18	$9,821,706
36"	39,600	LF	$ 380.28	$15,059,119
42"	0	LF	$ 473.44	$0
48"	0	LF	$ 602.17	$0
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	341	acres	$ 96,667	$32,963,333
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 4,300,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	17.4	MGD	$ 51,872	$902,568
100 TDH	54	MGD	$ 78,493	$4,238,597
150 TDH	0	MGD	$ 101,849	$0
200 TDH	12	MGD	$ 129,088	$1,549,052
300 TDH	0	MGD	$ 155,300	$0
400 TDH	17.4	MGD	$ 189,447	$3,296,378
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	96	each	$ 1,011,743	$97,127,318
Arsenic Treatment	98	MGD	$ 1,239,385	$121,955,488
TOTAL CAPITAL COST				$527,280,115
O&M COSTS				
Pipelines	14.25	miles	$ 3,561	$ 50,746
Recharge Basin	36,691,000	1,000 gallons	$ 0.05	$ 1,879,369
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,378	AF	$ 281.00	$ 949,287
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	79,151,436	kwh	$ 0.08	$ 6,332,115
Maintenance	1	3% of Capital	$ 845,639	$ 845,639
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	17,953,000	1,000 gallons	$ 0.53	$ 9,445,186
TOTAL O&M COST				$ 24,812,341
PRESENT WORTH OF O&M[2]				$ 262,862,297
TOTAL PRESENT WORTH[2]				$ 790,142,412

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 1B: "Injection" Recharge by SPA (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	49	acres	$ 40,470	$1,983,016
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	1,320	LF	$ 242.39	$319,951
30"	34,320	LF	$ 286.18	$9,821,706
36"	39,600	LF	$ 380.28	$15,059,119
42"	0	LF	$ 473.44	$0
48"	0	LF	$ 602.17	$0
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	0	acres	$ 96,667	$0
Recharge Capital (vadose zone/injection wells)	100.5	MGD	$ 4,300,000	$432,150,000
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	17.4	MGD	$ 51,872	$902,568
100 TDH	54	MGD	$ 78,493	$4,238,597
150 TDH	0	MGD	$ 101,849	$0
200 TDH	12	MGD	$ 129,088	$1,549,052
300 TDH	0	MGD	$ 155,300	$0
400 TDH	17.4	MGD	$ 189,447	$3,296,378
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	96	each	$ 1,011,743	$97,127,318
Arsenic Treatment	98	MGD	$ 1,239,385	$121,955,488
TOTAL CAPITAL COST				$913,678,351
O&M COSTS				
Pipelines	14.25	miles	$ 3,561	$ 50,746
Recharge Basin	0.0	1,000 gallons	$ 0.05	$ -
Recharge Capital Costs Operations (basins/injection)	37,047,500	1,000 gallons	$ 0.44	$ 16,300,900
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	0	AF	$ 281.00	$ -
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	79,151,436	kwh	$ 0.08	$ 6,332,115
Maintenance	1	3% of Capital	$ 845,639	$ 845,639
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	17,953,000	1,000 gallons	$ 0.53	$ 9,445,186
TOTAL O&M COST				$ 38,284,585
PRESENT WORTH OF O&M[2]				$ 405,587,443
TOTAL PRESENT WORTH[2]				$ 1,319,265,795

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 1C: Spreading Basin Recharge by Combining SPAs (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	365	acres	$ 40,470	$14,771,446
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	19,800	LF	$ 242.39	$4,799,264
30"	56,760	LF	$ 286.18	$16,243,591
36"	29,040	LF	$ 380.28	$11,043,354
42"	0	LF	$ 473.44	$0
48"	5,280	LF	$ 602.17	$3,179,436
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	341	acres	$ 96,667	$32,963,333
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 4,300,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	20.9	MGD	$ 51,872	$1,084,119
100 TDH	33.1	MGD	$ 78,493	$2,598,103
150 TDH	0	MGD	$ 101,849	$0
200 TDH	12	MGD	$ 129,088	$1,549,052
300 TDH	17.4	MGD	$ 155,300	$2,702,218
400 TDH	0	MGD	$ 189,447	$0
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	93	each	$ 1,011,743	$94,092,089
Arsenic Treatment	98	MGD	$ 1,239,385	$121,955,488
TOTAL CAPITAL COST				$532,256,652
O&M COSTS				
Pipelines	21	miles	$ 3,561	$ 74,783
Recharge Basin	36,691,000	1,000 gallons	$ 0.05	$ 1,879,369
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,378	AF	$ 281.00	$ 949,287
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	72,577,266	kwh	$ 0.08	$ 5,806,181
Maintenance	1	3% of Capital	$ 784,045	$ 784,045
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	17,953,000	1,000 gallons	$ 0.53	$ 9,445,186
TOTAL O&M COST				$ 24,248,852
PRESENT WORTH OF O&M[2]				$ 256,892,685
TOTAL PRESENT WORTH[2]				$ 789,149,337

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 1D: "Injection" Recharge by Combining SPAs (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	49	acres	$ 40,470	$1,983,016
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	19,800	LF	$ 242.39	$4,799,264
30"	56,760	LF	$ 286.18	$16,243,591
36"	29,040	LF	$ 380.28	$11,043,354
42"	0	LF	$ 473.44	$0
48"	5,280	LF	$ 602.17	$3,179,436
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	0	acres	$ 96,667	$0
Recharge Capital (vadose zone/injection wells)	100.9	MGD	$ 4,300,000	$433,870,000
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	20.9	MGD	$ 51,872	$1,084,119
100 TDH	33.1	MGD	$ 78,493	$2,598,103
150 TDH	0	MGD	$ 101,849	$0
200 TDH	12	MGD	$ 129,088	$1,549,052
300 TDH	17.4	MGD	$ 155,300	$2,702,218
400 TDH	0	MGD	$ 189,447	$0
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	93	each	$ 1,011,743	$94,092,089
Arsenic Treatment	98	MGD	$ 1,239,385	$121,955,488
TOTAL CAPITAL COST				$920,374,888
O&M COSTS				
Pipelines	21	miles	$ 3,561	$ 74,783
Recharge Basin	0.0	1,000 gallons	$ 0.05	$ -
Recharge Capital Costs Operations (basins/injection)	37,047,500	1,000 gallons	$ 0.44	$ 16,300,900
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	0	AF	$ 281.00	$ -
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	72,577,266	kwh	$ 0.08	$ 5,806,181
Maintenance	1	3% of Capital	$ 784,045	$ 784,045
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	17,953,000	1,000 gallons	$ 0.53	$ 9,445,186
TOTAL O&M COST				$ 37,721,096
PRESENT WORTH OF O&M[2]				$ 399,617,831
TOTAL PRESENT WORTH[2]				$ 1,319,992,720

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 2A: Recharge at Hieroglyphics and Agua Fria Linear Recharge Facilities (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	23	acres	$ 40,470	$930,803
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	13,200	LF	$ 242.39	$3,199,509
30"	54,120	LF	$ 286.18	$15,488,075
36"	42,240	LF	$ 380.28	$16,063,060
42"	47,520	LF	$ 473.44	$22,497,990
48"	34,320	LF	$ 602.17	$20,666,332
54"	0	LF	$ 726.28	$0
60"	7,920	LF	$ 866.08	$6,859,336
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	0	acres	$ 96,667	$0
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 4,300,000	$0
Regional Recharge Capital Cost (Agua Fria)	47,000	AF	$ 200	$9,400,000
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	9.5	MGD	$ 51,872	$492,781
100 TDH	64.7	MGD	$ 78,493	$5,078,467
150 TDH	0	MGD	$ 101,849	$0
200 TDH	12	MGD	$ 129,088	$1,549,052
300 TDH	0	MGD	$ 155,300	$0
400 TDH	0	MGD	$ 189,447	$0
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	90	each	$ 1,011,743	$91,056,860
Arsenic Treatment	98	MGD	$ 1,239,385	$121,955,488
TOTAL CAPITAL COST				$540,512,913
O&M COSTS				
Pipelines	38	miles	$ 3,561	$ 134,432
Recharge Basin	0.0	1,000 gallons	$ 0.05	$ -
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	65,459	AF	$ 8.00	$ 523,672
Regional Recharge O&M (Agua Fria Linear)	47,000	AF	$ 13.00	$ 611,000
CAGRD Replenishment	3,377	AF	$ 281.00	$ 949,067
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	67,852,490	kwh	$ 0.08	$ 5,428,199
Maintenance	1	3% of Capital	$ 759,650	$ 759,650
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	17,952,900	1,000 gallons	$ 0.53	$ 9,445,134
TOTAL O&M COST				$ 23,161,154
PRESENT WORTH OF O&M[2]				$ 245,369,594
TOTAL PRESENT WORTH[2]				$ 785,882,507

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 2B: Recharge at Hieroglyphics Recharge Facility (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	23	acres	$ 40,470	$930,803
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	13,208	LF	$ 242.39	$3,201,448
30"	58,080	LF	$ 286.18	$16,621,349
36"	95,040	LF	$ 380.28	$36,141,885
42"	0	LF	$ 473.44	$0
48"	39,600	LF	$ 602.17	$23,845,767
54"	7,920	LF	$ 726.28	$5,752,105
60"	7,920	LF	$ 866.08	$6,859,336
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	0	acres	$ 96,667	$0
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 4,300,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	95.1	MGD	$ 78,493	$7,464,641
150 TDH	0	MGD	$ 101,849	$0
200 TDH	0	MGD	$ 129,088	$0
300 TDH	42.4	MGD	$ 155,300	$6,584,715
400 TDH	12	MGD	$ 189,447	$2,273,364
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	89	each	$ 1,011,743	$90,045,117
Arsenic Treatment	98	MGD	$ 1,239,385	$121,955,488
TOTAL CAPITAL COST				$546,951,178
O&M COSTS				
Pipelines	42	miles	$ 3,561	$ 149,572
Recharge Basin	0.0	1,000 gallons	$ 0.05	$ -
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	112,459	AF	$ 8.00	$ 899,672
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,377	AF	$ 281.00	$ 949,067
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	67,852,490	kwh	$ 0.08	$ 5,428,199
Maintenance	1	3% of Capital	$ 1,035,722	$ 1,035,722
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	17,952,900	1,000 gallons	$ 0.53	$ 9,445,134
TOTAL O&M COST				$ 23,217,367
PRESENT WORTH OF O&M[2]				$ 245,965,112
TOTAL PRESENT WORTH[2]				$ 792,916,290

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 3: Serve Largest Reuse Customers by SPA (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	340	acres	$ 40,470	$13,759,703
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	131,201	LF	$ 71.46	$9,375,127
10"	0	LF	$ 88.51	$0
12"	982,086	LF	$ 107.26	$105,338,194
14"	0	LF	$ 125.10	$0
16"	205,036	LF	$ 151.59	$31,081,951
18"	0	LF	$ 169.82	$0
20"	91,656	LF	$ 194.00	$17,780,914
24"	33,789	LF	$ 242.39	$8,190,016
30"	249	LF	$ 286.18	$71,259
36"	3,792	LF	$ 380.28	$1,442,025
42"	0	LF	$ 473.44	$0
48"	0	LF	$ 602.17	$0
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	324	acres	$ 96,667	$31,320,000
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	31	MG	$ 1,225,289	$37,983,952
Reservoir (Potable System)	132	MG	$ 1,225,289	$161,738,117
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	0	MGD	$ 101,849	$0
200 TDH	7	MGD	$ 129,088	$903,613
300 TDH	5	MGD	$ 155,300	$776,499
400 TDH	34	MGD	$ 189,447	$6,441,198
Potable Booster Pump Station	111	MGD	$ 129,088	$14,328,728
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	64	each	$ 1,011,743	$64,751,545
Arsenic Treatment	77	MGD	$ 1,239,385	$95,432,648
TOTAL CAPITAL COST				$600,776,237
O&M COSTS				
Pipelines	274	miles	$ 3,561	$ 977,230
Recharge Basin	33,611,000	1,000 gallons	$ 0.05	$ 1,721,606
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,095	AF	$ 281.00	$ 869,600
Reservoirs	16	each	$ 7,122.23	$ 116,092
Booster Pump Stations				
Power	33,256,411	kwh	$ 0.08	$ 2,660,513
Maintenance	1	3% of Capital	$ 673,501	$ 673,501
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	20,073,000	1,000 gallons	$ 0.20	$ 4,061,743
Arsenic Treatment	14,051,000	1,000 gallons	$ 0.53	$ 7,392,320
TOTAL O&M COST				$ 18,472,605
PRESENT WORTH OF O&M[2]				$ 195,699,045
TOTAL PRESENT WORTH[2]				$ 796,475,283

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 4: Maximize Direct Reuse by SPA (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	267	acres	$ 40,470	$10,805,414
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	26,637	LF	$ 71.46	$1,903,379
10"	0	LF	$ 88.51	$0
12"	197,166	LF	$ 107.26	$21,147,955
14"	0	LF	$ 125.10	$0
16"	749,411	LF	$ 151.59	$113,605,201
18"	0	LF	$ 169.82	$0
20"	320,029	LF	$ 194.00	$62,084,404
24"	94,669	LF	$ 242.39	$22,946,540
30"	34,228	LF	$ 286.18	$9,795,378
36"	24,032	LF	$ 380.28	$9,138,908
42"	1,640	LF	$ 473.44	$776,446
48"	0	LF	$ 602.17	$0
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	261	acres	$ 96,667	$25,230,000
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	141	MG	$ 1,225,289	$172,765,716
Reservoir (Potable System)	0	MG	$ 1,225,289	$0
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	0	MGD	$ 101,849	$0
200 TDH	16	MGD	$ 129,088	$2,065,402
300 TDH	34	MGD	$ 155,300	$5,280,196
400 TDH	63	MGD	$ 189,447	$11,935,161
Potable Booster Pump Station	0	MGD	$ 129,088	$0
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	23	each	$ 1,011,743	$23,270,087
Potable Production Well (1,400 gpm)	0	each	$ 1,011,743	$0
Arsenic Treatment	0	MGD	$ 1,239,385	$0
TOTAL CAPITAL COST				$492,810,933
O&M COSTS				
Pipelines	274	miles	$ 3,561	$ 977,232
Recharge Basin	14,056,000	1,000 gallons	$ 0.05	$ 719,970
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	1,294	AF	$ 281.00	$ 363,664
Reservoirs	14	each	$ 7,122.23	$ 100,423
Booster Pump Stations				
Power	29,191,666	kwh	$ 0.08	$ 2,335,333
Maintenance	1	3% of Capital	$ 578,423	$ 578,423
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	1,010,000	1,000 gallons	$ 0.20	$ 204,372
Arsenic Treatment	0	1,000 gallons	$ 0.53	$ -
TOTAL O&M COST				$ 5,279,417
PRESENT WORTH OF O&M[2]				$ 55,930,217
TOTAL PRESENT WORTH[2]				$ 548,741,150

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 5A: Serve Largest Reuse Customers from 6 WRFs via Fully-Connected Dual Distribution System (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	336	acres	$ 40,470	$13,597,824
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	0	LF	$ 88.51	$0
12"	574,659	LF	$ 107.26	$61,637,719
14"	0	LF	$ 125.10	$0
16"	284,189	LF	$ 151.59	$43,080,964
18"	0	LF	$ 169.82	$0
20"	66,823	LF	$ 194.00	$12,963,407
24"	258,163	LF	$ 242.39	$62,575,368
30"	160,326	LF	$ 286.18	$45,882,135
36"	107,948	LF	$ 380.28	$41,050,549
42"	2,063	LF	$ 473.44	$976,712
48"	874	LF	$ 602.17	$526,293
54"	1,059	LF	$ 726.28	$769,126
60"	0	LF	$ 866.08	$0
20" PRV Station	15	each	$ 40,000	$600,000
Recharge Basins	322	acres	$ 96,667	$31,126,667
Recharge Capital (vadose zone/injection wells)	0	MGD	$3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	31	MG	$1,225,289	$37,983,952
Reservoir (Potable System)	132	MG	$1,225,289	$161,738,117
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	0	MGD	$ 101,849	$0
200 TDH	0	MGD	$ 129,088	$0
300 TDH	8	MGD	$ 155,300	$1,242,399
400 TDH	49	MGD	$ 189,447	$9,282,903
Potable Booster Pump Station	111	MGD	$ 129,088	$14,328,728
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$1,011,743	$0
Potable Production Well (1,400 gpm)	56	each	$1,011,743	$56,657,602
Arsenic Treatment	77	MGD	$1,239,385	$95,432,648
TOTAL CAPITAL COST				$692,024,059
O&M COSTS				
Pipelines	277	miles	$ 3,561	$ 987,640
Recharge Basin	33,611,000	1,000 gallons	$ 0.05	$ 1,721,606
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,095	AF	$ 281.00	$ 869,600
Reservoirs	16	each	$ 7,122.23	$ 116,092
Booster Pump Stations				
Power	36,909,454	kwh	$ 0.08	$ 2,952,756
Maintenance	1	3% of Capital	$ 745,621	$ 745,621
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	20,073,000	1,000 gallons	$ 0.20	$ 4,061,743
Arsenic Treatment	14,051,000	1,000 gallons	$ 0.53	$ 7,392,320
TOTAL O&M COST				$ 18,847,379
PRESENT WORTH OF O&M[2]				$ 199,669,399
TOTAL PRESENT WORTH[2]				$ 891,693,458

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 5B: Serve Largest Reuse Customers from 4 WRFs via Fully-Connected Dual Distribution System (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	336	acres	$ 40,470	$13,597,824
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	0	LF	$ 88.51	$0
12"	574,659	LF	$ 107.26	$61,637,719
14"	0	LF	$ 125.10	$0
16"	284,189	LF	$ 151.59	$43,080,964
18"	0	LF	$ 169.82	$0
20"	66,823	LF	$ 194.00	$12,963,407
24"	258,163	LF	$ 242.39	$62,575,368
30"	160,326	LF	$ 286.18	$45,882,135
36"	98,672	LF	$ 380.28	$37,523,065
42"	2,534	LF	$ 473.44	$1,199,703
48"	1,083	LF	$ 602.17	$652,146
54"	9,655	LF	$ 726.28	$7,012,193
60"	0	LF	$ 866.08	$0
20" PRV Station	15	each	$ 40,000	$600,000
Recharge Basins	322	acres	$ 96,667	$31,126,667
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	31	MG	$ 1,225,289	$37,983,952
Reservoir (Potable System)	132	MG	$ 1,225,289	$161,738,117
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	8	MGD	$ 101,849	$814,792
200 TDH	0	MGD	$ 129,088	$0
300 TDH	8	MGD	$ 155,300	$1,242,399
400 TDH	49	MGD	$ 189,447	$9,282,903
Potable Booster Pump Station	111	MGD	$ 129,088	$14,328,728
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	56	each	$ 1,011,743	$56,657,602
Arsenic Treatment	77	MGD	$ 1,239,385	$95,432,648
TOTAL CAPITAL COST				$695,903,278
O&M COSTS				
Pipelines	277	miles	$ 3,561	$ 987,640
Recharge Basin	33,611,000	1,000 gallons	$ 0.05	$ 1,721,606
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,095	AF	$ 281.00	$ 869,600
Reservoirs	16	each	$ 7,122.23	$ 116,092
Booster Pump Stations				
Power	37,883,163	kwh	$ 0.08	$ 3,030,653
Maintenance	1	3% of Capital	$ 770,065	$ 770,065
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	20,073,000	1,000 gallons	$ 0.20	$ 4,061,743
Arsenic Treatment	14,051,000	1,000 gallons	$ 0.53	$ 7,392,320
TOTAL O&M COST				$ 18,949,719
PRESENT WORTH OF O&M[2]				$ 200,753,596
TOTAL PRESENT WORTH[2]				$ 896,656,874

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 5C: Serve Largest Reuse Customers from 3 WRFs via Fully-Connected Dual Distribution System (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	336	acres	$ 40,470	$13,597,824
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	0	LF	$ 88.51	$0
12"	574,659	LF	$ 107.26	$61,637,719
14"	0	LF	$ 125.10	$0
16"	284,189	LF	$ 151.59	$43,080,964
18"	0	LF	$ 169.82	$0
20"	166,823	LF	$ 194.00	$32,363,025
24"	121,632	LF	$ 242.39	$29,482,022
30"	150,926	LF	$ 286.18	$43,192,041
36"	112,223	LF	$ 380.28	$42,676,249
42"	15,786	LF	$ 473.44	$7,473,764
48"	7,688	LF	$ 602.17	$4,629,451
54"	17,357	LF	$ 726.28	$12,605,970
60"	4,821	LF	$ 866.08	$4,175,361
20" PRV Station	21	each	$ 40,000	$840,000
Recharge Basins	322	acres	$ 96,667	$31,126,667
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	31	MG	$ 1,225,289	$37,983,952
Reservoir (Potable System)	132	MG	$ 1,225,289	$161,738,117
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	18	MGD	$ 101,849	$1,833,283
200 TDH	0	MGD	$ 129,088	$0
300 TDH	8	MGD	$ 155,300	$1,242,399
400 TDH	49	MGD	$ 189,447	$9,282,903
Potable Booster Pump Station	111	MGD	$ 129,088	$14,328,728
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	56	each	$ 1,011,743	$56,657,602
Arsenic Treatment	77	MGD	$ 1,239,385	$95,432,648
TOTAL CAPITAL COST				$705,951,634
O&M COSTS				
Pipelines	277	miles	$ 3,561	$ 987,640
Recharge Basin	33,611,000	1,000 gallons	$ 0.05	$ 1,721,606
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,095	AF	$ 281.00	$ 869,600
Reservoirs	16	each	$ 7,122.23	$ 116,092
Booster Pump Stations				
Power	39,804,441	kwh	$ 0.08	$ 3,184,355
Maintenance	1	3% of Capital	$ 800,619	$ 800,619
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	20,073,000	1,000 gallons	$ 0.20	$ 4,061,743
Arsenic Treatment	14,051,000	1,000 gallons	$ 0.53	$ 7,392,320
TOTAL O&M COST				$ 19,133,976
PRESENT WORTH OF O&M[2]				$ 202,705,617
TOTAL PRESENT WORTH[2]				$ 908,657,251

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 6A: Maximize Direct Reuse from 6 WRFs via Fully-Connected Dual Distribution System (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	262	acres	$ 40,470	$10,603,066
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	195,782	LF	$ 88.51	$17,328,838
12"	382,978	LF	$ 107.26	$41,078,084
14"	0	LF	$ 125.10	$0
16"	159,442	LF	$ 151.59	$24,170,236
18"	0	LF	$ 169.82	$0
20"	233,130	LF	$ 194.00	$45,226,330
24"	175,496	LF	$ 242.39	$42,537,958
30"	212,804	LF	$ 286.18	$60,900,303
36"	68,911	LF	$ 380.28	$26,205,528
42"	38,766	LF	$ 473.44	$18,353,474
48"	1,059	LF	$ 602.17	$637,694
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	15	each	$ 40,000	$600,000
Recharge Basins	257	acres	$ 96,667	$24,843,333
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	141	MG	$ 1,225,289	$172,765,716
Reservoir (Potable System)	0	MG	$ 1,225,289	$0
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	0	MGD	$ 101,849	$0
200 TDH	47	MGD	$ 129,088	$6,067,119
300 TDH	51	MGD	$ 155,300	$7,920,294
400 TDH	18	MGD	$ 189,447	$3,410,046
Potable Booster Pump Station	0	MGD	$ 129,088	$0
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	17	each	$ 1,011,743	$17,199,629
Potable Production Well (1,400 gpm)	0	each	$ 1,011,743	$0
Arsenic Treatment	0	MGD	$ 1,239,385	$0
TOTAL CAPITAL COST				$520,418,591
O&M COSTS				
Pipelines	280	miles	$ 3,561	$ 995,912
Recharge Basin	14,056,000	1,000 gallons	$ 0.05	$ 719,970
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	1,294	AF	$ 281.00	$ 363,664
Reservoirs	14	each	$ 7,122.23	$ 100,423
Booster Pump Stations				
Power	25,381,785	kwh	$ 0.08	$ 2,030,543
Maintenance	1	3% of Capital	$ 521,924	$ 521,924
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	1,010,000	1,000 gallons	$ 0.20	$ 204,372
Arsenic Treatment	0	1,000 gallons	$ 0.53	$ -
TOTAL O&M COST				$ 4,936,807
PRESENT WORTH OF O&M[2]				$ 52,300,603
TOTAL PRESENT WORTH[2]				$ 572,719,194

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 6B: Maximize Direct Reuse from 4 WRFs via Fully-Connected Dual Distribution System (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	262	acres	$ 40,470	$10,603,066
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	195,782	LF	$ 88.51	$17,328,838
12"	382,978	LF	$ 107.26	$41,078,084
14"	0	LF	$ 125.10	$0
16"	159,442	LF	$ 151.59	$24,170,236
18"	0	LF	$ 169.82	$0
20"	233,130	LF	$ 194.00	$45,226,330
24"	175,496	LF	$ 242.39	$42,537,958
30"	205,156	LF	$ 286.18	$58,711,596
36"	62,989	LF	$ 380.28	$23,953,506
42"	43,740	LF	$ 473.44	$20,708,377
48"	9,655	LF	$ 602.17	$5,813,911
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	15	each	$ 40,000	$600,000
Recharge Basins	257	acres	$ 96,667	$24,843,333
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	141	MG	$ 1,225,289	$172,765,716
Reservoir (Potable System)	0	MG	$ 1,225,289	$0
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	26	MGD	$ 101,849	$2,648,075
200 TDH	47	MGD	$ 129,088	$6,067,119
300 TDH	51	MGD	$ 155,300	$7,920,294
400 TDH	18	MGD	$ 189,447	$3,410,046
Potable Booster Pump Station	0	MGD	$ 129,088	$0
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	17	each	$ 1,011,743	$17,199,629
Potable Production Well (1,400 gpm)	0	each	$ 1,011,743	$0
Arsenic Treatment	0	MGD	$ 1,239,385	$0
TOTAL CAPITAL COST				$526,157,058
O&M COSTS				
Pipelines	280	miles	$ 3,561	$ 995,912
Recharge Basin	14,056,000	1,000 gallons	$ 0.05	$ 719,970
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	1,294	AF	$ 281.00	$ 363,664
Reservoirs	14	each	$ 7,122.23	$ 100,423
Booster Pump Stations				
Power	26,355,494	kwh	$ 0.08	$ 2,108,439
Maintenance	1	3% of Capital	$ 601,366	$ 601,366
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	1,010,000	1,000 gallons	$ 0.20	$ 204,372
Arsenic Treatment	0	1,000 gallons	$ 0.53	$ -
TOTAL O&M COST				$ 5,094,146
PRESENT WORTH OF O&M[2]				$ 53,967,454
TOTAL PRESENT WORTH[2]				$ 580,124,512

NOTES:
[1] June 2008 Costs (ENR CCI = 8,185).
[2] 20 Years, 7 Percent Interest.

Alternative 6C: Maximize Direct Reuse from 3 WRFs via Fully-Connected Dual Distribution System (70 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	262	acres	$ 40,470	$10,603,066
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	195,782	LF	$ 88.51	$17,328,838
12"	382,978	LF	$ 107.26	$41,078,084
14"	0	LF	$ 125.10	$0
16"	159,442	LF	$ 151.59	$24,170,236
18"	0	LF	$ 169.82	$0
20"	223,130	LF	$ 194.00	$43,286,368
24"	179,496	LF	$ 242.39	$43,507,506
30"	195,156	LF	$ 286.18	$55,849,794
36"	62,789	LF	$ 380.28	$23,877,450
42"	43,692	LF	$ 473.44	$20,685,652
48"	10,340	LF	$ 602.17	$6,226,395
54"	12,862	LF	$ 726.28	$9,341,360
60"	2,701	LF	$ 866.08	$2,339,276
20" PRV Station	28	each	$ 40,000	$1,120,000
Recharge Basins	257	acres	$ 96,667	$24,843,333
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	141	MG	$ 1,225,289	$172,765,716
Reservoir (Potable System)	0	MG	$ 1,225,289	$0
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	86	MGD	$ 101,849	$8,759,017
200 TDH	47	MGD	$ 129,088	$6,067,119
300 TDH	51	MGD	$ 155,300	$7,920,294
400 TDH	18	MGD	$ 189,447	$3,410,046
Potable Booster Pump Station	0	MGD	$ 129,088	$0
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	17	each	$ 1,011,743	$17,199,629
Potable Production Well (1,400 gpm)	0	each	$ 1,011,743	$0
Arsenic Treatment	0	MGD	$ 1,239,385	$0
TOTAL CAPITAL COST				$540,950,122
O&M COSTS				
Pipelines	280	miles	$ 3,561	$ 995,912
Recharge Basin	14,056,000	1,000 gallons	$ 0.05	$ 719,970
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	1,294	AF	$ 281.00	$ 363,664
Reservoirs	14	each	$ 7,122.23	$ 100,423
Booster Pump Stations				
Power	28,276,772	kwh	$ 0.08	$ 2,262,142
Maintenance	1	3% of Capital	$ 784,694	$ 784,694
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	1,011,000	1,000 gallons	$ 0.20	$ 204,574
Arsenic Treatment	0	1,000 gallons	$ 0.53	$ -
TOTAL O&M COST				$ 5,431,379
PRESENT WORTH OF O&M[2]				$ 57,540,104
TOTAL PRESENT WORTH[2]				$ 598,490,226

NOTES:

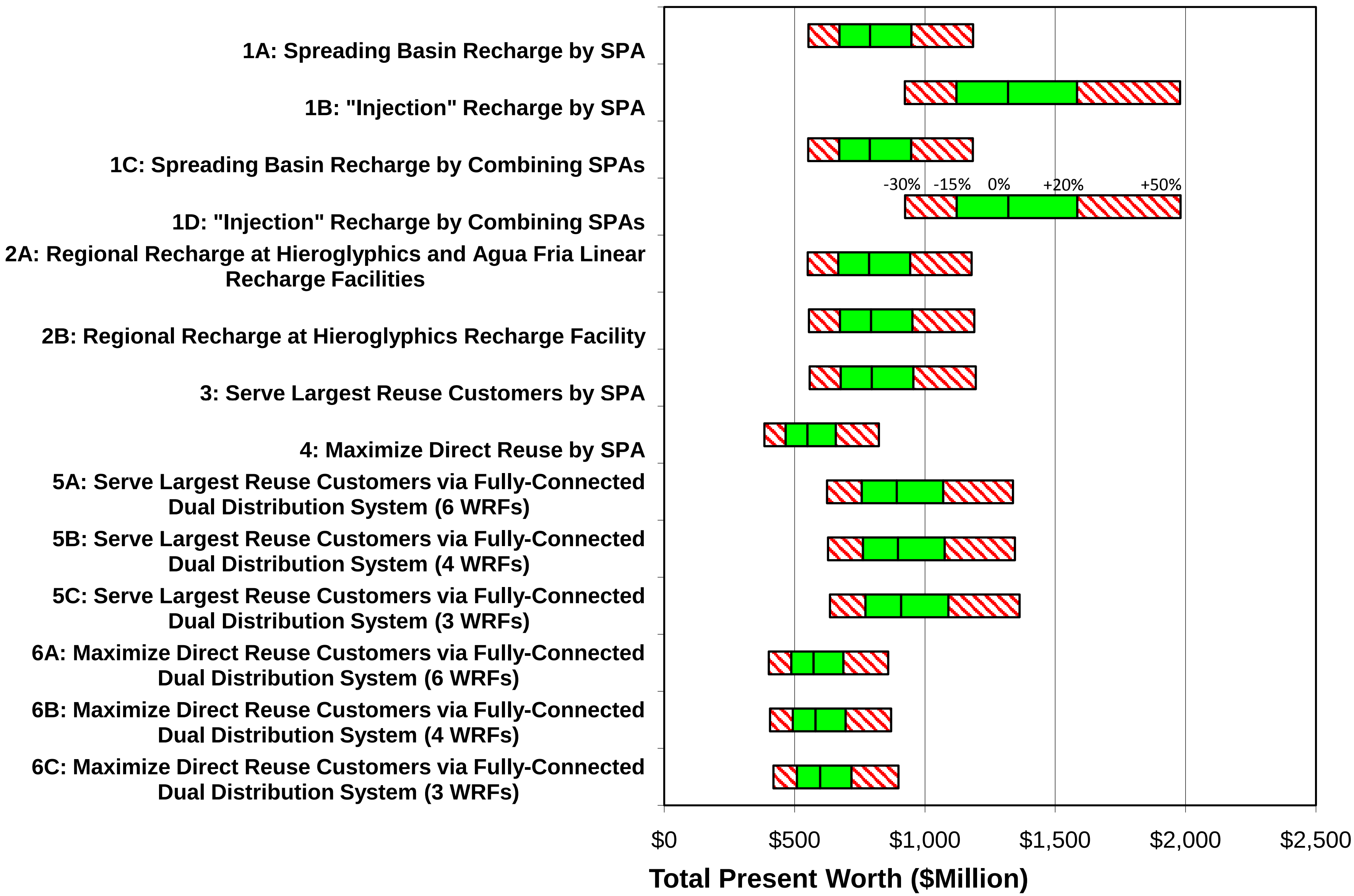
[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Comparison Cost Summary of Recharge Alternatives (70 Percent Potable Water Treated for Arsenic)

	Present Value ($)													
	1A: Spreading Basin Recharge by SPA	**1B: "Injection" Recharge by SPA**	**1C: Spreading Basin Recharge by Combining SPAs**	**1D: "Injection" Recharge by Combining SPAs**	**2A: Regional Recharge at Hieroglyphics and Agua Fria Linear Recharge Facilities**	**2B: Regional Recharge at Hieroglyphics Recharge Facility**	**3: Serve Largest Reuse Customers by SPA**	**4: Maximize Direct Reuse by SPA**	**5A: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (6 WRFs)**	**5B: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (4 WRFs)**	**5C: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (3 WRFs)**	**6A: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (6 WRFs)**	**6B: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (4 WRFs)**	**6C: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (3 WRFs)**
Capital														
Land	$14,771,446	$1,983,016	$14,771,446	$1,983,016	$930,803	$930,803	$13,759,703	$10,805,414	$13,597,824	$13,597,824	$13,597,824	$10,603,066	$10,603,066	$10,603,066
Infrastructure														
Pipelines	$25,200,776	$25,200,776	$35,265,644	$35,265,644	$84,774,302	$92,421,890	$173,340,232	$241,458,957	$270,633,218	$273,697,645	$282,727,511	$277,609,388	$280,699,779	$289,381,901
Recharge Basins	$32,963,333	$432,150,000	$32,963,333	$433,870,000	$9,400,000	$0	$31,320,000	$25,230,000	$31,126,667	$31,126,667	$31,126,667	$24,843,333	$24,843,333	$24,843,333
Reservoirs	$0	$0	$0	$0	$0	$0	$37,983,952	$172,765,716	$37,983,952	$37,983,952	$37,983,952	$172,765,716	$172,765,716	$172,765,716
Reservoirs (potable system)	$207,073,802	$207,073,802	$207,073,802	$207,073,802	$207,073,802	$207,073,802	$161,738,117	$0	$161,738,117	$161,738,117	$161,738,117	$0	$0	$0
Booster Pump Stations	$9,986,595	$9,986,595	$7,933,492	$7,933,492	$7,120,300	$16,322,719	$8,121,311	$19,280,759	$10,525,302	$11,340,094	$12,358,585	$17,397,459	$20,045,534	$26,156,476
Booster Pump Stations (potable system)	$18,201,357	$18,201,357	$18,201,357	$18,201,357	$18,201,357	$18,201,357	$14,328,728	$0	$14,328,728	$14,328,728	$14,328,728	$0	$0	$0
Vadose Zone Injection Wells	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Recharge Recovery Wells	$0	$0	$0	$0	$0	$0	$0	$23,270,087	$0	$0	$0	$17,199,629	$17,199,629	$17,199,629
Production Wells	$97,127,318	$97,127,318	$94,092,089	$94,092,089	$91,056,860	$90,045,117	$64,751,545	$0	$56,657,602	$56,657,602	$56,657,602	$0	$0	$0
Arsenic Treatment	$121,955,488	$121,955,488	$121,955,488	$121,955,488	$121,955,488	$121,955,488	$95,432,648	$0	$95,432,648	$95,432,648	$95,432,648	$0	$0	$0
TOTAL CAPITAL COST ($)	**$527,280,115**	**$913,678,351**	**$532,256,652**	**$920,374,888**	**$540,512,913**	**$546,951,178**	**$600,776,237**	**$492,810,933**	**$692,024,059**	**$695,903,278**	**$705,951,634**	**$520,418,591**	**$526,157,058**	**$540,950,122**
Operation and Maintenance														
Pipelines	$50,746	$50,746	$74,783	$74,783	$134,432	$149,572	$977,230	$977,232	$987,640	$987,640	$987,640	$995,912	$995,912	$995,912
Recharge Basins	$1,879,369	$16,300,900	$1,879,369	$16,300,900	$1,134,672	$899,672	$1,721,606	$719,970	$1,721,606	$1,721,606	$1,721,606	$719,970	$719,970	$719,970
Reservoirs	$120,366	$120,366	$120,366	$120,366	$120,366	$120,366	$116,092	$100,423	$116,092	$116,092	$116,092	$100,423	$100,423	$100,423
Booster Pump Station	$7,177,753	$7,177,753	$6,590,227	$6,590,227	$6,187,849	$6,463,921	$3,334,014	$2,913,756	$3,698,377	$3,800,718	$3,984,975	$2,552,467	$2,709,806	$3,046,836
Power	$6,332,115	$6,332,115	$5,806,181	$5,806,181	$5,428,199	$5,428,199	$2,660,513	$2,335,333	$2,952,756	$3,030,653	$3,184,355	$2,030,543	$2,108,439	$2,262,142
Maintenance	$845,639	$845,639	$784,045	$784,045	$759,650	$1,035,722	$673,501	$578,423	$745,621	$770,065	$800,619	$521,924	$601,366	$784,694
Vadose Zone Injection Wells	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Production Wells	$5,189,634	$5,189,634	$5,189,634	$5,189,634	$5,189,634	$5,189,634	$4,061,743	$204,372	$4,061,743	$4,061,743	$4,061,743	$204,372	$204,372	$204,574
Arsenic Treatment	$9,445,186	$9,445,186	$9,445,186	$9,445,186	$9,445,134	$9,445,134	$7,392,320	$0	$7,392,320	$7,392,320	$7,392,320	$0	$0	$0
Replenishment	$949,287	$0	$949,287	$0	$949,067	$949,067	$869,600	$363,664	$869,600	$869,600	$869,600	$363,664	$363,664	$363,664
ANNUAL O&M COST ($)	**$24,812,341**	**$38,284,585**	**$24,248,852**	**$37,721,096**	**$23,161,154**	**$23,217,367**	**$18,472,605**	**$5,279,417**	**$18,847,379**	**$18,949,719**	**$19,133,976**	**$4,936,807**	**$5,094,146**	**$5,431,379**
PRESENT WORTH O&M COST($)	**$262,862,297**	**$405,587,443**	**$256,892,685**	**$399,617,831**	**$245,369,594**	**$245,965,112**	**$195,699,045**	**$55,930,217**	**$199,669,399**	**$200,753,596**	**$202,705,617**	**$52,300,603**	**$53,967,454**	**$57,540,104**
TOTAL PRESENT WORTH COST ($	**$790,143,000**	**$1,319,266,000**	**$789,150,000**	**$1,319,993,000**	**$785,883,000**	**$792,917,000**	**$796,476,000**	**$548,742,000**	**$891,694,000**	**$896,657,000**	**$908,658,000**	**$572,720,000**	**$580,125,000**	**$598,491,000**

NOTES:
[1] June 2008 Costs (ENR CCI = 8,185).
[2] 20 Years, 7 Percent Interest.


1A: Spreading Basin Recharge by SPA
1B: "Injection" Recharge by SPA
1C: Spreading Basin Recharge by Combining SPAs
1D: "Injection" Recharge by Combining SPAs
2A: Regional Recharge at Hieroglyphics and Agua Fria Linear Recharge Facilities
2B: Regional Recharge at Hieroglyphics Recharge Facility
3: Serve Largest Reuse Customers by SPA
4: Maximize Direct Reuse by SPA
5A: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (6 WRFs)
5B: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (4 WRFs)
5C: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (3 WRFs)
6A: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (6 WRFs)
6B: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (4 WRFs)
6C: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (3 WRFs)
-30%
-15%
0%
+20%
+50%
$0
$500
$1,000
$1,500
$2,000
$2,500
Total Present Worth ($Million)

Summary of Capital Unit Costs[1]

ITEM	COST	UNITS	CCI	Total (June 2008)	Included in Unit Cost	SOURCE
CAPITAL COSTS						
Land	$40,000	$/acre	8090	$40,470	Land purchase	2008 land appraisal for SPA 5 WRF
Pipelines						
6"	$55	Linear Feet	8185	$55	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
8"	$71	Linear Feet	8185	$71	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
10"	$89	Linear Feet	8185	$89	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
12"	$107	Linear Feet	8185	$107	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
14"	$125	Linear Feet	8185	$125	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
16"	$152	Linear Feet	8185	$152	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
18"	$170	Linear Feet	8185	$170	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
20"	$194	Linear Feet	8185	$194	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
24"	$242	Linear Feet	8185	$242	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
30"	$286	Linear Feet	8185	$286	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
36"	$380	Linear Feet	8185	$380	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
42"	$473	Linear Feet	8185	$473	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
48"	$602	Linear Feet	8185	$602	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
54"	$726	Linear Feet	8185	$726	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
60"	$866	Linear Feet	8185	$866	Ductile iron pipe with excavation, five feet of cover, backfill, bedding	American Cast Iron Pipe Company Quote
Recharge Basin	$96,667	$/acre	8090	$97,802		Goodyear Adaman Design Concept Report
Alternatives 1B and 1D Recharge Capital Cost	$4,300,000	$/MGD	8185	$4,300,000	Assumes the average cost per MGD of spreading basin costs (Min) to Injection Wells with RO treatment for aquifer water quality standards (Max)	Current evaluation of recharge costs escalated from El Mirage for recharge basins and injection well costs. RO treatment costs based on City of Phoenix Master Plan
Alternatives 3, 4, 5, and 6 Recharge Capital Cost	$3,900,000	$/MGD	8185	$3,900,000	Assumes the average cost per MGD of vadose zone injection costs (Min) to Injection Wells with RO treatment for aquifer water quality standards (Max)	Current evaluation of recharge costs escalated from El Mirage for recharge basins and injection well costs. RO treatment costs based on City of Phoenix Water System Master Plan
Regional Recharge Capital Cost Agua Fria Linear	$200	$/AF	8185	$200		
Vadose Zone Well Injection (20 years, 200 gpm well)	$450,000	$/well site	8090	$455,284	Equipment, electrical, drilling, development	Engineering Judgment (3 wells lasting 7 years each)
Reservoirs	$1,107,475	$/MG	7398	$1,225,289	Includes fencing and access gates, site paving, landscaping, earth and concrete work, electrical, mechanical, instrumentation and SCADA	City of Phoenix Water System Master Plan
Booster Pump Stations					Includes fencing and access gates, site paving, landscaping, earth and concrete work, electrical, mechanical, instrumentation and SCADA	City of Phoenix Water System Master Plan
50 TDH	$ 51,872	$/MGD	8185	$51,872		
100 TDH	$ 78,493	$/MGD	8185	$78,493		
150 TDH	$ 101,849	$/MGD	8185	$101,849		
200 TDH	$ 129,088	$/MGD	8185	$129,088		
300 TDH	$ 155,300	$/MGD	8185	$155,300		
400 TDH	$ 189,447	$/MGD	8185	$189,447		
Production Well (1,400 gpm)	$1,000,000	$/well	8090	$1,011,743		Hard Bid for City of El Mirage, Canterbury Drive and Dietz Crane Phase II, October 2005
Arsenic Treatment	$1,225,000	$/MGD	8090	$1,239,385		Evaluation of Lease or Purchase of Skid-mounted Arsenic Treatment for Dietz Crane and Canterbury Drive Wells, City of El Mirage (June 2005)

NOTES:

(1) June 2008 Costs (ENR CCI = 8,185).

(2) Unit capital costs include materials of construction, installation and contractor overhead and profit.

Summary of Operations and Maintenance Unit Costs[1]

ITEM	COST	UNITS	CCI	Total (June 2008)	Included in Unit Cost	SOURCE
O&M COSTS						
Pipelines	$3,200	$/mile/year	7355	$3,561	Labor, materials	Peoria Water Reuse Master Plan
Recharge Basin	$0.05	$/1000	7355	$0.05	Labor, materials	Peoria Water Reuse Master Plan
Recharge Capital Costs Operations (basins/injection)	$0.44	$/1000	8185	$0.44	Labor, materials (average of no treatment needed and treatment required)	City of Avondale Surface Water Treatment Study
Recharge Capital Costs Operations (vadose zone/injection)	$0.44	$/1000	8185	$0.44	Labor, materials (average of no treatment needed and treatment required)	City of Avondale Surface Water Treatment Study
Recharge O&M Hieroglyphics	$8.00	$/AF	8185	$8.00	Labor, power, materials	Central Arizona Water Conservation District
Recharge Agua Fria Linear	$13.00	$/AF	8185	$13.00	Labor, power, materials	New River-Agua Fria River Underground Storage Project
CAGRD Recharge	$281.00	$/AF	8185	$281.00		CAGRD 2008/09 Published Rate
Reservoir	$6,400.00	$/yr-each	7355	$7,122.23	Labor, chemicals, power, materials	Peoria Water Reuse Master Plan
Booster Pump Station						
Power	$0.08	$/kWh	8185	$0.08		Engineering Judgment
Maintenance	3% of capital					Engineering Judgment
Vadose Zone Well Injection (200 gpm well)	$0.03	$/1,000 gallons	8090	$0.03	Labor, chemicals, power	Engineering Judgment (employing one additional operator)
Production Well (1,400 gpm)	$0.20	$/yr-each	8090	$0.20		Avondale Surface Water Treatment Plant Investigation (Wilson and Company)
Arsenic Treatment	$0.52	$/1000 gal	8090	$0.53		Evaluation of Lease or Purchase of Skid-mounted Arsenic Treatment for Dietz Crane and Canterbury Drive Wells, City of El Mirage (June 2005)

NOTES:
(1) June 2008 Costs (ENR CCI = 8,185).

Present Worth Assumptions

Discount Rate	7%
Term	20

Alternative 1A: Spreading Basin Recharge by SPA (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	365	acres	$ 40,470	$14,771,446
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	1,320	LF	$ 242.39	$319,951
30"	34,320	LF	$ 286.18	$9,821,706
36"	39,600	LF	$ 380.28	$15,059,119
42"	0	LF	$ 473.44	$0
48"	0	LF	$ 602.17	$0
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	341	acres	$ 96,667	$32,963,333
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 4,300,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	17.4	MGD	$ 51,872	$902,568
100 TDH	54	MGD	$ 78,493	$4,238,597
150 TDH	0	MGD	$ 101,849	$0
200 TDH	12	MGD	$ 129,088	$1,549,052
300 TDH	0	MGD	$ 155,300	$0
400 TDH	17.4	MGD	$ 189,447	$3,296,378
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	96	each	$ 1,011,743	$97,127,318
Arsenic Treatment	70	MGD	$ 1,239,385	$87,111,063
TOTAL CAPITAL COST				$492,435,690
O&M COSTS				
Pipelines	14.25	miles	$ 3,561	$ 50,746
Recharge Basin	36,691,000	1,000 gallons	$ 0.05	$ 1,879,369
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,378	AF	$ 281.00	$ 949,287
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	79,151,436	kwh	$ 0.08	$ 6,332,115
Maintenance	1	3% of Capital	$ 845,639	$ 845,639
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	12,823,500	1,000 gallons	$ 0.53	$ 6,746,524
TOTAL O&M COST				$ 22,113,679
PRESENT WORTH OF O&M[2]				$ 234,272,631
TOTAL PRESENT WORTH[2]				$ 726,708,321

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 1B: "Injection" Recharge by SPA (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	49	acres	$ 40,470	$1,983,016
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	1,320	LF	$ 242.39	$319,951
30"	34,320	LF	$ 286.18	$9,821,706
36"	39,600	LF	$ 380.28	$15,059,119
42"	0	LF	$ 473.44	$0
48"	0	LF	$ 602.17	$0
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	0	acres	$ 96,667	$0
Recharge Capital (vadose zone/injection wells)	100.5	MGD	$ 4,300,000	$432,150,000
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	17.4	MGD	$ 51,872	$902,568
100 TDH	54	MGD	$ 78,493	$4,238,597
150 TDH	0	MGD	$ 101,849	$0
200 TDH	12	MGD	$ 129,088	$1,549,052
300 TDH	0	MGD	$ 155,300	$0
400 TDH	17.4	MGD	$ 189,447	$3,296,378
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	96	each	$ 1,011,743	$97,127,318
Arsenic Treatment	70	MGD	$ 1,239,385	$87,111,063
TOTAL CAPITAL COST				$878,833,926
O&M COSTS				
Pipelines	14.25	miles	$ 3,561	$ 50,746
Recharge Basin	0.0	1,000 gallons	$ 0.05	$ -
Recharge Capital Costs Operations (basins/injection)	37,047,500	1,000 gallons	$ 0.44	$ 16,300,900
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	0	AF	$ 281.00	$ -
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	79,151,436	kwh	$ 0.08	$ 6,332,115
Maintenance	1	3% of Capital	$ 845,639	$ 845,639
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	12,823,500	1,000 gallons	$ 0.53	$ 6,746,524
TOTAL O&M COST				$ 35,585,923
PRESENT WORTH OF O&M[2]				$ 376,997,777
TOTAL PRESENT WORTH[2]				$ 1,255,831,703

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 1C: Spreading Basin Recharge by Combining SPAs (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	365	acres	$ 40,470	$14,771,446
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	19,800	LF	$ 242.39	$4,799,264
30"	56,760	LF	$ 286.18	$16,243,591
36"	29,040	LF	$ 380.28	$11,043,354
42"	0	LF	$ 473.44	$0
48"	5,280	LF	$ 602.17	$3,179,436
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	341	acres	$ 96,667	$32,963,333
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 4,300,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	20.9	MGD	$ 51,872	$1,084,119
100 TDH	33.1	MGD	$ 78,493	$2,598,103
150 TDH	0	MGD	$ 101,849	$0
200 TDH	12	MGD	$ 129,088	$1,549,052
300 TDH	17.4	MGD	$ 155,300	$2,702,218
400 TDH	0	MGD	$ 189,447	$0
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	93	each	$ 1,011,743	$94,092,089
Arsenic Treatment	70	MGD	$ 1,239,385	$87,111,063
TOTAL CAPITAL COST				$497,412,226
O&M COSTS				
Pipelines	21	miles	$ 3,561	$ 74,783
Recharge Basin	36,691,000	1,000 gallons	$ 0.05	$ 1,879,369
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,378	AF	$ 281.00	$ 949,287
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	72,577,266	kwh	$ 0.08	$ 5,806,181
Maintenance	1	3% of Capital	$ 784,045	$ 784,045
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	12,823,500	1,000 gallons	$ 0.53	$ 6,746,524
TOTAL O&M COST				$ 21,550,190
PRESENT WORTH OF O&M[2]				$ 228,303,019
TOTAL PRESENT WORTH[2]				$ 725,715,245

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 1D: "Injection" Recharge by Combining SPAs (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	49	acres	$ 40,470	$1,983,016
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	19,800	LF	$ 242.39	$4,799,264
30"	56,760	LF	$ 286.18	$16,243,591
36"	29,040	LF	$ 380.28	$11,043,354
42"	0	LF	$ 473.44	$0
48"	5,280	LF	$ 602.17	$3,179,436
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	0	acres	$ 96,667	$0
Recharge Capital (vadose zone/injection wells)	100.5	MGD	$ 4,300,000	$432,150,000
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	20.9	MGD	$ 51,872	$1,084,119
100 TDH	33.1	MGD	$ 78,493	$2,598,103
150 TDH	0	MGD	$ 101,849	$0
200 TDH	12	MGD	$ 129,088	$1,549,052
300 TDH	17.4	MGD	$ 155,300	$2,702,218
400 TDH	0	MGD	$ 189,447	$0
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	93	each	$ 1,011,743	$94,092,089
Arsenic Treatment	70	MGD	$ 1,239,385	$87,111,063
TOTAL CAPITAL COST				$883,810,463
O&M COSTS				
Pipelines	21	miles	$ 3,561	$ 74,783
Recharge Basin	0.0	1,000 gallons	$ 0.05	$ -
Recharge Capital Costs Operations (basins/injection)	37,047,500	1,000 gallons	$ 0.44	$ 16,300,900
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	0	AF	$ 281.00	$ -
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	72,577,266	kwh	$ 0.08	$ 5,806,181
Maintenance	1	3% of Capital	$ 784,045	$ 784,045
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	12,823,500	1,000 gallons	$ 0.53	$ 6,746,524
TOTAL O&M COST				$ 35,022,434
PRESENT WORTH OF O&M[2]				$ 371,028,165
TOTAL PRESENT WORTH[2]				$ 1,254,838,628

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 2A: Recharge at Hieroglyphics and Agua Fria Linear Recharge Facilities (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	23	acres	$ 40,470	$930,803
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	13,200	LF	$ 242.39	$3,199,509
30"	54,120	LF	$ 286.18	$15,488,075
36"	42,240	LF	$ 380.28	$16,063,060
42"	47,520	LF	$ 473.44	$22,497,990
48"	34,320	LF	$ 602.17	$20,666,332
54"	0	LF	$ 726.28	$0
60"	7,920	LF	$ 866.08	$6,859,336
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	0	acres	$ 96,667	$0
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 4,300,000	$0
Regional Recharge Capital Cost (Agua Fria)	47,000	AF	$ 200	$9,400,000
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	9.5	MGD	$ 51,872	$492,781
100 TDH	64.7	MGD	$ 78,493	$5,078,467
150 TDH	0	MGD	$ 101,849	$0
200 TDH	12	MGD	$ 129,088	$1,549,052
300 TDH	0	MGD	$ 155,300	$0
400 TDH	0	MGD	$ 189,447	$0
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	90	each	$ 1,011,743	$91,056,860
Arsenic Treatment	70	MGD	$ 1,239,385	$87,111,063
TOTAL CAPITAL COST				$505,668,488
O&M COSTS				
Pipelines	38	miles	$ 3,561	$ 134,432
Recharge Basin	0.0	1,000 gallons	$ 0.05	$ -
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	65,459	AF	$ 8.00	$ 523,672
Regional Recharge O&M (Agua Fria Linear)	47,000	AF	$ 13.00	$ 611,000
CAGRD Replenishment	3,377	AF	$ 281.00	$ 949,067
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	67,852,490	kwh	$ 0.08	$ 5,428,199
Maintenance	1	3% of Capital	$ 759,650	$ 759,650
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	12,823,500	1,000 gallons	$ 0.53	$ 6,746,524
TOTAL O&M COST				$ 20,462,544
PRESENT WORTH OF O&M[2]				$ 216,780,485
TOTAL PRESENT WORTH[2]				$ 722,448,973

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 2B: Recharge at Hieroglyphics Recharge Facility (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	23	acres	$ 40,470	$930,803
Pipelines				
6"	0	LF	$ 54.63	$0
8"	0	LF	$ 71.46	$0
10"	0	LF	$ 88.51	$0
12"	0	LF	$ 107.26	$0
14"	0	LF	$ 125.10	$0
16"	0	LF	$ 151.59	$0
18"	0	LF	$ 169.82	$0
20"	0	LF	$ 194.00	$0
24"	13,208	LF	$ 242.39	$3,201,448
30"	58,080	LF	$ 286.18	$16,621,349
36"	95,040	LF	$ 380.28	$36,141,885
42"	0	LF	$ 473.44	$0
48"	39,600	LF	$ 602.17	$23,845,767
54"	7,920	LF	$ 726.28	$5,752,105
60"	7,920	LF	$ 866.08	$6,859,336
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	0	acres	$ 96,667	$0
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 4,300,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	0	MG	$ 1,225,289	$0
Reservoir (Potable System)	169	MG	$ 1,225,289	$207,073,802
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	95.1	MGD	$ 78,493	$7,464,641
150 TDH	0	MGD	$ 101,849	$0
200 TDH	0	MGD	$ 129,088	$0
300 TDH	42.4	MGD	$ 155,300	$6,584,715
400 TDH	12	MGD	$ 189,447	$2,273,364
Potable Booster Pump Station	141	MGD	$ 129,088	$18,201,357
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	89	each	$ 1,011,743	$90,045,117
Arsenic Treatment	70	MGD	$ 1,239,385	$87,111,063
TOTAL CAPITAL COST				$512,106,753
O&M COSTS				
Pipelines	42	miles	$ 3,561	$ 149,572
Recharge Basin	0.0	1,000 gallons	$ 0.05	$ -
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	112,459	AF	$ 8.00	$ 899,672
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,377	AF	$ 281.00	$ 949,067
Reservoirs	17	each	$ 7,122.23	$ 120,366
Booster Pump Stations				
Power	67,852,490	kwh	$ 0.08	$ 5,428,199
Maintenance	1	3% of Capital	$ 1,035,722	$ 1,035,722
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	25,647,000	1,000 gallons	$ 0.20	$ 5,189,634
Arsenic Treatment	12,823,500	1,000 gallons	$ 0.53	$ 6,746,524
TOTAL O&M COST				$ 20,518,757
PRESENT WORTH OF O&M[2]				$ 217,376,003
TOTAL PRESENT WORTH[2]				$ 729,482,756

