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## SECTION 1: PURPOSE

### 1.1 PURPOSE

The *2009 Water and Sewer Master Plan* summarizes the Parker Water and Sanitation District's (District) existing water and sewer system components, projected future development, and anticipated infrastructure improvements to accommodate future growth.

### 1.2 CHANGES FROM THE PREVIOUS MASTER PLAN

#### 1.2.1 Ultimate Development

The *2009 Water and Sewer Master Plan* estimates 43,507 SFEs.

#### 1.2.2 Water Usage and Wastewater Production

Historic and current water demands and wastewater production values are provided in **Table 1-1**.

**Table 1-1: Historic Water Demand and Wastewater Production**

Year	Average Water Demand (gpd/SFE)	Average Wastewater Production (gpd/SFE)
1999	355	203
2003	319	210
2005	425	221
2007	391	234

## SECTION 2: DEVELOPMENT

### 2.1 LOCATION AND SERVICE AREA

#### 2.1.1 Location

The District is located approximately 20 miles southeast of Denver in Douglas County, Colorado.

#### 2.1.2 Service Area

The District's service area is the total area the District may legally serve without further inclusions or agreements, and is shown in **Exhibit 1**. The District has 27,599 acres within its current service area. The District's boundary represents the extents of its inclusions, while the service area reflects additional service agreements for area outside its boundary. The District has 20,924 acres within its current boundary area. The District's service area and boundary will grow as future developments are included.

### 2.2 DEVELOPMENT AND POPULATION

#### 2.2.1 Definition of Single-Family Equivalents (SFEs)

For the purposes of this document, growth projections are based on Single Family Equivalents (SFE). One SFE is equal to the water demand and wastewater production of a single family residence. One SFE has a three-quarter inch (3/4") water line and a 4" sanitary sewer line. A residential multi-family unit is equal to 0.75 SFEs. A multi-family unit is assumed to use less water than a single family residence because multifamily units typically have minimal to no irrigation. Commercial, non-commercial, and irrigation customers are converted to SFEs based on the cross-sectional area of the water service line. For example, a 1" water service equals 2 SFEs, a 1.5" water service equals 4 SFEs, and a 3" water service equals 16 SFEs.

#### 2.2.2 Existing Single-Family Equivalents

As of June 2008, the District had sold 15,802 water SFEs and 13,728 sewer SFEs. The water SFEs are higher due to dedicated irrigation systems that produce no wastewater. As of June 2008, the number of active water taps was 15,643 SFEs. The number of sold taps is higher than the number of active taps because not all sold taps were connected yet. **Table 2-1** summarizes the District's June 2008 SFE composition. State demographic data estimates the average number of people per household at 2.95. Based on the sewer SFEs, this results in an estimated population of 40,498. **Table 2-2** provides historic SFE data.

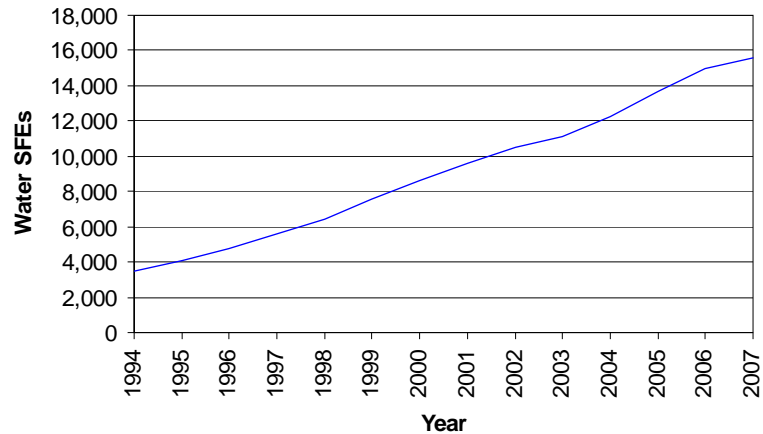
**Table 2-1: June 2008 District SFE Composition Data**

Category	Water SFEs	% of Total
Single Family	11,614	74
Multi-family	1,205	8
Commercial	1,009	6
Irrigation	1,815	12
<b>Total SFEs</b>	<b>15,643</b>	

Note: The numbers in **Table 2-1** represent the total number of active taps in use in the District.

**Table 2-2: Historic Tap Sales**

End of Year	Water SFEs
1994	3,459
1995	4,049
1996	4,735
1997	5,613
1998	6,399
1999	7,587
2000	8,624
2001	9,619
2002	10,480
2003	11,140
2004	12,215
2005	13,694
2006	14,960
2007	15,582



### 2.2.3 Future Development

Historically, most of the residential development in the District has been east of Parker Road. The older neighborhoods such as Parker North and Parker Heights have existed since the 1970's. Development in the 1990's was concentrated in two major subdivisions: Villages of Parker/Canterberry Crossing and Hidden River. Clarke Farms was the largest subdivision on the west side of Parker Road. Other developments, such as Challenger Park, were mostly built-out by 2002. Development is currently concentrated on the west side of the District with large developments like RidgeGate, The Canyons, and Anthology.

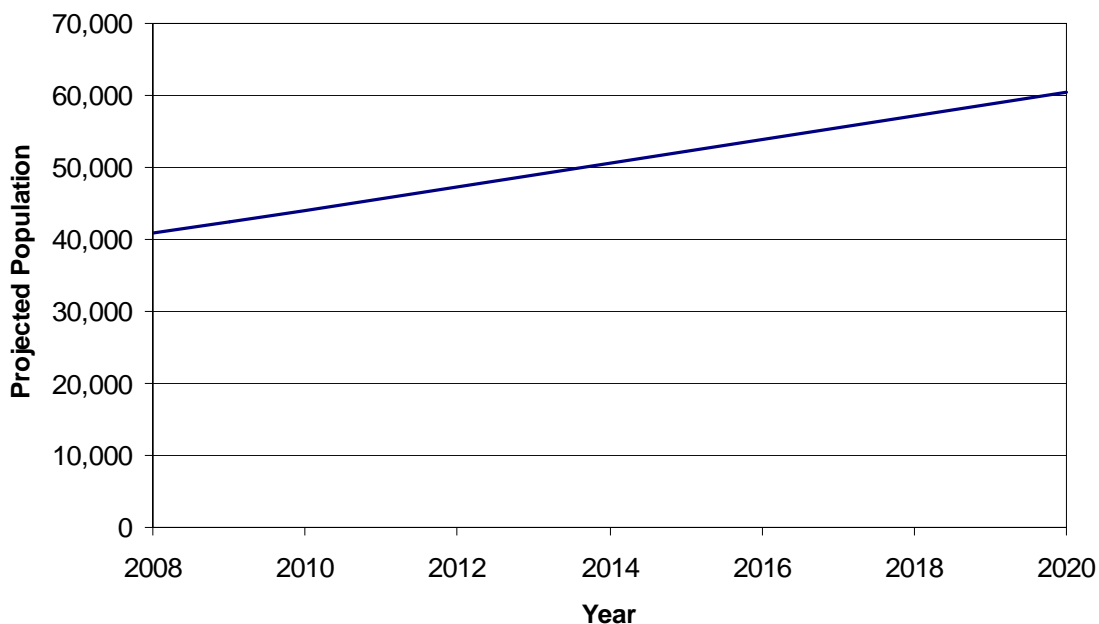
SFE and population projections are given in **Table 2-3**. The projections are based on Colorado Department of Local Affairs projections. Other regional projections reviewed were the Town of Parker, Douglas County, and the Denver Regional Council of Governments. The projections are for informational purposes only.

**Table 2-3: Projected Growth Summary**

Description	2008	2009	2010	2015	2020
Projected District Population <sup>1</sup>	40,793	42,354	43,975	52,284	60,449

(1) Projected District population is based on 2.95 people per non-irrigation SFE (single family residential, multifamily, and commercial properties).

Note: All numbers estimated at the end of the year listed.



The projected growth for each of the individual developments within the District's anticipated service boundary is provided in **Table 2-4**.

**Table 2-4: Projected Growth by Development in SFEs**

Development Name	2008	2009	2015	2020	Ultimate
Antelope Heights	215	215	215	215	215
Anthology	0	0	150	300	5,566
Auburn Hills	419	419	419	419	419
Bell Cross Ranch	74	74	74	74	74
Bradbury Ranch	1,368	1,368	1,368	1,368	1,368
The Canyons	0	0	100	200	1,533
Canterberry Crossing	2,190	2,250	2,400	2,525	2,662
Carousel Farms	0	10	50	90	175
Centennial Ranch	25	30	30	30	30
Challenger Park	437	450	473	473	473
Clarke Farms	1,521	1,625	1,900	2,125	2,277
Commercial property	1,009	1,020	1,040	1,060	1,100
ComPark	0	0	75	150	1,100
Cottonwood South	209	209	209	209	209
Cottrell Farms	74	74	74	74	74
Country Meadows	201	204	204	204	204
Coyle/Perkins	0	0	40	80	102
Creekside at Parker	37	37	37	37	37
Dransfeldt Place	0	0	15	30	63
The Enclave	0	0	100	200	250
Fairweather Landings	0	10	50	100	149

<b>Development Name</b>	<b>2008</b>	<b>2009</b>	<b>2015</b>	<b>2020</b>	<b>Ultimate</b>
Hidden River	925	935	975	1,023	1,023
Hilltop Apartments	78	90	175	250	365
Horse Creek	0	15	100	175	422
Horseshoe Ridge	6	15	100	175	450
Idyllwilde	230	250	375	500	919
Ironstone Apartments	128	130	135	145	160
Jordan Crossing	29	45	90	110	110
Lincoln Creek	9	25	100	150	213
Lincoln Meadows	0	10	100	150	150
Miller Creek	0	10	50	50	50
New Horizons	81	84	84	84	84
Newlin Acres	0	0	15	30	60
Newlin Meadows	225	235	300	350	556
Neu Towne	88	100	150	200	532
Overlook at Cherry Creek	0	10	50	100	200
Parker Auto Plaza	0	10	50	100	100
Parker Heights	73	80	80	80	80
Parker Homestead	0	0	150	275	400
Parker North	309	309	309	309	309
Parker Ranch	90	90	90	90	90
Parker Vista	200	210	220	220	220
Pine Bluffs	36	50	100	150	602
Pineview Condominiums	4	4	4	4	4
Quail Creek	99	102	102	102	102
Rampart Station	139	150	178	178	178
Rancho Montecito	12	15	25	25	25
Reata Ridge	0	0	50	90	150
Reata West	0	0	50	90	150
Regency	31	40	100	150	235
RidgeGate	0	0	150	300	11,000
Robinson Ranch	61	75	125	151	151
Roth Property	0	0	25	50	81
Rowley Downs	321	323	323	323	322
Saddlebrook	203	203	203	203	203
Salisbury Heights	0	0	100	150	150
Sierra Ridge	0	0	100	200	1138
Smith Property	0	0	50	100	240
Spirit Gulch	76	85	116	116	116
Stroh Ranch	1,423	1,440	1,500	1,550	1,632
Sunset Ridge	269	280	350	392	392
Sunmarke Townhomes	6	6	6	6	6
Tallman Gulch	1	13	52	114	130
Town & Country Townhomes	375	376	376	376	376
Townhomes at Canterbury	20	30	60	60	60
Trailside Apartments	66	66	66	66	66
Turtle Creek	156	165	250	300	352

<b>Development Name</b>	<b>2008</b>	<b>2009</b>	<b>2015</b>	<b>2020</b>	<b>Ultimate</b>
Valley Crest	0	0	25	50	120
Village on the Green	0	10	100	175	200
West Parker 98	0	0	50	100	300
Westcreek	0	10	50	50	50
Willow Park	266	266	266	266	266
Woody Creek	0	0	50	75	136.5
<b>Total</b>	<b>13,814</b>	<b>14,357</b>	<b>17,723</b>	<b>20,491</b>	<b>43,507</b>

Note: New development information is limited. 3 SFEs per acre were assumed for residential (as an approximated average between low- and medium-density development) and commercial development.

The SFE projections provided in this section will be used to determine what future infrastructure will be required to provide water and sewer service to the District's customers.

## SECTION 3: WATER SYSTEM

### 3.1 GENERAL

The District provides water service to existing developed areas through a system of wells, storage tanks, booster stations, and transmission mains. As proposed developments are completed, resulting growth will place more demands on the system. The District will have to provide additional facilities to meet these demands. This section summarizes the water system, historical water use project demands, system design criteria and identifies the future infrastructure needs of the District.

