Yakima County

Terrace Heights Water System Plan

August 2019

Yakima County

Terrace Heights Water System Plan

This Document has been Prepared under the Direction of a Registered Professional Engineer

Joe Stump, P.E.
Utilities Manager

August 2019

Contents

Contents
(Continued)

Page

Contents
(Continued)

Page

Figures

Number **Page**

Tables

Executive Summary
Terrace Heights Water System Plan

The Washington State Department of Health requires that Yakima County prepare a water system plan for each of its Group A water systems, and that the plan be updated once every six years. The purpose of the plan is to evaluate the water system facilities and operations, and to develop an improvement plan to meet future system needs.

Background

The Terrace Heights Water System consists of the former Terraced Estates Water Company and the former Country Club District Water Company. Yakima County assumed ownership and operation of the Terraced Estates system in 1991, and the Country Club system in 1994. The two were combined in 1996.

The Terrace Heights Water System has undergone a number of improvements to increase system capacity and reliability since the County assumed ownership and operation. During this time, the County has constructed three new reservoirs, a supply well, two booster stations, transmission main, telemetry system, several distribution system improvements, and reconstructed three well houses.

The system serves an estimated 5,260 people. Peak day demands are 2,073,000 gallons per day.

System Evaluation

Existing facilities are adequate to meet existing system demands. Distribution facilities currently have capacity to serve an estimated 600 additional residential service connections, supply facilities have capacity to serve an estimated 760 additional residential service connections, storage facilities have capacity to serve an estimated 1,040 additional residential service connections, and water rights are adequate for an estimated 3,990 additional residential service connections. Based on past growth rates, these capacities should be sufficient for the next 20 years.

Although system capacity is adequate, the County plans to construct a number of improvements in the next 10 years to increase system reliability should one off the existing facilities fail during peak demand periods. These improvements include rehabilitating the Country Club Tower Reservoir, increasing the pumping capacity of Well 6, and constructing a new supply well. The County also plans to repaint Reservoir #1 and construct a new pipeline in Maple Avenue.

Additional storage is needed in a small zone that serves 20 residential customers above the reservoir on 57th Street. The County owns property north of the reservoir that could be used as a reservoir site for this upper pressure zone. Adding storage will require a new booster station and water line to be constructed. Because of the costs, the County plans to wait on this improvement until additional development occurs in this area.

A hydraulic analysis of the system shows that system pressures are adequate for all customers. The hydraulic analysis also shows that the distribution system can provide the necessary fire flows in most areas of the system. Three fire hydrants have less than 500 gpm available. Two of the hydrants are in the former Country Club system where 4-inch and smaller lines are common. The third is in the former Terraced Estates Water Company where supply is provided by a small booster station.

Distribution leakage, which includes water lost through leaks, metering inaccuracies, meter reading errors, and illegal connections, has averaged 10 percent the last two years since the County replaced all the service meters. Prior to replacing the service meters, distribution leakage was as high as 25 percent.

Water quality has been good in the past. No problems or trends have been experienced.

Operations Program

No major changes are planned to the County's operations and maintenance program. A program for testing source and service meters should be implemented. All Utility personnel should also receive training in the use of the fall restraint systems.

Improvement Program

The estimated cost of the six-year capital improvement program is $2,000,000. All of this is planned to be funded by Water System reserves, unless the County is able to draw on the remaining balance of Drinking Water State Revolving Fund loan dollars. Availability of the loan dollars, which total approximately $634,000, is currently on hold pending resolution of the State's capital budget.

Financial Program

Projected revenues and expenses indicate that revenues should be adequate through the year 2026.

Chapter 1
General Information

Ownership and Management

The Terrace Heights Water System is owned and operated by Yakima County. As a County owned facility, the Board of Yakima County Commissioners is the highest decision making body governing the water system. The Board has delegated the day to day management and operation of the system to the Yakima County Public Services Department.

Yakima County owns and operates twenty-nine water systems. System names, identification numbers, and group designations are listed below. System locations are shown on Figure K-1 in Appendix K.

System Name	I. D. Number	Group Designation
Terrace Heights	06029J	A
Buena	343018	A
Crewport	16242Q	A
Gala Estates	23280-K	A
Beckon Ridge	AA461P	B
Bittner	AB383H	B
Bonair	08042K	B
Buchanan	AA116D	B
Fairway Estates	AA484C	B
Gibson	06191B	B
Heysman	07338Q	B
Horizon View	AD114	B
Kodi South 1	06188P	B
Kodi South 2	61897	B
Meadowbrook	06359P	B
Nagler	07833T	B
Norman	AB9686	B
Oliver	AD303F	B
Pleasant Hills	67869 V	B
Raptor	AC2386	B
Ray Symmonds	08039X	B
Speyers	AB557A	B
Star Crest	05413-M	B
Stein Lower	08096X	B
Stein Upper	08157J	B
Wenas Button	66931	B
Wenas Huntzinger	06677K	B
Wendt Road	06251E	B
Wiseacre	AA042P	B

The Washington State Department of Health requires that Yakima County prepare a water system plan or a small water system plan for its Group A water systems. A water system plan for Buena and small water system plans for Gala Estates and Crewport are bound separately.

A copy of the current water facilities inventory for the Terrace Heights system is included in Appendix P.

History

The Terrace Heights Water System includes the former Terraced Estates Water Company (I.D. # 06029J) and the former Country Club District Water Company (I.D. # 15500). Yakima County acquired the Terraced Estates Water Company in May 1991, and the Country Club District Water Company in March 1994. The two systems were combined in January 1996 and are now referred to as the Terrace Heights Water System.

The Terraced Estates Water Company (TEWC) was formed in the late 1970's by a private developer to serve the Terraced Estates Subdivision. The subdivision consisted of approximately 400 lots located over 160 acres. Construction of the subdivision was completed in phases and includes a total of 11 divisions, the last of which was completed in 2003. As each division was constructed, the water system was expanded. Expansions also occurred to serve the Country Meadows and Terrett Lane developments.

In 1993, after acquiring the TEWC, the County began construction of a major water system improvement project. Included in the project was a new supply well, booster station, transmission main, storage reservoir, and telemetry system. Construction on the project was completed in 1994, and totaled $3.1 million.

The Country Club District Water Company (CCDWC) was formed in 1926 to serve residential development in the Terrace Heights area. Initially, the system was owned by a private individual who constructed the first well and storage facility. The system was then expanded as development occurred. Approximately 50 years ago, ownership of the company was transferred to the customers with each customer owning a share of stock. After that time, all administrative decisions were made by an elected Board of Directors.

In 1988 the CCDWC Board of Directors, at the direction of the Department of Health, hired a consulting firm to prepare an engineering report on their water system. The report, which was completed in 1989, identified major deficiencies within the existing system. Most notably, the report identified serious shortcomings in water storage and in the hydraulic capacity of the distribution system. The report was reviewed and approved by the Department of Health with the expectation that the CCDWC would undertake the improvements recommended in the report. However, most of the improvements were not completed.

In 1994, the CCDWC share holders voted overwhelmingly (approximately 90 percent in favor) to sell their system to Yakima County. Their decision was based on Yakima County's assurance that the needed improvements would be undertaken and with the knowledge that their water rates would increase approximately 90 percent to help fund the needed improvements.

After purchasing the CCDWC, Yakima County began construction on a second phase of water system improvements. The purpose of this second phase was to intertie the Country Club and Terrace Heights systems, install meters on all unmetered services, rehabilitate three existing well houses, and complete the improvements recommended in the CCDWC's 1989 engineering report. Construction of the second phase of improvements began in 1995 and was completed in 1999. The cost of the improvements was $1,011,000.

Yakima County is currently undergoing a third phase of improvements funded by a Washington State Drinking Water State Revolving Fund loan. This project involves construction of a new 1.5 million gallon storage reservoir, relocating three 30,000 gallon tanks, and increasing the pumping capacity of Well 6. The new reservoir and tank relocation have been completed, and the Well 6 improvements are under design.

Geographical Description

The Terrace Heights Water System lies east of the Yakima River along the southern foothills of the Yakima Ridge. The Yakima River is a natural barrier that serves as the boundary between the City of Yakima's Water System and the Terrace Heights Water System. The Yakima Ridge serves as a natural barrier on the north side of the system as it rises in elevation from approximately 1,000 feet to 2,500 feet. Nearly all of the area along the ridge is undeveloped range land, much of which is too high in elevation to be served. Properties that are serviceable are provided an excellent view of the Yakima Valley.

To the east and south is the Moxee Valley. The Moxee Valley consists of mostly rural agricultural land and undeveloped range land.

Five irrigation canals reside within the Terrace Heights Water System. The Roza Canal is the largest and serves as a boundary between two pressure zones. The remaining canals, which include the Selah-Moxee, Moxee, Hubbard and Union Gap, are small enough not to create significant barriers within the system. Most customers from the former Country Club system receive irrigation water from one of these canals.

The Terrace Heights area is considered a desert, receiving on average about 8-inches of precipitation per year. Most of the precipitation falls in the winter months making the summer irrigation season a high water use period.

Service Area

The Terrace Heights Water System Service Area is shown on Figure 1-1. The Service Area includes all of the Yakima Urban Growth Area east of the Yakima River. It also includes approximately 170 acres outside the Yakima Urban Growth Area below elevation 1550. In general, the County does not plan to serve outside the Yakima Urban Growth Area. Some of the area that is outside the Yakima Urban Growth Area is already partially served, and some includes a parcel that is too close to the landfill to allow a private well to be drilled. The pressure zone serving this area can serve up to elevation 1550, and will need to be extended anyway to include the higher elevations within the Yakima Urban Growth Area. Lots shown within the Service Area and not adjacent to an existing water main will require improvements (main extensions, etc.) to be made before water service is available.

The Service Area includes one 49 acre parcel that had previously been outside the Service Area. The County is proposing to add this parcel to the Service Area because it is too close to the Terrace Heights Landfill to allow a private well to be drilled. Current state regulations prohibit drilling a well within 1,000 feet of a landfill.

The Retail Service Area is the same as the service area.

Figure 1-1 also shows privately owned water systems within the Terrace Heights Water System Service Area. According to Department of Health records, more than 40 privately owned water systems lie within the Service Area. Yakima County does not have service area agreements with any of these systems. This has not posed problems in the past. Newly developed lots are given the option of receiving water from one of the systems if the system has adequate capacity.

Service Area Policies

The following paragraphs describe County policies that affect growth and development of the water system.

Wholesaling Water

Yakima County is not currently wholesaling water. If the need should arise, Yakima County will consider wholesaling water. Conditions of the service would need to be negotiated and formalized in a written agreement.

Wheeling Water

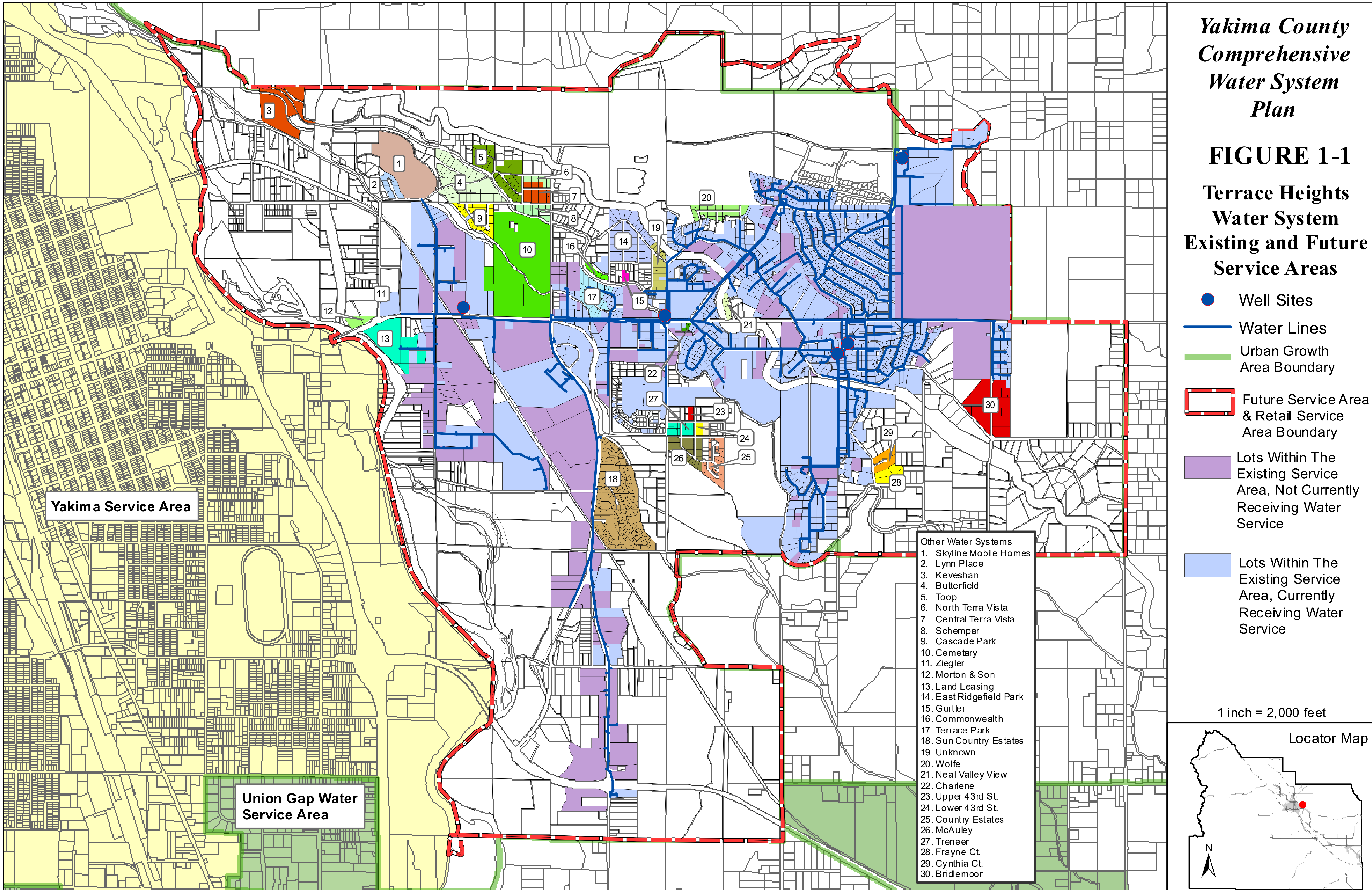
Yakima County will not allow the system's mains to be used to wheel water to another water system.

Annexation

Annexation policies apply to water purveyors that have the authority to annex, such as cities and water districts, and are not applicable to county owned water systems.

Direct Connection and Satellite/Remote Systems

Yakima County is a Department of Health approved Satellite Management Agency. The County will own and operate satellite water systems with three or more connections that are within the urban area. Systems that are outside the urban area must have five or more connections. The County will



Date: January 8, 2010

File: \\gis-bluedog\gis_data\disk_5\projects\county\pw\waterplan\t_heights\watersystemplan_09\fig11_waterplan.mxd not manage or operate systems that it does not own. For a detailed description of the County's satellite management policies, refer to the *"Yakima County Water System Satellite Management Plan."*

Water service may be provided by extending service from the Terrace Heights Water System, or by constructing a satellite water system. Developments must connect to the Terrace Heights Water System if the estimated cost of connecting is less than twice the estimated cost of installing and operating a satellite system. Developments must also connect if they involve structures built or moved to within 200 feet of an existing main water line for residential, business, industrial or institutional purposes (*Yakima County Code 12.08.150*). Developments within 200 feet of an existing main where the estimated cost to connect is more than twice the estimated cost of installing and operating a satellite system will be considered on a case by case basis. Generally, extending a main 200 feet will be less than twice the cost of installing and operating a satellite system unless major barriers are involved.

Satellite systems must be dedicated to the County for ownership and operation. As the Terrace Heights Water System expands, the County owned satellite systems will be connected. Non County owned systems may also connect to the Terrace Heights Water System. Policies regarding the transfer of private systems into the Terrace Heights system are described below.

Transfer of Private Systems into the Terrace Heights System

A long term goal for the Terrace Heights area is to consolidate existing privately owned public water systems into the Terrace Heights Water System. Policies relating to the transfer of ownership are as follows:

1. Facilities of a private system should be in reasonable compliance with County standards before connection to the Terrace Heights Water System, or, provisions must be made to upgrade deficiencies in the private system within a reasonable time following connection to the Terrace Heights Water System. The cost to correct deficiencies in the private system and connect to the Terrace Heights Water System will be at the expense of the private system.

2. Each individual customer in the private system must have a separate service connection and meter.

3. The transfer of a private system to the Terrace Heights Water System will be by agreement between the private system and the Board of County Commissioners.

4. The private system must pay a capital cost recovery charge to the Terrace Heights Water System. To make it more economically feasible for systems to transfer ownership, the capital recovery charge will be equal to the connection permit charge calculated as if the private system were to be served by a single meter. Table 1-1 is used in determining the capital cost recovery charge.

Table 1-1 Capital Recovery Charges for Private Systems	
Number of Connections in Private System	Capital Cost Recovery Charge
2	1" Meter Charge
3 to 8	2" Meter Charge
9 to 30	3" Meter Charge
31 to 80	4" Meter Charge
81 to 170	6" Meter Charge
171 to 270	8" Meter Charge

Design and Performance Standards

Minimum design and performance standards for new development are included in Chapter 4 and Appendix A.

Formation of Local Improvement Districts (LIDs)

The County will work with property owners in forming LIDs to facilitate construction of water facilities.

Urban Growth Area

The Terrace Heights Water System's service area includes the Yakima Urban Growth Area east of the Yakima River. The system is responsible for providing water service in areas not already served by existing water systems in this service area as described by other policies in this Chapter.

Latecomer Agreements

The County will prepare latecomer agreements for developers that extend the water system. Terms of the latecomer's agreement must be consistent with RCW 35.91.020.

Oversizing

If the County requests that improvements be oversized to serve properties outside a proposed development, then the County will reimburse the developer for the difference in material cost to oversize the improvement. An agreement describing the terms and conditions of the reimbursement would be executed by the developer and the Board of County Commissioners before commencement of construction. A sample service extension agreement is included in Appendix B.

Cross-Connection Control Program

The County's cross-connection control program is described in Appendix H.

Required Connections

Any building or structure built or moved to within 200 feet of an existing main water line for residential, business, industrial or institutional purposes must connect to and obtain water from the Terrace Heights Water System (*Yakima County Code 12.08.150*).

Single Connections for Multi-Family Units

Apartment complexes, mobile home parks, or other similar multiple dwelling units that are on a single parcel may be considered as an individual customer and may be served by a single service connection with a master meter. If the service connection is 2-inches or larger, it shall be served by a compound meter.

Multiple dwelling units served by a single meter that later subdivide or convert to condominiums shall first install individual meters to each dwelling unit.

Fire Protection

An approved water supply capable of supplying the required fire flow for fire protection shall be provided to all premises upon which facilities, buildings or portions of buildings are hereafter constructed or moved into or within the jurisdiction, except as described in Chapter 4.

Private Water Lines

Private water lines may be allowed when the impact to the system is insignificant, as determined by the Public Services Director. Examples of the types of development in which private lines may be allowed include apartment complexes, mobile home parks, or other similar multiple dwelling units that are on a single parcel. They may also be allowed to serve a commercial or industrial facility that is on a single parcel. They may not be used to serve multiple parcels. Private water lines connected to the County owned and operated system shall be constructed in conformance with applicable County standards. All private water lines shall be installed, owned, and maintained by the customer. Private water lines are addressed in County Ordinance 4-1985.

Duty to Serve Policies for Retail Service Area

The Terrace Heights Water System shall provide water service to all new service connections within the retail service area when the following conditions are met:

- The applicant completes an application for service and pays a water connection permit charge based on the size of the service. Once the connection is installed, the applicant shall also be required to pay the actual cost of installing the service connection.

- There is sufficient capacity to serve the connection in a safe and reliable manner. System improvements needed to serve the connection, including but not limited to, water line extensions, supply facilities, booster stations, storage facilities, and pressure reducing stations will be paid for by the applicant. Costs to be paid include design, plan review, construction and inspection costs.

- There are sufficient water rights to provide the service and the project does not use an unreasonable amount of water per acre for the land use proposed based on demand projections in Chapter 3. Projects utilizing more than 500 gpm or 300 acre-ft per year shall require Board of County Commissioner approval.

- The water service is consistent with County plans and regulations.

County Code

Yakima County Code Chapter 12.08 relates to the provision of drinking water. Included in the code are the following major provisions:

- Establishes a utilities division within the Public Services Department

- Authorizes the County to develop and operate domestic water systems

- Prescribes general provisions for construction, ownership, and maintenance of private and public water lines and fire hydrants

- Prescribes procedures and regulations for connecting to the water systems

- Establishes rates and charges related to water service

- Establishes a billing and collection procedure for water service

- Provides a penalty for violating the provisions of the ordinance

A copy of the Code is included in Appendix G.

Chapter 2
System Description

The Terrace Heights Water System includes seven pressure zones, six supply wells, three booster stations, three storage reservoirs, and approximately 44 miles of pipeline. The facilities are shown on Figure 2-1.

Pressure Zones

Hydraulic grade lines and general information regarding each pressure zone is listed in Table 2-1. A hydraulic profile showing how the pressure zones are related is presented in Figure 2-2.

As shown in Figure 2-2, Wells 3 through 6 pump into Reservoirs 2 and 3 in Zone 1. The Sycamore Booster Station and the Well 5 Booster then pump from Zone 1 to Zone 3, and the Terrett Booster Station pumps from Zone 3 to Zone 4. Well 2 pumps into Reservoir 1 in Zone 3. Pressure reducing stations are used to move water from Zones 1 and 3 down to the lower zones.

Table 2-1
Pressure Zones

Pressure Zone	HGL	Service Area Ground Elevations		Source of Supply	Storage
		at 40 psi	at 100 psi		
1a	1169	1077	938	33rd Street PRV	None (Closed System)
1	1288	1196	1057	Wells 3, 4, 5 & 6 and PRV at Well 5 and Sycamore Booster	Reservoirs 2 & 3
2a	1370	1278	1139	Santa Roza PRV, & Terrace Drive PRV	None (Closed System)
2	1430	1338	1199	Sky Vista, 57th St., Bridle Way, & Sycamore PRVs	None (Closed System)
3a	1460	1368	1229	Channel Drive PRV & Castle Mt. Ct. PRV	None (Closed System)
3	1513	1421	1282	Well 2, Sycamore Booster Station and Well 5 Booster	Reservoir 1
4	1682 to 1717	1590 (HGL 1682)	1486 (HGL 1717)	Terrett Booster Station	Three 87 gallon pressure tanks at Terrett Booster Station

Comments:
1. HGL is the normal maximum "Hydraulic Grade Line" elevation for the pressure zone under static conditions.
2. The future HGL for Zone 4 is approximately 1640. The service area ground elevations for this HGL are 1548 and 1409 at 40 psi and 100 psi respectively.

Supply Wells

The Terrace Heights Water System includes six supply wells. Wells 4, 5 and 6 draw from the Ellensburg formation, which consists of semi-consolidated deposits of clay, silt, sand and gravel. Well 3 draws from the Saddle Mountain formation in the Yakima Basalt aquifer, which underlies the Ellensburg formation. Well 1 draws from the Wanapum formation in the Yakima Basalt aquifer, which underlies the Saddle Mountain, and Well 2 draws from the Lower Ellensburg. Information regarding each well is included in Table 2-2 and the following paragraphs.

Well 1

Well 1 was drilled in 1975 to serve the Terraced Estates subdivision. In 1978, a well test showed the well produced 1,051 gpm with 118 feet of drawdown. The static water level at the time was 96 feet.

In 1991, a well test was conducted again after it was found that the pump was breaking suction. This test showed the well would only produce about 100 gpm, and that the static water level had dropped from 96 to 258 feet. Because of its drop in capacity, Well 1 has not been used since 1994.

Since the time when the well was last used, the aquifer has recovered to a static level of 82 feet (2005 measurement). The well draws water from a perched aquifer on Yakima Ridge that is susceptible to over pumping.

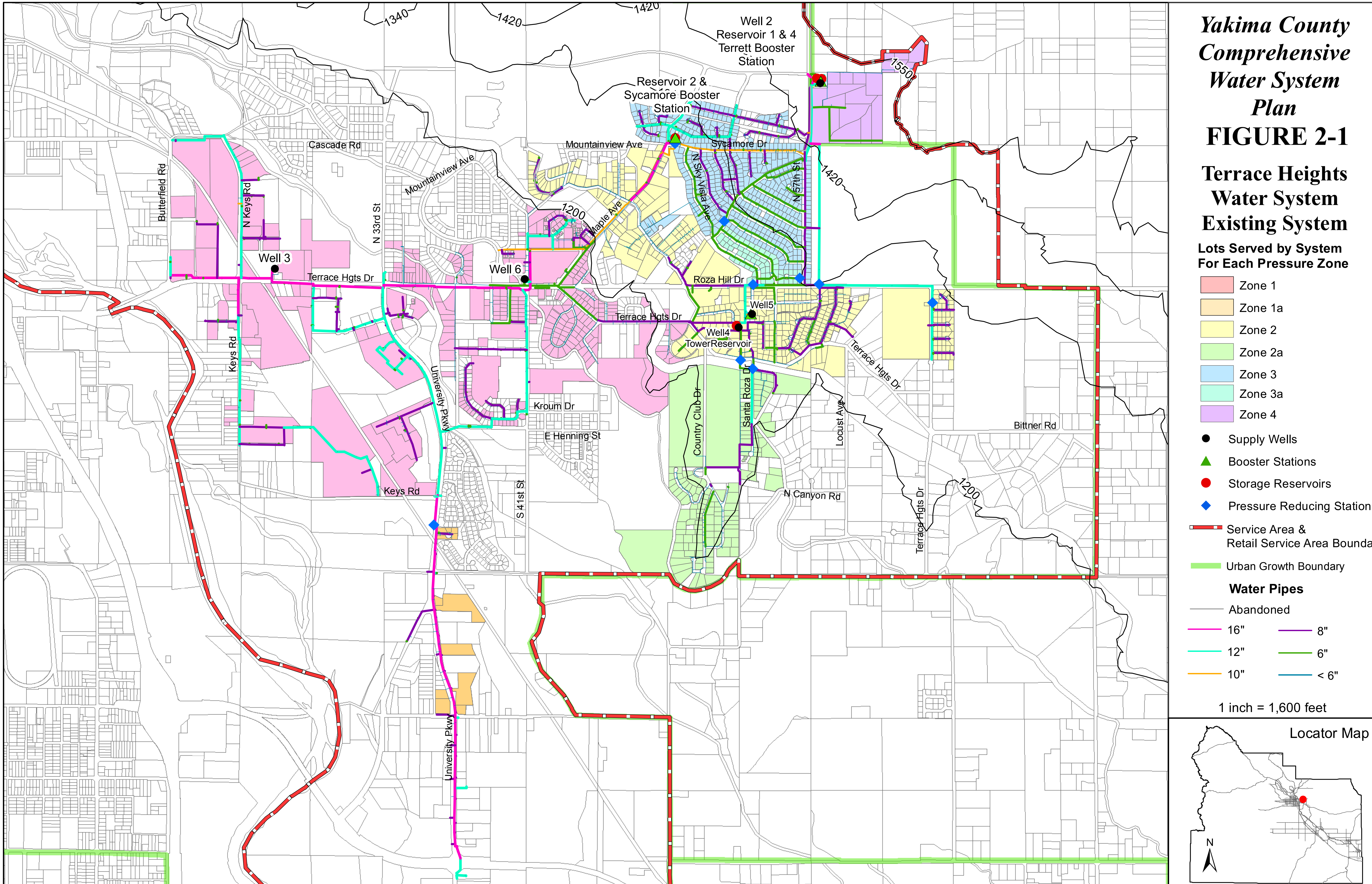
Well 2

Well 2 was drilled in 1978 to also serve the Terraced Estates subdivision. The well was drilled to a depth of 1,072 feet and sealed to a depth of 21 feet. It is cased to a depth of 806 feet with 12" casing. The static water level in 1978 was 360 feet.

The static water level as fluctuated over the years. By 1991, the static water level had dropped from 360 to 374 feet, and by 1996 it had dropped to 415 feet. In 2008, 2010 and 2011 the static level was 409 feet, indicating the decline had stabilized. In 2015, after the well had been off for nearly a year due to power supply issues, the static level had increased back up to 400 feet.

In 1991, a well test showed the well produced 326 gpm with 200 feet of drawdown. In 2008 the well produced 330 gpm with 189 feet of drawdown. In 2010, the pump was trimmed slightly to keep the motor from operating in its service factor. This reduced the flow to 270 gpm. In July 2017, after running nonstop for 19 days, the depth to water was 573 feet with an estimated drawdown of 173 feet.

In 1991, while installing a new pump, it was noted that the well was very crooked. This condition was confirmed in 1996 when the pump was pulled and the well video inspected. Because it is crooked, it is difficult to pull and set the pump without damaging the electrical cable. The well is too crooked for a vertical lineshaft turbine.



Date: September 2017

Document Path: R:\disk_5\projects\county\pw\waterplan\t_heights\watersystemsplan_17\fig21_waterplan.mxd

Terrace Heights Water System
Hydraulic Profile

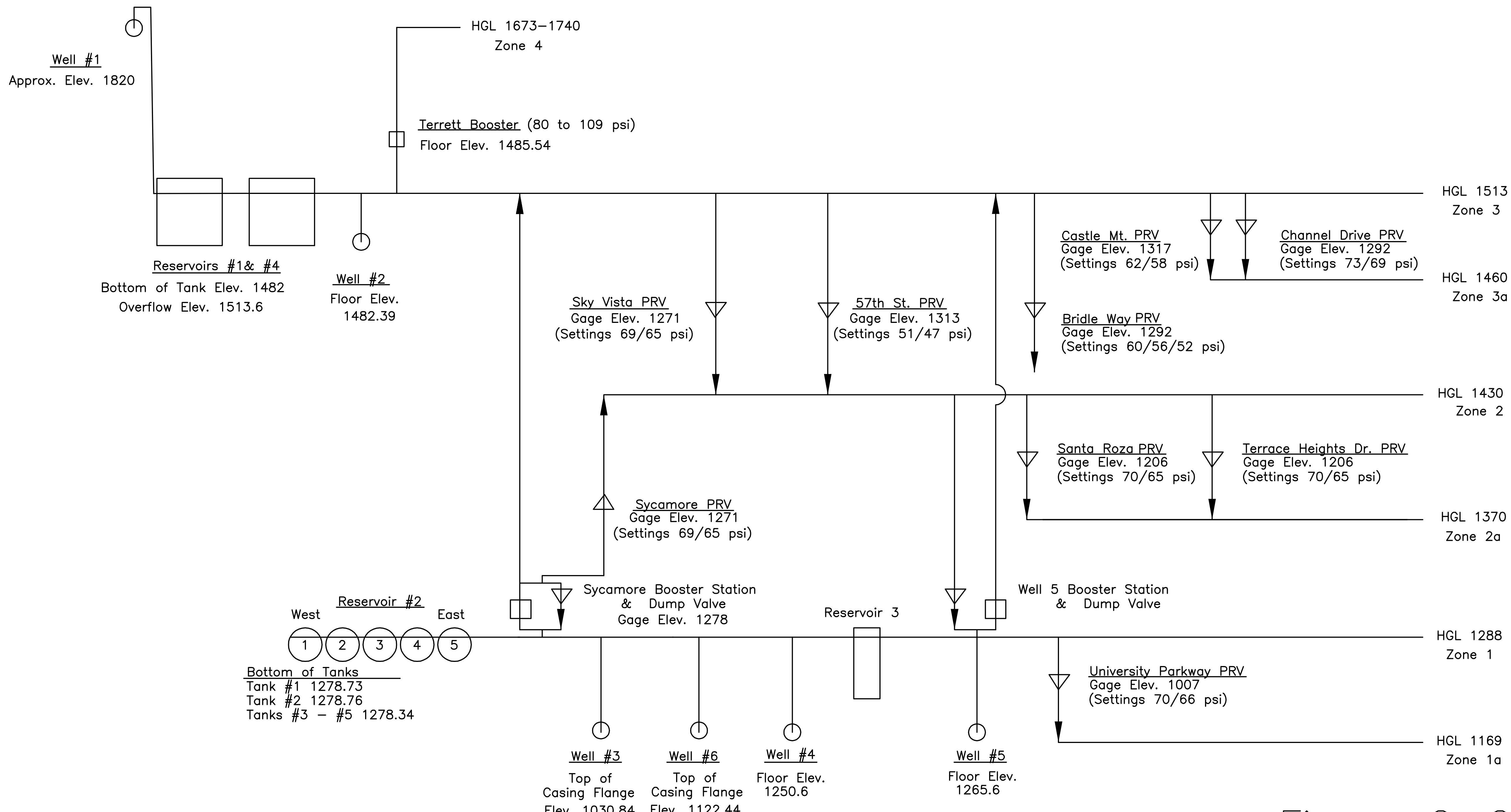


Figure 2–2

C:\Users\Tony\Desktop\HGL2_10_18_2017.dwg, Layout1, 10/18/2017 3:06:28 PM

Well 3

Well 3 was constructed in 1993 as part of the Terrace Heights Water System Phase 1 Improvement Project. The well was drilled to a depth of 2,421 feet and sealed to a depth of 1,725 feet. It is cased its entire length with 26", 20", 16", 12" and 10" casing. The 10" casing is perforated with 1/4" and 3/16" perforations below 1725 feet. Only the 10" casing is perforated. In 1993 the well was artesian with 18 psi of static pressure. The well produces approximately 1500 gpm at 455 feet of drawdown.