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 3: Serve Largest Reuse Customers by SPA (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	340	acres	$ 40,470	$13,759,703
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	131,201	LF	$ 71.46	$9,375,127
10"	0	LF	$ 88.51	$0
12"	982,086	LF	$ 107.26	$105,338,194
14"	0	LF	$ 125.10	$0
16"	205,036	LF	$ 151.59	$31,081,951
18"	0	LF	$ 169.82	$0
20"	91,656	LF	$ 194.00	$17,780,914
24"	33,789	LF	$ 242.39	$8,190,016
30"	249	LF	$ 286.18	$71,259
36"	3,792	LF	$ 380.28	$1,442,025
42"	0	LF	$ 473.44	$0
48"	0	LF	$ 602.17	$0
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	324	acres	$ 96,667	$31,320,000
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	31	MG	$ 1,225,289	$37,983,952
Reservoir (Potable System)	132	MG	$ 1,225,289	$161,738,117
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	0	MGD	$ 101,849	$0
200 TDH	7	MGD	$ 129,088	$903,613
300 TDH	5	MGD	$ 155,300	$776,499
400 TDH	34	MGD	$ 189,447	$6,441,198
Potable Booster Pump Station	111	MGD	$ 129,088	$14,328,728
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	64	each	$ 1,011,743	$64,751,545
Arsenic Treatment	55	MGD	$ 1,239,385	$68,166,177
TOTAL CAPITAL COST				$573,509,766
O&M COSTS				
Pipelines	274	miles	$ 3,561	$ 977,230
Recharge Basin	33,611,000	1,000 gallons	$ 0.05	$ 1,721,606
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,095	AF	$ 281.00	$ 869,600
Reservoirs	16	each	$ 7,122.23	$ 116,092
Booster Pump Stations				
Power	33,256,411	kwh	$ 0.08	$ 2,660,513
Maintenance	1	3% of Capital	$ 673,501	$ 673,501
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	20,073,000	1,000 gallons	$ 0.20	$ 4,061,743
Arsenic Treatment	10,036,429	1,000 gallons	$ 0.53	$ 5,280,228
TOTAL O&M COST				$ 16,360,514
PRESENT WORTH OF O&M[2]				$ 173,323,520
TOTAL PRESENT WORTH[2]				$ 746,833,286

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 4: Maximize Direct Reuse by SPA (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	267	acres	$ 40,470	$10,805,414
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	26,637	LF	$ 71.46	$1,903,379
10"	0	LF	$ 88.51	$0
12"	197,166	LF	$ 107.26	$21,147,955
14"	0	LF	$ 125.10	$0
16"	749,411	LF	$ 151.59	$113,605,201
18"	0	LF	$ 169.82	$0
20"	320,029	LF	$ 194.00	$62,084,404
24"	94,669	LF	$ 242.39	$22,946,540
30"	34,228	LF	$ 286.18	$9,795,378
36"	24,032	LF	$ 380.28	$9,138,908
42"	1,640	LF	$ 473.44	$776,446
48"	0	LF	$ 602.17	$0
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	0	each	$ 40,000	$0
Recharge Basins	261	acres	$ 96,667	$25,230,000
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	141	MG	$ 1,225,289	$172,765,716
Reservoir (Potable System)	0	MG	$ 1,225,289	$0
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	0	MGD	$ 101,849	$0
200 TDH	16	MGD	$ 129,088	$2,065,402
300 TDH	34	MGD	$ 155,300	$5,280,196
400 TDH	63	MGD	$ 189,447	$11,935,161
Potable Booster Pump Station	0	MGD	$ 129,088	$0
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	23	each	$ 1,011,743	$23,270,087
Potable Production Well (1,400 gpm)	0	each	$ 1,011,743	$0
Arsenic Treatment	0	MGD	$ 1,239,385	$0
TOTAL CAPITAL COST				$492,810,933
O&M COSTS				
Pipelines	274	miles	$ 3,561	$ 977,232
Recharge Basin	14,056,000	1,000 gallons	$ 0.05	$ 719,970
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	1,294	AF	$ 281.00	$ 363,664
Reservoirs	14	each	$ 7,122.23	$ 100,423
Booster Pump Stations				
Power	29,191,666	kwh	$ 0.08	$ 2,335,333
Maintenance	1	3% of Capital	$ 578,423	$ 578,423
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	1,010,000	1,000 gallons	$ 0.20	$ 204,372
Arsenic Treatment	0	1,000 gallons	$ 0.53	$ -
TOTAL O&M COST				$ 5,279,417
PRESENT WORTH OF O&M[2]				$ 55,930,217
TOTAL PRESENT WORTH[2]				$ 548,741,150

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 5A: Serve Largest Reuse Customers from 6 WRFs via Fully-Connected Dual Distribution System (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	336	acres	$ 40,470	$13,597,824
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	0	LF	$ 88.51	$0
12"	574,659	LF	$ 107.26	$61,637,719
14"	0	LF	$ 125.10	$0
16"	284,189	LF	$ 151.59	$43,080,964
18"	0	LF	$ 169.82	$0
20"	66,823	LF	$ 194.00	$12,963,407
24"	258,163	LF	$ 242.39	$62,575,368
30"	160,326	LF	$ 286.18	$45,882,135
36"	107,948	LF	$ 380.28	$41,050,549
42"	2,063	LF	$ 473.44	$976,712
48"	874	LF	$ 602.17	$526,293
54"	1,059	LF	$ 726.28	$769,126
60"	0	LF	$ 866.08	$0
20" PRV Station	15	each	$ 40,000	$600,000
Recharge Basins	322	acres	$ 96,667	$31,126,667
Recharge Capital (vadose zone/injection wells)	0	MGD	$3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	31	MG	$1,225,289	$37,983,952
Reservoir (Potable System)	132	MG	$1,225,289	$161,738,117
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	0	MGD	$ 101,849	$0
200 TDH	0	MGD	$ 129,088	$0
300 TDH	8	MGD	$ 155,300	$1,242,399
400 TDH	49	MGD	$ 189,447	$9,282,903
Potable Booster Pump Station	111	MGD	$ 129,088	$14,328,728
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$1,011,743	$0
Potable Production Well (1,400 gpm)	56	each	$1,011,743	$56,657,602
Arsenic Treatment	55	55	$1,239,385	$68,166,177
TOTAL CAPITAL COST				$664,757,588
O&M COSTS				
Pipelines	277	miles	$ 3,561	$ 987,640
Recharge Basin	33,611,000	1,000 gallons	$ 0.05	$ 1,721,606
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,095	AF	$ 281.00	$ 869,600
Reservoirs	16	each	$ 7,122.23	$ 116,092
Booster Pump Stations				
Power	36,909,454	kwh	$ 0.08	$ 2,952,756
Maintenance	1	3% of Capital	$ 745,621	$ 745,621
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	20,073,000	1,000 gallons	$ 0.20	$ 4,061,743
Arsenic Treatment	10,036,429	10,036,429	$ 0.53	$ 5,280,228
TOTAL O&M COST				$ 16,735,287
PRESENT WORTH OF O&M[2]				$ 177,293,874
TOTAL PRESENT WORTH[2]				$ 842,051,462

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 5B: Serve Largest Reuse Customers from 4 WRFs via Fully-Connected Dual Distribution System (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	336	acres	$ 40,470	$13,597,824
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	0	LF	$ 88.51	$0
12"	574,659	LF	$ 107.26	$61,637,719
14"	0	LF	$ 125.10	$0
16"	284,189	LF	$ 151.59	$43,080,964
18"	0	LF	$ 169.82	$0
20"	66,823	LF	$ 194.00	$12,963,407
24"	258,163	LF	$ 242.39	$62,575,368
30"	160,326	LF	$ 286.18	$45,882,135
36"	98,672	LF	$ 380.28	$37,523,065
42"	2,534	LF	$ 473.44	$1,199,703
48"	1,083	LF	$ 602.17	$652,146
54"	9,655	LF	$ 726.28	$7,012,193
60"	0	LF	$ 866.08	$0
20" PRV Station	15	each	$ 40,000	$600,000
Recharge Basins	322	acres	$ 96,667	$31,126,667
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	31	MG	$ 1,225,289	$37,983,952
Reservoir (Potable System)	132	MG	$ 1,225,289	$161,738,117
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	8	MGD	$ 101,849	$814,792
200 TDH	0	MGD	$ 129,088	$0
300 TDH	8	MGD	$ 155,300	$1,242,399
400 TDH	49	MGD	$ 189,447	$9,282,903
Potable Booster Pump Station	111	MGD	$ 129,088	$14,328,728
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	56	each	$ 1,011,743	$56,657,602
Arsenic Treatment	55	MGD	$ 1,239,385	$68,166,177
TOTAL CAPITAL COST				$668,636,807
O&M COSTS				
Pipelines	277	miles	$ 3,561	$ 987,640
Recharge Basin	33,611,000	1,000 gallons	$ 0.05	$ 1,721,606
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,095	AF	$ 281.00	$ 869,600
Reservoirs	16	each	$ 7,122.23	$ 116,092
Booster Pump Stations				
Power	37,883,163	kwh	$ 0.08	$ 3,030,653
Maintenance	1	3% of Capital	$ 770,065	$ 770,065
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	20,073,000	1,000 gallons	$ 0.20	$ 4,061,743
Arsenic Treatment	10,036,429	1,000 gallons	$ 0.53	$ 5,280,228
TOTAL O&M COST				$ 16,837,628
PRESENT WORTH OF O&M[2]				$ 178,378,070
TOTAL PRESENT WORTH[2]				$ 847,014,877

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 5C: Serve Largest Reuse Customers from 3 WRFs via Fully-Connected Dual Distribution System (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	336	acres	$ 40,470	$13,597,824
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	0	LF	$ 88.51	$0
12"	574,659	LF	$ 107.26	$61,637,719
14"	0	LF	$ 125.10	$0
16"	284,189	LF	$ 151.59	$43,080,964
18"	0	LF	$ 169.82	$0
20"	166,823	LF	$ 194.00	$32,363,025
24"	121,632	LF	$ 242.39	$29,482,022
30"	150,926	LF	$ 286.18	$43,192,041
36"	112,223	LF	$ 380.28	$42,676,249
42"	15,786	LF	$ 473.44	$7,473,764
48"	7,688	LF	$ 602.17	$4,629,451
54"	17,357	LF	$ 726.28	$12,605,970
60"	4,821	LF	$ 866.08	$4,175,361
20" PRV Station	21	each	$ 40,000	$840,000
Recharge Basins	322	acres	$ 96,667	$31,126,667
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	31	MG	$ 1,225,289	$37,983,952
Reservoir (Potable System)	132	MG	$ 1,225,289	$161,738,117
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	18	MGD	$ 101,849	$1,833,283
200 TDH	0	MGD	$ 129,088	$0
300 TDH	8	MGD	$ 155,300	$1,242,399
400 TDH	49	MGD	$ 189,447	$9,282,903
Potable Booster Pump Station	111	MGD	$ 129,088	$14,328,728
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	0	each	$ 1,011,743	$0
Potable Production Well (1,400 gpm)	56	each	$ 1,011,743	$56,657,602
Arsenic Treatment	55	MGD	$ 1,239,385	$68,166,177
TOTAL CAPITAL COST				$678,685,163
O&M COSTS				
Pipelines	277	miles	$ 3,561	$ 987,640
Recharge Basin	33,611,000	1,000 gallons	$ 0.05	$ 1,721,606
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	3,095	AF	$ 281.00	$ 869,600
Reservoirs	16	each	$ 7,122.23	$ 116,092
Booster Pump Stations				
Power	39,804,441	kwh	$ 0.08	$ 3,184,355
Maintenance	1	3% of Capital	$ 800,619	$ 800,619
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	20,073,000	1,000 gallons	$ 0.20	$ 4,061,743
Arsenic Treatment	10,036,429	1,000 gallons	$ 0.53	$ 5,280,228
TOTAL O&M COST				$ 17,021,885
PRESENT WORTH OF O&M[2]				$ 180,330,091
TOTAL PRESENT WORTH[2]				$ 859,015,254

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 6A: Maximize Direct Reuse from 6 WRFs via Fully-Connected Dual Distribution System (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	262	acres	$ 40,470	$10,603,066
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	195,782	LF	$ 88.51	$17,328,838
12"	382,978	LF	$ 107.26	$41,078,084
14"	0	LF	$ 125.10	$0
16"	159,442	LF	$ 151.59	$24,170,236
18"	0	LF	$ 169.82	$0
20"	233,130	LF	$ 194.00	$45,226,330
24"	175,496	LF	$ 242.39	$42,537,958
30"	212,804	LF	$ 286.18	$60,900,303
36"	68,911	LF	$ 380.28	$26,205,528
42"	38,766	LF	$ 473.44	$18,353,474
48"	1,059	LF	$ 602.17	$637,694
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	15	each	$ 40,000	$600,000
Recharge Basins	257	acres	$ 96,667	$24,843,333
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	141	MG	$ 1,225,289	$172,765,716
Reservoir (Potable System)	0	MG	$ 1,225,289	$0
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	0	MGD	$ 101,849	$0
200 TDH	47	MGD	$ 129,088	$6,067,119
300 TDH	51	MGD	$ 155,300	$7,920,294
400 TDH	18	MGD	$ 189,447	$3,410,046
Potable Booster Pump Station	0	MGD	$ 129,088	$0
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	17	each	$ 1,011,743	$17,199,629
Potable Production Well (1,400 gpm)	0	each	$ 1,011,743	$0
Arsenic Treatment	0	MGD	$ 1,239,385	$0
TOTAL CAPITAL COST				$520,418,591
O&M COSTS				
Pipelines	280	miles	$ 3,561	$ 995,912
Recharge Basin	14,056,000	1,000 gallons	$ 0.05	$ 719,970
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	1,294	AF	$ 281.00	$ 363,664
Reservoirs	14	each	$ 7,122.23	$ 100,423
Booster Pump Stations				
Power	25,381,785	kwh	$ 0.08	$ 2,030,543
Maintenance	1	3% of Capital	$ 521,924	$ 521,924
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	1,010,000	1,000 gallons	$ 0.20	$ 204,372
Arsenic Treatment	0	1,000 gallons	$ 0.53	$ -
TOTAL O&M COST				$ 4,936,807
PRESENT WORTH OF O&M[2]				$ 52,300,603
TOTAL PRESENT WORTH[2]				$ 572,719,194

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 6B: Maximize Direct Reuse from 4 WRFs via Fully-Connected Dual Distribution System (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	262	acres	$ 40,470	$10,603,066
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	195,782	LF	$ 88.51	$17,328,838
12"	382,978	LF	$ 107.26	$41,078,084
14"	0	LF	$ 125.10	$0
16"	159,442	LF	$ 151.59	$24,170,236
18"	0	LF	$ 169.82	$0
20"	233,130	LF	$ 194.00	$45,226,330
24"	175,496	LF	$ 242.39	$42,537,958
30"	205,156	LF	$ 286.18	$58,711,596
36"	62,989	LF	$ 380.28	$23,953,506
42"	43,740	LF	$ 473.44	$20,708,377
48"	9,655	LF	$ 602.17	$5,813,911
54"	0	LF	$ 726.28	$0
60"	0	LF	$ 866.08	$0
20" PRV Station	15	each	$ 40,000	$600,000
Recharge Basins	257	acres	$ 96,667	$24,843,333
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	141	MG	$ 1,225,289	$172,765,716
Reservoir (Potable System)	0	MG	$ 1,225,289	$0
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	26	MGD	$ 101,849	$2,648,075
200 TDH	47	MGD	$ 129,088	$6,067,119
300 TDH	51	MGD	$ 155,300	$7,920,294
400 TDH	18	MGD	$ 189,447	$3,410,046
Potable Booster Pump Station	0	MGD	$ 129,088	$0
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	17	each	$ 1,011,743	$17,199,629
Potable Production Well (1,400 gpm)	0	each	$ 1,011,743	$0
Arsenic Treatment	0	MGD	$ 1,239,385	$0
TOTAL CAPITAL COST				$526,157,058
O&M COSTS				
Pipelines	280	miles	$ 3,561	$ 995,912
Recharge Basin	14,056,000	1,000 gallons	$ 0.05	$ 719,970
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	1,294	AF	$ 281.00	$ 363,664
Reservoirs	14	each	$ 7,122.23	$ 100,423
Booster Pump Stations				
Power	26,355,494	kwh	$ 0.08	$ 2,108,439
Maintenance	1	3% of Capital	$ 601,366	$ 601,366
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	1,010,000	1,000 gallons	$ 0.20	$ 204,372
Arsenic Treatment	0	1,000 gallons	$ 0.53	$ -
TOTAL O&M COST				$ 5,094,146
PRESENT WORTH OF O&M[2]				$ 53,967,454
TOTAL PRESENT WORTH[2]				$ 580,124,512

NOTES:

[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Alternative 6C: Maximize Direct Reuse from 3 WRFs via Fully-Connected Dual Distribution System (50 Percent Potable Water Treated for Arsenic)

ITEM	QUANTITY	UNITS	UNIT COST	COST[1]
CAPITAL COSTS				
Land	262	acres	$ 40,470	$10,603,066
Pipelines				
6"	1,112	LF	$ 54.63	$60,747
8"	7,140	LF	$ 71.46	$510,197
10"	195,782	LF	$ 88.51	$17,328,838
12"	382,978	LF	$ 107.26	$41,078,084
14"	0	LF	$ 125.10	$0
16"	159,442	LF	$ 151.59	$24,170,236
18"	0	LF	$ 169.82	$0
20"	223,130	LF	$ 194.00	$43,286,368
24"	179,496	LF	$ 242.39	$43,507,506
30"	195,156	LF	$ 286.18	$55,849,794
36"	62,789	LF	$ 380.28	$23,877,450
42"	43,692	LF	$ 473.44	$20,685,652
48"	10,340	LF	$ 602.17	$6,226,395
54"	12,862	LF	$ 726.28	$9,341,360
60"	2,701	LF	$ 866.08	$2,339,276
20" PRV Station	28	each	$ 40,000	$1,120,000
Recharge Basins	257	acres	$ 96,667	$24,843,333
Recharge Capital (vadose zone/injection wells)	0	MGD	$ 3,900,000	$0
Regional Recharge Capital Cost (Agua Fria)	0	AF	$ 200	$0
Reservoir (Reclaimed System)	141	MG	$ 1,225,289	$172,765,716
Reservoir (Potable System)	0	MG	$ 1,225,289	$0
Booster Pump Stations				
50 TDH	0	MGD	$ 51,872	$0
100 TDH	0	MGD	$ 78,493	$0
150 TDH	86	MGD	$ 101,849	$8,759,017
200 TDH	47	MGD	$ 129,088	$6,067,119
300 TDH	51	MGD	$ 155,300	$7,920,294
400 TDH	18	MGD	$ 189,447	$3,410,046
Potable Booster Pump Station	0	MGD	$ 129,088	$0
Vadose Zone Well Injection (200 gpm well)	0	wells	$ 455,284	$0
Recharge Recovery Well (1,400 gpm)	17	each	$ 1,011,743	$17,199,629
Potable Production Well (1,400 gpm)	0	each	$ 1,011,743	$0
Arsenic Treatment	0	MGD	$ 1,239,385	$0
TOTAL CAPITAL COST				$540,950,122
O&M COSTS				
Pipelines	280	miles	$ 3,561	$ 995,912
Recharge Basin	14,056,000	1,000 gallons	$ 0.05	$ 719,970
Recharge Capital Costs Operations (basins/injection)	0	1,000 gallons	$ 0.44	$ -
Regional Recharge O&M (Hieroglyphics)	0	AF	$ 8.00	$ -
Regional Recharge O&M (Agua Fria Linear)	0	AF	$ 13.00	$ -
CAGRD Replenishment	1,294	AF	$ 281.00	$ 363,664
Reservoirs	14	each	$ 7,122.23	$ 100,423
Booster Pump Stations				
Power	28,276,772	kwh	$ 0.08	$ 2,262,142
Maintenance	1	3% of Capital	$ 784,694	$ 784,694
Vadose Zone Well Injection (200 gpm well)	0	1,000 gallons	$ 0.03	$ -
Recovery/Production Wells (1,400 gpm)	1,010,000	1,000 gallons	$ 0.20	$ 204,372
Arsenic Treatment	0	1,000 gallons	$ 0.53	$ -
TOTAL O&M COST				$ 5,431,176
PRESENT WORTH OF O&M[2]				$ 57,537,960
TOTAL PRESENT WORTH[2]				$ 598,488,083

NOTES:

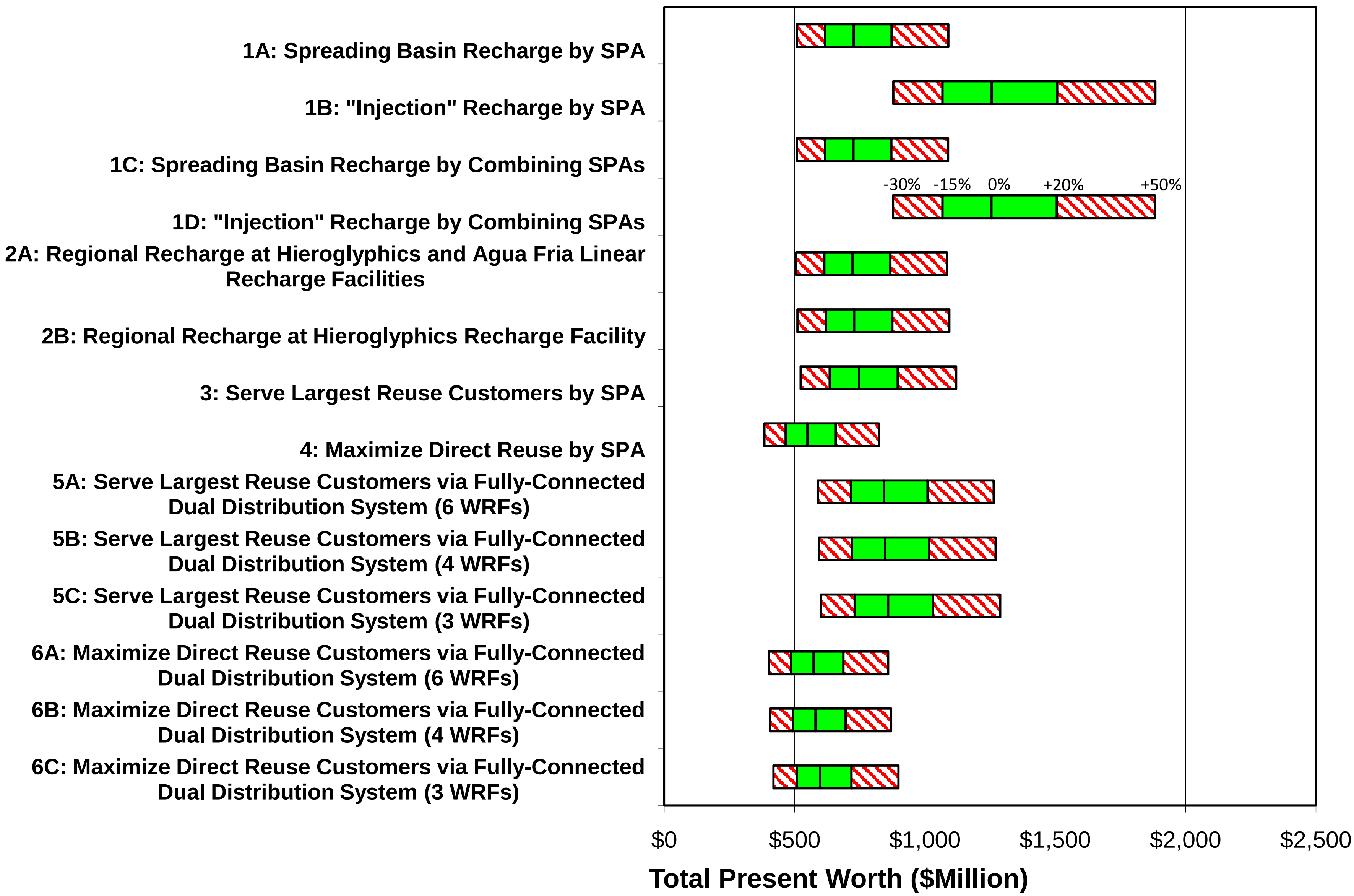
[1] June 2008 Costs (ENR CCI = 8,185).

[2] 20 Years, 7 Percent Interest.

Comparison Cost Summary of Recharge Alternatives (50 Percent Potable Water Treated for Arsenic)

	Present Value ($)													
	1A: Spreading Basin Recharge by SPA	**1B: "Injection" Recharge by SPA**	**1C: Spreading Basin Recharge by Combining SPAs**	**1D: "Injection" Recharge by Combining SPAs**	**2A: Regional Recharge at Hieroglyphics and Agua Fria Linear Recharge Facilities**	**2B: Regional Recharge at Hieroglyphics Recharge Facility**	**3: Serve Largest Reuse Customers by SPA**	**4: Maximize Direct Reuse by SPA**	**5A: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (6 WRFs)**	**5B: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (4 WRFs)**	**5C: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (3 WRFs)**	**6A: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (6 WRFs)**	**6B: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (4 WRFs)**	**6C: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (3 WRFs)**
Capital														
Land	$14,771,446	$1,983,016	$14,771,446	$1,983,016	$930,803	$930,803	$13,759,703	$10,805,414	$13,597,824	$13,597,824	$13,597,824	$10,603,066	$10,603,066	$10,603,066
Infrastructure														
Pipelines	$25,200,776	$25,200,776	$35,265,644	$35,265,644	$84,774,302	$92,421,890	$173,340,232	$241,458,957	$270,633,218	$273,697,645	$282,727,511	$277,609,388	$280,699,779	$289,381,901
Recharge Basins	$32,963,333	$432,150,000	$32,963,333	$432,150,000	$9,400,000	$0	$31,320,000	$25,230,000	$31,126,667	$31,126,667	$31,126,667	$24,843,333	$24,843,333	$24,843,333
Reservoirs	$0	$0	$0	$0	$0	$0	$37,983,952	$172,765,716	$37,983,952	$37,983,952	$37,983,952	$172,765,716	$172,765,716	$172,765,716
Reservoirs (potable system)	$207,073,802	$207,073,802	$207,073,802	$207,073,802	$207,073,802	$207,073,802	$161,738,117	$0	$161,738,117	$161,738,117	$161,738,117	$0	$0	$0
Booster Pump Stations	$9,986,595	$9,986,595	$7,933,492	$7,933,492	$7,120,300	$16,322,719	$8,121,311	$19,280,759	$10,525,302	$11,340,094	$12,358,585	$17,397,459	$20,045,534	$26,156,476
Booster Pump Stations (potable system)	$18,201,357	$18,201,357	$18,201,357	$18,201,357	$18,201,357	$18,201,357	$14,328,728	$0	$14,328,728	$14,328,728	$14,328,728	$0	$0	$0
Vadose Zone Injection Wells	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Recharge Recovery Wells	$0	$0	$0	$0	$0	$0	$0	$23,270,087	$0	$0	$0	$17,199,629	$17,199,629	$17,199,629
Production Wells	$97,127,318	$97,127,318	$94,092,089	$94,092,089	$91,056,860	$90,045,117	$64,751,545	$0	$56,657,602	$56,657,602	$56,657,602	$0	$0	$0
Arsenic Treatment	$87,111,063	$87,111,063	$87,111,063	$87,111,063	$87,111,063	$87,111,063	$68,166,177	$0	$68,166,177	$68,166,177	$68,166,177	$0	$0	$0
TOTAL CAPITAL COST ($)	**$492,435,690**	**$878,833,926**	**$497,412,226**	**$883,810,463**	**$505,668,488**	**$512,106,753**	**$573,509,766**	**$492,810,933**	**$664,757,588**	**$668,636,807**	**$678,685,163**	**$520,418,591**	**$526,157,058**	**$540,950,122**
Operation and Maintenance														
Pipelines	$50,746	$50,746	$74,783	$74,783	$134,432	$149,572	$977,230	$977,232	$987,640	$987,640	$987,640	$995,912	$995,912	$995,912
Recharge Basins	$1,879,369	$16,300,900	$1,879,369	$16,300,900	$1,134,672	$899,672	$1,721,606	$719,970	$1,721,606	$1,721,606	$1,721,606	$719,970	$719,970	$719,970
Reservoirs	$120,366	$120,366	$120,366	$120,366	$120,366	$120,366	$116,092	$100,423	$116,092	$116,092	$116,092	$100,423	$100,423	$100,423
Booster Pump Station	$7,177,753	$7,177,753	$6,590,227	$6,590,227	$6,187,849	$6,463,921	$3,334,014	$2,913,756	$3,698,377	$3,800,718	$3,984,975	$2,552,467	$2,709,806	$3,046,836
Power	$6,332,115	$6,332,115	$5,806,181	$5,806,181	$5,428,199	$5,428,199	$2,660,513	$2,335,333	$2,952,756	$3,030,653	$3,184,355	$2,030,543	$2,108,439	$2,262,142
Maintenance	$845,639	$845,639	$784,045	$784,045	$759,650	$1,035,722	$673,501	$578,423	$745,621	$770,065	$800,619	$521,924	$601,366	$784,694
Vadose Zone Injection Wells	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Production Wells	$5,189,634	$5,189,634	$5,189,634	$5,189,634	$5,189,634	$5,189,634	$4,061,743	$204,372	$4,061,743	$4,061,743	$4,061,743	$204,372	$204,372	$204,372
Arsenic Treatment	$6,746,524	$6,746,524	$6,746,524	$6,746,524	$6,746,524	$6,746,524	$5,280,228	$0	$5,280,228	$5,280,228	$5,280,228	$0	$0	$0
Replenishment	$949,287	$0	$949,287	$0	$949,067	$949,067	$869,600	$363,664	$869,600	$869,600	$869,600	$363,664	$363,664	$363,664
ANNUAL O&M COST ($)	**$22,113,679**	**$35,585,923**	**$21,550,190**	**$35,022,434**	**$20,462,544**	**$20,518,757**	**$16,360,514**	**$5,279,417**	**$16,735,287**	**$16,837,628**	**$17,021,885**	**$4,936,807**	**$5,094,146**	**$5,431,176**
PRESENT WORTH O&M COST($)	**$234,272,631**	**$376,997,777**	**$228,303,019**	**$371,028,165**	**$216,780,485**	**$217,376,003**	**$173,323,520**	**$55,930,217**	**$177,293,874**	**$178,378,070**	**$180,330,091**	**$52,300,603**	**$53,967,454**	**$57,537,960**
TOTAL PRESENT WORTH COST ($	**$726,709,000**	**$1,255,832,000**	**$725,716,000**	**$1,254,839,000**	**$722,449,000**	**$729,483,000**	**$746,834,000**	**$548,742,000**	**$842,052,000**	**$847,015,000**	**$859,016,000**	**$572,720,000**	**$580,125,000**	**$598,489,000**

NOTES:
[1] June 2008 Costs (ENR CCI = 8,185).
[2] 20 Years, 7 Percent Interest.


1A: Spreading Basin Recharge by SPA
1B: "Injection" Recharge by SPA
1C: Spreading Basin Recharge by Combining SPAs
1D: "Injection" Recharge by Combining SPAs
2A: Regional Recharge at Hieroglyphics and Agua Fria Linear Recharge Facilities
2B: Regional Recharge at Hieroglyphics Recharge Facility
3: Serve Largest Reuse Customers by SPA
4: Maximize Direct Reuse by SPA
5A: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (6 WRFs)
5B: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (4 WRFs)
5C: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (3 WRFs)
6A: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (6 WRFs)
6B: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (4 WRFs)
6C: Maximize Direct Reuse Customers via Fully-Connected Dual Distribution System (3 WRFs)
-30%
-15%
0%
+20%
+50%
$0
$500
$1,000
$1,500
$2,000
$2,500
Total Present Worth ($Million)

THIS PAGE INTENTIONALLY LEFT BLANK

E. Water Resource Model

Water resource modeling, or comparison of water demands against water supplies, was accomplished by integrating the Demand Module into the Water Resource Model. The Demand Module provides the water demand projections while the Water Resource Model provides the comparison of demands against existing and potential future water supplies. This section describes the methodology used to design the Water Resource Model and to integrate it with the Demand Module.

E.1. General Overview

The Water Resource Model compares water demand projections developed in the Demand Module to existing and potentially available water supplies. The output of the Water Resource Model allows the user to determine whether the available supplies are sufficient to meet anticipated demands. Alternatively, the model can predict when existing water supplies will be fully used, when a gap (deficit) between supply and demand occurs, and the magnitude of the gap.

The City's Water Resource Model was compiled and run using commercially-available PowerSim software. The software reads from the Demand Module's database file and imports indoor, outdoor, and landscape demands for each water service provider and SPA within the Surprise MPA. In the *Integrated Water Master Plan*, the Water Resource Model uses 2008, 2020, 2030, and build-out as the planning periods and interpolates for interim years.

The water supplies included are based on assured water supply designations, hydrogeologic models (physical availability of groundwater), surface water rights, CAP subcontracts, and reclaimed water production projections. Additional water supplies can be added to the Water Resource Model based on anticipated water supply development projects, or other new water supply projections.

The Water Resource Model output includes a series of graphs that show the aggregated water demand in each category (indoor, outdoor, and landscape) for each SPA, for each water service provider, and for each provider within each SPA. The user can change demands and supplies in the Water Resource Model interface to evaluate multiple water resource scenarios.

E.2. Water Resource Supplies

Water supplies are layered graphically and mathematically in the model starting with the known existing water supplies available. As future water resources become available, they can be added to the water supply. In the case of reclaimed water, where there is a linkage between land use/water demand and reclaimed water production, the growth in reclaimed water supplies becomes a function of the growth of calculated indoor water use (i.e., 90 percent of indoor demand).

E.3. Water Resource Model Dashboard

The Water Resource Model includes a dashboard to control model assumptions and to display graphics of water supply and demand. There are five tables in the dashboard: the SPA table (Figure E-1), the provider table (Figure E-2), the development dates table (Figure E-3), the conservation table (Figure E-4), and the water supply table (Figure E-5).

The SPA table can be set to either serve or not serve customers in each SPA. The provider table can be set to provide potable water for indoor demands for each provider area; serve potable water, reclaimed water, or no water for outdoor use to each provider area; and serve potable water, reclaimed water, or no water for landscaping for each provider area. The supply table can accept input for additional future water supplies, which may be speculative, in addition to the year that future supplies are assumed to become available. The conservation table can be set to reduce water demand by a fixed percent for indoor, outdoor, and landscape uses. The development dates table can be set to choose specific years for build-out. The resulting water demands and water supply are automatically updated in the graphical outputs.

In addition to the dashboard tables, the water supply table includes an additional switch that indicates whether possible CAP subcontract water, groundwater, and other water that is entitled to other providers (Circle City, Arizona American, and MWD) is to be included in the total water supply. The Model also includes necessary mathematical calculations to produce the graphics and data structures to generate the detailed graphics.

Planning Areas	
SPA 1	Serve
SPA 2	Serve
SPA 3	Serve
SPA 4	Serve
SPA 5	Serve
SPA 6	Serve

Figure E-1: SPA Table

	Indoor demand	Outdoor Demand	Landscape Demand
Arizona American Water Co	Do not serve	Do not serve	Do not Serve
Beardsley Water	Serve	Serve potable	Serve potable
Brook/Circle City Water	Serve	Serve potable	Serve potable
Brooks Water Utilities	Serve	Serve potable	Serve potable
Chaparral Water	Serve	Serve potable	Serve potable
City of El Mirage	Serve	Serve potable	Serve potable
Morristown Water	Serve	Serve potable	Serve potable
Puesta Del Sol Water	Serve	Serve potable	Serve potable
Saquaro Acres	Serve	Serve potable	Serve potable
Saquaro View	Serve	Serve potable	Serve potable
Surprise	Serve	Serve potable	Serve potable
West End Water	Serve	Serve potable	Serve potable

Figure E-2: Provider Table

Year for demand module

	Year
Year 1	2008
Year 2	2020
Year 3	2030
Year 4	2060

Figure E-3: Development Dates

Water Conservation

Year	2008	2020	2030	2060
Indoor conservation (%)	0	0	0	0
Outdoor conservation (%)	0	0	0	0
Landscape conservation (%)	0	0	0	0

Figure E-4: Conservation Table

Current and future sources of water

	Year	Quantity
Groundwater physical availability	Current	16,744 af/yr
CAP allocation	Current	10,437 af/yr
Additional CAP supplies from other providers		0 af/yr
Reclaimed water	Current	3,584 af/yr
Additional water for reclamation	Depends on demand	117,858 af/yr
Imported Colorado River Water	2008	0 af/yr
Additional WWTP capacity	2012	0 af/yr
Tribal lease water	2008	0 af/yr
Imported stored water	2020	0 af/yr
Groundwater from other providers	2008	0 af/yr
Imported groundwater	2008	0 af/yr
MWD surface water	2008	0 af/yr

☐ turn on additional CAP from other providers

Figure E-5: Water Supply Table

E.4. Display of Water Resource Model Results

The results from the Water Resource Model are displayed in two graphs on the dashboard: total demand and total supply. The total demand graph shows aggregated demand for indoor, outdoor, and landscape use for each year through build-out (Figure E-6). In addition, the demand graph can show these quantities for each previously saved scenario as reference data. The supply graph shows each of the sources of water from the water resources spreadsheet depending on the year the supply initially becomes available (Figure E-7). Both the demand graph and the supply graph include lines for total supply and total demand – the intersection of these two lines indicates the year that water demands begin to exceed water supplies.

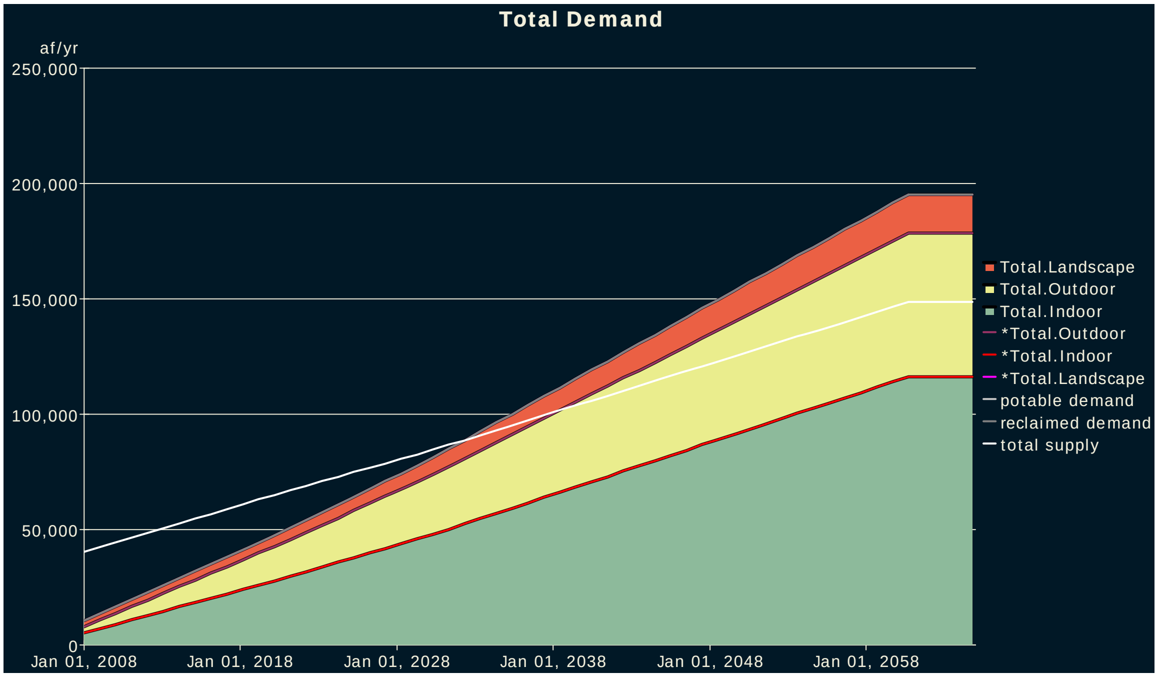


Figure E-6: Example Demand Graph

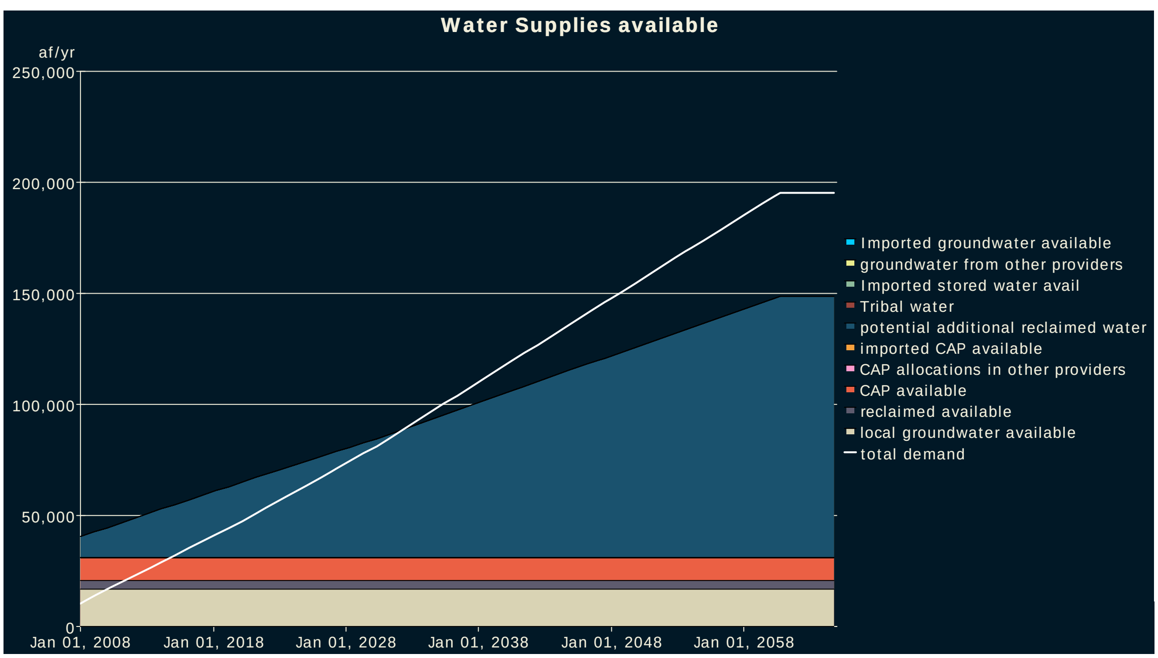


Figure E-7: Example Supply Graph

Scenarios can be generated by selecting values from each of the control tables on the dashboard in combination with changing parameters in the Demand Module. Each scenario run automatically produces new output graphs in the Water Resource Model. Analysis of model results can be viewed immediately by comparing the water supply and water demand graphs. In addition, graphs that show the total water demand for each category, each provider, and each SPA can be viewed by navigating to other screens in the Water Resource Model through hyperlinks. The complete dashboard display is displayed on Figure E-8.

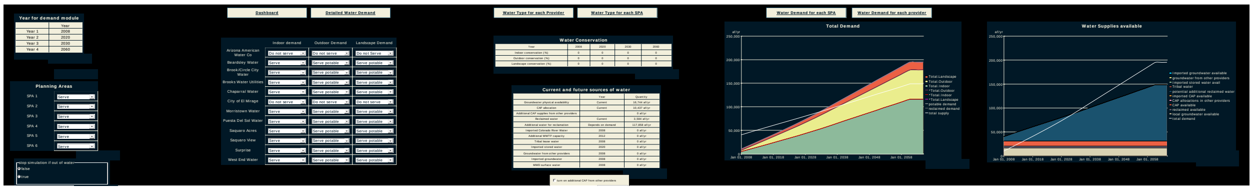


Figure E-8: Complete Water Resource Model Dashboard Display

E.5. Model Summary

The Water Resource Model is an excellent tool for evaluating numerous water supply and demand scenarios and for making informed water resource planning decisions. For example, if a water provider wishes to simply analyze when a water supply may be fully consumed, a number of assumptions can be tested simply by adjusting the rate of growth and the corresponding water demand to see at what time water supplies would be exhausted and new supplies would be needed.

The Water Resource Model can illustrate how much reclaimed water will be added to the water supply portfolio if the relationship with demand is linear, or reclaimed water can be subtracted from the water supply portfolio if the reclaimed water is controlled by other entities, or if there are physical conditions that would limit the ability to reuse the reclaimed water directly or indirectly (using recharge and recovery).

The Water Resource Model can also be used to simulate short and longer term droughts by simply reducing the scope of the model to focus on a very short term, and by removing supplies that are drought susceptible (or subject to curtailment for other reasons). Water supply scenarios can include longer term reliability reduction attributed to climate change, water quality degradation, and even institutional change. Other scenarios can include the inability to produce water – for example, the lack of a filtration plant for treatment of surface and/or CAP water.

Water demands and the relationships to supply can be modeled reflecting changes in land use, density, limitations and/or expansions of the areas to be served including the acquisition of private water companies (these decisions can take into account both demand and supplies, and potentially the cost of developing the water supplies for use).

FINAL Report

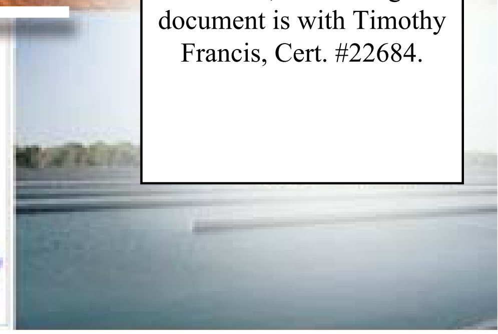
SURPRISE
ARIZONA

Integrated Water Master Plan
Water Resources

NOVEMBER 2008

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



4957-002

MALCOLM PIRNIE
INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS AND CONSULTANTS

ASU DECISION THEATER
ARIZONA STATE UNIVERSITY

MALCOLM PIRNIE

INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS AND CONSULTANTS

Malcolm Pirnie, Inc.
4646 East Van Buren Street, Suite 400
Phoenix, Arizona 85008
T: 602.241.1770 F: 602.231.0131
www.pirnie.com

November 28, 2008

James E. Swanson, Manager
Public Works Department
City of Surprise
12425 W. Bell Road, Suite C305
Surprise, AZ 85374

Re: *Integrated Water Master Plan:* Water Resources
Final Report

Dear Mr. Swanson:

Malcolm Pirnie, Inc., in association with Replenishment Services, LLC and ASU Decision Theater, is pleased to submit the Final Report for the Water Resources component of the *Integrated Water Master Plan* project. The Water Resources component presents recommended water resources management and assured water supply strategies that will support future City growth and help to maintain the City's Designation of Assured Water Supply with the Arizona Department of Water Resources.

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

Very truly yours,

MALCOLM PIRNIE, INC.

Timothy Francis, P.E.
Senior Associate
Project Manager
Board Certified Environmental Engineer

Enclosures

4957-002

City of Surprise, Arizona
Water Services Department • 12425 West Bell Road • Surprise, AZ 85374-9002

Integrated Water Master Plan

Water Resources

November 2008

Report Prepared By:

Malcolm Pirnie, Inc.

4646 East Van Buren Street
Suite 400
Phoenix, AZ 85008

4957-002

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

Contents

Tables

Figures

Appendices

List of Abbreviations

A.R.S.	Arizona Revised Statutes
AAC	Arizona Administrative Code
AACE	Association for the Advancement of Cost Engineering
AAWC	Arizona American Water Company
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AF	acre-feet
AFY	acre-feet per year
AMA	active management area
AMWUA	Arizona Municipal Water Users Association
AOC	Approval of Construction
APP	Aquifer Protection Permit
ASR	aquifer storage and recovery
ASU	Arizona State University
ATC	Approval to Construct
AWS	assured water supply
AZPDES	Arizona Pollutant Discharge Elimination System
BADCT	best available demonstrated control technology
BOD_5	biological oxygen demand
CAGRD	Central Arizona Groundwater Replenishment District
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CCR	Consumer Cost Index
CFU	colony forming units
City	City of Surprise
COG	Council of Governments
CPP	continuing planning process
CWA	Clean Water Act
du/acre	dwelling units per acre
ENR	Engineering News Record
FHSD	Fountain Hills Sanitary District
GIS	geographical information systems
gpad	gallons per acre per day
gpcd	gallons per capita per day
gpd	gallons per day
gpd/du	gallons per day per dwelling unit
gpm	gallons per minute
HOA	Homeowner's Association
M&I	municipal and industrial

MAG	Maricopa Association of Governments
MCESD	Maricopa County Environmental Services Department
MCL	maximum contaminant level
μg/L	micrograms per liter
mg/L	milligrams per liter
mgd	million gallons per day
MPA	municipal planning area
MWD	Maricopa Water District
NPDES	National Pollutant Discharge Elimination System
NTU	nephlometric turbidity units
O&M	operation and maintenance
SBR	squencing batch reactor
SPA	special planning area
SR	State Route
SROG	sub-regional operating group
SRP	Salt River Project
TAZ	Traffic Analysis Zone
TBD	to be developed
TDS	total dissolved solids
THM	trihalomethane
TMP	Third Management Plan
TOC	total organic carbon
TSS	total suspended solids
TTHM	total trihalomethane
UIC	underground injection
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDW	underground sources of drinking water
USEPA	United States Environmental Protection Agency
USF	underground storage facility
WQMP	Water Quality Management Plan
WRF	water reclamation facility
WS	water storage
WSF	water supply facility

THIS PAGE INTENTIONALLY LEFT BLANK

Executive Summary

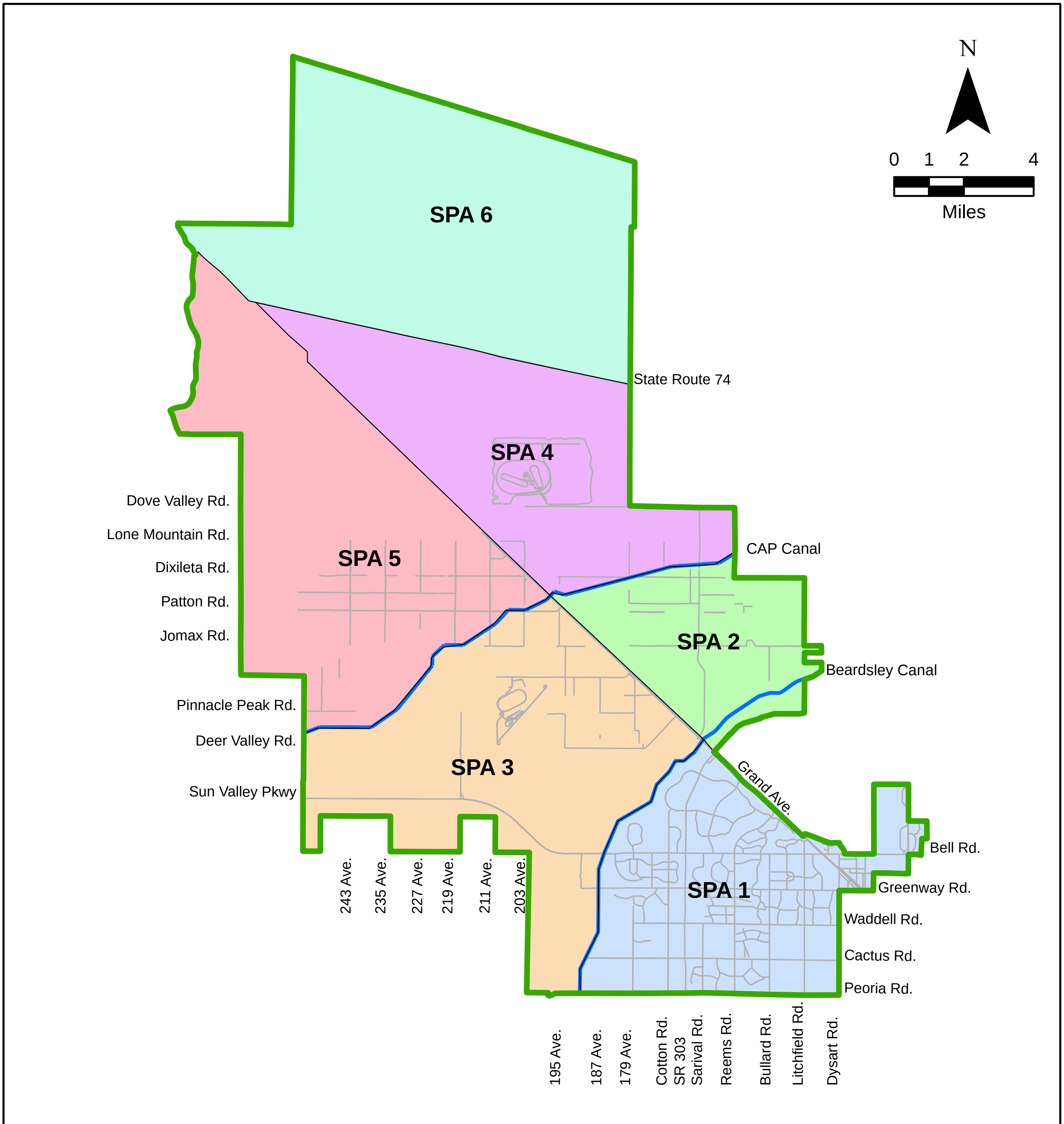
Introduction

The City of Surprise (City) Public Works Department is responsible for management of the City's drinking water, wastewater, reclaimed water, and recharge systems and the associated long range master planning documents.

The City is expecting to grow from a 2007 population of 104,895 to over 400,000 by 2030 (Maricopa Association of Governments, 2007) within the planning area shown on Figure ES-1. The planning area is divided into six special planning areas (SPAs) to maintain consistency with the City's previous water resources and infrastructure planning efforts and for convenience of wastewater and reclaimed water planning; i.e., the SPAs comprise logical drainage areas for existing and potential water reclamation facilities.

Because of recent growth activity, the City commissioned the *Integrated Water Master Plan* project, which has Water Resources and Water Infrastructure components. This executive summary addresses the Water Resources component, which identifies the projected water demands and develops a water supply strategy that will meet the demands in a cost-effective and sustainable manner. To prepare for the Water Infrastructure component, the Water Resources component also includes updates to projections of wastewater flows, reclaimed water availability, and reclaimed water demands in an integrated fashion. Finally, the Water Resources component includes a review and evaluation of reclaimed water management alternatives, a critical element of the City's water resource portfolio.

The *Integrated Water Master Plan* project was completed under the guidance of two City committees: the Technical Committee composed of management staff from the City Public Works, Information Technology, and Planning Departments; and the Steering Committee composed of the Deputy City Managers and the Assistant City Manager overseeing public works, planning, and development agreement activities. The Technical Committee provided information and data to the consultant team, reviewed the consultant team's technical work, and provided water, wastewater, and reclaimed water technical advice and guidance. The Steering Committee provided policy direction and oversight. The two committees gave valuable input and guidance on technical memoranda developed during the project and participated in all project workshops where results of the technical work were presented.



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets

SURPRISE ARIZONA | MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Study Area

November 2008 | **Figure ES-1**

M:\4957002\GIS\Project_MXDs\Final Report\Figure ES-1 Study Area.mxd

Existing Water Supply Portfolio

The current provisions of the City's Designation of Assured Water Supply are contained within the Decision and Order number AWS 99-04, signed by the Arizona Department of Water Resources (ADWR) Director on September 7, 1999. The Designation recognized that the City's projected and committed demands for 2010 are 20,334 acre-feet (AF) annually derived from physically available groundwater and effluent, and that the City's projected demand in 2010 would not exceed that amount of water. The Designation also states that the City meets the requirements for water quality, financial capability, and legal availability. By virtue of its membership in the Central Arizona Groundwater Replenishment District (CAGRD), and the finding that the CAGRD's Plan of Operation is consistent with achieving the goal of the Phoenix Active Management Area (AMA), the City's Designation is also deemed to be consistent with achieving the goals of the AMA. The City will be required to file an Application for Modification of Designation of Assured Water Supply in 2008. Table ES-1 presents a summary of currently available water resources according to the City's current Designation.

Table ES-1.
Existing Water Supply Portfolio

Water Supply Source	Annual Supply (AF)
Groundwater (Physically available per designation)	16,744
Surface Water	0
CAP Water (Must have ability to treat and deliver)	0
Reclaimed Water (Must have direct use demand)	3,584
Total Available Supply	**20,328**
Actual and Committed Demand (2006 Annual Report)	9,891.5
Current Supply Available for Growth	10,436.5

Water Resource Demand Projections

A Water Resource Demand Module (Demand Module) was created to allow the City to dynamically simulate its existing and future water resource needs derived from GIS-based data and land use-based demand factors. The Demand Module provides water demand (potable and non-potable) and wastewater flow projections in a format compatible with City drinking water, wastewater, and reclaimed water infrastructure models. The land use-based water resources demand factors that the Demand Module uses to project water resource needs are derived from historical City water demands and wastewater flows, factors used by other communities, literature values, and engineering judgment.