At this time, 100 percent of the District's raw water is from the ground, either deep Denver Basin aquifers or the Cherry Creek alluvium. The Denver Basin consists of four major aquifers: Dawson, Denver, Arapahoe, and Laramie Fox-Hills (LFH). The District owns water rights in these four aquifers and uses well facilities to extract the groundwater. Additionally, the District has rights to use groundwater in the Cherry Creek alluvium. Regardless of the source, the District disinfects the groundwater and delivers it to the potable water system for use by its customers; no additional treatment is required by Colorado Department of Public Health and Environment regulations.

**Exhibit 1** shows the existing water system. **Exhibit 2** shows the ultimate water system improvements. The system improvements have been created based on design criteria and calculations in this document.

### 3.2 HISTORIC DEMANDS, WATER RIGHTS, AND WATER QUALITY

#### 3.2.1 Historic System Demands

**Figure 3.1** shows the monthly system demands for the years 2005 through 2008. This data reflects the water conservation measure currently in use by the District, such as increasing the rates.

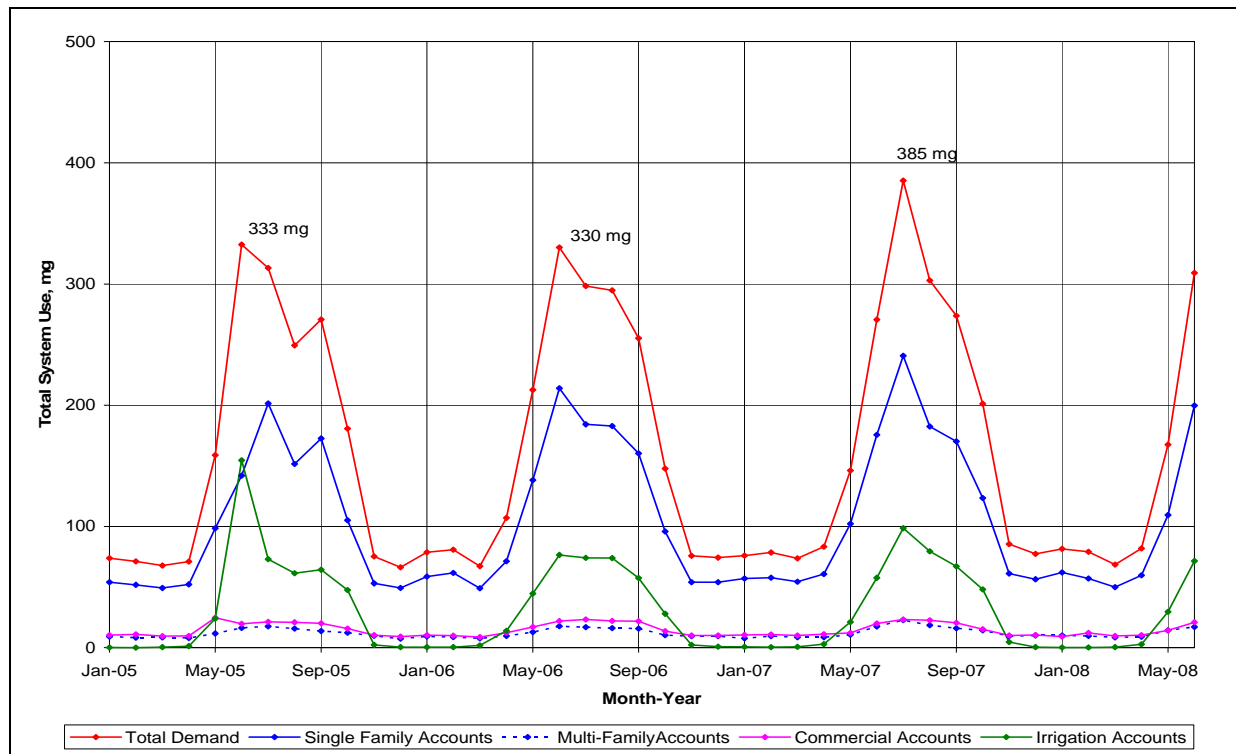


Figure 3.1 Monthly System Demands

As shown in **Figure 3.1**, peak system monthly demands varied from 330 million gallons (mg) and 385 mg between the years 2005 and 2007. Peak months were June and July when both Irrigation and Single Family accounts showed heavy use due to summer irrigation season. Multi-Family and Commercial accounts had a relatively stable demand over the course of the year with a slight increase over the summer irrigation season.

**Table 3-1** shows the percentage of demand accounted for on a yearly basis for each of the four account types.

**Table 3-1: Demand by Account Type**

Account Type	2005		2006		2007	
	Demand (mg)	% of Total Demand	Demand (mg)	% of Total Demand	Demand (mg)	% of Total Demand
Single Family	1,181	61	1,324	65	1,342	65
Multi-Family	138	7	144	7	154	7
Commercial	182	9	181	9	177	9
Irrigation	429	22	374	19	382	19
<b>Totals</b>	<b>1,931</b>		<b>2,023</b>		<b>2,054</b>	

Single Family accounts have used approximately 65 percent of total demand over the past three years while irrigation accounts use another 19 to 22 percent. Commercial and Multi-Family uses have accounted for 9 and 7 percent of total system demand, respectively.

The District uses the concept of single family equivalents (SFE's) for water accounting and planning. **Table 3-2** shows the growth in the four SFE accounts over the three and one-half year period between January 2005 and June 2008.

**Table 3-2: District SFE Growth**

Account Type	January 2005 SFE's	June 2008 SFE's	Percent Increase
Single Family	9,374	11,614	24%
Multi-Family	974	1,205	24%
Commercial	796	1,009	27%
Irrigation	1,240	1,815	46%

As shown in **Table 3-3**, the average demand per SFE has dropped from 425 gallons per day per SFE (gpd/SFE) to 391 gpd/SFE from 2005 to 2007.

**Table 3-3: Demand per SFE**

Year	Average SFE's	Total Water Use (mg)	gpd/SFE
2005	12,452	1,931	425
2006	13,776	2,023	402
2007	14,394	2,054	391

Between 2005 and 2007, the average total water consumption per SFE for all account types was 406 gpd/SFE.

It is important to note that during the summertime the District has agreed to provide the Canterbury Golf Course, located in the Canterbury Crossing subdivision, with up to 1.0 mgd of water per day. This water fills the golf course's irrigation pond. This demand is in addition to the demands from the District's other customers.

### **3.2.2 Definitions of Average Day, Maximum Daily, Peak Hour, and Fire Flow Demands for the Water System**

Average Day Demand (ADD) is defined as the average water consumption per day over an entire year. When maximum day and peak hour demands are not known, average day demand, and multipliers are used to estimate these higher demands.

Maximum Day Demand (MDD) normally occurs during one of the peak demand months. In the District's case, the maximum month has typically occurred in June or July. However, the District has no data on maximum day usage. Maximum day demand is an important value and is used to determine system treatment capacity, the size of transmission mains, and storage requirements. Additionally, the distribution system's response to fire flow demands is tested with maximum day demand plus fire flow demand scenario.

Peak Hour Demand (PHD) is the highest hourly consumption that the water system experiences at any given point in the year. It can be thought of as the consumption on a hot summer day with a high irrigation and recreational use demands. The system must be able to provide this demand. However, sizing facilities for this flow would be extremely expensive and unnecessary.

The difference between maximum day demand and peak hour demand is provided by system storage.

Fire flow demands are dictated by the South Metro Fire Protection District. The instantaneous demand depends on the type of structure. For example a single-family home’s fire flow demand is 1,750 gpm, while an attached unit or small commercial buildings will have a fire flow of 3,500 gpm. Schools and other high occupancy buildings will have a fire flow even higher than 3,500 gpm depending on the square footage and amount of fire sprinkler systems.

**3.2.3 Design Criteria**

The following table displays the District’s design demands and design criteria for the sizing of pipelines, potable storage, and other facilities.

**Table 3-4: Water System Design Values**

<b>Criteria</b>	<b>Value</b>
Average Day Demand (ADD) per SFE	400 gallons per day
Maximum Daily Demand Factor	2.5 times ADD
Peak Hour Demand Factor	5.0 times ADD
Ideal Minimum System Pressure at PHD	40 psi
Ideal Maximum System Pressure	150 psi
Minimum Fire Flow Pressure at MDD + Fire Flow Demand	20 psi
Maximum Pipeline Velocity at PHD	10.0 feet per second
Pumping Requirements for closed systems	Peak hour flow or maximum day plus fire flow, whichever is greater
Provided Water Storage	18 hours of maximum daily demand plus fire flow of 6,000 gpm for 4 hours

**3.2.4 Water Rights**

The previous section discussed the water supply requirements. In every distribution system there are losses between the water production facilities and the users’ tap. These losses include treatment plant waste, evaporation and percolation losses in storage reservoirs, and supply line leakage. These losses can typically run between 10 and 20 percent of total water produced. In the District’s case, most of the water that goes unaccounted for is untracked because of system leaks and non-metered usage. Thus, when determining what water supply requirements are necessary for future development, the District requires 0.7 ac-ft/year per SFE (624 gpd/SFE).

The District has, at a minimum, water rights of 25,137.8 ac-ft/yr (excluding Cherry Creek alluvial rights). A breakdown between the Denver Basin aquifers and alluvial rights is provided in **Table 3-5**. The Denver Basin rights are divided into non-tributary, not non-tributary, and Pre Senate 213 rights. Not non-tributary rights require some type of augmentation. In the District’s case, the use of tributary Cherry Creek water must be augmented. Tributary rights allow water withdrawal based on a priority system. Those acquiring rights in recent years are junior to those who have owned them since the 1850’s. During certain times of the year when water availability may be tight, such as the irrigation season, junior rights’ holders may be limited or precluded

from use of their tributary rights. For this reason, the District places little stock in most Cherry Creek rights which come up for sale from time to time because the creek is grossly over-appropriated.

**Table 3-5: District Water Rights**

<b>Aquifer(s)</b>	<b>Annual Appropriation (ac-ft./yr)</b>
Lower Dawson	5,282.8
Denver	7,161.6
Arapahoe	7,982.1
Laramie-Fox Hills	4,710.3
Cherry Creek Alluvial (CCA)	15,494.0
<b>Total</b>	<b>40,630.8</b>
<b>Total without CCA</b>	<b>25,136.8</b>

The District does have the right, however, to withdraw water from the Cherry Creek alluvium when the creek is determined to be a “free stream”, that is, when there are no calls on the stream by senior water rights holders.

### **3.2.5 Water Quality**

The District's raw water supply consists of deep Denver Basin aquifer wells and shallower wells in the Cherry Creek alluvium. The waters are of generally good quality and require little treatment. However, some of the Denver Basin aquifer wells contain higher than normal levels of iron and manganese, and water from Alluvial wells CC17 and CC15 contain radionuclide levels that are above drinking water standards.

#### **Iron and Manganese**

In sufficient concentration, iron and manganese are the cause of a reddish or blackish discoloration of the potable water. Though not a public health hazard, “red water” as it is often known, is a nuisance because it causes inconveniences, including staining of washed clothes.

In 1996, the District analyzed the raw water from existing wells. Their conclusions are summarized in the report titled, "Parker Water Discoloration Study," dated July 18, 1996. When their results are cross-referenced with complaints from homeowners, the most likely source of the red water appears to come from the Arapahoe aquifer. In particular, the A-3, Hidden River, Rowley Downs, Clarke Farms-Arapahoe, and Stroh Ranch-Arapahoe wells are believed to be the major contributors of high iron concentrations.

Water quality data from the report “PWSD Water Supply Operations Review” by John C. Halepaska and Associates, Inc., dated July 2004 indicates that water from the Clarke Farms, A-2, Parker North, Rowley Downs, Bradbury, Robinson Ranch and Hidden River well facilities have manganese levels at or above the secondary drinking water standard of 0.05 mg/l.

Suspended iron and manganese containing particles settle to the bottom of the well column when the pump is turned off. At start-up, this concentration of particles is pumped into the system, resulting in isolated pockets of red water. As a result, a "Blow Down" system has been installed at every operational well house in the District. The Blow Down system allowed this

highly concentrated red water to be washed away from the distribution system for a period of approximately thirty minutes after start-up of the well, prior to the water being introduced into the distribution system. In addition, well facilities have been equipped with “Seaquest” chemical injection systems. Seaquest is a proprietary sequestering agent that converts iron particles to a colorless state. As a result of these improvements, there are only a few customer complaints related to “red water” each year.

**Radionuclides**

Two of the water potential groundwater sources, CC-15 and CC-17, for the Regional Pumping Facility have Gross Alpha and Uranium concentrations that exceed the National Primary Drinking Water Standards (NPDWS) of 15 pCi/L and 30 µg/L, respectively. To achieve compliance with the NPDWS, water from CC-15 and CC-17 is blended with other groundwaters at the Districts Regional Pumping Facility to achieve compliance levels prior to being pumped into the distribution system.