The static artesian pressure has declined slightly since the well was drilled, but does appear to have stabilized. In 1997, the static artesian pressure had dropped to 13 psi and by 2002 it had dropped to 11 psi. In May 2008, the static artesian pressure was 7.5 psi. In May 2015, it had increased slightly to 8.5 psi. All of the above readings were taken after the well had been off all winter or for an extended period of time.

Well 4

Well 4 is in the Country Club Tower and was originally Well 1 of the Country Club system. It was drilled in the fall of 1925 to a depth of 420 feet. Records show the well has a 20 foot section of iron casing at the bottom slotted with 1/4 by 2-½ inch perforations. The last 20 feet reportedly penetrate a water bearing stratum of sand and gravel. It is not known if the well has a surface seal.

In 1945, the static water level was reported to be 200 feet from the ground surface. In 1997, the static water level was 232 feet and the drawdown was approximately 12 feet when pumping 200 gpm. In May 2008, the static water level was still at 232 feet.

In 2008 the well was video inspected as part of a project to increase the pumping capacity. The video showed a section of open hole 2 feet in length between the end of the 10-inch casing and the beginning of the 8-inch casing. The 10-inch casing ends approximately 267 feet below the top of the well and the 8-inch begins approximately 269 feet below the top of the well. A 5 foot section of casing between approximately 367 and 373feet is perforated with round holes. Between 380 and 392 feet the casing is slotted. The well was encrusted with what appeared to be an iron bacteria growth in the slotted area, and was heavily encrusted from 390 to 401 feet. Sediment had filled the bottom of the well to a depth of 415 feet from the top of the well.

The well was subsequently wire brushed, surged, and dry iced to open some of the perforations. Sediment was removed from the bottom, which was found to be at 422 feet. The well is open hole from 395 to 422 feet. The well has occasional perforations due to corrosion and deterioration below approximately 352 feet.

Following the redevelopment, the well was test pumped at 300 gpm with 17 feet of drawdown after 3 hours, and at 440 gpm with 21 feet of drawdown for a short period of time. Flows above 400 gpm produced a small amount of sand that may clear with additional pumping. A 1949 Report of Findings estimated that Well 4 is capable of producing 1200 gpm.

Well 4 was not returned to service for approximately one year following the redevelopment due to unsatisfactory coliform samples. Samples collected within 24 hours of disinfection and flushing were generally satisfactory, but later samples were unsatisfactory. None of the samples were positive for E. coli. Bacteria detected include Pseudomonas Fluorescens and Cedecea Neteri. These bacteria are not known to be waterborne pathogens. In June 2009, the well was temporarily piped and flushed for several days into an irrigation box at Well 5. Samples collected during and following the sampling were satisfactory and the well was returned to service.

Well 4 has since been used as one of the primary wells and is used year round. As of 2015, the static water level was 238 feet.

Well 5

Well 5 is about 500 feet from Well 4 and was originally Well 2 of the Country Club system. Well 5 was drilled during the winter of 1946-1947 to a depth of 590 feet. It has a 26 foot section of 10-inch nickel alloy rustless drawn tubing slotted with approximately 800 3/16 x 2-1/2 inch perforations. The water in Well 5 rises to the same level as the water in Well 4.

In 1999, Well 5 was video inspected as part of the Terrace Heights Water System Phase 2 Improvement Project. The inspection showed the lower 60 feet of the well had filled with sand. The sand was subsequently removed and the well was again video inspected. The perforations were found to be partially plugged. Due to budget limitations, the well was not redeveloped. After removing the sediment from the bottom of the well to expose the perforations, and increasing the pumping capacity from approximately 250 gpm to 330 gpm, the well produced a considerable amount of sand. The well was flushed for several days into a nearby irrigation weir box to clear most of the sand. The well still produces a small amount of sand today.

During construction of the project it was also noted that the well has a surface seal, although the depth of the seal is unknown.

Static water levels have only dropped 5 feet since the well was originally constructed. According to the well log, the static water level was 234 feet and the drawdown when pumped at 165 gpm was 20 feet when the well was originally constructed. In 1986, the static water level was 235 feet and the drawdown at 300 gpm was 16 feet. In 1994, the static water level had dropped to 254 feet and the pumping capacity had dropped to 250 gpm. Drawdown at 250 gpm was 18 feet. In 2008, the static water level was 242 feet after the well had been off all winter and in 2015 the static water level was 239 feet after the well had been off all winter.

Pumping levels have not changed significantly since the last water plan update. At the end of summer in 2008, after the well had been in operation continuously all summer, the pumping level was 280 feet with the pump producing 325 gpm. At the end of summer in 2015, after the well had been in operation continuously all summer, the pumping level was 276 feet with the pump producing 320 gpm.

It appears the pump in Well 5 is showing signs of wear. In October 2017, after running all summer, the pumping level was 273 feet with a flow rate of approximately 275 gpm.

Well 6

Well 6 was constructed in 1983 and was previously Well 3 of the Country Club system. The well was drilled and cased to a depth of 1,495 feet, and sealed to a depth of 405 feet. The lowest screened interval is at 770 feet and, based on a video inspection of the well, all of the water produced comes from the screened sections and not the bottom of the well. The well has a history of producing sand when pumped above 400 gpm.

In 1996, the well was redeveloped and pump tested. Pump test results showed the well could produce over 1,100 gpm with approximately 96 feet of drawdown. During the pump test, the well continued to produce a small amount of sand at the higher pumping rates. It is believed the sand can be eliminated with a sand separator when the pumping capacity is increased.

In 2008, the well was producing 340 gpm with 15 feet of drawdown and a static water level of 91-feet. This was only one foot lower than the static water level when the well was drilled.

In July 2017 the Well was video inspected. Static water level after approximately one day without pumping was 103'. Drawdown was approximately 20 feet when pumping 340 gpm.

Well straightness was also measured in July 2017. At about 225 feet the well drift exceeds that recommended by the American Water Works Association. A vertical line-shaft pump could still be installed, but additional wear would result on the pump and shaft.

Table 2-2 **Well Summary**								
Well #	Location	Approx. Ground Elev.	Diameter & Depth	Depth of Surface Seal	Screened Interval(s)	Principal Aquifer or Formation	Yield	Static Water Level
1	SE¼ NE¼ Sec 10, T. 13 N., R. 19 E.W.M.	1820	8" casing to 337'. Original depth 340'. Depth after reconditioning 337".	40'	318' to 337'	Wanapum	1,051 gpm with 118' of drawdown in 1978. Approx. 100 gpm (1994)	96' in 1975. 262' in 1985. 258' in 1991. 82’ in 2005.
2	SW¼ NW¼ Sec 14 T. 13 N., R. 19 E.W.M.	1480	12" casing to 806'. Completed depth 1072'	21'	Open hole below 806'.	Lower Ellensburg	330 gpm with 140' of drawdown in 1991. 330 gpm with 189’ of drawdown in 2008 270 gpm with 173’ of drawdown in 2017	360' in 1978. 374' in 1991. 415' in 1996. 409’ in 2008 400’ in 2015 436’ in 2017
3	SW¼ SW¼ Sec 16 T. 13 N., R. 19 E.W.M.	1029	16" casing to 996'. 12" casing from 980' to 1725. 10" casing from 1703' to 2421'. Completed depth 2421'.	1725'	1725' to 1900', 1935' to 1980', & 2010' to 2400'.	Saddle Mountain	1,500 gpm with 455' of drawdown in 1993.	18 psi artesian in 1993. 13 psi artesian in 1997. 7 psi artesian in 2008. 8.5 psi artesian in 2015
4	NW¼ NE¼ Sec 22 T. 13 N., R. 19 E.W.M.	1250	12” Pitless unit to 5’ 10" casing from 5’ to 267'. 8" casing from 269' to 395'. Completed depth 422'.	Unknown	367’ to 373’ 380' to 392' Open hole below 395’	Ellensburg	165 gpm with 10' of drawdown in 1945. 300 gpm with 17’ of drawdown in 2008. 410 gpm with operating level at 256’ in 2013.	200' in 1945. 225' in 1992. 232' in 1997. 232’ in 2008. 238’ in 2015
5	NE¼ NE¼ Sec 22 T. 13 N., R. 19 E.W.M.	1268	12" casing to 527'. 10" casing from 495' to 587'. Completed depth 588'.	Unknown	541' to 565'.	Ellensburg	165 gpm with 20' of drawdown in 1947. 250 gpm with 18’ of drawdown in 1994. 325 gpm with 38’ of drawdown in 2008 320 gpm with 37’ of drawdown in 2015 275 gpm with 34’ of	234' in 1947. 254' in 1994. 242’ in 2008. 239’ in 2015. 239’ in 2017

Well #	Location	Approx. Ground Elev.	Diameter & Depth	Depth of Surface Seal	Screened Interval(s)	Principal Aquifer or Formation	Yield	Static Water Level
							drawdown in 2017	
6	SE¼ SE¼ Sec 16 T. 13 N., R. 19 E.W.M.	1120	12" casing to 405'. 10" casing from 380' to 1495'. Completed depth 1495.	405’	440' to 450', 490' to 500', 520' to 530', 580' to 590', & 750' to 770'	Ellensburg	450 gpm with 33' of drawdown in 1983. 1260 gpm with 120' of drawdown in 1983. 340 gpm with 15’ of drawdown in 2008. 340 gpm with 26’ of drawdown in 2015	90' in 1983. 103' in 1994. 91' in 1996. 91’ in 2008 104’ in 2015 103’ in 2017

Supply Pump Stations

Information regarding each supply pump station is included in Table 2-3 and the following paragraphs.

Well 1 Supply Pump Station

The supply pump station for Well 1 is a small wood framed structure. The structure is heated and insulated, but there is no ventilation or chlorination equipment installed.

The County does not plan to use this facility in the near future. Use of the facility would require a new pumphouse to be constructed, installation of chlorination equipment, raising the wellhead to at least 6-inches above the floor slab, and installing a new pipeline between the well and the distribution system. Even with these improvements, the well would still be at too high of an elevation to properly serve the existing system. The well is at a ground elevation of approximately 1820, and the reservoir it pumps into has an overflow elevation of 1513. Consequently, the cost to bring this facility up to current standards would be high for the supply capacity that it could provide.

If the well was returned to service, it would need to be as an emergency supply since it is not capable of sustaining a pumping rate for a long period of time without over withdrawing the perched aquifer that it pumps from.

If the well is sold, the bill of sale must say that no water rights are included. All water rights would need to be transferred to a new or existing County well.

Well 2 Supply Pump Station

The supply pump station for Well 2 was replaced in 1999 as part of the Phase 2 Improvement Project. The building is a small wood framed structure that is heated and insulated and in good condition. Two small vents can be opened at either end of the structure during the summer. Because the pump is a submersible, mechanical ventilation has not been needed. Sodium hypochlorite chlorination is used for disinfection, and a telemetry system is used to signal flow, pressure, and alarms to the main computer at the County Courthouse.

A transfer switch was installed to enable the facility to be connected to the County's trailer mounted generator. This is the only facility in the Terrace Heights system with backup power capability.

The pump and/or motor have been replaced several times in recent years. In June 2008, the pump and motor were replaced with an 8-inch diameter pump and motor. Previous pump and motors were 6-inch diameter and were only lasting about 4-years. A larger diameter pump and motor were installed to take advantage of bigger bearings and better cooling capability with the larger motor frame.

The power supply for Well 2 has a history of being unbalanced during large electrical demand periods (high summer or low winter air temperatures). The electrical utility has attempted to rebalance the loads in the area, but the pump station has continued to experience an unbalanced power supply. The unbalanced power supply caused frequent pump motor trips and may have been shortening the pump motor life. In 2015, a variable speed drive was installed to balance the power supply to the motor.

Well 3 Supply Pump Station

The supply pump station for Well 3 is a new facility that was constructed in 1994 as part of the Phase 1 Improvement Project. The building is made of concrete masonry and is heated, insulated, and ventilated. It includes a separate room for the chlorination equipment and a separate room for the motor controls. When first constructed, the pump station used gas chlorination. In 2012, a tablet chlorination system was installed. The gas chlorination equipment is still available as a backup system. The chlorine room is ventilated and includes a chlorine leak detector. The motor control room is air conditioned since it houses a variable frequency drive.

Well 4 Supply Pump Station

The supply pump station for Well 4 is a brick building that also encloses the Country Club Tower Reservoir. The building has a unique architecture and is considered a landmark by many in the Terrace Heights area.

In 2009, the County completed a project to install a new pump and motor, and motor controls. The new controls include a variable frequency drive and telemetry equipment to operate the well from the Courthouse. Other improvements planned for the pump house include insulating the building, repairing the roof and installing more secure doors.

The discharge is chlorinated with a sodium hypochlorite system.

Well 5 Supply Pump Station

The supply pump station for Well 5 was replaced in 1999 as part of the Phase 2 Improvement Project. The building is concrete masonry structure that is heated, insulated and mechanically ventilated. Ventilation equipment was included with this structure since it also includes a booster pump to pump from Zone 1 into Zone 3. Sodium hypochlorite chlorination is used for disinfection, and a telemetry system is used to signal flow, pressure, and alarms to the main computer at the County Courthouse. The building has space for one additional booster pump and is in good condition.

The pump station is currently operated manually 24-hours a day during the summer. The pump station is not operated automatically due to the surge created when the pump starts and stops with the Tower Reservoir off line. The Tower Reservoir either needs to be returned to service, a pump control valve installed, or a variable speed drive installed to reduce surge during startup and shutdown.

The pump capacity gradually drops during the summer as the water levels decline. In May of 2015, the well was producing 320 gpm and by October the capacity had dropped to 290 gpm. The operation of Well 4 also affects the capacity from Well 5.

Well 6 Supply Pump Station

The supply pump station for Well 6 was also replaced in 1999 as part of the Phase 2 Improvement Project. The building, which consists of a wood framed structure that is heated, insulated and mechanically ventilated, is in good condition. Ventilation equipment was included to allow the option of installing a vertical lineshaft turbine pump and motor. Sodium hypochlorite chlorination is used for disinfection, and a telemetry system is used to signal flow, pressure, and alarms to the main computer at the County Courthouse.

One option for increasing system supply capacity is to increase the pumping capacity of Well 6. Installing a larger pump and motor with a variable speed drive would allow the pump to normally operate at a flow rate similar to its current pumping capacity to avoid pumping sand. If another supply facility should fail, and additional capacity becomes necessary, then the pump speed could be temporarily increased to help meet demands.

The Well 6 pumphouse is in a park and is not fenced. The County will consider fencing the pumphouse if security needs to be increased. The well is located within the pumphouse.

Table 2-3
Supply Pump Stations

Location	Capacity (gpm)	Pump Type	Column Size	Motor HP	Speed (rpm)
Well #1	0	Submersible	325' of 4"	40	3600
Well #2	270	Submersible	147’ of 4” 525’ of 6"	60	Variable 1800-3600
Well #3	1,500	Vertical Lineshaft	550' of 10"	400	Variable 1100-1800
Well #4	400	Submersible	357' of 5"	50	Variable 1800-3600
Well #5	270	Submersible	399’ of 6”	40	3600
Well #6	340	Submersible	210' of 5"	40	3600
Total Supply Capacity = 2,780 gpm or 4.0 mgd					

Comments:
1. The Capacity for Well 1 is shown as zero due to the improvements needed to place the well in service. The pump capacity in Well 1 is over 400 gpm.
2. Wells #1 and #2 were originally part of the Terraced Estates Water System. Wells #4, #5 and #6 were originally part of the Country Club District Water Company.

Booster Pump Stations

Three booster stations are used to move water up to the higher pressure zones. The booster stations include the Sycamore, Well 5 and Terrett Booster Stations. Information regarding each booster station is included in Table 2-4 and the following paragraphs.

Prior to the time it was acquired by the County, the Country Club system included two booster stations that pumped into two separate zones. Both pump stations were removed from service when the Country Club system was combined with the Terrace Heights system. Areas previously served by the booster stations are now being served by pressure reducing stations.

Sycamore Booster

The Sycamore Booster Station is a vital link in the Terrace Heights Water System. This station is used to move water from Zone 1, which has nearly 90 percent of the supply capacity, to Zone 3, which ultimately provides water to 80 percent of the customers. The station actually acts as a transfer station. Pumps in the station are signaled to turn on and off based on the water level in the lower reservoir (Reservoir 2), rather than the water level in the upper reservoir (Reservoir 1). Wells 3 through 6 pump into Reservoir 2, and as the water level rises in Reservoir 2, one or more booster pumps are signaled to pump the water up to Reservoir 1. Under normal conditions, all of the wells operate based on the water level in Reservoir 1. Wells 3 and 6 will also run if the water level in Reservoir 2 drops too low.

The Sycamore Booster Station was constructed in 1994 as part of the Phase 1 Improvement Project. Included were 3 pumps with provisions for a fourth. The fourth pump was added in 2017 for additional redundancy. The pumps rotate between lead pump and lag with the first pump on becoming the first pump off. Currently, the pump controller is programmed to allow up to 3 pumps to run at one time. This could be changed in the future to allow all 4 pumps to operate if required to meet system demands. The number of pumps operating at one time is limited to 3 to reduce the potential for pressure surges.

The booster pumps are not equipped with a means to gradually increase or decrease flow on startup and shutdown. Consequently, a 10-15 psi pressure surge occurs on pump startup and shutdown. A soft start or pump control valve should be considered to lessen the chance of water main breaks in the distribution system.

An electronically controlled valve allows water from Zone 3 to flow back to Zone 1. The valve is set to maintain between 1.8 and 4.0-feet of water in Reservoir 2. If the water level drops to 4-feet, the valve will open provide a flow of 300 gpm into Reservoir 2. If the water level continues to drop the valve will open further. With 1.8-feet or less in Reservoir 2, the valve will provide a flow of 2,250 gpm into Reservoir 2 for fire protection. The upper flow limit of 2,250 gpm can be increased if needed.

The station is in good condition.

Well 5 Booster

The pump station for Well 5 includes a booster pump that, like the Sycamore Booster, pumps from Zone 1 to Zone 3. The booster pump is identical to the booster pumps in the Sycamore Booster. Also included in Well 5 are provisions for a second booster pump.

The booster in Well 5 serves as an emergency backup to the Sycamore Booster. The booster is intended to pump from the Tower Reservoir, and without the Tower Reservoir in service, there is not sufficient hydraulic capacity to the pump to keep it from cavitating without throttling the discharge.

The booster station includes a hydraulically operated valve to allow water from Zone 2 to flow back to Zone 1. The valve is set to maintain a minimum downstream pressure of 3 psi. The valve also includes a pressure relief override pilot to relieve pressure in Zone 2 if the pressure exceeds 80 psi.

Terrett Booster

The Terrett Booster Station was constructed around 1986 to serve the Terrett Lane development located northeast of Terraced Estates. It includes two variable speed pumps that operate off a pressure sensor and pump into three 86-gallon pressure tanks. The lead pump turns on at 90 psi and shuts off at 100 psi. The lag pump turns on at 85 psi and shuts off at 95 psi. The lead pump rotates to the lag position after 24 hours of run time. The building is constructed of wood and is heated and insulated. A small air conditioner cools the building in the summer.

The Terrett Booster is located adjacent to Well 2 and was planned to be replaced as part of the Phase 2 Improvement Project. However, there was not sufficient funding to include replacement of the booster station with the project. This building should be replaced when Pressure Zone 4 is expanded.

Table 2-4
Booster Pump Stations

Name and Location	Pump Number	Pump Capacity		Motor Size (HP)
		Flow (gpm)	Head (feet)	
Sycamore Booster (Sycamore Dr. and North Sky Vista Ave.)	1	780	240	60
	2	780	240	60
	3	780	240	60
	4	760	240	60
	Two Pumps Combined	1450	260	-
	Three Pumps Combined	1950	270	-
Well 5 Booster (Morningside Drive & Tower Lane)	1	760	240	60
Terrett Booster (Near Reservoir 1)	1	43	180	5
	2	43	180	5
	Two Pumps Combined	79	210	-

Comments:
1. Pump capacities shown for the Terrett Booster pumps are based on the lag pump start set point of 85 psi. Capacity of each pump at lead pump start set point of 90 psi is 41 gpm at 200'.

Pressure Reducing Stations

Nine pressure reducing stations are used to supply water to Pressure Zones 1a, 2a, 2 and 3a. All of the pressure reducing stations are less than twenty five years old and are in reasonably good condition. Lids on the Sky Vista, 57th Street, and University Parkway stations need minor repair. Pressure reducing station locations, size and settings are listed in Table 2-5.

Pressure in Zone 2 is monitored by the telemetry system at Well 5. If a valve malfunctions and the pressures exceed 80 psi, the pressure relief valve at Well 5 will open and dump water into Zone 1. Pressures in Zones 1a, 2a and 3a are not monitored by the telemetry system. Consequently, there is no way to know if a valve has malfunctioned. Pressures could reach 130 psi if a valve supplying Zones 1a or 2a malfunctions. Because of their locations, it would be expensive to monitor the pressures in these two zones with telemetry. Pressures could reach 100 psi if a valve supplying Zone 3a malfunctions.

Table 2-5
Pressure Reducing Stations

Location	Valve Size	Downstream Setting	
		HGL (ft)	Pressure (psi)
Channel Drive (near Pear Butte Dr)	2" and 6"	1460	73
Castle Mt. Ct. (near 57th Street)	2" and 6"	1460	62
Roza Hill Drive (near 57th Street)	2" and 6"	1430	51
Sycamore (at booster station)	2" and 6"	1430	69
Sky Vista Place (north side of Terrace Hts Dr)	2" and 6"	1430	69
Bridle Way (near Hilltop Drive)	3" and 8"	1430	60
Santa Roza Drive (near Kilgary Way)	2" and 6"	1370	70
Terrace Heights Drive (West of Santa Roza Dr.)	2" and 6"	1370	70
33rd Street (near Royale Court)	2" and 8"	1169	70

Comments:

1. Pressure settings shown are for the smallest pressure reducing valve in each station. Settings for larger valves are approximately 4 psi less.

Interties

The Terrace Heights Water System does not have interties with other utilities, although it may be possible for an emergency intertie in the future with the City of Yakima or the City of Moxee.

Yakima County has had preliminary discussions with the City of Yakima for an emergency intertie. An intertie between these two systems would require a bridge crossing of the Yakima River. One possible location is along Terrace Heights Drive. The City has a 16-inch waterline in Terrace Heights Drive approximately 900 feet west of the Yakima River and the County has a 16-inch waterline in Terrace Heights Drive approximately 900 feet east of the Yakima River. Another possible location is along the proposed east-west corridor located approximately 3,500 feet north of Terrace Heights Drive. Provisions for a waterline are planned to be included in the bridge design for this river crossing.

The City's hydraulic grade line is lower than the County's (1264' vs. 1288'). Consequently, water from the City would not flow into the Terrace Heights Water System unless it was boosted or reservoir levels in Zone 1 were below normal. City water also could not be used to supply the upper pressure zones since the Sycamore Booster Station is above the City's hydraulic grade line. When a new booster station is constructed, consideration should be given to locating it at an elevation to allow it to operate if Zone 1 was being supplied by the City of Yakima.

The City of Moxee has a 16-inch water line in Beaudry Road near the intersection with State Route 24. The 16-inch water line reduces to 12-inches and extends north on Beaudry Road to approximately Mieras Road. There is also an existing utility easement along the north side of State Route 24 between Beaudry Road and University Parkway that could be used for a future water line extension between the two systems. The City's hydraulic grade line (overflow elevation) is 1195.5 while the County's is 1169 in this area (Zone 1a). It should be possible to raise the County's hydraulic grade line to supply the City in an emergency by adjusting the County's pressure reducing station in University Parkway, but it would be difficult for the City to supply the County since most of the County's demands are above the pressure reducing station.

In May 2010, an engineering consultant hired the City of Moxee and Yakima County completed a study to evaluate the ability of the City and County to provide water service to future development along the State Route 24 corridor. The study included an evaluation of the feasibility of an intertie between the two systems. One location identified was near the intersection of State Route 24 and Birchfield Road, and a second was near the intersection of Mieras Road and Birchfield Road.

Storage Reservoirs

Storage is provided by two 1.5 million gallon welded steel reservoirs (Reservoirs 1 and 4), five 30,000 gallon horizontal cylindrical steel tanks (Reservoir 2), and one 88,000 gallon concrete reservoir (Reservoir 3).

Reservoir 1 was constructed in 1994 as part of the Phase 1 Improvement Project, and Reservoir 4 was constructed in 2016 as part of the Phase 3 Improvement Project. The reservoirs are located on the same site and are the main storage facilities within the system. They are used to control operation of the well pumps, and provide emergency and fire flow storage for most of the system. Both include separate fill and drain lines.

Reservoir 1 was cleaned and inspected in 2017 when it was drained to add a separate fill line. The reservoir walls were stained and some corrosion was occurring along the painter's rail. The walls were pressure washed to remove as much of the staining as possible from the ground level. The lower two thirds of the wall and the floor were pressure washed. Walls on the east side of the reservoir cleaned up well, but the walls on the west side remained stained. A consultant inspected the reservoir while it was still on line and suggested we wait a few more years to repaint the inside of the reservoir. The reservoir should be inspected again within the next three to five years with further consideration given as to when the reservoir should be repainted. According to the coating representative, the coating installed should last at least 20 years, and coating is now 23-years old.

Before Reservoir 1 was constructed, storage was provided by five 30,000 gallon horizontal cylindrical steel tanks. Two of these tanks were relocated to the Sycamore Booster Station in 1994 and the remaining three were relocated in 2017. All of the tanks were sand blasted and repainted in 2017. The three tanks relocated in 2017 (the most easterly of the tanks) had considerable pitting from corrosion on the interior. The wall thickness on these tanks was 0.25" and the pitting depth was close to half of the wall thickness. This could limit their useful life if the coating is not maintained. All five of the tanks are referred to as Reservoir 2.

Reservoir 2 is used to provide operational storage for the Sycamore booster pumps. The five 30,000 gallon tanks which make up Reservoir 2 are not large enough to provide standby, fire suppression, and equalizing storage for Zone 1. These storage components are provided by Reservoir 1 through a pressure reducing valve in the Sycamore Booster Station. The valve opens and closes as required to maintain between 1.8 and 4-feet of water in the two tanks.

Reservoir 3, which is also called the Country Club Tower, operates at the same hydraulic gradeline as Reservoir 2. The Tower is the oldest facility in the system. It also serves as a well house for Well 4. The Tower Reservoir was removed from service in 1996 for repairs and cleaning. The amount of work needed to return the reservoir to service was more than originally anticipated, and as a result, has still not been completed. The cover on the reservoir has deteriorated and needs to be replaced, and the walls need to be coated to prevent leakage. The County plans to further investigate alternatives for replacing the cover and returning the reservoir to service. Returning the reservoir to service will help prevent surges when Well 5 starts and stops, provide a means to control the booster at Well 5, and help to prevent cavitation of the Well 5 booster.

The location, size, and overflow elevation of each reservoir is listed in Table 2-6.

Table 2-6 Storage Reservoirs				
Reservoir #	Location	Dimensions	Overflow Elevation (feet)	Capacity (gallons)
1	N. 57th Street & Terracotta Place	32' Depth 90' Diameter	1513.6 (31.6')	1,500,000
2	Sycamore & Maple	11' Depth (Dia.) 42' Length (5 tanks total)	1289.8	150,000
3	Morningside and Manor	41.6' Depth 19' Diameter (Conical bottom)	1290.2	88,000 (not currently in use)
4	N. 57th Street & Terracotta Place	32' Depth 90' Diameter	1513.6 (31.6')	1,500,000
Total Storage Capacity of all Reservoirs in service is 3,150,000 gallons				

Distribution System

Most of the distribution pipe installed as part of the Country Club system is 2" galvanized or 4" to 8" cast iron. There is also some 4" and 6" steel pipe in the system. At the time the system was acquired by the County, more than 70 percent of the pipelines were 4-inch and smaller with very few loops. As a result, only 2 of 14 fire hydrants could supply a minimum fire flow of 500 gpm. The others were covered with plywood boxes. Now that the Country Club and Terraced Estates systems are combined and several pipe improvements are in place, all but two can provide a minimum fire flow of 500 gpm.

Hydrant spacing could be improved in the former Country Club system. In some areas hydrants are up to 3,000 feet apart. The County plans to install additional hydrants in the future when funding is available and as improvements are made to increase system capacity. Approximately six hydrants need to be raised and or rotated to make the ports more accessible.

Most of the pipe installed as part of the Terraced Estates system is 6" to 10" Class 160 or Class 200 PVC pipe. All fire hydrants connected to this system can provide fire protection.

New pipeline installations are either Class 50 Ductile Iron or Class 150 AWWA C900 PVC.

There is approximately 44 miles of pipeline in the Terrace Heights Water System. The length of each size pipe in the Terrace Heights Water System is as follows:

16"	17,000 lineal feet
12"	38,000 lineal feet
10"	7,000 lineal feet
8"	53,000 lineal feet
6"	34,000 lineal feet
4"	28,000 lineal feet
<4"	54,000 lineal feet

Telemetry System

The telemetry system was installed in 1994 as part of the Phase 1 Improvement Project. It includes a microcomputer at the courthouse and remote telemetry units (RTUs) at Wells 2, 3, 4, 5 and 6, and the Sycamore Booster Station. Water levels at Reservoirs 1 and 2 are monitored from the RTUs at Well 2 and the Sycamore Booster Station respectively. The telemetry system starts and stops the well pumps based on the water level in Reservoir 1.