Potential Future Water Supplies

Long-term renewable water supplies currently available to the region (CAP, MWD surface water, etc.) have essentially been fully allocated. There are no more large blocks of readily available renewable supplies that the City can pursue to fill significant shortfalls in future water supply. Reclaimed water is possibly the additional future water supply that will be most available to the City.

The next large blocks of other water supply for the region are believed to be brackish groundwater from the southwest valley area and/or desalinated seawater, perhaps from as far away as Mexico. Both supplies will require large-scale and complex water exchange agreements to allow cities like Surprise to gain access to them. The permitting and institutional process to develop new renewable water supplies will also be too challenging, lengthy, and expensive for a single entity like Surprise to achieve on its own. Likely, a regional water agency like the Central Arizona Water Conservation District (CAWCD) Bureau of Land Management will implement the new supplies with the coordination of, and for the benefit of, all communities in the region.

Recommended Reclaimed Water Management Strategy

Reclaimed water will be a critical component of the City's water resources portfolio and could account for a significant share of the total water supply at build-out. A detailed evaluation, using life cycle cost and non-cost decision criteria, conducted on the range of available reclaimed water management strategies indicated the following priorities:

- Recharge of all reclaimed water produced using surface spreading basins is the most preferable alternative and should be implemented where possible. However, until additional hydrogeologic and water quality information is established, there is no guarantee that all recharge can be accomplished with surface spreading basins.
- Recharge of all reclaimed water using CAWCD regional recharge facilities is the next most preferable alternative and should be implemented where possible. However, it is unknown at this time if and when CAWCD will permit the recharge facilities to accept reclaimed water. Use of these facilities may also require that the City convey some of its stored water credits to CAWCD, which is not desirable given the importance of the credits as part of the City's future water supply.
- Building a dual distribution system to deliver reclaimed water to all potential direct reuses (including residential and commercial outdoor uses) is the next most preferable alternative. This alternative was ultimately not chosen, however, because of the high initial capital costs to install the infrastructure and the potential social and political concerns related to serving reclaimed water to individual residences.

The recommended reclaimed water management strategy is to install a dual distribution system to serve only the largest reuse customers, including landscape irrigation of homeowner's association (HOA) common areas, schools, parks, etc., to use surface basin recharge where possible to balance reclaimed water demand and supply, and to recharge excess reclaimed water that is not directly reused. If surface basin recharge is not possible, use of vadose zone injection and/or aquifer storage and recovery wells should be investigated and implemented.

Because the City does not want to preclude other direct reuse opportunities in its planning area, the Water Infrastructure component of the *Integrated Water Master Plan* investigates provisions for how the dual distribution system might be configured and reinforced (through pumping, looping of the pipe network, limited pipe upsizing, etc.) to potentially serve a larger direct reuse customer base.

Recommended Water Demand/Supply Balance Strategy

A Water Resource Model was developed to import demand projections from the Demand Module and compare them to available water supplies. The tool uses a dashboard approach to vary a number of water resource factors, such as whether to serve or not serve certain areas, development timing, water conservation, and potential future water supplies.

Simulation of potential future water demand/supply scenarios with the Water Resource Model indicates that if the City continues to develop according to the current General Plan with a target build-out population of about 1,000,000, water demands will exceed available water supplies as soon as 2030. Given that acquisition of additional renewable water supplies will be lengthy, expensive, and challenging, it is recommended that the City plan to balance demands with existing available water supplies (groundwater, CAP surface water, and reclaimed water) at build-out. Table ES-2 summarizes the water supplies included in the City's current Designation of Assured Water Supply and other supplies that are considered available to the City to meet water demands at build-out.

Table ES-2.
Existing and Potential Future Water Supplies

Supply	Existing (AFY)	Potential Future (AFY)
Groundwater – Physically Available	16,744	16,744
CAP Allocation	10,249	10,249
Additional CAP Supplies from Other Providers [1]	--	3,932
Reclaimed Water	3,584	3,584
Additional Reclaimed Water [2]	--	84,267
Groundwater from Other Providers [3]	--	2,106
TOTAL	**30,577**	**120,819**

NOTES:
(1) Existing CAP allocation for Brooke/Circle City Water Company.
(2) Additional reclaimed water based on target population of 700,000.
(3) Physically available groundwater for developments primarily within Beardsley Water Company service area.

The recommended strategy to balance water demand at build-out with the water supplies shown in Table ES-3 is to target a build-out population between 500,000 and 700,000 by managing future development densities. This strategy will require the following:

- In order to achieve the target population between 500,000 to 700,000, the City must be prepared to aggressively manage the allowable future development densities, particularly in the Rural Residential land uses planned in the northern SPAs.
- Future landscaping guidelines must be implemented and enforced. The City cannot continue to develop using high water using landscape that is currently prevalent in SPA 1. At a minimum, the City should be prepared to implement the newly developed *Scenic Integrity Guidelines* to manage future landscape irrigation demands.
- Any additional water supply that can be added to the City's portfolio (e.g., CAP incentive recharge water, additional physically available groundwater, long term storage credits) would dramatically improve the projected demand/supply balance.
- The City should provide water service to the new SPA 6 to ensure development of uniform water resources infrastructure and provision of a uniform level of water service for all residents within the City's planning area.

Recommended Water Resource Management Strategy

The water resources management strategy deals with the "wet water" issues; in other words, the water that is actually available to be used by the City. The recommended water resource management plan (summarized on Figure ES-2) is organized chronologically into three time horizons:

- Near-Term Recommendations should be addressed immediately to effectively manage supplies that are currently available, including groundwater, CAP water, Maricopa Water District (MWD) water, and reclaimed water.
- Mid-Term Recommendations can be addressed over the next few years to potentially acquire other supplies that may also be currently available.
- Long-Term Recommendations are those that would achieve true water supply sustainability; they would position the City for its share of next available renewable water supplies.

Near-Term Water Resource Management Recommendations

In addition to the typical infrastructure master plan evaluations, the following recommendations have been considered in completing the Water Infrastructure component of the *Integrated Water Master Plan*:

- <u>Compare costs of groundwater treatment to surface water treatment.</u> Compare the costs for groundwater production, treatment, disinfection, and distribution, against the cost of constructing and operating a surface water filtration plant for direct use of the CAP supply.

Water Resources Management

Near-Term

- In preparing Water Infrastructure Master Plans:
  - Drinking water: compare costs of groundwater and surface water treatment
  - Drinking water: compare costs of city-owned and regional recharge of CAP surface water
  - Reclaimed water: master plan dual distribution system to directly serve largest reuse customers
  - Recharge: identify recharge locations and capacity for excess reclaimed water
- Conduct groundwater recharge and water quality studies for planning area
- Determine need for future groundwater treatment
- Implement recharge of CAP water and reclaimed water
- Complete perfection process for CAP water allocation
- Acquire and bank other available CAP water as much as possible
- Encourage continued urban irrigation with MWD water
- Pursue GSF permits for reclaimed water deliveries to farms

Mid-Term

- Investigate potential to acquire private water company CAP allocations
- Investigate temporary assignments of other CAP allocations

Long-Term

- Participate in regional water supply development discussions
- “Fill out” water portfolio with additional resources to achieve true water resources sustainability

Assured Water Supply

Groundwater

- Maximize groundwater physical availability
- Acquire pledges for extinguished groundwater rights

Surface Water

- Maximize physical availability of surface water
- Document MWD supply for urban irrigation

Reclaimed Water

- Maximize physical availability of reclaimed water
- Document direct reuse facilities and demands

Water Conservation

- Document existing water conservation program
- Develop formal water conservation plan

Recommended Water Resources Management and Assured Water Supply Strategies

- Compare costs of city-owned and regional recharge facilities to recharge CAP surface water. Compare the methods of long-term recharge of CAP water at the CAWCD regional facilities versus prospective City-owned facilities.
- Master plan reclaimed water dual distribution system to directly serve largest reuse customers. Develop a reclaimed water master plan for a dual distribution system that serves landscape irrigation of HOA common areas, schools, parks, etc. Identify the potential to serve additional reuses by modeling the dual distribution system to serve all potential reuse customers. Identify additional infrastructure and costs, for City consideration, to potentially serve additional reuse demands.
- Develop city-owned recharge capacity for excess reclaimed water. Identify locations and facility sizing for recharge of all excess reclaimed water by focusing on surface spreading basin recharge where possible, followed by vadose zone wells, then by aquifer storage and recovery wells.

In addition to the Water Infrastructure component recommendations, the following are water resources management recommendations that the City should implement in the near-term:

- Conduct groundwater recharge and water quality studies. The primary purpose of the studies would be to remove the uncertainties related to 1) recharge capabilities and locations, and 2) potential for future treatment of groundwater supplies.
- Implement groundwater management. The City should continue recharging all its allocated CAP surface water that it does not use directly and developing the recharge element of the reclaimed water program.
- Prepare for future groundwater treatment. The City should include a detailed evaluation of treatment technologies and brine management in its Water Technology Assessment project. The City should also consider investigating opportunities to secure lower cost energy alternatives to support potential future treatment operations, as well as to accommodate additional groundwater pumping.
- Complete perfection process for CAP surface water allocation. The City should complete the ratification process to "perfect" its total allocation of CAP water. CAP represents the only source of imported renewable water that the City can currently access.
- Acquire and bank other available CAP surface water. The City should embark on an aggressive strategy to bank water now at the lowest possible cost. Currently, there is a subclass of CAP water available known as incentive recharge water that is periodically offered at a discount rate. When the City has funds available, it should purchase and recharge as much of this water as possible to gain storage credits while they are still available. This financial advantage is planned to be eliminated by the CAWCD in 2012.
- Encourage continued urban irrigation with MWD water. The City should encourage the delivery of MWD surface water to its member lands for exterior water use (urban

irrigation), thereby reducing the demand on the City to provide potable and/or reclaimed water to these lands.

- Pursue Groundwater Savings Facility (GSF) permits for reclaimed water deliveries to farms. The City should permit the current deliveries of reclaimed water to farms as GSFs that will allow the City to accrue long term storage credits for the water delivered.

Mid-Term Water Resource Management Recommendations

- Investigate potential to acquire additional CAP allocations. The City should investigate the potential to acquire the CAP allocation currently assigned to the Brooke/Circle City Water Company, either through temporary assignment of this water to the City or through permanent acquisition. Circle City currently does not appear to have plans to put this water to direct use in the immediate future.
- Investigate temporary assignments of other allocations. The City should investigate the potential for obtaining temporary assignment of the CAP allocation for Arizona American Water Company (AAWC) who does not currently fully use all its allocation. The City may be able to approach AAWC to see if it would be willing to assign any potentially unused portions of its CAP subcontract for a specific period of time, until AAWC can fully utilize its allocation.

Long-Term Water Resource Management Recommendations

A portion of the City's existing water supply portfolio is mined groundwater that requires replenishment or storage of additional water in advance to avoid creating a need for replenishment. As such, the City should attempt to "fill out" its water portfolio with additional resources developed as part of a regional supply effort in order to achieve true future water resources sustainability. This will eliminate groundwater "mining," provide a water supply buffer, and provide additional water supplies that could allow the City to plan for enhancing future development opportunities.

The City should establish a high profile presence in ongoing discussions that could generate a regional water supply augmentation program. The City should actively participate in the regional discussions to 1) express expectations to participate in newly developed supplies, 2) secure a "place at the table", and 3) be seen and be heard.

Recommended Assured Water Supply Strategy

The assured water supply strategy (also summarized on Figure ES-2) deals with the "paper water" issues. In other words, the regulatory framework and reporting requirements associated with Arizona's water laws. The components of assured water supply for the City include groundwater, surface water, reclaimed water, and water conservation.

Assured Water Supply Recommendations – Groundwater

- Maximize groundwater physical availability. The City should make all efforts to maximize its groundwater physical availability in its Application for Modification of Assured Water Supply. The City should complete the following activities:
  - Develop a well phasing plan (included as part of the Water Infrastructure component of the *Integrated Water Master Plan*).
  - Demonstrate financial capability to construct new needed infrastructure in the water capital improvement plan and executed annexation and development agreements.
  - Develop a pumping plan for existing and potential wells in the service and planning areas.
- Acquire pledges for extinguished groundwater rights. The City should require that groundwater rights in and near the City's water service and planning areas (within the City's annexed, or to be annexed, areas) be extinguished and the credits pledged to the City's account at ADWR.

Assured Water Supply Recommendations – Surface Water

- Maximize physical availability of surface water. The City should maximize the physical availability of its CAP water by permitting and operating annual underground storage and recovery facilities and permitting all existing and new wells as recovery wells.
- Document MWD supply for urban irrigation. The City should develop and maintain a relationship with MWD for urban irrigation deliveries for the land located within the City and the MWD service area. The City should also work with MWD to document that MWD member lands will have its exterior irrigation water supplied by the MWD.

Assured Water Supply Recommendations - Reclaimed Water

- Maximize physical availability of reclaimed water. The City should maximize its physical availability of reclaimed water by permitting and operating annual underground storage and recovery facilities and permitting all existing and future City wells as recovery wells.
- Document direct reuse facilities and demands. The City should document all direct delivery opportunities, facilities and infrastructure, and projected demands for reclaimed water in its current Application for Modification of Designation of Assured Water Supply. The Water Infrastructure component of the *Integrated Water Master Plan* documents planned infrastructure construction that will supply projected future demands.

Assured Water Supply Recommendations - Water Conservation

- Document existing water conservation program. The City should meet the minimum requirements of the Groundwater Management Act by documenting the elements of its current water conservation program for inclusion in its Application for Modification of Designation of Assured Water Supply.
- Develop a formal water conservation plan. The City should develop a water conservation plan that identifies measures that are currently in place and those that will be implemented in the future. The plan should also provide a projection of the expected water savings.

THIS PAGE INTENTIONALLY LEFT BLANK

1. Introduction

1.1. Background

The City of Surprise (City) Public Works Department is responsible for the management of the City's drinking water, wastewater, reclaimed water, and recharge systems and the associated long range master planning documents.

The City is expecting to grow from a 2007 population of 104,895 to over 400,000 by 2030 (Maricopa Association of Governments, 2007). To prepare for this growth and additional growth as the City approaches build-out, the City prepared a *Water Resources Master Plan* and an *Infrastructure Master Plan* in June 2004. The Water Resources Master Plan was developed to ensure that the City's water supplies were adequate to meet the current and projected demands. The Infrastructure Master Plan addressed water, wastewater, reclaimed water, and groundwater recharge infrastructure. The master plans considered a municipal planning area (MPA) of 228 square miles that was broken up into five special planning areas (SPAs): SPA 1 through SPA 5. The master plans, however, did not consider the sixth, 71 square-mile expansion area in the north, SPA 6, that has since been added to the City's MPA.

The existing water resources and infrastructure master plans are in need of updating; they are now four years old, and considerable changes have been experienced in growth and development patterns, as well as the addition of SPA 6 to the City's MPA. In December 2007, the City retained Malcolm Pirnie, Inc., in association with Replenishment Services, LLC and ASU Decision Theater, to update the master plans into an *Integrated Water Master Plan*.

1.2. Project Purpose and Scope

The purpose of the *Integrated Water Master Plan* project is to provide a long-term guidance document for the orderly improvement and growth of the City's water supply portfolio and drinking water, wastewater, reclaimed water, and groundwater recharge infrastructure. Table 1-1 provides a summary of the scope of work technical tasks for each master plan component of the *Integrated Water Master Plan* project.

The *Integrated Water Master Plan project* is divided into two components: Water Resources and Water Infrastructure. The purpose of the Water Resources component (Tasks 2.1 through 2.14) is to identify the projected water demands as the City continues to grow and to develop a water supply strategy that will meet the demands in a cost-effective and sustainable manner. To prepare for the Water Infrastructure component, the

Water Resources component also includes updates to projections of wastewater flows, reclaimed water availability, and reclaimed water demands in an integrated fashion. Finally, the Water Resources component includes a review and evaluation of water reuse options and reuse program alternatives, a critical element of the City's water resource portfolio.

The purpose of the Water Infrastructure component (Tasks 3.1 through 6.5) is to support the findings and general approaches outlined in the Water Resources component by developing comprehensive plans and infrastructure improvements that allow the City to implement water infrastructure improvements and expansions in a legal, cost-effective, and sustainable manner.

Table 1-1.
Integrated Water Master Plan Technical Scope of Work Tasks

Water Resources	**Water Infrastructure: Drinking Water**
2.1 Review of Regulations and Guidelines	4.1 Review of Regulations and Guidelines
2.2 Review of Background Information	4.2 Review of Background Information
2.3 Supplies	4.3 Fire Flow Testing
2.4 CAGRD Replenishment Obligations	4.4 Flow Model
2.5 Demand and Flow Factors	4.5 Evaluation of the Existing System
2.6 Demand Module	4.6 Improvements to the Existing System
2.7 Additional Water Supplies	4.7 Drinking Water Master Plan Report
2.8 Reclaimed Water Management	**Water Infrastructure: Wastewater**
2.9 Dual Water System Evaluation	5.1 Review of Regulations and Guidelines
2.10 Water Resource Model	5.2 Review of Background Information
2.11 Water Resource Scenarios	5.3 Wastewater Collection System Monitoring
2.12 Water Resource Management	5.4 Flow Model
2.13 Assured Water Supply Management	5.5 Evaluation of the Existing System
2.14 Water Resources Master Plan Report	5.6 Improvements to the Existing System
	5.7 Wastewater Master Plan Report
Water Infrastructure: Recharge	**Water Infrastructure: Reclaimed Water**
3.1 Regulations and Background Information	6.1 Review of Background Information
3.2 Recharge Methods and Evaluation	6.2 Flow Model
3.3 Recharge Improvements	6.3 Evaluation of the Existing System
3.4 Build-out of the Recharge System	6.4 Improvements to the Existing System
3.5 Recharge Master Plan Report	6.5 Reclaimed Water Master Plan Report

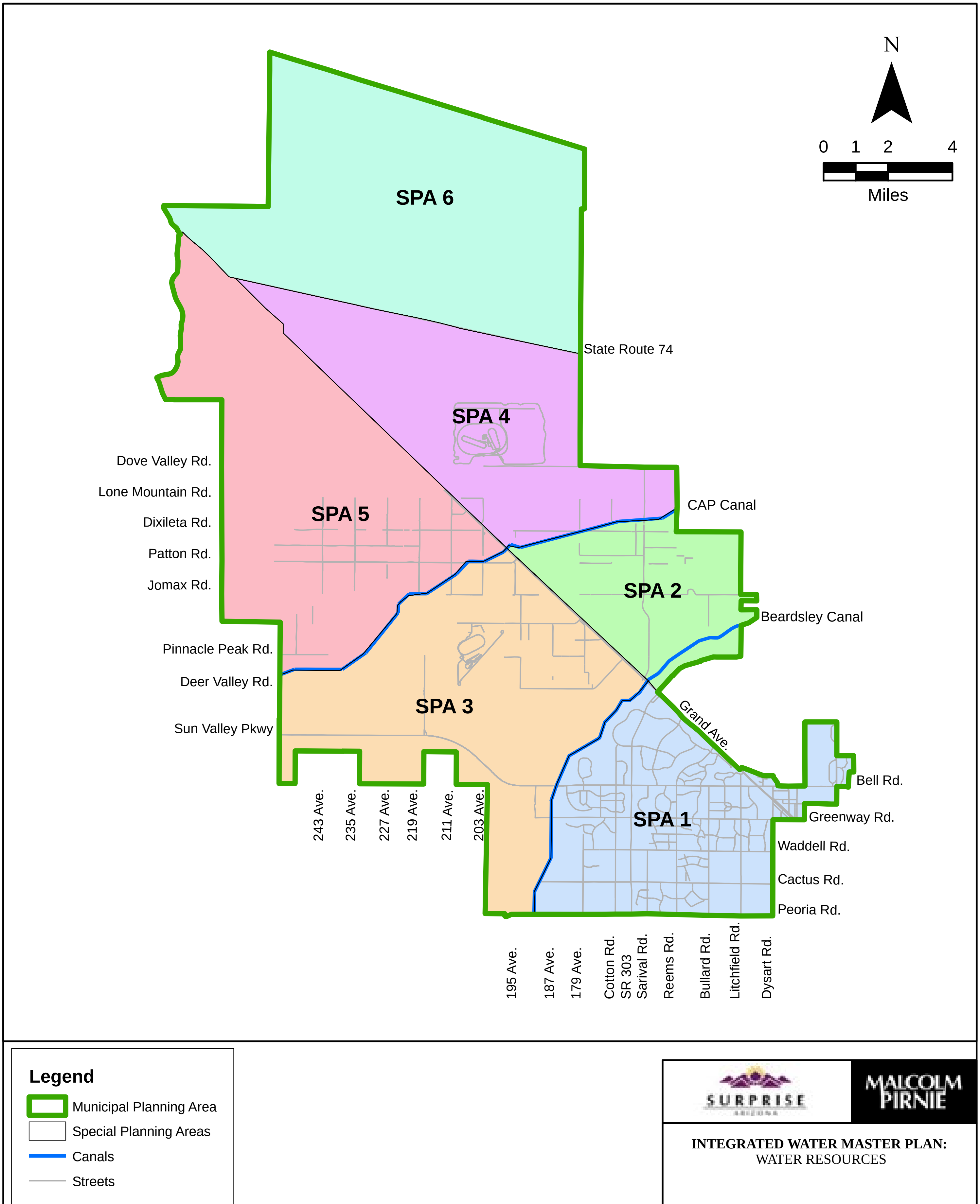
1.3. City Technical and Policy Guidance

The *Integrated Water Master Plan* project was completed under the guidance of two City committees: the Technical Committee composed of management staff from the City Public Works, Information Technology, and Planning Departments; and the Steering

Committee composed of the Deputy City Manager and the Assistant City Managers overseeing public works, planning, and development agreement activities. The Technical Committee provided information and data to the consultant team, reviewed the consultant team's technical work, and provided water, wastewater, and reclaimed water technical advice and guidance. The Steering Committee provided policy direction and oversight. The two committees gave valuable input and guidance on technical memoranda developed during the project and participated in all project workshops where results of the technical work were presented.

1.4. Study Area

The study area for this project, illustrated on Figure 1-1, includes all of the City's MPA. The MPA has been divided into six SPAs to maintain consistency with the City's previous master plan efforts and for convenience of wastewater and reclaimed water planning; i.e., the SPAs comprise logical drainage areas for existing, planned, and potential water reclamation facilities.



SURPRISE ARIZONA | MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Study Area

November 2008 | **Figure 1-1**

M:\4957002\GIS\Project_MXDs\Final Report\Figure 1-1 Study Area.mxd

2. Regulatory Framework

Multiple state and federal laws, contracts, agreements, and City policies govern water resource development and delivery. The water resource planning regulatory framework within which the City operates is summarized in this section.

2.1. Groundwater Management Act

Arizona Revised Statute (A.R.S.) Title 45 – Water governs the allocation and use of water resources in Arizona. Title 45 is subdivided into 16 chapters; each chapter subdivided again into articles, which contain the specific statutes. While Chapter 2 is titled "Groundwater Code," additional provisions within Title 45 (such as Chapter 3.1, Underground Water Storage, Savings and Replenishment) could potentially impact the City's water supplies. Following is a summary of the key provisions in the Groundwater Code. While the Code is a very detailed and comprehensive law, the following focuses on the portions of the Code most relevant to the City's water resources planning efforts.

- Chapter 2, Article 6 relates to "Groundwater Rights and Uses within Service Areas." This article provides authority to the City to withdraw and transport groundwater within its service area for the benefit its landowners and residents. The article also contains specific provisions against expansions of the service area specifically to include a well field or to withdraw and distribute groundwater for irrigation purposes (agricultural). Along with a few other related provisions, the article also requires that the City retain an updated map of its water service area.
- Chapter 2, Article 7 relates to groundwater withdrawal permits. These are permits that have a limited term and are typically used for special purposes, such as a hydrologic testing permit for well drilling. Groundwater rights are typically not time restricted, where permits have an expiration date.
- Chapter 2, Article 8 relates to the transportation of groundwater. The key provision of this article allows the City to transport groundwater within a sub-basin within its service area without payment of damages to other groundwater users.
- Chapter 2, Article 8.1 addresses the transportation of groundwater from the Butler Valley and Harquahala Irrigation Non-Expansion Area. With specific requirements, this article would allow the City to import groundwater from these two areas if it chose to pursue such a strategy for future water supplies.
- Chapter 2, Article 9 addresses the management of groundwater supplies. This article provides for the Arizona Department of Water Resources (ADWR) to develop management plans for active management areas (AMAs), including the Phoenix AMA, within which the City of Surprise resides. This article provides authorization for the specific conservation program options the City may choose to operate within,

specific provisions that relate to assured water supply (AWS) certificates and designations and the adoption of administrative rules needed to carry out the provisions of the statutes, and the requirements for planning by the replenishment district and water conservation and water district plans. ADWR must adopt a series of management plans for each AMA designed to achieve the AMA's management goal. For the time period of 2000 through 2010, the Third Management Plan in the series of five plans is in effect. The management goal for the Phoenix AMA is safe-yield (A.R.S. § 45-562). Safe-yield is a long-term balance between the annual amount of groundwater withdrawn in the AMA and the annual amount of natural and artificial recharge in the AMA (A.R.S. § 45-561). Each management plan must include a continuing mandatory conservation program for all persons withdrawing groundwater in the AMA (A.R.S. § 45-563).

- Chapter 2, Article 10 relates to wells (discussed further in Section 2.7).
- Chapter 2, Article 11 relates to the financial provisions of the ADWR and the fees it may charge in its role administering the provisions of the Groundwater Code.
- Chapter 2, Article 12 relates to the enforcement authority of the ADWR.
- Chapter 2, Article 15 relates to obtaining a Certificate of Groundwater Oversupply.
- Chapter 3.1 addresses underground water storage, savings and replenishment (the relevant statutes that apply to the City are discussed in Section 2.3).
- Chapter 4 addresses water exchanges.

The remaining chapters may, from time to time, affect various uses and management of water resources, but are very specific as to their application and tangential to the water resources planning and management functions.

2.1.1. Assured Water Supply Designation

When the Groundwater Code was being developed, the State Groundwater Water Study Commission recommended that the State prohibit urban development in areas where no AWS (100 year supply) is available. The Groundwater Management Act codified this recommendation. In an AMA, a person proposing to sell subdivided or unsubdivided land must obtain a certificate of AWS from the director of ADWR prior to any sale. Alternatively, the director of ADWR designates service areas of cities, towns, and private water companies where assured water supplies exist. As a result, developers within designated service areas are not required to obtain their own certificates of AWS.

The director of ADWR has adopted rules to implement the AWS provisions. These rules are located under the Arizona Administrative Code (AAC) Title 12, Natural Resources, Number 15, Arizona Department of Water Resources, Article 7, Assured and Adequate Water Supply (A.A.C. R12-15-701 through R12-15-730). Under the rules, groundwater in the Phoenix AMA is "physically available" only if it is pumped from a depth that does not exceed 1,000 feet below land surface (A.A.C. R12-15-716.B.2). Central Arizona Project (CAP) water is physically available if the provider has a long-term subcontract for CAP water. Other CAP water is physically available only if the provider demonstrates a back-up supply of water. Surface water other than CAP water (such as water from the Agua Fria River) is physically available under a formula provided in the rules. If a proposed source of water for an AWS is water to be recovered from an underground storage project, the volume of water legally available is represented by stored water credits existing on the date of the application for designation of an AWS. If the applicant wants to use credits for stored water that do not exist at the date of the application, ADWR will consider the physical availability of the water to be stored and the presence of an existing storage project in determining whether to include the proposed credits.

The AWS rules limit the amount of groundwater a municipal provider may withdraw "consistent with the management goal" of the AMA. The volume of groundwater the provider may withdraw is calculated pursuant to rule A.A.C. R12-15-722 (A and B). The amount of groundwater use allowed can be increased through several mechanisms. The first increase to the allowed groundwater use is by an incidental recharge baseline factor of 4 percent of water use. The amount of groundwater use allowed may also be increased by the amount of credits obtained for the extinguishment of grandfathered water rights (extinguishment or assured water supply credits).

The Groundwater Management Act provides a mechanism for a designated provider to increase the amount of groundwater it may withdraw pursuant to the assured water supply rules. Under A.R.S. § 45-576.01, ADWR may find that a water provider's additional use of groundwater is consistent with the management goal if the provider is a member service area of the Central Arizona Groundwater Replenishment District (CAGRD) and ADWR has approved CAGRD's plan of operation. As long as the groundwater is physically available, the municipal provider may pump more groundwater than the assured water supply rules allow. However, as a member of CAGRD, the provider must pay CAGRD for the cost of recharging a like amount of water. CAGRD is discussed in more detail in Section 2.2.

Currently, the assured water supply rules state that the Director shall review a designation at least every 15 years following issuance of the designation to determine whether the City’s designation should be modified or revoked (A.A.C. R12-15-715.C). The Director may revoke the City’s designation if, after notification and initiating a review:

- The City has less water than the amount required for a 100-year supply for the City’s current demand, committed demand, and projected demand for the next two calendar years;
- The City fails to construct adequate delivery, storage, and treatment works in a timely manner; or

- Arizona Department of Environmental Quality (ADEQ) or another governmental entity with equivalent jurisdiction has determined, after notice and an opportunity for a hearing, that the designated provider is in significant noncompliance with A.A.C. 18, Chapter 4 and is not taking action to resolve the noncompliance.

According to the ADWR, all designated water providers in the Phoenix AMA, including the City of Surprise, will be required to apply for a modification of Designation of Assured Water Supply by 2010. Since the initiation of this project, ADWR has accelerated it schedule and is currently requiring that most designated providers located within the Phoenix AMA submit applications for modification of their Designations in the fall of 2008. ADWR will require that the same procedures, models, and assumptions be used by all applicants to ensure that the approach to physically available groundwater is consistent for all water providers.

2.1.2. Groundwater Rights

The Groundwater Code created several different classes of groundwater rights within AMAs. With the exception of service area rights, no additional groundwater rights can be created within AMAs. There are provisions for other types of temporary groundwater withdrawals under permit systems.

Groundwater Rights were established during a period of qualification that preceded the passage of the Groundwater Management Act of 1980. This was a five year period from 1975 to 1980. Groundwater must have been used, or a substantial capital investment needs to have been made with the intent of using groundwater, during this period. These uses were grandfathered in, hence the term "grandfathered groundwater rights."

Other than service area rights, which are discussed below, there are three basic classes of groundwater rights. The use of groundwater for commercial agriculture resulted in the establishment of Irrigation Grandfathered Groundwater Rights. These rights are appurtenant, or attached, to the land where the rights were established. With very few exceptions (substitution of lands damaged by floods, for example) these rights cannot be moved from the land where they were established.

If the land is to be converted to some other type of non-irrigation use, such as a dairy, golf course, residential subdivision, or industry, and the land is not located within a specified distance of an existing potable water provider, the irrigation right can be converted to a Type 1 non-irrigation right. This process is referred to as "retirement" since the irrigation use is retired to a non-irrigation use. This process is irreversible, meaning that once an irrigation right has been converted to a Type 1 non-irrigation right, it cannot be changed back for use on irrigated agriculture.

If groundwater was used for a non-irrigation use during 1975 to 1980, a Type 2 Grandfathered Groundwater Right was created. This right is unique in that it can be leased or sold to other water users anywhere within the AMA. With respect to a lease, the entire right or only a portion of it may be leased.

2.1.3. Service Area Rights

Service area rights are unique in that they have the ability to be expanded, and they are the only groundwater right that can still be created (as such, these are not truly "grandfathered" groundwater rights) within an AMA. There are specific methods for expanding/extending existing service area rights, and for establishing new or "satellite" service areas.

2.1.4. Third Management Plan

To achieve the management goal for each AMA, water management requirements are established in each of the five management periods. The Third Management Plan addresses the ADWR's long term water management strategy, with particular emphasis on the third management period (2000- 2010).

The Plan is organized into 12 chapters that address water supply, demands, and management issues for the Phoenix Active Management Areas for all sectors of water use. It includes water conservation requirements for agricultural, municipal, and industrial groundwater uses; a water quality assessment and management program; an augmentation and recharge program; conservation and assistance programs; and other management programs.

The third management period constitutes the midpoint in Arizona's effort to achieve its groundwater management goals. After the end of the third management period in 2010, there will only be 15 years left to achieve safe-yield by 2025. The Third Management Plan must identify a water management strategy that encompasses the use of water conservation, augmentation, recharge, and water quality management by the agricultural, municipal, and industrial sectors to achieve the water management strategy during the third management period. All water users must continue to commit to using available water supplies efficiently and to making additional use of renewable supplies to replace existing groundwater use and to meet growing water demands.

The Plan was modified in May of 2003. The modifications focused on the water conservation programs and the Department's Water Management Assistance Program. A second modification to the Plan is proceeding through the adoption process at the time this document was drafted. The proposed modifications result from amendments to the Groundwater Code during the 2007 legislative session (Senate Bill 1557, which amended A.R.S. 45 §45-566.01). The proposed modifications are focused on a specific provision that affects the non-per capita conservation program.

Most of the requirements of the management plan are focused on water conservation. The primary goal of the municipal conservation program is to assist in moving the AMA toward safe yield by reducing per capita water consumptions, and encouraging the use of the best available water conservation practices, and maximizing the efficient use of all water supplies including the direct use of reclaimed water. Based on the annual report for the City filed in 2000, the City began using more than the 250 acre-feet per year (AFY) under its service area water right that would make the City eligible for regulation as a large water provider. However, since the ADWR uses a 3 year average because of the variables that can affect annual water demand (primarily climate), the City actually became eligible in 2003. Communications with the ADWR reveal that the City will likely become regulated as a large provider some time in 2008.

The distinction of being a large provider is that the City will have a new regulatory framework to address under the Third Management Plan, which will likely be focused on water conservation requirements. ADWR will likely contact the City during calendar 2008 to discuss this. In addition, the City must also manage its distribution system such that lost and unaccounted for water does not exceed 10 percent. Water that can be excluded from this provision includes water used for well purging, line flushing, estimated water use for construction (such as dust control), or fire services.

2.2. Central Arizona Groundwater Replenishment District

2.2.1. Background

The genesis of the CAGRD is found in the ADWR Draft AWS Rules dated November 1988. The ADWR had proposed to significantly reduce the amount of groundwater that could be withdrawn for assured water supply purposes. For undeveloped (desert) lands, ADWR had proposed that 0.5 AFY of groundwater would be the maximum amount of water that could be used, which equates roughly to a 1 dwelling unit per acre density. For agricultural lands, this allocation of water was doubled to 1 AFY, or roughly two dwelling units per acre. After the year 2000, restrictions became more stringent. Additionally, the depth-to-water criteria were changed from 1,200 feet below ground surface to 1,000 feet in the Phoenix AMA. While this was a proposed rule package, it was also immediately adopted by ADWR as a statement of policy that implemented the new criteria as additional guidelines.

There was broad opposition to the proposed rules, especially from smaller cities and counties that did not have CAP subcontracts, agricultural interests, and the development community and the related industries (e.g., banking and housing construction). Many of the opposition arguments to the proposed rules felt that those cities that did not have to obtain an assured water supply designation until 2000 would have an advantage. Further, it was difficult to supplement water supplies since the CAP water was allocated, reclaimed water supplies were not necessarily under water provider’s control, and water farms were not viable because of costs and transportation issues. Others felt the density limitations were arbitrary and went beyond the authority of ADWR, that it imposed severe limitations many years prior to the requirement to achieve safe yield, and that the rules would have an immediate and potentially devastating effect on the economy of the State.

The ADWR amended its Statement of Policy on March 15, 1989. The ADWR would continue under the 1982 guidelines, but the rule-making process would continue. This resulted in several years of negotiations regarding the use of replenishment as a means of achieving consistency with the management goal.

There are two predecessors to the CAGRD: one for the Tucson AMA and a second for the Phoenix AMA. The Phoenix Groundwater Replenishment District was not formed; however, the legislation is still in place in an amended form.

In early 1992, ADWR issued a concept paper that explored three ways to address the consistency with the management goal requirement in the assured water supply process. The paper supported the replenishment model. Later that year, ADWR also issued proposed rules limiting the total groundwater amount that could be relied upon by those applying for an assured water supply, pressuring the water community to adopt groundwater replenishment district legislation.

Since the Phoenix Groundwater Replenishment District did not form, a new bill was submitted and adopted in 1993 (Senate Bill 1425) that created the current CAGRD. At the time, one of the motivations was to encourage the full utilization of CAP water. Many believe the use of the Central Arizona Water Conservation District (CAWCD) to "house" the CAGRD was an advantage since the institution was already in place with an existing elected board and access to a water supply. Eventually, in 1995, ADWR adopted the assured water supply rules that drove the formation of the CAGRD.

2.2.2. Current Issues

There are a host of issues being evaluated regarding the CAGRD. One of the issues is that the CAGRD only has to replenish withdrawals within the AMA, as opposed to being within the vicinity of where the water was extracted. There are those who believe this will encourage groundwater pumping from areas adjacent to their well fields, while the replenishment of the withdrawn water will occur elsewhere within the AMA.

Another issue of concern is that home buyers who purchase a resale home in areas that are not served by a designated provider will not be aware that they will be paying a tax to replenish the groundwater that has been delivered to them. Secondary to this concern is that the cost of replenishment may continue to escalate dramatically as CAGRD attempts to secure renewable water supplies in a very restricted and competitive market – in fact, in a market that may place the CAGRD in direct competition with individual water providers who are trying to secure their own independent water supplies so that they can avoid paying the CAGRD and be “water independent.”

Rapid enrollment has also been of concern. In the last real estate development rush, many more lands were enrolled than anticipated within the CAGRD’s 10 year plan of operation. This has created an obligation for the CAGRD to obtain water supplies adequate to replenish water to meet this obligation; however, since much of the enrolled land has not developed, the CAGRD does not have the sufficient revenue to acquire and develop the water supplies needed to support the level of the replenishment obligation. The majority of CAGRD’s revenues are realized only after its members actually pump excess groundwater, against which CAGRD can collect assessments.

In member service areas, developers must pay an activation fee to the CAGRD even if they somehow were able to provide a 100 year supply of water needed to support their project. There is no statutory exemption to provide relief if the developer is able to secure a 100 year supply (such as long term storage credits) from having to pay this fee. The CAGRD and the water community are working towards addressing this by investigating the feasibility of the CAGRD using revenue bonds to support its operations. This would require legislation in 2009.

2.2.3. Contract Requirements

Water providers have different forms of agreements with the CAGRD. Some have to replenish a portion of the water they use based upon a “grow in” formula that gradually escalates their obligation over time. Others have a set amount of groundwater they must replenish consistently through the term of their agreement. Still others have a cap on their replenishment agreement set to the limit of their assured water supply designation, meaning that they must renew a contract with the CAGRD upon modification of their designation. It could be possible that at some point the CAGRD may be oversubscribed preventing the designated provider from obtaining a modification of its assured water supply.

2.2.4. Membership

The CAGRD currently has approximately 23 member service areas (water providers) and 1,000 member land subdivisions, with long-term replenishment obligations of up to 225,000 AFY.

2.2.5. Benefits

The primary benefit of membership in the CAGRD is that obtaining a modification to a designation of assured water supply is easier as the membership within the CAGRD automatically addresses the consistency with management goal requirement.

2.2.6. Liabilities

The cost of using groundwater that must be replenished (excess groundwater) is very expensive as compared to the full cost of CAP water (currently $91/AF for CAP municipal and industrial (M&I) subcontract water, $112/AF for excess CAP M&I water, or $51/AF for excess incentive recharge water). The only way to not pay ANY replenishment obligation to the CAGRD for member service areas is to use 100 percent recovered credits derived from renewable water stored underground from permitted recovery wells. Even if a water provider has enough stored water credits to offset 100 percent of its groundwater use, if a well is not permitted as a recovery well, then the water extracted from that well must be replenished. The use of funds for replenishment takes away revenue that the water provider could use to secure additional credits, which would reduce the obligation to replenish by the CAGRD.

2.3. Underground Storage and Savings

Title 45, Chapter 3.1 entitled “Underground Water Storage, Savings and Replenishment” governs the planning, design, operations and administration of groundwater recharge, and storage and recovery of surface water and reclaimed water. Article 1 covers the general provisions.

2.3.1. Recharge

Within the ADWR, “recharge” is used to describe the addition of water to the aquifer without intent to establish storage credits to recapture the water through recovery wells. This may happen on rare occasions, but as water resources economics become more focused and relevant, it is likely that very few situations will occur where this is done. Recharge is more likely to be performed to satisfy a requirement to replenish water previously extracted from the aquifer as legally defined groundwater.

Except as provided for in the statutes governing the replenishment of groundwater, underground storage with the resulting storage credits then conveyed for “recovery” purposes to prevent water from being classified as groundwater will be the more likely method of operation.

The proper legal terminology used for what is typically thought of as recharge is “nonrecoverable water.” This is addressed under Article 3 of Chapter 3.1, A.R.S. §45-833.01.

2.3.2. Storage

There are actually two permits involved in underground storage projects; they are the underground storage facility permit governed by Chapter 3.1, Article 2 of the A.R.S., and the water storage permit governed by Chapter 3.1, Article 3 of the A.R.S.

Underground storage facility permits regulate the "how" of underground storage. There are two types of physical facilities that are permitted:

- Constructed – just as it says, a constructed facility would be a facility that is actually built such as spreading basins, injection wells, or vadose zone wells.
- Managed – these are facilities where water is discharged into a natural stream and water is allowed to infiltrate through natural processes.

There is a third type of "facility" that is known as a "groundwater savings facility." This is really more of a water exchange, and has also been called in-lieu or indirect underground storage. This typically is accomplished through the delivery of a renewable water supply (such as CAP water) to a user of groundwater (typically an irrigation district) that has access to a CAP canal but is unable to use it directly because of institutional, financial, or other ADWR deemed appropriate reasons.

In this case, the renewable water is delivered to the irrigation district who agrees to reduce groundwater pumping gallon for gallon for the water being delivered. The entity providing the renewable water gets credits to the amount of water delivered minus transportation losses, and a 5 percent cut to the aquifer. This type of project is used to acquire credits quickly and inexpensively, and the user of the water (the irrigation district) also contributes to the cost of the water since they are saving energy by not pumping groundwater.

Water storage permits (and recovery well permits) are addressed under A.R.S. Title 45, Chapter 3.1, Article 3. The water storage permit is the permit that is issued to the entity that wishes to accrue the credits. In other words, this is the permit that regulates the "how much to whom" aspect of underground storage activities.

Recovery well permits are required if stored water credits are to be withdrawn from a well. An existing well can be permitted as a recovery well, subject to approval of an application to ADWR that demonstrates that other wells in the vicinity will not be harmed by the recovery of stored water from the well. Water may be recovered from any well located within the same AMA subject to the conditions issued pursuant to the permit. The water recovered from the well retains the identity of the water when it was stored. In other words, if CAP water was stored, it is accounted for as recovered CAP water for the purposes of annual reporting to the ADWR.

2.3.3. Exchanges

Water exchanges are covered under A.R.S Title 45, Chapter 4. A.R.S. § 45-1001 defines a water exchange as "a trade between one or more persons, or between one or more persons and one or more Indian communities, of any water for any other water, if each party has a right or claim to use the water it gives in trade." A.R.S. Title 45, Article 2 addresses the enrollment of water exchange contracts, which is specific to contracts and amendments that pre-date 1994 and 1995, respectively. A.R.S. Title 45, Article 3 addresses applications, fees and permits for water exchanges.

2.4. Central Arizona Project Subcontract

In order for a water provider to obtain and use CAP water, it must have a valid executed agreement with the CAWCD. The CAWCD administers and manages the CAP under its contract with the United States Bureau of Reclamation (USBR) for the State of Arizona.

The City of Surprise apparently did not acquire an initial allocation of CAP water during the initial contracting period. However, as a result of urbanizing lands within the McMicken Irrigation District, the City has acquired a substantial allocation of CAP water. In addition, the City acquired additional CAP water through the Arizona Water Settlements Act, known as Indian Settlement Water. The timeline and allocation amounts are discussed in detail in Section 3.

2.5. Maricopa Water District Agreements

The Maricopa Water District (MWD), formally the Maricopa Water Conservation and Drainage District, has storage rights within the reservoir behind the New Waddell Dam. This storage was created with the construction of the original Waddell Dam that was replaced and the reservoir enlarged as part of the Central Arizona Project construction. The increased space is used to store CAP water on a seasonal basis. As a condition of construction, an agreement between the MWD and the United States Bureau of Reclamation quantified and protected the storage rights of the MWD.

Currently, the City does not have any formal agreements with MWD. As MWD lands urbanize, it may be possible for the City to enter into an agreement with the MWD to secure the ability to take the water appurtenant to the lands in MWD and treat it (or have it treated) to potable standards for delivery to those lands. MWD will become an agent of the land owner in this way, but the rights to the water remain with the owner of the land to which the water rights are appurtenant.

The City could also elect to have MWD continue to serve lands water for urban irrigation providers as an untreated water provider. The advantage of this option is that the water demand does not count against the City’s Designation of Assured Water Supply, nor does it incur an obligation for replenishment for the portion of MWD water that is groundwater. The disadvantage is that the potable water demands for these lands would have to be met with other water supplies acquired and managed by the City.

2.6. City Ordinances, Rules, and Policies

The City does not have any specific rules or ordinances related to water resources; however, several City documents provide guidance on the design of water, wastewater, and reclaimed water infrastructure. Please refer to the following documents for the most current guidelines and policies:

- General Plan
- Integrated Water Master Plan: Water Resources and Water Infrastructure
- Water Guidelines and Standards
- Engineering Development Standards

In the event that there is a conflict between any of these documents and individual development agreements, the development agreements will prevail.

2.7. Arizona Well Spacing and Well Impact Rules

The ADWR new well spacing rules for non-exempt wells drilled in AMAs became effective on August 7, 2006 (Arizona Administrative Code, R12-15-1301 through R12-15-1308). According to ADWR, “The rules are designed to prevent unreasonably increasing damage to surrounding land or other water users from the concentration of wells. The well spacing criteria address three types of unreasonably increasing damage: (1) additional drawdown of water levels at neighboring wells of record; (2) additional regional land subsidence; and (3) migration of contaminated groundwater to a well of record.” The following discussion provides a general summary of the well spacing requirements as they apply for most new service area production wells.

New production well(s), may not cause more than 10 feet of additional drawdown after the first five years of operation on one or more wells of record in existence as of the date of receipt of the application to construct new well(s). The owner of the new production well will generally have the following options to address this issue:

- Attain a written consent form from the owners of effected well(s) of record consenting to the withdrawals from the proposed well;
- Reduce the planned pumping rate for the proposed well to reduce the drawdown impact on the well(s) of record; and
- Move the proposed location of the new well further away from potentially effected well(s) of record.

If the proposed well is also planned to be permitted as a recovery well, the owner may submit a hydrological study to ADWR that demonstrates that the new well will be located within the area impact of an underground storage facility, and that the owner will account for all of the water recovered from the well as water stored at the facility.

The owner of new well(s) that will be located in an area of known land subsidence may be required to submit a hydrological study or geophysical study to demonstrate the impact of the withdrawals from the proposed well or wells. In other words, the owner will be required to demonstrate that the new production well(s), at its proposed pumping rate and location, will not significantly contribute to additional land subsidence in the area.

The owner of new production well(s) that will be located in close proximity to a area of known groundwater contamination may be required to submit a hydrologic study to demonstrate that the new production well at its proposed pumping rate and location will not result in degradation of the quality of the water withdrawn form a well of record so that the water will no longer be useable for the purpose for which it is currently being used without additional treatment.

2.8. Water Reuse Regulations

The following describes the institutional and regulatory environment that relates to water reuse planning and reuse infrastructure design, construction and operation.

2.8.1. Aquifer Protection Permit

The Environmental Quality Act of 1986 provided for replacement of the former State Groundwater Quality Protection permit program with the Aquifer Protection Permit (APP) Program. In December 2000, modifications to the APP Rules were made final and codified in Arizona Administrative Code (AAC) Title 18, Chapter 9, Articles 1 through 3. Under the revised Rules, regulated facilities will be issued either an individual or a general permit. Facilities requiring APPs include: drywells, industrial facilities, mining facilities, wastewater facilities, and solid waste disposal facilities.

For wastewater treatment facilities, the APP Program requires facilities to obtain an individual APP and to use best available demonstrated control technology (BADCT) to achieve the greatest degree of discharge reduction determined for a facility. ADEQ will incorporate treated wastewater discharge limitations and associated monitoring specified in the Rules into the individual permit to ensure compliance with the BADCT requirements. The applicant must prove the technical adequacy of the facility to meet treatment objectives; demonstrate financial capability to construct, operate, and close the facility; and develop a contingency plan that includes an emergency response plan.

In January 2001, ADEQ promulgated a new unified permitting approach for wastewater treatment, collection, reuse, and recharge systems. The APP program Rules were expanded to include all categories of discharge, and the previously existing sewerage rules were repealed and placed in the APP Rules. The rules for the direct use of reclaimed water, which also include a new permit program, were also updated at the same time as the APP Rules. The new APP Rules also eliminated the Approval to Construct (ATC) and Approval of Construction (AOC) processes, modified definitions of BADCT for water reclamation facilities (WRFs), and incorporated guidelines and requirements of ADEQ’s Engineering Bulletin Nos. 11 and 12. Although the formal ATC and AOC processes have been eliminated from ADEQ, within Maricopa County, the Maricopa

County (MCESD) will continue to review construction plans and specifications and will inspect facilities without notice to ensure that construction generally conforms to the design as part of the APP review and approval process.

Each of the City's water reclamation facilities (WRFs) will require an APP. The APP may be waived if the facility has a permit for direct reuse of reclaimed water (A.R.S. 49-250). If the City recharges its water at a regional facility, the APP will be held by the entity owning the facility.

2.8.2. National Pollutant Discharge Elimination System Permit

Federal regulatory restrictions apply to discharges from WRFs to watercourses in Arizona. The National Pollutant Discharge Elimination System (NPDES) permit program establishes discharge quality requirements enforced through monitoring and reporting. The United States Environmental Protection Agency (USEPA) relies on both Federal Clean Water Act mandates and State Surface Water Quality Standards in developing plant-specific discharge standards for NPDES permits. USEPA is responsible for regulating the NPDES permit program unless it has approved a state NPDES program. Over the last several years, Arizona has been working to revise statutory authority and to develop program rules to obtain USEPA approval to manage its NPDES program. In the past, many NPDES permits were researched and drafted by the ADEQ and issued by USEPA.

In June 2002, Articles 9 and 10 were added to AAC, Chapter 9, which codified the new Arizona Pollutant Discharge Elimination System (AZPDES). On December 5, 2002, Arizona received approval from the USEPA to operate the NPDES Permit program on the state level. Arizona will now administer any permit authorized or issued under the NPDES program, including expired permits that USEPA has continued in effect.

For any City water reuse opportunities resulting in discharge or recharge in a waterway or regional recharge, a NPDES permit will be necessary. Similar to the APP program, the NPDES permit will be held by the regional recharge facility.

2.8.3. ADEQ Reuse Regulations

The AAC, Title 18, Chapter 11, Article 3 details the reclaimed water use and quality standards that became effective January 2001. The new regulations identify beneficial means of reuse and identify the minimum reclaimed water quality requirements for each. Reclaimed water can be used for landscape irrigation, including irrigation of golf courses, parks, highway landscapes, cemeteries, greenbelts, common areas, and large turf areas. If adequately treated, reclaimed water can be used safely to irrigate school grounds, playgrounds, and residential lawns. Reclaimed water can be used to create artificial lakes, lagoons, ponds, and other recreational and landscape water features.

Classes of Reclaimed Water

The new Rules establish five classes of reclaimed water: Classes A+, A, B+, B, and C. The classes are expressed as a combination of minimum treatment requirements and a set of numeric reclaimed water quality criteria. For reuse applications where there is a relatively high risk of human exposure to the reclaimed water, Class A reclaimed water is required. Where the potential risk to public health is lower, Class B and Class C reclaimed water are acceptable.

Table 2-1 summarizes the current numeric criteria, required treatment levels, and allowable uses for Classes A+, A, B+, and B reclaimed water. Class C is not included in the table because none of its acceptable uses are anticipated in Surprise.

The two "+" categories of reclaimed water include nitrogen removal requirements to produce reclaimed water with a total nitrogen concentration of less than 10 milligrams per liter (mg/L). These two categories minimize the risk of nitrate contamination of groundwater that may lie below reuse application sites. The Rules do not require the "+" categories of reclaimed water for reuse; however, the current recharge regulations require nitrogen removal to 10 mg/L total nitrogen for groundwater recharge.

- Class A+ reclaimed water has undergone secondary treatment, filtration, nitrogen removal treatment, and high-level disinfection. A water reclamation facility producing Class A+ water must have chemical addition facilities such that it has the capability of adding coagulants or polymers if they are necessary to achieve consistent compliance with the Class A+ reclaimed water quality criteria. The chemical addition facilities may remain idle if the turbidity criteria for filtered effluent prior to disinfection can be met without chemical addition. Impoundments storing Class A+ reclaimed water are not required to be lined.
- Class A reclaimed water is a Class A+ reclaimed water without the nitrogen removal requirement. Impoundments storing Class A reclaimed water are required to be lined. Classes A+ and A reclaimed water may be safely used for any listed reuse application.
- Class B+ reclaimed water has undergone secondary treatment, nitrogen removal treatment, and disinfection. Impoundments storing Class B+ reclaimed water are not required to be lined.
- Class B reclaimed water is a Class B+ reclaimed water without the nitrogen removal requirement. Impoundments storing Class B reclaimed water must be lined.
- Class C reclaimed water has been treated in wastewater stabilization ponds or in a lagoon system. Class C reclaimed water is acceptable for irrigation of pasture for non-milking animals, livestock watering, sod farm irrigation, silviculture, and irrigation of fiber, seed, forage, and other nonfood crops.

Reclaimed water generated from the City's existing and planned WRFs will meet Class A+ reclaimed water standards.

Table 2-1.
Matrix of Water Quality Objectives for Water Reuse

Parameter	Open-Access Irrigation		Restricted-Access Irrigation	
	Class A+	Class A	Class B+	Class B
Turbidity (NTU) [2]	2 (24-hour average never >5)	2 (24-hour average never >5)	5[5]	5[5]
Biological Oxygen Demand, BOD_5 (mg/L)	30 (30-day average) 45 (7-day average)	30 (30-day average) 45 (7-day average)	30 (30-day average) 45 (7-day average)	30 (30-day average) 45 (7-day average)
Total Suspended Solids, TSS (mg/L)	30 (30-day average) 45 (7-day average)	30 (30-day average) 45 (7-day average)	30 (30-day average) 45 (7-day average)	30 (30-day average) 45 (7-day average)
Total Dissolved Solids, TDS (mg/L)[5]	450 – crops 1,000 – landscape irrigation			
Total Nitrogen (mg/L)[5]	<10	--	<10	--
Fecal Coliforms (CFU) [3]	No detect [4] (4 of last 7 daily samples) 23/100 mL (single sample maximum)	No detect [4] (4 of last 7 daily samples) 23/100 mL (single sample maximum)	200/100 mL (4 of last 7 daily samples) 800/100 mL (single sample maximum)	200/100 mL (4 of last 7 daily samples) 800/100 mL (single sample maximum)
Chlorine Residual (mg/L)[5]	1			
Treatment Requirements	Secondary Treatment Nitrogen Removal Coagulant/ Polymer Feed Filtration Disinfection	Secondary Treatment Coagulant/ Polymer Feed Filtration Disinfection	Secondary Treatment Nitrogen Removal Disinfection	Secondary Treatment Disinfection
Lining Requirements	--	Low hydraulic conductivity artificial liner or site-specific liner with discharge rate <550 gal/ac/day	--	Low hydraulic conductivity artificial liner or site-specific liner with discharge rate <550 gal/ac/day
Allowable End Uses	• open-access landscape irrigation (e.g., residential landscaping and school grounds) • irrigation of food crops, including spray irrigation of orchards or vineyards • fishing and boating recreational impoundments • toilet and urinal flushing • fire protection systems • commercial closed-loop air conditioning systems • vehicle washing • snow-making		• restricted-access landscape irrigation (e.g., golf courses and landscape impoundments) • surface irrigation of an orchard or vineyard • dust control and soil compaction • pasture for milk-making animals • livestock watering • concrete and cement mixing • materials washing and sieving • street cleaning	

Notes:
1. Source: A.A.C., Title 18, Chapter 11, Article 3. March 31, 2002
2. NTU – Nephlometric Turbidity Units
3. CFU – Colony Forming Units
4. No detect - <2 CFU or MPN/100mL
5. Operational Guidelines - Water quality requirements that limit clogging, promotion of algae growth, decay of permeability and adverse effects on plants

Reclaimed Water Permitting

AAC Title 18, Chapter 9, Article 7 presents the new permit monitoring requirements for the use of reclaimed water. These regulations place the burden of assuring reclaimed water quality at the place where wastewater is treated. Monitoring and reporting requirements are conditions of the individual APP for the WRF. End users must obtain a Type 2 General Permit that requires the following:

- Records and Reporting: The permittee must maintain records for five years on the direct reuse site, the volume of water applied monthly, the total nitrogen concentration of the water applied (except for A+ and B+ water), and the acreage and type of vegetation on which the reclaimed water is applied. The permittee must also submit annual reports to ADEQ identifying the volume of reclaimed water received, the type of reclaimed water application, the irrigation use, and acres irrigated.
- Nitrogen Management: Unless the reclaimed water supplied is Classe A+ or B+, the permittee must ensure that storage impoundments are lined and that the application rates are based on one of the following: ADWR allotments, a water balance that considers consumptive use of the water, or an alternative method approved by ADEQ.
- List of Impoundments: The permittee must provide a list of impoundments and liner characteristics.
- Signage: The permittee must provide signage at the reuse site in accordance with guidelines contained in the regulations for the particular type of site and class of reclaimed water.