The Gross Alpha and Uranium water quality data for wells supplying the Regional Pumping Facility is summarized in **Table 3-6**. The five groundwater wells located on the Regional Facility site, the two wells on the Salisbury site, CC-7, and CC-9 all produce water that has concentrations of Gross Alpha and Uranium below the NPDWS. Groundwater from well CC-15 and CC-17 exceeds the NPDWS by more than double for Gross Alpha and Uranium.

**Table 3-6: Gross Alpha and Uranium Water Quality Data for Regional Pumping Facility Groundwater Sources**

Well	Est. Flow, gpm	Gross Alpha, pCi/L	Adjusted Gross Alpha, pCi/L	Uranium, µg/L	Notes
Regional Dawson	175	3	3	1	Uranium below detection limit of 1
Regional Laramie Fox Hills	300	0.9	0.9	1	Uranium below detection limit of 1
Regional Arapahoe	350	1	1	1	Uranium below detection limit of 1
CC-13	750	17	9.0	12	
Regional Denver	45	1.1	1.1	1	Uranium below detection limit of 1
Salisbury Dawson	115	3.1	3.1	1.86	Uranium below detection limit of 1.86
Salisbury Arapahoe	150	1.8	1.8	1	Uranium below detection limit of 1.
CC-9	500	4.6	3.5	1.6	
CC-7	1,000	34	12.6	32	
CC-15	2,000	57	21	79	Highest value listed in well report used in the blending analysis.
CC-17	1,200	56	23	50	Highest value listed in well report used in the blending analysis.

Note: Corrected Gross Alpha = Gross Alpha Concentration – Uranium concentration\*0.67.

Wells CC-15, CC-17, CC-7 and CC-9 discharge to a common pipeline that is connected to the Regional Pumping Facility. Because CC-15 and CC-17 discharge to this pipeline and water from CC-15 and CC-17 needs to be blended prior to discharge into the distribution system, the amount of flow from this source needs to be limited to the blending capacity of the system. This is accomplished by utilizing a flow control valve on the pipeline carrying water from CC-7, CC-9, C-15, and CC-17.

**Disinfection**

All well waters delivered to the distribution system are disinfected with chlorine. To achieve the required disinfection, the District uses gaseous chlorine at some locations, but at the newer facilities liquid sodium hypochlorite is used for disinfection. The liquid chemical is preferred as it is safer to handle than gas.

**3.3 EXISTING WATER SYSTEM FACILITIES**

The District serves its customers with a series of groundwater wells, storage tanks, booster pump stations, and transmission mains. Each of these major facilities, which are owned and operated by the District, will be described in the following sections.

**3.3.1 Pressure Zones**

The District has three pressure zones, which can be seen in **Exhibit 1**. Because the District is centered along Cherry Creek, its topography is best described as a wide valley. The lowest area of the District is Zone 1. As you move east and west from Cherry Creek, the elevation increases and both the east and west portions of the service area include Zones 2 and 3. Elevations for the three existing pressure zones are shown below in **Table 3-7**.

**Table 3-7: District Pressure Zones**

<b>Pressure Zone</b>	<b>Ground Elevation Range</b>	<b>Max. Hydraulic Grade Line <sup>(1)</sup></b>	<b>Min. Hydraulic Grade Line <sup>(2)</sup></b>
1	5,780 ft – 6,000 ft	6128 ft	6078 ft
2	6,000 ft – 6,205 ft	6324 ft	6302 ft
3	6,205 ft – 6,440 ft	6595 ft	6571 ft

(1) Maximum hydraulic grade line is top of tanks in zone  
 (2) Minimum hydraulic grade line based on bottom of tanks in zone

The various pressure zones are connected by booster pump stations and Pressure Reducing Valve (PRV) stations. Each pump station can pump water from the lower pressure zone to the next higher zone, and also contains PRV's so that water from the higher pressure zone can be released into the lower pressure zone, as needed.

2007 system demands by zone are shown in **Table 3-8**.

Table 3-8: 2007 System Demands

Pressure Zone	ADD, mgd	MDD, mgd	PHD, mgd
1	3.73	9.32	18.65
2	1.75	4.38	8.75
3	0.21	0.53	1.05
<b>Totals</b>	<b>5.69</b>	<b>14.23</b>	<b>28.45</b>

### 3.3.2 Potable Water Storage

Typically, system storage is sized to provide equalization for the difference between peak day and peak hour demands, fire flow reserves and an emergency reserve volume in case of a system supply failure. System storage requirements, per zone, have been developed using the following criteria:

- Demand Equalization Volume = 6 hours at MDD
- Emergency Storage Volume = 12 hours at MDD
- Fire Flow Storage = 4 hours at 6,000 gpm

The South Metro Fire Protection District has dictated the fire flow rate and duration. For the District, the fire flow is 6,000 gpm, the duration is 4 hours and the required volume is 1.44 MG.

The existing development within the District is served by six tanks totaling 20.0 million gallons (MG) of potable water storage. **Table 3-9** shows a summary of the existing tanks.

Table 3-9: Existing Potable Water Storage Facilities

Name	Capacity (MG)	Construction Type	Zone	Service Year	High Water Elevation
Butterfield	1.0	Buried Steel	1	1985	6128.5
Butterfield	2.0	Buried Steel	1	1985	6128.5
Bradbury	4.0	Buried Concrete	1	1998	6118.5
Crestview	3.0	Buried Concrete	2	1994	6324.0
Hess	5.0	Buried Concrete	2	2004	6,324.0
Singing Hills	5.0	Buried Concrete	3	2003	6,592.0
<b>Total Storage: 20.0 MG</b>					

The 3.0 million gallon Crestview tank is located in the Crestview subdivision and its site has room for two more tanks. The Butterfield tanks are located along Hilltop Road. They and are situated next to each other and total 3.0 million gallons. In 1999, a solenoid control valve vault was installed at the Butterfield site. This setup allows for remote shut-down of its pipeline in case of an emergency.

The Bradbury tank is 4.0 million gallons and the site has room for two more 4.0 MG tanks. The site also contains the Bradbury Ranch Well Facility and Booster Pump Station. The Bradbury tank was constructed lower than the Butterfield tanks, thus it has an altitude valve located in a vault on the north side of the site. This valve also allows for remote shut-off of the pipeline in case of an emergency. In 2004, the Hess tank was completed and put into service. Its volume

is 5.0 million gallons and serves Zone 2 on the west side of the District. As stated in the previous section, once a Zone 2 transmission line is completed, the Hess tank will be able to serve a greater area in Zone 2, specifically Bradbury Ranch, Newlin Meadows, and other surrounding developments.

The Singing Hills tank is located along Singing Hills Drive to the east of the District. The tank's volume is 5.0 million gallons and is the only tank in Zone 3. The Singing Hills site has room for three more 5.0 million gallon tanks.

**Table 3-10** shows the required and available storage by zone, for the existing system.

**Table 3-10: Required and Available Water Storage**

Pressure Zone	MDD, mgd	Required Storage, mg <sup>(1)</sup>	Available Storage, mg
1	9.32	8.4	7.0
2	4.38	4.7	8.0
3	0.53	1.8	5.0

(1) 18 hours at MDD plus 4 hours at 6,000 gpm fire flow.

The total required storage for the system is approximately 15 mg and the available storage is 20 mg. Though **Table 3-10** shows a storage deficit of 1.4 mg for Zone 1, the more than ample storage in Zone 2 can easily provide water to Zone 1 through numerous interconnections between the two Zones.

### **3.3.3 Well Facilities**

The District has 46 on-line wells currently providing water to the District's customers. The wells are located at 20 different well facilities spread out over the service area. Most well facilities contain more than one well. This is made possible by the "well field" concept, which allows the District to drill a well anywhere within the service area. The only restrictions are physical obstacle and proper separation from other wells in the same aquifer (typically about a half mile). Most new well facilities within the District contain a well from at least two aquifers, typically the Arapahoe and the Dawson and/or Denver aquifers. Because each well facility contains disinfection equipment (chlorine gas or sodium hypochlorite), it is more efficient to cluster them, thus reducing operating costs. Chlorine is dosed at a rate to ensure water entering the system has a chlorine concentration of about 2.0 milligrams/liter. Until recently regulations required that chlorinated groundwater be detained for a minimum of 30 minutes before it reached a customer's tap, and most of the District's facilities have been designed to meet this standard. The Groundwater Rule, promulgated in 2006 and effective December 1, 2009, has changed the chlorine disinfection requirement for groundwater from 30 minutes to a CT (concentration multiplied by time) calculation to achieve a minimum of 4 log virus removal.

The number of wells that are installed in the District is a function of peak production, which is not necessarily the same as the well design pumping rate. Peak production is the highest flow rate from each well during peak demand season, typically June or July. Well production decreases as the summer passes because drawdown is at its greatest in June or July, thus decreasing peak pumping capacity. This creates the need to construct more wells than appears necessary based on design pumping rates. **Table 3-11** shows both the design and peak production pumping rates.

Table 3-11: Existing 2008 Well Production

No.	Well Name/Aquifer	Well Facility	Pressure Zone	Design Pumping Rate (gpm)	Peak Pumping Rate (gpm)
1	Bradbury Arapahoe	Bradbury	1	1200	750
2	Bradbury Dawson	Bradbury	1	90	90
3	Bradbury LFH	Bradbury	1	300	0
4	Bradbury Denver	Bradbury	1	80	80
5	A-3 (Arapahoe)	A-3	2	750	0
6	LFH-1	A-3	2	0	0
7	KOA I (Alluvial)	KOA I	1	1800	0
8	KOA II (Alluvial)	KOA II	1	600	0
9	Rowley Downs Arapahoe	Rowley Downs	1	884	390
10	Stroh Arapahoe	Stroh Ranch	1	600	450
11	Stroh Dawson	Stroh Ranch	1	85	85
12	Stroh Alluvial	Stroh Ranch	1	600	350
13	Stroh Denver	Stroh Ranch	1	150	150
14	Parker North Arapahoe	Parker North	1	1300	600
15	Parker North Dawson	Parker North	1	250	0
16	Parker North LFH	Parker North	1	205	0
17	Parker North Denver	Parker North	1	100	100
18	Clark Farms Arapahoe	Clarke Farms	1	650	550
19	A-2 (Arapahoe)	Clarke Farms	1	900	400
20	Hidden River Arapahoe	Hidden River	1	750	400
21	Rustic Dawson	Rustic	1	200	140
22	Robinson Ranch	Robinson	2	497	340
23	Parker Ridge Arapahoe	Parker Ridge	2	600	400
24	Parker Ridge Dawson	Parker Ridge	2	80	80
25	Newlin Arapahoe	Newlin	3	875	840
26	Rueter-Hess Arapahoe	Rueter-Hess	3	1336	840
27	Rueter-Hess Dawson	Rueter-Hess	3	260	170
28	Rueter-Hess Denver	Rueter-Hess	3	85	75
29	Nue Town Arapahoe	Nue Town	1	500	500
30	Nue Town Lower	Nue Town	1	120	120
31	Reata North Arapahoe	Reata North	1	400	325
32	A-3 Lower Dawson	A-3	2	120	115
33	Regency Arapahoe	Regency	1	300	300
34	Salisbury Arapahoe	Regional	1	175	150
35	Salisbury Dawson	Regional	1	115	115
36	Regional LFH	Regional	1	300	300
37	Regional Arapahoe	Regional	1	350	350
38	Regional Dawson	Regional	1	175	175
39	Regional Denver	Regional	1	45	45
40	Hess 1 Arapahoe	Hess 1	3	1275	820

No.	Well Name/Aquifer	Well Facility	Pressure Zone	Design Pumping Rate (gpm)	Peak Pumping Rate (gpm)
41	Hess 2 Arapahoe	Hess 2	3	1467	800
42	CC-9 Alluvial	Regional	1	500	500
43	CC-7 Alluvial	Regional	1	1000	1000
44	CC-13 Alluvial	Regional	1	750	0
45	CC-15 Alluvial	Regional	1	2000	0
46	CC-17 Alluvial	Regional	1	1200	0
<b>Totals, gpm</b>				26,019	12,895

In **Table 3-11**, the peak production for some wells is 0 gpm. This is because the District may not be able to operate them during the summer time, or they choose not to include them for planning purposes. Bradbury LFH and Parker North LFH are strictly emergency wells, because of the high levels of hydrogen sulfide. The District can only operate either the Rustic Dawson or the Parker North Dawson, but not both at the same time due their close proximity. Typically, the District will operate the Rustic Dawson, thus the Parker North Dawson value is 0 gpm. Some alluvial wells have peak pumping rate values of 0 gpm because it is not guaranteed that the District can operate them during the peak season. By excluding some of the alluvial wells from the peak production total, the District can plan future wells conservatively and if the augmentation plan allows, the District has possible reserve.