The telemetry system also controls the rate of discharge from Well 3 based on the water levels in Reservoirs 1 and 2. Under normal operating conditions, the pump in Well 3 is signaled to start based on the water level in Reservoir 1. Initially, the variable frequency drive (VFD) at Well 3 will operate the pump at a minimum rate (typically 600 gpm). If the water level in Reservoir 1 continues to drop, the telemetry system will signal the VFD to increase the pump speed. The water level in Reservoir 2 also affects the speed at which the pump in Well 3 operates. At low water levels, the pump is allowed to pump at a higher rate, and as Reservoir 2 fills, the pump speed is reduced. This prevents the two tanks (Reservoir 2) from overflowing.

The telemetry system controls the rate of discharge from Well 4 based on the water level in Reservoir 1. Under normal operating conditions, the pump in Well 4 is signaled to start and ramp to a specified speed based on the water level in Reservoir 1. If the Reservoir 1 water level drops to a second set point, then the pump is signaled to ramp to a higher speed. Unlike Well 3, the water level in Reservoir 2 does not impact the speed at which Well 4 operates.

The Sycamore booster pumps are controlled locally based on the water level in Reservoir 2. The telemetry system monitors their operation and alarm conditions.

Besides controlling well pumps and monitoring the booster station, the telemetry system monitors alarm conditions. If an alarm condition occurs, the microcomputer at the courthouse will produce both a sound and visual alarm message. If the alarm message is not acknowledged within a short time, the microcomputer will dial from a list of telephone numbers and announce the alarms over the telephone. Operators can also call the microcomputer over the phone to check alarm conditions.

Chapter 3
Basic Planning Data

The basic planning data includes data from the former Terraced Estates and Country Club water systems. Data for the two systems was not combined, even though they now operate as one system, due to the difference in demands between the two systems. The difference is a result of the Country Club area being served by a separate irrigation system, while the Terraced Estates area is not.

Current Population, Service Connections and ERUs

Current Population

The Terrace Heights Water System serves an estimated population of 5,260. The estimate is based on the number of households served as of December 31, 2016 and the 2010 U.S. Census Bureau's estimate of 2.42 people per occupied housing unit. Terrace Heights is considered a Census Designated Place by the U.S. Census Bureau, so the estimate of 2.42 people per occupied housing unit is specific to Terrace Heights. The number of households includes 1,472 single-family and 703 multi-family dwelling units. Population data from the Washington State Office of Financial Management is not available since the Terrace Heights area is unincorporated.

Service Connections

As of December 31, 2016, there were 1,610 service connections in the system. All but 90 of the connections serve residential customers. Nonresidential customers include 70 commercial, 3 industrial, 7 education and 10 government customers. There are no agricultural customers. A summary of the historical number of service connections through 2016 is included in Table 3-1.

Table 3-1
Historical Number of Service Connections

Customer Classification	Number of Service Connections						
	2010	2011	2012	2013	2014	2015	2016
Single-Family (TE)	721	727	734	747	752	754	794
Single-Family (CC)	642	644	645	648	651	657	678
Multi-Family	26	27	27	27	33	40	48
Commercial	55	56	57	60	63	67	70
Industrial	0	1	1	3	3	3	3
Education	5	6	6	6	6	7	7
Government	10	10	10	10	10	10	10
Totals	1,460	1,472	1,481	1,502	1,519	1,538	1,610

Notes:
1. Number of customers is as of December of each year.

Services and ERUs by Pressure Zone

The number of service connections and residential dwelling units by pressure zone are shown in Table 3-2. The number of connections shown in the table is as of December 2016. The number of equivalent residential units (ERUs) for each non-residential customer was determined by dividing the customer's 2015 water consumption by 539 gallons/day per ERU, which is the 2015 average day demand for single-family customers without separate irrigation (Terrace Estates customers).

Table 3-2
Number of Services and Residential Dwelling Units by Pressure Zone

Customer Class	Connections/Dwelling Units by Pressure Zone						
	1a	1	2a	2	3	4	Totals
Single Family	5	348	133	407	559	20	1,472
Multi-Family							
Connections	4	39	5	3	0	0	51
ERUs (Dwelling Units)	11	604	12	76	0	0	703
Commercial							
Connections	3	60	2	2	0	0	67
ERUs	6	140	18	1	0	0	165
Industrial							
Connections	0	3	0	0	0	0	3
ERUs	0	51	0	0	0	0	51
Education							
Connections	0	7	0	0	0	0	7
ERUs	0	60	0	0	0	0	60
Government							
Connections	1	4	1	3	0	1	10
ERUs	1	14	6	16	0	<1	37
Totals							
Connections	13	461	141	415	559	21	1,610
ERUs	23	1,217	169	500	559	20	2,488

Notes:
1. ERU refers to equivalent residential unit.
2. Number of ERU's is based on the 2015 annual consumption for each customer class divided by 539 gpd, which is the 2015 average day demand for Terraced Estates single-family customers in 2015.
3. Number of connections shown is as of December 2016.

Future Population

Population Trends

Since the County assumed ownership of the Country Club system in 1994, the number of new connections has averaged 30 per year while the number of new ERU's has averaged 57 per year. Growth in the last 10 years (2007-2016) has been similar, averaging 23 new connections and 75 new ERU's per year. The population increase in the last 10 years is equivalent to approximately 180 people per year.

Much of the growth as occurred in the last two years (2015 & 2016) and is the result of the University Apartments project. As of the end of 2016, this project has resulted in 24 new services and 450 ERU's. By the end of 2017, there are projected to be an additional 5 services and 84 ERU's. Not including the University Apartments, growth in the last 10 years has averaged 21 new services and 30 new ERU's. A summary of the increases is shown in Table 3-3.

TABLE 3-3
NEW CONNECTIONS & ERU'S PER YEAR

Year	New Single-Family Connections/ERU's	New Multi-Family		New Non-Residential		Total New Connections	Total New ERU's
		Connections	ERU's	Connections	ERU's		
1995	29	0	0	2	8	31	37
1996	30	0	0	2	4	32	34
1997	24	1	3	4	7	29	34
1998	45	1	11	3	33	49	89
1999	36	2	6	4	6	42	48
2000	40	0	1	0	0	40	40
2001	17	1	4	2	1	20	22
2002	58	0	1	4	4	62	63
2003	57	0	2	5	9	62	68
2004	26	0	2	0	0	26	28
2005	17	0	1	6	11	23	29
2006	15	0	5	2	3	17	23
2007	25	0	2	2	3	27	30
2008	15	0	1	9	18	24	34
2009	9	0	2	1	0	10	11
2010	21	0	2	1	2	22	25
2011	8	1	23	3	1	12	32
2012	8	0	5	1	0	9	13
2013	16	0	4	5	21	21	41
2014	8	6	128	3	1	17	137
2015	8	7	146	4	7	19	161
2016	61	8	200	3	0	72	261

Notes:

1. ERU's for new nonresidential customers are based on a 2015 average day demand for Terrace Estates single-family residential customers of 539 gpd.
2. ERU's for Quail Run mobile home park are estimated from aerial photographs and information provided by the park. Quail Run was new in 1997, and had approximately 6 homes in 1998, 12 homes in 2002, 16 in 2004, 17 in 2005, 22 in 2006, 25 in 2008, 27 in 2009, 31 in 2011, 40 in 2013, 56 in 2015 and 64 in 2016.

A breakdown of the number of new ERUs by pressure zone is included in Table 3-4. Data shown is based on new connections that have occurred since January 2009. Most new ERUs have occurred in Zone 1 which includes the University Apartments. A lesser number have occurred in Zone 3, which includes Terraced Estates, and Zone 2 which includes Quail Run.

Table 3-4
New ERUs by Pressure Zone

	Zone 1a	Zone 1	Zone 2a	Zone 2	Zone 3	Zone 4	Total
Number of New ERUs since January 2009.	5	561	0	51	64	0	681
Percentage of Total	1%	82%	0%	8%	9%	0%	100
Number of New ERUs since January 2009 excluding University Apartments.	5	111	0	51	64	0	231
Percentage of Total	2%	48%	0%	22%	28%	0%	100
Projected ERU's per year excluding University Apartments	1	14	0	7	8	0	30

Notes:
1. The University Apartments are projected to add an additional 84 ERU's to Zone 1 during 2017, and are in addition to the numbers shown above.

Population Projections

The University Apartments are projected to have 5 new apartment buildings and services installed by the end of 2017, consisting of 84 additional ERU's. Once the project is complete, population growth is anticipated to be similar to what the system has experienced in the past 10 years.

Future population projections are based on serving 30 new equivalent residential units per year, in addition to the University Apartments. The population projection is equivalent to approximately 70 new people per year, plus an additional 200 new people through 2017 due to the University Apartments. It also results in an estimated population increase of approximately 5.3 percent for 2017, followed by an estimated increase of approximately 1.3 percent per year through 2026.

The existing and projected populations are as follows:

	Population	ERUs
Existing (December 2016)	5,260	2,175
Project Year 2017	5,540	2,290
Projected Year 2022	5,900	2,440
Projected Year 2026	6,200	2,560
Projected Year 2036	6,900	2,860

The projected growth rate is similar to what is shown in the *Yakima Urban Area Comprehensive Plan 2025* adopted by the Board of County Commissioners in December 2006 for the Terrace Heights Urban Area. Plan 2025 included an intermediate and a high growth projection. The intermediate growth projection for the Terrace Heights Urban Area was 2.3% per year between 2015 and 2020, and 2.0 percent between 2020 and 2025. The intermediate growth projection was considered to be the more likely scenario in Plan 2025 for the next 20-years.

Growth rates were also provided in the *1999 Terrace Heights Neighborhood Plan.* Population projections presented in the Neighborhood Plan for a 20-year planning period were based on 3 percent and 10 percent annual growth rates. The Neighborhood Plan states that "an average growth rate of 3 percent per year would be reasonable for Terrace Heights." This rate is higher than the projected growth rate for the Heights Water System.

The projected growth rate for the Terrace Heights Water System is greater than the historical growth rate shown in the Federal Census data for the Terrace Heights Designated Place. According to Federal Census data, between 2000 and 2010 the population in the Terrace Heights Designated Place increased less than one percent per year. In 2000, there were reportedly 6,452 people and 2,613 housing units. In 2010 there were 6,942 people and 2,868 housing units. The area of the Terrace Heights Designated Place remained almost identical between 2000 and 2010.

A projected growth rate of 30 new equivalent residential units per year (in addition to the University Apartments) will be used to provide an estimate of when system improvements may be necessary. The actual timing of when improvements will be needed will depend on when the number of customers and system demands reach a specified level. The demand from 30 ERU's will be based on using domestic water for irrigation.

Water Usage/Data Reporting

Service Meter Readings

Annual and Peak Month Consumption

Annual consumption for each customer classification is included in Table 3-5. Peak month consumption for each customer classification is included in Table 3-6. Monthly service meter readings for each customer classification are included in Appendix C.

Table 3-5
Annual Water Consumption

Customer Classification	2010	2011	2012	2013	2014	2015	2016
Single-Family (Terraced Estates)							
Consumption (cu-ft)	15,163,274	15,403,662	15,997,174	17,712,980	17,325,317	19,819,311	18,559,115
Customers	721	727	734	747	752	754	794
Average Consumption (gpd/cust)	431	434	447	486	472	539	479
Average Consumption (gpcd)	178	179	185	201	195	223	198
Percent of Total Consumption	53%	53%	55%	55%	52%	51%	51%
Single-Family (Country Club)							
Consumption (cu-ft)	7,535,501	7,412,309	7,222,460	7,037,403	7,633,445	7,912,568	7,366,388
Customers	642	644	645	648	651	657	678
Average Consumption (gpd/cust)	241	236	229	223	240	247	223
Average Consumption (gpcd)	99	97	95	92	99	102	92
Percent of Total Consumption	26%	26%	25%	22%	23%	20%	20%
Multi-Family							
Consumption (cu-ft)	1,784,512	1,681,829	1,598,534	1,692,485	2,158,024	3,422,053	4,262,975
Customers	26	27	27	27	33	40	48
Average Consumption (gpd/cust)	1,407	1,277	1,213	1,285	1,340	1,753	1820
Residential Units	224	245	245	245	365	503	703
Average Consumption/Unit (gpd)	163	141	134	142	121	139	124
Average Consumption (gpcd)	67	58	55	58	50	58	51
Percent of Total Consumption	6%	6%	5%	5%	6%	9%	12%
Commercial							
Consumption (cu-ft)	3,397,459	3,241,003	3,089,477	3,149,879	3,991,623	4,330,849	3,720,686
Customers	55	56	57	60	63	67	70
Average Consumption (gpd/cust)	1,266	1,186	1,111	1,076	1,298	1,325	1089
Percent of Total Consumption	12%	11%	11%	10%	12%	11%	10%
Industrial							
Consumption (cu-ft)	0	818	6,596	423,796	196,223	553,087	333,885
Customers	0	1	1	3	3	3	3
Average Consumption (gpd/cust)	N/A	17	135	2,895	1,340	3,778	2,281
Percent of Total Consumption	0%	0%	0%	1%	1%	1%	1%
Education							

Table 3-5
Annual Water Consumption

Customer Classification	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Consumption (cu-ft)	792,730	823,826	1,053,328	1,334,700	1,519,551	1,549,868	1,784,954
Customers	5	6	6	6	6	7	7
Average Consumption (gpd/cust)	3,249	2,814	3,598	4,559	5,190	4,537	5226
Percent of Total Consumption	3%	3%	4%	4%	5%	4%	5%
Government							
Consumption (cu-ft)	195,291	249,437	252,872	286,341	325,724	1,121,908	607,204
Customers	10	10	10	10	10	10	10
Metered Customers	7	7	7	7	7	10	10
Average Consumption (gpd/cust)	400	511	518	587	668	2,299	1244
Percent of Total Consumption	1%	1%	1%	1%	1%	3%	2%
Construction/Other							
Consumption (cu-ft)	2,715	223,590	25,928	419,868	129,680	15,593	69,070
Percent of Total Consumption	0%	1%	0%	1%	0%	0%	0%
Total Consumption (cu-ft)	28,871,482	29,036,474	29,246,369	32,057,452	33,279,587	38,725,237	36,704,277

Notes:

1. Consumption in gpcd is based on 2.42 people per household.
2. Construction/Other includes temporary service from fire hydrants.
3. November 2015 Government consumption was unusually high due to Well 5 meter being read after several months.

Table 3-6
Peak Month Water Consumption

Customer Classification	2010 (August)	2011 (July)	2012 (July)	2013 (August)	2014 (July)	2015 (August)	2016 (August)
Single-Family (Terraced Estates)							
Consumption (cu-ft)	3,431,498	2,920,245	2,906,191	3,354,175	3,161,348	3,433,604	3,243,781
Customers	721	727	734	747	752	754	794
Average Consumption (gpd/cust)	1,148	969	955	1,083	1,014	1,099	986
Average Consumption (gpcd)	475	401	395	448	419	454	407
Percent of Total Consumption	59%	58%	56%	59%	58%	53%	53%
Single-Family (Country Club)							
Consumption (cu-ft)	1,227,828	1,009,134	1,172,715	1,064,928	1,159,288	1,047,252	1,135,102
Customers	642	644	645	648	651	657	678
Average Consumption (gpd/cust)	461	378	439	397	430	385	404
Average Consumption (gpcd)	191	156	181	164	178	159	167
Percent of Total Consumption	21%	20%	22%	19%	21%	16%	19%
Multi-Family							
Consumption (cu-ft)	319,540	264,886	261,780	289,983	353,232	545,996	584,298
Customers	26	27	27	27	33	40	48
Average Consumption (gpd/cust)	2,965	2,367	2,339	2,591	2,583	3,294	2937
Residential Units	224	245	245	245	365	503	703
Average Consumption/unit (gpd)	344	261	258	286	234	262	201
Average Consumption (gpcd)	142	108	107	118	96	108	83
Percent of Total Consumption	6%	5%	5%	5%	7%	8%	10%
Commercial							
Consumption (cu-ft)	608,350	587,747	566,280	596,479	499,353	781,173	623,002
Customers	55	56	57	60	63	67	70
Average Consumption (gpd/cust)	2,669	2,532	2,397	2,399	1,913	2,813	2147
Percent of Total Consumption	11%	12%	11%	10%	9%	12%	10%
Industrial							
Consumption (cu-ft)	0	0	1,069	54,750	15,287	142,458	73667
Customers	0	1	1	3	3	3	3
Average Consumption (gpd/cust)	N/A	0	258	4,404	1,230	11,458	5925

Table 3-6
Peak Month Water Consumption

Customer Classification	2010 (August)	2011 (July)	2012 (July)	2013 (August)	2014 (July)	2015 (August)	2016 (August)
Percent of Total Consumption	0%	0%	0%	1%	0%	2%	1%
Education							
Consumption (cu-ft)	182,796	205,407	259,542	253,407	201,969	312,457	319,647
Customers	5	6	6	6	6	7	7
Average Consumption (gpd/cust)	8,821	8,260	10,437	10,191	8,122	10,770	11018
Percent of Total Consumption	3%	4%	5%	4%	4%	5%	5%
Government							
Consumption (cu-ft)	17,085	23,574	54,888	75,480	37,351	192,066	97,187
Customers	10	10	10	10	10	10	10
Metered Customers	7	7	7	7	7	10	10
Average Consumption (gpd/cust)	412	569	1,324	1,821	901	4,634	2345
Percent of Total Consumption	0%	0%	1%	1%	1%	3%	2%
Total Consumption (cu-ft)	5,787,097	5,010,993	5,222,465	5,689,202	5,427,828	6,455,006	6,076,684

Notes:

1. Peak month consumption from construction is not available.

Peak Day and Peak Hour Consumption (Beacon Records)

Peak Day consumption is now available in Beacon from the automated meter reading system for the system. Peak Day and Peak Hour consumption is available for smaller groups of services, such as for Pressure Zone 4. These consumption numbers do not account for leakage. For Pressure Zone 4, leakage is estimated to be less than 1 gpm, so numbers from Beacon should represent actual system demands relatively closely. Demands in Pressure Zone 4 are believed to have dropped after installing the automated meter reading system.

In reviewing the Beacon records, it was noted that the peak hour demand does not occur on the same day as the peak day demand.

<u>All Customers Peak Day Consumption:</u>

July 10, 2015	246,572 cu-ft, or 1,844,400 gallons
August 1, 2016	224,558 cu-ft, or 1,679,700 gallons
July 31, 2017	230,191 cu-ft, or 1,721,800 gallons

<u>Pressure Zone 4 Peak Day Consumption:</u>

July 6, 2015	48,790 gallons (34 gpm average and 55 gpm peak hour)
July 31, 2016	46,980 gallons (33 gpm average and 52 gpm peak hour)
August 1, 2017	41,930 gallons (29 gpm average and 69 gpm peak hour)

<u>Pressure Zone 4 Peak Hour Consumption:</u>

June 21, 2015	75 gpm
July 26, 2016	77 gpm
July 15, 2017	83 gpm

Source of Supply Meter Readings

Average Day, Peak Month and Peak Day System Demands

Available supply meter readings are included in Appendix C and summarized in Table 3-7. Included in the table are average day, peak month, and peak day demands. Average day demand is the total quantity of water delivered to the system during the year divided by the number of days in the year. Peak month demand is the total quantity of water delivered to the system during the month of highest water usage, divided by the number of days in the month. Peak day demand is the average rate of water use during the highest-use day of the year. The largest peak day demand occurred on Monday August 11, 2014 and was calculated at 2.07 million gallons.

Table 3-7 Source of Supply Meter Readings			
Year	**Average Day Demand (gpd)**	**Peak Month Demand (gpd)**	**Peak Day Demand (gpd)**
1997	513,859	1,013,000	1,270,000
1998	642,616	1,176,000	-
1999	633,075	1,106,000	-
2000	599,896	1,254,000	-
2001	675,604	1,257,000	-
2002	716,596	1,394,000	1,525,000
2003	771,098	1,491,000	1,681,000
2004	830,737	1,555,000	1,683,000
2005	820,624	1,600,000	1,722,000
2006	800,192	1,667,000	1,861,000
2007	825,544	1,636,000	1,865,000
2008	811,338	1,599,000	1,807,000
2009	831,831	1,665,587	1,953,000
2010	823,614	1,627,911	1,964,000
2011	788,513	1,614,903	1,781,000
2012	802,446	1,544,645	1,898,000
2013	804,189	1,759,610	1,946,000
2014	911,534	1,676,642	2,073,000
2015	880,062	1,718,106	1,977,000
2016	837,181	1,634,319	1,924,341
2017	-	1,712,274	1,966,000

Notes:
1. Data is for Terraced Estates and Country Club combined.
2. \- Data not available.

Average Day, Peak Month and Peak Day Zone 4 Demands

Average day, peak month and peak day demands for Pressure Zone 4 are included in Table 3-8. The highest peak day demand found for Zone 4 was 72,000 gpd on July 11, 2007.

2003 through 2008 peak month demands were estimated by reviewing the Terrett Booster meter readings for the month in which the system peak month demand occurred. Each month’s demands were not reviewed. 2003 through 2008 peak day demands were done in a similar manner and were estimated by reviewing the meter readings for the same day in which the system peak day demand occurred. Actual peak day demands may be slightly higher for this period.

2009 through 2017 peak month demands were estimated by reviewing each month’s Terrett Booster meter readings. 2009 through 2017 peak day demands were estimated by reviewing the meter readings for each day during the peak month.

Table 3-8 Zone 4 Supply Meter Readings			
Year	**Average Day Demand (gpd)**	**Peak Month Demand (gpd)**	**Peak Day Demand (gpd)**
2003	21,667	53,500	59,000
2004	27,131	47,400	54,000
2005	27,655	47,400	55,000
2006	25,767	62,900	71,000
2007	23,974	58,100	72,000
2008	23,042	47,100	51,000
2009	21,065	46,887	59,000
2010	20,892	46,639	61,000
2011	28,796	64,632	70,000
2012	26,256	55,142	67,000
2013	24,500	58,932	69,000
2014	33,202	55,716	63,000
2015	18,078	44,188	45,000
2016	15,100	35,667	46,000
2017	-	33,105	43,000

Notes:
1. Data is based on Terrett Booster meter readings.
2. 2003 through 2008 Peak Month demands are the demands during the month in which the system peak month demand occurred, and may not be the actual peak month for Zone 4. 2009 to 2017 are actual Peak Month demands.
3. 2003 through 2008 Peak Day demands are the demands during the day in which the system peak day demand occurred. The actual peak day demand for Zone 4 may be slightly higher during this period. 2009 to 2017 peak day demands were estimated by reviewing each days demand during the peak month.
4. The Terrett Booster flow meter was replaced in July 2015.

System Demands

Single-Family Demands

A summary of estimated system demands per single-family residence is included in Table 3-9. Values shown are based on historical consumption and production records.

Table 3-9 also includes values used for demand forecasts. In selecting the values, a greater emphasize was placed on demands recorded in the last 10 years, since these demands include effects from recent conservation measures and current water rates. A greater emphasize was also placed on production records than on consumption records due to the number of old service meters in use (prior to August 2014) and to account for distribution system leakage.

Values shown in Table 3-9 for Terraced Estates will be used in estimating demands for new single family residential connections without separate irrigation, while values shown for the Country Club will be used in estimating demands for new single family residential connections with separate irrigation. For planning purposes, peak day demands for each additional single-family customer without separate irrigation will be estimated at 1,700 gpd. For areas with separate irrigation, peak day demands for each additional single-family customer will be estimated at 700 gpd.

Table 3-9
Demands Per Single-Family Residence

Area	Year	Average Day Demand (gpd)		Peak Month Demand (gpd)		Peak Day Demand (gpd)
		Consumption Records	Production Records	Consumption Records	Production Records	Production Records
Terraced Estates	1990	-	630	-	1,450	2080
	1991	-	600	-	1,340	-
	1992	482	580	1,035	1,040	-
	1993	518	550	998	1,000	1270
	1994	585	-	1,284	-	-
	1995	524	-	1,191	-	-
	1996	553	-	1,367	-	1,790
	1997	-	-	1,580	1,500	1,800
	2003	553	596	1,306	1,275	1,438
	2004	509	665	1,397	1,489	1,612
	2005	489	654	1,126	1,448	1,558
	2006	486	630	1,163	1,513	1,689
	2007	509	616	1,089	1,435	1,636
	2008	467	584	1,077	1,234	1,394
	2009	485	620	1,191	1,377	1,615
	2010	431	600	1,148	1,338	1,615
	2011	434	580	969	1,294	1,427
	2012	447	599	955	1,171	1,438
	2013	486	603	1,083	1,388	1,535
	2014	472	633	1,014	1,298	1,605
	2015	539	598	1,099	1,212	1,395
	2016	479	534	986	1,099	1,294
	Value Used for Demand Forecast	630		1,500		1,700

Table 3-9 Demands Per Single-Family Residence						
Area	**Year**	**Average Day Demand (gpd)**		**Peak Month Demand (gpd)**		**Peak Day Demand (gpd)**
		Consumption Records	**Production Records**	**Consumption Records**	**Production Records**	**Production Records**
Country Club	1984	-	380	-	630	710
	1986	-	370	-	550	-
	1987	-	350	-	510	-
	1988	-	330	-	550	-
	1989	-	370	-	590	-
	1990	-	350	-	550	780
	1993	-	340	-	470	750
	1994	291	300	463	480	-
	1995	267	290	428	500	640
	1996	279	-	445	-	-
	1997	-	-	425	400	490
	2003	293	316	426	423	477
	2004	286	368	532	566	612
	2005	282	375	464	606	652
	2006	269	350	472	625	698
	2007	275	**334**	428	**561**	**639**
	2008	269	**332**	429	**599**	**677**
	2009	263	**332**	455	**526**	**617**
	2010	241	**336**	461	**537**	**648**
	2011	236	**315**	378	**505**	**557**
	2012	229	**307**	439	**538**	**661**
	2013	223	**277**	397	**509**	**563**
	2014	240	**322**	430	**550**	**681**
	2015	247	**274**	385	**425**	**489**
	2016	223	**249**	404	**450**	**530**
	Value Used for Demand Forecast	340		600		700

Notes:

1. - Data is not available.
2. Demands shown based on consumption records do not include nonrevenue water.
3. Demands calculated from production records are based on historical average day, peak month, and peak day system demands, the percentage of the consumption attributed to single-family customers, and the number of single-family customers.
4. In selecting values for demand forecasts, a greater emphasize was placed on the more recent demands, since the more recent demands include effects of water conservation measures.

Peak Hour System Demands

Peak hour demand is the largest water use over a one-hour period, usually occurring during the peak day. Peak hour demands were estimated based on telemetry system records. This was done by calculating the volume of water pumped into or drawn out of Reservoir #1 over a one hour period during the peak day, and adding it to the volume of water pumped from each well during that period.

Reservoir levels and the start and stop times for each well were taken from the telemetry system records.

Peak hour system demands for each year are summarized in Table 3-10.

Table 3-10 Peak Hour Demand			
Year	**Date**	**Peak Hour Demand (gpm)**	**Ratio of Peak Hour/Peak Day**
2002	Saturday July 13	2,132	2.01
2003	Monday July 28	2,126	1.82
2004	Monday July 5	2,038	1.74
2005	Monday July 18	2,030	1.70
2006	Monday July 24	2,294	1.78
2007	Wednesday July 11	2,397	1.85
2008	Monday July 21	2,449	1.95
2009	Monday August 3	2,530	1.87
2010	Monday July 26	2,597	1.91
2011	Friday July 1	2,773	2.24
2012	Monday August 6	2,853	2.16
2013	Monday July 29	2,706	2.00
2014	Monday August 11	2,786	1.94
2015	Wednesday July 8	2,533	1.84
2016	Monday August 1	2,544	1.90
2017	Wednesday August 2	2,585	1.89

Notes:
1. Peak hour demands for 2006 through 2017 include changes in water level for Reservoirs 1 and 2. Peak hour demands up through 2005 only include changes in water level for Reservoir 1.

Peak Day and Peak Hour Demands by Zone

Estimated peak day and peak hour demands for the system and each pressure zone are shown in Table 3-11. The percentage of the total water consumption in the zone for August 2014 (which is the month with the greatest peak day demand) was multiplied by the peak day system demand of 2.073

million gallons to estimate the peak day demand in the zone. Peak hour demands for each zone were estimated by multiplying the August 2014 percentages by the system peak hour demand. Peak day demands for Zone 4 are also noted based on pump meter readings for July 11, 2007.

Table 3-11
Peak Day and Peak Hour Demands by Zone

Pressure Zone	Monthly Consumption (cu-ft)	Percentage of Total Consumption	Peak Day Demand (gallons)	Peak Day Demand (gpm)	Peak Hour Demand (gpm)
Zone 1a (HGL 1169)	35,522	0.7%	15,193	11	20
Zone 1 (HGL 1288)	1,457,599	30.1%	623,428	433	838
Zone 2a (HGL 1370)	233,498	4.8%	99,869	69	134
Zone 2 (HGL 1430)	809,326	16.7%	346,156	240	465
Zone 3 (HGL 1513)	2,237,127	46.2%	956,839	664	1,286
Zone 4 (HGL 1,673-1,740)	73,681	1.5%	31,514 (72,000)	22 (50)	42 (100)
Total for System	4,846,753	100	2,073,000	1,440	2,786

Notes:
1. Monthly consumption for August 2014, which is the month with the highest peak day demand, was used to calculate the percentage of the total consumption for each zone. Booster pump meter readings are also noted in parenthesis for Zone 4 peak day demand.
2. Demand on July 11, 2007 was approximately 72,000 gallons for the Terrett Booster, or 50 gpm.

Demands by Land Use

Demands for various land uses are included in Table 3-12. Peak month demands per acre for each land use type were first determined using August 2016 consumption records. Average day and peak day demands were then estimated using peaking factors of 0.5 and 1.2 respectively. The peaking factors correspond to the ratios of average day to peak month and peak day to peak month system demands averaged over the last 6-years (demands from Table 3-7). Demands included in Table 3-12 are based on consumption records and do not take into consideration distribution system leakage.

Demands from future industrial customers can vary significantly from existing industrial customers.

Table 3-12 Demands by Land Use					
Land Use (County Zoning)	**Acres in Service**	**August 2016 Consumption (cu-ft)**	**August 2016 Consumption (gpd/acre)**	**Average Day Demand (gpd/acre)**	**Peak Day Demand (gpd/acre)**
Single-Family - R1	428	3,900,466	2,199	1,099	2,639
Multi-Family - R2	15	246,125	3,959	1,980	4,751
R3	38	334,993	2,127	1,064	2,553
Suburban Residential	117	537,168	1,108	554	1,329
Rural-10/5	48	143,613	722	361	866
Business	5	26,238	1,266	633	1,519
Small Convenience Center	5	14,049	678	339	814
General Commercial	5	551,646	2,335	1,168	2,802
Light Industrial	161	318,265	477	238	572
System Totals	874	6,072,563	14,871	7,436	17,846

Notes:
1. Projected ADD (average day demand) is based on the ratio of ADD to peak month demand averaged over the last 6-years, which is equal to 0.50.
2. Projected PDD (peak day demand) is based on the ratio of PDD to peak month demand averaged over the last 6-years, which is equal to 1.17.
3. Business includes Professional Business and Local Business.

Nonrevenue Water/Distribution System Leakage

Nonrevenue water is the difference between the service meter readings and the supply meter readings. It includes authorized consumption and distribution system leakage. Examples of nonrevenue authorized consumption include fire protection, system flushing, and other designated uses that can be estimated. Distribution system leakage is water lost through leaks, metering inaccuracies, meter reading errors, and illegal connections. Washington State's new water efficiency rules require the distribution system leakage to be less than 10 percent based on a three-year rolling average.