The Rule provides permitting options for a person to act as a reclaimed water agent for multiple end users. The reclaimed water agent can operate under a Type 3 general or individual reclaimed water permit that would allow end users to receive reclaimed water from the reclaimed water agent for appropriate reuse applications without having to notify the ADEQ to obtain permit coverage. Type 2 and Type 3 general permits for end users require the applicant to receive a written verification from ADEQ before operating. A person holding a Type 3 reclaimed water permit for a reclaimed water agent is required to maintain a contractual agreement with each end user, stipulating end user responsibilities for signage, impoundment liner, and nitrogen management requirements.

The City’s WRFs will produce Class A+ water, thereby allowing maximum flexibility with respect to direct use of reclaimed water. Producing Class A+ water also ensures that the water delivered meets the highest standards adopted in rule for human safety. With the City acting as the reclaimed water agent, end users will not have any reporting responsibility to ADEQ. However, as a reclaimed water agent, the City must have contractual agreements with each end user specifying requirements for signage, impoundment liner, and nitrogen management. The reuse permit will be necessary for all direct use of reclaimed water.

2.8.4. Underground Storage and Recovery of Reclaimed Water

The statutes and rules governing underground storage and savings in general were discussed in Section 2.3. The discussion below points out water storage credits and permits as they relate to recharge and recovery of reclaimed water.

Stored Water Credits

Under the Underground Water Storage, Savings, and Replenishment Program, stored water credits may be accrued through direct underground storage or groundwater savings resulting from the use of reclaimed water (until 2025). Direct storage must be conducted in an underground storage facility permitted by the State and may either be constructed (designed and constructed to cause recharge for underground storage) or managed (utilizing the channel of a natural stream; i.e., river discharge). Groundwater savings must occur at a permitted groundwater savings facility that replaces an existing groundwater use on a gallon-for-gallon basis.

Stored water may either be used on an annual basis or credited to a long-term storage account. If the stored water belongs to a groundwater replenishment district, a conservation district, or a water district, it may be credited to that district's master replenishment account. If stored water is recovered on an annual basis, it may be recovered any time during the calendar year in which it is stored. Excess water at the end of the calendar year may be credited to the storer's long-term storage account.

Long-term storage accounts are divided into subaccounts, which correspond to active management areas, irrigation non-expansion areas, groundwater basins, groundwater sub-basins, and type of water. The appropriate subaccount is credited with one hundred percent of all recoverable water stored or saved. An exception to this is reclaimed water stored at a managed underground storage facility which does not add value to a national park, national monument, or state park, in which case only fifty percent of the recoverable water stored will be credited to the storer's subaccount. Long-term storage credits may be: (1) pumped from a permitted recovery well meeting ADWR requirements, (2) assigned to another party, or (3) used for proof of assured or adequate water supply unless the credits result from reclaimed water storage at a managed underground storage facility.

The reclaimed water provider can recover the groundwater (pursuant to its long-term storage credits) anywhere within its service area. The recovered water is administered as reclaimed water by ADWR when recovered within the area of hydrogeologic influence and is not counted in the calculation of gallons per capita per day (gpcd) municipal conservation requirements. Reclaimed water recovered outside the area of hydrogeologic influence is included in the gpcd calculation. Recovery of long-term storage credits resulting from the storage of reclaimed water is not subject to the typical five percent "cut-to-the-aquifer" associated with storage of other renewable water resources.

The Underground Water Storage, Savings, and Replenishment Program provides the City an opportunity to receive storage credits for either direct underground storage of reclaimed water or groundwater savings due to the use of reclaimed water. The provisions of this Program offer a significant incentive to participate in regional recharge projects, to construct City-owned recharge facilities, to provide reclaimed water for exchanges, or to replace groundwater sources with reclaimed water for use in water features. The major advantage to the reclaimed water provider is a conversion of its non-potable reclaimed water resource to potable groundwater on a one-for-one basis.

Water Storage Permits

When stored water is recovered, it must be used in a manner that is consistent with the water use prior to storage. Reclaimed water that has been treated at a WRF can be used in any portion of the service area after recovery. In order to accrue credits for recharged water, the City will need to hold water storage permits for the reuse opportunities that involve recharging reclaimed water.

Water Exchanges

The 1980 Groundwater Management Act provides for a tool to manage groundwater resources through water exchanges. Water exchanges involve the exchange of one water supply for another, either to avoid the costs of physically moving water or to match water supplies of varying qualities with appropriate uses. Utilizing canals for water exchanges involving reclaimed water is currently only permitted if the canal water is only used for non-potable applications.

2.8.5. Clean Water Act Section 404

Section 404 of the Clean Water Act (CWA) establishes a permitting program to regulate excavation in waters of the United States. The program is jointly administered by USEPA and the Army Corps of Engineers with advisory input from U.S. Fish & Wildlife, National Marine Fisheries Services, and State Agencies, such as ADEQ, ADWR, and Arizona Game and Fish. If substantial areas of affected waterways are disturbed by excavation activities, biological evaluations, archaeological surveys, and other activities relevant to the affected area could be required. The 404 permit is issued by the United States Army Corps of Engineers (USACE), and certification is required by the State. If the City decides to pursue a recharge opportunity that intercepts on infringes in on a United States waterway, 404 permitting process will be triggered, and a USACE 404 permit may be required.

2.8.6. 208 Water Quality Management Plan

Area-wide Waste Treatment Management Planning is authorized by the CWA, Section 208. It requires regional planning agencies to develop comprehensive Water Quality Management Plans (WQMPs). These plans identify existing and proposed wastewater treatment facilities to meet the anticipated municipal and industrial waste treatment needs of an area over a 20-year period and provide general planning guidance for non-point source, sludge, storm water, and other activities. The WQMPs assure the State's water quality standards will be consistently maintained and provide control over the discharge or placement of dredged or fill material. The 208 WQMPs also provide the foundation for activity to be conducted pursuant to best management practices, which can be terminated or modified.

Under Section 208 in Arizona, the six Councils of Governments have been designated as planning agencies. As such, the COGs have been given this responsibility for developing the WQMPs. The original area-wide 208 WQMP for Maricopa County was prepared and adopted by the Maricopa Association of Governments (MAG) in 1979 and was updated in 1993 and 2002. Both USEPA Region IX and ADEQ review the plan and monitor implementation, and local governments implement the plan.

The Area-wide Plans are incorporated into the State Water Quality Management Plans through the State Continuing Planning Process (CPP), as required under Section 303.e.(1) of the CWA. When construction projects, State Revolving Fund loans, or certain types of permit applications are submitted to ADEQ, the proposal must be reviewed for plan consistency. The CPP covers WQMP approval and amendment processes along with a discussion of permits and programs required to maintain consistency with the WQMP. The appendix section containing the WQMP requirements is continually used to help implement new amendments to the plan. The CPP represents an ongoing effort to develop and implement consistent and effective water quality management programs throughout the State.

The purpose of the 208 Consistency Review process, as required by Section 303, et. al., of the CWA, is to assure the proposed facility or usage will be consistent with the existing Certified Regional WQMP. Consistency Reviews are required for all the following types of projects:

- NPDES permits (new and renewals)
- New wastewater treatment facilities discharging over 3,000 gallons per day
- Modifications to existing facilities, including, but not limited to:
  - Change in design capacity
  - Increase in the quantity of pollutants discharged
  - Change in method of effluent disposal
  - Change in the amount of effluent processed
  - New subdivisions with conventional or alternative on-site treatment and flows over 3,000 gallons per day.

A facility that is not consistent with the 208 WQMP will be required to develop an amendment to the current 208 Regional Plan in their area, and the amendment must be approved by a public process. Inclusion of plans in the 208 WQMP is a prerequisite to obtain an NPDES permit.

THIS PAGE INTENTIONALLY LEFT BLANK

3. Existing Water Supply Portfolio

This section discusses the City's existing water resources that have been recognized by the ADWR. The discussion includes how these resources were secured by the City in terms of its physical and service capacity volumes, and how they are accounted for by the ADWR.

3.1. Existing Designation of Assured Water Supply

The current provisions of the City's Designation of Assured Water Supply are contained within the Decision and Order number AWS 99-04, signed by the ADWR Director on September 7, 1999. The Designation recognized that the City's projected and committed demands for 2010 are 20,334 acre-feet (AF) annually derived from physically available groundwater and effluent, and that the City's projected demand in 2010 would not exceed that amount of water. The Designation also states that the City meets the requirements for water quality, financial capability, and legal availability. By virtue of its membership in the CAGRD, and the finding that the CAGRD's Plan of Operation is consistent with achieving the goal of the Phoenix AMA, the City of Surprise Designation is also deemed to be consistent with achieving the goals of the Phoenix AMA.

Table 3-1 presents a summary of currently available water resources according to ADWR's Designated Provider Tracking Sheet for the City of Surprise.

Table 3-1.
Available Water Resources as of June 2008

Water Supply Source	Annual Supply (AF)
Groundwater (Physically available per designation)	16,744
Surface Water	0
CAP Water (Must have ability to treat and deliver)	0
Reclaimed Water (Must have direct use demand)	3,584
Total Available Supply	**20,328**
Actual and Committed Demand (2006 Annual Report)	9,891.5
Current Supply Available for Growth	10,436.5

3.2. Surface Water

The only surface water allocation that the City has currently is CAP water. The City's entitlement is not currently being used due to lack of a filtration plant. The annual capital charge for this water is currently $21/AF and must be paid whether the water is used or not.

By subcontract executed on November 12, 1994, the City acquired 4,500 AF of CAP M&I water from an assignment of the McMicken Irrigation District subcontract. By subcontract executed June 27, 1995, the City acquired an additional 2,873 AF of CAP M&I water from an assignment of the McMicken Irrigation District subcontract. The Arizona Water Settlements Act, and the negotiations that preceded, resulted in the City obtaining an additional 2,876 AF of CAP M&I water, bringing the City's total CAP entitlement to 10,249 AFY for M&I uses including, but not limited to, underground storage. This amended subcontract is dated July 13, 2007, and was transmitted to the City on July 20, 2007. The subcontract has three conditions that must be satisfied in order for the amended contract to be effective:

- Condition 1 had to do with the Arizona Water Settlements Act. That condition was satisfied.
- Condition 2 required that the City pay or provide for payment of past M & I water service capital charges associated with the CAP allocation. This particular contract amendment apparently did not result in an increase in the CAP entitlement for the City, and therefore there may not be additional capital charges due. This is almost always the case where Indian Settlement water is concerned as the United States assumes that cost as part of its Trust obligation to the Tribes.
- Condition 3 required that the Amended CAP Subcontract be validated by a court of competent jurisdiction by December 31, 2007. The City was required to provide the CAWCD with three certified copies of the court judgment validating the amended CAP subcontract. As of a letter dated January 31, 2008 from the CAWCD to the City, the court judgment had not yet been obtained and/or verified to the satisfaction of the CAWCD.

The City has retained a legal representative to complete the process of validating the 10,249 AFY CAP allocation by a court.

3.3. Groundwater

3.3.1. Assured Water Supply

Once a Designation of Assured Water Supply has been issued by ADWR, an initial allowance of groundwater may be credited to a water provider's Designation of Assured Water Supply. Because the City was still classified as a small water provider at that time, it appears that it was not eligible to receive an initial allowance of groundwater in its account. This provision for those who may have qualified expired on February 7, 1995 (Administrative Rule R12-15-724.A.3).

According to Administrative Rule R12-15-724.A.4, for each calendar year of a designation, the director of ADWR shall calculate the volume of incidental recharge by multiplying the provider's total water use from any source in the previous calendar year by the standard incidental recharge factor of 4 percent. This water is added to the groundwater allowance account and can be used to reduce the City's CAGRD replenishment obligation.

All grandfathered groundwater rights (Type 2 Non-Irrigation, Type 1 Non-Irrigation, and Irrigation) are eligible for extinguishment and the resulting credits can be pledged to a designated provider's allowable groundwater account. According to the City's existing *Water Resources Master Plan*, the City had 1,959.24 AF of credits pledged to its account at the time it had submitted its application for a designation of assured water supply.

According to ADWR records, the City currently has 44,748.39 AF of credits in its groundwater allowance account. These credits can be used in the designation of assured water supply, but each credit can only be used once. Therefore, for the purposes of calculating the credits as a contribution towards an assured water supply, the total amount of credits must be divided by 100 years. In other words, the City's 44,748.39 AF of credits are equal to 447.48 AF per year for 100 years. However, these credits can be used, just as incidental recharge and groundwater allowance credits, to reduce the obligation to the CAGRD. The City applied groundwater allowance credits to its annual reports in 1999, 2000, and 2002 (45.59 AF, 721.17 AF, and 71.02 AF, respectively). The City has chosen to pay CAGRD for 100 percent of its groundwater withdrawals since 2003 rather than reducing its obligation using these credits. The City is taking steps to modify the annual reports such that the credits can be used to reduce the obligation in the future.

3.3.2. Central Arizona Groundwater Replenishment District

The City enrolled as a member of the CAGRD on or around July 24, 1998, according the Decision and Order confirming the City's status as having a Designation of Assured Water Supply (AWS 99-04).

The 2005 amended City annual CAGRD report shows an excess groundwater factor of 0.47, which means that the total groundwater use multiplied by this factor will result in an obligation for the City. In 2005, the City reported 2,972 AF of groundwater use, resulting in a replenishment obligation of 1,392 AF. The balance (1,570 AF) could be offset through use of the allowable groundwater account, which could include incidental recharge credits and extinguishment credits, therefore providing a large financial savings to the City. Apparently the City chose not to apply them and paid the CAGRD for the full amount of groundwater withdrawn.

The CAGRD replenishment rate in 2005 (paid in 2006) was $212/AF. Based upon the amended annual report filed by the City with the CAGRD, the City incurred a replenishment obligation of $630,064 based upon the reported withdrawal of 2,972 AF of groundwater. Had the City chosen to use 1,570 AF of extinguishment credits, it would have reduced its replenishment obligation by $338,810 for 2005.

The CAGRD rate in 2006 (paid in 2007) was $236/AF. Based upon the 2006 annual CAGRD report, the City had an obligation to report 0.53 of its groundwater withdrawals as excess groundwater subject to the CAGRD replenishment fees. In addition, the remaining 0.47 of the groundwater was not offset with any credits, so the full amount of groundwater withdrawals (2,139 AF) was assessed $236/AF for a total obligation of $504,804. Had the City chosen to use the extinguishment credits (0.47 or 1,005 AF), the City would have reduced its 2006 replenishment obligation by $237,256.

The CAGRD rate for water use in 2007 is $240/AF. The current cost of replenishment (to be reported in 2009) in the Phoenix AMA is $251/AF. Rates for 2009 and 2010 are approved at $288 and $317, respectively. There are currently discussions underway to address CAGRD financing legislatively in the 2009 legislature. Efforts to address this in 2008 were diverted by discussions between the CAGRD stakeholder process and the Arizona Municipal Water Users Association (AMWUA) Sustainability Task Force process. The outcome of this legislative effort is likely to have implications to future rates; however, it cannot be determined at this time whether rates will increase or decrease.

3.3.3. Drought Exemption Groundwater

Historically, the City has not received any drought exempt groundwater allocation. ADWR grants water providers a special drought pumping provision if they rely on surface water supplies that are constrained pursuant to a drought condition. Under these provisions, the amount of allowable groundwater pumping is quantified for each water provider that is not required to be replenished for that water year. Since the City is not reliant on surface water at this time, it has not had the opportunity to take advantage of this situation. In the future, if the City develops its CAP supplies using underground storage and recovery and/or developing a water treatment plant, the drought exemption provision may apply if M&I supplies are reduced due to drought conditions on the Colorado River. However, it is uncertain at this time how that would specifically affect the use of resources by the City, or to quantify how much water that might be.

3.4. Reclaimed Water

According to ADWR records, the City has been producing and using reclaimed water since 2002. Table 3-2 summarizes the reclaimed water production and use for the City for reporting years 2002 through 2006. It is assumed for the purposes of this document that “other” uses, as reported for the reclaimed water use on the City’s annual reports, is for landscaping purposes as opposed to agricultural irrigation.

Table 3-2.
Reclaimed Water Production (2002-2006)

Year	Production (AF)	Direct Use (AF)	Underground Storage (AF)
2002	1,716	0	1,716
2003	2,394	0	2,394
2004	4,931	4,172	759
2005	5,673	4,990	683
2006	6,403	5,372	1,031
Totals	21,117	14,534	6,583

Source: Arizona Department of Water Resources

THIS PAGE INTENTIONALLY LEFT BLANK

4. Water Resources Infrastructure

This section describes the water and wastewater service providers within the City's planning area and presents a brief summary of the existing and planned City water resources infrastructure and water quality.

4.1. Water and Sewer Service Providers

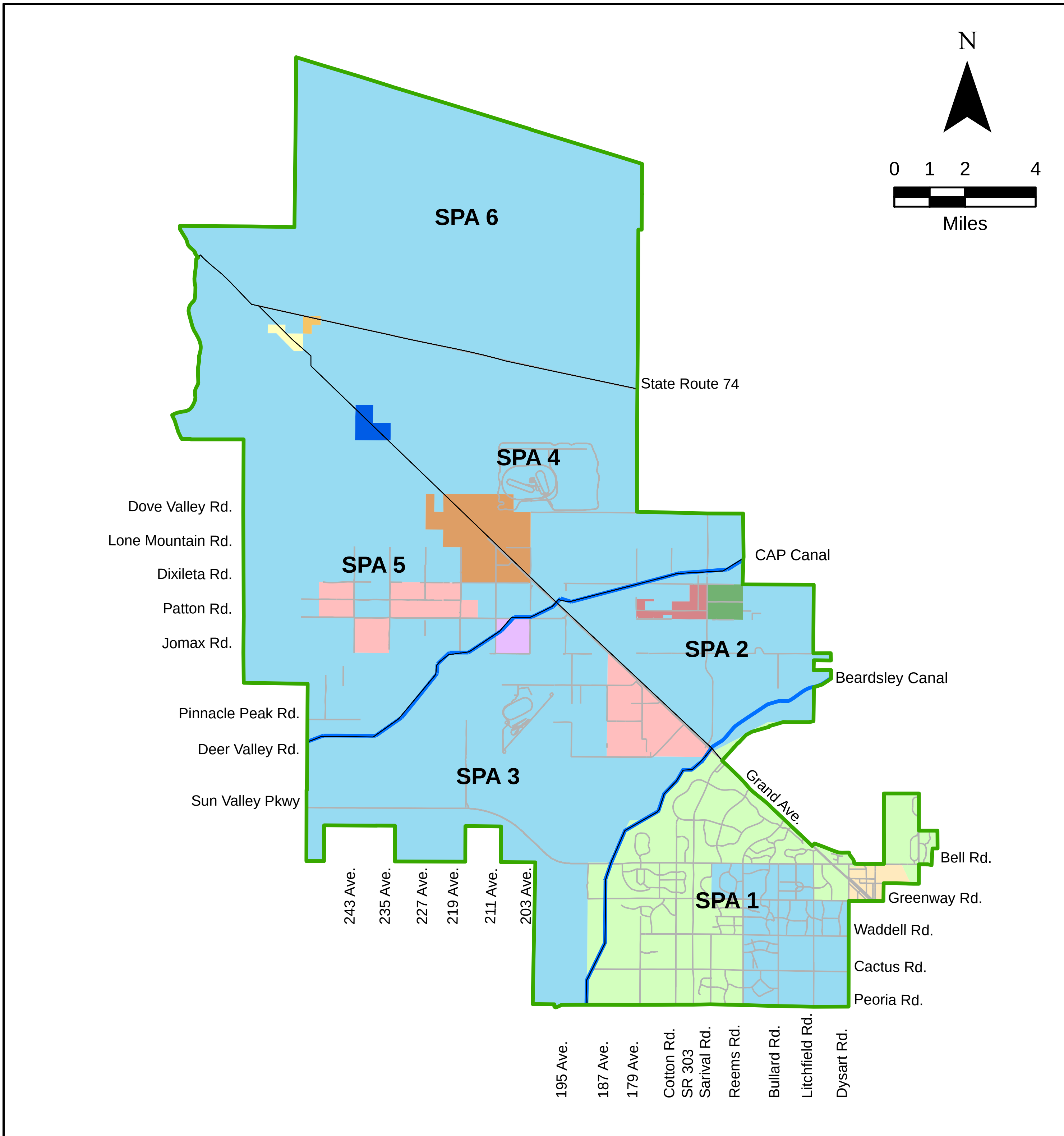
Throughout the City's MPA, there are 12 water service providers, including the City of Surprise (Figure 4-1). In SPA 1, the City of El Mirage provides water service to the Original Townsite. Arizona American Water Company (AAWC) and the City of Surprise currently serve the remaining portions of the SPA 1. The City currently contracts with AAWC for the operations and maintenance of the City's drinking water system. The AAWC contract is up for renewal in Summer 2009. However, the City plans to take over operations and maintenance of the drinking water system within its water service area at that time.

In the remaining SPAs, the City plans to serve a majority of the area; however, there are nine other water service providers. As the City grows to the north, it may or may not choose to purchase the private water companies. Similarly, the City will have the option to serve reclaimed water within private water company service areas. The 2004 *Water Resources Master Plan* conservatively assumed that the City would acquire the service areas of the private water companies outside of SPA 1 without obtaining any additional water rights from the companies.

Throughout the City's MPA, there are only two sewer service providers (Figure 4-2). While the City serves most of the planning area, AAWC serves the Coyote Lakes development and various small pockets along Bell Road.

The Steering Committee provided guidance that the current master plan should, as a baseline, consider the following planning areas:

- Serving potable water to customers in all private water provider service areas, except the AAWC and City of El Mirage service areas;
- Serving reclaimed water to customers in all private water provider service areas, except the AAWC and City of El Mirage service areas;
- Providing wastewater collection and treatment services only within the City's current sewer service area.



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets
- City of Surprise
- AZ American Water Company
- City of El Mirage
- Beardsley Water Company
- Brook/Circle City Water
- Chaparral Water Company
- Morristown Water Company
- Puesta del Sol Water Company
- Saguaro Acres
- Saguaro View
- West End Water Company

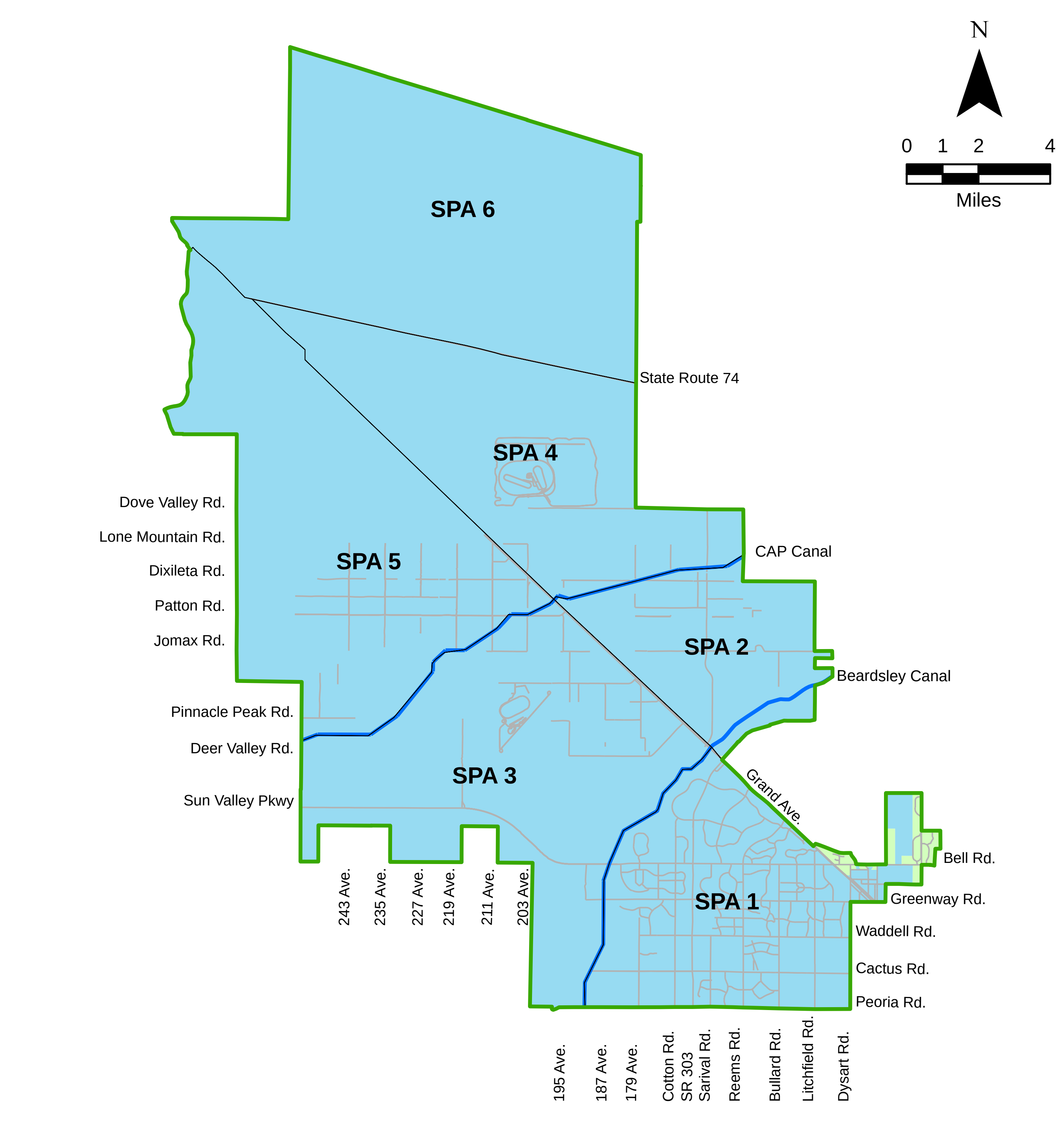
SURPRISE ARIZONA | MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Water Service Providers

November 2008	**Figure 4-1**

M:\4957002\GIS\Project_MXDs\Final Report\Figure 4-1 Water Service Providers.mxd



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets

Sewer Service Providers

- City of Surprise
- AZ American Water Company

SURPRISE ARIZONA

MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Sewer Service Providers

November 2008	**Figure 4-2**

M:\4957002\GIS\Project_MXDs\Final Report\Figure 4-2 Sewer Service Providers.mxd

4.2. Existing and Planned Water Infrastructure

The City's existing and planned water resources infrastructure includes groundwater production wells, water supply facilities (WSFs), WRFs, and aquifer recharge facilities. Figure 4-3 illustrates the locations of the existing and currently planned water resources infrastructure. These facilities are briefly discussed in the following sections.

4.2.1. Groundwater Production Wells

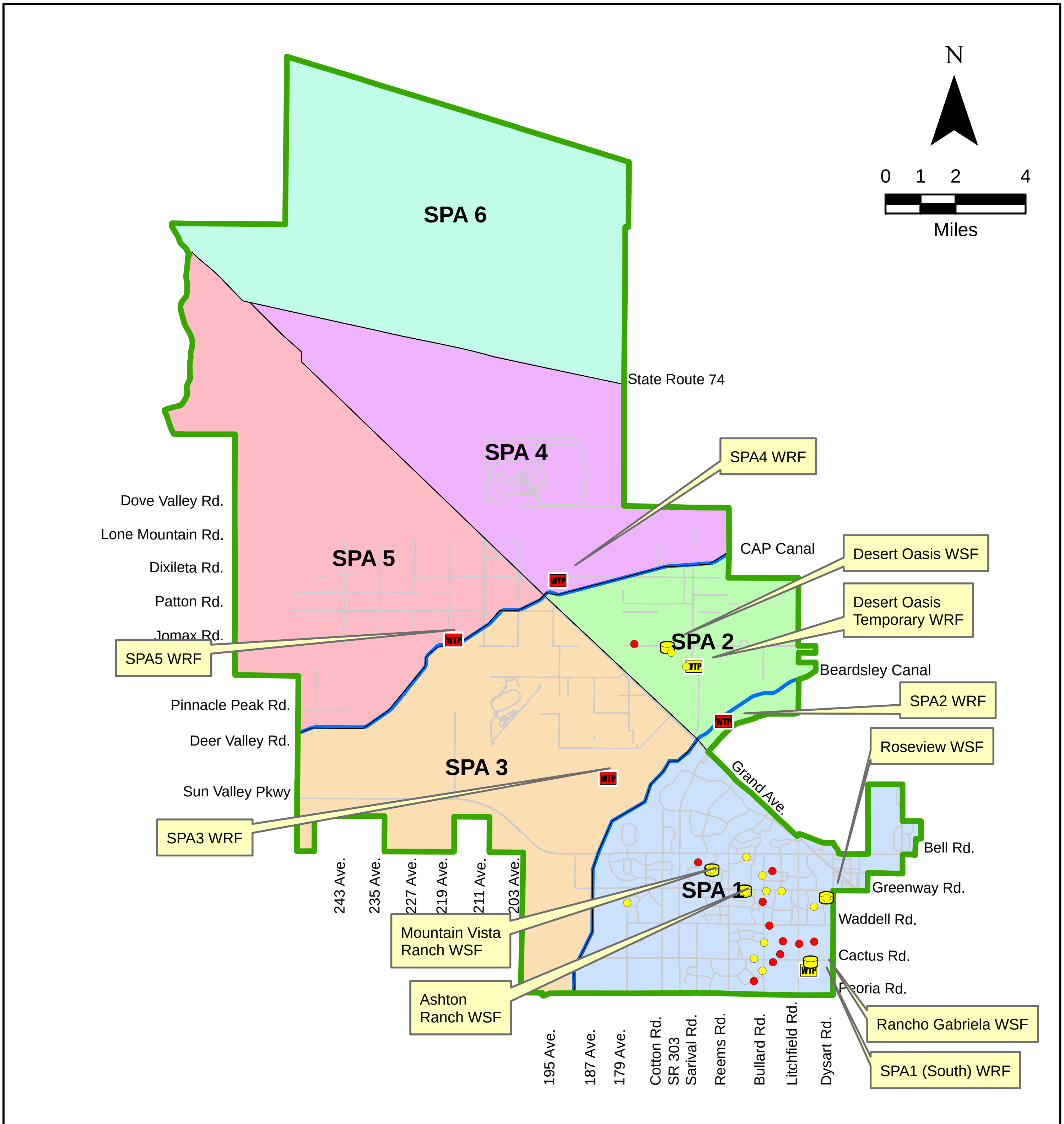
The existing and planned groundwater production wells for the City water service area were identified using the City's water system GIS files and discussions with City staff. Eleven groundwater production wells are currently used to meet water demands in the City's service area and are operated and maintained by AAWC. Twelve additional wells are currently under construction or in the planning stages. The City's existing wells have a firm capacity (defined by the City as 80 percent of the total well capacity) of approximately 19 mgd (21,800 AFY). A summary of the existing and planned wells is presented in Table 4-1.

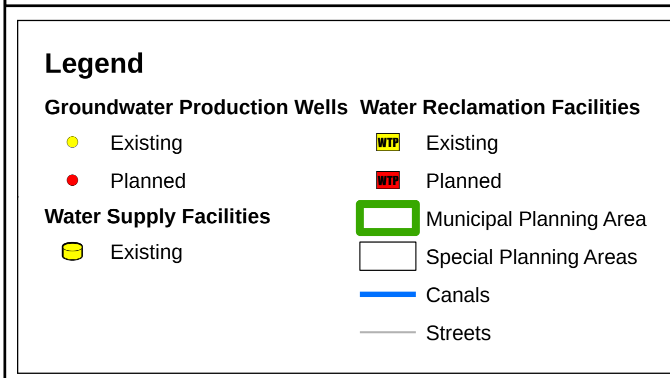
4.2.2. Water Supply Facilities

Water from production wells is routed to a regional WSF, where contaminants, if present above 70 percent the maximum contaminant level (MCL), are removed prior to entering the distribution system. The City currently owns 5 WSFs (Table 4-1), each accommodating between 2 to 8 production wells. Operation and maintenance of the facilities are currently contracted through AAWC.

To date, the primary contaminant of concern is arsenic. At Ashton Ranch WSF, direct filtration with ferric chloride is used to remove elevated levels of arsenic in the groundwater. The City is currently in the process of designing arsenic treatment facilities at Roseview WSF (adsorption via granular ferric oxide media) and Rancho Gabriela and Desert Oasis WSFs (arsenic treatment facilities using direct filtration with ferric chloride). No other facilities require treatment at this time; however, arsenic, fluoride, and nitrate remain contaminants of concern for the future. The City's upcoming *Water Technology Assessment* project will consider site-specific constraints and identify potential treatment processes for these contaminants.

On-site chlorine generation is used for disinfection at the Rancho Gabriela WSF, and tablet chlorination is used at Desert Oasis and Roseview WSFs. The City is in the process of replacing the tablet chlorinators at Ashton Ranch and Mountain Vista Ranch with on-site generation systems. Disinfection practices for future sites will be evaluated in the *Water Technology Assessment* project.





SURPRISE ARIZONA

MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Water Resources Infrastructure

November 2008	**Figure 4-3**

M:\4957002\GIS\Project_MXDs\Final Report\Figure 4-3 Water Resources Infrastructure.mxd

Table 4-1.
Water Supply Facilities and Groundwater Production Wells

Site Name	Status	Well Capacity	
		(gpm)	(mgd)
SPA1			
Mountain Vista Ranch WSF			
Mountain Vista Ranch 1	Existing	1,260	1.81
Mountain Vista Ranch 2	Planned	TBD[1]	TBD
Ashton Ranch WSF			
Ashton Ranch 1	Existing	1,180	1.70
Orchards	Existing	1,780	2.56
Surprise Center	Existing	1,700	2.45
Royal Ranch	Existing	1,470	2.12
Sierra Verde	Existing	1,270	1.83
Future	Planned	TBD	TBD
Future	Planned	TBD	TBD
Roseview WSF			
Roseview	Existing	1,900	2.74
Litchfield Manor	Existing	800	1.15
Rancho Gabriela WSF			
Rancho Gabriela 1	Existing	1,250	1.80
Rancho Gabriela 2	Existing	1,270	1.83
Marley Park 1	Existing	1,150	1.66
Marley Park 2	Planned	TBD	TBD
Marley Park 3	Planned	TBD	TBD
Marley Park 4	Planned	TBD	TBD
Surprise Pointe	Planned	TBD	TBD
Nitta / Cyburt Hall	Planned	TBD	TBD
Future	Planned	TBD	TBD
Future	Planned	TBD	TBD
SPA 2			
Desert Oasis WSF			
Desert Oasis 1	Existing	1,400	2.02
Desert Oasis 2	Existing	1,280	1.84
Desert Oasis (Lancer)	Planned	TBD	TBD

Notes:
1. TBD – To Be Determined.

4.2.3. Water Reclamation Facilities

The City currently owns two WRFs: South WRF, which serves SPA 1, and Desert Oasis Temporary WRF, which serves developments in SPA 2. A permanent SPA 2 WRF is currently under construction. A temporary WRF in SPA 3 is under construction, and the permanent facility in SPA 3 is currently under design (90 percent completed). The SPA 4 and SPA 5 WRFs have been planned, but design has not started; no WRF in SPA 6 has been planned to date.

South (SPA 1) WRF

The South WRF, located north of Peoria Road, between Dysart Road and Litchfield Road, is being constructed in phases and is planned to have an ultimate capacity between 24 and 28 mgd:

- Plants 1 to 4, with a total capacity of about 12 mgd, are operational. Plants 1 to 4 have capacities of 0.8 mgd, 2.7 mgd, 4.8 mgd and 4.0 mgd, respectively;
- Plant 5 is currently under construction and will add another 4.0 mgd of capacity;
- Plants 6 and 7 are master-planned on the site, but are not constructed yet.

The liquid stream treatment process train at the South WRF is similar for all of Plants 1 through 5, and consists of the following:

- Headworks – grit removal and screening of large solids
- Oxidation ditch – aeration and microbial activity (activated sludge) treatment
- Clarification – settling of large activated sludge particles
- Filtration (disk filters) – removal of small particles
- Chlorination (on-site sodium hypochlorite generation) – disinfection of microorganisms
- Storage – lined basins for direct, non-potable reuse and/or spreading basin recharge

Prior to 2007, Plants 1 and 2 water was filtered through dual media filters before passing through ultra violet (UV) disinfection and a chlorine contact chamber. In 2007, the media filters and UV disinfection chambers in Plants 1 and 2 were replaced with disk filters. The South WRF treatment process produces Class A+ reclaimed water.

The reclaimed water from the chlorine contact chamber is either recharged in the City's two spreading basins for recharge or stored in two uncovered and lined storage reservoirs. Reclaimed water that is not recharged is diverted through a series of pumps serving low-pressure and high-pressure reuse distribution systems. Most of the water is pumped south through the low-pressure system to irrigate G Farms, south of Peoria Avenue and outside the City's planning area. No formal agreements are in place for this use. Although not currently utilized, water can also be pumped to Kenly Farms in the north through a high-pressure system. The City is also in the process of installing reclaimed water meters at the Surprise Center and will supply reclaimed water to this location once the meters are installed.

SPA 2 WRFs

The temporary Desert Oasis WRF currently serves SPA 2. The facility is located on the southeast corner of 163rd Avenue and Desert Oasis Boulevard. The Desert Oasis WRF is a 0.35 mgd facility, serving an approximate one-square mile development. This facility uses a Modified Ludzack Ettinger (MLE) treatment process that produces Class A+ reclaimed water. The effluent from the treatment process passes through disk filters and a chlorine contact chamber before going to an unlined water storage basin located just west of the facility. When the basin nears capacity, the reclaimed water is used to irrigate desert landscaping around the facility.

The City is planning to build additional reclaimed water storage in the northwest portion of the Desert Oasis development. A pipeline will connect this storage to both the Asante and Desert Oasis developments

The City has designed a permanent SPA 2 WRF, and Phase 1 of the new WRF is currently under construction. The facility will have an initial capacity of 1.2 mgd and will use a sequencing batch reactor (SBR) treatment process that will also produce Class A+ reclaimed water. A second phase of the permanent WRF will add an additional 2.0 mgd of capacity utilizing a membrane bioreactor (MBR) treatment process. Construction of the second phase is scheduled to start in 1 to 3 years.

4.2.4. Recharge Facilities

The City’s only currently permitted recharge facility, the South Recharge Facility, is in SPA 1. The South Recharge Facility receives reclaimed water from the SPA 1 WRF. The City has been recharging reclaimed water at the South Recharge Facility under Underground Storage Facility (USF) Permit 71-562521.0002 since May 1998. The current USF permit allows the City to recharge up to 8,066 AFY of reclaimed water, or the equivalent of 7.2 mgd. Due to poor infiltration rates in the spreading basins, the City is currently constructing 5 vadose zone injection wells at the South WRF and plans to construct an additional 20 vadose zone injection wells between 2011 and 2015. Each vadose zone injection well is expected to have a recharge capacity of approximately 200 gallons per minute (gpm).

Reclaimed water that is not used for direct reuse in SPA 2 is currently recharged using spreading basins and could use vadose zone injection wells in the future if needed. The planned SPA 3 WRF will use spreading basins to recharge reclaimed water that is not directly reused.

4.3. Water Quality

4.3.1. Surface Water

At present, the only surface water available to the City is CAP and MWD water. Water quality data of the CAP and MWD water reaching the Surprise planning area were not available; however, other Phoenix-area cities have historically found CAP water easier to treat than other surface waters. CAP water does not require treatment if it is recharged. If potable water is desired, CAP water is typically treated using conventional water treatment technologies (coagulation, flocculation, and sedimentation followed by filtration and disinfection), pending a water quality study and treatment process evaluation.

4.3.2. Groundwater

Groundwater entering the Ashton Ranch WSF is treated for elevated levels of arsenic using coagulation (ferric chloride) followed by direct filtration. The City is currently in the process of installing arsenic treatment facilities at Roseview, Rancho Gabriela, and Desert Oasis WSFs. After treatment, all WSFs will comply with both state and federal drinking water regulations. Contaminants of concern at other facilities will be addressed on an as-needed basis to meet the drinking water standards.

4.3.3. Reclaimed Water

The reclaimed water produced at the City's existing WRFs meet Class A+ standards. Planned facilities will also produce Class A+ reclaimed water. Class A+ reclaimed water has undergone secondary treatment, filtration, nitrogen removal treatment, a high level of disinfection, and meets ADEQ water quality standards for water reuse (summarized in Section 2.8.3).

If used for deep well injection or aquifer storage and recovery (ASR), reclaimed water must generally meet drinking water standards to comply with APP and aquifer water quality standards. The additional treatment, including TOC removal and disinfection by-product control, is needed because there is no opportunity for additional subsurface treatment prior to the reclaimed water entering the aquifer.

THIS PAGE INTENTIONALLY LEFT BLANK

5. Water Resource Demand Projections

This section describes the methodology used to develop water resource demand projections (drinking water, wastewater, and reclaimed water) and presents the baseline projections. Included are overviews of the demand projection methodology and the computer tool used to develop the projections, a review of the City's land uses, and development of water resource demand factors.

5.1. General Overview

In order to ensure that a city has sufficient water for its residents and commercial customers, historical water consumption data are typically analyzed and used to project future water demands. The two most common methods to determine future water demands and wastewater flows utilize population projections and land use projections. Both methods are described below for water demands, but apply to wastewater flows similarly.

The population-based method applies a unit per capita demand factor, in gallons per capita per day (gpcd), to population projections to determine future water demands. The unit per capita demand factor is determined by dividing a service area's historical water demands by the historical population. The factor can be compared to nearby cities to confirm the value is indicative of the region.

The land use-based method applies land use-based demand factors, in gallons per acre per day (gpad) or gallons per day per dwelling unit (gpd/du), to a city's land use projections to determine future water demands. Similar to the population-based method, demand factors based on historical water billing data can be compared to nearby cities.

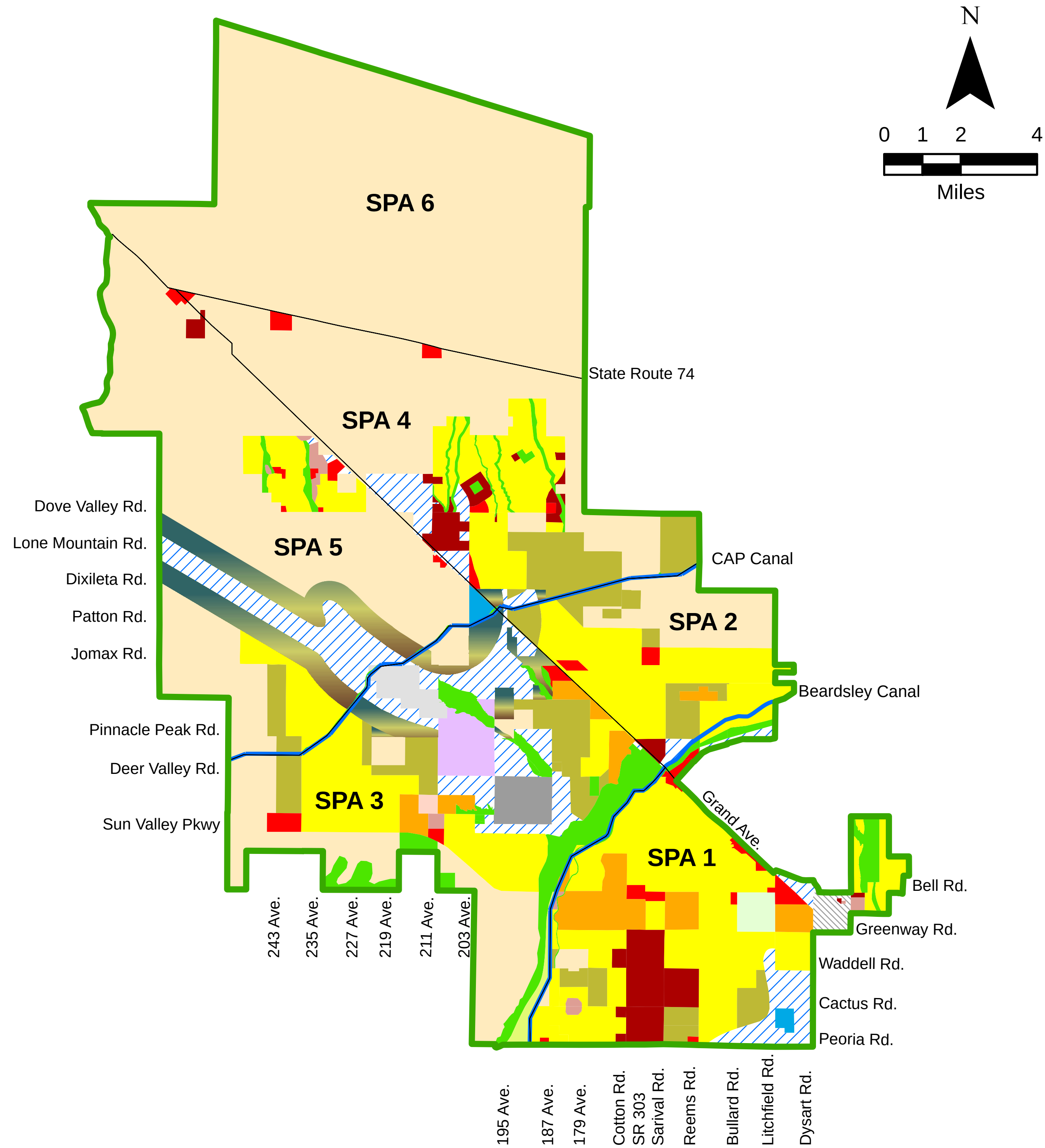
The City's 2004 *Water Resources Master Plan* utilized the population-based method to project future water demands and wastewater flows. The population of the City's water service area was estimated from City planning department and MAG population projections. For the *Integrated Water Master Plan*, however, the land use-based method was used to project drinking water demands, wastewater flows (and, consequently, reclaimed water availability), and potential reclaimed water demands.

5.2. General Plan Land Use Categories

The City's *General Plan 2020* Land Use Plan provides general guidelines for land use designations throughout the City's MPA. For the purposes of the *Integrated Water Master Plan*, the most recent (January 2008) Land Use Plan was provided by the City

(Figure 5-1). Definitions for each land use category obtained from the City's *General Plan 2020* are given below along with density ranges, in dwelling units per acre (du/acre), for each residential land use category:

- **Rural Residential (0-1 du/acre)** - This category is intended to be a setting for large-lot single-family housing in a rural setting. Development in these areas consist mainly of homes on one acre lots (gross) or larger, ranging up to ten acres in more remote, unincorporated areas in the county. The basic character of development is rural, with most natural features of the land retained. Keeping of horses or other livestock is permitted in certain areas subject to the City adopted Rural Development Standards and Design Guidelines Policy. Public services are not required at a level as great as in higher density development. No commercial or industrial development is anticipated.
- **Airport Preservation (0-2 du/acre)** - This designation refers to appropriate areas where service uses, proving grounds, warehouse, business park, and/or manufacturing-type industrial uses are allowed. These uses are encouraged within the F-16 Fighting Falcon aircraft (F-16) high noise impact area. This designation also allows for incidental supportive commercial use and single-family residential uses having a density range of 0 to 2 du/acre outside of the F-16 65 day-night level (ldn) sound boundaries. All future residential development within this category inside the high noise impact area shall be in compliance with Arizona Revised Statutes (A.R.S.) Section 28-8481. The overall intent of this designation is to maximize intensity of land uses and to locate those land uses in areas that are compatible with operations at Luke Auxiliary Airfield # 1.
- **Suburban Residential (1-3 du/acre)** - This category is intended for large-lot, single-family housing. Suitability is determined on the basis of location, access, existing land use pattern, and natural and man-made constraints. Suburban Residential designated areas range from one to three du/acre. Limited neighborhood commercial areas are permitted in this category to serve local residents where deemed appropriate by the City.
- **Low Density Residential (3-5 du/acre)** - This category is intended for predominantly single-family detached residential development. Residential densities of up to five du/acre (gross) are typical of this category. In general these areas are quiet residential single-family neighborhoods, but in some areas a mix of single-family, duplexes, townhouses, and low rise apartments would also be suitable, provided that the average density of such areas does not exceed five du/acre. This designation may also include supporting shops and services, parks and recreation areas, religious institutions, and schools. A full range of urban services and infrastructure is required.



Source: City of Surprise Planning Department (January 2008)

Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Rural Residential (0-1 du/acre)
- Airport Preservation (0-2 du/acre)
- Suburban Residential (1-3 du/acre)
- Low Density Residential (3-5 du/acre)
- Medium Density Residential (5-8 du/acre)
- Medium/High Density Residential (8-15 du/acre)
- High Density Residential (15-21 du/acre)
- Commercial
- Employment
- Mixed Use Gateway
- Agriculture
- Landfill
- Military
- Open Space
- Public Facilities
- Proving Grounds
- Open Space
- Original Townsite
- Surprise Center

SURPRISE ARIZONA

MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Land Use Plan

November 2008 | **Figure 5-1**

M:\4957002\GIS\Project_MXDs\Final Report\Figure 5-1 Land Use Plan.mxd

- **Medium Density Residential (5-8 du/acre)** - This category may include detached or attached single-family residential developments. This category may also include a mix of single-family homes, duplexes, manufactured, and modular homes. The gross density range for this category is five to eight du/acre. This category may also include supporting shops and services, parks and recreation areas, religious institutions, and schools. A full range of urban services and infrastructure is required.
- **Medium/High Density Residential (8-15 du/acre) –** This category may include duplexes, manufactured and modular homes, apartments, townhouses, and other forms of attached or detached housing on smaller lots. The gross density range for this category is 8 to 15 du/acre. This category may also include supporting shops and services, parks and recreation areas, religious institutions, and schools. A full range of urban services and infrastructure is required.
- **High Density Residential (15-21 du/acre)** - This category provides for apartment and condominium complexes ranging from 15 to 21 gross du/acre. This category may also include supporting parks and recreation areas, religious institutions, and schools. A full range of urban services and infrastructure is required.
- **Agriculture** - The Agriculture designation denotes areas that are intended to remain in agricultural production over the long-term. There are additional locations within the planning area that are expected to remain in agricultural production for the short-term. However, these areas are anticipated to transition to other land uses over time. According to the City's *1998 Growing Smarter Act*, agricultural land must be designated to provide residential development up to one du/acre.
- **Commercial** - The Commercial designation denotes retail areas larger than 25 acres. These sites are typically considered community or regional commercial and may include major tenants and smaller stores or services. These commercial uses are intended to have direct access to major roadways. The City may approve community and neighborhood commercial under 25 acres within other land use designations (i.e., residential) that may not be shown on the Land Use Plan, if appropriate. Criteria for locating commercial properties in non-commercial land use designations may include, but is not limited to, market feasibility, adequate access, buffering, and compatibility to surrounding land uses.
- **Proving Grounds** - Within the planning area, the Volvo Corporation has a proving ground that is used to test new vehicles and equipment. This use is expected to continue in the future.
- **Landfill** - The Landfill designation is where the Northwest Regional Landfill (1,200 acres) is located. The fairly new landfill has an 80-year life span. Therefore, this use will continue in the foreseeable future.
- **Military** - The Military designation is land owned or leased by Luke Air Force Base and is intended for air base-related uses. Auxiliary Field #1 has a runway that is used to train military pilots as well as uses such as small target practice. This use is expected to continue into the foreseeable future.

- **Employment** - The Employment designation refers to appropriate areas where professional office, tourism/recreational uses (e.g., resorts, amusement facilities), service uses, office/warehouse, and/or manufacturing-type industrial uses is encouraged. This use allows incidental supportive residential in appropriate locations that is adequately buffered on a case-by-case basis. Supportive residential may be a component of an employment related development where deemed appropriate. The specific allowable use will be determined based upon the particular site, adjacent land use impact, buffering techniques, intensity of development, and traffic implications. However, the overall intent of this designation is to locate employment uses and generate jobs for the City.
- **Resort Development** - The northern foothills of White Tank Mountain Regional Park offer a unique opportunity for a high-end resort development project. A resort for the purposes of the White Tank Mountain development area is a hotel and recreation facility that includes residential accommodations consistent with a temporary use. The area's unique and sensitive environment should be planned for uses that can be integrated with the natural environment and positioned to take advantage of the unique setting. Another resort area has been identified off of State Route (SR) 60 south of SR 74 in the northwest corner of the planning area. The area is a key entry to the City planning area, and the natural environment makes it an attractive area for tourists. At present, no Resort Development areas have been designated in the City's Land Use Plan.
- **Original Townsite -** The Original Townsite is the area that includes the first 640 acres that were incorporated in December 1960. The area is unique in character and demographics. Specific guidelines for the Original Townsite are included in the *Revitalization Element* of the City's *General Plan 2020*.
- **Surprise Center** - This area is intended as a mixed-use, 640-acre development project to include private sector commercial and employment land uses as well as municipal uses. The City of Surprise Municipal Center will include, but not be limited to, recreational and aquatic facilities, City offices, and a library. Surprise Center is intended to be a signature centerpiece for the City.
- **Mixed-Use** - Within the planning area are several "Mixed-Use" gateways located at primary entry areas to the City. These areas provide a unique mixed-use area that makes a unified statement to visitors entering the City. The Mixed-Use Gateway complements the surrounding area while providing a mix of commercial, employment, and public uses, such as a community college and civic facilities, with residential uses in a master-planned way that creates a unique, special environment. No single land use is intended to dominate a Mixed-Use Gateway. For example, the southern Mixed-Use Gateway is intended to be a high-intensity entry that might include a community college site/educational facility or spring training facility combined with higher intensity uses that benefit from the visibility afforded from SR 303.
- **Open Space** - This designation denotes areas that are to be precluded from development except for public recreational facilities or nature preserves. Open Space

areas should be left in a natural state due to topographic, drainage, vegetative, and landform constraints or the need to provide buffers between potentially incompatible land uses. The plan strives to create a linked open space system through the preservation of washes, public utility easements, and major corridors that link to the regional park and trail systems. State Trust lands or privately held lands identified as park or open space may be developed at a maximum of one du/acre per *Growing Smarter* legislation.

- **Public Facilities** - This designation denotes acreage dedicated for public or semi-public uses that may include police/fire substations, schools, libraries, community centers, wastewater treatment plants, and others.

5.3. Water Resource Demand Module

The Water Resource Demand Module (Demand Module) was created to allow the City to dynamically simulate its existing and future water resource needs derived from GIS-based data and land use-based demand factors. The objective of the Demand Module was to provide water demand (potable and non-potable) and wastewater flow projections in a format compatible with City drinking water, wastewater, and reclaimed water infrastructure models.

Historically, integrated water master planning relied on spreadsheets to calculate water resource needs, and existing/future demands were manually entered into water system models. By utilizing the City's GIS-based data in an interactive database setting, future water resource needs can be calculated quickly and easily exported into water and wastewater system models. In addition, the Demand Module allows users the opportunity to change development characteristics (land uses and development densities) or demand factors that can then be used to dynamically recalculate water resource needs. For example, if the City accepts a proposal for a large development in SPA 6, the City can quickly update the Demand Module to determine the development's effect on water resource needs. Similarly, if historical data suggest that average water use in high density residential areas has decreased, the City can adjust the demand factors and rerun the Demand Module to obtain revised water resource needs.

The Demand Module integrates the City's GIS database for planned land uses (General Plan), water and sewer service providers, SPAs, landscape plans, and development plans to spatially allocate demands across the City's planning area. That is, by intersecting these GIS databases, the tool creates a composite map composed of many small polygons, and the user can select any polygon, or combination of polygons, and change the attributes of the polygons (land use type, density, landscape type, etc.) to quickly recalculate the demand projections. The user can also change the drinking water, reclaimed water, and wastewater flow demand factors input into the tool to vary the demand projections. The Demand Module uses MAG population projections as a surrogate for estimating timing of development growth, or for providing a timeline for the demand projections. A detailed description of the development and calibration of the Demand Module is provided in Appendix A.