### 3.3.4 Booster Pump Stations

The District currently has four operating booster pump stations. The Hidden River and Parker Ridge Pump Stations convey potable water from Zone 1 to Zone 2 and Zone 2 to Zone 3, respectively. In these two cases, the zones receiving water contain storage tanks that control the hydraulic grade and pressure.

There are also two “closed” system pump stations, Bell Cross Ranch Pump Station and Bradbury Ranch Booster Pump Station. Both of these stations provide water to areas that are not served by a storage tank. The absence of a storage tanks requires these pump stations to meet water demands and to maintain the service pressure in the zone. The Bell Cross Ranch Pump Station will never pump to an open system. It serves approximately 18 homes in a portion of the Bell Cross Ranch subdivision that is in Zone 3. The particular area is not contiguous with other areas of Zone 3 and it is not cost effective to connect it.

The Bradbury Ranch Booster Pump Station will eventually pump to an open system. Currently, it provides pressure to a closed portion of Zone 2 on the west side of the District. The Hess Water Storage Tank, which will serve Zone 2 and this area is already constructed and is located in Zone 2 approximately 1.6 miles south of the Bradbury Ranch Booster Pump Station. The pipeline that connects the two facilities has not been completed but should be in service in May or June of 2009. Once the pipelines are completed, the Bradbury Ranch Booster Pump Station could be converted into a transfer pump station to lift Bradbury Ranch well water from Zone 1 to Zone 2.

Provided in **Table 3-12** is a summary of the District’s four existing pump stations:

**Table 3-12: Existing Booster Pump Stations**

Name	Capacity (gpm)	From Zone	To Zone	Open Zone	Back-up Power
Hidden River	2,400	1	2	Yes	Yes
Parker Ridge	3,000	2	3	Yes	Yes
Bradbury	1,500	1	2	No	Yes
Bell Cross	1,500	2	3	No	Yes

### 3.3.5 Transmission Mains

The District determines where and when the major transmission mains (typically larger than 12” diameter) are constructed to provide a robust distribution system capable of maintaining acceptable system wide pressured during peak demand and fire flow situations. Within specific subdivisions, the developer is responsible for installing the major pipelines and for designing and installing the interior waterlines. All pipelines are sized so that during the peak hour demands, pipe velocities are reasonable (less than 10 feet per second) as to preserve water pressure and minimize energy costs.

The District has three major east-west transmission mains. The first is located in East and West Mainstreet and is mostly a 16” line. The second major east-west pipeline is a 20” line that runs from the Crestview Tank and is aligned in Hilltop Road. It connects to the rest of system around the Hidden River Booster Pump Station.

The third east-west line is the Zone 3 High Pressure Pipeline. It is a 30” waterline that extends from the Singing Hills Tank west to the Zone 2 Hess Tank. Major laterals that connect to the High Pressure Pipeline line have PRV’s which reduce the high pressure to the required service pressure of that zone. The intent of the High Pressure Pipeline was to connect the east and west sides of the District with a continuous pipeline. The major north-south transmission main is a 20” pipeline primarily located in Parker Road and Dransfeldt Road.

### Existing System Hydraulic Performance

A steady state computer analysis of the existing water distribution system was performed to evaluate performance under PHD and MDD plus fire flow scenarios. **Table 3-13** shows the well facilities and booster pump stations that were assumed to be in service during the modeling.

**Table 3-13: Well Facilities and Booster Pump Stations**

Name
Bradbury Ranch Booster
Parker Ridge Booster
Clarke Farms
Parker North
KOA Alluvial
Rueter-Hess
Hess 2
Hess 1
Hidden River Booster

Name
Bradbury Ranch Booster
Stroh Ranch
Parker Ridge Booster
Parker Ridge Well House Wet Well Pump 1
Hidden River
A3 Arapahoe
Rowley Downs Arapahoe Well Pump
Reata North
Rustic Dawson
Bell Cross

**Fire Flow and PHD Modeling Results.** Table 3-14 shows modeling results fire flow plus maximum day demand scenarios at multiply locations across the system. System storage tanks were set below their maximum hydraulic grade lines at the following elevations:

- Zone 1 Tanks – 6118
- Zone 2 Tanks – 6314
- Zone 3 Tanks – 6582

**Table 3-14: Fire Flow Scenarios**

Service Type	Location	Zone	Elevation (ft)	Fire Flow Demand (gpm)	Static Pressure (psig)	Residual Pressure (psig)
Multi-Family	Hunter's Chase Condo's	1	5924	2,500	84	21
Residential	Rancho Montecito. East end of subdivision	3	6292	1,800	126	29
Residential	Robinson Ranch. South end Robinson Ranch Drive	2	6070	1,800	105	39
Residential	Regency. West end Angelica Drive	1	5940	1,800	77	40
Residential	Pine Bluffs. East Majestic Pine Place	1	5971	1,800	64	41
Residential	New Horizon	1	5965	1,800	66	43
Residential	Stroh Ranch. Bolero Dr.	1	5993	1,800	54	45
Multi-Family	Cotton Wood South Apts. on Wilde Ave	1	5755	2,500	97	46

<b>Service Type</b>	<b>Location</b>	<b>Zone</b>	<b>Elevation (ft)</b>	<b>Fire Flow Demand (gpm)</b>	<b>Static Pressure (psig)</b>	<b>Residual Pressure (psig)</b>
Residential	Pine Bluffs. East Crooked Pine Circle	1	5978	1,800	61	47
Residential	Jordan Crossing	1	5955	1,800	71	48
Multi-Family	Horseshoe Ridge. West side of development	1	5949	2,500	73	49
Residential	Cotton Wood South, NE portion on Waterhouse Circle	1	5742	1,800	102	51
Residential	Auburn Hills. South (higher) portion of subdivision. On Pitchfork Court	2 (isolated)	6004	1,800	65	52
Residential	Bell Cross Ranch	3	6287	1,800	----	53
Residential	Bell Cross Ranch. East Side Bell Cross Circle, below Bell Cross Court	2	6177	1,800	59	54
Multi-Family	Ironstone Apts. Center of complex	1	5930	2,500	81	58
Multi-Family	Stroh Townhomes. South edge of development	1	5919	2,500	86	58
Residential	Reata North/ Idyllwild. Tall Kid Ave.	2	6153	1,800	70	59
Residential	Centennial Ranch. Jakes Ranch	1	5917	1,800	87	61
Commercial	SW Quadrant Stroh and Parker Roads	1	5945	4,000	75	61
Residential	Parker Vista. Parker Vista Circle	1	5954	1,800	71	62
Multi-Family	Sun Marke Town Homes. On Saskatoon Place	1	5940	2,500	77	63
Residential	Preston Hills Rampart Station	1	5957	1,800	70	67

<b>Service Type</b>	<b>Location</b>	<b>Zone</b>	<b>Elevation (ft)</b>	<b>Fire Flow Demand (gpm)</b>	<b>Static Pressure (psig)</b>	<b>Residual Pressure (psig)</b>
Residential	Country Meadows. Gaines Mill Court	1	5894	1,800	97	67
Residential	Auburn Hills. NW portion of subdivision on Firebrick Lane.	1	5939	1,800	77	68
Multi-Family	Lincoln Creek	1	5917	2,500	87	69
Residential	Parker North	1	5931	1,800	81	70
Residential	Rowley Downs. Seibert Circle and Sussex Court	1	5936	1,800	79	76
Multi-Family	Nue Town Condos. Cedar Gulch Drive	1	5910	2,500	90	76
Residential	Willow Park	1	5926	1,800	83	76
Residential	Bradbury Ranch. NW portion of subdivision	1	5920	1,800	86	78
Multi-Family	Town Homes at Canterbury. York Ave and Oakdale Rd.	2	6030	2,500	123	83
Residential	Nue Town. Springfield Court and Nue Town Circle	1	5903	1,800	93	86
Residential	Horse Creek. East Grass River Place	2 (isolated)	6115	1,800	97	87
Residential	Cottrell Farms NW portion of subdivision	1	5844	1,800	119	88
Commercial	SW Quadrant Mainstreet and Parker Road	1	5852	3,500	115	88
Multi-Family	Hilltop Apts. West side Club House Drive.	1	5876	2,500	105	89
Residential	Turtle Creek. Pine Drive	1	5904	1,800	93	91
Multi-Family	Parker Ranch Briar gate Apts. NE quadrant Dransfeldt and Stage Run	1	5878	2,500	104	91

<b>Service Type</b>	<b>Location</b>	<b>Zone</b>	<b>Elevation (ft)</b>	<b>Fire Flow Demand (gpm)</b>	<b>Static Pressure (psig)</b>	<b>Residual Pressure (psig)</b>
Commercial	SW Quadrant Twenty Mile Rd and Parker Road	1	5844	3,500	119	92
Residential	Stroh Ranch. Intersection Elk Creek and Clear Creek Drives	1	5897	1,800	96	93
Commercial	SE Mainstreet and Parker Road	1	5863	3,500	110	96
Commercial	SE Quadrant Parker Rd. and Pie Lane	1	5834	3,500	123	96
Commercial	NE Quadrant Lincoln Ave and Parker Road	1	5831	3,500	124	100
Residential	SE portion Challenger Park	1	5786	1,800	144	100
Multi-Family	T&C Townhomes + Pine View Condos. Victorian Drive	1	5878	2,500	104	102
Multi-Family	Challenger Park Town Homes on Deerhorn Court	1	5800	2,500	138	106
Residential	Parker Heights. Alcorn Ave. and Calyson St.	1	5848	1,800	117	106
Residential	Challenger Park. Coltsfoot Drive and Thimbleberry Way	1	5784	1,800	145	107
Commercial	Dransfeldt Rd South of Mainstreet	1	5842	3,500	119	114
Residential	CC and VOP. Black Wolf way and Black Wolf Lane	2	6028	1,800	124	115
Residential	Antelope Heights. East Jackalop Drive and east Prairie Goat Ave.	2	6018	1,800	139	117
Residential	Hidden River. Heather Lane	2	6005	1,800	134	119

Service Type	Location	Zone	Elevation (ft)	Fire Flow Demand (gpm)	Static Pressure (psig)	Residual Pressure (psig)
Residential	Clarke Farms near Clarke Farm Drive and Sedgwick Way	1	5831	1,800	124	121
Residential	Newelin Meadows. East Pine Drop Ave and South Tumble Brush Street	1	5970	1,800	140	121
Multi-Family	Trail Side Apts.	1	5813	2,500	132	121
Residential	CC and VOP. Needles Court	2	6005	1,800	134	123
Commercial	NW Quadrant Lincoln Ave and Parker Road	1	5813	4,000	132	123
Multi-Family	Creek Side Condos. East of Twenty Mile Road	1	5813	2,500	132	123
Residential	Sunset Ridge. Mount Antero Way.	2	5995	1,800	138	127
Commercial	NW Quadrant Lincoln Ave and Twenty Mile Rd.	1	5794	4,000	140	130
Residential	Saddle Brook. South east portion of subdivision	1	5965	1,800	151	134
Residential	CC and VOP. Pine Top St near Rock Dale Place	3	6252	1,800	143	137
Residential	Spirit Gulch. Mystic Court	3	6221	1,800	156	147

As shown in **Table 3-14**, there were no reported fire flow pressures below 20 psig.

In addition to fire flow scenarios a peak hour demand scenario was modeled. A few system pipes were reported to have velocities above five feet per second. These pipes and their locations are listed in **Table 3-15**.

**Table 3-15: PHD High Velocity Pipelines**

Location	Size (in)	Reported Velocities (ft/s)
On Buffaloberry Dr. between Paper Flower Dr. and Sara Gulch Circle	16	5.6 – 5.1
On Canterbury Parkway between Canterbury Ln. and Riverdale Way	8	5.3
On Bay Oak Ct. between Desert St. and tie-in on Canterbury Parkway	12	6.2
East of Parker Road, between Robinson Ranch Circle to tie-in to at Hess Rd	12	6.7

The pipes with velocities above 5 feet per second do not appear to be adversely affecting pressures and are only minimally above the recommended maximum.

**Table 3-16** shows the locations of pressures below 40 psig at PHD.

**Table 3-16: PHD Lower Pressure Locations**

Location	Reported Pressures (psig)
Hill Top Rd., between Hess Rd and East Narrow Pine Parkway	39 - 37
Just west of Hill Top Rd at East end of east Shady Ridge Rd.	31
Near intersection of Mill Valley St and South Canterbury Trail	32 - 39

There are other locations with reported pressures below 40 psig at PHD. However these locations are in transmission mains near storage tanks with no service connections.