In 2014, the County began a program to replace all of the service meters. All but one of the service meters were replaced in 2014. An 8" meter for Quail Run was replaced in 2015. Since that time distribution system leakage has dropped from over 20 percent to 10%. A summary of distribution system leakage is included in Table 3-13.

Table 3-13 Distribution System Leakage					
Year	**Production (cubic feet)**	**Consumption (cubic feet)**	**Leakage (cubic feet)**	**% Leakage**	**3-year Running Average**
2016	40,851,738	36,704,277	4,147,461	10.2%	15%
2015	42,944,211	38,725,237	4,218,974	9.8%	18%
2014	44,479,933	33,279,587	11,200,346	25.2%	23%
2013	39,241,858	32,057,452	7,184,406	18.3%	23%
2012	39,156,791	29,246,369	9,910,422	25.3%	26%
2011	38,476,917	29,036,474	9,440,443	24.5%	25%
2010	40,189,713	28,871,482	11,318,231	28.2%	23%
Notes: 1. In 2014 the County installed new service meters.					

Land Use

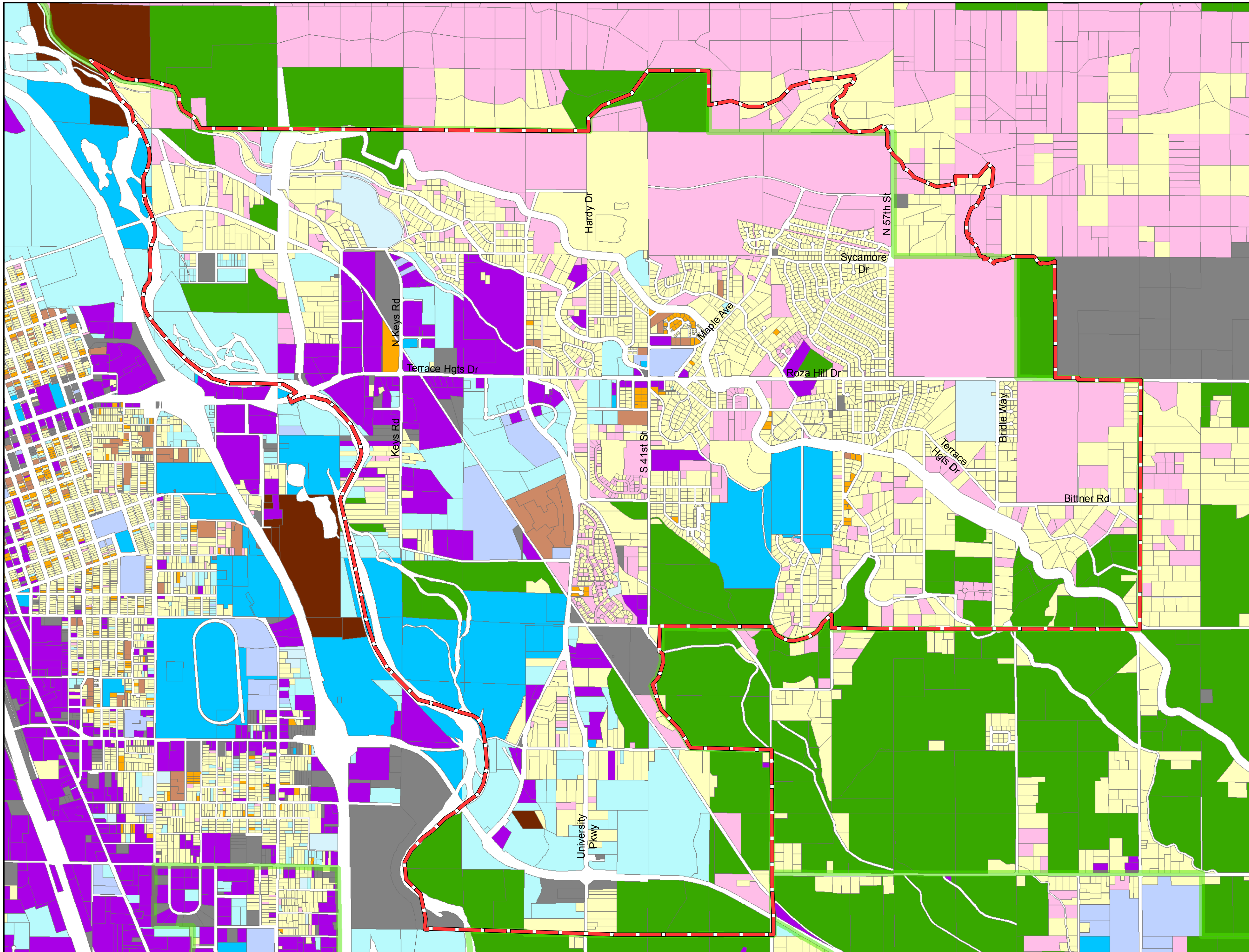
Existing Land Use

The Terrace Heights Water System service area encompasses a variety of land uses including:

- Single-Family Residential
- Duplex-Fourplex Residential
- Five or More Residential
- Mobile Home Parks
- Commercial (Retail and Services)
- Wholesale Trade and Industry
- Education and Government
- Parks and Other Open Spaces
- Agriculture
- Vacant

Most of the existing service area is single-family residential or vacant. Near the west end of the service area next to the railroad and Keys Road are the system's largest commercial and industrial areas. A few small commercial areas reside along Terrace Heights Drive. The existing land use is shown on Figure 3-1.

In comparison to the number of acres currently served by the Terrace Heights Water System (874 acres), the service area includes a significant number of acres that are vacant or in agriculture (1,993



Yakima County Comprehensive Water System Plan

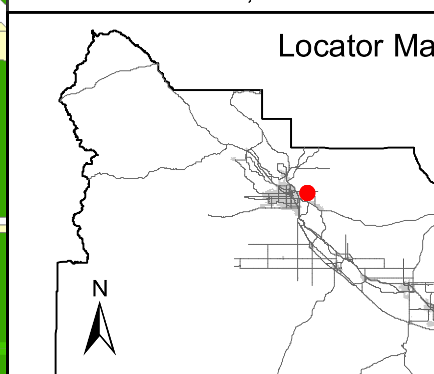
FIGURE 3-1

Terrace Heights Water System Existing Land Use

- Single Residential
- Duplex - Fourplex Residential
- Five or More Residential
- Mobile Home Park
- Wholesale Trade & Industry
- Utilities & Transportation
- Education & Government
- Parks & Other Open Spaces
- Agriculture
- Mining
- Residential Land Undeveloped
- Vacant
- Service Area & Retail Service Area Boundary
- Urban Growth Area Boundary

1 inch = 2,000 feet

Locator Map



Date: September 2017

Document Path: R:\disk_5\projects\county\pw\waterplan\t_heights\watersystemsplan_17\fig31_waterplan.mxd

acres). Once developed, this acreage will have a major impact on system demands. Table 3-14 lists the number of acres in each pressure zone that are vacant or in agriculture. Acreage in agriculture is expected to have a lesser impact due to the availability of a separate irrigation system. Figure 3-2 shows the vacant and agricultural parcels in the system.

Table 3-14
Vacant or Agricultural Acreage

Existing Land Use	Pressure Zone	Zoning	Number of Acres
Vacant or Undeveloped	1 and 1a	Single-Family	84
		Multi-Family – R2	10
		Suburban Residential	135
		Small Convenience Center	12
		General Commercial	84
		Light Industrial	272
	2 and 2a	Single-Family	251
		Suburban Residential	188
	3	Single-Family	127
		Suburban Residential	74
	4	Single-Family	108
		Suburban Residential	52
		Rural-10/5	40
Agriculture	1 and 1a	Single-Family	33
		Suburban Residential	316
		Light Industrial	168
	2	Single-Family	11
		Suburban Residential	28
		Total	1,993

Notes:
1. Acreage shown does not include lots that are currently developed and are large enough to be subdivided further.

Future Land Use

Future land use is shown on Figure 3-3. The land uses shown are from the County's growth management plan (*Horizon 2040*). Land use is not expected to change significantly in the future, except for the conversion of vacant land to developed land. Currently, nine areas are either being developed or are proposed for development. The areas include approximately 1,800 dwelling units. Areas proposed include:

- Villas at Terrace Heights
- Abraham Doleson Addition
- Quail Run

- Yakima Ridge
- Terrace Heights Development
- Pacific Northwest University
- University Apartments
- Quail Court
- Highlands at Yakima Ridge

The Villas at Terrace Heights is a gated community for adults 55 and over. Originally, it featured 149 residential lots in four phases on approximately 40 acres. It was later reduced to 68 lots in two phases on approximately 20 acres. Roads and utilities for the first two phases were completed in 2008. Twenty-nine of the lots have been or are being built upon. The Villas is located on the west side of 41st Street between Terrace Heights Drive and Scenic Crest Road.

Abraham Doleson is a gated community on 7 acres and 9 residential building lots located on the west side of 41st Street along Isabella Way. Three of the nine lots have been developed.

Quail Run, formerly known as Silver Meadows, is a 25-acre development consisting of a 120 space manufactured home park. The development is a retirement community and is being built in phases. Improvements for the first phase were completed in 1996. Only 56 of the spaces are built on at this time. The development is south of Roza Hill Drive along the extension of Bridle Way.

Yakima Ridge Phases 2 and 3 are a 14 acre subdivision located along Boulder Way consisting of 37 single family residential lots. Ten of the lots have been built on.

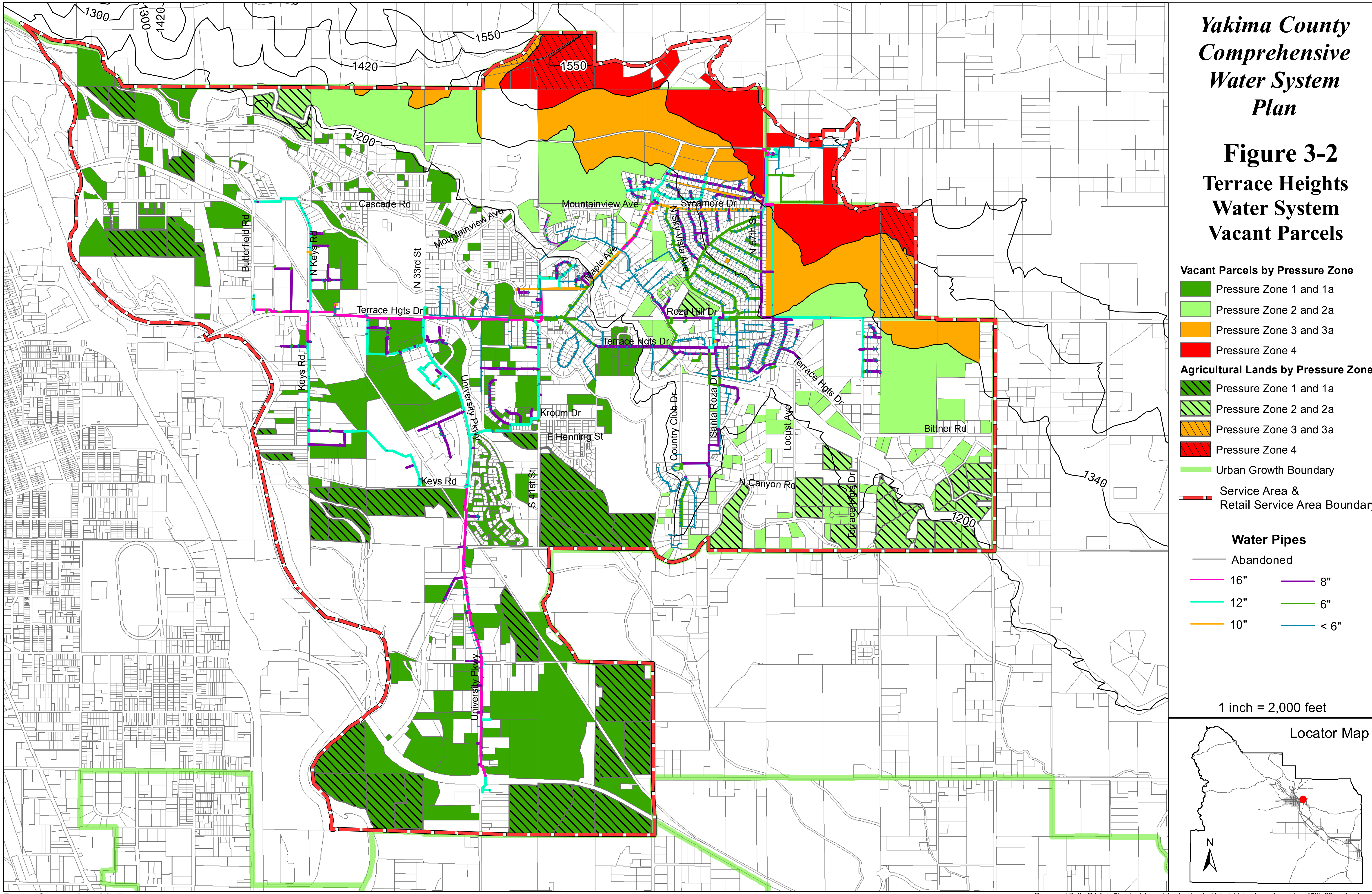
Terrace Heights Development, formerly known as Creekside, is a 188 acre mixed-use development featuring housing, retail shops, and offices. Iron Horse Lodge, Pacific Northwest University and two credit unions have been completed to date. Terrace Heights Development is located south of Terrace Heights Drive and North of Keys Road along University Parkway.

Pacific Northwest University of Health Sciences is a new four-year university for osteopathic medicine located on 66 acres on University Parkway south of Terrace Heights Drive. The private four-year university currently serves about 280 medical students annually. The university, which is the first new medical school in the northwest in 60-years, has additional land for future campus growth.

University Apartments is a 534 unit apartment complex on 37 acres. Construction on the Apartments began in 2014 and was completed in 2017. An additional 168 units is being proposed at this time. This development has had a significant impact on the number of ERU's served by the system.

Quail Court is a 19 lot single-family subdivision on 5 acres near Hillcrest and Channel Drive. Three of the lots have been built on.

The Highlands at Yakima Ridge is a proposed subdivision of 317 acres with up to 1,260 homes and a winery inspired chateau with approximately 200 suites, conference center, restaurant, and wine-tasting rooms. Development of the project is in the early stages at this time. Development of the



Yakima County Comprehensive Water System Plan

Figure 3-2
Terrace Heights Water System Vacant Parcels

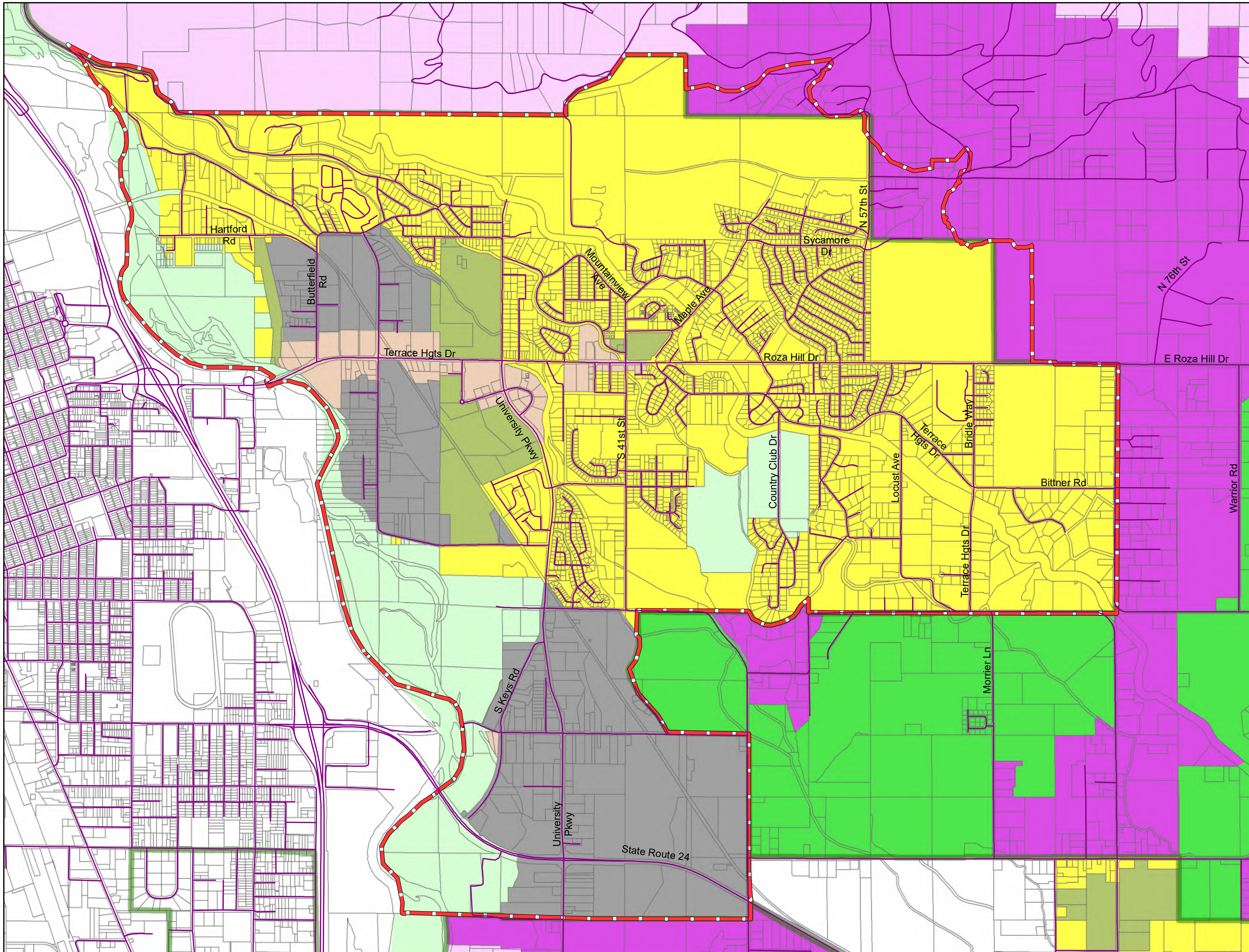
Date: September 2017

Document Path: R:\disk_5\projects\county\pw\waterplan\t_heights\watersystemsplan_17\fig32_waterplan.mxd

Yakima County Comprehensive Water System Plan

FIGURE 3-3

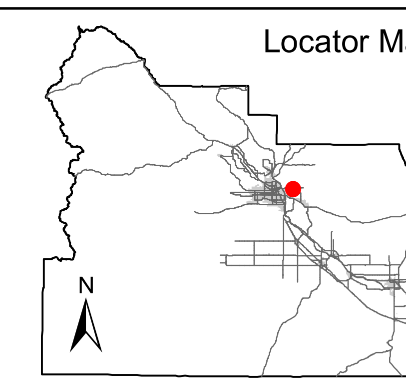
Terrace Heights Water System Future Land Use



Service Area & Retail Service Area Boundary
Urban Growth Area Boundary
Agricultural Resource
Rural Self-Sufficient
Rural Remote/ELDP
Urban Residential
Urban Commercial
Urban Industrial
Urban Public
Urban Parks and Open Space

1 inch = 2,000 feet

Locator Map



Date: December 2018

Document Path: R:\disk_5\projects\county\pw\waterplan\t_heights\watersystemsplan_17\fig33_waterplan.mxd

property has been contemplated off and on since the mid 1990's.

As described in Chapter 1 and shown on Figure 1-1, nearly all of the future service area is within the Urban Growth Area. The only exceptions are two small areas in the northeast part of the system that are zoned Rural-10/5. Yakima County's growth management plan (*Horizon 2040*) estimates the future density within the Urban Growth area at 4 or more units per acre. This is similar to the density of 3.5 units per acre that has occurred in the Terraced Estates and Mount Adams Estates subdivisions. The proposed single-family developments described above average approximately 3.9 units per acre.

Further subdivision in the area zoned Rural-10/5 is expected to be minimal within the planning period. Parcels in this area must be at least 10 acres in size to be subdivided, since the average parcel size must be at least 5 acres following a subdivision. There are only 4 parcels large enough to be subdivided in this area. Three 10-acre parcels could be subdivided into two parcels each, and one 49-acre parcel could be subdivided into 9 lots.

Water Demand Forecast

6, 10 & 20 Year Demand Projections

Future water demands were estimated based on historical demands plus the demand from the University Apartments and an additional 30 new equivalent residential units (ERUs) per year. Demand estimates for new ERUs are listed below. Future peak hour demands from new ERUs were estimated based on a peak hour to peak day peaking factor of 2.

Average Day Demand	630 gpd/ERU
Peak Day Demand	1,700 gpd/ERU
Peak Hour Demand	3,400 gpd/ERU

In estimating future demands, it was assumed that separate irrigation would not be available and that the distribution of new connections between the pressure zones would be similar to what has occurred in the past (refer to Table 3-4). Actual demands will vary depending on the progress of developments that are being proposed.

Demands from the additional 84 units planned at the University Apartments was added to the future estimated demands based on 2015 consumption for Building A through F of the University Apartments. These buildings (A through F) account for 120 units. In 2015, the average consumption was 69 gpd/unit, while the peak day was 103 gpd/unit, and the peak hour was 0.16 gpm/unit.

Table 3-15 includes a water demand forecast for the system and Pressure Zone 3. A separate forecast was not included for Zone 4 since new connections are not being allowed in this zone until additional pumping, storage and distribution system improvements are made to this zone. The cost of these improvements makes it more likely for the lower zones to develop first. The lower zones include sufficient undeveloped land to accommodate 20-years of growth.

Table 3-15 also includes a demand forecast with projected water savings from the Water Use Efficiency Program. Projected water savings are based on a 3% reduction every 6 years for single-family residential customers. Single-family residential customers make up approximately 70% of the system demand. This results in an overall water savings of approximately 0.35% per year.

Table 3-15
Water Demand Forecast

	2016	2016 plus Apartments	2022	2026	2036
Demands without projected water savings from Water Use Efficiency Program					
System					
Projected Additional ERUs	-	-	180	300	600
Additional University Apartments ERUs	-	84	-	-	-
Average Day Demand (gpd)	912,000	918,000	1,031,000	1,107,000	1,296,000
Peak Day Demand (gpd)	2,073,000	2,082,000	2,388,000	2,592,000	3,102,000
Peak Hour Demand (gpm)	2,850	2,860	3,320	3,600	4,310
Zone 3					
Projected Additional ERUs	-	-	90	150	300
Peak Day Demand (gpd)	1,434,000	1,434,000	1,587,000	1,689,000	1,944,000
Peak Hour Demand (gpm)	1,930	1,930	2,200	2,350	2,700
Zone 4					
Projected Additional ERUs	-	-	0	0	0
Peak Day Demand (gpd)	72,000	72,000	72,000	72,000	72,000
Peak Hour Demand (gpm)	100	100	100	100	100
Demands with projected water savings from Water Use Efficiency Program					
System					
Projected Additional ERUs	-	-	180	300	600
Additional University Apartments ERUs	-	84	-	-	-
Average Day Demand (gpd)	912,000	918,000	1,010,000	1,068,000	1,205,000
Peak Day Demand (gpd)	2,073,000	2,082,000	2,338,000	2,501,000	2,885,000
Peak Hour Demand (gpm)	2,850	2,860	3,250	3,470	4,010
Zone 3					
Projected Additional ERUs	-	-	90	150	300
Peak Day Demand (gpd)	1,434,000	1,434,000	1,554,000	1,630,000	1,808,000
Peak Hour Demand (gpm)	1,930	1,930	2,160	2,260	2,510
Zone 4					
Projected Additional ERUs	-	-	0	0	0
Peak Day Demand (gpd)	72,000	72,000	70,000	69,000	67,000
Peak Hour Demand (gpm)	100	100	98	97	93

Table 3-15 Water Demand Forecast
Notes: 1. Future consumption for the University Apartments is based on an average day demand of 69 gpd/unit, a peak day demand of 103 gpd/unit, and a peak hour demand of 0.16 gpm/unit. These values are based on 2015 demands from Buildings A-F. 2. Number of customers and demands for Zone 3 include all zones except Zone 1 and 1a. 3. Water demand forecasts are based on the highest recorded average day, peak day and peak hour demands through 2016, plus demand projections for future single-family residential customers without separate irrigation, plus demands from the University Apartments at buildout. 4. New connections are not being allowed in Zone 4 until additional pumping, storage and distribution system improvements are made to this zone. 5. Demands with projected water savings are based on a 3% reduction every 6 years for single-family residential customers. Single-family residential customers make up approximately 70% of the system demand. 6. Demands without projected water savings from water use efficiency program will be used in the system analysis.

Demands Per Acre

Single-family demand projections per acre are listed below. The projections are based on 3.5 units per acre, which is similar to Terraced Estates (423 units per 120 acres) and Mount Adams Estates (79 units per 22 acres).

	Without Separate Irrigation	With Separate Irrigation
Average Day Demand	2,200 gpd per acre, or 2.5 acre-feet per acre per year	1,200 gpd per acre, or 1.3 acre-feet per acre per year
Peak Day Demand	6,000 gpd per acre, or 4.1 gpm per acre	2,450 gpd per acre, or 1.7 gpm per acre

Chapter 4

Design Criteria

Water system design criteria define the desired standard level of service provided by the County's water systems. It is important that the County reviews their use and implications. If standards are set too low, customers will not be satisfied. If standards are set too high, the cost of installing facilities to meet such standards becomes prohibitive. Therefore, it is important that the County periodically review the standards established by the design criteria to ensure their continued validity.

Pressure Zones

Pressure zone boundaries should be such that the upper boundary of the zone is no higher in elevation than the ground surface contour that results in a static pressure of 40 psi. This low pressure standard is usually sufficient to ensure that the pressure will not fall below 30 psi during peak demand conditions. The lower boundary should be no lower in elevation than the ground surface contour that results in a static pressure of 90 psi. This high pressure standard is usually sufficient to ensure that the pressure will not increase above 100 psi when pumps are operating. It also provides some flexibility in establishing zone boundary locations.

Source Capacity

Source facilities must be capable of meeting the maximum daily demand. The minimum required source capacity applies to each pressure zone as well as to the overall system. For reliability purposes, DOH also recommends that source facilities be capable of the following:

- Replenishing depleted fire suppression storage within a 72-hour period while concurrently supplying the maximum daily demands.
- Providing the maximum daily demand for the system with 18 hours of pumping.
- Providing the average daily demand with the largest source out of service.
- Power connections to two independent primary public power sources, or backup generators.

Yakima County's goal for reliability is to be capable of providing the maximum daily demand with the largest source out of service.

Booster Capacity

Like source facilities, booster pump stations must be capable of meeting the maximum daily demand for the pressure zone in which they are supplying. If equalizing storage is not available, then the booster pump stations must be capable of meeting peak hour demands.

For reliability purposes, DOH recommends the following:

- Providing the maximum daily demand with the largest pump out of service.
- Maintaining a minimum of 20 psi at the pump intake under peak hour demand or fireflow plus maximum daily demand conditions.
- An automatic shut-off in place for when the intake pressure drops below 10 psi.
- Power connections available to two independent primary public power sources or provision of in-place auxiliary power if the pumps provide fireflow, or are pumping from ground-level storage.

Storage Capacity

The total storage volume must be capable of providing the sum of the following storage components:

- Operational Storage
- Equalizing Storage
- The larger of Standby Storage or Fire Suppression Storage
- Dead Storage

Operational Storage

Operational storage is the quantity of storage above the lowest pump start set point. The volume of operational storage must be sufficient to avoid excessive pump cycling. It must also provide adequate separation between pump start and stop set points, high and low water alarms, and the overflow piping.

Equalizing Storage

Equalizing storage is the quantity of storage needed to meet peak demands that exceed the supply capacity. The volume of equalizing storage needed depends upon several factors including peak system demand, diurnal variations in system demand, and source production capacity. Equalizing storage must be available at a minimum of 30 psi to all services.

The sum of the operational and equalizing storage components is generally the maximum volume of water drawn from the reservoir during the peak day demand. If this information is not available, equalizing storage can be estimated based on the following equation from the Department of Health's "*Water System Design Manual"*:

Equalizing Storage = (PHD-Q) x150

Where PHD = peak hour demand in gallons per minute
Q = source production rate in gallons per minute (excluding emergency sources)

Standby Storage

The purpose of standby storage is to provide a measure of reliability should sources fail or unusual conditions impose higher demands than anticipated. The volume of standby storage needed depends upon several factors including the number of connections in the system, if the system has single or multiple sources, the duration of a potential emergency, and the supply capacity to the system. Department of Health guidelines for determining the minimum standby storage are as follows:

1. **Water Systems with a Single Source**

   The recommended SB volume for systems served by a single source of supply is two (2) times the system's *average day demand* (ADD) for the design year to be available to all service connections at 20 psi. .

$$SB_{TSS} = \text{(2 days) (ADD) (N)}$$

Where: SB_{TSS} = *Total standby storage component for a single source system, in gallons;*

ADD = *Average day demand for the design year, in gpd/ERU; and*

N = *Number of ERUs.*

2. **Water Systems with Multiple Sources**

   The recommended SB volume for systems served by multiple sources **should** be based upon the following equation:

$$SB_{TMS} = \text{(2 days) (ADD) (N)} - t_m (Q_S - Q_L)$$

Where: SB_{TMS} = *Total standby storage component for a multiple source system; in gallons*

ADD = *Average day demand for the system, in gpd/ERU;*

N = *Number of ERUs;*

Q_S = *Sum of all installed and continuously available source of supply capacities, except emergency sources, in gpm. See Section 9.1.1 for the definition of a continuously available source.*

Q_L = *The largest capacity source available to the system, in gpm.*

t_m = *Time that remaining sources are pumped on the day when the largest source is not available, in minutes. (Unless restricted otherwise, this is generally assumed to be 1440 minutes.)*

Note: SB volume should not be less than 200 gallons/ERU.

Fire Suppression Storage

Fire suppression storage is the quantity of storage needed to meet required firefighting flows. The volume of fire flow storage needed is equal to the required fire flow in gpm, multiplied by the fire duration in minutes.

Dead Storage

Dead storage is that portion of a reservoir's volume that is below an elevation capable of providing adequate system pressures. Dead storage is considered based on two conditions: the volume below an elevation capable of providing 30 psi during normal operating conditions, and the volume below an elevation capable of providing 20 psi during emergency conditions, such as a fire flow. Dead storage occurs primarily in systems using standpipes where the standpipes are located on land within the zone being served.

Storage Reliability

For reliability purposes, DOH recommends the following:

- More than one gravity storage tank when feasible with the ability to isolate each tank while continuing to provide service.
- Storage sufficient to provide a standby storage volume of at least two times the average day demand for all users, and/or to ensure that fire suppression storage will be available at 20 psi at all service connections.
- A minimum standby storage volume of 200 gpd per equivalent residential unit (ERU), regardless of the number of, and/or excess capacity of the sources available.
- An alarm system that notifies operators of overflows, or when the storage level drops below the point where the equalizing storage is depleted.

Distribution System

Minimum Pipe Sizes

Water mains serving fire hydrants, either as part of new construction or planned phased improvements, shall not be less than 8-inches in diameter. In a dead end cul-de-sac, smaller diameter mains may be installed from the last hydrant to remaining residences.

Water mains should be sized to limit head losses to less than 10 feet per 1,000 feet of pipe length during peak hour demand conditions. Head loss greater than this is an indication of insufficient pipeline diameter.