5.4. Demand Factor Data Sources

Water demand and wastewater flow factors were generated from data provided by the City, AAWC, and MAG. A summary of the data received and used in the calculations is provided in Table 5-1. The analyses of these data are described in the sections that follow.

Table 5-1.
Data Used to Calculate City Water Resource Demand Factors

Data	Source	Dates	Notes
Monthly Operation Reports	AAWC contract for City of Surprise	Jan. 2004 – Dec. 2007	City of Surprise Water Service Area Only
Water Customer Billing Data	AAWC contract for City of Surprise	Sept. 2005 – Oct. 2007	City of Surprise Water Service Area Only
Wastewater Flow Data	City of Surprise	Jan. 2005 – Dec. 2007	South WRF and Desert Oasis Temporary WRF
2030 DRAFT General Plan Land Use Projections	City of Surprise	Revised Jan. 2008	ArcGIS shapefile
Traffic Area Zone (TAZ) Population Projections	MAG	2005 – 2030 (Revised May 2007)	ArcGIS shapefile
Parcel Areas	MAG via City of Surprise	Unknown	ArcGIS shapefile

5.5. Water Demand Factors

Land use-based water demand factors were developed by evaluating historical water production and use and assigning the historical data to known land uses within the City's service area. For land use categories where data do not exist, the City's existing design guidelines for the water system and demand factors used by surrounding communities are summarized. The existing demand factors described in this section were subsequently used as a basis for the *Integrated Water Master Plan* planning factors, which are presented in Section 5.8.

5.5.1. Historical Water Production and Use

AAWC operates and maintains drinking water infrastructure and provides water billing services to customers in the City's current water service area. As indicated in Table 5-1, Monthly Operation Reports and water billing data were obtained from AAWC for customers in the City's service area. Although the operations reports provide useful information on service area-wide water use, the billing data were most helpful in developing the land use-based water demand factors as the billing data gives an indication of water use spatially throughout the service area (i.e., the water meters are geographically located within the water billing database). However, the billing data only relates the water that was delivered to each customer and does not include any water that was lost in the system prior to the customer due to leaks, unmetered uses, etc., or water that is known as non-revenue water. In order to develop demand factors that represent water that must be produced, non-revenue water must be determined and added to the consumed water.

Historical water production and consumption data obtained from the Monthly Operation Reports were used to determine the City's average non-revenue water (Table 5-2). Non-revenue water averaged 3.5 percent from 2004 to 2007. The extreme values in 2004 and 2005 were most likely due to AAWC meter reader/input errors in November 2004 (133 percent non-revenue water), which was later corrected in 2005. Based on this assessment, a non-revenue water factor of 6 percent will be added to the calculated water demand projections to project total system water demands. Non-revenue water was not described in the City's previous *Water Resources Master Plan* because demand factors were determined from production data (inclusive of non-revenue water) and not water billing data.

Between 2004 and 2007, all water demands in the City's service area were served with potable water from City-owned groundwater production wells or two metered interconnects with AAWC (located at Mountain Vista Ranch and Ashton Ranch Water Supply Facilities). Even though the City does not routinely rely on these interconnects, interconnects provided 5.0 percent of the total water served within City's service area in 2007. The amount has been steadily decreasing since 2004 when it was 33 percent.

Table 5-2.
Historical Drinking Water Production and Use[1]

Year	Groundwater Production (AFY)[2]	Interconnects (AFY)[2]	Total Water Produced (AFY)[2]	Total Water Consumed (AFY)[2]	Non-Revenue Water (%)
2004	2,297	1,144	3,442	3,556	-3.3%
2005	3,848	1,108	4,956	4,492	9.4%
2006	6,163	511	6,674	6,486	2.8%
2007	7,180	379	7,559	7,310	3.3%
TOTAL	19,488	3,142	22,631	21,844	3.5%

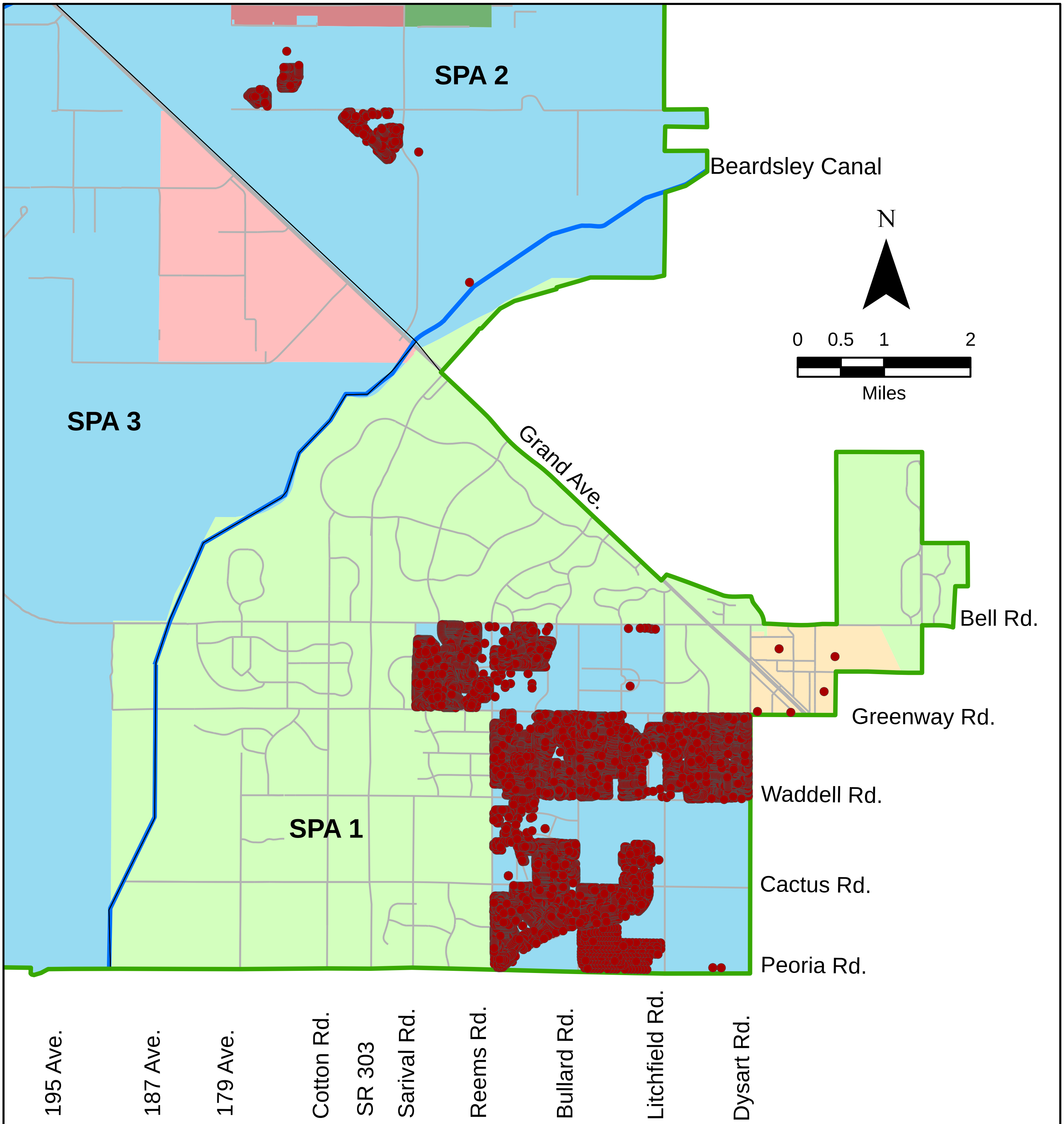
NOTES:
(1) Source: 2004 – 2007 Monthly Operation Reports for City of Surprise service area. These numbers are subject to change pending the revised City submission to ADWR.
(2) AFY- acre-feet per year.

5.5.2. Calculated Land Use Based-Demand Factors

An average water consumption value for each water service meter was calculated from water customer billing data and used to calculate water demand factors. A description of the methodology used is provided below:

- Total 2007 average water consumption for all meters was multiplied by 106 percent (non-revenue water) and compared to 2007 historical water production. The two values were within 3 percent of each other.
- Meter addresses from water customer billing data were geocoded into a shapefile using an address match function from ESRI's ArcMap. Using this method, 97 percent of the existing 14,171 water meters were geographically located. The remaining meters that were not geospatially located accounted for 19 percent of 2007 annual average water consumption. Thirty of these meters with the highest water demands were manually located in GIS using Google Maps® in conjunction with the MAG *Parcels* shapefile. In this manner, 90 percent of the total annual average water consumption was accounted for in the located meters (Figure 5-2). The remaining 10 percent of water that could not be spatially allocated was assumed to be distributed evenly across the service area.
- Using the current Land Use Plan provided by the City and water meter billing data, each water meter was spatially assigned to a land use category, and water demand factors were calculated.
  - For residential areas, the total annual average metered water consumption (September 2005 to October 2007) for each land use category was multiplied by 116 percent (to account for meters not located in GIS and for non-revenue water). This value was divided by the number of residential meters in the land use category, resulting in a demand factor (gpd/du) for each land use type (Table 5-3).
  - For non-residential areas, the total annual average water consumption for each land use category was multiplied by 116 percent (to account for meters not located and for non-revenue water) and divided by the total area obtained from the MAG *Parcels* shapefile, resulting in a demand factor (gpad) for each land use type (Table 5-3).

Land use categories do not limit the type of developments within an area, but rather describe the general policy for that area. For example, commercial properties and public use facilities (e.g., schools and parks) are often located within residential land use categories. Consequently, the "per dwelling unit" and "per acre" factors calculated above reflect the total was use for all types of uses within a land use category. The meter type designation in the billing data was used to further categorize the water use in each land use category into irrigation and non-irrigation uses. Note that irrigation uses refer to large turf or xeriscaped areas (e.g., parks, schools, roadway medians, and HOA common areas) and does not refer to irrigation of small areas such as individual residences or businesses.



Legend

Municipal Planning Area
Special Planning Areas
Canals
Streets
Water Meters

Water Service Providers

City of Surprise
AZ American Water Company
City of El Mirage
Beardsley Water Company
Saguaro Acres
Saguaro View

SURPRISE ARIZONA

MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Water Meter Locations

November 2008 | **Figure 5-2**

M:\4957002\GIS\Project_MXDs\Final Report\Figure 5-2 Water Meters.mxd

Table 5-3.
Calculated Land Use-Based Water Demand Factors

Land Use Category [1]	Type	Demand Factor	Units
Suburban Residential (1-3 du/acre)	Residential	410	gpd/du
Low Density Residential (3-5 du/acre)	Residential	470	gpd/du
Medium Density Residential (5-8 du/acre)	Residential	420	gpd/du
Surprise Center [2]	Commercial	1,700	gpad
Employment [3]	Commercial	850	gpad

NOTES:
(1) Data not available for other City land use categories.
(2) Limited data available (7 commercial properties)
(3) Limited data available (2 commercial properties and 212 dwelling units).

City non-residential demand factors (Surprise Center and Employment) were calculated; however, due to insufficient data, values obtained from other cities with more developed land use categories characteristic of the City's may more accurately depict City demands in the future. The demand factors shown in Table 5-3 include billed water use for all types of meters within each land use category (i.e., residential, commercial, and irrigation). Overall, approximately 30 percent of the City's billed water use was through irrigation meters.

5.5.3. Water Demand Factors for Surrounding Communities

For land use categories where no data were available, water demand factors were obtained from the literature and from cities in the surrounding area with similar land use categories. Table 5-4 summarizes the water demand factors for surrounding communities, as well as the factors calculated for Surprise. Because each city defines its land use categories differently, demand factors were extracted for the City's land use categories using engineering judgment and definitions of each land use type.

5.5.4. City Design Guidelines

The City's *Water Guidelines and Standards* (June 2006) provide annual average water demand factor design guidelines for estimating water demands (Table 5-5). While the commercial demand factor (1700 gpd/acre) appears to align similarly with other cities' commercial factors, the single family residential (640 gpd/du) and open space (4,800 gpd/acre) factors are higher. Using values based on historical demands and cities in the surrounding area along with the appropriate contingencies for non-revenue water may help the City to better plan future infrastructure, ensuring the system has been sized properly to meet the anticipated future demands in both a conservative and cost-effective manner.

Table 5-4.
Surrounding Area Demand Factors

Land Use Category	Units	Surprise	Avondale[1]	Phoenix[2]	Peoria[3]	El Mirage[4]	Goodyear[5]
Rural Residential (0-1 du/acre)	gpd/du	--	500	240 – 3,400	547	240	444
Suburban Residential (1-3 du/acre)	gpd/du	410	500	58 – 1,400		240	
Low Density Residential (3-5 du/acre)	gpd/du	470	500	120 – 590	504	240	390
Medium Density Residential (5-8 du/acre)	gpd/du	420	500	200 - 390	268	240	285
Medium/High Density Residential (8-15 du/acre)	gpd/du	--	500	110 – 440	40	240	256
High Density Residential (15-21 du/acre)	gpd/du	--	500	55 – 470	64	240	222
Airport Preservation (0-2 du/acre)	gpd/acre	--	1,000	62 - 990	417		
Surprise Center	gpd/acre	1,700					
Original Townsite	gpd/acre	--					
Commercial	gpd/acre	--	2,000	750 - 2,200		2,000	2,323
Employment	gpd/acre	850	1,000			1,300	
Mixed Use Gateway	gpd/acre	-	1,000		1,215		
Agriculture	gpd/acre	-					
Landfill	gpd/acre	--					
Military	gpd/acre	--					
Open Space	gpd/acre	--			1,466	2,700	
Turf	gpd/acre				2,182		
Desert Landscape	gpd/acre						

NOTES:
(1) Adapted from the City of Avondale *2002 Water Resources Master Plan.*
(2) Adapted from the City of Phoenix *2005 Water System Master Plan.*
(3) Adapted from the City of Peoria *2006 Water Resources Master Plan.*
(4) Adapted from the City of El Mirage 2008 *Water and Wastewater Master Plan Updates.*
(5) Adapted from the City of Goodyear *2007 Integrated Water Master Plan.*

Table 5-5.
City Water Demand Factor Design Guidelines

Land Use Category	Demand Factor
Residential (Single Family)	640 gpd/du
Residential (Multiple Family)	400 gpd/du
Commercial	2,500 gpd/acre
Open Space	4,800 gpd/acre

Source: City of Surprise 2006 Water Guidelines and Standards

5.6. Wastewater Flow Factors

Historical wastewater flow data were assessed, but there were not sufficient data to spatially allocate the flows and calculate land use-based flow factors. Instead, a methodology that relates wastewater flows to water demands was used to estimate the wastewater flow factors. The resulting land use-based wastewater factors used in the *Integrated Water Master Plan* for planning purposes are summarized in Section 5.8.

5.6.1. Historical Wastewater Flows and Reclaimed Water Production

Historical wastewater flows and reclaimed water production data were obtained for the South WRF and the Desert Oasis Temporary WRF from 2005 through 2007 (Table 5-6). Comparing plant influent flows with effluent production, approximately 10 percent of the influent flows were diverted as solids (grit, sludge) or were otherwise consumed in the treatment process, leaving the remaining 90 percent available as reclaimed water. Based on this assessment, it was assumed that 90 percent of wastewater flow will be available for recharge or for direct reuse.

Table 5-6.
Historical Wastewater Flows and Reclaimed Water Production[1]

Year	SPA 1 (South WRF)			SPA 2 (Desert Oasis Temporary WRF)		
	Influent (AFY)	Effluent (AFY)	Efficiency (%)	Influent (AFY)	Effluent (AFY)	Efficiency (%)
2005	6,441	5,828	90%	--	--	--
2006	8,166	6,548	80%	17	18	103%[2]
2007	8,590	7,826	91%	58	53	92%
AVERAGE			87%			95%

NOTES:
(1) Source: City of Surprise SCADA Data January 2005 – December 2007.
(2) Desert Oasis WRF effluent was estimated from January 2006 through May 2006.

5.6.2. Historical Wastewater Flow Monitoring

As part of the 2004 *Water Infrastructure Master Plan*, the City measured wastewater flows at nine locations throughout SPA 1 to estimate per capita wastewater flow factors. Comparing the data to WRF influent flows, the study determined the 2002 average per capita system-wide wastewater generation factor to be 64 gpcd.

In relating the historical monitoring data to water use, it is helpful to discuss water demands in terms of irrigation demand (landscaping at schools, parks, HOA common areas) and non-irrigation demand (inside and outside uses in residential and commercial areas). The monitored wastewater flows represented approximately 42 percent of the total water demand (including irrigation and non-irrigation uses), which was estimated at 152 gpcd in 2004.

5.6.3. Wastewater Flow Factor Methodology

Because the available wastewater flow data could not be used to develop land use-based flow factors, the flow factors were developed by relating wastewater flows to water demands. Nearly all indoor water consumption will return to the sewer collection system. Literature values from a study in California suggest that 62 to 70 percent of residential (i.e., non-irrigation) water demands are used for indoor purposes while the remaining 30 to 38 percent are used outdoors (Forecasting Urban Water Demands, 2000). Nationally, wastewater flows in collection systems range between 60 and 85 percent of the per capita water consumption; the lower percentages applicable to semiarid regions in the southwest (Metcalf and Eddy, 1991). These values are also in line with the ADWR's *Third Management Plan* (TMP).

To determine the wastewater factor as a percentage of total water demand (i.e., the sum of irrigation and non-irrigation uses), it is necessary to first consider the amount of water used for non-irrigation uses and then consider the amount of water used for interior uses. The historical water billing data indicated 30 percent of the calculated Surprise water demands are for irrigation uses (large landscape) and 70 percent are for non-irrigation (indoor and outdoor) demands. Using the information above, it was assumed that indoor water use, and subsequently wastewater flow, was 65 percent of the non-irrigation (indoor and outdoor) water demand. When considering the total water demand (i.e., the sum of irrigation and non irrigation uses), the wastewater factor is approximately 45 percent of the total demand, which is consistent with the value described above in Section 5.6.2.

5.7. Reclaimed Water Demand Factors

The City is currently in the process of installing reclaimed water meters for its first reuse customers. Historically, reclaimed water from the South WRF was recharged or pumped to G Farms south of the plant. No reclaimed water customers were metered or billed. At the Desert Oasis Temporary WRF, reclaimed water was used to irrigate desert landscaping. Similar to the South WRF, no reclaimed water customers were metered or billed. Because no historical data were available, potential reclaimed water demand factors were based on values obtained from literature. Reclaimed water could be directly used for outdoor demands (front and backyards) or for larger landscape demands such as parks, school grounds, homeowner association (HOA) common areas, etc.

5.7.1. Residential/Commercial Outdoor Demand Factors

Residential/commercial indoor water demands must be met with potable water while outdoor water demands can either be met with potable water or non-potable water. As described above, indoor water use will constitute 65 percent of the non-irrigation water demand. Thus, it is assumed that the remaining 35 percent will constitute residential/ commercial outdoor demands that could be served with either potable or reclaimed water.

5.7.2. Landscape Demand Factors

The Demand Module calculates landscape demands (capable of being served by reclaimed water) separate from land use category demands. The irrigation component of the residential demand factor was incorporated into the Demand Module using turf and xeriscape demand factors described in the ADWR TMP (4,000 and 1,300 gpad, respectively). Because schools, parks, and HOA areas are not found in other land use categories, landscape demand factors were not applied to non-residential land use categories.

5.8. Baseline Water Resource Projections

The land use database (General Plan land use categories and development densities) and the selected water resource demand factors (provided in Appendix A) were incorporated into the Demand Module. The Demand Module was then used to develop baseline water resource projections.

5.8.1. Basis for Baseline Projections

The baseline water resource demand projections were developed for land use and development conditions that City staff indicated were currently being discussed to develop the next edition of the City's General Plan. The following key assumptions were used to formulate the baseline water resource projections (water demands, wastewater flows, reclaimed water availability, and reclaimed water demands):

- Indoor, outdoor, and landscape demand factors were derived from City historical production and billing data. Demand factors for areas where the City had no data were obtained from literature or other community master plans having similar land use categories.
- The landscape use codes and percentage of landscaped area were derived from the City's *Scenic Integrity Guidelines (May 2008).*
- MAG population projections were used as a surrogate for the rate of development throughout the planning area.
- Based on City Planning Department guidance, for build-out conditions, all densities within the Rural Residential land use category north of State Route (SR) 74 were set to 2 du/acre; all Rural Residential polygons south of SR 74 were set to 3 du/acre.
- For build-out, the mid-point for the dwelling unit density ranges given in the City's current General Plan were used for all remaining residential land use categories.
- Consistent with the City's previous Infrastructure Master Plan, the City will not serve drinking water or reclaimed water in the AAWC or City of El Mirage service areas, but it will serve all other private water companies.

- The City will continue to receive wastewater from its wastewater service area which encompasses all of the municipal planning area except AAWC's wastewater service area located in the southeastern portion of the City.
- Based on historical flows entering and exiting the City's WRFs, the reclaimed water available is equal to 90 percent of the wastewater generated.

5.8.2. Baseline Projections

Based on the key assumptions above, the City's baseline water resource projections were calculated for 2008, 2020, 2030, and build-out and are summarized in Tables 5-7 and 5-8. The projected baseline water resource projections at City build-out were as follows:

- The total MPA baseline water demand (indoor, outdoor, and irrigation demands) was projected to be 228,200 AFY. Of this total demand, 194,500 AFY is in the City's water service area, and 33,700 AFY is in AAWC and El Mirage water service areas.
- The total MPA wastewater generated (indoor demands only) was projected to be 134,800 AFY. Of the total, 133,700 AFY is from the City's wastewater service area, and 1,100 AFY is from the AAWC wastewater service areas.
- The total MPA reclaimed water available (90 percent of wastewater generated) was projected to be 121,300 AFY. Of the total, 120,400 AFY is from the City's wastewater service area, and 1,000 AFY is from the AAWC wastewater service area.
- The total MPA reclaimed water demand for the potential largest reuse customers (irrigation demands only) was projected to be 20,700 AFY. Of this total, 17,100 AFY is in the City's water service area, and 3,600 AFY is in AAWC and El Mirage water service areas.
- The total MPA reclaimed water demand for all potential reuse customers (outdoor and irrigation demands) was projected to be 93,400 AFY. Of this total, 78,700 AFY is in the City's water service area and 14,700 AFY is in AAWC and El Mirage water service areas.

Since the City does not know when, or if, it will acquire private water companies, the baseline projections presented in Tables 5-7 and 5-8 include demands within the private water company service areas effective immediately (i.e., starting in 2008).

Table 5-7.
Baseline Water Demand Projections

SPA	Water Service Provider	Existing (2008)			Build-out		
		Indoor[1] (AFY)	Outdoor[2] (AFY)	Irrigation[3] (AFY)	Indoor[1] (AFY)	Outdoor[2] (AFY)	Irrigation[3] (AFY)
SPA 1	Arizona American Water Co. (AAWC)	9,100	4,800	2,200	16,800	9,900	3,500
	Beardsley Water	0	0	0	0	0	0
	Brooks Water Utilities	0	0	0	0	0	0
	City of El Mirage	1,000	500	0	1,100	600	0
	City of Surprise	3,700	2,000	2,200	6,400	3,400	2,400
SPA 2	AAWC	0	0	0	200	100	0
	Saguaro Acres	0	0	0	500	200	100
	Saguaro View	100	0	0	400	200	100
	City of Surprise	100	100	0	11,000	5,800	1,600
SPA 3	AAWC	0	0	0	1,000	500	100
	Beardsley Water	0	0	0	2,200	1,200	400
	Chaparral Water	200	100	0	400	200	100
	City of Surprise	0	0	0	22,200	11,800	2,200
SPA 4	Brook/Circle City Water	0	0	0	200	100	0
	Morristown Water	0	0	0	100	0	0
	Puesta Del Sol Water	0	0	0	100	0	0
	City of Surprise	0	0	0	20,100	10,800	2,800
	West End Water	0	0	0	1,300	900	0
SPA 5	Beardsley Water	400	200	0	1,900	1,000	100
	Brook/Circle City Water	0	0	0	200	100	0
	Chaparral Water	0	0	0	0	0	0
	Morristown Water	0	0	0	100	100	0
	City of Surprise	0	0	0	25,700	13,600	3,500
	West End Water	500	300	100	1,500	800	300
SPA 6	Puesta Del Sol Water	0	0	0	0	0	0
	City of Surprise	0	0	0	21,700	11,300	3,400
TOTAL	**Municipal Planning Area**	**15,200**	**8,000**	**4,700**	**134,800**	**72,700**	**20,700**
	Surprise Service Area	**5,200**	**2,700**	**2,400**	**115,800**	**61,600**	**17,100**
	AAWC and El Mirage Service Areas	**10,100**	**5,300**	**2,300**	**19,000**	**11,100**	**3,600**

NOTES:
(1) All indoor water demands are served with potable or drinking water.
(2) All outdoor water demands at residential homes and commercial properties; can be served with potable or reclaimed water.
(3) All water demands used for homeowner's association areas, schools, parks, golf courses, etc.; can be served with potable or reclaimed water.

Table 5-8.
Baseline Wastewater and Reclaimed Water Projections

SPA	Wastewater Service Provider	Existing (2008)		Build-out	
		Wastewater Flow (AFY)	Reclaimed Water Available (AFY)[1]	Wastewater Flow (AFY)	Reclaimed Water Available (AFY)
SPA 1	Arizona American Water Co. (AAWC)	800	700	1,000	900
	City of Surprise	12,900	11,600	23,200	20,900
SPA 2	AAWC	0	0	0	0
	City of Surprise	200	200	12,000	10,800
SPA 3	City of Surprise	300	300	25,800	23,200
SPA 4	City of Surprise	0	0	21,700	19,500
SPA 5	City of Surprise	900	800	29,400	26,500
SPA 6	City of Surprise	0	0	21,700	19,500
TOTAL	**Municipal Planning Area**	**15,200**	**13,700**	**134,800**	**121,300**
	City of Surprise Service Area	**14,400**	**13,000**	**133,700**	**120,400**
	AAWC Service Area	**800**	**700**	**1,100**	**1,000**

NOTES:
(1) 90 percent of the wastewater flow.

6. Potential Future Water Supply Opportunities

This section describes additional water supplies that are potentially available to the City in the future. The potential future supplies were identified and are discussed to the extent that credible references were available, including informal interviews of staff from the CAP, CAGRD, CAWCD, AMWUA, ADWR, and others. The additional water supplies potentially available to the City include the following general categories:

- Groundwater
- Surface Water
- Water Stored Outside the AMA
- Water Obtained from Private Water Company Acquisitions
- Reclaimed Water

6.1. Groundwater

6.1.1. Physical Availability

The current provisions of the City's Designation of Assured Water Supply are contained within the Decision and Order number AWS 99-04, signed by the director of ADWR on September 7, 1999. The Designation recognized that the City of Surprise projected and committed demands for 2010 are 20,334 acre-feet annually derived from physically available groundwater and effluent, and the City's projected demand for 2010 would not exceed that amount of water. The ADWR has further quantified the components of the water supplies in the designation specifically identifying 16,744 AF of groundwater are deemed to be physically available under the current designation, while the balance of the designated supply is composed of reclaimed water (effluent).

The Designation also states that the City meets the requirements for water quality, financial capability, and legal availability. By virtue of its membership in the CAGRD, and the finding that the CAGRD's Plan of Operation is consistent with achieving the goal of the Phoenix AMA, the City of Surprise Designation is also deemed to be consistent with achieving the goals of the Phoenix AMA.

As required by the ADWR, the City submitted a new application for Modification of Designation of Assured Water Supply in August 2008. ADWR has committed to providing a new groundwater model that will serve as the basis of the groundwater availability determination in the new application. The amount of groundwater determined to be available under the new determination is unknown; however, it is very likely to be an increase over the current physical availability component of the designation. While this is not technically a new supply, it is a new allocation of locally available groundwater. The application for Modification of Designation of Assured Water Supply is still being reviewed by ADWR.

Local groundwater is defined in this plan as groundwater located within the boundaries of the City's water service and planning areas. The City has an amount of groundwater assigned to its designation that is quantified by its physical availability determination under its current Designation of Assured Water Supply. To avoid confusion with the semantics associated with the word "allocation," it is used here in the context that it is an expression of how much local groundwater is deemed available under the City's current designation of assured water supply. It is analogous to a water duty, or allocation under a CAP subcontract, in that the amount of groundwater available to the City is limited in volume (16,744 AF) over a specific period of time (annually for 100 years).

While additional local groundwater may be available to the City for its future use, it will come at a cost. As is the case for use of groundwater under the current designation, the City must demonstrate that its use of groundwater will be consistent with the Phoenix AMA goal, which is safe yield as established by statute. This means the City must offset its groundwater use with a combination of underground storage and recovery of renewable water supplies (CAP water, MWD surface water, reclaimed water, or other water supplies imported from outside the Phoenix AMA) or rely on the services of the CAGRD. Reliance on the CAGRD is not without risk, however, as it may be very possible that the CAGRD also runs out of renewable water supplies for meeting its future obligations, and if the water is not replenished within the City's water service area, physical availability can still prove to be a limitation.

Many potable water users confuse the right to use groundwater with the physical supply. For example, many have operated under the impression that they can acquire Type 2 groundwater rights for their use. The cost of acquiring these water supplies is expensive (currently around $1,500/AF) and rarely sold in today's market (1 or 2 transactions per year). Second, these water supplies are typically leased to a direct user, such as a golf course or other industry, or for construction and dust control, to use as an alternative to potable water delivered by the City. In this way, the water is not included in the City's annual water use and delivery reports, and it is not subject to the City's CAGRD contract. On the other hand, the City does not realize revenues from the use of the City's potable water supply, and the use of this water can be deducted from the City's physically available supply.

6.1.2. Groundwater Allowance Account

The City has a Groundwater Allowance Account under its Designation of Assured Water Supply. Many service areas had this account established with a specific balance when first receiving a designation; however, the City was deemed a small water provider until 2004 and then became a large water provider. As a result of the timing of this classification and the Designation, the initial Groundwater Allowance Account was set at zero.

There are "deposits" that are made into the Groundwater Allowance Account over time. There are two components:

- Incidental Recharge – this is an amount of water that is projected to be returned to the groundwater aquifer within the City's service area through normal water use during each year. This amount is set at 4 percent of total water use during the year, but it can be increased if definitive hydrologic evidence is provided to ADWR to substantiate an upward adjustment.
- Extinguishment Credits – also known as Assured Water Supply credits, these are created by the extinguishment of existing Irrigation Grandfathered Groundwater Rights, Type 1 Non-Irrigation Grandfathered Groundwater Rights, and Type 2 Non-Irrigation Grandfathered Groundwater Rights.

The City should require by ordinance that Type 1 Non-Irrigation Grandfathered Groundwater Rights (there may not be any of these currently in the City's water planning area, and there may not be the opportunity for any in the future), and Irrigation Grandfathered Groundwater Rights associated within the City's current annexed or future planning area be extinguished and the resulting credits pledged to the City's designation as a condition of zoning and/or development. While there are other water providers located within the City's annexed and planning area, none are designated and therefore have no use for the extinguishment credits other than for sale and generation of revenue.

Since credits do have an intrinsic value in that they can be used to reduce an existing obligation to the CAGRD, some compensation may be logically granted to the party conveying them to the City so that the potential for charges of an "unreasonable taking" are not justifiable. The City can also decide to shop in the open spot market for credits held by landowners and others who may be willing to sell them. They are currently selling for $45/AF to $65/AF in the market. These are very likely to increase in cost in the future as fewer will become available on the spot market.

Type 2 Non-Irrigation Grandfathered Groundwater Rights can also be extinguished. However, by virtue of their character, they are typically not extinguished but simply added to the City portfolio for future uses, which may include establishment of a satellite service area in the City's future.

6.1.3. Poor Quality Groundwater

There are areas of groundwater supply that have very high TDS or are undergoing remediation for contamination immediately to the south of the City. While these supplies will incur some costs in acquisition, they should be evaluated more closely to determine whether the use of this water is physically and economically viable. Based upon an interview with staff of the CAGRD, this is likely to be one of the first new regional water supplies developed, and it is likely that the CAWCD will be the entity that will develop this water supply on behalf of existing and future CAP subcontractors using revenue bonds as a financing mechanism for the development of the water supply and the construction of the needed infrastructure.

In the waterlogged area near Buckeye, much of the water would require wellhead treatment, treatment residuals disposal, and conveyance by newly constructed pipeline or by exchange for the City to realize any benefits. One specific example might be financing the costs of treatment and treatment by-product disposal. The water could be used by another service area or by the CAGRD for satisfying replenishment obligations by others for a corresponding credit from the CAGRD to the City. As more supplies become available, and if the City of Surprise is active in the water resources development arena, it may be possible to increase water supplies through a series of creative water trades and exchanges that would help the City to mitigate the costs associated with the development of new infrastructure to deliver these water resources. The other side of this coin, however, is that the cost of the water will have to bear the financing costs associated with the development and deliveries of these water supplies. There are currently no estimates for this water available, but speculating this water to cost $200 to $800/AFY is probably a good range.

There are similar opportunities to use and treat brackish groundwater in the Yuma area; however, for the purposes of efficiency, the discussion regarding Colorado River water supplies (Section 6.2.3) also applies to this potential water source and, as such, will not be repeated here.

In other cases, if there are groundwater supplies that are contaminated and subject to remediation, the water can be treated and used directly by the City for non-potable, and potentially potable, purposes. Under the statutes, such water supplies are deemed as if they are renewable water supplies and therefore do not incur a replenishment obligation for their use. Again, this water could be delivered to the City directly by a constructed pipeline or credited to the City by exchange with another water provider or directly with the CAGRD. While this water may be lower in cost when compared to desalinated brackish groundwater, it is unlikely to be plentiful in supply and may have a finite time frame. Costs for this water can be free, depending on where the site is located and the remediation plan associated with the contamination, or in the neighborhood of CAP costs if a pipeline would need to be constructed to bring the water to the City. The probability of this becoming a significant water supply for the City's future is considered very low.

6.2. Surface Water

6.2.1. Maricopa Water District

A small portion of the City lies within the MWD planning area. Lands within this district have allocations to surface water from the Agua Fria River. The surface water is appurtenant to the lands where the water rights were historically established, and the City would need to execute a water delivery contract with the district to either have the water delivered to a treatment facility to treat the water to potable use and then have the City deliver that water to the lands where the rights are appurtenant (as agent for the landowner), or use an underground storage and recovery project to accomplish the treatment and annual delivery of water using the aquifer. The project would have to operate as an annual storage and recovery facility to comply with the surface water statutes that govern the use of surface water in Arizona.

This water is a very low cost alternative but only available to those lands located within the MWD boundaries. Based on MWD's recent average deliveries to its member lands of about 1.0 acre-foot per acre per year, this constitutes a very small supply of renewable surface water (estimated at 1,440 AFY average for the 1,440 acres of MWD member lands that are within the City's water service area). If this water is desired for treatment and potable use, the City could also approach the MWD to see if it could purchase capacity or a bulk water delivery contract from the proposed White Tanks Water Treatment Plant, which is being developed by a partnership between MWD and AAWC at a site along the Beardsley Canal near Cactus Road. Current costs for bulk water purchases are approaching $2/1,000 gallons according to the City of Goodyear who will also participate in the White Tanks facility.

Another, and probably more realistic, method would be to encourage the use of this water for urban lawn irrigation as much of the area is currently doing. While the City does not derive a direct benefit either by adding this water supply to its portfolio or by generating revenues from the delivery and sale of this water, it avoids the cost of treatment and/or underground storage and recovery. However, it would entail a more complicated annual reporting process. The City would not incur the lawn irrigation demand in its portfolio, and would only be responsible for delivery of potable water for indoor use in the MWD service area. Because of the limited amount of potential MWD water and the complexities involved with treatment and/or recharge and recovery of this water, use of the water for urban lawn irrigation is probably the best course for this water supply.

6.2.2. Central Arizona Project Water

6.2.2.1. Current CAP Allocations

The City currently has a subcontract for CAP water. Prior to 2008, the City was not using the water because it did not have a water filtration plant, a permit to use one of the CAWCD regional recharge facilities, nor an underground storage project that could store

CAP water within its planning area. However, in calendar year 2008, the City recharged 5,690 AF through its agreement with CAWCD. The agreement allows the City to recharge its CAP allocations at any of three CAWCD regional recharge facilities: Tonopah, Hieroglyphic Mountains, and Aqua Fria facilities. The City holds Water Storage permits for all of these facilities. The agreement with CAWCD is probably the most cost-effective way for the City to continue to use its CAP subcontract. Regardless, in the near term, the City should continue to deliver its CAP allocation to groundwater savings facilities and/or constructed recharge facilities in an amount equal to the City's annual water demand. This will create what is known as an annual storage and recovery project, which operates as if the City were delivering its CAP water to a water filtration plant from the ADWR accounting perspective.

The City could investigate the option for "leasing" its unused CAP subcontract to reduce costs. In this case, the City could use the revenue to purchase incentive recharge water at a lower cost for banking purposes to reduce the potential liability to the CAGRD. This alternative would only be viable while there is incentive priced CAP water and a capital repayment obligation for the City's CAP allocation. The City could structure the lease to "take back" the CAP water as it is needed or for underground storage when there is not annual interruptible water supply available. Once the CAP capital repayment provision expires, and/or when incentive priced water is equal to the M&I water delivery costs, there will not be a holding cost associated with this water. At that point, the City could fully deploy this water in an aggressive underground storage program, preferably in a facility that is within area of hydrologic impact of the City's groundwater pumping system so that this stored water is added to the City's physical availability.

In reality, however, such a lease is probably undesirable as projections show this water may be needed in the near future as the City continues to grow and potentially add other water provider service areas into its current obligations. In addition, it is also prudent to build a stored water "reserve" while the City continues to add underground storage facilities for maximizing its reclaimed water supplies to provide a "drought reserve" of stored water credits should there be a shortage (either operationally or climatologically induced). Established credits can then also be marketed if revenue is needed to fund additional infrastructure needs or other water supply management activities.

6.2.2.2. Additional CAP Supplies

The City could pursue an aggressive policy with the CAWCD to work to acquire any potentially available CAP water for future allocation to the City. While this is a low percentage opportunity, the value of the water to the City's future in terms of the cost of the water and the avoidance of CAGRD obligations make it attractive and a high priority for future acquisition. Even if agricultural priority water (first to be reduced during shortages on the Colorado River) is all that is available, the City could acquire and bank this water for future use.

CAP water is offered in several different types of contracts, with one of the most reliable being a subcontract for M&I use, which is most commonly granted to potable water providers. Additional CAP water can be contracted on an interim basis and is referred to as an annual interruptible subcontract. This means that this subcontract must be renewed on an annual basis (it is not an annual allocation). This water is subject to shortages and outages, and deliveries under the authority of these subcontracts will be curtailed before all "permanent" subcontracts to CAP water.

Currently, there is a subclass of water available pursuant to an annual interruptible subcontract known as incentive recharge water. This water is offered at a discount rate and can be used to deliver water for underground storage (recharge). If the City has funds available and is willing to secure additional permitted capacity at existing storage facilities owned and operated by others (primarily the CAWCD), it could purchase this water and gain storage credits. The City may also be able to use this less expensive water instead of its more expensive M&I subcontract water, however, the M & I subcontract water is more reliable in case there are shortages or outages on the CAP system. At this time, there is a minimal risk that shortage or outage may occur, so it is likely that the City could use this water at a lower cost and therefore increase the amount it can store. This financial advantage is planned to be eliminated by the CAWCD in 2012, however, as the incentive rate is predicted at that time to match the full M&I rate.

6.2.2.3. Indian Leases

The City could pursue water that may be available for lease from tribes that have the authority to do so under recent water rights settlements. The two tribes that may currently be willing to lease water to the City are the Gila River Indian Community and the San Carlos Apache Tribe. The Gila River Indian Community water is available now subject to the willingness of the tribe to entertain a lease to the City. There is a large initial investment required in obtaining a lease (anecdotally, this amount has been stated to be around $2,400 to $3,000/AF), and the costs of delivery for the leased water are equivalent to the cost of water delivery under the City's current CAP subcontract. Availability of water from the San Carlos Apache Tribe is not currently established as the settlement terms have not yet been fully determined or satisfied; however, some amount of water has been predicted to become available in the future.

The availability of Indian lease water to the City is entirely controlled by the Tribes and guided by the language of the complex Indian Water Rights settlements. Competition for available tribal water is also increasing, reducing the chances for success in obtaining long term leases for tribal water. If lease water is available, the water may be obtained for a 100-year period of time, helping the City to maintain a Designation of Assured Water Supply and potentially bridging the time needed for Arizona to develop additional regional water supplies that are truly sustainable and can eventually replace the need for leasing water on a long term basis. Costs for obtaining a supply of this water is likely to be somewhere between $2,400 to $3,000/AF initial lease cost plus the cost of delivering the water to the City for use. Based on an investment of this magnitude, the City would likely want to consider constructing its own water filtration plant along the CAP canal or purchasing capacity in a plant that could deliver water to the City.

6.2.3. Imported Water Supplies

Additional Colorado River could be acquired by purchasing farm land along the Colorado River and conveying the water through the CAP to the City. This potential supply could actually become more reliable than CAP water by virtue of the fact that water allocated historically for direct use on the river is higher in priority than the CAP. As a result, there is likely to be opposition by the CAWCD board and the CAP subcontractors to this strategy. According to CAGRD staff, the CAP becomes the likely candidate to purchase and deliver this water on behalf of existing and new subcontractors. The amount of water transferable would be based on the historic consumptive use (water actually used by crops) subtracting return flows that have run off the farms back to the river or infiltrated to the river's subflow. Additionally, the CAP has yet to authorize the use of the CAP for conveying non-CAP water in its facilities, which now appears unlikely as the CAP would have to prioritize use of its canal and may encounter challenges as to equitable distribution of its capacity. It is more likely that the CAP would acquire any such supplies on behalf of all existing and new subcontractors, and potentially would do the same for treated brackish groundwater from the Yuma region as previously discussed. Lastly, the agricultural economy on the Colorado River is experiencing a positive economic growth period, and the likelihood of water being permanently severed from the river and brought through the CAP is low for the foreseeable future.

Several tribes along the Colorado River also have large allocations to Colorado River water, but the ability to move water off their reservations to other water users by sale or lease is subject to legal challenge and unlikely to be resolved in the near future. Many believe that allowing the tribes to move the water off the reservations is somewhat of a water resources "Pandora's Box" as it may be possible for the tribes to move the water anywhere along the river in any tributary state, thus increasing the risks of shortages to the CAP by virtue of the CAP's last priority designation on the river.

6.3. Water Stored Outside the AMA

6.3.1. Storage Potential

There are several opportunities for surplus CAP water to be stored outside the Phoenix AMA for later recovery and importation. Although not an additional supply, these represent the potential to store water that perhaps other more local facilities could not. The issue of CAP wheeling this water also remains a factor. Water can be currently stored and imported from the Harquahala Irrigation Non-Expansion Area immediately to the west of the Phoenix AMA. A constructed facility and a groundwater savings facility are being operated by the Vidler Water Company in this area. Vidler is a company that specializes in buying and marketing water resources for profit.

In addition, the City could enter into an agreement with the Harquahala Valley Irrigation District to operate a groundwater savings facility directly. This would reduce the cost of water by the amount the irrigation district would contribute (by virtue of power savings attributed to not having to pump groundwater) to the purchase of the CAP water for their direct use. The groundwater saved would become CAP water stored on behalf of the City for future withdrawal and use through the CAP (although this has several challenges as already discussed) or by exchange potentially with the CAGRD (this may have more potential).

6.3.2. Groundwater Importation

Groundwater supplies can also be acquired and imported from the Harquahala Irrigation Non-Expansion Area (INA) for use by the City pursuant to specific statutory provisions that allow this to occur. Again, transportation or exchange of this water would have to be negotiated with the CAP/CAGRD in order to realize this supply. Currently, Vidler Water Company and a real estate concern that has purchased a significant amount of acreage in the area have indicated a willingness to sell all or part of their lands as a “water farm” to cities located downstream along the CAP, including the City of Tucson. The cost of this water is unknown, but it is believed that the land was purchased for prices up to $25,000/acre, and the purchase of the land to access the water would have to be at a significant increase in order to meet the rate of return expectations of the sellers.

In addition, two other groundwater basins have similar legal ability to have water exported to the Phoenix AMA: the McMullen Valley and Butler Valley areas. The McMullen Valley has a large amount of irrigated acreage that has been purchased for future importation by the City of Phoenix, and these withdrawals would have to be considered in the implementation of this strategy. It is quite possible that the City of Phoenix could view this as a threat to their investment in the groundwater of the area so they would certainly have to be party to the implementation and negotiations for this supply. Significant, however, is the fact that the City of Phoenix still does not have a wheeling arrangement with the CAP for bringing the water to its service area. It is unclear how this will ultimately be resolved.

Once again, both of these basins could be used to store and recover CAP water in the future using constructed facilities, or even groundwater savings facilities, but would require construction of diversions and discharges back to the CAP canal to implement, along with obtaining the ability to convey water (or more likely to exchange water) through the CAP.

6.4. Water Obtained from Private Water Company Acquisitions

Within the exterior boundaries of the City's current annexed area, and within the City's general planning area, there are several private water companies. Two of these, the AAWC and Brook/Circle City Water Company, have CAP subcontracts. AAWC has a subcontract for 11,093 AFY for use within its entire service area inside and outside of the City's planning area. This allocation is not considered available to the City unless it acquires and/or arranges to provide water service within the AAWC service area. Brooke/Circle City Water Company has an allocation of 3,932 AFY and is located entirely within the City's planning area.

All of the private water companies located within the City of Surprise annexed and general planning areas are non-designated suppliers, meaning that they do not have their own designation of assured water supply. As a result, developers within these service areas and Certificate of Convenience and Necessity areas (a planning area for a private water company awarded by the Arizona Corporation Commission) must apply for their own Certificates of Assured Water Supply. Part of the criteria for obtaining a Certificate is demonstrating that there is enough water physically available to satisfy the demand for the next 100 years. To facilitate development, some water companies have hydrogeologic models constructed to determine the amount of groundwater available and as such are awarded a Physical Availability Determination. When such a determination has not been made, the developer must conduct this analysis independently. This could be a factor in demonstrating future water supplies for private water companies that the City may consider acquiring in the future.

At the time of acquisition, the City will also gain access to the amount of groundwater that has been deemed physically available to developments, or planned developments, that have been issued Certificates of Assured Water Supply. A cursory review of ADWR records of entities that have filed for an Analysis of Assured Water Supply reveals that there may currently be 2,106 AFY of additional groundwater physically available (from primarily within the Beardsley Water Company service area). The City would also assume the water demands associated with these projects. In addition, if land owners have applied for and been granted a physically available groundwater supply by filing applications for an Analysis of Assured Water Supply, that groundwater is tied to the prospective project for up to 10 years, with some limited rights for extension. Those water supplies could be assigned to the City as part of the development, or if the land does not develop in the future, the City could also acquire that physical availability for use on other lands within the City's planning area.

6.5. Reclaimed Water

Currently, reclaimed water produced by the City's South WRF in SPA 1 is delivered to a farm, and the City is currently working to permit the farm as a groundwater savings facility. The City is also in the process of installing reclaimed water meters at the Surprise Point for eventual reclaimed water service. Reclaimed water that is not currently sent to the farms is sent to the City's only currently permitted recharge facility, the South Recharge Facility, also in SPA 1. The City has been recharging reclaimed water at the South Recharge Facility since May 1998. The current USF permit allows the City to recharge up to 8,066 AFY of reclaimed water. The City is planning to add up to 5 vadose zone injection wells at the South Recharge Facility by the end of 2009 and an additional 15 between 2011 and 2015. Each vadose zone injection well is expected to have a recharge capacity of approximately 200 gallons per minute (gpm), which would provide an additional recharge capacity of approximately 7,700 AFY.

Currently SPA 2 has a temporary developer WRF in operation and a new regional WRF under construction. Under the City's current plan, reclaimed water that is not used for direct reuse will be recharged using spreading basins and vadose zone injection wells. A WRF planned for SPA 3 is currently under design and spreading basins are planned to be used to recharge reclaimed water that is not directly reused. SPA 4 and SPA 5 are also planned to have their own WRFs, but design has not started; no WRF has been planned for SPA 6.

The City previously developed plans for direct reuse and recharge of reclaimed water because it recognized this supply as a critical component of its water resource portfolio. Reclaimed water is recognized as a drought proof supply of water that will grow as development continues. Direct use of reclaimed water will benefit the City by removing some non-potable demands from the drinking water system. Recharged reclaimed water will provide water storage credits that can be recovered as potable and/or non-potable supplies.

6.5.1. Reclaimed Water Availability

Using the Demand Module previously described in Section 5, future reclaimed water availability was estimated for 2008 through build-out (Table 6-1). It should be noted that these values represent baseline conditions as determined from estimates of land use densities, open space, and landscape types provided by the City Planning Department. Reclaimed water production within the City's wastewater service area (which includes wastewater supply from portions of the AAWC and El Mirage water service areas) was estimated to grow from about 13,000 AFY currently to 120,400 AFY at build-out.

Reclaimed water will be produced from wastewater that is returned as a result of consumption of "primary" water supplies (current and future physically available groundwater and CAP allocations) and recovered long-term storage credits (storage credits derived from recharge of excess surface water and reclaimed water).

Table 6-1.
Reclaimed Water Availability: City Service Area

SPA	2007 (AFY)	2020 (AFY)	2030 (AFY)	Build-out (AFY)
SPA 1	11,600	17,500	18,600	20,900
SPA 2	200	3,600	7,100	10,800
SPA 3	300	6,800	12,200	23,200
SPA 4	0	3,000	6,300	19,500
SPA 5	800	5,800	11,300	26,500
SPA 6	0	600	1,000	19,500
TOTAL	13,000	37,300	56,600	120,400

6.5.2. Components of Reclaimed Water

Table 6-2 presents an analysis of the projected reclaimed water components. The table indicates that reclaimed water will be generated within the City's wastewater service area, which includes portions of the water service areas of AAWC and El Mirage. The reclaimed water available from the City's water service area would be derived from the City's current and future primary water supplies.

Table 6-2 also presents an estimate of the reclaimed water that could be available from full consumption of the City's primary water supplies. As discussed in the previous subsections and in Section 3, the City's current primary water supplies would be 16,744 AFY of physically available groundwater, 10,249 AFY of CAP allocations, 3,932 AFY of potential additional CAP allocations from the Brooke/Circle City Water Company, and 2,106 AFY of potential additional physically available groundwater from primarily within the Beardsley Water Company service area, for a total of approximately 33,000 AFY. The reclaimed water that could be available from full consumption of these supplies would be approximately 19,300 AFY (65 percent returned to the sewer, of which 90 percent would be recovered as reclaimed water). As the amount of additional physically available groundwater and future long term storage credits are unknown at this time, the estimated reclaimed water available is held constant in Table 6-2 based on the current primary water supplies.

Table 6-2 indicates that there are sufficient primary water supplies to generate the reclaimed water that is projected from now to nearly 2020. The primary water supply that is not consumed would be recharged to generate long-term storage credits. In addition, reclaimed water that is not used for direct delivery will also be recharged to generate long-term storage credits. After 2020, more water than is available from the primary supply would be required to generate all the projected reclaimed water. The additional water would come from the long-term storage credits. Although there are many uncertainties, a crude year-by-year water balance was developed that considered water demand, water supply, recharge, and development of long-term storage credits. The rudimentary analysis indicated that there would be more than enough long-term storage credits available to support the projected reclaimed water production.

Table 6-2.
Components of Reclaimed Water

	2008 (AFY)	2020 (AFY)	2030 (AFY)	Build-out (AFY)
Total Projected Reclaimed Water	13,000	37,300	56,600	120,400
From AAWC Water Service Area	7,500	11,800	13,000	15,200
From El Mirage Water Service Area	800	1,000	1,000	1,000
From Surprise Water Service Area	4,600	24,600	42,700	104,200
Reclaimed Water Available from Current Primary Water Supplies[1]	19,300	19,300	19,300	19,300
Variance[2]	14,700	-5,300	-23,400	-84,900

NOTES:
(1) Based on 65 percent wastewater return and 90 percent reclaimed water production from current physically available groundwater, current City CAP allocation, potential additional private water company CAP allocations, and physically available groundwater.
(2) Negative variance will be made up with additional physically available groundwater and recovery of long term storage credits.

6.6. Long Term Vision for Future Water Supplies

In the very long term, much of Arizona is going to require augmentation of its water supplies. It is a virtual certainty that the ability for Arizona to grow will be tied ultimately to ocean desalination (CAGRD staff concurred with this), construction of the power generation facilities to treat and move desalinated water, potential international treaties if the facilities are to be built in Mexico if they cannot be built in the U.S., and environmental permits to construct facilities for treatment, treatment residuals disposal, and conveyance systems to bring the water to Arizona and to the City. The positive aspect of this future is that it will take the will of the state of Arizona as one entity to accomplish and will not rely exclusively on actions of the City of Surprise. That being said, however, the City will need to be a noticeable and vocal stakeholder in the process to secure the water it may need for its foreseeable future. And, finally, this will in fact truly represent a sustainable water supply for Arizona's long-term future.

THIS PAGE INTENTIONALLY LEFT BLANK

7. Evaluation of Reclaimed Water Management Alternatives

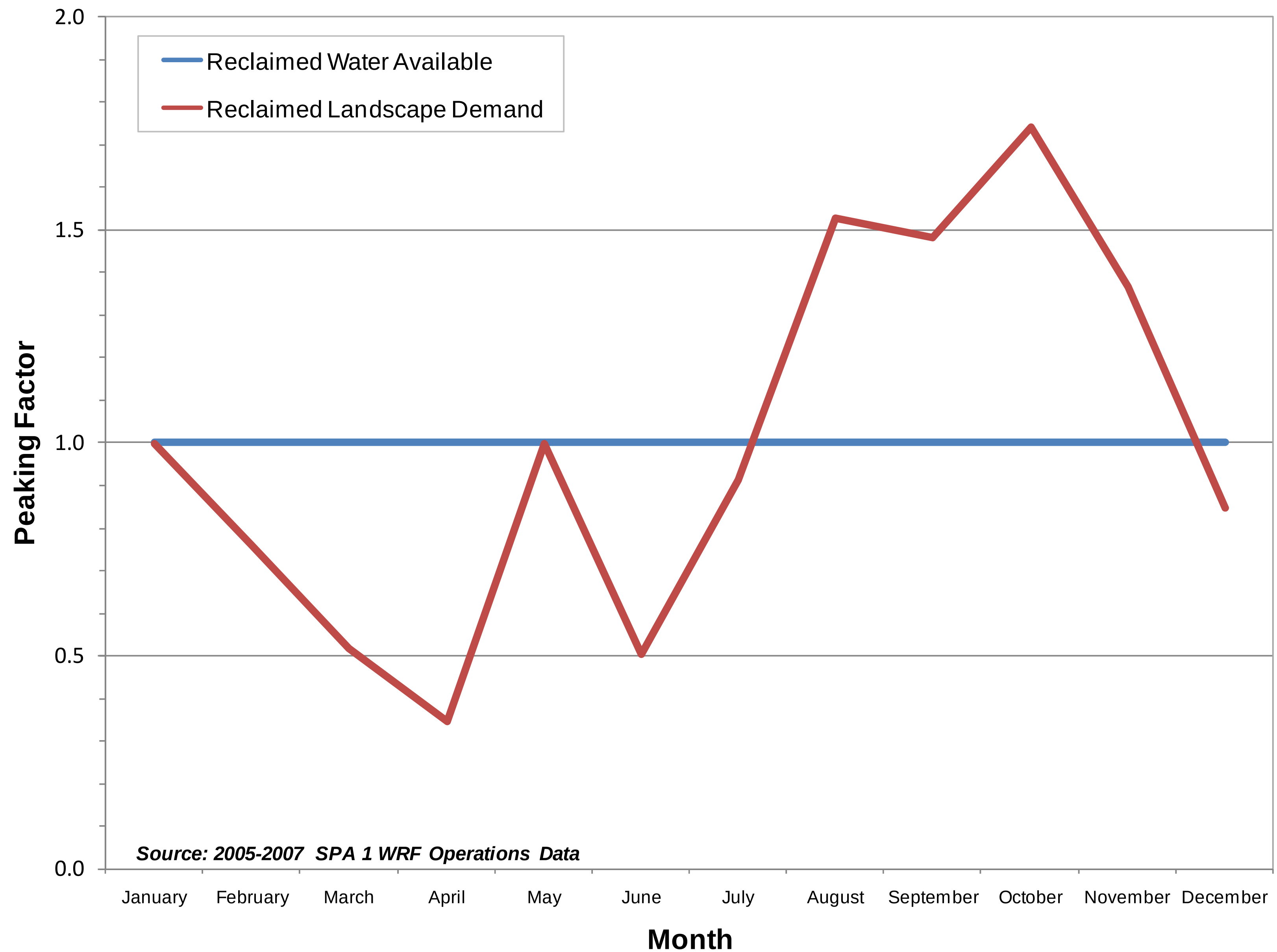
This section provides a review of the City's available water reuse options and an evaluation of reclaimed water management program alternatives, including dual water systems and groundwater recharge and recovery. The City's Technical and Steering Committees provided guidance on future reclaimed water management based on the review and evaluations.