### **Future Water System Facilities**

This section discusses water system improvements that may be required to serve the District over the next five years and at ultimate build-out. Included in the five year analysis will be the capital costs for each of the required improvements.

### **3.3.6 Projected Water Demands**

Provided below are the estimated water demands for the years 2009, 2015, 2020 and ultimate. These demands are based on the growth outlined in Section 2 and the District’s design criteria from **Section 3.2.3**.

Table 3-17: Future Water Demands

Description	2009	2015	2020	Ultimate
ADD, mgd	5.83	7.19	8.32	17.66
ADD, gpm	4,046	4,995	5,775	12,262
MDD, gpm	10,116	12,488	14,438	30,655
PHD, gpm	20,232	24,975	28,876	61,310
<b>Total Demand (acre-ft/yr)</b>	<b>6,529</b>	<b>8,059</b>	<b>9,318</b>	<b>19,784</b>

### 3.3.7 Future Well Facilities

To meet future demands the District will need to increase its raw water supply. Because the aquifers are constantly changing, it is difficult to predict how much pumping capacity will be available in the future. The District’s groundwater hydrologists evaluate the well situation annually. The hydrologists attempt to predict the pumping capacity of the four aquifers and then recommend sites for potential wells. Because of the continual decline of the aquifers, the hydrologists are projecting a four percent drop in peak production annually over the coming years. **Table 3-18** shows the well capacity that must be added to meet demand over the next 10 years.

**Table 3-18** assumes a starting point in 2008 with a peak production of 12,895 gpm (18.57 mgd). It is assumed that any new well facility will produce 600 gpm (0.86 mgd) during its first year of operation. As a contingency, we’ve assumed that one well facility, or 600 gpm (0.86 mgd), will be off line year to account for any repair and maintenance at the facilities that may occur during peak season. This adjusted well production was then reduced by four percent each year. Additionally, we have assumed that the proposed Rueter-Hess WTP will start water production in 2012.

Table 3-18: Required Additional Well Capacity

Year	MDD (mgd)	Reduced Well Production (mgd) <sup>(1)</sup>	WTP Production, (mgd)	Reduced Well + WTP Production (mgd)	Additional Production Required (mgd)	Additional Well Facilities Required <sup>(2)</sup>	Well Production (mgd)	Total Production (mgd)
2009	15.44	16.97	0.00	16.97	-1.52	0.00	16.97	16.97
2010	16.05	16.25	0.00	16.25	-0.20	0.00	16.25	16.25
2011	16.65	15.57	0.00	15.57	1.08	2.00	17.23	17.23
2012	17.25	16.50	10.00	26.50	-9.25	0.00	16.50	26.50
2013	17.86	15.81	10.00	25.81	-7.95	0.00	15.81	25.81
2014	18.46	15.14	10.00	25.14	-6.68	0.00	15.14	25.14
2015	19.07	14.50	10.00	24.50	-5.44	0.00	14.50	24.50
2016	19.66	13.89	10.00	23.89	-4.23	0.00	13.89	23.89
2017	20.26	13.30	10.00	24.16	-3.90	0.00	13.30	24.16

(1) Assumes well production less 600 gpm contingency and reduced by 4 percent.

(2) Assumes 600 gpm per well facility.

In addition to more groundwater wells, the District is in the process of drilling alluvial wells along Cherry Creek. These wells will extract alluvial water for eventual storage in Rueter-Hess Reservoir.

**3.3.8 Future Potable Water Storage**

As stated previously, the required potable water storage is a combination of maximum day demand and fire flow. The table below shows a summary of the potable water storage requirements, by zone, for the next six years and at ultimate build-out.

**Table 3-19: Potable Water Storage Requirements**

Description	2009	2015	2020	Ultimate	Existing Storage, mg
Required Storage, mg <sup>(1)</sup>					
Zone 1	7.03	8.67	9.98	16.26	7.00
Zone 2	3.36	4.08	4.67	11.65	8.00
Zone 3	0.54	0.74	0.94	5.20	5.00
Required Fire Flow Storage, mg	1.44	1.44	1.44	1.44	----
<b>Totals</b>	<b>12.37</b>	<b>14.93</b>	<b>17.03</b>	<b>34.55</b>	<b>20.00</b>

(1) Includes 18 hours at maximum day demand and 4 hours at required fire flows of 6,000 gpm

As growth occurs in the different pressure zones, modeling should be done to ensure that higher zones can provide required fire and peak hour flows to zones with lower hydraulic grade lines. Particular attention should be paid to the Canyons and Ridge Gate where development is currently expected to start around 2015.

**3.3.9 Transmission Mains**

Based on the District’s latest demand projects, most demand between 2009 and 2015 will occur more or less within areas that are currently served by the District transmission mains. These areas include Canterbury Crossing, Clarke Farms, Idyllwilde, Lincoln Creek, Lincoln Meadows, Newlin Meadows, Stroh Ranch and Turtle Creek. Some development is expected to occur in the Anthology development to the south Hess Road and east of Rueter–Hess Reservoir. This area is bounded by existing 24- and 16-inch Zone 2 transmission mains on the north, and an existing 30-inch Zone 3 transmission main runs east-west through the center of the area.

Major development expected to occur after 2015 includes continued development in Anthology and new development in the Canyons and Ridge Gate areas to the west of the District’s existing distribution system. The Canyons and Ridge Gate developments have a projected ultimate maximum day demand of approximately 12 mgd. Both the Canyons and Ridge Gate developments will require major transmission mains in the 24-inch to 16-inch size range to connect these new developments to the existing distribution system. The majority Canyons and Ridge Gate development is expected to occur in Zones 3 and 2. A portion of the north end Ridge Gate is located in Zone 1. It seems likely that the Canyons development will be served via the existing 30-inch Zone 3 high pressure pipeline from the east. As development in Ridge Gate occurs and demands increase, Ridge Gate and Canyons could be served by an expanded Rueter-Hess WTP from the east with treated water being pumped into Zone 3.

### **3.4 THE RUETER-HESS RESERVOIR AND WATER TREATMENT PLANT**

#### **3.4.1 Rueter-Hess Reservoir**

Phase II of the Rueter-Hess Reservoir is currently being constructed in western portion of the District, between Bradbury Ranch and the Canyons. The reservoir's purpose is to store raw water, which can then be treated and delivered as potable water. Between October 2004 and December 2006, the District constructed the permitted Phase I dam located on Newlin Gulch. During the course of Phase I construction, the District decided to build the dam so it could accommodate future enlargement of both the dam and reservoir. The Phase II Reservoir will increase the dam crest height by sixty-one (61) feet and embankment length by 2,357 feet. The Phase II project will provide reservoir storage up to 71,700 acre-feet of water and inundate approximately 1,140 acres. Phase II Reservoir construction is expected to be complete in November 2011.

The Rueter-Hess Reservoir will receive raw water from the District's deep and alluvial wells year-round, which includes off-peak times of the year (winter months). This concept is called "base loading" and as opposed to peaking, it maintains a much more consistent draw on the Denver Basin aquifers. By "base loading," the District's wells should not experience large draw downs and decline in production throughout the summer. Summer time peak water supplies will be provided by water drawn from the reservoir, treated and then pumped into the District's distribution system.

The reservoir also provides a storage area for spring run-off flows and storm flows that occur in the Cherry Creek drainage basin. Regardless of the raw water sources, it is the District's intent to have sufficient raw water storage to last throughout the summer months. Operationally, it will help to mitigate the problems associated with balancing well production and summer time demands, and will allow well production to be more consistent by minimizing varying rates due to fluctuating aquifer draw downs.

#### **3.4.2 Diversion Dam, Diversion Pump Station, and 48" Pipeline**

The District has constructed a diversion dam and pump station near Stroh Road and Motsenbocker Road. During high flow events in Cherry Creek, when there are no senior water rights calls, the Diversion Dam will re-direct surface water from Cherry Creek into the wet well of the Diversion Pump Station. The diversion dam is an air bladder operated Obermeyer steel gate gate system. When not in use, the Obermeyer gates will lay in a down position in the creek, out of sight.

The Diversion Pump Station is located on the west bank of Cherry Creek. In addition to periodic Cherry Creek flows, the pump station will convey water from the District's alluvial well system to Rueter-Hess Reservoir. The pump station can convey up to 78 cfs (50 mgd) of raw water through a 48-inch diameter transmission pipeline to Rueter-Hess Reservoir. The pump station has five 4,160 volt pumps with a total of 4,750 hp, each driven by a variable frequency drive.

#### **3.4.3 Alluvial Manifold**

The District plans on drilling several more alluvial wells along Cherry Creek. These wells will pump into a manifold pipeline, also along Cherry Creek. Through the Augmentation Plan, alluvial water will be transported to the Diversion Pump Station and on to Rueter-Hess.

In the future, during “free stream” periods, which are periods of time when the District’s water consumption is low, water will be withdrawn from Cherry Creek and pumped to storage in Rueter-Hess reservoir, once it is completed in 2011. It will also have the right to withdraw water during periods of storm flows, when the creek is temporarily released from its appropriated condition. To do this, new alluvial wells will be drilled along the creek, from Lincoln Avenue to Stroh Road.

**3.4.4 Water Treatment Plant**

A new 10 mgd drinking water treatment plant to treat water from the Rueter-Hess Reservoir is currently in the final design phase. This facility has been planned to allow for an ultimate expansion to a capacity of 40 mgd. Construction of the initial 10 mgd plant is expected to be complete in 2012. As noted above, Rueter-Hess WTP will treat local surface water, alluvial well water and water from Cherry Creek.

The Rueter-Hess WTP design incorporates a ballasted sedimentation process for primary treatment, a ballasted recirculating PAC system for DOC removal and ceramic membrane filters. Chlorine dioxide will be used for metals oxidation and pre-filter disinfection. Sodium hypochlorite will be used to maintain a disinfectant residual in the water distribution system.

Treated water from the initial 10 mgd plant will be pumped into Zone 2 near the intersection of Hess Road and Newlin Gulch Road and can serve Zone 2 directly, Zone 1 through existing pressure reducing stations, and Zone 3 through existing booster pump stations.

**3.5 SUMMARY OF 5-YEAR IMPROVEMENTS PROJECTION**

Over the next five years, the District will need to construct several water system facilities. Many of these will be paid for by developers as the need arises for service to new areas. This includes the majority of the large transmission mains.

Provided below in **Table 3-20** is the summary of District funded water projects over the next five years. It includes two well facilities and the Rueter-Hess WTP. The cost for the WTP includes a 24-inch main from the WTP to the existing distribution system.

**Table 3-20: Future 5-Year Water System Improvements**

Description	2009	2010	2011	2012	2013
Future Well Facility #1 and #2	0	0	\$8,000,000	0	0
Rueter-Hess WTP	0	0	\$25,000,000	\$25,000,000	0
<b>Annual Total</b>	<b>0</b>	<b>0</b>	<b>\$33,000,000</b>	<b>\$25,000,000</b>	<b>0</b>

## SECTION 4: WASTEWATER COLLECTION SYSTEM

### 4.1 GENERAL

This section describes the District’s wastewater generation and its collection system. Treatment and effluent reuse systems are presented in Section 5. **Exhibit 3** shows the existing wastewater system. **Exhibit 4** shows the ultimate wastewater system improvements. The system improvements have been created based on design criteria and calculations in this document.

Wastewater generated within the District is collected by a network of sanitary sewers, mostly 8” in diameter. These flows are gathered by outfalls, typically 12” or 15” in diameter. The outfalls convey raw wastewater to large sanitary sewer interceptors, and the interceptors transport the wastewater to one of two water reclamation facilities. The North Water Reclamation Facility (NWRf) and South Water Reclamation Facility (SWRF) are discussed in detail in Section 5.

The District topography consists of gently to moderately rolling hills, which are sloped toward the drainage basins of Sulphur, Newlin, Tallman, and Baldwin Gulches, and Cherry Creek. The land generally decreases in elevation northward from a high of approximately 6400 feet in The Canyons development to a low of approximately 5700 feet near the North Water Reclamation Facility.

### 4.2 SEWER SYSTEM DESIGN CRITERIA

The wastewater conveyance systems (sewer lines and lift stations) are sized based on peak flows.