Flow Rates

During peak-hour demand conditions, flow rates should be limited to less than 5-feet-per-second. It is generally more cost effective over a facility's service life to provide a larger diameter pipeline or parallel pipeline than to pay additional pumping costs.

During firefighting demand conditions, flow rates should be limited to less than 10-feet-per-second. Velocities greater than this may result in excessive pressure losses or pressure surges.

Reliability

Water mains should be looped whenever feasible, as determined by the Public Services Director or Utilities Division Manager. Water mains shall be capable of being flushed at a flow velocity of at least 2.5 feet per second.

System Pressures

Existing system pressures should be no less 30 psi at any customer's water meter during peak hour demand conditions. Extensions to the existing system must be designed to provide peak hour demands at no less than 40 psi in the distribution system, unless special conditions justify a reduction in pressure. Under no circumstances shall extensions to existing systems be designed to provide peak hour demands at less than 30 psi.

When fire protection is required, pressures must be no less than 20 psi throughout the distribution system under maximum daily plus fire flow demand conditions.

In transmission lines (lines with no service connections), pressures must be no less than 5 psi except when directly adjacent to a storage tank.

Fireflow

Yakima County has adopted Appendix B, Appendix C, Chapter 5 and relating amendments to the current edition of the International Fire code (IFC) and the International Building Code (IBC) regarding fire flow. The County Fire Marshall uses these documents to establish fire protection requirements for new construction. Minimum fire flow requirements apply to all new construction except Group R, Division 3 or U occupancies with a building area less than 3,600 square feet located on one of the following areas:

- On properties where no land use action is required; or
- Urban Areas: no more than two (2) lots created; or
- Rural Areas: lots greater than 1/3 acre up to 8 lots maximum or no more than four lots created

In general, Group R Division 3 occupancies refer to one-and two-family dwellings, and U occupancies refer to accessory buildings such as garages and sheds.

The minimum fire flow and duration for one- and two-family dwellings is 1,000 gpm for 60 minutes.

Fire flows required for other types of buildings is based on Tables B105.1(2) and B105.2. The fire flow varies depending on (1) the type of construction, (2) the size of the building, (3) whether or not the building has an automatic fire sprinkler system and/or (4) a monitored fire alarm system. The maximum fire flow is 2,250 gpm for 120 minutes. The County requires that new construction be built in a way that satisfies the requirements of the IBC and IFC with a fire flow of 2,250 gpm or less.

The minimum fire flow and duration for existing pipelines is 500 gpm for 30 minutes.

Level of Service Thresholds

Yakima County's growth management plan (Horizon 2040) includes level of service (LOS) standards for supply wells, pump stations, pipelines, reservoirs, and water treatment facilities. The LOS standards establish the minimum reserve capacities for each of these facilities. In essence, the LOS standards state that a facility is deficient and in need of improvement when the capacity used is 85 percent or more of the capacity available.

In applying the LOS standard to storage capacity, only equalizing, standby and fire suppression storage are reduced. The LOS standard is not applied to operational and dead storage since these volumes do not increase with the addition of more customers and they do not directly impact the quality of service provided.

Chapter 5
System Analysis

Supply

Existing Capacity

All Pressure Zones

Supply facilities must be capable of meeting the maximum daily demand (MDD) of the system, and the MDD of each pressure zone. If equalizing storage is not available, then supply facilities must be capable of meeting the peak hour demand.

For the Terrace Heights Water System, the combined capacity of all the Wells must be capable of meeting the MDD of the system. Well 2 and the Sycamore Booster Station must be capable of meeting the MDD of all pressure zones above Pressure Zone 1. In addition, the Terrett Booster Station must be capable of supplying the peak hour demand for Zone 4.

For added reliability, DOH recommends that source facilities be capable of the following:

- Replenishing depleted fire suppression storage within a 72-hour period while concurrently supplying the maximum daily demands.
- Providing the maximum daily demand for the system with 18 hours of pumping.
- Providing the average daily demand with the largest source out of service.

Yakima Count's goal for reliability is to be capable of meeting the peak day demand with the largest capacity pumping facility out of service.

Table 5-1 summarizes the existing supply capacity and the supply required for the system and Pressure Zones 3 and 4. The other pressure zones are not listed individually since they are supplied by upper pressure zones through pressure reducing stations. As shown, the existing supply capacity is adequate for the system and Zone 3 except when Well #3 is out of service. To provide increased reliability, the County plans to increase the pumping capacity of Well 6 from 340 to 900 gpm.

Pressure Zone 4

Supply capacity for Pressure Zone 4 is marginal. Based on supply meter readings and a peak hour to peak day factor of 2, the Terrett Booster Station capacity has been adequate since the new service meters were installed in 2015. Estimated peak hour demands prior to 2015 exceed the Terrett Booster Station capacity. Some customers in this part of the system experienced a large increase in their water bills after the new meters were installed, which resulted in more efficient water use.

Peak day and peak hour readings shown in the Beacon meter reading system correspond reasonably well to the supply meter readings. The largest estimated peak day demand between 2015 and 2017 based on supply meter readings is 46,000 gpd. Using a peak hour to peak day peaking factor of 2 results in a peak hour demand of 64 gpm. This is similar to the peak day and peak hour demands shown in Beacon (49,000 gpd and 55 gpm in 2015, 47,000 gpd and 52 gpm in 2016, and 42,000 gpd and 69 gpm in 2017).

Higher peak hour demands can be found if days other than the peak day are considered. The greatest peak hour demand to occur between June 1st and August 30th of each of the last three years based on Beacon records was 83 gpm (see Chapter 3). A peak hour flow of 83 gpm would result in a drop in pressure of approximately 5 psi. This was the only instance Beacon records showed a peak hour flow exceeding the pumping capacity in the last three years. This pressure zone has an estimated leakage of less than 1 gpm, so the Beacon consumption records represent peak day and peak hour demands reasonably well.

If either of the Terrett booster pumps should fail, then Zone 4 will not have adequate capacity to meet peak hour demands. To minimize the impact from a pump failure, a spare pump and motor are kept on hand at the booster station.

Yakima County has not received complaints about low system pressures. The County is not allowing new connections in this pressure zone until improvements are made, and will continue to monitor the zone for adequate supply capacity.

Pressure Zone 3

If the Sycamore Booster Station is out of service during peak demand conditions, the supply capacity for Zone 3 would not be adequate. Returning the Tower Reservoir to service will allow one booster at Well 5 to be placed in service and a second booster to run intermittently, provided Wells 4 and 5 are operating. This would be sufficient to meet current peak day demands in Zone 3 if the Sycamore Booster should fail. A 12-inch water line will need to be installed between the 16-inch water line in 41st Street and Well 5 to fully utilize two boosters at Well 5.

Table 5-1
Existing Supply Requirements

Description	System (all pressure zones)	Zone 3	Zone 4
<u>All Pumps in Service</u>			
Existing Supply Capacity (gpm)	2,780	2,220[1]	79
Supply Required (gpm)[2]	1,440	1,000	100
Percent Capacity Used	52%	45%	127%
Replenish Fire Suppression Storage within <u>72 Hours While Supplying MDD</u>			
Existing Supply Capacity (gpm)	2,780	2,220[1]	Not Applicable.
Supply Required (gpm)[2]	1,500	1,060	Zone 4 does not
Percent Capacity Used	54%	48%	provide fire flow.

Table 5-1
Existing Supply Requirements

<u>With 18 Hours of Pumping</u>			
Existing Supply Capacity (gpm)	2,780	2,220[1]	Not Applicable.
Supply Required (gpm)[2]	1,920	1,330	Zone 4 does not
Percent Capacity Used	69%	60%	have storage.
<u>Largest Pump out of Service</u>			
Existing Supply Capacity (gpm)	1,280	1,720[1]	43
Supply Required (gpm)[2]	1,440	1,000	100
Percent Capacity Used	113%	58%	233%[3]

Notes:
1. Supply capacity shown for Zone 3 does not include the booster at Well 5.
2. Except for Zone 4, supply required is equal to the peak day demand. For Zone 4, it is equal to the peak hour demand. Supply required is based on a 2,250 gpm fire flow for 2 hours.
3. A spare pump is on hand at the Terrett Booster to limit the length of time the facility might be operating on one pump.

Capacity for Future Connections

The existing supply facilities have capacity to serve an estimated 1,110 additional ERUs. Based on the County's level of service criteria, additional supply should be added before the number of additional ERUs reaches approximately 760. If the number of ERUs increases at an average rate of 30 per year, then the existing supply capacity would be adequate for the next 25 years. However, additional supply capacity is needed now for the system to be able to meet peak day demands with the largest supply facility out of service.

Zone 3 supply facilities, which provide water to all zones above Zone 1, have capacity to serve an estimated 1,030 additional ERUs. Based on the County's level of service criteria, additional supply should be added before the number of additional ERUs reaches approximately 750. If the number of ERUs above Zone 1 increases at an average rate of 13 per year, then the existing supply capacity would be adequate for the next 25 years. The existing supply capacity for Zone 3 is also capable of meeting DOH's reliability criteria, including meeting demands with the largest pump out of service, for the next 20 years. The booster at Well 5 needs to be made operational for the Zone 3 supply capacity to meet the County's reliability criteria, which is to meet peak day demands with the largest facility out of service. Once the Tower Reservoir is returned to service along with one booster at Well 5, then the supply capacity for Zone 3 will be capable of meeting the County's reliability criteria for only about one year.

Table 5-2 shows the estimated number of additional ERUs possible for the system and each zone. Also included is the projected year in which additional supply capacity will be needed based on various criteria and the historical growth shown in Table 3-4.

Table 5-2
Supply Capacity Available for Future Connections

Description	System (all zones)	Zone 3	Zone 4	
			W/out Equalizing Storage	With Equalizing Storage
All Pumps in Service				
Existing Supply Capacity (gpm)[1]	2,780	2,220	80	80
Existing Supply Required (gpm)	-1,440	-1,000	-100	-50
University Apartments (gpm)	-20	-0	-0	-0
Capacity Remaining for Growth (gpm)	1,320	1,220	-20	30
Capacity Remaining for Growth (gpd)	1,900,800	1,756,800	0	43,200
Additional number of ERU's that can be served with the existing supply capacity[2]	1,110	1,030	0	25
All Pumps in Service and LOS Criteria[3]				
LOS Supply Capacity (gpm)[1]	2,360	1,890	68	68
Existing Supply Required (gpm)	-1,440	-1,000	-100	-50
University Apartments (gpm)	-20	-0	-0	-0
Capacity Remaining for Growth (gpm)	900	890	-32	18
Capacity Remaining for Growth (gpd)	1,296,000	1,281,600	0	25,920
Additional number of ERU's that can be served with the existing supply capacity[2]	760	750	0	15
Replenish Fire Suppression Storage within 72 Hours While Supplying MDD				
Existing Supply Capacity (gpm)[1]	2,780	2,220	Not applicable. Zone 4 does not provide fire flow.	Not applicable. Zone 4 does not provide fire flow.
Existing Supply Required (gpm)	-1,500	-1,060		
University Apartments (gpm)	-20	-0		
Capacity Remaining for Growth (gpm)	1,260	1,160		
Capacity Remaining for Growth (gpd)	1,814,400	1,670,400		
Additional number of ERU's that can be served with the existing supply capacity[2]	1,060	980		
Supply MDD with 18 Hours of Pumping				
Existing Supply Capacity (gpm)[1]	2,780	2,220	Not applicable. Zone 4 does not have storage.	Not applicable. Zone 4 does not have storage
Existing Supply Required (gpm)	-1,920	-1,330		
University Apartments (gpm)	-20	-0		
Capacity Remaining for Growth (gpm)	840	890		
Capacity Remaining for Growth (gpd)	1,209,600	1,281,600		
Additional number of ERU's that can be served with the existing supply capacity[2]	710	750		

Table 5-2 Supply Capacity Available for Future Connections				
Description	System (all zones)	Zone 3	Zone 4	
			W/out Equalizing Storage	With Equalizing Storage
Largest Pump Out of Service				
Existing Supply Capacity (gpm)[1]	1,280	1,720	41	41
Existing Supply Required (gpm)	-1,440	-1,000	-100	-50
University Apartments (gpm)	-20	-0	-0	-0
Capacity Remaining for Growth (gpm)	-180	720	-59	-9
Capacity Remaining for Growth (gpd)	0	1,036,800	0	0
Additional number of ERU's that can be served with the existing supply capacity[2]	0	610	0	0
Projected year when additional supply capacity will be needed[5]			See Note 4	See Note 4
All Pumps in Service and Supply >MDD	> 30 years	>30 years		
Level of Service Criteria and Supply >MDD[4]	25 years	25 years		
Replenishing fire suppression within 72 hours	>30 years	>30 years		
Supplying MDD with 18 hours of pumping	23 years	25 years		
Largest pump out of service	0 years	20 years		

Notes:
1. The existing supply capacity for Zone 3 does not include the booster at Well 5.
2. The additional number of ERUs that can be served is based on a peak day demand of 1,700 gpd per additional ERU. The additional number of ERUs that can be served by Zone 3 includes ERUs in Zones 2, 2a and 4.
3. Level of service criteria states that supply required is not to exceed 85% of supply capacity.
4. Additional connections are not allowed in Pressure Zone 4 until storage is available.
5. The projected year when additional supply will be needed is based on 30 new ERUs per year. Of this number, 13 new ERUs per year are projected for Zone 3 (Zones 2, 2a, 3, 3a and 4).
6. The boosters at Well 5 need to be placed in service for Zone 3 supply capacity to meet the County's reliability criteria of meeting peak day demands with the largest facility out of service.

Future Supply Alternatives for Zone 1

Supply capacity for Zone 1 can be increased by increasing the pumping capacity of Well 6. A pump test conducted in 1996 showed the pumping capacity could be increased from its current level of 340 gpm to at least 1,200 gpm. Due to limitations on the diameter and straightness of the well, the County plans to increase the pumping capacity to approximately 900 gpm. This improvement alone would provide capacity for an additional 320 single-family residential connections with the largest source out of service.

The 1996 Well 6 pump test showed the well produced sand when pumped at higher rates. Installing a variable speed drive would allow the pump to be operated at lower capacities under normal conditions and at higher capacities when needed to meet demands if another source is out of service.

Installing a sand separator should alleviate concerns with sand.

Water rights for Well 3 already include provisions for a second point of withdrawal with a combined capacity of up to 2,250 gpm. The County had preliminary discussions with Pacific Northwest University for a possible well site. Other well site options include areas along University Parkway north of the pressure reducing station and south of Terrace Heights Drive, and along Keys Road and 41st Street. The well site should be close to a 12” diameter or larger water line.

The 2001 Water System Plan mentioned that the proposed Creekside development included provisions for a future well site. This was not a requirement of the development and any site acquired would likely need to be purchased.

The 2001 Water System Plan also mentioned a 1949 Report of Findings from the Department of Ecology that stated Wells 4 and 5 are capable of producing an estimated 1,500 gpm. A larger pump and motor were subsequently installed in Well 4 in 2008 to increase the pumping capacity from approximately 200 to 400 gpm. The pump that was installed was about the largest that could fit in the well, so increasing the pumping capacity even further is not considered a viable option at this time. Well 5 produced a significant amount of sand when its pumping capacity was increased from 250 gpm to 320 gpm in 1999, so further increases in capacity of this well are also not being considered at this time.

Future Supply Alternatives for Zone 3

Supply capacity in Zone 3 can be increased by changing the programming of the controller in the Sycamore Booster Station to allow all 4 pumps to operate simultaneously in a lead lag capacity. A surge analysis should be done on the system prior to making the changes. A fourth pump would increase the capacity by approximately 400 gpm.

Supply capacity can also be increased by placing the booster pump at Well 5 in service and by adding a second booster pump in the pump house. The Well 5 pump house includes space for a second booster to be installed to further increase capacity once other system improvements are made. Improvements required to place one or two booster pumps in service include:

> One booster pump – Return Tower Reservoir to service or construct a new water tank near Well 5.
>
> Two booster pumps – Improvements needed for one booster and installation of a 12-inch water line from Well 5 to the 16-inch water line at 41st and Terrace Heights Drive.

Smaller booster pumps or variable speed drives could be installed to limit the booster discharge and prevent the pumps from cavitating. This would provide some additional reliability, but it would not enable the system to meet peak demands with the Sycamore Booster Station out of service.

In the distant future, supply capacity could be further increased by constructing a third booster station. Because the booster station would be pumping from Zone 1, it would need to be below elevation 1288. It may also be desirable to locate this booster station at an elevation low enough to allow it to operate if Zone 1 was being supplied through an emergency intertie with the City of Yakima. A possible location is shown on Figure F-1 in Appendix F.

Future Supply Alternatives for Zone 4

The Phase 2 Improvement Project included plans for building a new booster station for Zone 4. The new booster station was to be within the same building as Well 2, and was to include space for multiple pumps so that capacity could be added as needed. However, the project ran short of funding and the booster station was eliminated from the project. The booster station could still be constructed in a separate building on the same property as the current booster station.

A second booster station is proposed for Zone 4 as part of the proposed Highlands project. The proposed location is shown on Figure F-1 in Appendix F.

Zone 4 includes approximately 300 acres, of which approximately 220 acres is undeveloped. When fully developed, peak day demands are projected to reach approximately 300 gpm.

Storage

Existing Conditions

Storage facilities must be capable of providing the sum of the volumes needed for operational, equalizing, and dead storage requirements, plus the larger of standby and fire flow storage requirements. This requirement applies to the system as a whole, as well as to each pressure zone. In the Terrace Heights system, storage from Zone 3 is used to meet equalizing, standby and fire suppression storage requirements for Zone 3 and each lower zone. This is possible because pressure reducing valves permit water to flow from Zone 3 back down to each lower zone. Storage components required for each zone are as follows:

> Zone 1 - Operational Storage for the Sycamore Booster Station. All other storage requirements are provided by Zone 3.
>
> Zones 1a, 2, 2a and 3a - No storage required since these zones are supplied through pressure reducing stations. All equalizing, standby, and fire suppression storage requirements are provided by Zone 3.
>
> Zone 3 - Operational storage for each supply well, and equalizing, standby, and fire suppression storage for Zones 1a through 3.
>
> Zone 4 - Operational, equalizing, and standby storage for Zone 4. Fire suppression storage is not required at this time since all lots are currently greater than 1/3 acre in size.

Operational Storage

Operational storage for Zone 1 includes the top 9.2 feet of storage in Reservoir 2. The upper 6.5 feet is for pump control and high level alarms and is based on a Pump #1 start set point of 4.5 feet and a water tank diameter of 11. The depth from 1.8 feet to 4.0' is for operation of the dump valve. The top 9.2' is equivalent to 133,000 gallons. If Reservoir 3 is returned to service, the operational storage will be increased.

In Zone 3, operational storage is 818,000 gallons. This volume is based on a depth to overflow of 31.6' in Reservoirs 1 and 4, and a Well 3 start point of 23'. Well 3 is the last pump to come on line. It is also noted that the maximum recommended operating water level in Reservoirs 1 and 4 is 29.7'. This is to allow for sloshing during an earthquake and is based on a sloshing wave height of 2.3' shown in the Reservoir No. 4 Predesign Report. Maintaining a normal operating level below this height provides storage above the high level alarm to allow County operators time to turn pumps off before an overflow condition occurs after receiving a high level alarm.

Operational storage required in Zone 4 is minimal due to the variable speed drives. The pumps are capable of operating at less than 0.3 gpm. Based on a maximum of 5 pump starts per hour and the pumps not rotating between each run cycle, the operational storage is less than 2 gallons. The maximum number of pump starts occurs when demand is 50 percent of the minimum pumping capacity.

Equalizing Storage

Equalizing storage for the system is provided by Reservoirs 1 and 4 in Zone 3. The volume of equalizing storage provided is approximately 150,000 gallons, which is equivalent to 1.5-feet of storage in both reservoirs combined. During the summer months, prior to placing Reservoir 4 in service, the water level in Reservoir 1 would drop up to 3-feet below the start point for Well #3. This is not due to demands exceeding the supply capacity of the system but is due to the lag observed between the time Well 3 is called to start and the time an additional pump is signaled to start at the Sycamore Booster. Well 3 must first raise the water level in Reservoir 2 before an additional booster pump is signaled to start and begin filling Reservoirs 1 and 4. It is also due to generally only running Well 3 at 600 gpm and not at its full capacity of 1,500 gpm. Now that Reservoir 4 is in service, the water level in Reservoirs 1 and 4 should only drop 1.5-feet below the start point for Well 3.

Zone 3 Equalizing Storage = 2[3.14 x (45 feet)^2 x 1.5 feet x 7.48 gallons/cu-ft] = 142,685 gallons

For Zone 4, equalizing storage is:

(PHD-Q) x 150 = (83 gpm - 79 gpm) x 150 minutes = 600 gallons

Standby Storage

DOH guidelines recommend a minimum standby storage volume of two times the average day demand minus the daily supply capacity with the largest source of supply out of service. The standby storage volume should not be less than 200 gallons per equivalent residential unit.

For Zone 3, the basic standby storage volume was calculated based on the following:

1. The supply capacity for the system with the largest source of supply out of service; and
2. The supply capacity for Zone 3 with the largest pump out of service.

Using the supply capacity for the system with the largest source of supply out of service, the standby storage volume is:

2 x (912,000 gallons/day) – 1,280 gpm x 1,440 minutes/day = -19,200 gallons

Using the supply capacity for Zone 3 with the largest pump out of service, the standby storage volume is:

2 x (912,000 gallons/day) – 1,720 gpm x 1,440 minutes/day = -652,800 gallons

Both of these volumes are less than 200 gallons per equivalent residential unit; therefore, the minimum standby storage volume for Zone 3 is:

200 gallons/ERU x 2,488 ERU's = <u>497,600 gallons</u>

For Zone 4, the basic standby storage volume is:

2 x (33,200 gallons/day) – 43 gpm x 1,440 minutes/day = 4,480 gallons

This is more than 200 gallons per equivalent residential unit.

200 gallons/ERU x 20 ERU's = 4,000 gallons

Therefore, the minimum standby storage volume for Zone 4 is 4,480 gallons.

Fire Suppression

Reservoirs 1 and 4 provide fire flow to all zones except Zone 4. Zone 4 does not require fire flow at this time since it is in the rural area and all lots are greater than 1/3 acre in size. The storage required for fire flow is 270,000 gallons, and is based on a maximum fire flow of 2,250 gpm for 120 minutes. The fire suppression storage volume (270,000 gallons) is less than the standby storage volume (497,600 gallons), so standby storage is controlling.

Dead Storage

Reservoirs 1 and 4 must be capable of providing more than 30 psi to the highest service connection in Zone 3 during normal operating conditions. Since the highest service connection is at elevation 1418, and friction losses are minimal between the reservoirs and the highest service connections, equalizing and operational storage requirements must be met with a minimum hydraulic grade line elevation of 1487 feet. This is higher than the bottom of the tank (elevation 1482), so only the reservoir volume above 1487 may be used for equalizing and operational storage requirements.

Any part of the reservoir volume may be used to meet standby and fire flow storage requirements, since more than 20 psi is available at the highest service connection when the water level is at the bottom of the tank.

Reservoirs 1 and 4 do have a silt ring on the discharge pipe that is approximately 6" in height. Consequently, the only dead storage is the volume below the silt ring, or approximately 50,000 gallons.

Reservoirs 2 and 3 must be capable of providing more than 30 psi to the highest service connection in Zone 1 during normal operating conditions. Since the highest service connection is at elevation 1199 near the end of South 49th Street, a minimum water surface elevation of 1268 must be maintained during static conditions. The hydraulic model shows only 1' of head loss between Reservoir 2 and this location during peak hour demands. Assuming a worst case scenario of both Wells 4 and 5 off, the water surface elevation in Reservoir 2 must remain above 1269 to maintain 30 psi in Zone 1. The bottom of Reservoir 2 is at elevation 1278, so all of Reservoir 2 is above this elevation. Therefore, dead storage is not applicable to Reservoir 2. Dead storage is applicable however, to Reservoir 3. A minimum of 31-feet of water is needed in Reservoir 3 to keep from draining Reservoir 2. Therefore, only the upper 11-feet in Reservoir 3 can be used to meet operational storage requirements, and the bottom 31-feet (66,000 gallons) is considered dead storage.

Total Storage Required for Existing Conditions

A comparison of the storage available in each pressure zone versus the existing storage requirements is presented in Table 5-3. Storage volume is adequate for all zones except Zone 4.

Table 5-3
Total Storage Requirements for Existing Conditions

	Zone 1	Zone 3	Zone 4
Storage Available (gallons)	150,000	3,000,000	66
Existing Storage Requirements (gallons)			
Operational	133,000	818,000	2
Equalizing	0	150,000	600
Standby and Fire Suppression	0	498,000	4,500
Dead	0	50,000	0
Total	133,000	1,516,000	5,100
Percent Capacity Used	89%	51%	>100%

Comments:

1. Equalizing, Standby, and Fire Suppression storage for Zone 1 is provided by Reservoirs 1 and 4 in Zone 3.
2. Fire suppression storage is included in the volume for standby storage.
3. Additional storage is needed in Zone 4 which includes three 86 gallon pressure tanks. Each tank has a drawdown of approximately 22 gallons.

Capacity for Future Connections

Reservoirs 1 and 4 have capacity to serve an estimated 1,240 additional equivalent residential units (ERUs). Based on the County's level of service criteria, additional storage should be added when the number of additional ERUs reaches approximately 1,040. If the number of ERUs increases at an average rate of 30 per year, then the existing storage capacity would be adequate for more than 30 years without exceeding the County's level of service criteria. The storage allocations estimated for an additional 1,040 connections are as follows:

Operational	818,000 gallons
Equalizing	512,000 gallons
Standby and Fire Suppression	1,290,000 gallons
Dead	50,000 gallons
Total	2,670,000 gallons

Storage available based on level of service criteria: 2,687,000 gallons.

Increasing the supply capacity will reduce the volume of standby storage required and increase the allowable number of connections that can be served by Reservoirs 1 and 4. If the supply capacity for Well 6 is increased to 900 gpm, the estimated number of additional ERUs that could be served by Reservoirs 1 and 4 would increase to approximately 1,470. If the supply capacity for Well 6 is increased to 900 gpm and the booster at Well 5 is made operational, the estimated number of additional ERUs that could be served by Reservoirs 1 and 4 would increase to approximately 1,600.

A spreadsheet showing the estimated number of connections that can be served by Reservoir 1 under various conditions is included in Appendix D.

Future Storage Alternatives for Zone 1

Returning the Tower Reservoir to service is the preferred alternative for increasing storage in Zone 1. This improvement would allow the booster at Well 5 to be placed in service and help to prevent surges when Well 5 starts and stops.

If the Tower Reservoir is returned to service, it would be preferred to pipe Well 4 directly to the reservoir and utilize separate fill and drain pipes, or install a mixing system. This would help to prevent stagnation and provide better chlorine contact time should the well experience unsatisfactory coliform samples. Stagnation could be an issue if provisions are not made due to the limited range for operational storage. The range is limited because the Sycamore boosters have only 3.5-feet between pump on and pump off with three of the four pumps in operation. The boosters at Well 5 should be similar to prevent the dump valve at the Sycamore booster from opening and pumping the water in a circle.

An alternative to returning the Tower Reservoir to service is to construct a new water tank next to Well 5. A 300,000 gallon reservoir approximately 20-feet in height and 50-feet in diameter would provide better operational storage for the boosters. The operational storage provided by the Tower Reservoir would be minimal. A tank in this location would not increase the chlorine contact time for

Well 4 without installing a new pipeline to the tank.

A long term plan of the County is to construct a 0.5 mg reservoir next to Reservoir 2. Space is available on the site to construct a larger reservoir while keeping Reservoir 2 in service. One benefit of a larger tank at this location is that it would reduce pumping costs by reducing the volume of water that is currently pumped into Reservoirs 1 and 4 and subsequently brought back to Reservoir 2 through the dump valve. With a larger tank, one or more of the wells could be programmed to start and stop based on the water level in Reservoir 2.

The existing storage capacity can provide operational storage for the fourth pump at the Sycamore booster when it is added to the control sequence. Currently, the controller is programmed to allow only three of the four pumps to operate at any one time.

Future Storage Alternatives for Zone 3

Now that Reservoir 4 has been built in Zone 3, additional storage should not be needed for many years. There is not sufficient space at the Reservoir 1 and 4 site to build a third reservoir, so when additional storage is needed it would need to be constructed elsewhere in the system near elevation 1513. One possible location, provided the distribution system has sufficient capacity to allow all three reservoirs to operate at similar hydraulic grade lines, is south of Cougar Lane. A reservoir in this location could connect to an existing 16-inch water line that extends into a field east of 57th Street. This would improve system reliability by not having all the reservoirs supplied off of common piping.

Future Storage Alternatives for Zone 4

Zone 4 is the only zone with a shortage of storage. One option for increasing storage is to move one or more of the 30,000 gallon tanks from the Sycamore Booster. The new site should be at an elevation that would provide an overflow elevation of between 1630 and 1640. Yakima County owns property near the end of north 57th Street that could be used for a reservoir site. A new water line would need to be installed from the Terrett Booster to the reservoir site. The existing water line along north 57th Street was damaged when the street was improved and is not in a usable condition. A hydraulic grade line of 1640 will provide 95 psi at the bottom of the zone, and approximately 40 psi at the top of the service area along 57th Street.

Additional storage for Zone 4 was also proposed with the Highlands Project. The proposed site is near elevation 1640.

One drawback with installing a storage reservoir with a hydraulic gradeline near 1640 is that it will be too low to serve four existing connections in the far northeast part of the system. The highest of these connections is at elevation 1605. Rather than increase the hydraulic grade line to accommodate these connections, separate pumps will be installed to increase pressures. Pressure tanks will be used for storage, and the existing 2" line will be used for distribution.

The estimated number of connections that could be served by moving one, two, or three of the existing 30,000 gallon tanks is presented in Table 5-4. The number of connections shown could be further increased by installing larger pumps to reduce equalizing storage requirements. Spreadsheets showing the estimated number of connections that could be served with various storage scenarios are included in Appendix D.

Table 5-4
Storage Capacity Evaluation for Zone 4

	With No Fire Flow Capability			**With 1,000 gpm Fire Flow Capability**			**With 1,500 gpm Fire Flow Capability**		
Number of 30,000 gallons storage tanks	1	2	3	1	2	3	1	2	3
Estimated total number of service connections that can be supplied based on LOS criteria	20	31	43	See Note 2.	32	43	0	0	44
Estimated Storage Allocations (gallons)									
Operational	8,200	16,300	24,500	See Note 2	16,300	24,500	See Note 2	See Note 2	24,500
Equalizing	3,200	7,100	11,400		7,500	11,400			11,800
Standby & Fire Suppression	14,600	28,400	43,500		30,000	43,500			45,000
Dead	0	0	0		0	0			0
Total	26,000	51,800	79,400		53,800	79,400			81,300
Storage available based on LOS criteria (gallons)	26,700	53,500	80,200	See Note 2	58,000	80,200	See Note 2	See Note 2	86,900

Comments:

1. Operational storage with one tank is estimated based on the following: Overflow 11', High water Alarm 10', Pumps Off 9.5', Pump 1 Start 8.5', and Pump 2 Start 7.5'.
2. A 1,000 gpm fire flow requires at least 2 tanks and a 1,500 gpm fire flow requires at least 3 tanks.

Hydraulics

Methodology and Description of Program

A hydraulic analysis was performed on the Terrace Heights system using the computer model WaterCAD. WaterCAD is distributed by Bentley Systems of Exton, Pennsylvania. The model was originally prepared about 23 years ago and was updated for the 2001 and 2009 Water System Plans, and again for this plan.