7.1. Reclaimed Water Availability and Demand

The reclaimed water evaluations were conducted early in the *Integrated Water Master Plan* project, at a time when the Demand Module described in Section 5 was in development. The evaluations, documented in technical memoranda for the reclaimed water evaluation tasks, were based on preliminary water resource demand projections that reflected initial guidance and planning assumptions provided by the City. To accommodate the project schedule, the evaluations and technical memoranda were finalized with the preliminary demand projections. The baseline water resource demand projections were updated based on final planning assumptions provided by the City (Section 5.8). The evaluations described in this section have been updated with the final baseline water resource demand projections.

The Demand Module described in Section 5 was used to project build-out reclaimed water availability and potential reclaimed water demands (outdoor and large landscape irrigation demands). The baseline projections described in Section 5.8 were used as the basis for the evaluation of reclaimed water management alternatives.

The reclaimed water evaluations also had to consider the seasonal balance between reclaimed water supply and demand. The South WRF monthly reclaimed water production data from 2005 to 2007 were normalized (by dividing monthly flows by the average yearly flows) to determine seasonal fluctuations in reclaimed water availability (Figure 7-1). The data suggest that reclaimed water production does not fluctuate seasonally to a great extent. A similar analysis was performed on 2005-2007 monthly metered billing data from the City's irrigation meters (which are assumed to represent large landscape irrigation demands), also shown on Figure 7-1. Between January and July, landscape irrigation demand was below average, dropping to 0.35 times the annual average demand. After July, the demand increased to 1.7 times the annual average demand. Due to these differences in availability and demands, a portion of the available



CITY OF SURPRISE, ARIZONA
INTEGRATED WATER MASTER PLAN: WATER RESOURCES

Seasonal Reclaimed Water Availability and Demand

November 2008

Figure 7-1

reclaimed water would need to be recharged during low demand periods and recovered during peak months when reclaimed demands exceed the reclaimed water available.

For the purposes of this evaluation, potential reclaimed water availability was assumed to be constant. The minimum reclaimed water demand was assumed to be 0.35 times the average reclaimed water demand. Maximum day reclaimed water demand was assumed to be 2 times average demand, which is consistent with the water billing data above and the City's June 2006 *Water Guidelines and Standards*.

7.2. Water Reuse Opportunities

The water reuse opportunities presented in this section are the building blocks for the reclaimed water program alternatives developed in Section 7.3 and evaluated in Section 7.4. General water reuse opportunities were presented and discussed at a workshop with the City's Steering Committee and Technical Committee, resulting in the identification of opportunities that are applicable to the City. The applicable water reuse opportunities were divided into the following categories:

- Groundwater Recharge
- Direct Use of Reclaimed Water
- Discharge to Waterways
- Water Exchanges

Within these categories, there are several methods to strategically use reclaimed water. Descriptions of each opportunity, including general infrastructure needs, permitting and institutional requirements, and cost information are presented in this section.

7.2.1. Groundwater Recharge

Groundwater recharge serves two primary functions: it can reduce the effects of groundwater pumping on the groundwater table, and it can store water for future use. Recharge opportunities available to the City include use of local (City-owned) facilities and regional facilities.

7.2.1.1. City-Owned Recharge Facilities

The methods of groundwater recharge for reclaimed water considered in this project include surface recharge basins, vadose zone injection, and deep well injection/aquifer storage and recovery. The recharge concepts are depicted on Figure 7-2.

Surface Recharge

In surface recharge, water is introduced into constructed recharge basins and allowed to infiltrate through the bottoms of the basins. Surface recharge is by far the most common method of recharge, with many examples of large aquifer recharge facilities in the West Salt River Basin that use surface recharge basins.

The feasibility of surface recharge depends greatly on the geologic conditions of the recharge area. Review of available City hydrogeologic studies revealed infiltration rates ranging from 0.2 to 0.5 feet per day in SPA 1, up to 1.2 feet per day in SPA 2, and 4 to 10 feet per day in SPA 3. In general, relatively large areas are required to employ this recharge method, and at least 2 or more basins are required to allow for wet/dry cycling of the basins to optimize recharge and long term basin maintenance.

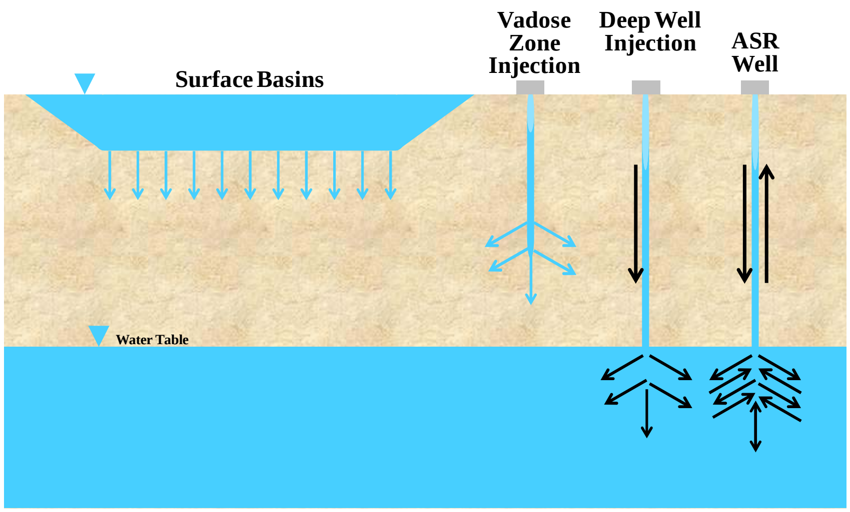


Figure 7-2: Groundwater Recharge Options

The potential advantages of using recharge basins may include:

- High surface filtration area through the floor of basins can reduce plugging potential
- Less frequent maintenance and longer life expectancy as compared to injection wells and other subsurface technologies
- Because water is discharged at the surface, additional trihalomethane (THM), total organic carbon (TOC), or total suspended solids (TSS) treatment is generally not needed
- Relatively low cost, generally ranging from $100,000 to $250,000 per acre in capital and $8 to $10 per acre-foot recharged in operations and maintenance (O&M)

Potential limitations of using constructed recharge basins may include limited available land area, high land costs, proximity to airports (large open bodies of water near airports pose a bird hazard concern), and loss of valuable land space.

At a minimum the following permits would be required to construct and operate recharge basins:

- ADWR USF and Water Storage (WS) Permits

- ADEQ APP – The APP may be added to the WRF's APP if the recharge facility is proximal to the WRF
- MCESD Approval to Construct (ATC) and Approval of Construction (AOC)

For a description of the applicable permits and other permits described in this section, refer to the Water Infrastructure component of the *Integrated Water Master Plan*.

Vadose Zone Injection

In vadose zone injection recharge, water is introduced into large diameter (3 to 4 foot) bore holes with 12 to 20-inch diameter well casings drilled to several hundred feet (but above the local groundwater table) and is allowed to infiltrate into the unsaturated vadose zone. Similar to surface recharge, the feasibility of vadose zone injection depends greatly on the geologic conditions of the recharge area. Geologic conditions dictate the recharge rate, which can typically range from 200 to 500 gpm. The vadose zone injection wells planned for SPA 1 are expected to have injection capacities of approximately 200 gpm. At these capacities, vadose zone injection wells are typically spaced, at minimum, 100 feet apart.

The potential advantages of utilizing vadose zone injection wells include:

- The ability to inject water below potential fine grained confining units in the upper 100 feet of vadose zone that might otherwise limit the effectiveness of surface recharge basins due to perching of recharge water on silts and clay layers
- Small surface footprint (10 feet by 10 feet, or less) for individual vadose zone injection wells
- Relatively low cost and maintenance as compared to deep well and ASR type wells – Capital costs for a typical 200 feet deep vadose zone injection well may range from $100,000 to $150,000

A limiting factor for the feasibility of vadose zone recharge is the lifetime of the injection wells. Typically a vadose zone injection well has a limited lifetime of 5 to 10 years due to microbial activity and TSS decreasing the recharge rate. Pretreatment (filtration and disinfection) in addition to adequate operation and maintenance can extend the lifetime of an injection well. For the SPA 1 vadose zone injection wells, the City is treating the reclaimed water to remove particles larger than 10 microns. When considering the anticipated lifetime of the well and replacement costs, vadose zone wells and deep injection wells have similar requirements for capital expenditures.

If vadose zone injection wells are operated within the hydraulic capture zone of reclaimed water production wells, additional reclaimed water treatment may not be needed if the City can prove it is recovering all the reclaimed water that was recharged on a routine basis. Water recovered in such an operation would have to be used for non-potable purposes. If the City can show that the vadose zone thickness is sufficient for providing supplemental soil/aquifer treatment, additional reclaimed water treatment may also not be necessary. If, however, vadose zone injection wells are used solely for recharge and the water is not recovered on a routine basis, additional reclaimed water treatment would most likely be required to ensure that aquifer water quality regulations are met at the point of compliance, specifically the total trihalomethane (TTHM) MCL of 80 µg/L. It is important to note that if soil/aquifer treatment is used for either surface spreading basins or vadose injection wells, additional monitoring wells may be required by ADEQ to demonstrate the MCLs are met at the point of compliance.

At a minimum, the following permits would be required for operating vadose zone injection wells:

- ADWR USF and WS Permits
- ADEQ APP - may be included with the WRF's APP if the recharge facility is proximal to the WRF
- MCESD Approval to Construct (ATC) and Approval of Construction (AOC)
- EPA Underground Injection Control Permit for Class V wells

Deep Injection and Aquifer Storage and Recovery

Deep injection wells are large (14 to 18-inch diameter) wells that are designed to inject water into deeper aquifer units, generally in the range of 600 to 2,500 feet below ground surface. Deep injection wells are designed similar to production wells. Unlike production wells, which are designed to only withdraw water from the aquifer, deep injection wells are designed to both inject water into the aquifer as well as periodically reverse flow to back flush the well. A discharge location for the back flush water such as a dry well or storage tank (for off-site disposal) will be required for deep injection and ASR wells. ASR wells are dual purpose wells that allow water to be injected and recovered (pumped out) using the same well. The advantage of using ASR wells is the dual purpose design allows for storage and recovery.

An Under Ground Injection Control (UIC) Permit issued by USEPA will be required for a deep injection well, and for an ASR well if it is drilled deep enough, if they are used for the purpose of injecting reclaimed water from a municipal water reclamation facility. The UIC permit rules require that a deep injection well must be designed to inject hazardous and non-hazardous wastes into deep, isolated rock formations below the lowermost underground sources of drinking water (USDW).

Permitting deep injection wells for the sole purpose of recharging reclaimed water may be difficult in Arizona because the state has determined that all groundwater in the state is potential drinking water and that any water injected cannot degrade the water groundwater quality. It is important to note that the ASR wells that have been permitted and that are in operation are for wells that recharge treated water from surface water sources (i.e., CAP water) or reclaimed water that is stored and recovered.

Deep injection wells or ASR wells may require a higher level of treatment prior to injection to help reduce the rate of fouling or clogging of the well screen and filter pack. Because of geological conditions in the area that prohibit surface recharge and vadose zone injection, Fountain Hills Sanitary District (FHSD) has been using ASR wells to store and recover reclaimed water used for its parks and golf courses. After 5 years of operation, biofouling forced FHSD to abandon all the ASR wells until it used a pressurized carbon dioxide solution to restore the wells to their original capacity.

FHSD passes the reclaimed water through 0.5 micron filters prior to chlorination. High TTHM levels in the aquifer forced FHSD to install ultraviolet disinfection, which was later abandoned due to biofouling. At present, FHSD is using chlorination again with periodic flushing to maintain the well. FHSD is currently in the process of evaluating additional treatment technologies, including granular activated carbon and reverse osmosis, to remove additional TOC and TSS and decrease biofouling of the ASR wells.

The City of Scottsdale and City of Chandler also employ ASR wells. The City of Scottsdale is concerned with groundwater decline and stores treated CAP water for potable water use. The City of Chandler uses ASR wells to store and recover Class A^+ reclaimed water for non-potable reuse. Prior to injection, the water is filtered through anthracite filters and chlorinated. TSS is below 1.5 mg/L. Frequent purges with sodium hypochlorite are used to maintain the operational capacity of the wells.

Similar to vadose zone injection wells, if deep injection wells are operated within the impact zone of recovery wells (acting as true storage and recovery operations), additional reclaimed water treatment may not be needed if the City can prove it is recovering all the reclaimed water recharged. If, however, deep injection wells are used solely for recharge and the water is not duly recovered, additional reclaimed water treatment would be required to ensure that aquifer water quality regulations are met.

At a minimum, the following permits would be required for operating deep injection wells or ASR wells:

- ADWR USF and WS Permits
- ADEQ APP - may be added to the WRF's APP if the recharge facility is proximal to the WRF
- MCESD Approval to Construct (ATC) and Approval of Construction (AOC)
- EPA Underground Injection Control Permit for Class I wells for deep wells
- ADWR recovery well permit, for ASR wells

High Level Assessment of City-Owned Recharge Alternatives

In order to assess the viability of the recharge options, a high-level cost evaluation was performed for recharge and recovery of a specific volume of reclaimed water. In order to compare the recharge options on an equal basis, both recharge and recovery were considered. It was assumed that recovery for the surface recharge, vadose zone injection and deep injection would be via potable production wells that would need treatment for arsenic, including residuals disposal. Recovery in an ASR well would not need treatment, but the recovered water could only be used for non-potable purposes.

The review of the recharge technologies reveal that recharge facility design, operation, and the need for additional reclaimed water treatment depend highly on local hydrogeology, groundwater quality, and reclaimed water quality conditions, and are normally not determined until site-specific studies are completed. To bracket the possible range of costs, two high level evaluations were completed. The initial evaluation considered no additional reclaimed water treatment, and the second evaluation considered additional treatment to meet aquifer water quality standards necessary for sub-surface injection (vadose zone, deep injection, and ASR). Details of the high level cost evaluations are provided in Appendix B.

The following assumptions were used when conducting the initial evaluation that considered no additional reclaimed water treatment:

- Surface spreading basins, deep injection wells, and ASR wells were all assumed to have a life expectancy greater than 20 years. Vadose zone injection wells were assumed to have a life expectancy of 7 years, thus the vadose zone wells would have to be replaced twice over the 20-year evaluation period.
- No additional treatment would be required to recharge the water (i.e. no TOC/TSS removal).
- The surface spreading basin infiltration rate was 1.0 ft/day. Vadose zone injection well capacity was 200 gpm. Deep injection and ASR well recharge capacities were 800 gpm. ASR recovery capacity, as well as potable production capacity, was 1,400 gpm.

In the second evaluation, considering advanced treatment, the following additional assumptions were made:

- Surface spreading basins would not require any additional treatment.
- Vadose zone injection wells would directly impact the aquifer, and additional treatment would be required to remove TTHM precursor material (TOC).
- Deep injection and ASR wells would require additional treatment to remove TTHM precursor material and other particulates that cause biofouling.

- The treatment technology used in the evaluation was reverse osmosis with brine treatment and disposal. Granular activated carbon is also an accepted technology, but its cost depends greatly on the extent of TOC and TTHM precursor removal needed, which is unknown at this time. Evaporation ponds were assumed for brine disposal.

The high level cost comparison of the recharge technologies indicate that if both recharge of reclaimed water and recovery of water to meet reclaimed water demands are considered, and if additional reclaimed water treatment is not needed, the four recharge technologies are comparable on a 20-year present worth basis. In this case, other non-cost decision criteria such as depth to groundwater, infiltration rates, relative proximity to other recharge facilities, availability of land, etc. should be considered when choosing an appropriate technology for an area. If additional reclaimed water treatment is necessary, however, surface spreading basins are the most economical.

Because the need for additional reclaimed water treatment and hydrogeologic conditions are not known at this time, surface recharge technologies will be used for the purposes of the evaluation of reclaimed water management program alternatives unless another technology is specified in the alternative.

7.2.1.2. Regional Recharge Facilities

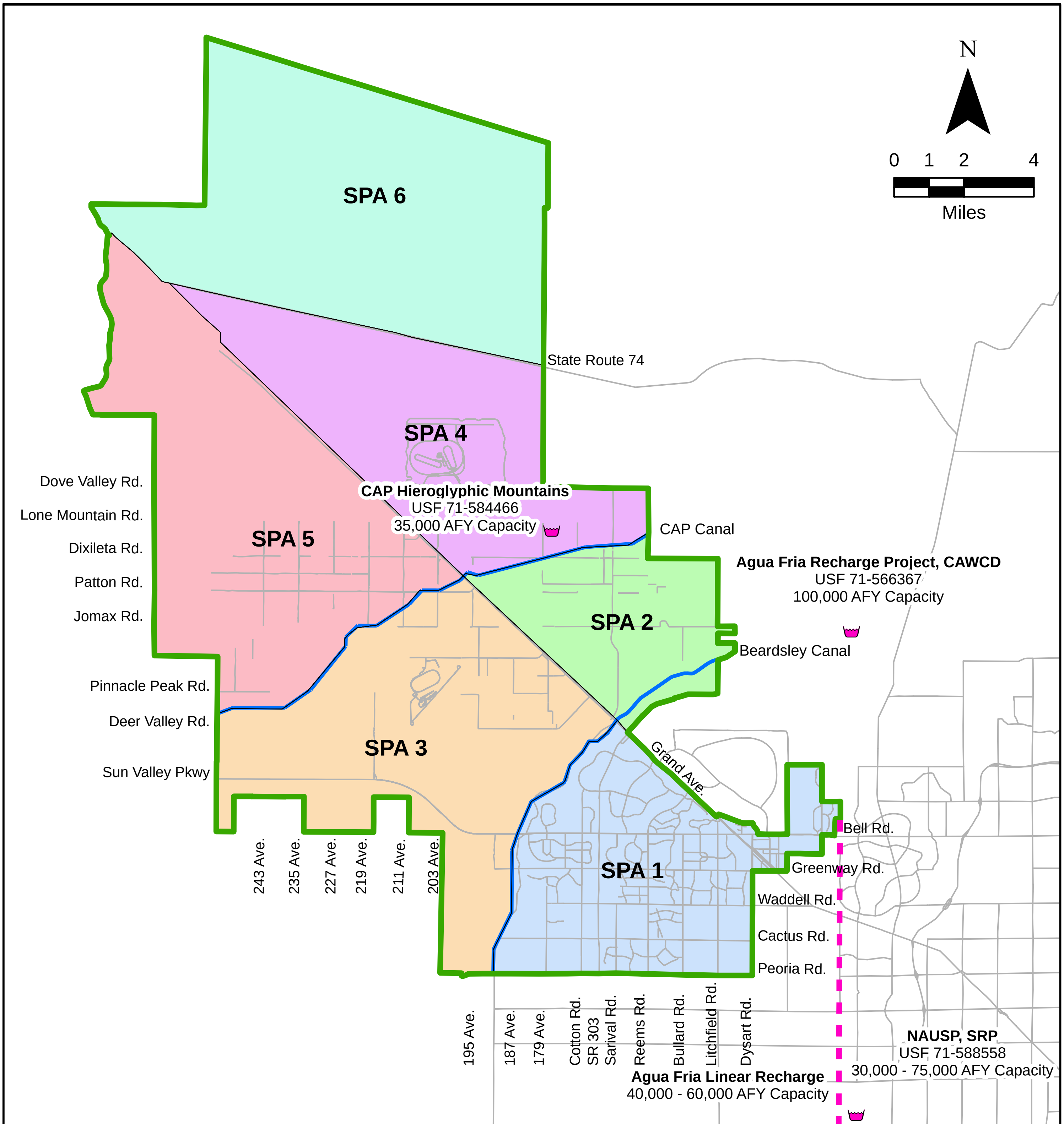
Regional recharge facilities are large projects in which several entities (e.g., municipalities, governmental agencies, and private water companies) participate by sharing the cost of constructing and operating the facility or by paying the implementing agency a recharge fee to use the facility. The following regional recharge projects were considered available to the City for potentially recharging reclaimed water (Figure 7-3):

- Hieroglyphic Mountains and Agua Fria Recharge Projects
- New River-Agua Fria Underground Storage Project
- Agua Fria Linear Recharge Project

Hieroglyphic Mountains and Agua Fria Recharge Projects

The Hieroglyphic Mountains and Agua Fria regional recharge facilities are owned and operated by the CAWCD. The Arizona Water Banking Authority, CAGRD, City of Goodyear, City of Peoria, and other entities currently use the facilities to recharge CAP surface water allocations as well as excess CAP supplies. Currently, only the City of Peoria has purchased capacity ownership in one of these facilities (15 percent of the Agua Fria facility) for its designation of assured water supply purposes.

The Hieroglyphic Mountains and Agua Fria facilities have annual permitted recharge capacities of 35,000 AFY and 100,000 AFY, respectively. In general, the recharge facilities are operated on a “first-come, first-served” basis. Entities that have permits to use the facilities have surface water allocations or have purchased excess supplies and



Legend

- Municipal Planning Area
- Special Planning Areas
- Canals
- Streets
- Linear Recharge Project
- Permitted Recharge Facilities

SURPRISE ARIZONA

MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Regional Recharge Options

November 2008 | **Figure 7-3**

M:\4957002\GIS\Project_MXDs\Final Report\Figure 7-3 Regional Recharge Options.mxd have a Water Use Agreement with CAWCD. The entities can order recharge capacity in the facilities by October for recharge in the following year. There are no capital costs associated with recharging CAP water at the regional recharge facilities for municipalities, only an O&M or recharge fee, which is currently $8 per acre-foot.

The CAWCD facilities are currently not permitted to take reclaimed water; however, there has reportedly been recent interest to permit some facilities for reclaimed water. The interest is related to the CAGRD's charge to acquire long-term water supplies or credits for their state-wide replenishment obligations. One long-term, renewable water supply that is being considered is reclaimed water from communities that cannot, or will not, utilize this water. The CAWCD and CAGRD have indicated that they are open to participating in cost-sharing agreements to construct the necessary conveyance facilities to deliver the reclaimed water to a regional CAWCD facility, and that they would obtain the necessary reclaimed water recharge permits. In exchange, the CAGRD would receive a portion of the resulting long term storage credits. The exchange ratio, as well as the cost-sharing arrangements, would be subject to negotiations on a case-by-base with CAWCD and CAGRD. There are no examples of this arrangement as yet, but CAGRD has indicated that the exchange ratio would likely be less than one-for-one, and it could be as low as 50 percent. As such, the costs for this alternative are based on the current costs for recharging CAP water, and it was assumed that up to 50 percent of the credits for recharging the reclaimed water could be subject to exchange with the CAGRD.

Pipelines and booster pumps would be required to get the reclaimed water from the City's WRFs to the regional recharge facilities. The City would have to obtain an ADWR Water Storage Permit to recharge and store reclaimed water at the CAWCD facilities (as well as any permits associated with the pipeline routes and constructing the pipeline). In addition, the City would have to negotiate cost sharing and water exchange agreements with CAWCD and CAGRD.

Because the facility is located within the City's MPA, thus minimizing the infrastructure needed to deliver water and also increasing the amount of water stored beneath the City's MPA, use of the Hieroglyphic Mountains facility was retained for the reclaimed water management alternatives evaluation described in Section 7.3.

New River-Agua Fria River Underground Storage Project (NAUSP)

The NAUSP, constructed by the Salt River Project (SRP), began operations in October 2006 at a permitted capacity of 30,000 AFY. The facility is located in Glendale near the intersection of 107th Avenue and Bethany Home Road, adjacent to Skunk Creek. The facility currently includes five off-channel recharge basins. SRP anticipated that the facility will be re-rated to a permitted capacity of 50,000 AFY in October 2008. SRP is also currently in the process of permitting a sixth basin which will be in the Skunk Creek channel. The ultimate permitted capacity of all six recharge basins is anticipated to be

75,000 AFY, although there is some uncertainty because of actual recharge rates achieved and impacts to other recharge facilities in the region.

The NAUSP is currently fully owned by five participants: Chandler, Avondale, Glendale, Peoria, and the SRP. SRP indicates that there are no planned expansions of the facility and that there is no capacity ownership available to others at this time. There could be some flexibility in the future, but it is too early to know for sure.

SRP holds the APP, AZPDES, and USF permits necessary for this facility to receive reclaimed water. The City would have to obtain an ADWR Water Storage Permit to recharge and store reclaimed water at this facility.

Because the capacity of the facility is fully taken by others and the uncertainty in future permitted capacity and future expansions, the NAUSP regional recharge facility was dropped from further consideration.

Agua Fria Linear Recharge Project

The Agua Fria Linear Recharge Project is a proposed regional project sponsored by the Multi-Cities Sub-Regional Operating Group (SROG): Phoenix, Mesa, Tempe, Scottsdale, and Glendale. SROG is proposing to recharge reclaimed water and create recreational and wetland habitat areas in the Agua Fria River. In "linear recharge," rather than recharging all the water at one location, several discharge points along the riverbed are used. The project would have discharge locations along a ten-mile portion of the Agua Fria River stretching from Bell Road to Indian School Road. The primary objective of the project is to recharge treated wastewater from the 91st Avenue Wastewater Treatment Plant; however, the Phoenix and SROG have been looking for additional participants.

The SROG cities started the project in 2001 and completed Phase 1: Stakeholders Coordination and Public in 2003. Phase 2: Initial Technical Investigations / Economic Analyses / Feasibility Report Update is currently in process, and the final feasibility report is anticipated by the end of this year. Phase 2 also included preparation and submittal of a draft Environmental Impact Statement which stipulates a capacity of up to 100,000 AFY. The SROG project team indicated that the future of the project is currently unknown and that no additional funds have been set aside for the project for the next ten years. The project team also could not project a schedule for the remaining two phases of the project: Preliminary Designs and Final Design and Implementation.

Pipelines and booster pumps would be required to get the reclaimed water from the City's WRFs to the regional recharge facility. The City would have to obtain an ADWR Water Storage Permit to recharge and store reclaimed water at the facility (as well as any permits associated with the pipeline routes and constructing the pipeline). In addition, the City would have to negotiate cost sharing (if any) and facility use agreements with SROG.

Because the facility is located close to the City's planning area, the Agua Fria Linear Recharge Project was retained for the evaluations described in Section 7.3.

7.2.2. Direct Use of Reclaimed Water

Direct use of reclaimed water occurs when reclaimed water is used in place of potable water for irrigation and other non-potable applications. Replacing current water sources with reclaimed water can result in an increase in available potable water. Direct reuse opportunities within the City's planning area include landscape irrigation (e.g. HOA common spaces, parks, golf courses, and highway landscaping), residential irrigation, ornamental lakes, industrial and commercial applications (e.g. large evaporative cooling units, and/or landscape irrigation), and agricultural irrigation. The actual use of reclaimed water at these sites will depend on several factors, including cost-effectiveness of conveying water to the user, total demand, water quality needs, and the user's perception of using reclaimed water.

In general, direct use of reclaimed water is broken down into two categories: open-access and restricted-access. As defined by ADEQ, open-access means that "access to reclaimed water by the general public is uncontrolled." Open-access applications typically have a high potential for incidental human contact, especially with children (e.g., turf irrigation at schools, parks, and front yards or use in surface water recreational features). According to ADEQ, restricted-access means that "access to reclaimed water by the general public is controlled." Restricted-access applications typically have a lower potential for incidental human contact, especially children (e.g., turf irrigation at golf courses, landscape irrigation along freeways and rights-of-way, and industrial/ commercial uses).

Instead of open-access and restricted-access demands, reclaimed water demands for this project were divided into large landscape irrigation demands and residential and commercial outdoor demands. The Demand Module provided the mechanism for projecting potential reclaimed water demands, based on the methodology described in Section 5. Large landscape demands (HOA common areas, parks, water features, schools, etc.) accounted for approximately 30 percent of the total water demand in 2008, but that percentage is expected to decrease as the City implements the *Scenic Integrity Guidelines*. Outdoor demands include residential and commercial outdoor water use, which was approximately 35 percent of the total residential and commercial demand. For the direct reuse alternatives described below, "serving the largest customers" will constitute serving the large landscape irrigation demands, and "maximizing reuse" will constitute serving all landscape and outdoor demands.

The infrastructure for direct reuse opportunities will depend on the reclaimed water demand within an area. If reclaimed water is only served to the largest customers, a skeleton system with a few connections would be sufficient. If, however, reclaimed water is served to all potential users including residential outdoor use, a larger network of pipes with multiple connections would be needed to sufficiently deliver water to the users. In both cases, the reclaimed water distribution system must also be able to manage imbalances in supply and demand caused by seasonal changes.

In workshops held with the City Technical and Steering Committees, four general direct use alternatives were identified for further evaluation:

- **Serve largest reuse customers by SPA -** The largest reuse customers in each SPA will be served with reclaimed water produced in each SPA. Any reclaimed water not used within a SPA will be recharged. Reclaimed demands exceeding reclaimed water available will be met with untreated groundwater or CAP water.
- **Maximize direct reuse by SPA -** All potential reclaimed water customers will be served with reclaimed water produced in each SPA. Any reclaimed water not used within a SPA will be recharged. Reclaimed demands exceeding reclaimed water available will be met with untreated groundwater or CAP water.
- **Serve largest reuse customers via a fully-connected dual distribution system -** The largest reuse customers will be served and water will be allowed to be moved among SPAs. Reclaimed demands exceeding reclaimed water available will be met with untreated groundwater or CAP water.
- **Maximize direct reuse via a fully-connected dual distribution system -** All potential reuse customers will be served and water will be allowed to be moved among SPAs. Reclaimed demands exceeding reclaimed water available will be met with untreated groundwater or CAP water.

All WRFs will produce Class A+ water, allowing direct use of reclaimed water for all of the direct reuse applications. Currently, the City does not act as a reclaimed water agent and all customers currently receiving reclaimed water from the City must have their own water reuse permit. The City may become a reclaimed water agent as the reclaimed water program develops. As a reclaimed water agent, the City must have contractual agreements with each end user specifying requirements for signage, impoundment liner, and nitrogen management (if not Class A+ water). The reuse permit will be necessary for all direct use of reclaimed water.

7.2.3. Discharge to Waterways

The City Technical and Steering Committees provided guidance that discharge to waterways would not be considered as a routine method of managing reclaimed water. The primary reason for this is that the maximum amount of long term storage credits that this opportunity could derive is 50 percent of the water discharged. Instead, a qualitative review of this opportunity is presented because it would be used by the City to provide flexibility; i.e., it would provide for emergency releases to back up other methods of reclaimed water use.

Waterways identified for discharge include the Agua Fria River, McMicken Dam (originally called Trilby Wash Detention Basin Dam), and the Hassayampa River (Figure 7-4). McMicken Dam is a 10-mile long, 34 feet high, earthen embankment located between Peoria Road and Happy Valley Road. It was constructed in 1954 and 1955 for flood control purposes. Storm water from the north is collected in an impoundment basin and transported northeasterly through the McMicken Dam Outlet Channel and then southerly through the McMicken Dam Outlet Wash (4 miles) to the Agua Fria River. There is also an emergency spillway associated with the dam. Extremely large storms can result in releases and downstream flooding.

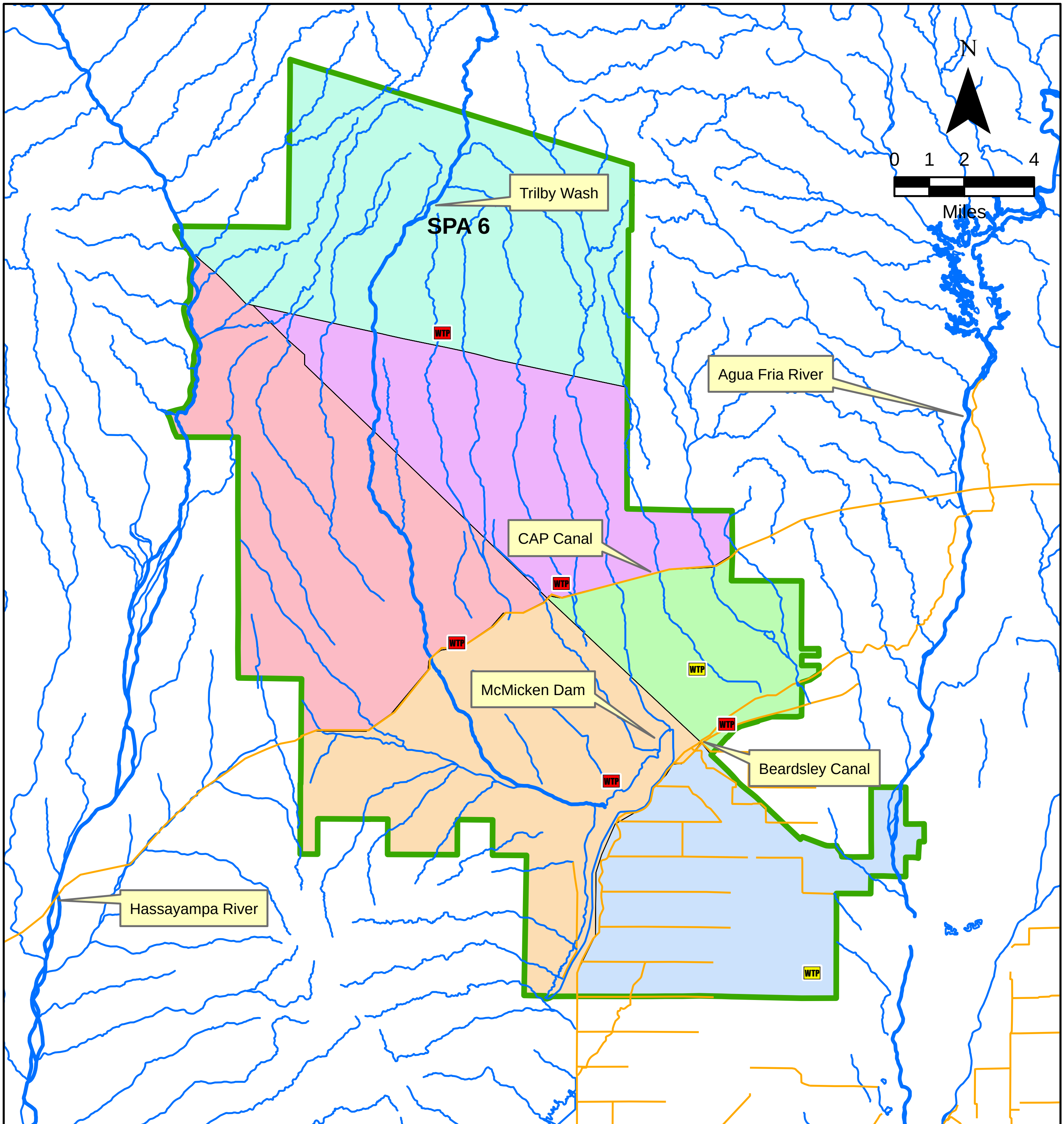
Infrastructure required to implement discharge to waterways would include valves to direct flow to the discharge pipeline, a pipeline to the selected waterway, and outlet structure that would dissipate the flow energy in order to eliminate erosion and/or scouring. Discharge of reclaimed water to waterways is regulated under the National Pollutant Discharge Elimination System. If excavation within these waterways is a component of the project, then Section 404 of the Clean Water Act also applies. Arizona has received approval from the USEPA to operate the NPDES Permit program on the state level (AZPDES).

7.2.4. Water Exchange Options

Water exchanges refer to the possibility of trading reclaimed water for potable water or for rights to potable water. Exchanges with the CAGRD, local irrigation districts, or neighboring communities may be possible.

Potential Exchanges with CAGRD

There are two possible exchange opportunities with the CAGRD. First, the City could recharge reclaimed water wherever it can in its planning area (subject to the infrastructure and regulatory requirements discussed for City recharge facilities) and give the storage credits to the CAGRD. In return, the City could receive raw surface water for treatment at a surface water treatment plant. Second, the City could enter into a cost-sharing and exchange agreement as previously discussed in Section 7.2.1.2. In either option, the CAGRD would likely need an exchange ratio greater than one-for-one before agreeing to the exchange. The first option would be attractive to the City if it had, or was planning to build, a surface water treatment plant. The second option would be attractive if the City just needed recharge capacity to manage reclaimed water.



Legend

Municipal Planning Area

Special Planning Areas

Water Reclamation Facilities

Existing

Planned/Proposed

Waterways

Rivers/Streams/Washes

Canals/Ditches

SURPRISE ARIZONA

MALCOLM PIRNIE

INTEGRATED WATER MASTER PLAN:
WATER RESOURCES

Discharge to Waterways Options

November 2008

Figure 7-4

M:\4957002\GIS\Project_MXDs\Final Report\Figure 7-4 Discharge to Waterways Options.mxd

Potential Exchanges with Irrigation Districts

In this reuse opportunity, the City would deliver reclaimed water to a local irrigation district and/or farmer to replace pumped groundwater. In exchange, the City would receive long term storage credits through a groundwater savings facility. The ADWR rules for its Underground Water Storage, Savings and Replenishment Program allows for exchanges whereby a facility can use surface water or other renewable water supply “on a gallon-for-gallon substitute basis” in-lieu of the groundwater that it otherwise would have pumped. This program has typically been used to replace groundwater used for irrigated agriculture with CAP surface water, but it could also apply to reclaimed water.

In order to obtain a groundwater savings facility permit, the applicant must demonstrate 1) that the groundwater to be replaced would have otherwise been pumped, 2) that no other source of in-lieu water is reasonably available, and 3) that the recipient of the in-lieu water could not reasonably be expected to use the in-lieu water without the added benefits of establishing the exchange. The applicant obtains long term storage credits for the in-lieu water provided. The amount of storage credits that will be assigned to the applicant, or storer, may vary, but the amount is generally 95 percent of the water exchanged minus evaporation losses. The storage credits can generally be recovered anywhere within the AMA that the exchange was achieved. Because groundwater pumping is being replaced, this type of exchange achieves the same benefits to the aquifer as a recharge operation would.

The City is currently providing reclaimed water from its South WRF to a farmer outside of the City’s planning area. A groundwater savings facility permit is not currently in place, but the City is working to obtain this permit soon. The City is not aware of any local irrigation districts that could participate in such an exchange on a large scale at this time. Further, the Maricopa Water District currently supplies surface water from the Lake Pleasant Reservoir to local farmers.

Because no local irrigation districts have been identified that could participate in a water exchange with the City, this option was dropped from further consideration for the water reuse evaluations.

Potential Exchanges with Neighboring Communities

Similar to exchanges with irrigation districts, the City could deliver reclaimed water to a neighboring community to replace groundwater pumped for a non-potable use. In exchange, the City would receive credits through a groundwater savings facility, or potentially receive raw surface water at a water treatment plant. Because the reclaimed water would most likely not be used for agricultural irrigation, this type of exchange would likely require a greater than one-for-one exchange. The City of El Mirage may be interested in receiving reclaimed water, but it has not expressed interest in the water exchange component. The City is not aware of other neighboring communities that are currently pumping groundwater for non-potable uses or are looking for large volumes of reclaimed water.

Because no neighboring community has been identified that could participate in a water exchange with the City, this option was dropped from further consideration for the water reuse evaluations.

7.3. Development of Reclaimed Water Program Alternatives

This section briefly describes alternatives identified for recharging and/or reusing reclaimed water produced by existing and future WRFs. Details for the alternatives, including design considerations, concept schematics, and anticipated infrastructure requirements (including pumps, wells, land requirements, and preliminary piping arrangements) for each alternative are provided in Appendix C.

7.3.1. Reclaimed Water Program Alternatives

Reclaimed water management alternatives developed with the assistance of the City's Steering Committee and Technical Committees generally considered both reclaimed water recharge (local and regional) and direct re-use (serving largest customers and serving all customers), multiple WRF scenarios (6 WRFs with one in each SPA, 4 WRFs, and 3 WRFs), and interconnected systems (by SPA or City-wide). The following specific alternatives were identified for evaluation:

Recharge at City-Owned Facilities

In these alternatives, all reclaimed water generated at build-out will be recharged. The differences between the sub-alternatives include the technology used for recharge (i.e., spreading basins vs. injection technologies) and the location of the recharge facilities.

- 1A: Spreading Basin Recharge by SPA - Under this alternative, the City will continue to plan and construct WRFs in each SPA. All reclaimed water produced at the WRFs will be recharged within the respective SPA boundaries using spreading basins.
- 1B: "Injection" Recharge by SPA – In this alternative, reclaimed water is also recharged in the SPA where it is generated; however, injection technologies are used for recharge rather than spreading basins.
- 1C: Spreading Basin Recharge by Combining SPAs – This alternative is similar to 1A in that all reclaimed water is recharged using spreading basins; however, due to the proximity of some WRFs and the feasibility of recharging water in SPA 6, reclaimed water from some WRFs were combined.
- 1D: "Injection" Recharge by Combining SPAs – This alternative uses the same recharge locations as Alternative 1C; however, injection technologies are used instead of spreading basins.

Recharge at Regional Recharge Facilities

Based on discussions with their owners, both the Hieroglyphic Mountains Recharge Facility and SROG's Agua Fria Linear Recharge Projects can potentially accommodate reclaimed water and have available capacity. Because of the uncertainty of the Agua Fria Linear Recharge Project, two regional recharge alternatives were considered.

- 2A: Recharge at Hieroglyphic Mountains and Agua Fria Linear Recharge Facilities - Under Alternative 2A, all available reclaimed water from SPA 1, 2, and 3 WRFs will be recharged at the Agua Fria Linear Recharge Facility; and all available reclaimed water from SPA 4, 5, and 6 WRFs will be recharged at the Hieroglyphic Mountains Recharge Facility.
- 2B: Recharge at Hieroglyphic Mountains Recharge Facility - Under this alternative, reclaimed water from all WRFs will be sent to the Hieroglyphic Mountains Recharge Facility.

Direct Reuse via Dual Distribution System

Eight alternatives were considered for direct reuse via a dual distribution system. To balance reclaimed water supply and demand imbalances, recharge (using spreading basins) was included in these alternatives. Also, because reclaimed water demand will exceed supply during some periods of the year when maximizing reuses, it was assumed that the peak demands would be met by supplementing the reclaimed water with non-potable groundwater (i.e., from wells that are not treated for arsenic, nitrate, etc., but are plumbed directly to the reclaimed water distribution system).

- 3: Serve Largest Reuse Customers by SPA - Alternative 3 assumed that reclaimed water generated in each SPA would remain within each respective SPA and be delivered to large irrigation users (parks, schools, HOA common areas, etc.) only. Residential and commercial outdoor demands will be met using the drinking water distribution system.
- 4: Maximize Direct Reuse by SPA - Under Alternative 4, reclaimed water generated in each SPA would remain within each respective SPA and be delivered to *all* potential reclaimed water users. In addition to the large reclaimed water users included in Alternative 3, maximum direct reuse will include residential, commercial, and industrial outdoor water demands.
- 5A, 5B, and 5C: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System - Under these alternatives, reclaimed water generated in each SPA would enter into a single reclaimed water system that extends over the entire City planning area and deliver reclaimed water to large irrigation users.
    - 5A – Six WRFs: one in each SPA.
    - 5B – Four WRFs: one each in SPAs 1, 2, and 3, and one in SPA 5 that receives wastewater from SPAs 4, 5, and 6.

- 5C – Three WRFs: one in SPA 1, one in SPA 3 that receives wastewater from SPAs 3 and 5, and one in SPA 2 that receives wastewater from SPAs 2, 4, and 6.

- 6A, 6B, and 6C: Maximize Direct Reuse via Fully-Connected Dual Distribution System – These alternatives are similar to 5A, 5B, and 5C except that reclaimed water would be distributed to all potential reclaimed water users, including all outdoor and landscape demands.
  - 6A – Six WRFs: one in each SPA.
  - 6B – Four WRFs: one each in SPAs 1, 2, and 3, and one in SPA 5 that receives wastewater from SPAs 4, 5, and 6.
  - 6C – Three WRFs: one in SPA 1, one in SPA 3 that receives wastewater from SPAs 3 and 5, and one in SPA 2 that receives wastewater from SPAs 2, 4, and 6.

7.3.2. Basis for Evaluation of Alternatives

The reuse program alternatives considered the anticipated infrastructure required to accommodate all potential reclaimed water supplies and demands at build-out. Distribution system pipe and pump sizing were determined using Bentley's WaterGEMS V8 XM in combination with design criteria derived from the *City of Surprise Water Guidelines and Standards* (Revised June 2006) and other sources (Table 7-1). The evaluations did not consider WRF construction or improvements, WSF construction or improvements, pipelines with diameters smaller than 12 inches, or reclaimed water meters. As such, the evaluations did not consider the onsite, or subdivision level infrastructure, but only the regional transmission and distribution infrastructure. For all the alternatives involving recharge, it was assumed that the City will continue to install the 24 vadose zone injection wells as planned in SPA 1.

Table 7-1.
Design Criteria

Infrastructure	Design Criteria	Source
Recharge Infrastructure		
Pipelines	• Based on annual average demand • Velocity < 5.5 fps	Engineering judgment
Pumps	• Based on annual average demand • 85% motor efficiency • 75% pump efficiency	Engineering judgment
Spreading Basins	• Based on annual average demand • Infiltration rate = 1 ft/day • One basin out of service • 10% contingency for earthen mounds and walkways	Engineering judgment based on City hydrogeologic studies
Vadose Zone Injection Wells	• Based on annual average demand • Recharge capacity = 200 gpm • 7 year life expectancy • No spares	Engineering judgment, existing/planned City infrastructure, and other city experiences using similar technologies (City of Chandler, City of Scottsdale, and Fountain Hills)

Table 7-1 (cont.)
Design Criteria

Infrastructure	Design Criteria	Source
Recharge Infrastructure (cont.)		
Deep Injection Wells	• Based on annual average demand • Recharge capacity = 800 gpm (60 percent production well capacity) • No spares	Other city experiences using similar technologies (City of Chandler, City of Scottsdale, and Fountain Hills)
ASR Wells	• Based on annual average demand • Recharge capacity = 800 gpm (60 percent production well capacity) • Production capacity = 1,400 gpm • No spares	*City of Surprise Water Guidelines and Standards* (June 2006), other city experiences using similar technologies (City of Chandler, City of Scottsdale, and Fountain Hills), and the City's average historical production well capacity
Reclaimed Water Infrastructure		
Production Wells	• Based on difference between annual average reclaimed water available and maximum day demand (2 times annual average) • Capacity = 1,400 gpm • No spares	*City of Surprise Water Guidelines and Standards* (June 2006), historical WRF data (2005-2007), and the City's historical average day production well capacity
Pipelines	• Based on peak hour demand (3 times annual average) • Velocity < 5.5 fps	*City of Surprise Water Guidelines and Standards* (June 2006) and engineering judgment
Pumps	• Based on peak hour demand (3 times annual average) • 85% motor efficiency • 75% pump efficiency	*City of Surprise Water Guidelines and Standards* (June 2006) and engineering judgment
Reservoirs	• Based on annual average demand	*City of Surprise Water Guidelines and Standards* (June 2006)
Recharge	• Based on difference between annual average reclaimed water available and minimum day demand (0.35 times annual average)	Calculated value
Potable Water Infrastructure (Outdoor Demands Only)		
Production Wells	• Based on difference between annual average reclaimed water available and maximum day demand (2 times annual average) • Capacity = 1,400 gpm • Firm Capacity = 1,120 gpm • One well out of service per system	*City of Surprise Water Guidelines and Standards* (June 2006) and the City's historical average day production well capacity
Arsenic Treatment	• Split-stream treatment for 70 percent of water requiring treatment (i.e., reclaimed water demand served with potable water)	Roseview WSF design criteria
Reservoirs	• 1.2 times annual average demand	*City of Surprise Water Guidelines and Standards* (June 2006)

In order to compare the alternatives on an equal basis, the evaluations included both the cost to recharge reclaimed water and the cost to extract the water to meet reclaimed water demands. The alternatives that involve recharge of all reclaimed water and no dual distribution system would achieve recovery through the potable water distribution system, meaning that all water used to satisfy reclaimed water demands (outdoor and landscape demands) must be treated to potable water standards. As a baseline, the evaluations assumed that split-stream treatment where 70 percent of groundwater recovered in the potable system would be treated to achieve the City's goals of less than 7 micrograms per liter (µg/L) of arsenic and less than 2 mg/L of fluoride. Water production to meet indoor potable water demand was not included in the evaluations because it is the same in all alternatives and is not a differentiating factor.

The evaluations also considered water loss through evaporation for the full recharge via surface spreading basin alternatives (all except for 1B and 1D). Based on local annual evaporation rates and typical recharge basin designs, the water lost through evaporation was estimated at 3 percent of water recharged. The water loss was added as an additional annual cost to these alternatives based on the amount of additional CAGRD water that would have to be purchased, currently at $281 per acre-foot.

Table 7-2 summarizes the general water resources infrastructure requirements (recharge, production wells, water treatment, and water lost through evaporation) capacities that were provided under each alternative. Table 7-2 was developed based on the annual balance between reclaimed water demands and reclaimed water availability.

Facility locations and alignments were conceptually determined by considering previous master planning efforts, floodplains and other geographical boundaries, depth to groundwater, future transportation plans, and areas of known subsidence. As previously described in Section 5, it was assumed that the City would serve reclaimed water to all private water company service areas within the City, except AAWC and the City of El Mirage.

Concept schematics and infrastructure summaries were also developed for each alternative. Although booster stations, wells, and reservoirs were conceptually placed in the water system models for the purposes of sizing pipelines and booster stations, they have been omitted from the schematics, but they were included in the cost comparisons. Additional details on development of alternatives, schematics, and infrastructure requirements are provided in Appendix C.

Table 7-2.
General Water Resource Infrastructure Requirements

Alternative	Recharge Capacity (mgd)[1]	No. Reclaimed Production Wells[2]	No. Potable Production Wells[3]	Reclaimed Storage (MG)[4]	Potable Storage (MG)[5]	Treatment Capacity (mgd)[6]	Annual Water Recharged (MG)[7]	Annual Water Recovered (MG)[8]	Annual Recovered Water Treated (MG)[9]	Annual Water Evaporated (MG)[10]
1A	100.5	0	96	0	169	98.4	36,691	25,647	17,953	1,101
1B	100.5	0	96	0	169	98.4	36,691	25,647	17,953	0
1C	100.5	0	93	0	169	98.4	36,691	25,647	17,953	1,101
1D	100.5	0	93	0	169	98.4	36,691	25,647	17,953	0
2A	100.5	0	90	0	169	98.4	36,691	25,647	17,953	1,101
2B	100.5	0	90	0	169	98.4	36,691	25,647	17,953	1,101
3	95.2	0	64	31	132	77.0	33,611	20,073	14,051	1,008
4	75.9	23	0	141	0	0.0	14,056	1,010	0	422
5A	95.2	0	56	31	132	77.0	33,611	20,073	14,051	1,008
5B	95.2	0	56	31	132	77.0	33,611	20,073	14,051	1,008
5C	95.2	0	56	31	132	77.0	33,611	20,073	14,051	1,008
6A	75.9	17	0	141	0	0.0	14,056	1,010	0	422
6B	75.9	17	0	141	0	0.0	14,056	1,010	0	422
6C	75.9	17	0	141	0	0.0	14,056	1,010	0	422

NOTES:

(1) Recharge Capacity = annual average reclaimed water available - 0.35(annual average water demand served via the reclaimed distribution system)

(2) No. Reclaimed Production Wells = 2(annual average water demand served via the reclaimed distribution system) / (1,400 gpm/well) [no arsenic/fluoride treatment]

(3) No. Potable Production Wells = outdoor and irrigation demands not served with reclaimed water / (1,400 gpm/well) / (0.80 firm capacity) [arsenic/fluoride treatment]

(4) Reclaimed Storage = maximum day demands (outdoor and irrigation) served with reclaimed water

(5) Potable Storage = 1.2[maximum day demands (outdoor and irrigation) not served with reclaimed water]

(6) Treatment Capacity = 70 percent of maximum day demands (outdoor and irrigation) not served with reclaimed water

(7) Annual Water Recharged = volume of water recharged when reclaimed water available exceeds reclaimed water demands

(8) Annual Water Recovered = volume of water recovered to meet peak reclaimed water demands (WRF output insufficient for peak demands)

(9) Annual Recovered Water Treated = 70 percent of total demand (outdoor and irrigation) served via the drinking water distribution system [assumed arsenic/fluoride treatment and 70 percent of treated water could be blended with the remaining 30 percent to meet the arsenic/fluoride MCLs]

(10) Annual Water Evaporated = 0.03(volume of water recharged via spreading basins)

7.4. Evaluation of Reclaimed Water Program Alternatives

This section discusses the basis of the cost evaluations and presents the capital, O&M, and total present worth costs determined for each alternative. In addition to economic costs, this section provides a summary of other non-cost decision criteria that were used to compare the alternatives and to identify a preferred reclaimed water program strategy. The objective of the cost evaluation is to provide relative costs for comparing alternatives, and the costs are not intended to for use in detailed capital improvement planning budgets or setting rates.

7.4.1. Basis of Costs

Capital and O&M cost estimates were developed for the required system improvements and upgrades identified for each reclaimed water program alternative. The cost estimates presented herein are 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 to plus 20 percent in the best case and minus 30 percent to plus 50 percent in the worst case.

Appendix D contains unit cost information and other assumptions used in this project for construction and O&M of the reclaimed water infrastructure. The unit capital costs include materials of construction, installation, and contractor costs (overhead, profit, bonding, mobilization). All costs include a 20 percent factor for engineering and construction administration and 30 percent for project contingencies. The unit O&M costs include labor, power, chemicals, maintenance, and materials. All costs are in June 2008 dollars referenced to an Engineering News Record Construction Cost Index (ENR CCI) of 8,185.

The relative economic feasibility of the alternatives was compared based on an equivalent present worth cost basis. The equivalent present worth cost for each alternative is the sum of total capital cost plus the estimated annual O&M cost, annualized over a 20-year study period at an interest rate of 7 percent.

7.4.2. Cost Evaluation of Alternatives

A summary of the costs determined for each of the 14 alternatives is presented in Table 7-3 and is shown graphically on Figure 7-5. Appendix D contains the detailed cost evaluations for each alternative.

SURPRISE ARIZONA

November 2008

CITY OF SURPRISE, ARIZONA
INTEGRATED WATER MASTER PLAN: WATER RESOURCES

Reclaimed Water Program Alternatives: Total Present Worth (70 Percent Groundwater Treated)

MALCOLM PIRNIE

In Association With ASU Decision Theater

Figure 7-5

Table 7-3.
Summary of Costs for Reclaimed Water Program Alternatives (70 Percent Split-Stream Groundwater Treatment)

	Total Capital Cost ($M)	O&M Cost ($M)	20-Year Present Worth ($M)	Cost Rank
Alternative 1A	$527	$263	$790	7
Alternative 1B	$914	$406	$1,319	13
Alternative 1C	$532	$257	$789	6
Alternative 1D	$920	$400	$1,320	14
Alternative 2A	$541	$245	$786	5
Alternative 2B	$547	$246	$793	8
Alternative 3	$601	$196	$796	9
Alternative 4	$493	$56	$549	1
Alternative 5A	$692	$200	$892	10
Alternative 5B	$696	$201	$897	11
Alternative 5C	$706	$203	$909	12
Alternative 6A	$520	$52	$573	2
Alternative 6B	$526	$54	$580	3
Alternative 6C	$541	$58	$598	4

The cost comparisons can be summarized as follows:

- The low cost group of alternatives range from $540 to $600 million: 4, 6A, 6B, and 6C. This group consists of maximizing direct reuse via fully-connected dual distribution alternatives.
- The next lowest 20-year cost alternatives range from $780 to $800 million: 1A, 1C, 2A, 2B, and 3. This includes the City-owned recharge via spreading basins, regional recharge alternatives, and serving largest reuse customers by SPA.
- The next highest group of 20-year cost alternatives range from $890 to $910 million: 5A, 5B, and 5C. This includes the alternatives for dual distribution only to the largest users.
- The highest cost group of alternatives has costs of approximately $1,300 million: 1B and 1D. This group includes the full recharge by “injection.” The injection alternatives were highest cost because they have the highest amount of groundwater treatment needed, as well as additional reclaimed water treatment needed prior to recharge. However, as shown in Section 4.1.1, these alternatives would be comparable to Alternatives 1A and 1C if additional reclaimed water treatment prior to recharge is not needed.

A sensitivity analysis (included in Appendix D) was performed on the effect of groundwater treatment on the overall cost evaluation of reclaimed water program alternatives. The sensitivity analysis considered reducing the split-stream portion of groundwater treated to 50 percent (i.e., assumes less water needs treatment to achieve City treatment goals). Although the reduced groundwater treatment assumption did reduce costs overall, it did not affect the relative cost rankings and groupings described above for the baseline 70 percent split-stream groundwater treatment assumption.