**Table 4-1** shows current design criteria for sizing the District’s collection system components.

**Table 4-1: Sanitary Sewer System Design Criteria**

Criteria	Value
Average Wastewater Flow	260 gallons per day per SFE 1.68 SFEs per acre for existing capacity 2.63 SFEs per acre for ultimate capacity
Peaking Factor	(per Wastewater Engineering, Metcalf and Eddy, 2003)
Population of 0 – 5,000:	4.0
Population of 5,001 – 20,000:	3.5
Population of 20,001+:	3.0
Infiltration & Inflow	200 gallons per acre per day
Friction Factor (Manning roughness coefficient, ‘n’)	0.013
Pipe Size, Minimum	8 inches
Maximum flow in pipe (d/D) <sup>1</sup>	0.80 at peak flow
Velocity, Minimum <sup>2</sup>	2 feet per second
Velocity, Maximum <sup>2</sup>	10 feet per second

(1) ‘d’ = depth of flow in pipe, ‘D’ = pipe inside diameter.

(2) As calculated by the Manning formula under all flow conditions.

Note: The design criteria in this table are for general planning use only; the District reserves the right to modify the criteria at any time for the design of specific projects. Refer to the District’s latest edition of Sanitary Sewer System Specifications.

### 4.3 EXISTING SYSTEM

#### 4.3.1 Historic Wastewater Production

Average wastewater production data shows minimal seasonal variation because indoor water use is relatively constant throughout the year. During major storm events, the District has experienced significant inflow into the District’s collection system.

From 2005 to 2008, the total wastewater flow increased from an average of 2.59 mgd to 3.05 mgd. Wastewater flow to the NWRf increased from 0.74 mgd to 1.30 mgd, and wastewater flow to the SWRF decreased from 1.85 mgd to 1.75 mgd. The average monthly flow to the SWRF decreased in June 2006 because a new force main was constructed for the Clarke Farms Lift Station that diverted its flow from the SWRF to the NWRf.

Data from 2005 to 2008 shows increasing wastewater flows that correlate with the growth experienced by the District in recent years. The data shows most growth in areas contributing wastewater to the NWRf. **Table 4-2** summarizes recent wastewater production.

**Table 4-2: Recent Wastewater Production**

Year	Non-irrigation SFEs <sup>(3)</sup>	Avg. Monthly SWRF Influent (mgd)	Avg. Monthly NWRf Influent (mgd)	Total Avg. Monthly Influent (mgd)	Avg. WW Production (GPD/SFE)
2005	11,712	1.85	0.74 <sup>(1)</sup>	2.59	221
2006 <sup>(2)</sup>	12,810	1.65	1.03	2.68	209
2007	13,313	1.75	1.36	3.11	234
January 2008	13,504	1.79	1.38	3.17	235
February 2008	13,592	1.84	1.24	3.09	227
March 2008	13,611	1.77	1.29	3.06	225
April 2008	13,658	1.66	1.28	2.94	215
May 2008	13,754	1.52	1.32	2.84	206
June 2008	13,828	1.95	1.31	3.26	236
<b>2008 Average GPD/SFE = 224</b>					

(1) Average influent value was obtained from data between May 1, 2005 to December 31, 2005.

(2) In June 2006, the discharge from Clarke Farms Lift Station was diverted from the SWRF to the existing splitter box in Dransfeldt Road and Longs Way via a new pipeline.

(3) Non-irrigation SFEs include single family residential, multifamily, and commercial properties.

Based on early 2008 records, the average wastewater flow per SFE was approximately 224 gpd/SFE. For verifying existing and future capacities of the interceptor system, a value of 236 gpd/SFE was used since this was the largest average flow in the past 3 years.

#### 4.3.2 Existing Lift Stations

The District has four wastewater lift stations, three of which are used to pump wastewater across Cherry Creek.

The Clarke Farms Lift Station was built in approximately 1985, and was upgraded in 2002. In 2006, a new 16-inch force main was constructed across Cherry Creek to direct the wastewater flows to the splitter box at Dransfeldt Road and Longs Way, which allows the wastewater to flow

to either the SWRF or NWRF. This lift station services the Clarke Farms, Bradbury Ranch, New Horizon, and portions of Auburn Hills, Newlin Meadows, and a portion of the Douglas 234 developments. The Clarke Farms Lift Station currently serves approximately 3,645 SFEs.

The Challenger Park Lift Station was built in 1999, and serves the Challenger Park subdivision. Challenger Park pumps wastewater across Cherry Creek in a 10-inch force main, and flows to the NWRF. In 2007, an additional 12-inch force main across Cherry Creek was constructed for future use by developments with wastewater flowing to the Challenger Park location. The Challenger Park Lift Station currently serves approximately 437 SFEs.

The Lincoln Meadows Lift Station was built in 2003, and serves the southerly portion of the Lincoln Meadows development. Lincoln Meadows pumps wastewater through an 8-inch force main, and flows to the NWRF. The Lincoln Meadows Lift Station currently serves approximately 226 SFEs based on the District area.

The Cottonwood South Lift Station was built in 2004, and serves the Cottonwood South development. Cottonwood South pumps wastewater through an 8-inch force main across Cherry Creek to a junction box on the NWRF site. The Cottonwood South Lift Station currently serves approximately 209 SFEs based on June 2008 billing.

**Table 4-3** summarizes information on the District’s lift stations.

**Table 4-3: Existing Lift Stations**

<b>Lift Station</b>	<b>Capacity (gpm)</b>	<b>Number of Pumps</b>	<b>Diesel-Fueled Emergency Generator</b>
Clarke Farms	3,000	3	Yes
Challenger Park	1,100	2	Yes
Lincoln Meadows	600	2	Yes
Cottonwood South	300	2	Yes

### **4.3.3 Existing Sewer Pipelines**

District wastewater flows are divided between the NWRF and SWRF. A splitter box located at the intersection of Dransfeldt Road and Longs Way allows the District some control over the amount of flow to each facility.

Wastewater flowing to the NWRF is conveyed primarily in a pipeline in Dransfeldt Road from the splitter box at Long Way north to the NWRF. Most of the pipeline is 27-inch PVC.

Wastewater flowing to the SWRF is conveyed primarily in one of two interceptors, referred to as the East Interceptor and the West Interceptor for its paralleling of the respective side of Cherry Creek. The East Interceptor starts on the east side of Cherry Creek at Stroh Road. It starts as a 12-inch PVC pipeline, and increases to a 27-inch PVC where the West Interceptor connects with the East Interceptor as approximately the intersection of Twenty Mile Road and Mainstreet, just north of the District’s Bar CCC Reservoir.

The West Interceptor starts on the west side of Cherry Creek at Stroh Road. It starts as a 24-inch PVC pipeline, and increases to 36-inch PVC before it connects to the East Interceptor.

The East and West Interceptors flow north along the east side of Cherry Creek in a 27-inch PVC pipeline to the SWRF.

The District’s total existing wastewater-contributing area is approximately 7,930 acres. In June 2008, the total non-irrigation SFE’s billed in June 2008 were 13,828, resulting in an average of 1.74 non-irrigation SFE’s per acre.

For the purposes of this Master Plan, the condition of the existing sanitary sewer system was evaluated with a simple series of calculations. The evaluation was performed based on a pipeline slope of 0.002 feet per foot, as a conservative basis per previous master planning efforts. While this is a conservative projection for planning purposes, the actual pipeline slopes are important as they have a significant impact on the pipeline capacity. The actual capacity could be significantly different from that assumed for this planning effort. The District is developing a detailed computer model of the existing sanitary sewer collection system, which includes more accurate slope information. The modeling will identify system limitations and necessary improvements in much greater detail than is possible with the simple calculations performed for this Master Plan.

This Master Plan’s assessment evaluated the sewer system’s main pipelines, or interceptors, with general assumptions. The average flow for each section of interceptor pipeline was determined by estimating its contributing area, then applying the number of non-irrigation SFE’s per acre. **Tables 4-4** and **4-5** summarize the existing sanitary sewer interceptor evaluation under existing flow conditions.

**Table 4-4: Existing Sanitary Sewer Interceptors to SWRF under Existing Flow Conditions**

<b>Section</b>	<b>Discharge Point</b>	<b>Pipe Dia. (in)</b>	<b>Total SFEs</b>	<b>Avg. Flow (mgd) <sup>(1)</sup></b>	<b>Peak Flow (mgd) <sup>(2)</sup></b>	<b>Allowable Capacity (mgd) <sup>(3)</sup></b>	<b>Percent of Allowable Capacity</b>
E-6 to E-5	E-5	18	1,474	0.35	1.56	2.65	59%
E-5 to E-4	E-4	24	1,600	0.38	1.69	5.70	30%
E-4 to E-3	E-3	27	1,820	0.43	1.71	7.81	22%
Subtotal #1: E-3			1,820				
B-3 to B-2	B-2	18	2,501	0.59	2.53	2.65	89%
B-2 to B-1	B-1	21	2,696	0.63	2.53	4.00	63%
B-1 to E-3	E-3	21	3,357	0.79	3.15	4.00	79%
Subtotal #2: E-3			3,357				
<b>Total E-3</b>			<b>5,177</b>				
E-3 to E-2	E-2	27	5,177	1.22	4.86	7.81	62%
Subtotal #1: E-2	E-2		5,177				
F-3 to F-2	F-2	24	719	0.17	0.76	5.70	13%
F-2 to F-1	F-1	18	1,773	0.42	1.66	2.65	63%
F-1 to E-2	E-2	18	1,773	0.42	1.66	2.65	63%
Subtotal #2: E-2			1,773				
<b>Total E-2</b>			<b>6,950</b>				
E-2 to SWRF	SWRF	27	7,145	1.68	5.87	7.81	75%
<b>Sum at SWRF</b>			<b>7,145</b>	<b>1.68</b>	<b>5.87</b>		

- (1) Avg Flow assumed 236 gpd/SFE.
- (2) Peak Flow multiplied the Avg Flow by a population-dependent Peaking Factor then added the infiltration contributed by the collection area.
- (3) Allowable Capacity represents a d/D ratio of 0.80.

**Table 4-5: Existing Sanitary Sewer Interceptors to NWRf under Existing Flow Conditions**

Section	Discharge Point	Pipe Dia. (in)	Total SFEs	Avg. Flow (mgd) <sup>(1)</sup>	Peak Flow (mgd) <sup>(2)</sup>	Allowable Capacity (mgd) <sup>(3)</sup>	Percent of Allowable Capacity
H-2 to H-1	H-1	12	2,085	0.49	1.96	0.90	218%
C-1 to A-5	A-5	18	2,319	0.55	2.18	2.65	82%
A-5 to A-4	A-5	21	4,830	1.14	4.54	4.00	114%
A-4 to A-3	A-3	24	5,377	1.27	5.05	5.70	89%
A-3 to A-2	A-2	27	5,763	1.36	5.41	7.81	69%
A-2 to A-1	A-2	27	6,563	1.55	6.16	7.81	79%
A-1 to NWRf Headworks	NWRf Headworks	36	6,683	1.57	6.28	16.82	37%
<b>Sum at NWRf</b>			<b>6,683</b>	<b>1.57</b>	<b>6.28</b>		

- (1) Avg Flow assumed 236 gpd/SFE.
- (2) Peak Flow multiplied the Avg Flow by a population-dependent Peaking Factor then added the infiltration contributed by the collection area.
- (3) Allowable Capacity represents a d/D ratio of 0.80.

#### 4.4 FUTURE WASTEWATER SYSTEM FACILITIES

##### 4.4.1 Projected Production Based On Growth

Anticipated growth in the District is presented in **Section 2**. Based on this information and on the historic wastewater production rates, projected wastewater flows are presented in **Table 4-6**.

**Table 4-6: Projected Wastewater Flows**

Description	2009	2015	2020	Ultimate
Total Wastewater SFEs	14,357	17,723	20,491	43,507
Total Wastewater (mgd)	3.4	4.2	4.8	10.3

##### 4.4.2 Future Sewer Pipelines

The capability of the existing sanitary sewer system to accommodate future wastewater flows was evaluated with a simple series of calculations summarized in **Tables 4-7** and **4-8**. The District's total future wastewater-contributing area was estimated to be approximately 16,116 acres. The District's ultimate build-out number of non-irrigation SFE's was estimated to be 32,408. 20,865 non-irrigation SFE's will be within the current evaluation area of 7,930 acres, resulting in an average of 2.63 non-irrigation SFE's per acre. The remaining 11,543 non-irrigation SFE's were from the future subdivisions outside of the current evaluation area. The ultimate SFEs from these future subdivisions were applied directly to the sewer evaluation area to which they will most likely contribute wastewater.

At the District's ultimate build-out, the average wastewater flow was anticipated to be approximately 10.3 mgd. **Tables 4-7** and **4-8** summarize the existing sanitary sewer interceptor evaluation under ultimate flow conditions.