For this water plan update, a new scaled parcel layer from the County's GIS system showing newer parcels was imported into the model and used as a base drawing. In addition to new parcel lines, the parcel layer included surveyed locations and elevations of valves, fire hydrants and service meters. Other input data updated for the model included:

> Pump Stations: Supply and booster pump stations were modeled using the latest pump curves and well drawdown data.
>
> Pipes: Nominal pipe diameters were used since the pipe type or pressure class is often unknown. Pipe lengths were calculated by WaterCAD based on the parcel layer. Pipe friction losses were calculated using a Hazen-Williams coefficient of 140 for PVC pipe, 130 for ductile iron pipe, and 110 for cast iron and galvanized pipe.
>
> Junctions: Ground elevations for pipe junctions were based on surveyed elevations for valve and meter boxes. System demands were modeled by applying August 2016 consumption for each parcel to the nearest junction (node) in the computer model. Peak day and peak hour demands were modeled by multiplying the August 2016 consumption by the following peaking factors:

Demand Condition	Peaking Factor
Peak Day	1.35 (Peak Day/Peak Month)
Peak Hour	2.63 (Peak Hour/Peak Month)

Model calibration was checked in 2001 and 2009 when the model was updated and field measured pressures were found to match well with the model results. For this update, field measured pressures and model results were compared at each of the pump houses and all were within 4 psi. It was noted that production from Well 5 was approximately 60 gpm less than anticipated, indicating the pump may be showing signs of wear. Model calibration should be further checked once fire hydrants are flowed.

Existing Demands

Peak-Hour Demand Conditions

The system was modeled under an August 1, 2016 peak hour demand condition of 2,800 gpm with Wells 2, 4, 5 and 6 operating at capacity. Water levels in Reservoirs 1 and 2 were 1505 and 1283 respectively to correspond to minimum water levels. Well 3 was modeled as being off to simulate a worst case scenario of supplying a peak hour demand with reservoir levels just above the pump start set point. Normally during days of peak demand Wells 2, 4, 5 and 6 will run continuously and Well 3 will cycle to meet demand.

Results from the model are shown as pressure contours on Figure 5-1. As shown, pressures are above 30 psi for all customers. In the last water plan update one customer at the northeast end of Zone 4 was shown to have pressures below 30 psi just prior to when the lag booster pump at the Terrett Booster Station was signaled to start. Installation of variable speed drives on both booster pumps has resulted in more consistent pressures than the previous controls which relied on a pressure switch.

Results from the model also show pressures increasing to 100 psi at the Sycamore Booster Station with 2 pumps operating. This is slightly less than what was observed in the field. Field pressures observed at the booster station were 104 psi with two pumps operating. Field measured static pressure was also 5 psi different (97 versus 102 psi), so the pressure gauge may have been slightly off.

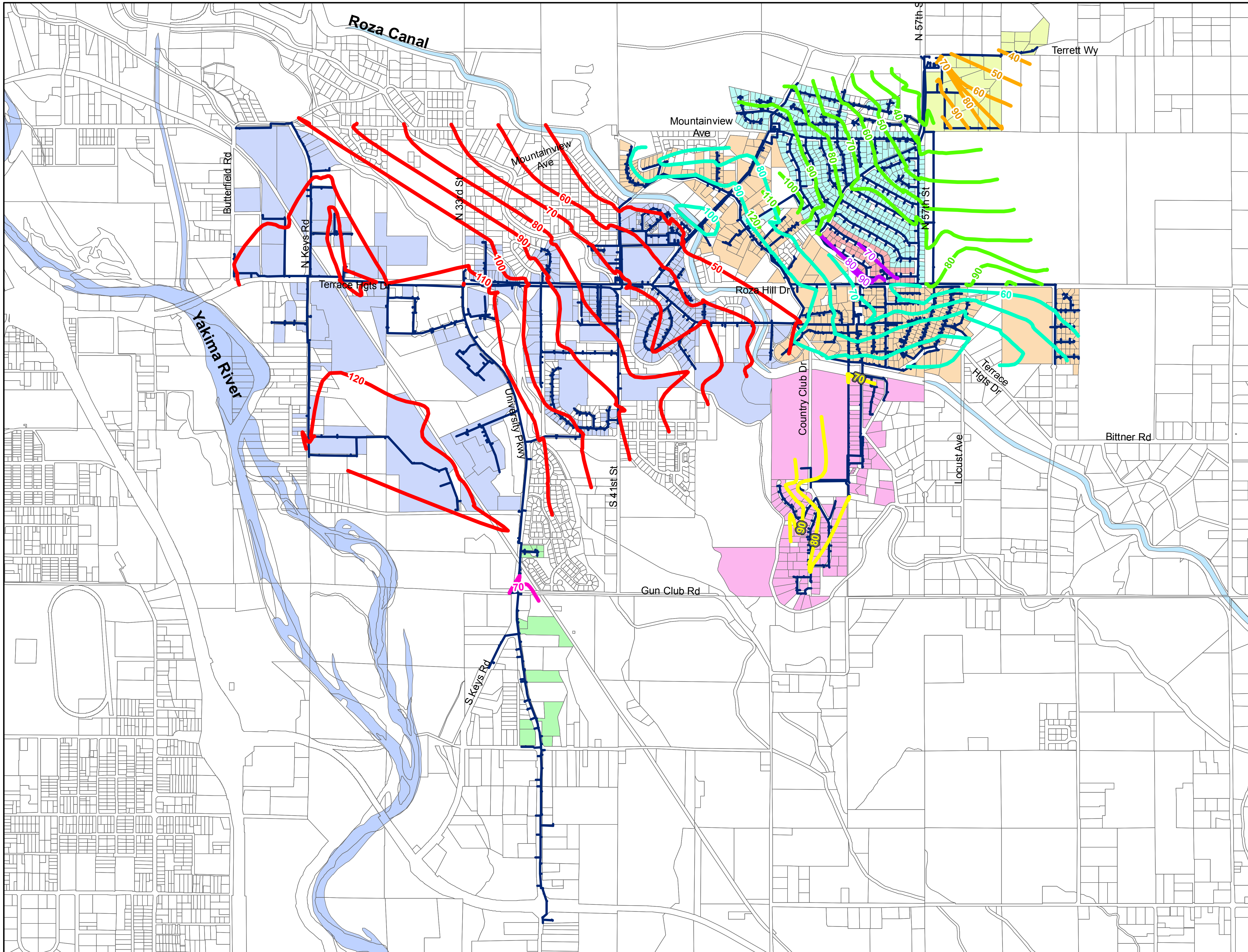
With three booster pumps operating, velocities were just over 4 feet per second in the 10" line leaving the Sycamore Booster Station. Velocities were also over 4 feet per second in the 8" line leaving Well 4. With Well 5 operating and Well 4 operating at 370 gpm, the velocity in this line is approximately 4.4 fps. Returning the Tower Reservoir to service and placing the booster at Well 5 in service will reduce the velocities in this line and the 10" line in Maple Ave.

Pressures are above 100 psi in the lower areas of Zone 1. Although higher than desired, the high pressures do help to provide good fire flow capability to the industrial park area. With Well 3 operating, pressures near the south end of Keys Road were approximately 120 psi. Future service connections will need to have pressure reducing valves installed.

Pressures are also above 100 psi in a small area north of Hillcrest Drive that is served from a small diameter water line off of North Sky Vista Avenue. The line serves six homes and has pressures over 120 psi at the lower end. When this line becomes due for replacement it should be served off the water line in Hillcrest Drive.

Velocities were below 5 feet per second (fps) in all areas except one. The 10-inch line between Terrace Heights Elementary School and Hillcrest Drive can exceed 5 fps when all wells are running and demands are less than peak hour. A portion of this line is planned to be replaced in 2018 as part of a County road project. The project also includes replacing an existing 4-inch line in Maple Avenue south of Hillcrest Drive and approximately 600 feet of 4-inch line in Hillcrest Drive.

The remainder of the 10-inch line north of the Terrace Heights Elementary School and east of the connection with the Nola Loop line should be replaced or a parallel line installed prior to operating Wells 3 through 6 above approximately 2,200 gpm. This equates to approximately 3,100 equivalent residential units (ERUs), or approximately 600 additional ERUs. Rehabilitating the Country Club Tower and operating the Well 5 booster will reduce these velocities and delay the need to increase the hydraulic capacity in this area. Level of service criteria from the County's growth management plan was not applied to this waterline since the velocity does not impact the quality of service



Yakima County Comprehensive Water System Plan

FIGURE 5-1

Terrace Heights Water System Peak Hour Pressures

Peak Hour Pressure Contours For Each Zone, With Pressure

- Zone 1
- Zone 1a
- Zone 2
- Zone 2a
- Zone 3
- Zone 3a
- Zone 4
- Water Lines

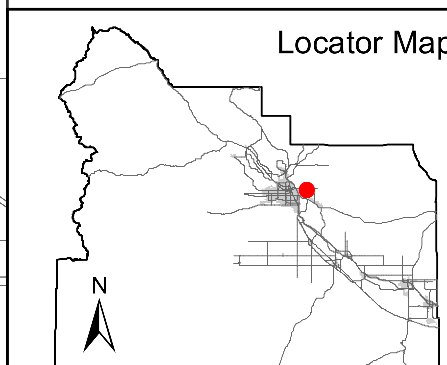
Lots Served by System

For Each Pressure Zone

- 1
- 1a
- 2
- 2a
- 3
- 3a
- 4

1 inch = 1,600 feet

Locator Map



Date: September 2015

Document Path: R:\disk_5\projects\county\pw\waterplan\t_heights\watersystemsplan_17\fig51_waterplan.mxd

provided.

Peak Day Plus Fire Flow Demands

Peak day plus fire flow demands were simulated on the model to estimate the fire flow available in each part of the system. Results of the model are shown as fire flow contours on Figure 5-2. The fire flows are based on a minimum residual pressure of 20 psi throughout the distribution system, and positive pressure in the transmission mains. From the figure it can be seen that all of the Light Industrial area has more than the maximum required fire flow, and all of Terraced Estates has more than the maximum required residential fire flow. The problem areas are in the Country Club system where 4-inch and smaller lines are common, and in pressure zone 4 which has no storage. In three areas, less than 500 gpm is available to the hydrant.

Hydrants in areas with less than 1,000 gpm are listed in Table 5-5. Included in the table are the estimated fire flows currently available, and the improvements needed to increase the fire flows to 500 gpm and 1,000 gpm. Because of costs, improvements necessary to provide 1000 gpm to all of the hydrants are not planned at this time. Hydrant locations are shown on Figure 5-2.

Table 5-5 Fire Flow Analysis			
Hydrant Location	**Estimated Fire Flow Currently Available (gpm)**	**Improvements Needed to Provide a Fire Flow of 500 gpm**	**Improvements Needed to Provide a Fire Flow of 1000 gpm**
Mountain View	320	1	1
N. 34th Street	580	None	2
Terrace Park	900	None	3
Ferncrest	500	None	4
Sunset Point	910	None	5
Mesa Vista	460	6	6
Laredo Lane	10	7	7
Morningside Drive	760	None	8

Improvements
1. Replace 4" line in Hillcrest from Maple Avenue to Mt. View with 8" line.
2. Replace 4" line in 34th Street with 8" line, or provide loop for existing 4" line.
3. Replace 4" line in Terrace Park with 8" up to hydrant and connect to existing 16" line.
4. Replace 4" line in Ferncrest with 8" from Country Club Drive to existing hydrant in Ferncrest.
5. Replace 4" line in Sunset Point with 8" from south end of existing 8" in Country Club Drive to existing hydrant in Sunset Point.
6. Construct 8" line from south end of existing 8" in Country Club Drive to existing hydrant in Mesa Vista.
7. Construct storage in upper pressure zone and replace 2.5" waterlines in Zone 4.
8. Replace 4" line in Morningside Drive with 8".

Comments:
1. Fire flows are based on a residual pressure of 20 psi throughout the system.

Future Demands

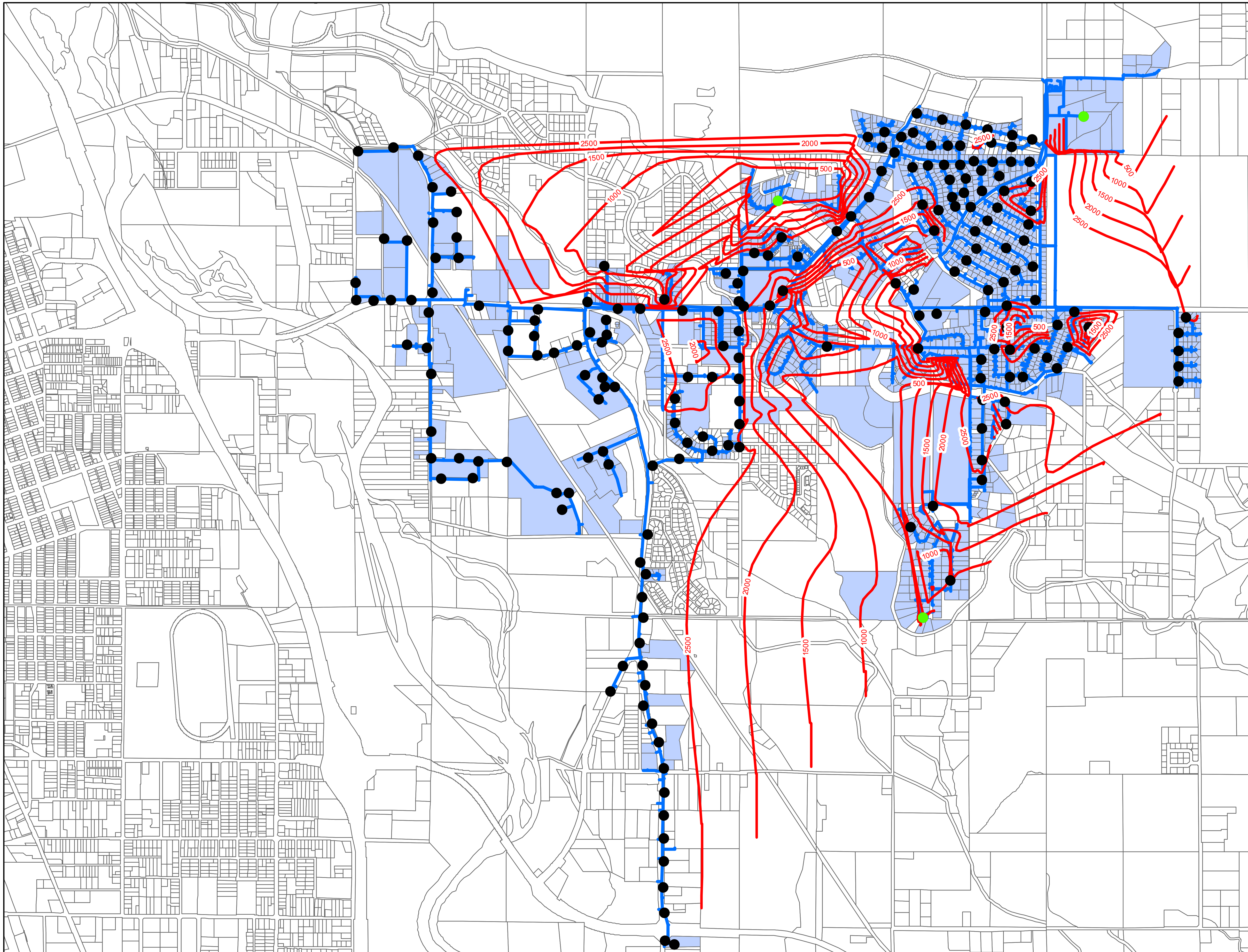
Year 2026 peak hour and peak day plus fire flow demand conditions were modeled to determine future system improvements. Demands for the Villas at Terrace Heights, Abraham Doleson, Quail Run, Yakima Ridge, University Apartments and Quail Court were increased to simulate demands at full development. Demands for Pacific NW University were increased slightly so the total system demand equaled the estimated 2026 peak day and peak hour demands of 1,800 and 3,600 gpm. No additional deficiencies were found with this analysis. Demands for the year 2036 were not modeled due to the uncertainty in knowing where the demands would be located.

For the 2001 Water System Plan, the hydraulic model was used to determine a conceptual pipe grid for the future service area. Although this analysis was not repeated for this water plan update, it is still considered valid. For the previous water plan, demands were modeled based on an average density of 3.5 dwelling units per acre, which is similar to the density in Terraced Estates. Results of the model showed that a grid of 12-inch lines every half mile, with 8-inch lines in between, should

Yakima County Comprehensive Water System Plan

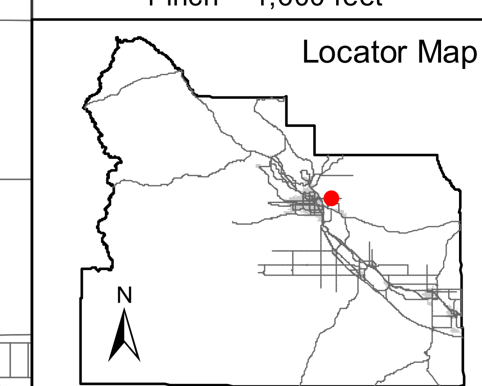
FIGURE 5-2

Terrace Heights Water System Fire Flows



Fire Hydrants
Fire Hydrants with < 500 gpm
Served By System
Water Lines
Fire Flow Contours
(Fire Flows in gpm)

1 inch = 1,600 feet



Date: September 2017

Document Path: R:\disk_5\projects\county\pw\waterplan\t_heights\watersystemsplan_17\fig52_waterplan.mxd

generally be adequate. Eventually, 16-inch lines will be needed from Reservoir 1 to 33rd Street, and from Reservoir 1 to Bridle Way. Supply wells will need to be distributed throughout Zones 1 and 3 to reduce head losses and help maintain system pressures during peak demand periods. A 12-inch line was also found to be needed between the existing 16-inch line in Terrace Heights Drive and Well 5. This line is needed to provide adequate supply capacity to the booster pump at Well 5. The existing distribution system is adequate for only one 760 gpm pump if both wells are operating and the Tower Reservoir is in service.

A conceptual distribution grid is shown in Figure F-1 in Appendix F. The figure is intended to provide a general idea of the main sizes required at full development. As the system develops, further refinement of the grid will become necessary.

Water Quality Analysis

Summary

Yakima County conducts water quality monitoring in accordance with WAC 246-290-300. All monitoring results have met drinking water standards in the last 10-years and no trends of increasing contaminants were noticed while reviewing the water quality data.

Well 3 has a small amount of hydrogen sulfide. One sample has been taken that showed the hydrogen sulfide level at 0.12 mg/l. This has not resulted in any complaints since chlorination removes any odors after a few minutes of contact time. The County also blends water from Well 3 with water from one or more of the other wells as an added precaution.

Fluoride is one parameter that customers frequently ask about. Naturally occurring fluoride levels for Wells 2, 4, 5 and 6 are generally 0.3 to 0.4 mg/l. Fluoride in Well 3 is down from what it had been in 2000 when levels reached a high of 4.8 mg/l. The latest sample collected in 2009 was 1.27 mg/l.

Hardness is another parameter about which customers frequently ask. Hardness as CaCo3 varies between the wells from soft to hard. Well 3 is considered soft (8 mg/l), Wells 2, 5 and 6 are considered moderately hard (85, 101 and 65 mg/l respectively), and Well 4 is considered hard (142 mg/l).

Coliform

Seven coliform samples are required each month from the Terrace Heights Water System. All results have been satisfactory for the last 10-years. The last unsatisfactory sample was in July 2007. All repeats following the July 2007 sample were satisfactory. The unsatisfactory sample was also positive for E. coli. The unsatisfactory sample was ultimately attributed to an unsanitary sample site.

Nitrates

One nitrate sample is required from each well once a year. All results have been below the MCL of 10 mg/l and below the trigger of 5 mg/l. The highest nitrate levels are from Well 4.

Nitrate samples have not been collected from Well 1 since it is an emergency source.

Table 5-6
Nitrate Test Results (mg/l)

Date	Well 2	Well 3	Well 4	Well 5	Well 6
2017	0.09	<0.05	2.31	1.63	0.57
2016	0.11	<0.05	2.41	1.56	0.57
2015	0.10	<0.07	2.36	1.55	0.59
2014	0.12	0.08	2.26	1.46	0.58
2013	0.12	<0.05	2.73	1.51	0.58
2012	0.10	<0.05	2.28	1.41	0.50
2011	0.11	<0.05	2.26	1.34	0.64
2010	0.11	<0.05	2.33	1.30	0.42
2009	0.09	<0.05	3.04	1.25	0.43
2008	0.09	<0.05	3.01	1.32	0.44
2007	-	<0.05	2.58	1.22	0.39
2006	0.09	<0.05	2.66	0.81	0.43
2005	0.08	<0.05	-	0.46	1.12
2004	0.11	<0.05	2.64	1.05	0.37
2003	ND	ND	2.64	0.87	0.12

Comments:
1. Well 4 was listed as an emergency source in 2005 so a sample was not collected.
2. A sample was not collected in 2007 for Well 2.
3. 2007 test results for Wells 3 and 4 were switched. Results shown are corrected results.

Inorganic Chemicals

One complete inorganic chemical sample per well is required from all wells between January 2011 and December 2019. All complete inorganic chemical samples have been collected for this monitoring period with the exception of Well 5 which is not due until July 2019. All complete inorganic chemical test results from the latest round of sampling were satisfactory.

In addition to the complete inorganic chemical samples, one arsenic sample is required every three years from Wells 2 and 3. More frequent arsenic sampling is a result of slightly elevated arsenic levels in these wells. Arsenic levels in Wells 2 and 3 are typically 0.005 and 0.006 mg/l respectively, as compared to a maximum contaminant level (MCL) of 0.01 mg/l.

One iron sample is also required every three years from Wells 2, 3, 4 and 6, and one manganese sample is required every three years from Wells 4 and 6. More frequent sampling is a result of a past sample exceeding the MCL. Samples collected in the last 10-years have all been satisfactory. Both iron and manganese are a secondary contaminant and are not considered a health concern.

In the case of Well 4, the past iron and manganese exceedances all occurred during a period when the well had been off line for several years. In 2003, iron was 3.18 mg/l (MCL 0.3 mg/l) and manganese was 0.0508 mg/l (MCL 0.05). It is suspected that the unsatisfactory samples were caused by not adequately flushing the well prior to sampling. Now that the well is operated consistently throughout the year, these two contaminants have not been an issue. The latest round of sampling (collected in 2017) showed iron levels at 0.0135 mg/l and manganese below the detection level of 0.0001 mg/l.

Well 3 Fluoride samples had been required quarterly and then annually due to the elevated levels of fluoride. They are now only required once every nine years when a complete inorganic chemical sample is collected.

Synthetic Organic Chemicals

Synthetic organic chemicals, including herbicides and general pesticides are required once every nine years from each well. Historical samples have been satisfactory with no analytes detected.

Volatile Organic Chemicals

Volatile organic chemical samples are to be collected once every six years from each well. All analytes were below the detection level in the last round of sampling.

Lead and Copper

One set of twenty lead and copper samples are required every three years from the distribution system. One set was collected in 2014 and another in 2017. All the samples collected were below the action levels.

Radio-Nuclides

Gross Alpha and Radium 228 samples are required from each well once every six years. The last samples collected were in 2015, and all were below the detection level.

Chlorine Residual

Sodium hypochlorite is added at each of the Terrace Heights Wells to maintain between 0.2 and 0.6 mg/l of free available chlorine in the distribution system. Yakima County checks chlorine residuals in the distribution system on a daily basis (Monday – Friday) and submits Daily Chlorination Reports to the Department of Health once a month.

Disinfection Byproducts

One trihalomethane and one haloacetic acid sample is required each year from the distribution system. The last samples collected were in 2017, and each was satisfactory. Total trihalomethanes were 17 ug/l and haloacetic acids were 6 ug/l, which is below the maximum contaminant levels of 80 and 60 ug/l respectively.

Chapter 6
Water Use Efficiency and Water Rights

In 2003, the Washington State Legislature passed what is known as the Municipal Water Law. The law requires municipal water suppliers to use water more efficiently in exchange for water right certainty and flexibility to meet future demands. In response to the Municipal Water Law, the Washington State Department of Health requires municipal water suppliers to develop and implement a Water Use Efficiency Program meeting the requirements of WAC 246-290-810.

Water Use Efficiency Program

The water use efficiency program includes the following items:

- Description of current water conservation program.
- Description of WUE goals that support the program and how the goals were established.
- Evaluation of WUE measures for cost-effectiveness.
- Description of WUE measures to be implemented to meet established goals for the next six years.
- Description of how we will educate customers to use water efficiently.
- Estimated water savings from selected WUE measures.
- Description of how we will evaluate the effectiveness of the WUE program.
- Evaluation of distribution system leakage.
- A water loss control action plan if the distribution system leakage exceeds the leakage standard.
- Evaluation of rate structures that encourage water demand efficiency.
- Evaluation of reclaimed water opportunities.
- Description of water supply characteristics.

Current Water Conservation Program

Yakima County's current water conservation program includes:

- Installation of a new automated metering infrastructure system with all new service meters providing hourly readings and leak notifications.
- Collecting daily source meter readings.
- Billing customers based on an inclining block rate structure for all customer classes.
- Notifying customers when an unusually large water bill is discovered or when the Beacon Advanced Metering Analytics software indicates a possible leak. A possible leak is indicated if the meter has 24-hours of continuous consumption.
- Assisting customers in determining if they have a leak by explaining how to use the leak detector on the meter and how to sign up for automated leak detection notices through the Beacon Eye-On-Water application.

- Assisting customers by using leak detection equipment on their service line if needed.
- Including occasional water conservation tips in mailings.
- Conducting leak surveys.

WUE Goals

Water use efficiency goals are intended to help conserve water for future generations and meet the State's new distribution system leakage standard. The County's water use efficiency goals for the Terrace Heights Water System include:

1. Reduce distribution system leakage to less than 10 percent based on a 3-year rolling average within the next 6-year planning period.
2. Reduce average day and peak month demands per single-family residence by 3 percent based on the average of the demands over the next 6-year planning period (2017 – 2023) as compared to the average over the previous 6-year period (2011-2016).

The Board of County Commissioners originally adopted the above water use efficiency goals in January 2010. The above goals were readopted in August 2019. A public meeting and a public hearing were held in May and June 2019. Meeting minutes and the Board's resolution readopting the water use efficiency goals are included in Appendix V.

Evaluation of Water Efficiency Measures

Measures that must be evaluated for the WUE rule include:

- Rates that encourage water demand efficiency, and
- Reclamation opportunities.

These two required measures are described later in this Chapter. In addition to the required measures, a minimum of five other WUE measures must be evaluated or implemented for a system the size of Terrace Heights. To satisfy this requirement, the County has implemented the WUE measures described below.

WUE Measures Implemented

Yakima County has implemented several WUE measures. One such measure is the implementation of a conservation rate structure. Because the WUE rule only requires that conservation rates be evaluated, implementing a conservation rate structure counts as one of the other five WUE measures that must be evaluated. In addition, the WUE rule allows measures to be counted as multiple measures if they are applied to different customer classes. Consequently, the County's inclining block rate structure for single-family, multi-family, commercial, education and government customer classes counts as five conservation measures.

An additional measure implemented is the notification of customers when they have an unusually high water bill or when the Beacon Advanced Metering Analytics software indicates a possible leak.

If a leak is suspected, the County meets with the property owner and checks the leak detector on the meter for water usage when the customer has all their faucets turned off.
Yakima County also shows consumptive history on their water bills. Like conservation rates, a bill showing consumption history counts as multiple measures if it applies to multiple customer classes.

Measures currently implemented therefore include:

Measure 1. Conservation rate structure for single-family customers.
Measure 2. Conservation rate structure for multi-family customers.
Measure 3. Conservation rate structure for commercial customers.
Measure 4. Conservation rate structure for education customers.
Measure 5. Conservation rate structure for government customers.
Measure 6. Notifying customers about leaks on their property.
Measure 7. Showing consumptive history on water bills for single-family customers.
Measure 8. Showing consumptive history on water bills for multi-family customers.
Measure 9. Showing consumptive history on water bills for commercial customers.
Measure 10. Showing consumptive history on water bills for education customers.
Measure 11. Showing consumptive history on water bills for government customers.

In addition to the measures above, WUE measures that must be implemented include:

- Installing source and service meters
- Performing meter calibration
- Implementing a water loss control action plan to control leakage
- Educating customers about water use efficiency practices.

Source and service meters have been installed. Source meters have been installed since before the County assumed ownership of the system in the 1990's. Service meters were installed just after the County assumed ownership of the system, with the exception of one service to Well #4 which was installed later.

Source meters were tested in May 2017 by a private contractor. All of the meters tested within 1% of the indicated flow. The County intends to retest the source meters once every two years.

All service meters were replaced in 2014 as part of an Automated Metering Infrastructure (AMI) project. Prior to that time, meter calibration was limited to testing a small number of service meters. Meters tested were within standards. The County plans to develop a process and timeline for inspecting, testing, calibrating, and replacing meters based on recommendations from the manufacturer and the American Water Work's Association manual entitled "*Water Meters-Selection, Installation, Testing, and Maintenance (M6)"*. The 8-inch and 3-inch service meters will be tested along with the source meters.

Customer Education

The WUE rule requires the County to educate their customers about the importance of using water efficiently. The County provides water conservation tips in their annual consumer confidence report and occasionally in the customer's monthly water bills. Examples of the water conservation tips are included in Appendix U. Appendix J of the Department of Health's Water Use Efficiency Guidebook has good water conservation tips. Water conservation brochures are also available from the Department of Health's website.

WUE Program Effectiveness Evaluation

Water saved as a result of the above program has been good. In the last 6-years, average day and peak month demands per single-family residence in the Terrace Heights area were down 6% and 10% respectively, based on consumption records. Over the same time period, supply records showed an 8% and 11% decrease in both average day and peak month demands. A summary of the reduction in demands is included in Table 6-1.

Table 6-1
Water Use Efficiency Program Effectiveness

Area	**Average Day Demand (gpd/single-family residence)**		**Peak Month Demand (gpd/single-family residence)**	
	Based on Consumption Records	**Based on Production Records**	**Based on Consumption Records**	**Based on Production Records**
Terraced Estates				
Average for 2005-2010	478	617	1,132	1,391
Average for 2011-2016	476	591	1,018	1,244
Percent Decrease	0.3%	4%	10%	11%
Country Club				
Average for 2005-2010	267	343	452	576
Average for 2011-2016	233	291	406	496
Percent Decrease	13%	12%	10%	12%
Combined Percent Decrease in Single-Family Residential Demand	6%	8%	10%	11%

Notes:
1. Water Use Efficiency goal includes a 3% reduction in single-family residential average day and peak month demands between 6-year planning periods.
2. The combined percent decrease in single-family residential demands is based on 794 single-family residential customers in Terraced Estates and 678 in Country Club at the end of 2016.

Estimated Water Savings

The projected water savings from the selected WUE measures can be difficult to estimate when weather variations and new customers are considered. However, based on the reductions observed in single family residential consumption the last 6-years as compared to the previous 6-years, the estimated water savings in just residential consumption is 1.2 million cubic feet per year.

Distribution System Leakage

Distribution system leakage for the last 3 years has averaged 15 percent. However, in the last 2 years, since replacing the service meters, distribution system leakage has averaged 10 percent. Prior to replacing the meters, distribution system leakage averaged 23 percent. A summary of distribution system leakage was presented in Table 3-13.