7.4.3. Cost Evaluation Conclusions

The infrastructure and cost evaluation of reclaimed water program alternatives presented in this section and the high level evaluation of recharge technologies presented in Section 7.2.1 lead to the following major conclusions:

- Maximizing direct reuse in a dual distribution system and using City-owned surface basin recharge to balance reclaimed water demand and supply is the least cost alternative. This conclusion, however, depends on availability of land and favorable recharge conditions for City-owned surface recharge facilities.
- Serving only the largest users in a dual distribution system and using City-owned surface basin recharge to balance reclaimed water demand and supply and to recharge excess reclaimed water is comparable in costs to the full recharge alternatives via City-owned and regional surface basin recharge facilities. This conclusion also depends on availability of land and favorable recharge conditions for City-owned surface recharge facilities.
- Combining SPAs for recharge may be more economical than keeping SPAs separate.
- If additional reclaimed water treatment prior to recharge is not needed, all recharge technologies would be cost comparable and would give the City more flexibility in choice of recharge technology to implement throughout its planning area.
- More WRFs is more economical than fewer WRFs. This finding must, however, be confirmed in conjunction with the analysis of wastewater collection system alternatives in the Water Infrastructure component of the *Integrated Water Master Plan*.

7.4.4. Non-Cost Decision Criteria

Non-cost decision criteria that were considered significant in the consideration and selection of a preferred reclaimed water program alternative were identified and discussed in several workshops held with the City Steering Committee. Based on these discussions, the following non-cost decision criteria were selected for use in the comparison of alternatives:

- **Jurisdictional Control -** Degree of City influence on the planning, design, and operation of reclaimed water infrastructure. The City would have much greater control with City-owned facilities compared to use of regional facilities owned by others.
- **Water Credits –** Potential for loss of stored water credits, either through an exchange/cost-sharing agreement or through evaporation. Because reclaimed water is a critical component of the City's water supply portfolio, any loss of credits may be a disadvantage.

- **Operational Flexibility** – The degree of flexibility available for managing the City's reclaimed water resource. In general, having more facilities and options available for managing the resource is favorable.
- **Regulatory/Institutional Complexity –** Complexity of implementation, including compliance with regulatory standards, number and complexity of required water exchanges, agreements, other agency approvals and support, etc. Alternatives that are less complex are favorable.
- **Water Supply Flexibility –** Degree of ability to convert reclaimed water to potable water. Groundwater recharge and water exchanges are currently the only methods to directly convert reclaimed water to potable water. Any water that is directly used or recovered within the direct influence of recharge facilities (i.e., ASR wells) can only be used as non-potable water.
- **Public Perception –** General perception of the public of the use of reclaimed water under a water scarce condition and of water reuse in general. Under a water scarce condition, the public may view groundwater recharge as more sustainable than irrigating turf. Public perception may also become more of a concern as the potential for public contact with reclaimed water is increased (e.g., dual distribution, maximizing reuse, etc.).

7.4.5. Matrix Evaluation of Alternatives

A matrix comparison of the alternatives was used to identify the preferred reclaimed water management strategy based on all decision criteria, including costs. The comparison was accomplished by a systematic weighting and scoring of the decision criteria for each alternative. The matrix evaluation was completed during a workshop with the City Steering and Technical Committees.

7.4.5.1. Prioritizing Decision Criteria

The first step of the matrix evaluation was to determine the City's prioritization for the decision criteria. The weighting, or assigning of relative importance between the criteria, was determined using a pair-wise comparison methodology. In this methodology, every criterion is compared against all the other criteria to determine the priority or degree of importance of each criterion relative to the other criteria.

In the workshop, the City Steering and Technical Committees were asked to compare each criterion against all other criteria, individually, to determine 1) which criterion was more important, and 2) by how much. The City was asked, "Is the more important criterion Equal To, Weakly More Important, Definitely More Important, Very Strongly More Important, or Absolutely More Important than the less important criterion?" A commercially available software program called Criterium DecisionPlus was used to assist in the weighting of the decision criteria. After each criterion was compared against all other criteria, the software calculated the resulting relative importance of each criterion.

Figure 7-6 illustrates the resulting priorities, or weights, determined for each criterion. Cost was identified as the most important criterion with over 46 percent weight. The next most important decision criteria were Water Supply Flexibility (19.9 percent weight) and Water Credits (17.1 percent weight). The remaining four criteria (Jurisdictional Control, Operational Flexibility, Regulatory/Institutional Complexity, and Public Perception) were weighted at 6.5 percent weight and less.

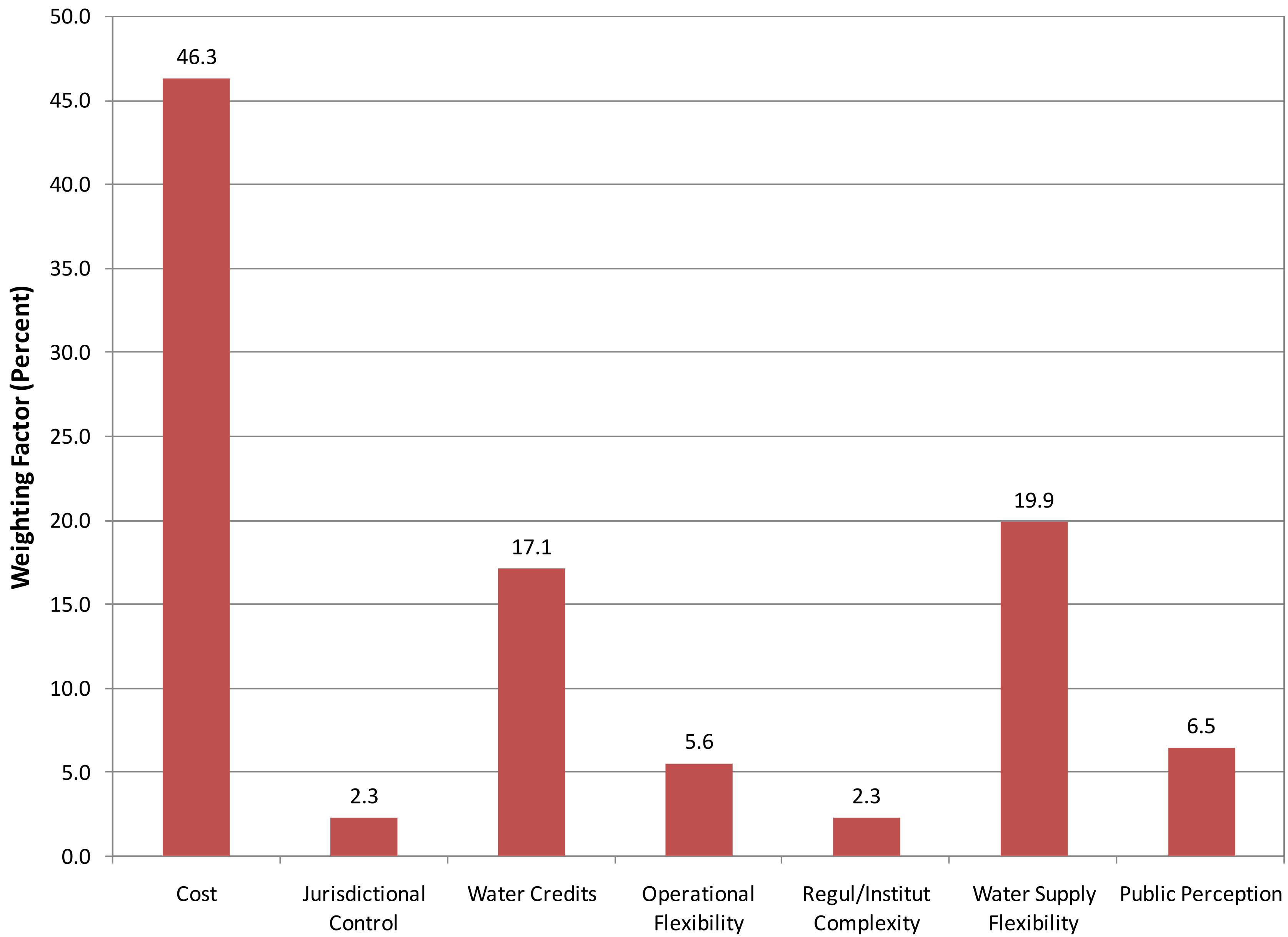
7.4.5.2. Scoring of Alternatives Relative to Decision Criteria

The second step of the process was to score each alternative based on the alternatives' attributes under each criterion. Table 7-4 summarizes the scoring of decision criteria for each alternative and includes the criteria, the attributes of each alternative under each criterion, and the score assigned to each alternative under each criterion based on the attributes. Scores between 1 and 5 were assigned, with 1 being least favorable to 5 being most favorable.

7.4.5.3. Ranking of Alternatives

The final step of the process was to determine the total weighted scores for the alternatives. This was accomplished by taking the sum of the criteria scores for each alternative presented in Table 7-4 and multiplying them by the weighting factors. Table 7-5 and Figure 7-7 present the results of the weighted scores and ranking of the reclaimed water program alternatives. The rankings lead to the following conclusions:

- Full recharge of reclaimed water via surface spreading basins and meeting reclaimed water demands with the potable water system is most preferable (Alternatives 1A and 1C are ranked first and second).
- The alternatives involving regional recharge, maximizing reuse via a fully-connected distribution system, and serving only the largest users (Alternatives 2, 3, 4, 5, and 6) are all ranked similarly.
- Alternatives requiring injection recharge rather than spreading basins (Alternatives 1B and 1D) are the lowest ranked alternatives.



November 2008

CITY OF SURPRISE, ARIZONA
INTEGRATED WATER MASTER PLAN: WATER RESOURCES

Reclaimed Water Program Alternatives: Decision Criteria Weights

In Association With

Figure 7-6

Table 7-4.
Reclaimed Water Program Alternatives: Decision Criteria Scoring

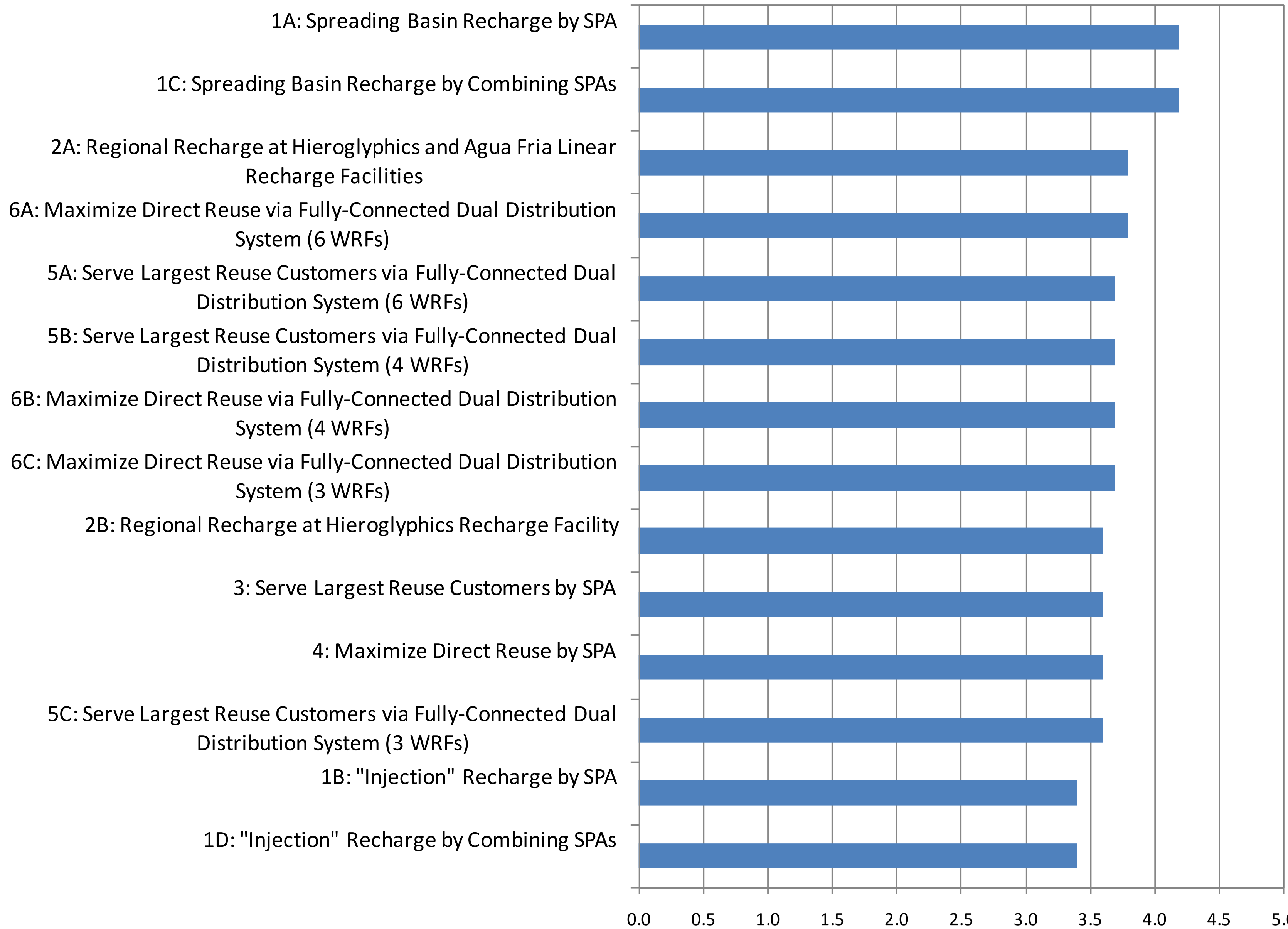
Decision Criteria	Cost		Jurisdictional Control		Water Credits		Operational Flexibility		Regulatory/ Institutional Complexity		Water Supply Flexibility		Public Perception	
1A: Spreading Basin Recharge by SPA	• Medium cost range	4	• All City-owned	5	• No loss of credits • 3% evaporation loss	4	• Most recharge facilities • Most WRFs • No direct delivery option	3	• Surface recharge permitting is routine • Most facilities to permit	3	• All water recharged can be recovered as potable	5	• Recharge of aquifer may be viewed as more sustainable • Public contact with reclaimed water is minimized	5
1B: "Injection" Recharge by SPA	• High cost, except if no additional treatment needed	2	• All City-owned	5	• No loss of credits	5	• Most recharge facilities • Most WRFs • No direct delivery option	3	• May be difficult to permit if injecting into the aquifer • Most facilities to permit	1	• All water recharged can be recovered as potable	5	• Recharge of aquifer may be viewed as more sustainable • Public contact with reclaimed water is minimized	5
1C: Spreading Basin Recharge by Combining SPAs	• Medium cost range	4	• All City-owned	5	• No loss of credits • 3% evaporation loss	4	• Can move between SPAs • Fewer recharge facilities • No direct delivery option	2	• Surface recharge permitting is routine • Fewer facilities to permit	4	• All water recharged can be recovered as potable	5	• Recharge of aquifer may be viewed as more sustainable • Public contact with reclaimed water is minimized	5
1D: "Injection" Recharge by Combining SPAs	• High cost, except if no additional treatment needed	2	• All City-owned	5	• No loss of credits	5	• Can move between SPAs • Fewer recharge facilities • No direct delivery option	2	• May be difficult to permit if injecting into the aquifer • Fewer facilities to permit	2	• All water recharged can be recovered as potable	5	• Recharge of aquifer may be viewed as more sustainable • Public contact with reclaimed water is minimized	5
2A: Regional Recharge at Hieroglyphics and Agua Fria Linear Recharge Facilities	• Medium cost range	4	• All recharge conducted at facilities owned by others • Need to deal with two owners	2	• Portion of recharge outside of service area (less wet water) • Potential for loss of credits to CAGRD • 3% evaporation loss	2	• Fewer recharge facilities • Combined conveyance • No direct delivery option	2	• City not responsible for permitting • Cost/credit sharing agreement needed • Agreement with SROG needed	5	• All water recharged can be recovered as potable	5	• Recharge of aquifer may be viewed as more sustainable • Public contact with reclaimed water is minimized	5
2B: Regional Recharge at Hieroglyphics Recharge Facility	• Medium cost range	4	• All recharge conducted at facilities owned by others • Facility located in service area	3	• All recharge inside service area (more wet water) • Potential for greater loss of credits to CAGRD • 3% evaporation loss	1	• Least recharge facilities • Most Combined conveyance • No direct delivery option	1	• City not responsible for permitting • Cost/credit sharing agreement needed	5	• All water recharged can be recovered as potable	5	• Recharge of aquifer may be viewed as more sustainable • Public contact with reclaimed water is minimized	5
3: Serve Largest Reuse Customers by SPA	• Medium cost range	4	• All City-owned	5	• No loss of credits • 3% evaporation loss	4	• Most WRFs • Can't move water between SPAs • Recharge/direct delivery options	2	• Water reuse permit and administration needed • Most recharge facilities to permit	3	• Water recharged can be recovered as potable	3	• Public could question turf irrigation • Additional public outreach may be necessary to overcome potential negative perceptions • Less potential for public contact with reclaimed water	3
4: Maximize Direct Reuse by SPA	• Low cost range	5	• All City-owned	5	• No loss of credits • 3% evaporation loss	4	• Most WRFs • Can't move water between SPAs • More customers to accept water • Recharge/direct delivery options	2	• Water reuse permit and more administration needed • Most recharge facilities to permit • Lower recharge volumes may facilitate permitting process	3	• Less water recharged that can be recovered as potable	1	• Public could question turf irrigation • Additional public outreach may be necessary to overcome potential negative perceptions • More potential for public contact with reclaimed water	2
5A: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (6 WRFs)	• Medium cost range	4	• All City-owned	5	• No loss of credits • 3% evaporation loss	4	• Most WRFs • Can move water between SPAs • Recharge/direct delivery options	4	• Water reuse permit and administration needed • Potential for fewer recharge facilities to permit	3	• Water recharged can be recovered as potable	3	• Public could question turf irrigation • Additional public outreach may be necessary to overcome potential negative perceptions • Less potential for public contact with reclaimed water	3
5B: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (4 WRFs)	• Medium cost range	4	• All City-owned	5	• No loss of credits • 3% evaporation loss	4	• Fewer WRFs • Can move water between SPAs • Recharge/direct delivery options	3	• Water reuse permit and administration needed • Potential for fewer recharge facilities to permit	3	• Water recharged can be recovered as potable	3	• Public could question turf irrigation • Additional public outreach may be necessary to overcome potential negative perceptions • Less potential for public contact with reclaimed water	3
5C: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (3 WRFs)	• Medium cost range	4	• All City-owned	5	• No loss of credits • 3% evaporation loss	4	• Least WRFs • Can move water between SPAs • Recharge/direct delivery options	2	• Water reuse permit and administration needed • Potential for fewer recharge facilities to permit	3	• Water recharged can be recovered as potable	3	• Public could question turf irrigation • Additional public outreach may be necessary to overcome potential negative perceptions • Less potential for public contact with reclaimed water	3
6A: Maximize Direct Reuse via Fully-Connected Dual Distribution System (6 WRFs)	• Low cost range	5	• All City-owned	5	• No loss of credits • 3% evaporation loss	4	• Most WRFs • Can move water between SPAs • More customers to accept water • Recharge/direct delivery options	5	• Water reuse permit and more administration needed • Potential for fewer recharge facilities to permit • Lower recharge volumes may facilitate permitting process	2	• Less water recharged that can be recovered as potable	1	• Public could question turf irrigation • Additional public outreach may be necessary to overcome potential negative perceptions • More potential for public contact with reclaimed water	2
6B: Maximize Direct Reuse via Fully-Connected Dual Distribution System (4 WRFs)	• Low cost range	5	• All City-owned	5	• No loss of credits • 3% evaporation loss	4	• Fewer WRFs • Can move water between SPAs • More customers to accept water • Recharge/direct delivery options	4	• Water reuse permit and more administration needed • Potential for fewer recharge facilities to permit • Lower recharge volumes may facilitate permitting process	2	• Less water recharged that can be recovered as potable	1	• Public could question turf irrigation • Additional public outreach may be necessary to overcome potential negative perceptions • More potential for public contact with reclaimed water	2
6C: Maximize Direct Reuse via Fully-Connected Dual Distribution System (3 WRFs)	• Low cost range	5	• All City-owned	5	• No loss of credits • 3% evaporation loss	4	• Least WRFs • Can move water between SPAs • More customers to accept water • Recharge/direct delivery options	3	• Water reuse permit and more administration needed • Potential for fewer recharge facilities to permit • Lower recharge volumes may facilitate permitting process	2	• Less water recharged that can be recovered as potable	1	• Public could question turf irrigation • Additional public outreach may be necessary to overcome potential negative perceptions • More potential for public contact with reclaimed water	2

THIS PAGE INTENTIONALLY LEFT BLANK

Table 7-5.
Reclaimed Water Program Alternatives: Alternatives Ranking

Decision Criteria	Cost	Jurisdictional Control	Water Credits	Operational Flexibility	Regul/Institut Complexity	Water Supply Flexibility	Public Perception	Weighted Score
Weight	**46.3%**	**2.3%**	**17.1%**	**5.6%**	**2.3%**	**19.9%**	**6.5%**	
1A: Spreading Basin Recharge by SPA	4	5	4	3	3	5	5	4.2
1C: Spreading Basin Recharge by Combining SPAs	4	5	4	2	4	5	5	4.2
2A: Regional Recharge at Hieroglyphics and Agua Fria Linear Recharge Facilities	4	2	2	2	5	5	5	3.8
6A: Maximize Direct Reuse via Fully-Connected Dual Distribution System (6 WRFs)	5	5	4	5	2	1	2	3.8
5A: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (6 WRFs)	4	5	4	4	3	3	3	3.7
5B: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (4 WRFs)	4	5	4	3	3	3	3	3.7
6B: Maximize Direct Reuse via Fully-Connected Dual Distribution System (4 WRFs)	5	5	4	4	2	1	2	3.7
6C: Maximize Direct Reuse via Fully-Connected Dual Distribution System (3 WRFs)	5	5	4	3	2	1	2	3.7
2B: Regional Recharge at Hieroglyphics Recharge Facility	4	3	1	1	5	5	5	3.6
3: Serve Largest Reuse Customers by SPA	4	5	4	2	3	3	3	3.6
4: Maximize Direct Reuse by SPA	5	5	4	2	3	1	2	3.6
5C: Serve Largest Reuse Customers via Fully-Connected Dual Distribution System (3 WRFs)	4	5	4	2	3	3	3	3.6
1B: "Injection" Recharge by SPA	2	5	5	3	1	5	5	3.4
1D: "Injection" Recharge by Combining SPAs	2	5	5	2	2	5	5	3.4

1 - Least Favorable and 5 - Most Favorable



CITY OF SURPRISE, ARIZONA
INTEGRATED WATER MASTER PLAN: WATER RESOURCES

Reclaimed Water Program Alternatives: Weighted Scores

November 2008

Figure 7-7

7.4.5.4. Selected Reclaimed Water Program Strategy

The selected reclaimed water program strategy was identified based on the results of the alternatives scoring and priority rankings described above and the results of a subsequent workshop with the City Committees to compare projected water demands and supplies. The purpose of the subsequent workshop described in Section 8 was to develop consensus on a strategy for overall future water resources planning. The results of that workshop illustrated that reclaimed water is a critical component of the water resources portfolio and could account for nearly 80 percent of the total water supply at build-out. Reclaimed water is also the additional future water supply that is most available to the City. As discussed in Section 6, obtaining other additional supplies will be very challenging and expensive in the future.

After discussing the water resource scenarios and the importance of reclaimed water as a future supply, additional discussion was held to identify the preferred reclaimed water program strategy. It was noted that recharge must be implemented as part of any strategy. The extent that recharge can be implemented is, however, unknown due to limited information on local hydrogeology, recharge capacity, and groundwater quality. The strategy must, therefore, include additional investigations by the City to better define vadose zone, aquifer, and groundwater quality conditions throughout its planning area.

The discussions leading to the basis for selecting a recommended reclaimed water management strategy can be summarized as follows:

- Full recharge using surface spreading basins is the most preferable alternative and should be implemented where possible. However, until additional hydrogeologic and water quality information is established, there is no guarantee that full recharge with surface spreading basins can be accomplished.
- Full recharge using regional recharge facilities is the next most preferable alternative and should be implemented where possible. However, it is unknown at this time if and when CAWCD will permit the recharge facilities to accept reclaimed water. Use of CAWCD facilities may also require that the City convey some of its stored water credits to CAWCD, which is not desirable given the importance of the credits as part of the City's future water supply.
- Maximizing direct reuse is the next most preferable alternative. This alternative was ultimately not chosen, however, because of the high initial capital costs to install the infrastructure and the potential social and political concerns related to serving reclaimed water to individual residences.

On the above basis, the recommended reclaimed water management strategy is to install a dual distribution system to serve only the largest reuse customers (landscape irrigation of HOA common areas, schools, parks, etc.), to use of surface basin recharge where possible to balance reclaimed water demand and supply, and to recharge reclaimed water that is not directly reused.

Because the City does not want to preclude other direct reuse opportunities in its planning area, the reclaimed water evaluations in the Water Infrastructure component of the *Integrated Water Master Plan* investigates provisions for how the dual distribution system might be configured and reinforced (through pumping, looping of the pipe network, limited pipe upsizing, etc.) to potentially serve a larger direct reuse customer base.

8. Evaluation of Water Resource Scenarios

This section summarizes how the new Water Resource Model tool was used to evaluate water demand and supply scenarios. Included are an overview of the modeling methodology, a discussion of the water resource scenarios that were modeled, and resulting City guidance provided on future water resource strategies.

8.1. Water Resource Modeling Methodology

A Water Resource Model was developed to dynamically compare water demand projections developed in the Demand Module to existing and potentially available water supplies. The output of the Water Resource Model allows the user to determine whether the available supplies are sufficient to meet anticipated demands. Alternatively, the model can predict when existing water supplies will be fully used, when a gap (deficit) between supply and demand occurs, and the magnitude of the gap.

The Water Resource Model was compiled and run using commercially-available PowerSim software. The software reads from the Demand Module's database file and imports indoor, outdoor, and landscape demands for each water service provider and SPA within the Surprise MPA. In the *Integrated Water Master Plan*, the Water Resource Model uses 2008, 2020, 2030, and build-out as the planning periods and interpolates for interim years. The planning periods can be adjusted by the user if the City's development horizon changes.

The water supplies included in the Water Resource Model are based on assured water supply designations, hydrogeologic models (physical availability of groundwater), surface water rights, CAP subcontracts, and reclaimed water production projections. Additional water supplies can be added to the Water Resource Model based on anticipated water supply development projects or other new water supply projections.

The Water Resource Model output includes a series of graphs that show the aggregated water demand in each category (indoor, outdoor, and landscape) for each SPA, for each water service provider, and for each provider within each SPA. The user can change demands and supplies in the Water Resource Model interface to evaluate multiple water resource scenarios. A detailed description of the Water Resource Model is provided in Appendix E.

8.2. Baseline Water Demands and Supplies

The baseline water resource demand projections described in Section 5.8 were input into the Water Resource Model as a starting point. The baseline water resource demand projections were developed for land use and development conditions that City staff indicated were currently being discussed during the development of the next edition of the City's General Plan. Key assumptions and resulting baseline demand projections were summarized in Section 5.8.

Existing and potential future water supplies were described in Sections 3 and 6. Based on the descriptions, the additional water supplies shown in Table 8-1 are considered potentially available to the City and have been incorporated into the Water Resource Model. Chapter 6 discussed other potentially available supplies such as unallocated CAP water, tribal lease water, development of brackish groundwater and/or ocean desalination, and groundwater importation. However, because obtaining these supplies will be challenging, lengthy, and expensive, if it can be done at all, these additional supplies were not included in the Water Resource Model. As described in Appendix E, the potential future water supplies can be turned on or off in the Water Resource Model.

Table 8-1.
Existing and Potential Future Water Supplies

Supply	Status	Quantity (AFY)
Groundwater – Physically Available	Existing	16,744
CAP Allocation	Existing	10,249
Additional CAP Supplies from Other Providers [1]	Potential Future	3,932
Reclaimed Water	Existing	3,584
Additional Reclaimed Water [2]	Potential Future	116,767
Groundwater from Other Providers [3]	Potential Future	2,106

NOTES:
(1) Existing CAP allocation for Brooke/Circle City Water Companies.
(2) Additional reclaimed water depends on demand projections.
(3) Physically available groundwater for developments primarily within Beardsley Water Company service area.

8.3. Modeling of Water Resource Scenarios

The Water Resource Model was demonstrated in a workshop with the City Steering and Technical Committees. The workshop provided an interactive environment for testing various demand and supply scenarios. The workshop participants used the model to investigate the effects of changing variables in the Water Resource Model and Demand Module on the water demand and supply balance.

A key parameter used in the Water Resource Model is the build-out date. The City uses information from MAG to project population over time. Although MAG projections do not currently go beyond 2030, the City provided guidance that an estimate of 2060 for a build-out date (i.e., 100 percent land coverage) is a reasonable assumption for planning purposes. If this development timeline changes, so will the estimated occurrence of various conditions (e.g., when demand exceeds supply) presented in this section.

8.3.1. Baseline Scenario

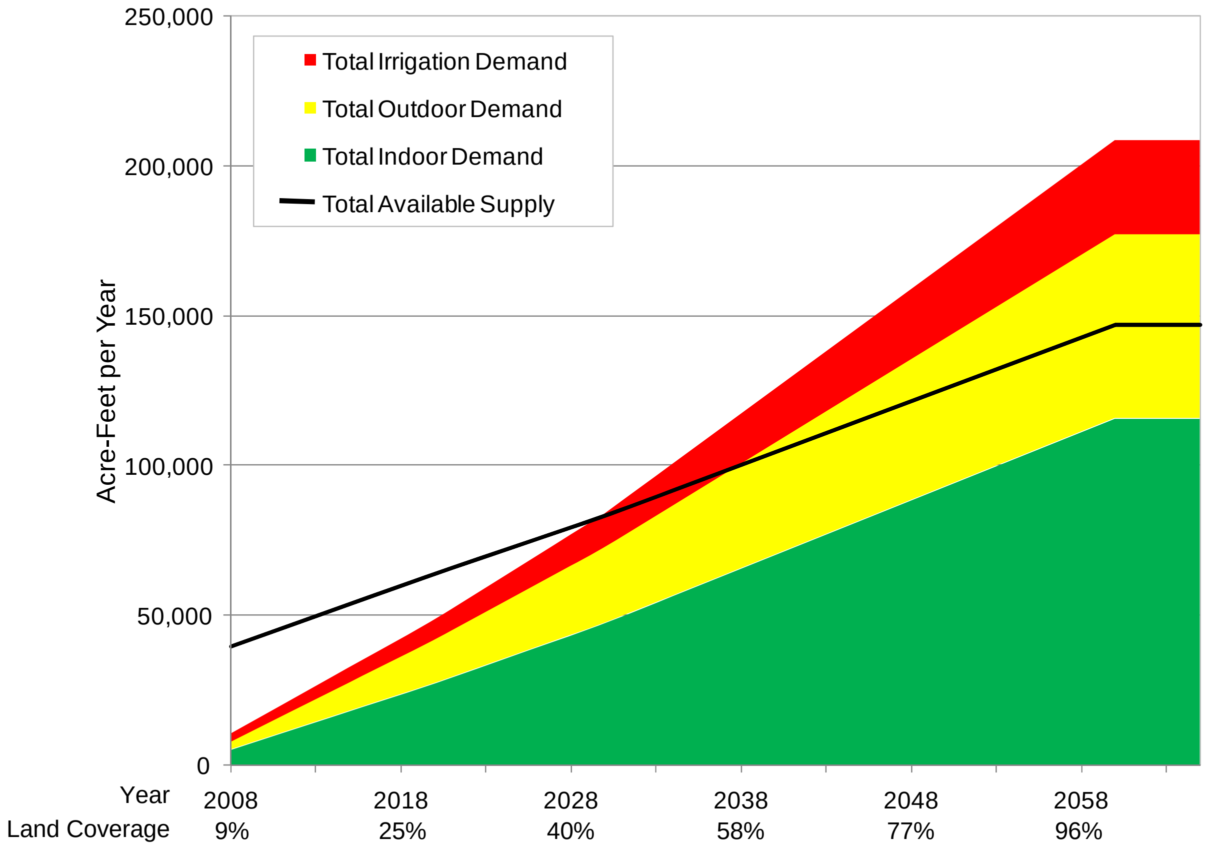
The assumptions used to develop the baseline scenario water demands were presented previously in Section 5.8 and are summarized below:

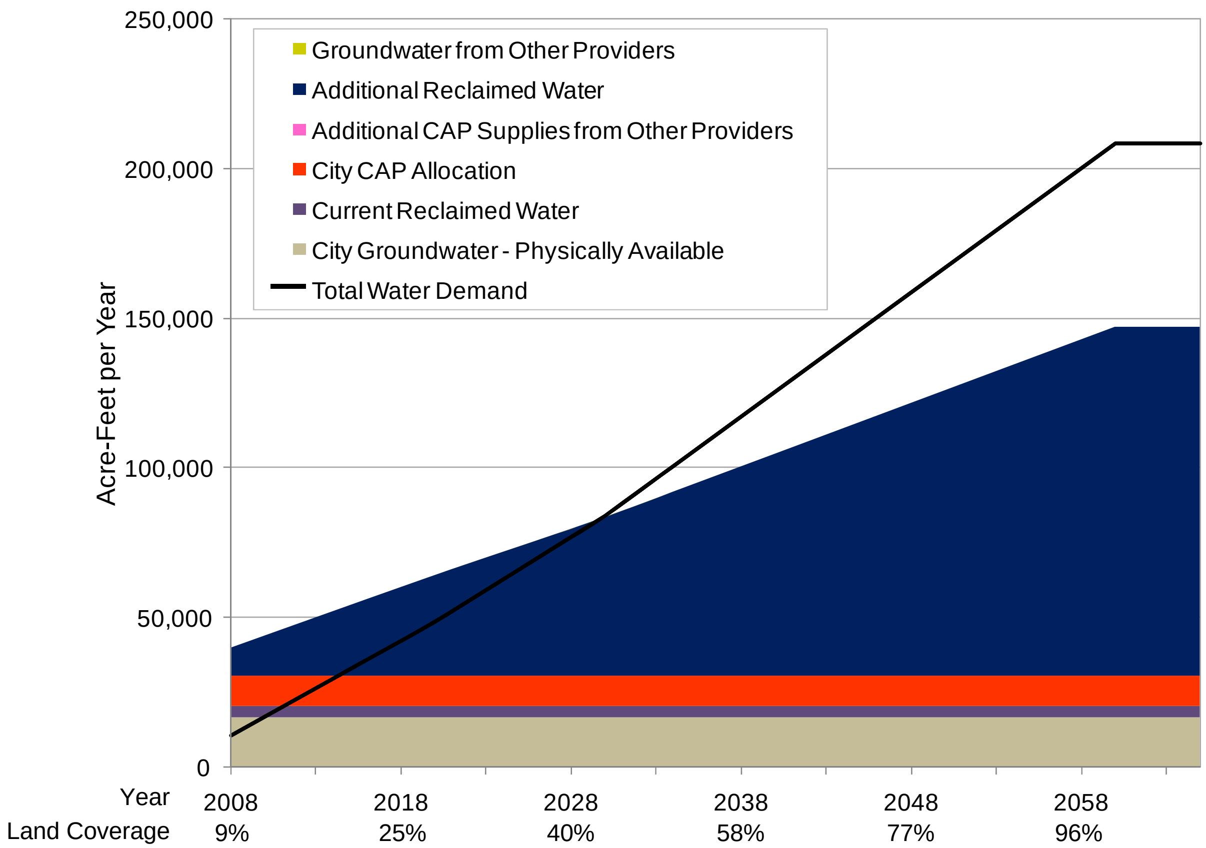
- Indoor, outdoor, and landscape demand factors were derived from City historical production and billing data.
- The landscape use codes and percentage of landscaped area were derived from the City's *Scenic Integrity Guidelines*.
- At build-out, all Rural Residential north of SR 74 was set to 2 du/acre; all Rural Residential south of SR 74 was set to 3 du/acre (average Rural Residential density of 2.6 du/acre). This results in a build-out population of approximately 1 million.
- At build-out, the dwelling unit target densities were the middle of the range for each category in all remaining residential land use categories.
- To remain similar to the 2004 *Water Resource Master Plan*, the baseline scenario includes serving potable and reclaimed water to all private water companies except for AAWC and the City of El Mirage. The baseline scenario assumes that private water company service areas are served as soon as 2008; however, private water company water allocations are not included in the total supply.

The baseline scenario demand and supply graphs generated by the Water Resource Model are shown on Figure 8-1. Figure 8-1 shows two parameters for the x-axis: year and projected land coverage associated with each year. The projected land coverage is a rough estimation of the amount of the City's planning area that is developed based on the distribution of MAG population projections within the planning area.

The following observations can be made from review of Figure 8-1:

- The total City water service area water demand exceeds currently available supply in approximately 2030-2035.
- Drinking water, or indoor water demands, can always be met at build-out with the currently available supply. Some additional (outdoor and landscaping) demands can also be met with the currently available supply.
- Reclaimed water is an important component of the water resources portfolio, potentially accounting for approximately 80 percent of the total supply at build-out. Reclaimed water can be either directly used or recharged to generate long term water storage credits.





CITY OF SURPRISE, ARIZONA
INTEGRATED WATER MASTER PLAN: WATER RESOURCES

November 2008

Baseline Scenario Supply/Demand Comparison

In Association With

Figure 8-1

8.3.2. Alternate Scenarios

In order to achieve a balance between supply and demand, either the demand must decrease or the supply must increase. As discussed in Section 6, except for obtaining CAP allocations or additional physically available groundwater as part of acquiring private water companies in the planning area and utilizing the future reclaimed water resource, developing other additional water supplies will be difficult, lengthy, and expensive. As such, modifications to the scenarios in the Water Resource Model focused on methods to reduce demands to potentially achieve a balance between supply and demand. The following methods of achieving this goal were suggested and tested in the workshop with City Steering and Technical Committees:

- Implementing water conservation
- Not serving individual water companies and/or certain SPAs
- Reducing dwelling unit densities (effectively reducing the build-out population)
- Changing landscaping plans to reduce the amount of water used for irrigation

8.3.2.1. Water Conservation

One method of reducing demand is to implement water conservation programs. The Water Resource Model provides an input table to evaluate the effect of implementing conservation methods as they apply to indoor water demands, outdoor water demands, and large landscaping water demands. The City Water Services Department provided typical conservation levels that would be reasonable to implement on a City-wide basis as follows:

- Interior savings - 15 gpd/du (approximately 7 percent) through installing high-efficiency plumbing fixtures and clothes washers
- Exterior savings - 18 gpd/du (approximately 16 percent) by replacing front yard turf with xeriscaping

Additional conservations measures such as replacing or removing backyard turf or removing pools may be possible but are likely more challenging to implement. When applying the reasonable conservation assumptions presented above, the point at which demand exceed supply occurs less than 5 years later as compared to the baseline scenario. If an aggressive conservation scenario is implemented (7 percent for indoor use and 90 percent reduction for outdoor use), supply is nearly balanced with demand at build-out; however, implementing 90 percent conservation in outdoor uses may not be realistic as evidenced by the lengthy discussion among the workshop participants that ensued after reviewing the scenario results.

The consensus gained from the water conservation evaluations was that conservation alone should not be relied on as a means of meeting demand at build-out, i.e., conservation should not be counted on as an additional water supply. However, conservation should be considered an important part of the City's water management strategy as it helps manage demands and increases awareness of sustainable water use practices.

8.3.2.2. Private Water Companies and Planning Areas

The Water Resource Model provides input tables allowing the user to turn on or off water service to private water companies and individual SPAs. The 2004 *Water Resource Master Plan* assumed that all private water companies (except for AAWC) would eventually be acquired by the City. To be conservative, that previous plan assumed that the City would not obtain any additional water supplies through the acquisitions. With respect to reclaimed water, the Water Resource Model assumes that even if not serving drinking water to an area, the City would still be the wastewater service provider and would therefore receive the water resource benefit of the reclaimed water in the area. This is a reasonable assumption as the City is the designated wastewater service provider in its MPA in the Maricopa Association of Governments 208 Water Quality Management Plan.

In addition to the baseline scenario, the following alternate service scenarios were evaluated, along with the stated Water Resource Model results:

- Serve none of the private water companies. Demand exceeded supply less than 5 years later as compared to the baseline scenario.
- Serve only Circle City Water Company (and acquire its CAP allocation). Demand exceeded supply nearly 10 years later as compared to the baseline scenario.
- Do not serve customers in SPA 6. Demand did not exceed supply until approximately 2040-2045.

City staff noted that it may be very challenging to acquire some of the larger water companies (e.g., Beardsley and West End Water). However, for the evaluation and planning purposes, it was assumed that all private water companies (other than AAWC) could be acquired if desired.

8.3.2.3. Dwelling Unit Densities

Another method of reducing demand is to plan for a smaller population at build-out. In the baseline scenario above, dwelling unit densities for undeveloped areas were set to the mid-point of the ranges defined in the General Plan with the exception of Rural Residential, which was set to 2 du/acre north of SR 74 and 3 du/acre south of SR 74. Assuming 2.2 people per dwelling unit, this scenario resulted in a population of approximately 1 million at build-out.

In addition to the baseline population scenario, the following two alternative population scenarios were evaluated and had the stated Water Resource Model results:

- Low Population – In this scenario, the dwelling unit densities were set to the low end of each range defined in the General Plan, except for Rural Residential, which was set to 0.5 du/acre (the mid-point of its range), and the resulting population was approximately 500,000. Demand exceeded supply approximately 5-10 years later as compared to the baseline scenario.
- Mid-Range Population – In this scenario, the dwelling unit densities for all areas were set to the mid-point of the ranges in the General Plan with the exception of Rural Residential, which was set to an average of 1.0 du/acre in all areas outside of currently developed or planned areas, and the resulting population was approximately 700,000. Demand exceeded supply approximately 10 years later as compared to the baseline scenario.

8.3.2.4. Landscaping Plans

The review of historical water demands in Section 5 indicated that the current large landscape irrigation demand, primarily in SPA 1, accounts for approximately 30 percent of the existing total water demand. The demand is associated with landscaping that includes an abundance of turf and other relatively high water using vegetation. The City recognizes that it cannot continue to develop with this amount of water demand for large irrigation uses and recently developed the *Scenic Integrity Guidelines*. The previous baseline scenario results indicate that if these landscaping guidelines are implemented in future development, the large landscape water demand will decrease to approximately 10 percent of total water demand. Even with this reduction, the baseline scenario indicates that total water demand will exceed available supplies in the 2030 to 2035 timeframe. Had the SPA 1 landscaping plan been duplicated in SPAs 2 through 6, demand would have exceeded supply much sooner, thus illustrating the importance of the xeriscape and other lower water using landscape guidelines contained in the *Scenic Integrity Guidelines*.

The last method of reducing demand that was evaluated with the Water Resource Model was to reduce the amount of water demand for landscaping beyond those assumed in the baseline scenario. After examining the *Scenic Integrity Guidelines* landscape use codes, it was determined that the area having the largest influence on overall landscape water demands was West Valley Plain, which comprises almost all of SPAs 3 and 5. In the alternative landscaping scenario, West Valley Plain was reconfigured to be more like the Bajada landscape code, which is a very low water-use landscape plan. The change in landscaping had minimal effect on the overall demand. The point at which demand exceeded supply did not change appreciably as compared to the baseline scenario. Because a change in the largest landscape area had minimal effect, further changes to the landscape plans were not evaluated in the workshop.

8.4. Summary of Water Resource Model Findings

The evaluations conducted with the Water Resource Model at the workshop with the City Steering and Technical Committees resulted in the following conclusions:

- Although conservation reduces overall demand, it should not be relied on as an additional water supply. However, implementing reasonable conservation methods should be included as part of the overall water management strategy.
- Whether or not to serve private water companies has a minimal effect on the system-wide water demands. As such, the City can continue with its current strategy of acquiring private water companies to the extent practical as development occurs over time. When acquiring service areas, it will be beneficial to also acquire any water resources that are allocated to the private water company service areas.
- Whether or not to serve SPA 6 has a dramatic effect on the system-wide water demands. SPA 6 was not included in the 2004 *Water Resources Master Plan,* and that plan showed a balance in supply and demand. When including SPA 6, water resources rapidly become stressed.
- Planning for lower build-out populations (managing dwelling unit densities to lower planned population) also has a dramatic effect on system-wide water demands.
- As the *Scenic Integrity Guidelines* could reduce large landscape demands to approximately 15 percent of the total demand at build-out in the baseline scenario, further changing the future landscaping plans has only minimal effect on the total water demand for the City.

8.5. Identification of Future Water Resources Direction

8.5.1. Planning for Sustainability

The most important guidance developed by the City Steering and Technical Committees as a result of the Water Resource Model evaluations was the desire to become sustainable, i.e., to manage development that will be supported by the water supplies that are available (including future reclaimed water). As such, the *Integrated Water Master Plan* project presents alternatives for achieving balance in supply and demand and does not rely on developing or obtaining other additional water supplies in the future. Although it will be an important part of the overall water management strategy, conservation should not be specifically counted on as an additional water supply to help achieve a balance in supply and demand.

8.5.2. Means to Achieve Sustainability

The results for the baseline scenario (Figure 8-1) illustrated that if the City continues to develop as currently planned and no additional supplies are acquired, water demand will exceed supply in approximately 2030-2035. According to the evaluations conducted and described above, the most promising alternatives for achieving a balance in supply and demand are as follows:

- No water service to SPA 6
- Management of development densities to a Mid-Population

The Water Resources Model results of these scenarios are presented below along with further discussion on how supply and demand can be in balance at build-out.

8.5.2.1. No Water Service to SPA 6

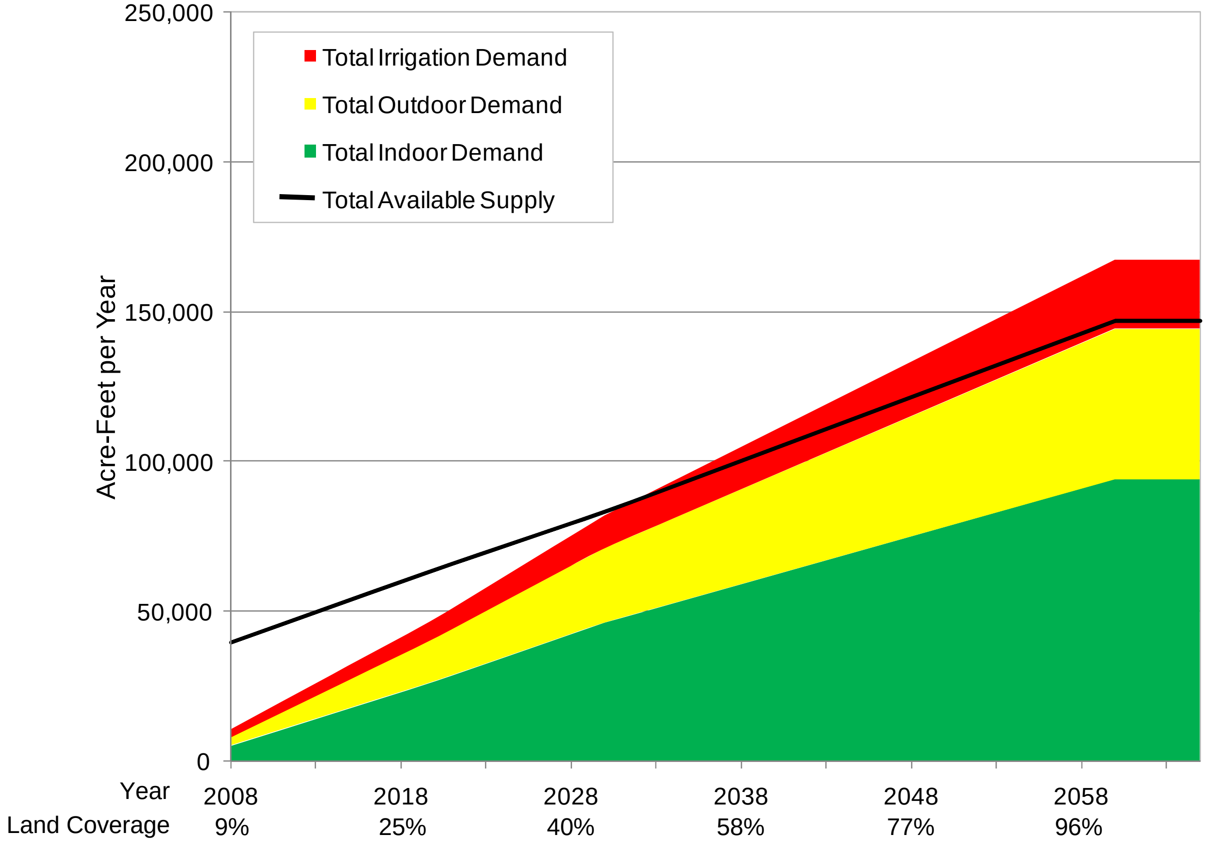
Under this scenario, the City would continue developing according to the current General Plan projections (i.e., under the baseline demand and supply assumptions), but would not plan to serve drinking water or reclaimed water within SPA 6. SPA 6 would be served by private water companies, individuals, or developers in the area. However, because SPA 6 is within the City's MPA, the City would provide wastewater service for SPA 6 and would obtain its reclaimed water resource. This scenario could be viewed as the 'no action' plan of following the 2004 *Water Resources Master Plan*.

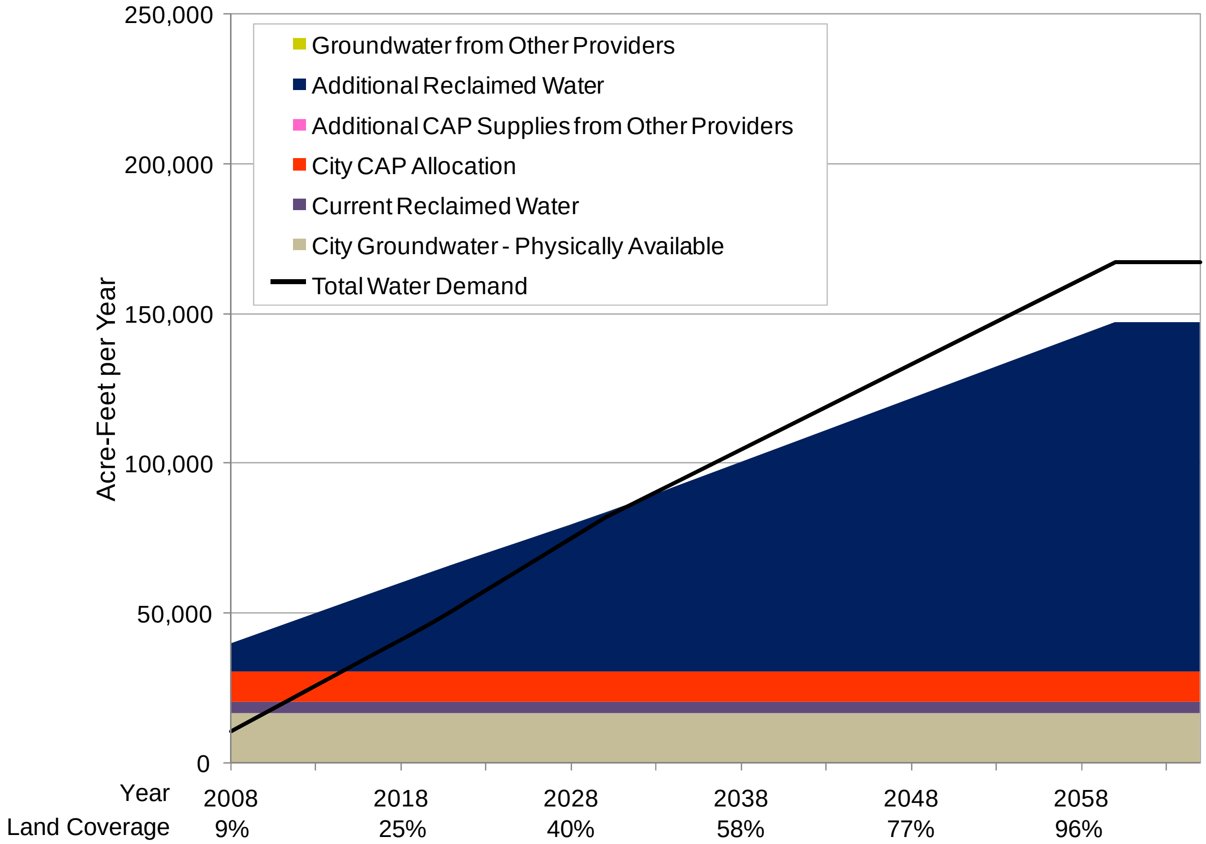
The Water Resource Model results for the no service to SPA 6 scenario are shown on Figure 8-2 (assuming that the City does not gain additional water allocations through acquisition of private water companies) and Figure 8-3 (assuming that the City obtains private water company water allocations through acquisitions). The results indicate the following:

- If the City does not obtain additional water allocations through acquisition of private water companies, demands will exceed supply around 2030-2035.
- If the City does obtain additional water allocations through acquisition of private water companies, demands will exceed supply around 2040-2045.

8.5.2.2. Management of Development Densities

Under this scenario, the City would plan to serve all areas within its planning area (except for the AAWC and El Mirage service areas), but would plan for a lower build-out population. To further evaluate the effects of managing future development densities, a range of build-out populations was evaluated, one that would achieve a population of approximately 500,000 and one that would achieve a population of 700,000 (previously discussed above). The target populations were achieved by setting the dwelling unit densities for all residential land uses to the mid-point ranges in the General Plan, except for currently undeveloped areas classified as Rural Residential, which were reduced as needed to achieve the target populations. To achieve the target populations of 500,000 and 700,000, the Rural Residential densities were reduced to an average of 0.5 du/acre and 1.0 du/acre, respectively.