**Table 4-7: Existing Sanitary Sewer Interceptors to SWRF under Ultimate Flow Conditions**

Section	Discharge Point	Pipe Dia. (in)	Total SFEs	Avg. Flow (mgd)	Peak Flow (mgd)	Allowable Capacity (mgd) <sup>(1)</sup>	Percent of Allowable Capacity
E-6 to E-5	E-5	18	2,511	0.59	2.26	2.65	85%
E-5 to E-4	E-4	24	2,701	0.64	2.43	5.70	43%
E-4 to E-3	E-3	27	3,033	0.71	2.73	7.81	35%
Subtotal #1: E-3			3,033				
B-3 to B-2	B-2	18	4,019	0.95	3.79	2.65	143%
B-2 to B-1	B-1	21	4,313	1.02	4.05	4.00	101%
B-1 to E-3	E-3	21	5,311	1.25	4.33	4.00	108%
Subtotal #2: E-3			5,311				
<b>Total E-3</b>			<b>8,344</b>				
E-3 to E-2	E-2	27	8,344	1.97	6.70	7.81	86%
Subtotal #1: E-2	E-2		8,344				
F-3 to F-2	F-2	24	8,637	2.03	7.43	5.70	130%
F-2 to F-1	F-1	18	10,467	2.47	8.86	2.65	335%
F-1 to E-2	E-2	18	10,467	2.47	8.86	2.65	335%
Subtotal #2: E-2			10,467				
<b>Total E-2</b>			<b>18,811</b>				
E-2 to SWRF	SWRF	27	19,106	4.50	15.79	7.81	202%
<b>Sum at SWRF</b>			<b>19,106</b>	<b>4.50</b>	<b>15.79</b>		

(1) Avg Flow assumed 236 gpd/SFE.

(2) Peak Flow multiplied the Avg Flow by a population-dependent Peaking Factor then added the infiltration contributed by the collection area.

(3) Allowable Capacity represents a d/D ratio of 0.80.

The total ultimate average flow to the SWRF was expected to be 4.5 mgd. Most of the District's growth is expected to occur on the west side of Cherry Creek. The Anthology and Canyons developments are major subdivisions, the wastewater flows from which will eventually be collected in the West Interceptor.

**Table 4-8: Existing Sanitary Sewer Interceptors to NWRF under Ultimate Flow Conditions**

Section	Discharge Point	Pipe Dia. (in)	Total SFEs	Avg. Flow (mgd)	Peak Flow (mgd)	Allowable Capacity (mgd) <sup>(1)</sup>	Percent of Allowable Capacity
H-2 to H-1	H-1	12	3,847	0.91	3.44	0.90	383%
C-1 to A-5	A-5	18	3,499	0.82	3.15	2.65	119%
A-5 to A-4	A-5	21	7,987	1.88	6.23	4.00	156%
A-4 to A-3	A-3	24	8,813	2.08	6.87	5.70	120%
A-3 to A-2	A-2	27	9,426	2.22	7.38	7.81	94%
A-2 to A-1	A-2	27	13,122	3.09	10.19	7.81	130%
A-1 to NWRF Headworks	NWRF Headworks	36	13,302	3.13	10.33	16.82	61%
<b>Sum at NWRF</b>			<b>13,302</b>	<b>3.13</b>	<b>10.33</b>		

(1) Avg Flow assumed 236 gpd/SFE.

(2) Peak Flow multiplied the Avg Flow by a population-dependent Peaking Factor then added the infiltration contributed by the collection area.

(3) Allowable Capacity represents a d/D ratio of 0.80.

The total ultimate average flow to the NWRF was expected to be 3.13 mgd. The majority of the growth in the NWRF basin will be occurring in the developments south of Mainstreet and west of Jordan Road, and the proposed Sierra Ridge and ComPark developments. The Sierra Ridge and ComPark developments are anticipated to install lift stations which will ultimately contribute flows to the Challenger Park Lift Station. Existing subdivisions such as Bradbury Ranch, Parker North and Parker Heights are completely built out.

The future RidgeGate development is anticipated to ultimately have 11,000 SFEs. This development will not contribute flow to the existing water reclamation facilities. A new wastewater treatment facility located within the RidgeGate development is planned to treat the sanitary sewer flows generated from the development.

Wastewater generated by the Bell Cross Ranch and Rancho Montecito developments is treated at each property by leach fields, so their combined 99 SFEs do not contribute flow to the existing water reclamation facilities.

**Tables 4-7 and 4-8** suggest additional investigation into the capacity of several interceptor segments. As discussed in **Section 4.3.3**, the District plans to use their wastewater collection system computer model to evaluate suspect interceptor segments, and would determine future improvements from that evaluation.

**Table 4-9** summarizes the sewer pipeline segments that appear to have inadequate capacity based on the evaluation of ultimate flow conditions performed for **Tables 4-7 and 4-8**. **Table 4-9** includes the proposed equivalent pipe size to accommodate the ultimate flow at an allowable pipe capacity of d/D equal to 0.8. The equivalent size could be accomplished by installing a single pipe of the listed size, or by installing a smaller parallel pipe that would provide an additional cross-sectional area to total the equivalent size's area.

Table 4-9: Suspect Sanitary Sewer Interceptor Segments

Section	Existing Pipe Size (in)	Proposed Equivalent Pipe Size (in)	Description
B-3 to B-2	18	21	Interceptor between Canterbury Parkway and Mainstreet at the Sunset Ridge subdivision.
B-2 to B-1	21	24	Interceptor paralleling south side of Sulphur Gulch between Sunset Ridge subdivision and Town of Parker office building.
B-1 to E-3	21	24	Interceptor on south side of Sulphur Gulch between Town of Parker office building and Sulphur Gulch and Twenty Mile Road.
F-3 to F-2	24	27	West Interceptor between Stroh Ranch and Regional Pond.
F-2 to F-1	18	30	West Interceptor between Regional Pond and Overlook Landings subdivision.
F-1 to E-2	18	30	West Interceptor between the Overlook Landings subdivision and combined interceptor at intersection of Mainstreet and Cherry Creek.
E-2 to SWRF	27	36	Combined interceptor between intersection of Mainstreet and Cherry Creek and the SWRF.
H-2 to H-1	12	21	Interceptor between Bradbury Ranch subdivision and Clarke Farms Lift Station.
C-1 to A-5	18	21	Interceptor between Rowley Downs subdivision and intersection of Dransfeldt Road and Pony Express Drive.
A-5 to A-4	21	27	Interceptor between intersection of Dransfeldt Road and Pony Express Drive and intersection of Dransfeldt Road and Plaza Road.
A-4 to A-3	24	27	Interceptor between intersection of Dransfeldt Road and Plaza Road and intersection of Lincoln Avenue and Twenty Mile Road.
A-2 to A-1	27	30	Interceptor between Parker Auto Plaza and NWRP property line.

#### 4.4.3 Future Lift Stations and Force Mains

Estimates of future wastewater collection infrastructure are shown in **Exhibit 4**.

In the next five years, the Canyons development is expected to begin construction and will require sewer service. The topography in the development suggests several smaller lift stations will be needed. A major lift station and force main will be required to transport flows over a major ridge to the West Interceptor in Stroh Ranch. This future lift station should be constructed so that it can easily be expanded to accommodate continuing growth in the Canyons.

The force main from the Canyon lift station will need to connect to the West Interceptor. The anticipated alignment is due east through the future Anthology subdivision into the existing West Interceptor.

There are two additional developments located in the northwest portion of the District's service area. One is currently known as the Sierra Ridge development and could contain up to 1,138 SFEs. It is located at the southwest corner of Lincoln Avenue and Chambers Road, immediately west of Stonegate. The second development is known as ComPark and could contain up to 1,100 SFEs. It is located south of E-470 and west of Chambers Road. Because of the location of both developments, sewer service could be difficult. The developers' current plan is to construct a lift station in each development. The force mains will combine, go through the Stonegate development, and pump raw wastewater to the Challenger Park Lift Station. This is expected to require the expansion of the Challenger Park Lift Station. If the developers decide to be included in the District, these sewer scenarios should be explored in more detail.

Future lift station and force main designs should be performed by the developer and should be designed to accommodate the anticipated peak hour flow as well as inflow and infiltration.

#### **4.5 SUMMARY OF 5-YEAR PROJECTION**

As discussed in **Section 4.3.3**, the District will further evaluate the capacity of the sewer interceptor segments using a computer model to determine necessary wastewater collection system improvements. The 5-Year Projection will be based on the computer modeling results.

## SECTION 5: RECLAIMED WATER SYSTEM

### 5.1 GENERAL

The District’s wastewater reclamation system (reclaimed water system) is designed to recapture wastewater as a valuable resource and to treat it to a high level. The system reduces demand on the Denver Basin aquifers by providing a high quality water source using alluvial rights through the District’s augmentation plan. The reclaimed water system includes the wastewater collection infrastructure, pumped effluent infrastructure, and the waste reclamation facilities, as shown in **Exhibit 3**.

The overall reclaimed water system starts with the raw wastewater collection system of sanitary sewers, lift stations, and force mains. However, this section of the Master Plan only addresses the treated wastewater component of the reclaimed water system.

#### 5.1.1 Augmentation Credit

The District exercises its augmentation plan by direct discharging its tertiary treated effluent from the North Water Reclamation Facility (NWRf) and South Water Reclamation Facility (SWRF). The permitted discharge point is in Sulphur Gulch, west of Twenty Mile Road. The discharged effluent flows to Cherry Creek. In general, for each gallon of treated effluent that is discharged to Cherry Creek, the District can withdraw one gallon of alluvial water from Cherry Creek.

When Cherry Creek is a “free stream”, the District receives no water rights benefit from discharge under its augmentation plan, since it is allowed to withdraw water from Cherry Creek without exercising its augmentation rights. More benefit can be gained by storing this effluent wastewater in the two effluent storage reservoirs (Bar CCC and Regional), so it can be discharged to the creek during peak summer demand periods when benefit can be derived from the augmentation plan.

### 5.2 DESIGN CRITERIA

The reclaimed water system’s design criteria are mostly focused around the pipelines. Pumping rates and pressures depend on the specific needs of the overall system and few general guidelines are applicable.

**Table 5-1: Reclaimed Water System Design Criteria**

Criteria	Value
Maximum Pipe Velocity	5 feet per second

### 5.3 EXISTING SYSTEM

#### 5.3.1 Historic Effluent Production

Effluent production is dependent on the amount of raw wastewater treated at the water reclamation facilities and the efficiency of the facilities. Effluent can be reused for other purposes such as augmentation water. **Table 5-2** provides recent wastewater production.

**Table 5-2: Recent Wastewater Production**

Year	Avg. Monthly SWRF Influent (mgd)	Avg. Monthly NWRf Influent (mgd)	Total Avg. Monthly Influent (mgd)
2005	1.85	0.74	2.59
2006	1.65	1.03	2.68
2007	1.75	1.36	3.11
2008	1.68	1.31	2.99

For the purposes of this Master Plan, influent wastewater was assumed to be approximately equal to the effluent production.

### 5.3.2 Water Reclamation Facilities

In order to comply with the District’s discharge permit, the two Water Reclamation Facilities must meet strict effluent standards. The strict standards are because the effluent is discharged to Cherry Creek, which is governed by the Cherry Creek Basin Authority and Regulation 72. Regulation 72 is administered by the Colorado Department of Public Health and Environment’s Water Quality Control Division.

One of the strict effluent standards is on phosphorous, which is a nutrient for biological growth and its presence in bodies of water can degrade the overall water quality. In the District’s case, the protected body of water is Cherry Creek Reservoir. The District’s discharge permit requires the effluent phosphorous concentration to be 0.05 mg/l or less to stay within their phosphorus allocation limit of 593 pounds per year.

The North Water Reclamation Facility (NWRf) and the South Water Reclamation Facility (SWRF) are each hydraulically rated at 2.0 mgd. However, the discharge permit combines the hydraulic capacity into a total of 4.0 mgd for both facilities. Raw wastewater flow is split between the two facilities to maximize their treatment capacities and delay facility expansion requirements. This flow split is accomplished with a splitter box, which was discussed in **Section 4.3.3**. As raw wastewater flows increase to near a total of 4.0 mgd, the District will need to assess facility Site Application amendments and expansion needs.

The NWRf is located at the northwest corner of Parker Road and E-470. It was originally constructed in 1973, and expanded in 1984. In 2003, a new facility was constructed to the east of the original site. The current NWRf’s capacity is 2.0 mgd, and includes tertiary treatment systems.