The majority of the remaining distribution system leakage appears to be due to leakage, since the total water loss is about the same during the winter as it is in the summer.

Some of the leakage is likely due to construction projects, such as the recent Reservoir #4 project. In recent years, Yakima County has placed greater emphasis on metering consumption from fire hydrants and construction projects and now owns 4 hydrant meters to rent out to contractors. Yakima County will continue to emphasize the importance of metering hydrant usage.

Water Loss Control Action Plan

Generally, a water loss control action plan is needed when the rolling three-year average distribution system leakage is greater than 10 percent. However, in this case 3-years of data is not available since the service meters were replaced. The County will continue to monitor distribution system leakage and if it is greater than 10 percent, then the County will perform a new leak detection survey. Prior to performing a new leak detection survey, the County will compare Beacon water consumption records for pressure Zones 1 and 1a with well and booster station pumping records to get an idea if the leakage is occurring above or below the Sycamore Booster. The County will also consider performing an International Water Association water audit.

A leak survey was completed in 2008 in the older part of the system that identified eight minor leaks. Six have been repaired and a seventh was excavated but not found. The remaining leak cannot be heard with the County's equipment and is being monitored. A leak survey was done on the remainder of the system in 2009 and three small possible leaks were found. None can be heard with the County's equipment and are being monitored.

Future leak surveys and other distribution system leakage costs including repairs will be covered by water system reserves.

Rate Structure Evaluation

One of the measures that must be evaluated is a rate structure that encourages water demand efficiency. Yakima County first implemented an inclining block rate structure in 1994 to encourage efficiency. Current consumption rates start out at $1.58 per 100 cubic feet for the first 1,000 cubic feet, then increase to $1.75 per 100 cubic feet for the second 1,000 cubic feet, and then increase to $1.92 per 100 cubic feet for all consumption over 2,000 cubic feet. The rate structure is the same for all customer classes.

Reclaimed Water Opportunities

The WUE rule requires the County to collect information on reclaimed water opportunities and include that information in the water plan. As a minimum, the information should include:

- Where reclaimed water could potentially be used, such as parks, golf courses, groundwater recharge facilities, and car washing facilities.
- Where reclaimed water production facilities exist and the locations of reclaimed water distribution lines.
- Any barriers to the use of reclaimed water, such as cost, permitting issues, water rights mitigation, and local regulations that govern the use of reclaimed water.
- Contractual obligations and agreements that limit the use of reclaimed water.
- Where reclaimed water is used or proposed to be used.
- The County's efforts to develop the use of reclaimed water.

There are currently no water reuse facilities, either sources or users, within the Terrace Heights service area and the number of potential sources is very limited. There are no fish hatcheries, storm water impoundments, or sewage treatment facilities in the service area. The most likely places where reclaimed water could be used include a golf course and a cemetery.

The only known barrier to the use of reclaimed water is the cost. Without a nearby source, the cost to pipe reclaimed water would be high. There are no contractual obligations or agreements that limit the use of reclaimed water. The County has not pursued development of reclaimed water due to the limited sources and cost.

Water Supply Characteristics

The Terrace Heights Water System includes six supply wells. Wells 4, 5 and 6 draw from the Ellensburg formation, which consists of semi-consolidated deposits of clay, silt, sand and gravel. Well 3 draws from the Saddle Mountain formation in the Yakima Basalt aquifer, which underlies the Ellensburg formation. Well 1 draws from the Wanapum and Well 2 draws from the Lower Ellensburg. Information regarding each well, including capacity, was included in Chapter 2.

The U.S. Geological Survey conducted a detailed study of the ground water sources in the Yakima River Basin. Results of the study indicated water levels were relatively stable in the Terrace Heights area (Township 13 Range 19). USGS's data showed a few wells with 5' of decline. East of Terrace Heights in the Moxee Valley, declines in the ground water level increased. Township 13 Range 20, which is six miles to the east of Terrace Heights, had some wells with declines of 40 to 50-feet in the Saddle Mountain and Wanapum aquifers. In Township 13 Range 21, the declines were worse. According to USGS, the declines were primarily in the basalt and deeper Ellensburg wells (wells over 1000'), although they also claimed the bottom of the Ellensburg can be course grain and very productive. The upper Ellensburg formations are recharged in part by irrigation and irrigation canals and are not experiencing the declines seen in the basalt wells. The recharge is estimated to be 10 to 20-inches per year.

According to USGS, water levels decline in the basalts during drought years due to increased pumping from irrigators with junior surface water rights. During drought years, irrigators with junior surface water rights resort to using their groundwater wells.

Wells to the north along Yakima Ridge are also experiencing declines. This is said to be due to the wells being located along the anticline of the ridge rather along the syncline of the valley. The Terrace Heights Well #2 is an example of this. This well has experienced nearly 80' of decline since it was drilled.

Seasonal variations do not have an impact on the ability of the Terrace Heights wells to meet demands.

Water Right Self Assessment

Existing Conditions

A summary of the water rights for the Terrace Heights Water System is presented in Table 6-2. The table shows that the current production capacity and 2014 annual withdrawals of each well are within the authorized withdrawal rates. Copies of the water right certificates, permits and report of examinations are included in Appendix E.

The Department of Ecology recently approved a water right change application to add Well 6 as an additional point of withdrawal to Ground Water Claim 886-A. This allows the County to increase the pumping capacity at Well 6. Prior to the change application, Ecology issued a letter extending the schedule for submitting Proof of Appropriations for the each of the permits. The new schedule coincides with the next water system plan update. Ecology's letter also clarified several questions regarding the water rights including whether a water right was additive or non-additive. This resolved the ministerial error noted in the previous water system plan. Copies of Ecologies letters are included in Appendix E.

Water right change applications should be submitted to Ecology to consolidate existing water rights withdrawing water from the same aquifer, similar to what was recently completed for Well 6. This would provide more flexibility in which wells are operated. As a minimum, a water right change application should be submitted to Ecology to add additional points of withdrawal to the Well 1 water rights. The existing well no longer has capacity to fully utilize these rights. Because the well is reportedly located near a fault, a pump test may be needed to demonstrate which body of water the well is drawing from. It is believed to be drawing from a body of water to the south of the fault, since it was impacting water levels in the Coyote Creek Water System when it was in operation.

Future Conditions

The existing water rights are adequate to serve an estimated 3,994 additional equivalent residential units (ERUs). This estimate is based on the maximum instantaneous authorized withdrawal, which in this case is more limiting than the annual authorized withdrawal.

Additional ERUs based on Instantaneous Authorized Withdrawal

Instantaneous water rights:	6,155 gpm
Existing peak day demand:	-1,440 gpm
Excess instantaneous water rights:	4,715 gpm, or 6,789,600 gallons per day
Peak day demand/ERU:	1,700 gallons per day
Additional ERUs:	6,789,600 gpd/1,700 gpd per ERU = 3,994 ERUs

Additional ERUs based on Annual Authorized Withdrawal

Annual water rights:	1,635,660,576 gallons per year (5,020 ac-ft per year)
Existing annual demand:	-332,709,900 gallons per year (2014)
Excess annual water rights:	1,302,950,676 gallons per year (3,999 ac-ft per year)
Average day demand/ERU:	630 gpd or 229,950 gallons per year
Additional ERUs:	1,302,950,676/229,950 gallons per ERU = 5,666 ERUs

If the system increases an average of 30 ERUs per year, then the existing water rights will be adequate for the 20 year planning horizon of this water plan. Tables 6-3 and 6-4 include a forecast of the water rights status in ten years and twenty years.

Table 6-5 provides an order of magnitude estimate of future demands from new development if the service area was fully developed. Single-family and suburban residential demand estimates for vacant land were assumed to be similar to current single-family demands where separate irrigation is not available, while single-family and suburban residential demands for agricultural land were assumed to be similar to current single-family demands where separate irrigation is available. Demands for all other zoning classifications were based on system demands from Table 3-12. Demand estimates in Table 6-5 indicate that vacant and agricultural lands have the potential of increasing average day demands by 3,300 acre-feet per year and peak day demands by 5,300 gpm. These projected additional demands are within the excess annual water rights of 3,999 acre-feet per year, but not within the excess instantaneous water rights of 4,715 gpm. Demands at full development could vary significantly from the above estimates.

Table 6-5
Vacant and Agricultural Land Future Demands

Pressure Zone	Existing Land Use	Zoning	No. of Acres	Average Day Demand (gpd/acre)	Average Day Demand (gpd)	Peak Day Demand (gpd/acre)	Peak Day Demand (gpd)
1 and 1a	Vacant or Undeveloped	Single-Family	84	2,200	184,800	6,000	504,000
		Multi-Family – R2	10	2,000	20,000	4,800	48,000
		Suburban Residential	135	2,200	297,000	6,000	810,000
		Small Conv. Center	12	300	3,600	800	9,600
		General Commercial	84	1,200	100,800	2,800	235,200
		Light Industrial	272	200	54,400	600	163,200
	Agriculture	Single-Family	33	1,200	39,600	2,450	80,850
		Suburban Residential	316	1,200	379,200	2,450	774,200
		Light Industrial	168	200	33,600	600	100,800
		Totals	1,114		1,113,000		2,725,850
2 and 2a	Vacant or Undeveloped	Single-Family	251	2,200	552,200	6,000	1,506,000
		Suburban Residential	188	2,200	413,600	6,000	1,128,000
	Agriculture	Single-Family	11	1,200	13,200	2,450	26,950
		Suburban Residential	28	1,200	33,600	2,450	68,600
		Totals	478		1,012,600		2,729,550
3	Vacant or Undeveloped	Single-Family	127	2,200	279,400	6,000	762,000
		Suburban Residential	74	2,200	162,800	6,000	444,000
		Totals	201		442,200		1,206,000
4	Vacant or Undeveloped	Single-Family	108	2,200	237,600	6,000	648,000
		Suburban Residential	52	2,200	114,400	6,000	312,000
		Rural-10/5	40	400	16,000	900	36,000
		Totals	200		368,000		996,000
Totals			1,993		2,935,800 (3,289 ac-ft/year)		7,657,400 (5,318 gpm)

Notes:

1. Average day and peak day single-family demands for vacant and undeveloped lands are based on average day (630 gpd/connection) and peak day (1,700 gpd/connection) demands for single-family residences without separate irrigation and 3.5 residences per acre.
2. Average day and peak day single-family demands for agriculture lands are based on average day (340 gpd/connection) and peak day (700 gpd/connection) demands for single-family residences with separate irrigation and 3.5 residences per acre.
3. Average day and peak day demands for all zoning classifications other than single-family are based on Table 3-12.

Table 6-2
Existing Water Rights Status

Permit Certificate or Claim #	Name of Rightholder or Claimant	Priority Date	Source Name/ Number	Primary or Supplemental	Existing Water Rights (gpm & ac-ft)		Existing Consumption		Current Water Right Status (Excess/Deficiency)	
					Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)
Permits/ Certificates G4-25728P	Yakima County	11/9/1977	Well #1	*****	800 [A]	741 [A]	0		800	
G4-25775P	Yakima County	3/14/1978	Well #1	*****	400 [A]	371 [NA]	0		400	
G4-25648C	J.E. Bittner	11/28/1977	Well #2	*****	540 [A]	448 [A], [NA]	270	78	270	848
G4-31494P	Yakima County	10/14/1992	Well #3	*****	2250 [A]	2722 [A]	1,500	91	750	2,631
GWC 891-D	Country Club District Water Company	6/1/1926	Well #4	*****	165 [A]	162 [A]	Included below with GWC 886-A			
CG4-CV2P892 (GWC 886-A)	Country Club District Water Company	6/21/1946	Well #4, #5 & #6	*****	1500 [A]	1210 [A]	670			
4. G4-27699P	Country Club District Water Company	9/21/1981	Well #6	*****	500 [A]	376 [NA]	340	852	1,155	520
TOTAL	*****	*****	*****	*****	6,155	5,020	2,780	1,021	3,375	3,999

Intertie Name/Identifier	Name of Purveyor Providing Water	Existing Limits on Intertie Water Use		Existing Consumption Through Intertie		Current Intertie Supply Status (Excess/Deficiency)	
		Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)
1. N/A							
TOTAL *****	***** ***** *****						

Pending Water Right Application	Name on Permit	Date Submitted	Primary or Supplemental	Pending Water Rights	
				Maximum Instantaneous Flow Rate (Qi) Requested	Maximum Annual Volume (Qa)
1. N/A					

Notes:

1. G4-25648C is additive in the amount of 185 ac-ft. The total withdrawal from G4-25775P, G4-25648C and G4-25728P shall not exceed 926 acre-ft per year, or 1,740 gpm.
2. The total withdrawal from GWC 891-D, GWC 886-A and G4-27699P shall not exceed 1,372 acre-ft per year, or 2,165 gpm.
3. G4-25728P and G4-25775P were assigned to Yakima County in August 1992.
4. Existing consumption shown is for 2014.
5. A July 24, 2017 letter from Ecology revised the terminology of previous water rights to reflect their additive/non-additive nature rather than primary, supplemental, etc.

Table 6-3
Forcasted Ten Year Water Right(s) Status

Permit Certificate or Claim #	Name of Rightholder or Claimant	Priority Date	Source Name/ Number	Primary or Supplemental	Existing Water Rights		Forcasted Water Use From Sources (10 Year Demand)		Forcasted Water Right Status (Excess/Deficiency - 6 Yr Demand In Water Right)	
					Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)
Permits/ Certificates G4-25728P	Yakima County	11/9/1977	Well #1	*****	800 [A]	741 [A]	0		800	
G4-25775P	Yakima County	3/14/1978	Well #1	*****	400 [A]	371 [NA]	0		400	
G4-25648C	J.E. Bittner	11/28/1977	Well #2	*****	540 [A]	448 [A], [NA]	270	200	270	726
G4-31494P	Yakima County	10/14/1992	Well #3	*****	2250 [A]	2722 [A]	1,500	240	750	2,482
GWC 891-D	Country Club District Water Company	6/1/1926	Well #4	*****	165 [A]	162 [A]				
CG4-CV2P892 (GWC 886-A)	Country Club District Water Company	6/21/1946	Well #4, #5 & #6	*****	1500 [A]	1210 [A]				
G4-27699P	Country Club District Water Company	9/21/1981	Well #6	*****	500 [A]	376 [NA]	1,570	800	595	572
TOTAL	*****	*****	*****	*****	6,155	5,020	3,340	1,240	2,815	3,780

Intertie Name/Identifier	Name of Purveyor Providing Water	Existing Limits on Intertie Water Use		Existing Consumption Through Intertie		Current Intertie Supply Status (Excess/Deficiency)	
		Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)
1. N/A							
TOTAL *****	***** ***** *****						

Pending Water Right Application	Name on Permit	Date Submitted	Primary or Supplemental	Pending Water Rights	
				Maximum Instantaneous Flow Rate (Qi) Requested	Maximum Annual Volume (Qa)
1. N/A					

Notes:

1. G4-25648C is additive in the amount of 185 ac-ft. The total withdrawal from G4-25775P, G4-25648C and G4-25728P shall not exceed 926 acre-ft per year, or 1,740 gpm.
2. The total withdrawal from GWC 891-D, GWC 886-A and G4-27699P shall not exceed 1,372 acre-ft per year, or 2,165 gpm.
3. G4-25728P and G4-25775P were assigned to Yakima County in August 1992.
4. A July 24, 2017 letter from Ecology revised the terminology of previous water rights to reflect their additive/non-additive nature rather than primary, supplemental, etc.

Table 6-4
Forcasted Twenty Year Water Right(s) Status

Permit Certificate or Claim #	Name of Rightholder or Claimant	Priority Date	Source Name/ Number	Primary or Supplemental	Existing Water Rights		Forcasted Water Use From Sources (20 Year Demand)		Forcasted Water Right Status (Excess/Deficiency - 20 Yr Demand In Water Right)	
					Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)
Permits/ Certificates 1. G4-25728P	Yakima County	11/9/1977	Well #1	*****	800 [A]	741 [A]	0		800	
G4-25775P	Yakima County	3/14/1978	Well #1	*****	400 [A]	371 [NA]	0		400	
G4-25648C	J.E. Bittner	11/28/1977	Well #2	*****	540 [A]	448 [A], [NA]	270	200	270	726
G4-31494P	Yakima County	10/14/1992	Well #3	*****	2250 [A]	2722 [A]	2,250	350	0	2,372
GWC 891-D	Country Club District Water Company	6/1/1926	Well #4	*****	165 [A]	162 [A]				
CG4-CV2P892 (GWC 886-A)	Country Club District Water Company	6/21/1946	Well #4, #5 & #6	*****	1500 [A]	1210 [A]				
G4-27699P	Country Club District Water Company	9/21/1981	Well #6	*****	500 [A]	376 [NA]	1,570	900	595	472
TOTAL	*****	*****	*****	*****	6,155	5,020	4,090	1,450	2,065	3,570

Intertie Name/Identifier	Name of Purveyor Providing Water	Existing Limits on Intertie Water Use		Existing Consumption Through Intertie		Current Intertie Supply Status (Excess/Deficiency)	
		Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)
1. N/A							
2.							
TOTAL *****	***** ***** *****						

Pending Water Right Application	Name on Permit	Date Submitted	Primary or Supplemental	Pending Water Rights	
				Maximum Instantaneous Flow Rate (Qi) Requested	Maximum Annual Volume (Qa)
1. N/A					
2.					

Notes:

1. G4-25648C is additive in the amount of 185 ac-ft. The total withdrawal from G4-25775P, G4-25648C and G4-25728P shall not exceed 926 acre-ft per year, or 1,740 gpm.
2. The total withdrawal from GWC 891-D, GWC 886-A and G4-27699P shall not exceed 1,372 acre-ft per year, or 2,165 gpm.
3. G4-25728P and G4-25775P were assigned to Yakima County in August 1992.
4. A July 24, 2017 letter from Ecology revised the terminology of previous water rights to reflect their additive/non-additive nature rather than primary, supplemental, etc.
5. A second well is anticipated within the next 20-years under G4-31494P.

Chapter 7
Source Water Protection

Sanitary Control Areas

Sanitary control areas are required around new wells to prevent activities that could contaminate the well. State Drinking Water Regulations specify that the minimum area that must be protected is a one hundred-foot radius around the well. The sanitary control area is to be owned by the purveyor, or the purveyor is to have complete sanitary control over the land through some other legal provisions, such as through a restrictive covenant. Potential sources of contamination typically prohibited within a sanitary control area include sewers, septic tanks, drainfields, underground storage tanks, manure piles, barns, or other enclosures for birds or animals, or storage of chemicals.

Yakima County owns varying amounts of land within the sanitary control areas. Sanitary control areas are described below and are shown on Figures 7-1 through 7-5.

Well 1. Property within the sanitary control area for Well 1 is owned by a private company. The County has a 50-feet easement around Well 1 but not a restrictive covenant. There are no known potential sources of contamination around Well 1.

Well 2. Yakima County owns the property within the sanitary control area for Well 2.

Well 3. Yakima County owns part of the property within the sanitary control area and has a restrictive covenant for the remainder.

Well 4. Yakima County owns part of the property within the sanitary control area, and does not have a restrictive covenant for the remainder. Within the sanitary control area is a shed and a garage that could be used for the storage of chemicals, and parts of two houses. There is also a bathroom within the same building as Well 4 that is to be removed.

Well 5. Yakima County owns part of the property within the sanitary control area, and does not have a restrictive covenant for the remainder. Within the sanitary control area are two sheds and part of a house.

Well 6. Yakima County owns part of the property within the sanitary control area, and does not have a restrictive covenant for the remainder. Paved roads lie within the sanitary control area and an irrigation canal lies just at the edge of the sanitary control area.

Obtaining restrictive covenants with adjacent property owners is not feasible now that the land has been developed. The County does, however, contact the landowners periodically as part of its wellhead protection program to let them know they are near a supply well and of the precautions that need to be taken.

Wellhead Protection Program

In 1996, Yakima County and seven other water purveyors formed the Upper Yakima Valley Regional Wellhead Protection Committee. The committee, which includes the Cities of Yakima, Union Gap, Selah, Moxee, and Tieton, the Town of Naches and the Nob Hill Water Association developed a regional wellhead protection program with the following elements:

- A delineation of wellhead protection zones around each well
- Identification of potential sources of contamination within the wellhead protection zones
- Notification of owners of the potential sources of contamination
- Development of educational programs to increase the public's awareness of the potential for and consequences of groundwater contamination including posting of signs, distribution of literature, and public education efforts
- Development of contingency planning to ensure that prompt response procedures are in place in the event that a well becomes contaminated

The wellhead protection program is generally updated every two years, with the last update occurring in December 2017. A copy of the contaminant source inventory, mailing list, and water quality exceedance maps developed for the 2017 update are included in Appendix L.

Yakima County Comprehensive Water System Plan

FIGURE 7-1
Terrace Heights
Water System
Well 1 Sanitary Control Area

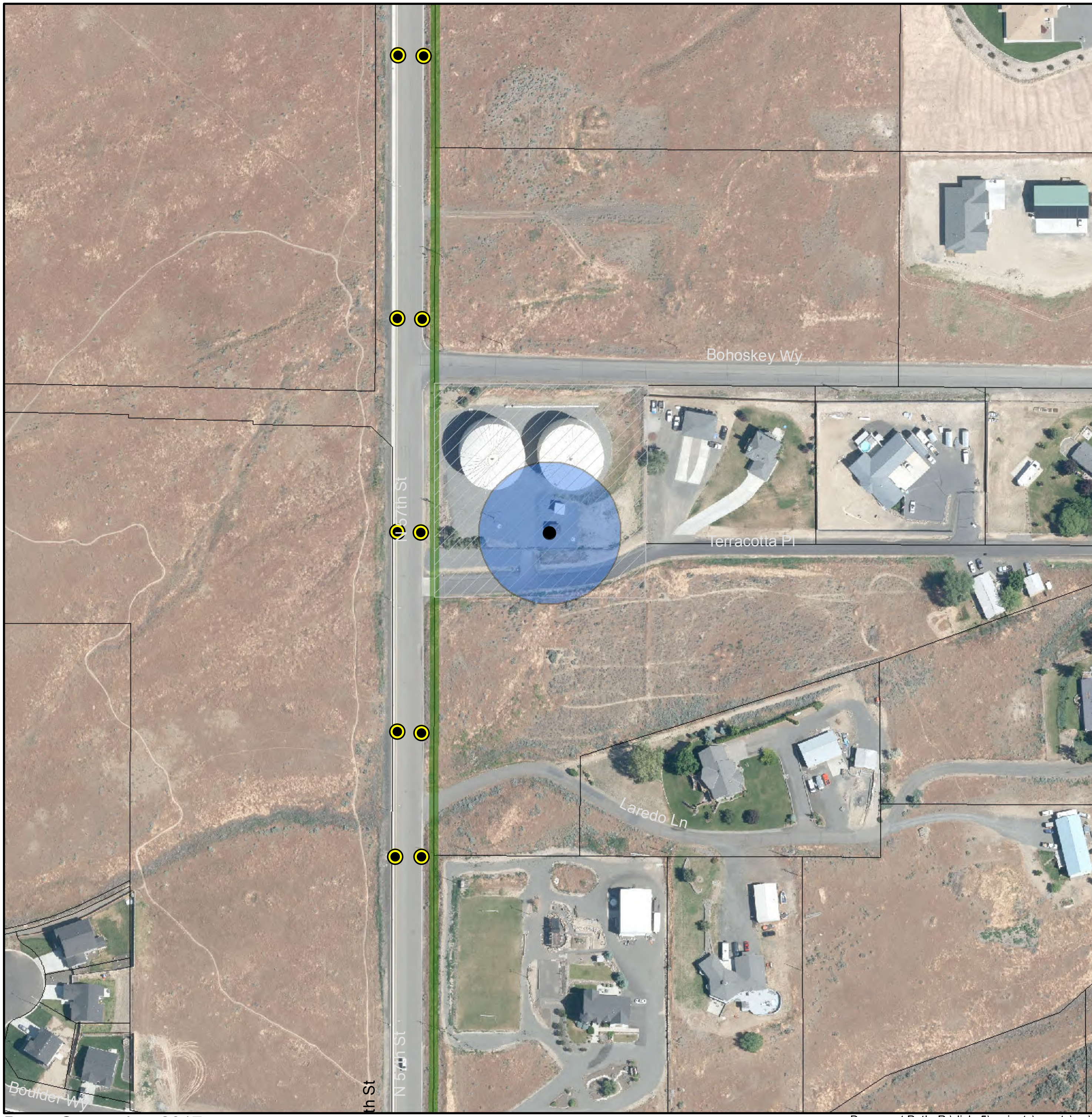
- Catchbasins
- Supply Wells
- Sewer Lines
- Restrictive Covenant Area
- Sanitary Control Area
- County Owned Property
- Parcels

2017 Yakima County Orthophotos

1 inch = 200 feet

Date: September 2017

Document Path: R:\disk_5\projects\county\pw\waterplan\t_heights\watersystemsplan_17\fig71_waterplan.mxd



Yakima County Comprehensive Water System Plan

FIGURE 7-2
Terrace Heights
Water System
Well 2 Sanitary Control Area

- Catchbasins
- Supply Wells
- Sewer Lines
- Restrictive Covenant Area
- Sanitary Control Area
- County Owned Property
- Parcels

2017 Yakima County Orthophotos

1 inch = 200 feet

Date: September 2017

Document Path: R:\disk_5\projects\county\pw\waterplan\t_heights\watersystemsplan_17\fig72_waterplan.mxd

Yakima County Comprehensive Water System Plan

FIGURE 7-3
Terrace Heights
Water System
Well 3 Sanitary Control Area

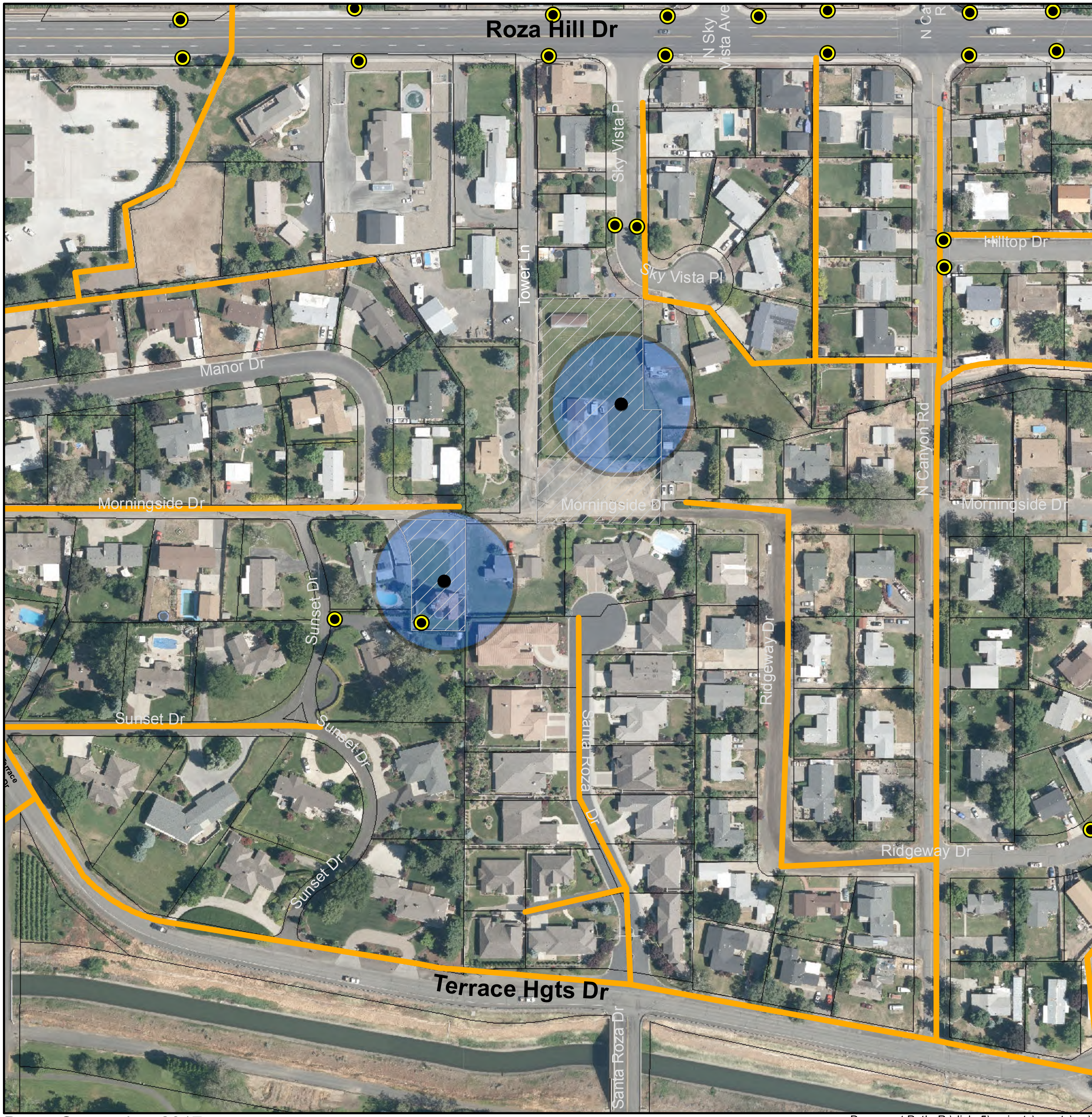
- Catchbasins
- Supply Wells
- Sewer Lines
- County Owned Property
- Restrictive Covenant Area
- Sanitary Control Area
- Parcels

2017 Yakima County Orthophotos

1 inch = 200 feet

Date: September 2017

Document Path: R:\disk_5\projects\county\pw\waterplan\t_heights\watersystemsplan_17\fig73_waterplan.mxd



Yakima County Comprehensive Water System Plan

FIGURE 7-4
Terrace Heights
Water System
Well 4+5 Sanitary Control Area

- Catchbasins
- Supply Wells
- Sewer Lines
- County Owned Property
- Restrictive Covenant Area
- Sanitary Control Area
- Parcels

2017 Yakima County Orthophotos

1 inch = 200 feet

Date: September 2017

Document Path: R:\disk_5\projects\county\pw\waterplan\t_heights\watersystemsplan_17\fig74_waterplan.mxd

Yakima County Comprehensive Water System Plan

FIGURE 7-5
Terrace Heights
Water System
Well 6 Sanitary Control Area

- Catchbasins
- Supply Wells
- Sewer Lines
- County Owned Property
- Restrictive Covenant Area
- Sanitary Control Area
- Parcels

2017 Yakima County Orthophotos

1 inch = 200 feet

Date: September 2017

Document Path: R:\disk_5\projects\county\pw\waterplan\t_heights\watersystemsplan_17\fig75_waterplan.mxd

Chapter 8
Operation and Maintenance Program

Water System Management and Personnel

Yakima County operates under the direction of an elected three member Board of Commissioners. The Yakima County Public Services Department has the responsibility of operating and maintaining the water system. The names and responsibilities of the Public Services personnel involved in the water system operation are as follows:

Responsible Parties:	Lisa Freund, Director of Public Services David Haws, P.E., Director of Environmental Services Joe Stump, P.E., Utilities Manager Bill Trout, Utilities Supervisor Don Campbell, Utilities Maintenance Technician Jose Campos, Utilities Maintenance Technician Jack Wells, Utilities Maintenance Technician Gene Buermann, Utilities Maintenance Technician

Phone Numbers for each individual are included in the Emergency Call-Up List in Appendix M.

Responsibilities of Positions

The following paragraphs briefly describe the responsibilities of each position listed above and required levels of certification/registration.