November 2008

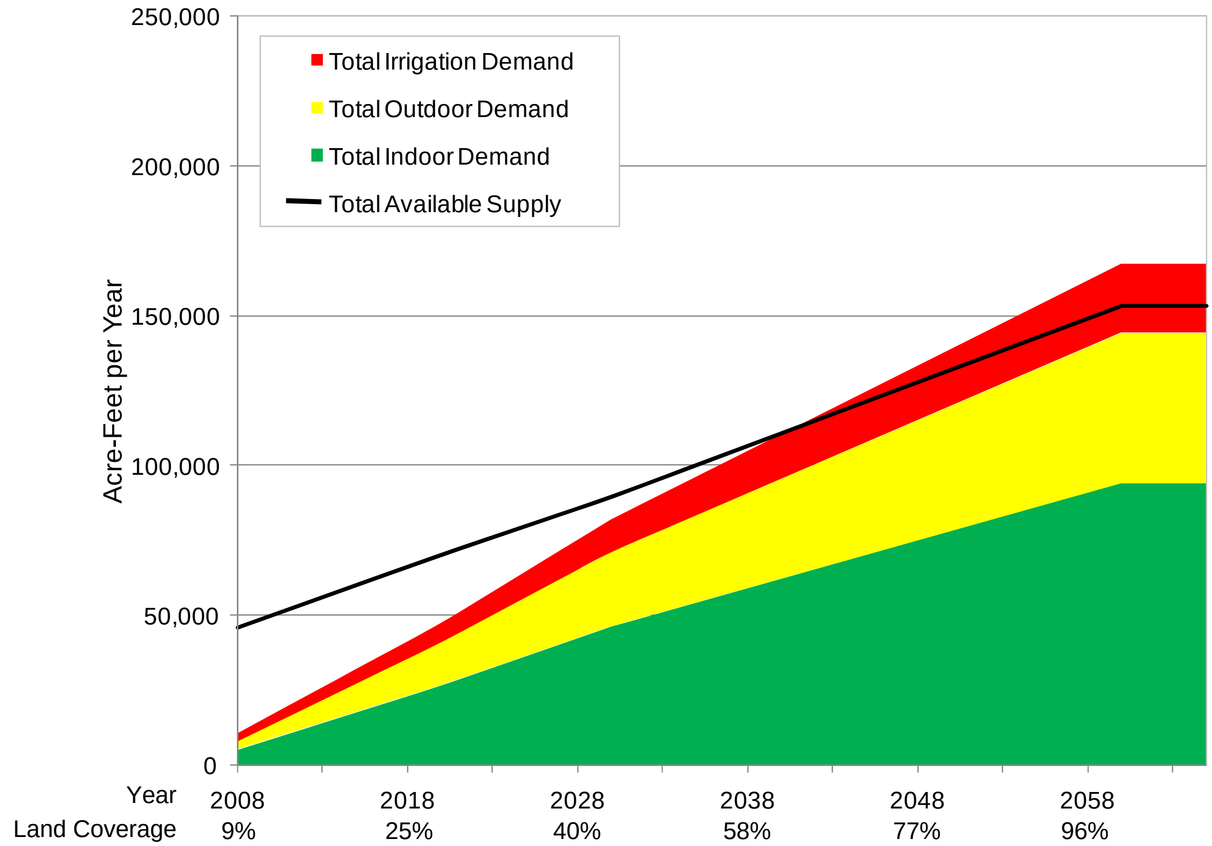
CITY OF SURPRISE, ARIZONA

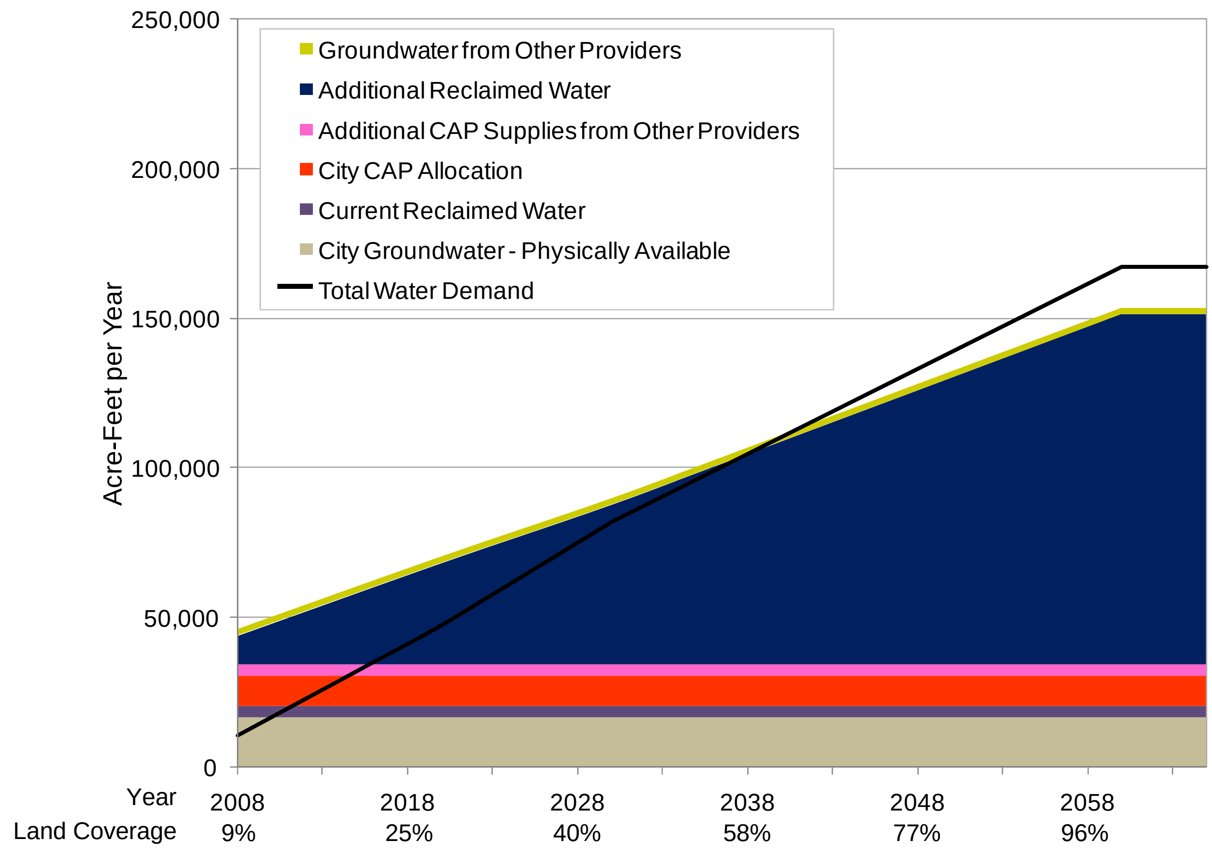
INTEGRATED WATER MASTER PLAN: WATER RESOURCES

No Service to SPA 6 Scenario – No Private Water Company Allocations

In Association With

Figure 8-2





November 2008

CITY OF SURPRISE, ARIZONA
INTEGRATED WATER MASTER PLAN: WATER RESOURCES

No Service to SPA 6 Scenario –
With Private Water Company Allocations

In Association With

Figure 8-3

The Water Resource Model results for the mid-population scenarios are shown on Figures 8-4 and 8-5 (assuming that the City does not gain additional water allocations through acquisition of private water companies), and Figures 8-6 and 8-7 (assuming that the City obtains private water company water allocations through acquisitions). The model results indicate the following:

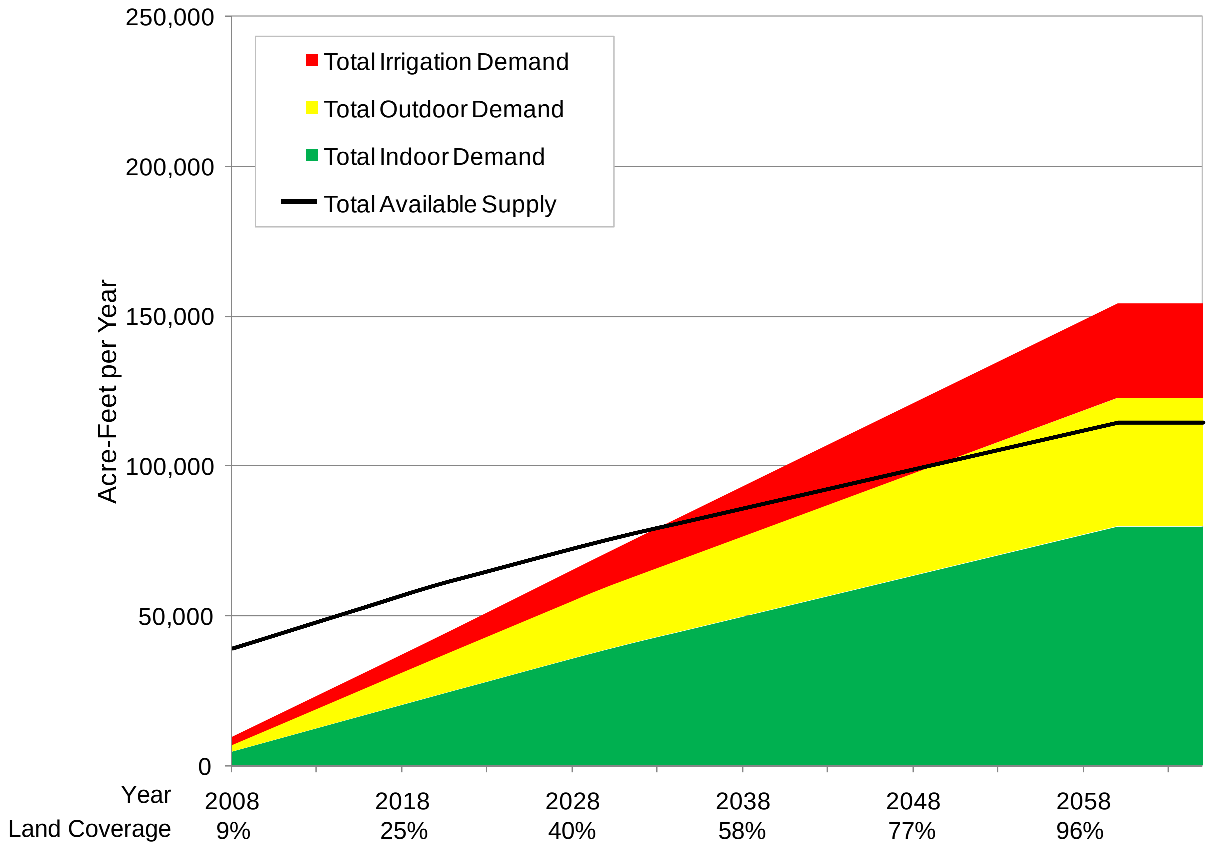
- If the City does not obtain additional water allocations through acquisition of private water companies, demands will exceed supply around 2030-2035 in both the 700,000 population scenario and the 500,000 population scenario.
- If the City does obtain additional water allocations through acquisition of private water companies, demands will exceed supply around 2035-2040 in both the 700,000 population scenario and the 500,000 population scenario.

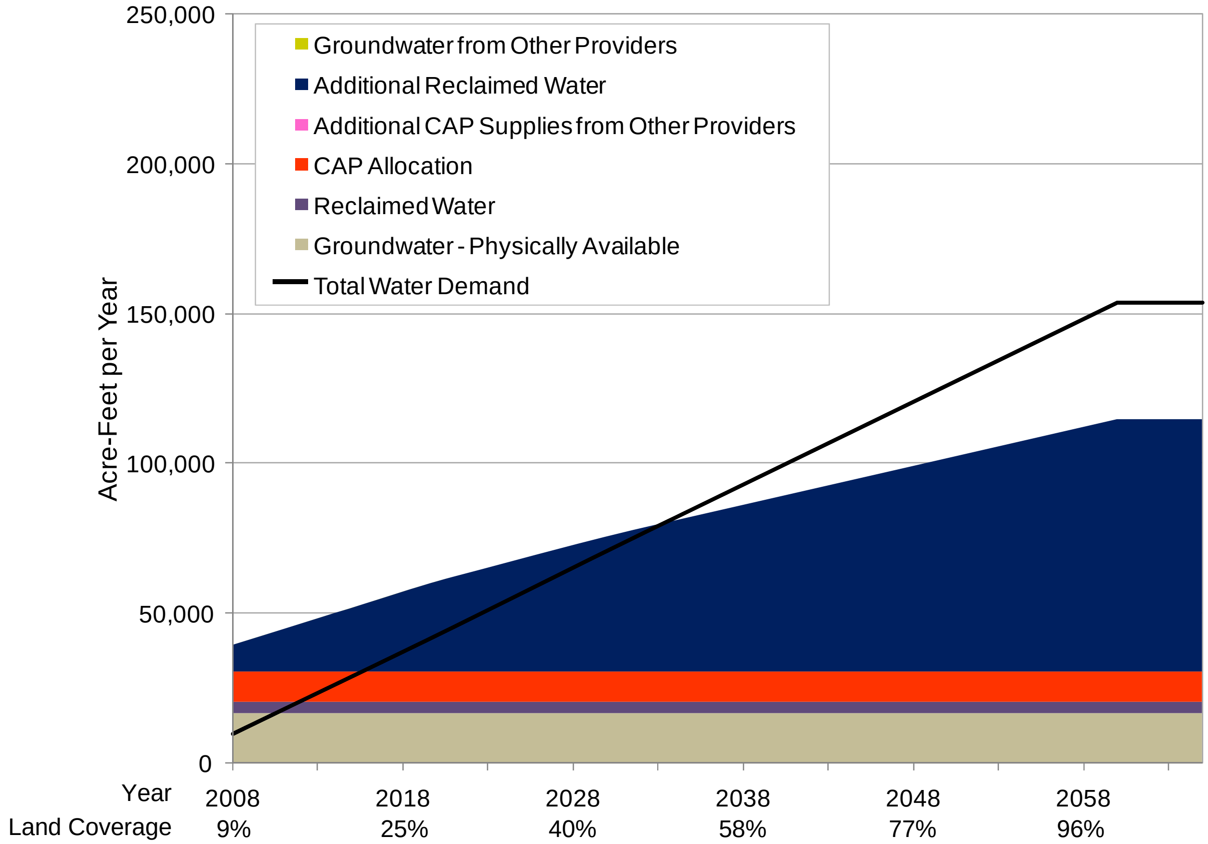
8.5.3. Future Water Resources Direction

Upon further review of alternatives to achieve a balance between water demands and available water supplies, the City committees selected the alternative of managing future development densities and planning for a target build-out population between 500,000 and 700,000 (compared to the baseline of 1 million). The committees agreed that the City should provide water service to SPA 6 to ensure development of uniform water resources infrastructure and provision of a uniform level of water service for all residents within the City's MPA.

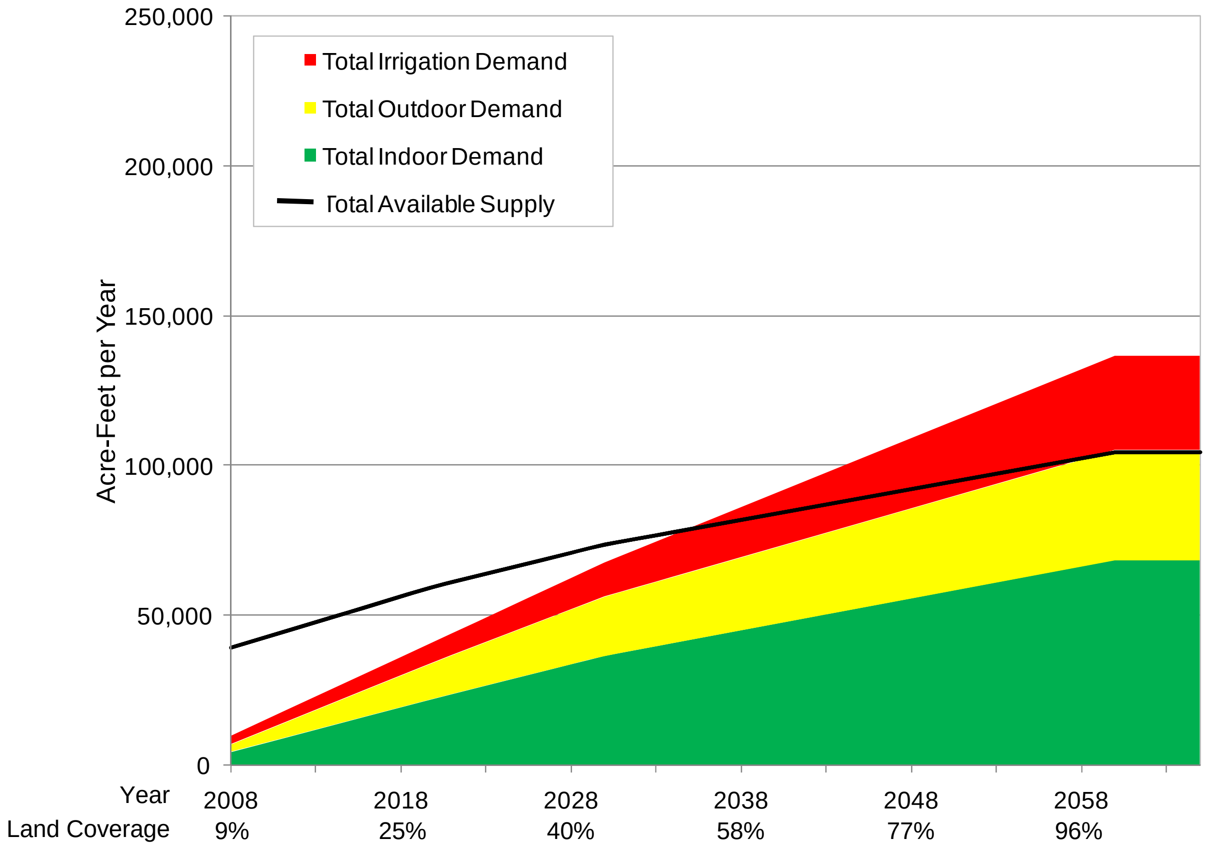
The Water Resource Model evaluations also pointed to the following conclusions that must be factored into the future water resources strategy:

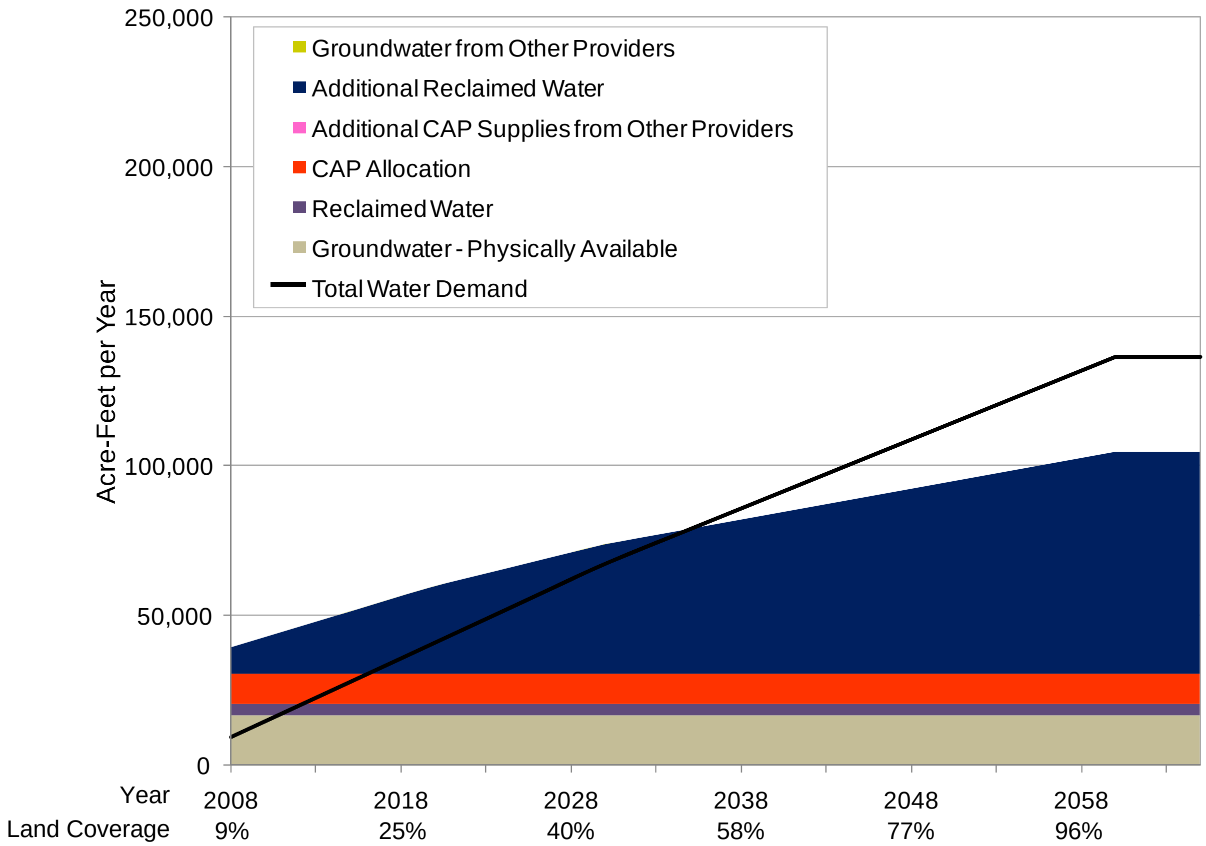
- Although Figures 8-4 through 8-7 show that demands will exceed supply beyond 2035-2040, the deficit is considered within the margin of error of the planning assumptions. Any additional water supply that can be added to the City's portfolio (e.g., CAP incentive recharge water, additional physically available groundwater, long term storage credits, etc.) would dramatically improve the demand/supply balance.
- In order to achieve the target population between 500,000 to 700,000, the City must be prepared to reduce the allowable development densities. For example, the evaluations were based on managing the undeveloped Rural Residential average densities to between 0.5 and 1.0 du/acre.
- Future landscaping guidelines must be implemented and enforced. The City cannot continue to develop using high water using landscape that is currently prevalent in SPA 1. At a minimum, the City should be prepared to implement the newly developed *Scenic Integrity Guidelines* to control future large landscape irrigation demands.





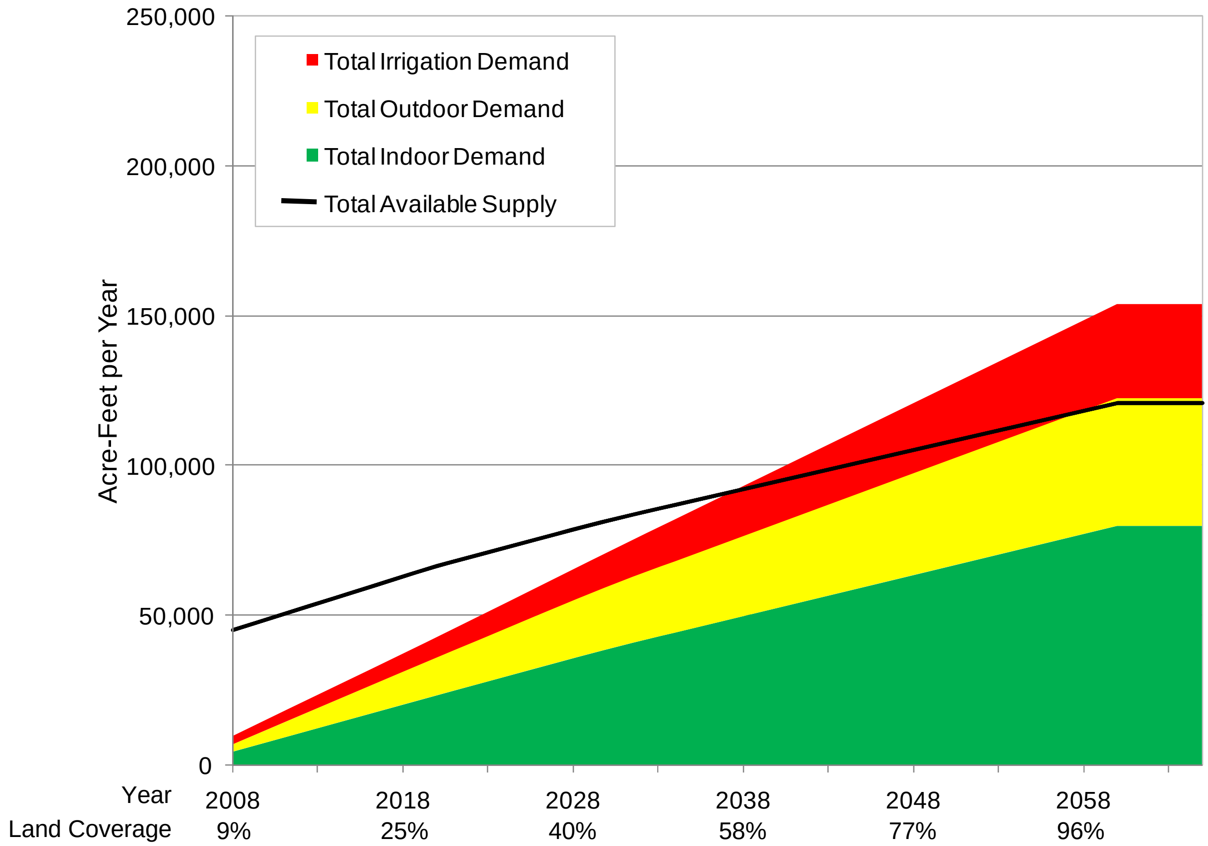
SURPRISE	CITY OF SURPRISE, ARIZONA INTEGRATED WATER MASTER PLAN: WATER RESOURCES **Mid Population Scenario (RR = 1.0 du/acre) Supply/Demand Comparison – No Private Water Company Allocations**	MALCOLM PIRNIE In Association With ASU Decision Theater
November 2008		**Figure 8-4**

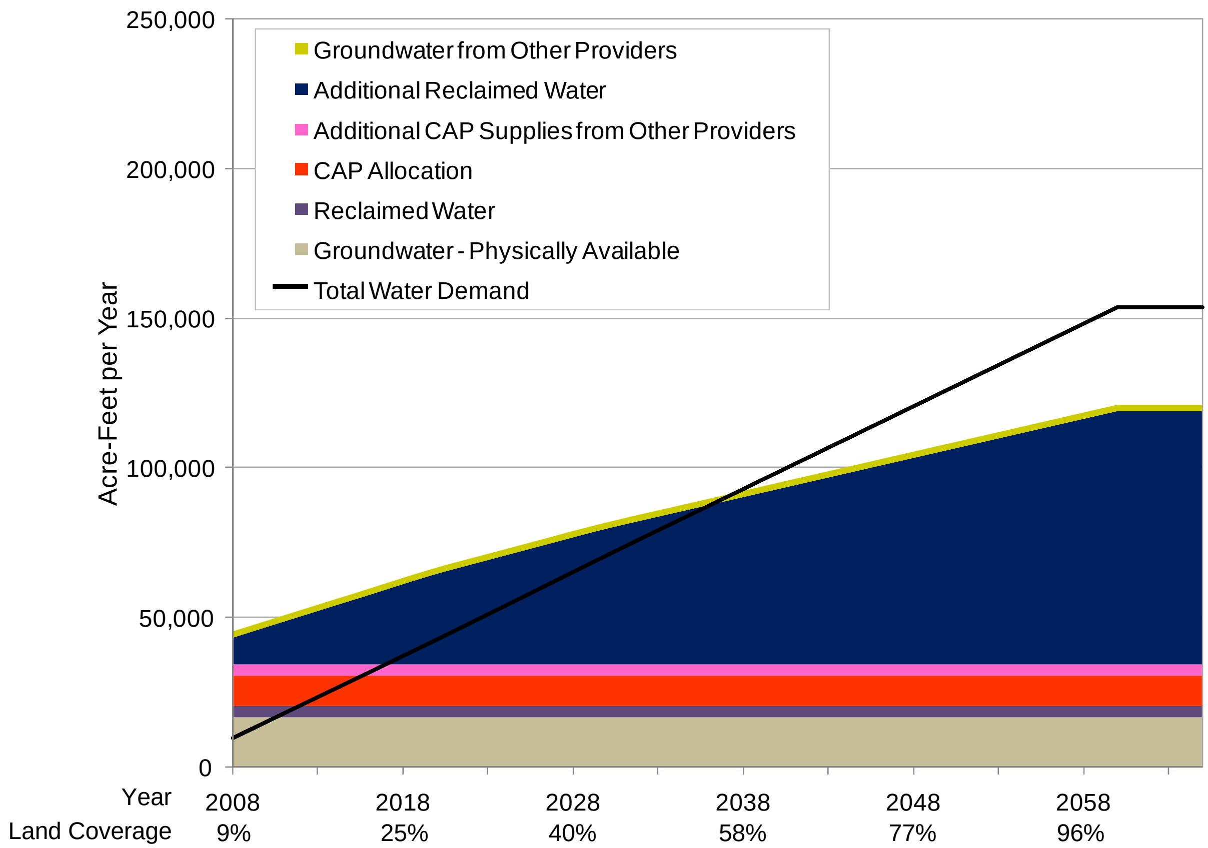




Mid Population Scenario (RR = 0.5 du/acre) Supply/Demand Comparison – No Private Water Company Allocations

Figure 8-5





CITY OF SURPRISE, ARIZONA

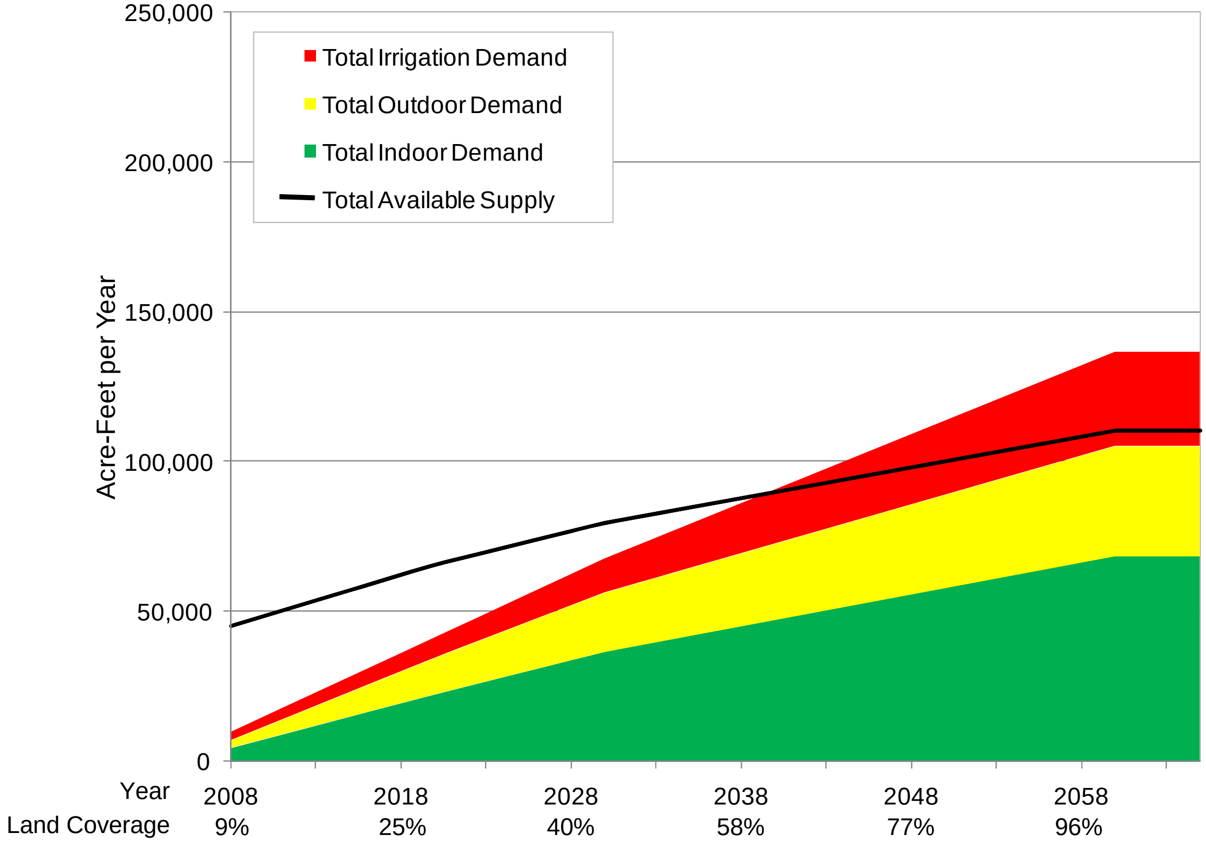
INTEGRATED WATER MASTER PLAN: WATER RESOURCES

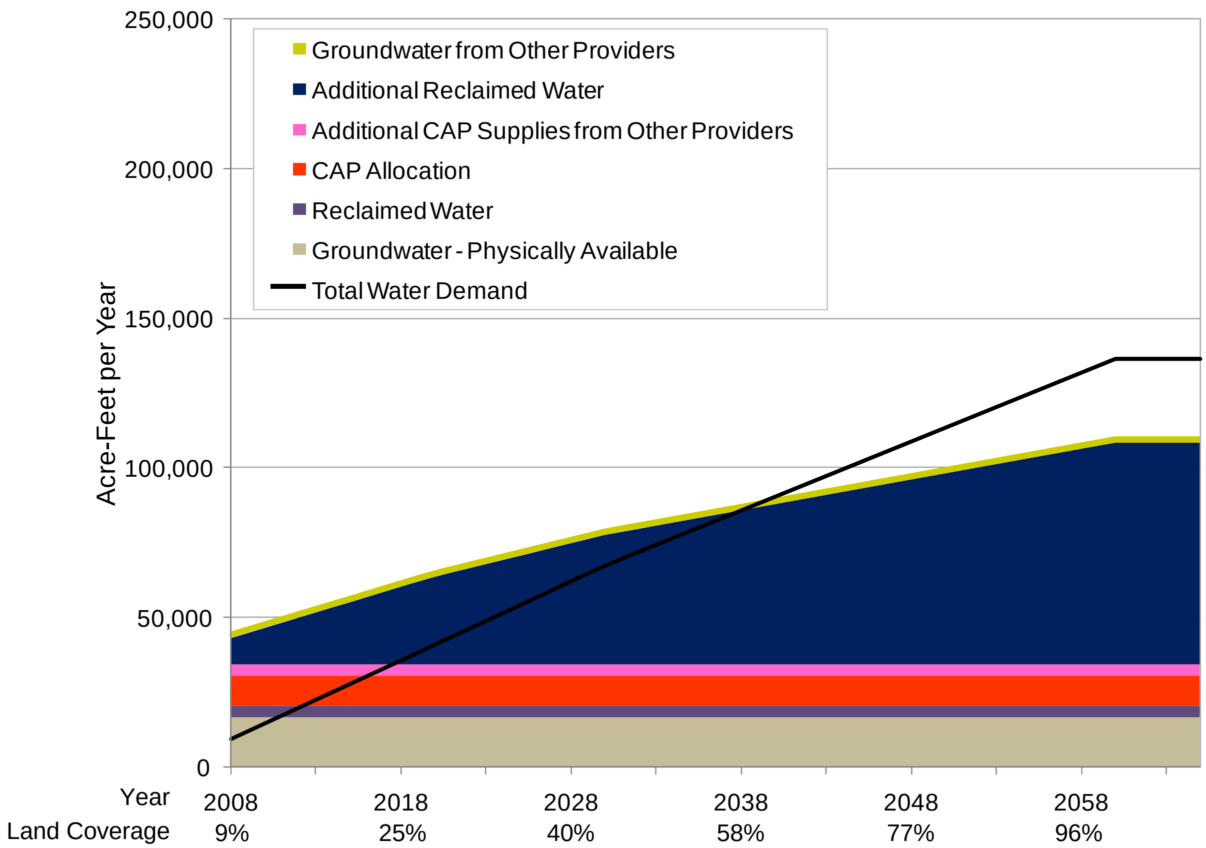
Mid Population Scenario (RR = 1.0 du/acre) Supply/Demand Comparison – With Private Water Company Allocations

November 2008

In Association With

Figure 8-6





November 2008

CITY OF SURPRISE, ARIZONA
INTEGRATED WATER MASTER PLAN: WATER RESOURCES

Mid Population Scenario (RR = 0.5 du/acre) Supply/Demand Comparison – With Private Water Company Allocations

In Association With

Figure 8-7

9. Water Resource Management and Assured Water Supply Strategy

This section provides the recommended water resource management strategy resulting from the evaluations and scenario comparisons completed and summarized in Sections 1 through 8. This section also provides the recommended approach to administratively achieving and maintaining assured water supply status with the ADWR.

9.1. Basis for Water Resources Master Plan

The recommended water resource management and assured water supply strategies were developed based on certain assumptions, significant findings related to potential future water supplies, and guidance provided by the City's Technical and Steering Committees during completion of the *Integrated Water Master Plan* Project.

Major Assumptions

The recommended water resource management and assured water supply strategies are based on the following major assumptions:

- Build-out will comprise 100 percent coverage of the land and uses described in the City's General Plan; i.e., any additional development (redevelopment, development intensification, etc.) beyond the current General Plan is not considered.
- Plans will provide full compliance with the regulatory framework.
- Recommendations are economically efficient and realistic.
- Recommendations are practical and implementable.
- These strategies represent a bridge to the eventual acquisition of sustainable water supplies and achieving a true sustainable balance between demands and supplies.

Potential Future Water Supplies

The significant findings from the review of potential future water supplies follow:

- Long-term renewable water supplies currently available to the region (CAP, SRP, MWD surface water, etc.) have essentially been fully allocated. There are no more large blocks of readily available renewable supplies that the City can pursue to fill significant shortfalls in future water supply.
- The next large blocks of water supply for the region are believed to be brackish groundwater from the southwest valley area and/or desalinated seawater, perhaps from as far away as Mexico. Both supplies will require large-scale and complex

water exchange agreements to allow cities like Surprise to gain access to the new supplies.

- The permitting and institutional process to develop the new additional water supplies will be too challenging, lengthy, and expensive for a single entity (like the City of Surprise) to achieve on its own. Likely, a regional water agency (like CAWCD, Bureau of Land Management, etc.) will implement the potential new supplies with the coordination of, and for the benefit of, all communities in the region.

Reclaimed Water Guidance

The following guidance was provided on future reclaimed water management, and the suggested evaluations were included in the infrastructure component of the *Integrated Water Master Plan*:

- Reclaimed water infrastructure is master planned to serve all large irrigation water customers, including parks, schools, HOA common areas, etc.
- The reclaimed water distribution system evaluation identifies how the City might configure and fortify the reclaimed water infrastructure to potentially serve additional water reuse demands.
- The reclaimed water and recharge evaluations identify facilities and infrastructure to recharge all excess reclaimed water that is not directly reused.

Planning For Sustainability

With respect to future water resources, the primary guidance provided by the City's Technical and Steering Committees is that the City must plan to manage existing available water supplies (groundwater, CAP surface water, and reclaimed water) to balance demands with supplies at build-out. The City will plan to achieve this balance by planning for a target build-out population between 500,000 and 700,000 and by implementing landscape guidelines that will reduce the landscape irrigation fraction of overall water demands significantly (as compared to current levels). In order to achieve this sustainable balance of supplies and demands, the City should adopt and incorporate the following into its future land use planning:

- Managing future development densities – The target population range was achieved by modeling residential densities in currently undeveloped areas to the middle of the density range identified in the General Plan for all residential categories except for Rural Residential ,which was modeled between 0.5 and 1.0 du/acre.
- Implementing the new *Scenic Integrity Guidelines* in all new developments.

9.2. Recommended Water Resource Management Strategy

In presenting the water resource management strategy, the following important definitions are noted:

- "Groundwater," as a physical resource, will be the primary basis of the City's future water supply for many years to come. While there are legal distinctions as to water that is actually pumped from City wells, for the purposes of this discussion, all water pumped from wells is considered groundwater. Addressing the legal distinctions for this water is addressed under Section 9.3. This will help to reduce the confusion in terminology between "wet" water and "paper" water.
- "Surface water" is constituted by water from the CAP, whether from the City's or other subcontracts, and water from the Agua Fria River as managed by the MWD.
- "Sustainable water" is water that is considered renewable on an annual basis which includes reclaimed, CAP surface water, MWD water, and desalinated seawater.

The recommended water resource management plan is organized chronologically into three time horizons: near-term recommendations should be addressed immediately, mid-term recommendations can be addressed over the next few years, and long-term recommendations are those that would achieve eventual water supply sustainability. The three time periods address the following water resources:

- Near-Term – effectively manage supplies that are currently available:

  Groundwater
  CAP water
  MWD water
  Reclaimed water

- Mid-Term – potentially acquire other supplies that may be currently available:

  Private water companies CAP water

- Long-Term – position the City for its share of next available renewable water supplies:

  Additional resources

9.2.1. Near-Term Water Resource Management: Groundwater

The water resource management recommendations related to groundwater supplies that should be addressed as soon as possible are listed below along with appropriate justification.

Conduct Groundwater Recharge and Quality Studies

The City should continue an aggressive campaign of groundwater development targeting areas where the depth to water (lift) and the quality of the groundwater are optimized to the extent practical. In order to accomplish this, the City should complete a comprehensive hydrogeologic study of its entire planning area and consider having a comprehensive groundwater model constructed from the results. The purpose of these studies would be to:

- Assist in well siting by identifying definitive areas of suitable water quality and predicting water production capacity
- Identify locations and project the amounts of natural groundwater recharge
- Identify artificial recharge potential and locations for recharge facilities to be used as part of underground storage and recovery projects
- Define groundwater quality to determine the types and extent of groundwater treatment needed for future potable supplies
- Identify saturated thickness and adjacent or near-by wells owned by other parties including domestic wells, MWD, and private water companies

Implement Groundwater Management

The City should continue recharging all its CAP water that it does not use directly and developing the recharge element of the reclaimed water program. Future uses of groundwater will have to be offset nearly 100 percent (there are some exceptions as discussed in Section 9.3) either by storing renewable water supplies underground in advance of withdrawals (long term storage), in the same year that withdrawals are occurring (annual storage and recovery), or after withdrawals have occurred by paying the CAGRD to perform this service.

Prepare for Future Groundwater Treatment

The City should include a detailed evaluation of treatment technologies and brine management in the Water Technology Assessment project that commenced recently. Where future wells are likely to require some additional treatment beyond disinfection, the well sites will need to accommodate the treatment facilities and treatment residual disposal requirements. Because treatment residuals can contain concentrated salts and minerals, disposing of the residuals into the wastewater system should be discouraged as these by-products will ultimately be recycled and change the quality of the reclaimed water, which is going to be needed for direct uses and for underground storage.

The City should also consider investigating opportunities to secure lower cost energy alternatives. As groundwater levels decline over time either by City use or because of other groundwater withdrawals in the area, power requirements for pumping will escalate. Also, additional power may be needed to provide treatment for poorer quality groundwater.

Compare Costs of Groundwater Treatment vs. Surface Water Treatment

The drinking water evaluation in the Water Infrastructure component of the *Integrated Water Master Plan* compares the costs for groundwater production, treatment, disinfection, and distribution against the cost of constructing and operating a surface water filtration plant for direct use of its CAP supply.

9.2.2. Near-Term Water Resources Management: Surface Water

The water resource management recommendations related to surface water supplies that should be addressed as soon as possible are listed below along with appropriate justification.

Complete Perfection Process for CAP Allocation

There is still one apparent step required for the City to "perfect" its total allocation of CAP water. This ratification is an essential step, and the City should give it first priority to resolve. CAP represents the only source of imported renewable water that the City can currently access. Until and if such time it is prudent to construct a water filtration facility, CAP water should be banked at City-owned or CAWCD storage facilities or at any groundwater savings facility where capacity exists. This will address issues with respect to the "paper water" accounting issues (assured water supply management), but it may not provide tangible "wet water" benefits to the City except at City-owned facilities or at CAWCD's Hieroglyphic Mountains facility. Because the Hieroglyphic Mountains facility is located within the City's water planning area, it should be the first choice for storage at CAWCD regional facilities.

Compare Costs of City-owned vs. Regional Recharge Facilities

A comparison of long-term recharge of CAP water at the CAWCD regional facilities versus prospective City-owned facilities is included in the drinking water evaluations in the Water Infrastructure component of the *Integrated Water Master Plan*.

Consider Acquiring and Banking other Available CAP Supplies

The City should embark on an aggressive strategy to bank water now at the lowest possible cost. Currently, there is a subclass of CAP water available, pursuant to an annual interruptible subcontract, known as incentive recharge water. This water is offered at a discount rate and can be used to deliver water for underground storage. As the City has funds available and is willing to secure additional permitted capacity at existing storage facilities (CAWCD regional facilities), it should purchase as much of this water as possible and gain storage credits while they are still available. This financial advantage is planned to be eliminated by the CAWCD in 2012.

Encourage Continued Urban Irrigation with MWD Water

The City should encourage the delivery of MWD surface water to member lands for exterior water use (urban irrigation), thereby reducing the demand on the City to provide potable and/or reclaimed water to these lands. The MWD may be able to provide its lands with an average of one acre-foot of surface water per year. There are approximately 1,440 acres of MWD lands within the City's water service area. The benefits are that the City can save on infrastructure needs, pumping costs, and groundwater offsets (assured water supply management) for these lands. If the lands require additional water above and beyond the one acre-foot of surface water, the MWD can also deliver groundwater from its groundwater wells, again, eliminating the need for the City provide infrastructure or water for these lands' exterior water uses.

9.2.3. Near-Term Water Resource Management: Reclaimed Water

The water resource management recommendations related to reclaimed water supplies that should be addressed as soon as possible are listed below along with appropriate justification.

Master Plan Dual Distribution System to Serve Largest Reuses

Reclaimed water has been identified as the primary future water supply for the City. The analyses of direct use and underground storage and recovery appear to have concluded that a combination of these strategies is warranted. As such, a master plan for a dual distribution system to serve large customers should be developed.

Identify Potential to Serve Additional Reuses

The City should investigate the potential to serve additional reuses by modeling the dual distribution system with the "maximize reuse" demands (i.e., serving all potential reuses). The Water Infrastructure component of the *Integrated Water Master Plan* includes this evaluation, identifies the portions of the system that are stressed, and proposed additional infrastructure and costs to reduce the stress associated with serving additional reuse demands.

Develop City-owned Recharge Capacity for Excess Reclaimed Water

The City should identify locations and facility sizing for recharge of all excess reclaimed water. This evaluation, which is included in the Water Infrastructure component of the *Integrated Water Master Plan*, focused on spreading basin recharge where possible, followed by vadose zone wells, then by aquifer storage and recovery wells.

Pursue GSF Permits for Reclaimed Water Deliveries to Farms

The City is currently delivering reclaimed water to a farm outside of the City's municipal planning area. Although providing this water is reducing the amount of groundwater pumped by the farm, a GSF permit has not been obtained that would allow the City to accrue long term storage credits for the water delivered to the farm. The City should obtain any potential GSF permits as soon as possible.

9.2.4. Mid-Term Water Resource Management: Private Water Companies

In addition to using its own allocation of CAP water, the City may have an opportunity to acquire additional CAP water from the private water companies located within the City's annexed and planning areas. While there are multiple ways to acquire this water, most will take some period of time to accomplish. The mid-term strategies for private water companies are as follows:

Potentially Acquire Private Water Company Allocation

The City should investigate the potential to acquire the CAP allocation currently assigned to Circle City Water Company, which has a CAP subcontract and does not appear to currently have plans to put this water to direct use in the immediate future. There are three alternatives for acquiring these allocations:

- Negotiate for a temporary assignment of this water to the City
- Negotiate for a permanent acquisition of CAP water without acquiring the water companies
- Negotiate for a permanent acquisition of CAP water as part of an acquisition of the water companies

Investigate Temporary Assignments of Other Allocations

The City should investigate the potential for obtaining temporary assignment of CAP allocations for the only other private water company within its planning area that has a CAP allocation: the AAWC. AAWC has a CAP subcontract that is currently not fully used. The City has expressed it does not have a desire to acquire this company because of its size and the potential cost of such an acquisition. However, the City may be able to approach AAWC to see if it would be willing to assign any potentially unused portions of its CAP subcontract for a specific period of time. While AAWC is apparently a prime partner in the cost of a water filtration plant to put their CAP water to use, it is unknown at this time if there will be excess water available in the interim or for some time into the future for the City to access.

9.2.5. Long-Term Water Resource Management: Additional Resources

A portion of the City's existing water supply portfolio is mined groundwater that requires replenishment or storage of additional water in advance to avoid creating a need for replenishment. As such, the City should attempt to "fill out" its water portfolio with additional resources developed as part of a regional supply effort in order to achieve true water resources sustainability. This will eliminate groundwater "mining," provide a water supply buffer in case water demands exceed projections, and provide additional water supplies that could allow the City to plan for enhancing development opportunities in the future.

The City should establish a high profile presence in discussions that could generate a regional water supply augmentation program. The City should actively participate in the regional discussions to:

- Express expectations to participate in newly developed supplies
- Secure a "place at the table"
- Be seen and be heard

9.3. Recommended Assured Water Supply Strategy

The assured water supply strategy deals with the "paper water" issues. In other words, the regulatory framework and reporting requirements associated with Arizona's water laws. In order to be effective, the City's assured water supply strategy:

- Must be compatible with the water resource management strategy
- Must provide the City the ability to grow
- Must pass the "common sense" test
- Must be economically efficient
- Must be diligently monitored

The components of assured water supply for the City include groundwater, surface water, reclaimed water, and water conservation.

9.3.1. Assured Water Supply Requirements

ADWR's Assured Water Supply program has very specific legal requirements the City must demonstrate. These requirements are briefly outlined below:

- Physical Availability for 100 Years: For groundwater, physical availability means that it must be hydrogeologically available (groundwater levels cannot exceed 1,000 feet below ground surface or bedrock, whichever is shallower), and the infrastructure must also be available to use the groundwater. For surface water, physical availability means that a water filtration plant or an annual storage and recovery program (water stored underground and recovered from recovery wells in the same year) must be in place.
- Legal Availability: For groundwater delivery and uses, water must be withdrawn pursuant to the City's service area right. For surface water to be legally available, there must be an executed contract for CAP water between the City and the CAWCD or to a party that contracts with the City, or there must be a valid permit or certificate of water right to the City. For reclaimed water, it must be produced at City-owned facilities or under a contract between the City and another reclaimed water producer for delivery to the City to be counted as legally available.

- Continuous Availability: The water supply must be considered uninterruptible (e.g., long term contracts, hydrologic analyses showing long term annual yield for surface water rights).
- Water Quality: The water supply must meet or be able to meet the requirements of the Safe Drinking Water Act with economically feasible treatment.
- Water Use Consistent with the Goal of the AMA: The goal of the AMA is safe yield by 2025; therefore, no mined groundwater can be used in new Designations of Assured Water Supply – it must be replaced with renewable water supplies or replenished by the CAGRD or the City must show it has 100 percent renewable water supplies.
- Water Use Consistent with the Goal of the AMA Management Plan: The water conservation requirements of the Groundwater Code must be met.
- Financial Capability: New drinking water infrastructure needed to meet water demands must be shown in the City's Capital Improvement Plan and/or executed development and/or annexation agreements.

9.3.2. Assured Water Supply - Groundwater

For the purposes of the assured water supply strategy, water pumped from wells is not always defined as groundwater. By permitting a well as a recovery well, the legal identify of the water pumped by the well can be changed to whatever type of water the City has previously stored underground (CAP or reclaimed water), or the City can simply choose to account for the water as groundwater. However, groundwater (as defined under the Groundwater Management Act and, therefore, the Assured Water Supply requirements) must be eliminated entirely from the City's water portfolio or it will have to be replenished by the CAGRD. This means that all water recovered from wells by the City actually are double cost – not only must the City pay for the cost of producing the water from the well, the City must store water in advance and have the water counted as stored water recovery, or the City must pay fees for replenishment to the CAGRD. On the other hand, if the City can demonstrate that it has enough renewable water supplies to meet 100 percent of the projected demand in its application for modification of the City's current Designation of Assured Water Supply), the City could withdraw from membership in the CAGRD.

There is an account created by the ADWR for the City known as a Groundwater Withdrawal Account. This account holds special credits available to the City. They are:

- Incidental Replenishment Credits – ADWR credits the City with 4 percent of its previous annual demand to the City's Groundwater Withdrawal Account based upon the assumption that this amount of water is returned to the aquifer as a result of the use of water within the City. This water can be "recovered" by the City to reduce the amount of water counted from wells as groundwater.

- Extinguishment Credits – Within the ADWR's administrative rules, there is a provision that grandfathered groundwater rights (Irrigation, Type 1 Non-Irrigation, and Type 2 Non-Irrigation) can be "extinguished," which means the grandfathered right is permanently eliminated from the AMA. Under the rules, extinguishment credits (also called assured water supply credits) equal to 1 acre-foot per credit, are created. For Irrigation Grandfathered Groundwater Rights, and for Type 1 Non-Irrigation Grandfathered Groundwater Rights, the formula for calculating the number of credits under the administrative rules is 1.5 multiplied by the number of acres on the groundwater right certificate, multiplied by the number of years between 2025 and the year the right is extinguished. For Type 2 Water Rights, it is the number of acre feet per year on the certificate. These credits can also be used to reduce the amount of the City's replenishment obligation.

The amount of groundwater determined to be physically available to the City must be estimated using a groundwater model acceptable to ADWR. For the application effort underway at the time this document is being written, ADWR is producing a new regional model that all water users will be using for their applications for modification of their Designations of Assured Water Supply. The amount of groundwater that will be determined to be physically available to the City will be based on the model and the City's ability to pump the amount of water that it projects it will need for the next 15 years (current capacity and the financial ability to build additional capacity).

To maximize this amount of water, the City must accurately project its maximum expected water demand through the year 2025. If, however, the projected demand exceeds the amount of groundwater determined to be physically available by ADWR, other water supplies will be needed to fill the gap, or development will be restricted to the amount of groundwater determined to be physically available. Local recharge at the Hieroglyphic Mountains regional recharge facility on behalf of the City and at City-owned facilities can increase the amount of water deemed physically available to the City.

Factors that have the potential to reduce the amount of groundwater physically available to the City include the City's existing commitments to serve, other local water providers' commitments and projections to serve, and other groundwater rights in the area (other existing groundwater rights and uses in or near the City).

The recommended assured water supply strategy for groundwater supplies is summarized as follows.

Maximize Physical Availability

The City should make all efforts to maximize its groundwater physical availability in its Application for Modification of Assured Water Supply. The City should complete the following activities:

- Develop a well development plan (included as part of the Water Infrastructure component of the *Integrated Water Master Plan*)
- Demonstrate financial capability to construct new needed infrastructure in the water capital improvement plan and executed annexation and development agreements
- Develop a pumping plan for existing and potential wells in the service and planning areas

Acquire Pledges for Extinguished Groundwater Rights

The City should require that groundwater rights in and near the City's water service and planning areas (within the City's annexed, or to be annexed, areas) be extinguished and the credits pledged to the City's account at ADWR.

9.3.3. Assured Water Supply – Surface Water

The City's permanent CAP allocation is considered perpetually renewable for the purposes of a Designation of Assured Water Supply. If the City develops treatment facilities to take delivery of the water and use it directly, the CAP water will be counted up to the capacity of the facility. If the City permits an annual underground storage and recovery facility, the capacity of the City to store and recover water on an annual basis will be counted as part of the City's available supply.

Water from the MWD would not be considered as part of the City's assured water supply if deployed pursuant to the water resources management strategy. However, the urban irrigation supply will effectively reduce the exterior water demand for the homes located within the MWD service area. The urban irrigation arrangement for this area may need documentation from the City and from the MWD. Additionally, during drier years, groundwater from MWD can be supplemented for urban irrigation customers without the City incurring a groundwater replenishment obligation for the water use.

The recommended assured water supply strategy for surface water supplies is summarized as follows.

Maximize Physical Availability of Surface Water

The City should maximize the physical availability of its CAP water by permitting and operating annual underground storage and recovery facilities, and permitting all existing and new wells as recovery wells.

Document MWD Supply for Urban Irrigation

The City should develop and maintain a relationship with MWD for urban irrigation deliveries for the land located within the City and the MWD service area. The City should also work with MWD to document that MWD member lands will have its exterior irrigation water supplied by the MWD.

9.3.4. Assured Water Supply - Reclaimed Water

Reclaimed water represents the City's largest growing renewable water supply in the future. Under the Assured Water Supply program, the ADWR only counts direct reuse opportunities as supply. In other words, a reclaimed water user that has the ability to take delivery and use reclaimed water can have its water demand counted as being met by reclaimed water, thereby "releasing" other water supplies for other uses. In addition, reclaimed water that is permitted for annual underground storage and recovery up to the capacity of the storage facilities and recovery wells can be counted in the assured water supply.

The recommended assured water supply strategy for reclaimed water supplies is summarized as follows.

Maximize Physical Availability

The City should maximize its physical availability of reclaimed water by permitting and operating annual underground storage and recovery facilities, including permitting all existing and future City wells as recovery wells.

Document Direct Reuse Facilities and Demands

The City should document all direct delivery opportunities, facilities and infrastructure, and projected demands for reclaimed water in its current Application for Modification of Designation of Assured Water Supply. The City should also clearly document planned infrastructure construction that will supply projected future demands. The reclaimed water infrastructure plans are included in the Water Infrastructure component of the *Integrated Water Master Plan.*

9.3.5. Assured Water Supply - Water Conservation

While water conservation is not a true water supply, it is an essential part of any water resource management program and is required under the Groundwater Management Act. The specific requirements are provided under the AMA management plans.

Historically, water conservation compliance was measured using gallon per capita per day (gpcd) targets. In the future, however, ADWR will work with the City to identify areas that show the greatest potential for water savings and will enter into an agreement with the City requiring implementation of specific water conservation programs and reporting on an annual basis using specific metrics agreed to by the City and ADWR.

Typically, most programs may be focused on exterior water uses by restricting landscape palettes in specific areas, requiring modern automated irrigation systems, and potentially even requiring artificial turf for large athletic and play surfaces. For interior uses, because most appliances are now efficient based on plumbing codes, even older, high water using devices will naturally be phased out with time. The City could accelerate the process if needed or required by ADWR through enforceable mandates and rebates. In some cases, for example, sub-metering of multi-family units has shown to be extremely effective and may be economically accomplished.

The recommended assured water supply strategy for water conservation is summarized as follows.

Document Existing Water Conservation Program

The City, at a minimum, will be required to and should document the elements of its current water conservation program for inclusion in its designation application.

Develop a Formal Water Conservation Plan

The City should develop a water conservation plan that identifies measures that are currently in place and those that will be implemented in the future. The plan should also provide a projection of the expected water savings.

THIS PAGE INTENTIONALLY LEFT BLANK

10. References

ADWR (Arizona Department of Water Resources). 1999. Third Management Plan 2000-2010: Phoenix AMA (December).

Billings, R.B. and C.V. Jones. 2000. Forecasting Urban Water Demand. American Water Works Association.

Black & Veatch. 2008. City of Goodyear 2007 Integrated Master Plan. City of Goodyear, Arizona (June).

EDAW/AECOM. 2008. City of Surprise Scenic Integrity Guidelines. City of Surprise, Arizona (May).

Malcolm Pirnie, Inc., HDR, and Clear Creek Associates. 2006. Water Resources Master Plan. City of Peoria, Arizona (January).

Malcolm Pirnie, Inc., Carollo Engineers, CH2MHill, and Hoque & Associates. 2006a. 2005 Water System Master Plan. City of Phoenix, Arizona (November).

Malcolm Pirnie, Inc. 2008. Water and Wastewater Master Plan Updates. City of El Mirage, Arizona (April).

Metcalf & Eddy. 1991. Wastewater Engineering: Treatment, Disposal, Reuse. McGraw-Hill, Third Edition.

RBF Consulting. 2002. Water Resources Master Plan. City of Avondale, Arizona (March).

RBF Consulting. 2004. Water Resources Master Plan. City of Surprise, Arizona (June).

RBF Consulting. 2004a. Water Infrastructure Master Plan. City of Surprise, Arizona (June).

Surprise, City of. 2000. Surprise General Plan 2020: Imagine the Possibilities. City of Surprise, Arizona (November).

Surprise, City of. 2006. Water Guidelines and Standards. City of Surprise, Arizona (June).