Raw wastewater is received at the headworks building where grit and other solids are removed, dewatered, and disposed. The wastewater then flows to the aeration basins for nitrification and denitrification steps. The treatment process uses activated sludge returned from the secondary clarifiers. Wastewater from the aeration basins flows to the secondary clarifiers where sludge is settled out. Most of the sludge is returned to the aeration basins and a small portion is wasted to the aerobic digesters for further stabilization. Clarified wastewater is pumped to the advanced wastewater treatment (AWT) building where chemicals are added for coagulation, flocculation, and filtration. After the AWT building, the water is considered tertiary effluent and, after a disinfection step, it can be pumped to storage or discharged to Sulphur Gulch.

The SWRF is located on Plaza Drive at Dransfeldt Road. Its capacity is also 2.0 mgd, and includes tertiary treatment systems. The overall treatment process is the same as the NWRf, with one minor difference: the filters in the AWT building utilize a “contact clarification” step in place of the flocculation step.

Both facilities’ filters include backwashing steps, where decanted backwash water is recycled back through the plant. Backwash sludge is pumped to the aerobic digesters. Both facilities have sludge thickening buildings that use belt filter presses.

### **5.3.3 Existing Effluent Storage**

The District currently owns two effluent storage reservoirs: Bar CCC and Regional Park. The combined storage capacity in the two reservoirs is approximately 106 million gallons. Approximately 10 percent of this capacity should be reserved as emergency storage in case of an AWT system malfunction. An AWT system malfunction would not allow direct discharge to Sulphur Gulch, but would allow wastewater treated to secondary standards to be pumped to the Bar CCC Reservoir.

The effluent storage reservoirs primarily store effluent generated in the winter. This effluent can be discharged during the summer months for alluvial credit. This allows alluvial water rights to be utilized during the peak water demand season.

#### **5.3.3.1 Bar CCC Effluent Storage Reservoir**

The existing Bar CCC Effluent Storage Reservoir is located on the southwest corner of the West Mainstreet and Twenty Mile Road intersection. The Bar CCC Reservoir was constructed in 1985, and consists of an earthen dam embankment and a clay liner.

Bar CCC Reservoir currently can store up to 57 million gallons of effluent from either water reclamation facility. The Bar CCC Reservoir is typically filled in the winter months and emptied in the summer months. The Bar CCC Reservoir serves as emergency effluent storage, with the capacity to pump the effluent back to the SWRF for treatment.

#### **5.3.3.2 Regional Park Effluent Storage Reservoir**

The existing Regional Park Effluent Storage Reservoir is located on the east side of the Salisbury Equestrian Park, between the Park and Cherry Creek. The Regional Park Reservoir was constructed in 1989, and consists of an earthen embankment and a clay liner.

Regional Park Reservoir currently can store up to 49 million gallons of effluent from either water reclamation facility. The Regional Park Reservoir is typically filled in the winter months, and emptied in the summer months. Regional Park Reservoir stores tertiary effluent from either the NWRf or SWRF. In 2008 the Regional Park Effluent Pump Station was completed to allow the future transfer of tertiary-treated wastewater to a future effluent discharge point on Cherry Creek.

### **5.3.4 Existing Effluent Pumping**

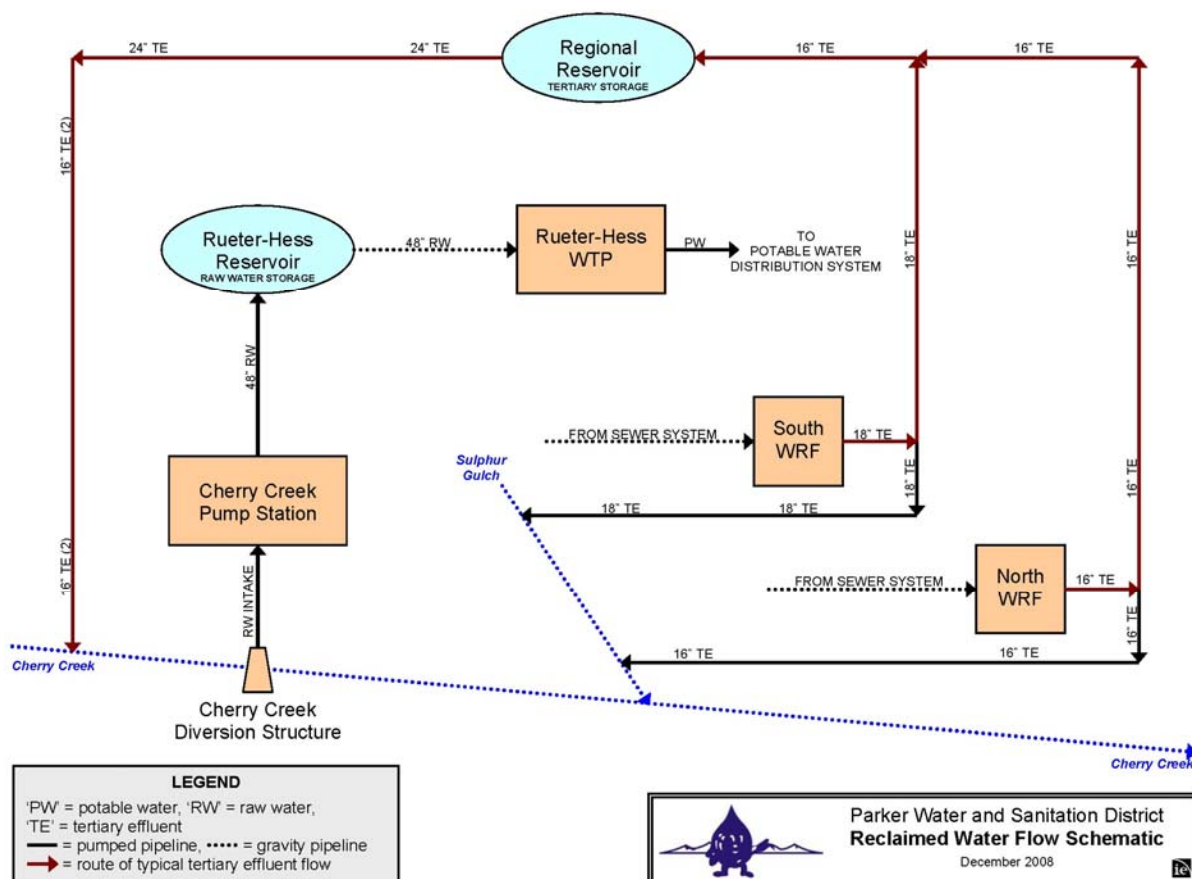
In addition to the pump stations at each water reclamation facility, the District has two other effluent pump stations: the Bar CCC Effluent Pump Station, and the Regional Park Effluent Pump Station.

The Bar CCC Effluent Pump Station is located on the west bank of the Bar CCC Reservoir. It has two constant-speed vertical turbine pumps, each rated for 1,000 gpm, with room for a future third pump. The Bar CCC Effluent Pump Station delivers effluent back to the SWRF. When the pump station delivers effluent back to the SWRF, the pumped flow rate is controlled to ensure the SWRF's hydraulic capacity is not exceeded.

The Regional Park Effluent Pump Station is located at the north end of Regional Park Reservoir. It has two variable-speed vertical turbine pumps, each rated for 2,800 gpm, with room for a future third pump. The Regional Park Effluent Pump Station will serve to transfer tertiary effluent from Regional Park Reservoir to a future Cherry Creek discharge point upstream of the Cherry Creek Diversion Structure. The pumps will discharge through two future 16-inch pipelines that have not yet been constructed.

**5.3.5 Existing Effluent Transmission Mains**

There are several effluent force mains in the District's reclamation system, most of which allow treated effluent to be transferred between the existing facilities as mentioned in previous sections. The District's transmission main configuration is summarized in **Figure 5.1**.



**Figure 5.1 Transmission Main Summary**

As noted previously, the pipelines connecting Regional Park Reservoir to Cherry Creek have not yet been constructed.

## 5.4 PROPOSED RECLAIMED WATER SYSTEM FACILITIES

### 5.4.1 Projected Effluent Production

**Table 5-3: Projected Effluent Production**

Description	2009	2010	2011	2012	2013	2014	2015	Ultimate
Total SFEs	14,357	14,907	15,432	15,975	16,538	17,120	17,723	43,507
Total Effluent (mgd)	3.4	3.5	3.6	3.8	3.9	4.0	4.2	10.3

1. The Total SFEs for 2009 through 2015 is based on Colorado Department of Local Affairs population growth rate projections for Douglas County from November 2007.
2. The Total Effluent assumes 236 gpd/SFE as discussed in **Section 4.3.1**.

Expansions to the District's existing water reclamation facilities will be needed in the near future. Because of the splitter box structure, the treatment capacity of the two facilities can be viewed as combined with a maximum permitted value of 4.0 mgd.

When the total combined wastewater influent is approximately 3.2 mgd, the District will have reached 80 percent of its permitted treatment capacity. This will require the District to begin the utility planning process for an expansion to one or both of their facilities. Based on **Table 5-3**, this is anticipated to occur in approximately 2009 or 2010.

When the total combined wastewater influent is approximately 3.8 mgd, the District will have reached 95 percent of its permitted treatment capacity. This will require the District to have completed its treatment capacity expansion. Based on **Table 5-3**, this is anticipated to occur in approximately 2012.

### 5.4.2 Future Water Reclamation Facilities

The current wastewater service plan for the future RidgeGate development is to construct an initial 0.7 mgd water reclamation facility to be called the West WRF. The West WRF would be located at the northeast corner of the RidgeGate development. The initial facility's construction timing will depend on the rate of development, which is currently very slow. The initial facility's construction is projected to occur sometime between 2010 and 2017. The capacity of the West WRF would later be increased to 1.6 mgd, projected to occur sometime between 2020 and 2030. The facility's ultimate capacity is expected to be 4.0 mgd.

### 5.4.3 Future Effluent Pump Stations

Additional pump stations will be required as the RidgeGate and Canyons developments grow, however this plan does not anticipate significant development from these areas in the next five years.

### 5.4.4 Future Effluent Storage

Currently, there are no plans to add storage capacity for effluent.

### 5.4.5 Future Effluent Force Mains

In the next five years, the District plans on installing two 16" effluent force mains from Regional Park Effluent Pump Station to upstream of the Cherry Creek Diversion Structure. The pipeline is intended to be in service by the time the Rueter-Hess Reservoir is complete.

**5.5 SUMMARY OF 5-YEAR IMPROVEMENTS PROJECTION**

The District is planning on funding the two 16” effluent force mains from Regional Park Effluent Pump Station to upstream of the Cherry Creek Diversion Structure within the next five years.

Much of the future wastewater collection infrastructure, including includes lift stations and force mains, will be paid for by developers as the need arises for service to new areas.

Preparation for expansion of one water reclamation facility may need to start around 2009, which would include preliminary studies, Site Application amendments, and possibly design.

Provided below in **Table 5-4** is the summary of District funded reclaimed water system projects over the next five years in 2008 dollars.

**Table 5-4: Future 5-Year Reclaimed Water System Improvements**

<b>Description</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
16” Effluent Force Main	\$2,000,000				\$2,000,000
NWRF Expansion	\$50,000	\$1,000,000	\$8,000,000	\$13,000,000	
Administration Building <sup>(1)</sup>					\$10,000,000
SWRF Improvements <sup>(1)</sup>			\$12,000,000		
<b>Annual Total</b>	<b>\$2,050,000</b>	<b>\$1,000,000</b>	<b>\$20,000,000</b>	<b>\$13,000,000</b>	<b>\$12,000,000</b>

1. Based on the 10-year wastewater capital outlook projection presented to the Board at the June 14, 2007 Board Meeting.

## SECTION 6: SUMMARY OF FUTURE INFRASTRUCTURE

**Table 6-1** summarizes the anticipated capital expenditures in 2008 dollars and the phasing associated with the water and reclaimed water improvements between 2009 and 2014 to adequately serve the projected 2014 development.

### 6.1 SUMMARY OF 5-YEAR IMPROVEMENTS PROJECTIONS

**Table 6-1: Summary of 5-Year Water and Reclaimed Water Systems Improvements**

Description	2009	2010	2011	2012	2013
<b>Water System</b>					
Future Well Facility #1 and #2			\$8,000,000		
Rueter-Hess WTP			\$25,000,000	\$25,000,000	
<b>Reclaimed Water System</b>					
16" Effluent Force Main	\$2,000,000				\$2,000,000
NWRF Expansion	\$50,000	\$1,000,000	\$8,000,000	\$13,000,000	
Administration Building					\$10,000,000
SWRF Improvements			\$12,000,000		
<b>Annual Total</b>	<b>\$2,050,000</b>	<b>\$1,000,000</b>	<b>\$53,000,000</b>	<b>\$38,000,000</b>	<b>\$12,000,000</b>

1. Wastewater collection system improvements to be determined after District's detailed computer modeling is complete.