The *Directors* are responsible for the overall management of the water systems, including managing water utility staff, reporting on water system operations to the County Commissioners, and responding to the media. The Director of Environmental Services is required to be a professional engineer.

The *Utilities Manager* is responsible for preparing and managing budgets; planning, design and construction management of system improvements; and reviewing developer proposed line extensions and water system plans. The Utilities Manager is required to be a professional engineer and certified as a Water Distribution Manager 2 and Cross Connection Control Specialist.

The *Utilities Supervisor* is responsible for the normal day to day operation of the water system, responding to customer concerns, cross connection control, emergency response, and overseeing the utility system operators. The Utilities Supervisor is required to be certified as a Water Distribution Manager 2 and Cross Connection Control Specialist.

The *Utilities Maintenance Technicians* are responsible for doing preventive maintenance, troubleshooting, making system repairs, collecting water samples, inspecting construction of system improvements, inspecting backflow assemblies and responding to requests for location of pipelines. The Utility System Operators are required to be certified as a Water Distribution Manager 1 and a Cross Connection Control Specialist.

Operator Certifications

State law (WAC 246-292) requires that a certified operator be in charge of the active, daily, technical operation of a water system. For a system serving between 1,501 and 15,000 people, the operator must be certified as a Water Distribution Manager Level 2, or higher. In addition, an operator certified as a Cross Control Specialist must be responsible for the system's cross connection control program. As shown in Table 8-1, the County meets these minimum requirements. Copies of the operator certifications are included in Appendix T.

Table 8-1
Water System Operator Certifications

Position	Name of Person	Certifications
Utilities Manager	Joe Stump	Water Distribution Manager 2 Cross Connection Control Specialist
Utilities Supervisor	Bill Trout	Water Distribution Manager 3 Cross Connection Control Specialist Backflow Assembly Tester Water Distribution Specialist Qualified Sanitary Surveyor
Utilities Maintenance Technician	Don Campbell Jose Campos Jack Wells	Water Distribution Manager 1 Cross Connection Control Specialist

Professional Growth Requirements

State law also requires each certified operator to demonstrate continued professional growth in the waterworks field. To demonstrate professional growth, each certified operator must accomplish one of the following activities every three years:

- Accumulate a minimum of three CEUs or college credits relevant to the operation, maintenance or management of a water system.
- Advance by examination in the Waterworks Operator Certification Program.

The County supports these professional growth requirements by sponsoring attendance of personnel at appropriate meetings and seminars. Employees are responsible for paying renewal fees, unless the requirement was added after being hired or the certification is not required for their position.

System Operation and Control

Major System Components

Major water system components include six supply wells, four reservoirs, three booster stations, and nine pressure reducing stations. The location of each of these facilities was shown on Figure 2-1 in Chapter 2.

Wells 2, 4 and 6 are currently the primary sources of supply. During the winter these are the only wells that operate. In the spring, when system demands begin to increase, Well 5 is brought on line and operated manually to supplement the supply. During times of peak summer demand, Well 3 operates as needed to maintain a minimum water level in Reservoirs 1 and 4. Wells 2, 3, 4 and 6 are controlled by the telemetry system. The telemetry system starts and stops the pumps in Wells 2, 3, 4 and 6 based on the water level in Reservoirs 1 and 4.

Well 3 is equipped with a variable frequency drive and can pump between 500 and 1500 gpm. The telemetry system controls the rate of discharge from Well 3 based on the water level in Reservoirs 1, 4 and 2. Under normal operating conditions, the pump in Well 3 is signaled to start based on the water level in Reservoirs 1 and 4. Initially, the variable frequency drive (VFD) at Well 3 will operate the pump at a minimum rate (typically 600 gpm). If the water level in Reservoirs 1 and 4 continues to drop, the telemetry system will signal the VFD to increase the pump speed. The water level in Reservoir 2 also affects the speed at which the pump in Well 3 operates. At low water levels, the pump at Well 3 is allowed to pump at a higher rate, and as Reservoir 2 fills, the pump speed is reduced. This prevents Reservoir 2 from overflowing.

Wells 3 through 6 pump into Reservoir 2 located outside the Sycamore Booster Station. The telemetry system is used to monitor the operation and alarm conditions of the Sycamore Booster Station, but is not used to signal pumps to start and stop. Control of the booster pumps is done locally based on the water level in Reservoir 2. When the water level in Reservoir 2 reaches 6 feet, the first booster pump is signaled to start. If the water level continues to increase and reaches 7 or 8 feet, the second and third pumps respectively are signaled to start. As the water level drops, the pumps are signaled to stop. Water from the booster station is pumped up to Reservoirs 1 and 4.

The Sycamore Booster Station has an electronically controlled valve to maintain a minimum water level in Reservoir 2. The system is programmed to open the valve and maintain a flow of 300 gpm if the water level drops to 4 feet. If the water level continues to drop the valve will open further. With 1.8-feet or less in Reservoir 2, the valve will provide a flow of 2,250 gpm into Reservoir 2 for fire protection.

The Terrett booster pumps are each equipped with a variable speed drive and are controlled locally based on a pressure sensor in the booster station. The lead pump is signaled to start when the pressure drops to 90 psi and shutoff when the pressure reaches 100 psi. Pump speed is regulated to meet system demand and minimize the number of pump starts. If the first pump is unable to keep up with demand, the second pump will start when the pressure drops to 85 psi and shutoff when the pressure reaches 95 psi. The Terrett booster pumps pump from Reservoir 1 into a small closed system with three 86 gallon pressure tanks.

Pressure reducing stations are used to supply Zone 1a from Zone 1, and Zones 2, 2a and 3a from Zone 3. Each pressure reducing station includes two pressure reducing valves. A small valve (2 or 3-inch) is used to meet low demand conditions, while a larger valve (6 or 8-inch) is used to meet higher demand conditions. To keep the valves from working against each other, the larger valve is set to maintain a pressure 4 psi less than the smaller valve.

Besides controlling well pumps and monitoring the booster station, the telemetry system monitors alarm conditions. If an alarm condition occurs, the computer will produce both a sound and visual alarm message. If the alarm message is not acknowledged within a short period of time, the computer will dial from a list of telephone numbers and announce the alarms over the telephone.

The County has operations and maintenance manuals for each well and booster facility. The County plans to update these manuals by providing more detailed operating procedures and listing all of the set points programmed into each controller and RTU. A listing of all set points is needed to help trouble shoot control problems and help in the repair or replacement of the various control devices.

Description of Routine Operation Procedures

Routine and preventive maintenance procedures are described below.

Pump Stations

Daily

1. Visit pump stations daily when in operation (wells and boosters) and check for proper operation, vandalism, leaks, building temperature, oil level in motors and discharge pressure. Record flow meter reading and chlorine volume.
2. Check chlorination equipment operation and solution level. Calculate and record chlorine input into system.
3. Check pump packing. Booster at Well 5 should have 5-6 drips per minute with pump operating.
4. Record amp readings.

Monthly

1. Record total volume pumped.
2. Check indicator lamps on control panels.
3. Clean pump houses (sweep floors, wipe down piping, remove cobwebs, etc.).
4. Calculate and record total system production.

Semi-Annually

1. Clean chlorine injector and install rebuild kit for chlorine pump and solution lines.

2. Each spring and fall, check and record static level in each well after the well has been off for at least one day. Check and record water level again after the well has been on for at least four hours.

Annually

1. Each fall, close the louver in chlorine room door for Well 3. Check unit heaters for proper operation and settings in each pump house. A unit heater is also used in the level sensor vault at Reservoir 1. Build tent around piping in Tower (only necessary until Tower is rehabilitated, including adding insulation and heating equipment). Each spring, open the louver at Well 3 and remove tent at the Tower.
2. Each fall run clean water through each chlorine pump that is off line for the winter.
3. Grease and change oil in pump motors every winter, or as recommended by the manufacturer.
4. Service and test generator.
5. Each spring, clean filters and lubricate equipment on ventilation systems.
6. Replace batteries in smoke alarms.

As Needed

1. Mow and water lawns and control weeds.
2. Flush wells before bringing them on-line if they have been off for more than 4 weeks.
3. Collect water samples.
4. Test source meters once every two years.

Distribution System

Daily

1. Check free chlorine residuals.
2. Check for utility locates.

Monthly

1. Read service meters that did not provide an automated reading. When reading meters, note any irregularities including the following:
    a. Nonworking meters
    b. Leaks
    c. Broken meter box or other parts
2. Submit daily chlorination logs to DOH.

Annually

1. Each fall, exercise all critical valves through a full close and full open cycle. Every other fall, exercise all non-critical valves. Record data for each valve including number of turns to open and ease of operation.

2. Each fall, exercise all hydrants through a full open and full close cycle and check for leaks and proper drainage of hydrant barrel. Record data including any maintenance work that needs to be done.
3. At the end of each year, summarize consumption records and compare with production records to determine unaccounted for water.
4. Each fall, insulate shallow meters.
5. Each winter inspect waterlines installed on bridges.

As Needed

1. Test service meters suspected, either by the customer or by the County, of reading inaccurately. Test 3-inch and larger valves once every two years when source meters are tested.
2. Flush water lines approximately once every five years. Some lines, such as dead end lines, may need to be flushed more frequently. Other lines may need to be flushed prior to a main extension to prevent dirty water complaints following flushing of a new main line.

Pressure Reducing Stations

1. Check pressure settings semi-annually.
2. Check pressure reducing valve operation each spring, including inspecting the disc retainers in the CRD pilot controls, exercising the main valves, checking and cleaning the strainers, and recalibration of the valve.
3. Rebuild main valve and pilot every five years.

Storage Reservoirs

1. On a monthly basis, visually inspect each reservoir for leakage, vandalism, or any exterior irregularities.
2. On an annual basis, visually inspect the interior of each reservoir above the water surface for corrosion or spawling concrete. Check water surface for signs of contamination or debris. Inspect vent screen and roof hatch integrity.
3. Drain, clean and inspect or contract with a diving service approximately every five to ten years, depending on results of the previous inspection and the condition of the reservoir.
4. Each fall, check unit heater for proper operation and setting in the level sensor vault at Reservoirs 1 and 4. Flush sensor piping (do not allow sensor to send a low water level alarm when flushing).

Water Quality Monitoring

Yakima County follows the water quality monitoring requirements of the Department of Health. A summary of the County's water quality monitoring program, including sampling frequency, date when last samples were taken, and date when next sample are due is included in Table 8-2. All samples collected in the last 10 years have been satisfactory.

Source samples should be collected in the summer when the wells are in operation to reduce electrical demand charges and eliminate the need to flush the wells.

Table 8-2
Water Quality Monitoring

Test Type	**Sample Location**	**Frequency**	**Last Sample Taken**	**Next Sample Due**
Coliform	Distribution System	7 per month	Routine	Monthly
Lead & Copper	Distribution System	Every three years	7/17	7/20
Disinfection Byproducts	Distribution System	Once each year.	7/17	7/18
Nitrates	Each Source S02 S03 S04, S06 S05	Annually	 3/17 9/17 6/17 8/17	 3/18 9/18 6/18 8/18
Complete Inorganic Chemicals	Source S02 S03 S04 S05 S06	Once every nine years.	 3/17 9/17 6/17 7/10 6/16	 3/26 9/26 6/26 7/19 6/25
Arsenic	Source S02 S03	Once every three years.	 3/17 9/17	 3/20 9/20
Iron	Source S02 S03	Once every three years.	 3/17 9/17	 3/20 9/20
Manganese	Source S04 S06	Once every three years.	 6/17 6/16	 6/20 6/19
Volatile Organic Chemicals	Source S02 S03 S04 S05 S06	Once every six years.	 4/17 9/17 7/14 8/16 7/13	 4/23 9/23 7/20 8/22 7/19
Herbicides & Pesticides	Source S02, S05 & S06 S03 S04	Once every nine years.	 6/09 7/13 6/17	 6/18 7/22 6/26
Gross Alpha	Source S02, S03, S04, S05 & S06	Once every six years.	 6/15	 6/21

Table 8-2 Water Quality Monitoring				
Radium 228	Source S02, S03, S04, S05 & S06	Once every six years.	6/15	6/21

Comments:
1. Routine coliform samples have been satisfactory for the last 10 years.
2. All lead and copper samples collected in the last 10 years have been below the action level.
3. No MCLs have been exceeded in the last 10 years.

Emergency Response

Emergency Call List

Names and phone numbers where water system personnel can be reached in an emergency are listed in Appendix M. Names and phone numbers of organizations that can possibly provide support in an emergency are also listed in Appendix M.

If the event of an emergency, the County may need to notify the public immediately. The Public Information Officer for Yakima County Public Services should be contacted if the notification involves the media. The Public Information Officer will contact the media and coordinate the release of information to the public. The current Public Information Officer is Lisa Freund. A media contact list is included in Appendix M.

The Yakima County Emergency Management Office is another good source to contact when public notification is necessary. Their phone number along with other emergency numbers are as follows.

Yakima County Emergency Management Office
Phone: (509) 574-1900
Fax: (509) 574-1901

Yakima County Sheriff's Office
Phone: (509) 574-2500
Fax: (509) 574-2501

Yakima County Fire District No. 4 (Terrace Heights)
Phone: (509) 457-8615

Washington State Department of Health (Spokane)
Phone: (509) 329-2100
Fax: (509) 329-2104
After Hours Emergency: 1-877-481-4901

Washington State Department of Ecology (Central Regional Office)
Phone: (509) 575-2490

Fax: (509) 575-2809

Vulnerability Assessment

Reservoirs 1 and 4: System demands can be met with either one of the reservoirs out of service. Each of the reservoirs is equipped with a pressure sensor and the telemetry system can be set to operate based on either one of the sensors.

Reservoirs 1 and 4 have been made as secure as reasonably possible. Both are within a 6' chain link fence with barbed wire at the top. The ladder leading to the access hatch at the top of each tank is within a locked safety cage. Both access hatches are locked and Reservoir 4 has an intrusion switch that alarms through the telemetry system when the hatch is opened.

Reservoir 2: Reservoir 2 consists of five separate horizontal tanks. System demands can be met with any one of the tanks out of service. Two of the tanks have pressure sensors for controlling the booster pumps at the Sycamore Booster Station. Once the Tower Reservoir is back on line, then Reservoir 2 and the Sycamore Booster Station could be taken out of service with very little impact on system operation.

For security, Reservoir 2 is within a 6' chain link fence with barbed wire at the top. There are no ladders leading to the top of the tanks and all openings are bolted down.

Tower Reservoir: The Tower Reservoir is currently out of service and has very little impact on system operation. Access to the reservoir is through a locked building.

Supply Wells: Peak day system demands can be met with any one of the supply wells out of service, with the exception of Well 3. Once the pumping capacity of Well 6 is increased, the system will be able to meet peak day system demands with Well 3 out of service.

Sycamore Booster Station: The Sycamore Booster Station is currently the most vital facility in the system. Without this facility, supply to Zones 2 through 4 would be limited to that provided by Well 2 and the booster at Well 5. Wells 4 and 5 would need to be in operation to run the booster at Well 5. Even with these wells running, the booster at Well 5 should be throttled slightly to prevent cavitation. The Sycamore Booster includes four pumps, so the chance of a complete failure is reduced. When the new telemetry system is installed, it would be desirable to have the option of operating Wells 4 and 5 based on the water level in the Tower Reservoir.

Pressure Reducing Stations: Any one of the pressure reducing stations can be out of service without seriously impacting system operation. Fire flows will be reduced in some areas. All of the major areas being supplied by pressure reducing stations have more than one station supplying the area. Areas served by only one pressure reducing station include Bridle Way and the south end of University Parkway. All of the pressure reducing stations include parallel pressure reducing valves, so the chance of needing to take an entire station out of service is small.

Transmission Main: Loss of the transmission main between Well 6 and the Sycamore Booster station will result in the loss of supply from the Sycamore Booster Station. This transmission main is 10” Class 160 or 200 PVC. Replacement of the main with larger diameter ductile iron pipe will lessen the chances of such a failure, while rehabilitation of the Tower Reservoir will lessen the impact from such a failure.

Telemetry System: Loss of the telemetry system requires that all of the wells be operated manually. Generally, the telemetry system can be repaired within a short period. The County has on hand spare radios, power supplies, RTUs, and a backup computer with all of the software needed to operate the system.

Power Supply: Well 2 is the only supply facility with backup power capabilities. Yakima County has a portable generator that can be used at this facility and two other water systems. During a major power outage, Well 2 could provide sufficient water for in-house use if irrigation was completed curtailed. Well 2 can provide 389,000 gallons per day, which is approximately equal to the typical winter demands. Backup power capabilities at Well 6 and the Sycamore Booster Station should be considered to increase supply capacity during a major power outage.

Emergency Response Procedures

Major Power Outage: If electrical power is lost due to wind, lighting, traffic accident, etc., system supply and telemetry facilities will be affected. Response procedures include the following:

1. Notify water system personnel.
2. Verify which supply facilities are without power.
3. Check reservoir water levels and calculate length of time reservoir volumes can satisfy system demands based on supply capacity available.
4. Contact Pacific Power (575-3133) to determine projected duration of power outage.
5. Operate Well 2 on portable generator if reservoir volume will not satisfy system demands for projected duration of power outage.
6. If necessary, notify customers to curtail usage.
7. Notify fire department of limited fire flow capacity if fire flow capacity is threatened.

16" Transmission Main Failure: Depending on the failure location, one or more supply facilities may be affected. Response procedures include the following:

1. Notify water system personnel.
2. Turn off wells feeding transmission main as needed if isolating area of break will cause excessive system pressures.
3. Isolate area of break.
4. Run Wells 4 and 5 and the booster at Well 5 if additional supply is needed.
5. Assign one person to assess property damage.
6. Check for other utilities in the area and repair break.
7. Flush the line as required.
8. Resume normal operation

Reservoirs 1 and 4 Failure: Failure of Reservoirs 1 and 4 could occur due to a natural disaster such as an earthquake, or due to a pipe failure or vandalism. Response procedures include the following:

1. Notify water system personnel.
2. Notify the public and Department of Health
3. Notify fire department of limited fire flow capacity.
4. If Reservoirs 1 and 4 will be out of service for an extended period of time, relocate one or more of the 30,000 gallon horizontal tanks from the Sycamore Booster Station.
5. If possible, operate Well 2 or the Sycamore Booster Station by pumping excess supply to waste, or by modifying control valve in Sycamore Booster Station to operate as a pressure sustaining valve.
6. Repair, test water quality and bring reservoirs back on line.

Source of Supply Failure: Failure of a source of supply could occur due to equipment failure, fire, vandalism, or contamination of groundwater. Response procedures include the following:

1. Notify water system personnel.
2. Flush and prepare other sources for operation.
3. Monitor reservoir levels and notify users of conservation measures if required. Currently, all but peak day summer demands can be met with the largest supply out of service.
4. Repair, test water quality and bring supply back on line.

Sycamore Booster Station Failure: Complete failure of the Sycamore Booster Station could occur due to a control system failure, a pipe break or vandalism. Response procedures include the following:

1. Notify water system personnel.
2. Determine cause of failure and estimated time to repair.
3. Make repair or call a contractor for assistance.
4. Prepare to bring Wells 4 and 5 and the booster at Well 5 on line if required.
5. Monitor reservoir levels and notify users of conservation measures if required.
6. Repair and bring facility back on line.

Major Fire: Yakima County Fire District No. 4 handles all fire events in the Terrace Heights area.

1. Notify water system personnel.
2. Assess the situation and prepare other supply sources for operation if necessary. Bring other supply wells on line as required.
3. If fire is in a low fire flow area, check system pressures to see if fire flows are excessive. If fire flows are in excess of system capacity, notify fire fighters of the situation.
4. Resume normal operation after fire is out and reservoirs are full.

Contamination of In-System Water Supply: Contamination of water supply could occur from such items as main breaks or pollution of an isolated source. Response procedures include the following:

1. Notify water system personnel and Department of Health.
2. Repair and/or remove source of contamination.
3. Flush and disinfect all contaminated lines

4. If contaminant is found in reservoir, chlorinate to achieve a free chlorine residual of 0.2 to 0.5 parts per million.
5. Test water quality and return facilities to service.

Contamination of Water Supply Source: Contamination of water source could come from accidental spillage of contaminants near the well site, sabotage, or from other sources.

1. Notify water system personnel.
2. Remove contaminated source of supply from system and do not use until problem is resolved.
3. Notify Department of Health.
4. Flush affected transmission mains and reservoirs.
5. Collect additional water quality samples.
6. Initiate public notification in accordance with the *Drinking Water Regulations* based on the contaminant involved.
7. Await Department of Health decision on returning source to service.

Freezing Weather:

1. Insulate shallow meters in late fall.
2. Ensure pump house heaters are operational and thermostats are set above freezing. A heater is also used in the level sensor vault at Reservoirs 1 and 4.

Water Shortage Response Plan: Loss or reduction of water supply could occur due to an extended drought. The Terrace Heights Water System draws from more than one aquifer so a total loss of supply is unlikely, but a long term drought could impact groundwater levels resulting in a reduction of pumping capacity or a complete loss of pumping capacity from one or more wells. In the future, the Terrace Heights Water System may have an emergency intertie with the City of Yakima or the City of Moxee. Possible response procedures depending on the severity include:

1. Implement voluntary water conservation measures.
2. Provide additional water conservation tips in bill inserts.
3. Conduct leak detection program.
4. Notify Department of Health.
5. Contact the Public Information Officer for Yakima County Public Services and request assistance in contacting the media and coordinating the release of information to the public.
6. Prepare resolution for the Board of County Commissioners if voluntary conservation measures are not sufficient and mandatory water conservation measures are required.
7. In an extreme emergency, hauling of water or bottle water may be necessary. Potable water tanker trucks and bottled water are available from the following sources:

Table 8-3 Alternate Water Sources		
Alternative Source	Name	Phone
Bottled Water	Crystal Springs Culligan Water	1-800-492-8377 509-590-1272
Tanker Trucks	IMT Holdings, Inc. LTI, Inc.	208-312-5013 509-839-5844, 1-800-422-5993

Safety Procedures

Chlorination

Calcium hypochlorite tablets are used at Well 3 and sodium hypochlorite chlorination is used at all other wells. Well 3 still has gas equipment as a backup. Both the tablet and gas chlorination systems are located in a separate chlorine room that includes ventilation and a chlorine detector. If chlorine gas is detected, the telemetry system sends an alarm to the main computer at the courthouse.

Confined Space

The County Road Maintenance Division maintains a tripod, harness, gas detector and blower for confined space entry. The Utilities Division also has a gas detector. This equipment is to be used when entering confined spaces including pressure reducing stations and the pit at Well 4. All utility personnel have received confined space training.

Trench Safety

The County keeps a small trench box on hand at Well 5 and a larger trench box at the County Road Maintenance facility for use in repairing water lines and other trench excavations. Trench boxes can also be rented from local companies. All utility personnel have received trench safety training.

Fall Protection

Reservoirs 1 and 4 are equipped with a fall restraint system. Safety harnesses are stored at Well 2. All utility personnel have received training in the use of the fall restraint system, with the exception of one newer employee which will receive training in the near future.

Cross Connection Control Program

A copy of the County's Cross Connection Control Program is included in Appendix H. Also included are a list of backflow assemblies and the Annual Summary Report for Year 2016.

Coliform Monitoring Plan

A copy of the Coliform Monitoring Plan is included in Appendix O.

Lead and Copper Monitoring Plan

Twenty lead and copper samples are required once every 3-years. Samples are to be collected from homes most vulnerable to lead and copper. Generally, these are these are homes built between 1982 and 1986 with copper pipes. The Terrace Heights water system is not known to contain lead service lines. Homes with water softeners should not be used. Samples should be collected from regularly used kitchen or bathroom cold-water taps left undisturbed for at least 6 hours, but no more than 12 hours.

Step by step sampling instructions are to be provided to homeowners collecting samples. Homeowners are to be provided a copy of the sample results within 30 days after the County receives the results from the laboratory. The County must also certify to the Department of Health within 3 months after notifying the homeowners that the homeowners were notified of the results.

Customer Complaint Response Program

Yakima County responds to customers that have issued a complaint either by phone, mail or in person depending upon the situation. Complaints and actions taken are recorded on a Customer Contact Form. An example Customer Contact Form is included in Appendix Q.

Fifteen complaints were logged since 2011. Four involved dirty water complaints, two involved taste or odor, and one involved low pressure. The remaining did not involve water quality type issues. Dirty water complaints and one taste complaint were resolved by flushing. The odor complaint was regarding a high chlorine odor. The chlorine residual was checked and found to be normal (0.56 ppm.) Pressures were found to be normal following the low pressure complaint.

Record Keeping and Reporting

Records are reported to the Department of Health as required. In general, primary drinking water violations are to be reported within 48-hours. Tier 1 violations, such as total coliform samples positive for fecal or E.coli, or nitrate, nitrite or total nitrate violations are to be reported within 24-hours. Positive total coliform samples are to be reported within 10-days. Daily Chlorination Reports are submitted by the 10th of the following month.

Procedures for keeping and compiling records and reports are summarized in Table 8-4.

Table 8-4 Record Keeping		
Record Type	**Record Location**	**Time on File**
Bacteriological Test Results	Public Services Accounting	5 Years
Chemical Test Results	Public Services Utilities	System Lifetime
Chlorine Residuals	Public Services Utilities	3 Years
Water Production	Public Services Utilities	10 Years
Water Consumption	Public Services Accounting	10 Years
Sanitary Survey Documentation	Public Services Utilities	10 Years
Project Reports, Construction Documents, Inspection Reports and Approvals	Public Services Utilities	Facility Lifetime
Backflow Test Reports	Public Services Utilities	3 Years
Customer Complaint	Public Services Utilities	6 Years

Power Consumption

Power consumption for each of the wells is similar, with the exception of Well 2 which pumps directly into Pressure Zone 3. Power consumption from Well 2 is similar to the other wells when the electrical costs from the Sycamore Booster Station are considered. Wells 6 and 4 are the most efficient of the wells. Power consumption can be minimized by limiting the amount of water that is flowed through the dump valve at the Sycamore Booster Station from Zone 3 back down to Zone 1. A summary of the power consumption per million gallons of water pumped is presented in Table 8-5.

Table 8-5 Electrical Power Consumption					
Pumping Facility	**Power Consumption (kwh/MG)**	**Energy Charge ($/MG)**	**Total Power Consumption pumping to Zone 3 (kwh/MG)**	**Total Energy Pumping to Zone 3 ($/MG)**	**Most Efficient**
Well 2	3,275	$219	3,275	$219	4
Well 3	2,002	$134	3,058	$204	3
Well 4	1,929	$129	2,984	$199	2
Well 5	2,392	$160	3,447	$230	5

Table 8-5 Electrical Power Consumption					
Pumping Facility	**Power Consumption (kwh/MG)**	**Energy Charge ($/MG)**	**Total Power Consumption pumping to Zone 3 (kwh/MG)**	**Total Energy Pumping to Zone 3 ($/MG)**	**Most Efficient**
Well 6	1,800	$120	2,855	$190	1
Sycamore Booster	1,055	$70			

Notes:
1. KWH consumption and well production are based on the period of May-July 2017.
2. Energy Charge is based on a cost of $0.06673/kwh.
3. Total power consumption pumping to Zone 3 includes consumption from the well and the Sycamore Booster, except for Well 2 which pumps directly to Zone 3.

Summary of Operations and Maintenance Improvements

A summary of operations and maintenance improvements is listed below. Tasks and programs noted will be developed by County staff and are not included in the capital improvements program or financial program described in Chapters 10 and 11.

1. Update operations and maintenance manuals for each facility, including supply sources, booster stations, storage reservoirs and pressure reducing stations. Include detailed operating procedures and a listing of all set-points programmed into each controller and RTU.
2. Develop and implement a more formal valve and hydrant exercise program. Valves and hydrants are currently exercised as time permits. Exercising valves and hydrants more frequently and maintaining inspection records will improve ratings from the Washington Surveying and Rating Bureau.
3. Develop and implement flushing program.
4. Develop service meter testing program.

Chapter 9

Distribution Facilities Design and Construction Standards

The Department of Health implemented an Alternative Review and Approval process for distribution main projects. The process allows construction of distribution main projects to take place without submitting project reports and construction documents to the Department for review and approval. To be eligible for the submittal exception, construction documents for distribution main projects must meet the following requirements.

Project Review

All line extensions to the Terrace Heights Water System must be shown on engineering design plans, reviewed by the Public Services Department and approved by the County Engineer before commencing construction. The engineering design plans must be prepared and stamped by a professional engineer, licensed in the State of Washington.

Policies and Requirements for Outside Parties

If a Developer, or other person desires to extend the water system, they must do so at their own expense, and they must comply with the standards and requirements of the County.

Prior to the installation of water mains, a “Developer Agreement for Watermain Extensions” must be signed by the Developer, and approved by the County. The agreement will set for the terms and conditions for extending the water system. An example agreement is included in Appendix B.

All engineering design plans must be prepared and stamped by a professional engineer, licensed in the State of Washington, at the Developer’s expense. Two or more copies of the preliminary plans must be submitted to the County for review. After review and approval by the County and all applicable agencies, the developer’s engineer will provide two (2) copies of the final water system design.

Depending on the complexity of the project, the Developer may be required to furnish a one year warranty bond.

Following completion of construction, the Developer’s engineer will be required to certify to the County that the project was constructed in accordance with the plans and specifications if the Developer’s engineer provided the primary construction inspection services for the project. This certification is not applicable if Yakima County provides the primary inspection services.

Yakima County or an engineering consultant hired by the County will generally provide the primary construction inspection services. All costs related to inspection of the project will need to be reimbursed by the Developer prior to acceptance by the County.

Design Standards

Distribution main projects shall be designed in accordance with the *Waterworks Standards*, as prepared by the Washington State Department of Health, and the following design standards.

General Facility Placement

Water mains shall be installed at a location that is compatible with the existing water system, the terrain, and the location of other utilities. In new plats and subdivisions, wherever practical, water mains should be installed on the north or west sides of the street, and 11-feet off the centerline or as required to minimize the number of valve boxes in wheel lanes.

In addition, all water mains and appurtenances shall be on public rights-of-way or dedicated utility easements. Utility easements must be a minimum of 20-feet in width, with piping installed no closer than 5 feet from the easement's edge. Exceptions to this minimum easement width may be approved by the Public Services Department if special conditions justify a reduction in width.

Separation from Other Utilities

Water mains and service lines shall be installed in a location to provide sufficient separation from other utilities to limit the possibility of contamination and to provide for future maintenance and repair without unnecessary risk to the adjacent utilities or workers. Separation from non-potable conveyance systems, such as sanitary sewer and irrigation lines, shall be in accordance with the latest edition of the Department of Health's Water System Design Manual. Separation from phone and cable television shall be a minimum of 3-feet (measured from the closest sides of the two utilities). Minimum separation from power and gas shall be five feet. Exceptions to the minimum separations may be approved by the Public Services Department if special conditions justify a reduction in width.

Pressure Requirements

Extensions to the existing system must be designed to provide peak hour demands at no less than 40 psi in the distribution system, unless special conditions justify a reduction in pressure. Under no circumstances shall new systems or extensions to existing systems be designed to provide peak hour demands at less than 30 psi. Service connections with pressures greater than 80 psi will be required to have individual pressure reducing valves installed.

When fire protection is required, pressures must be no less than 20 psi throughout the distribution system under peak day plus fire flow demand conditions.

In transmission lines (lines with no service connections), positive pressure is required to be maintained at all times.

Pipe Sizing

Water mains serving fire hydrants shall not be less than 8-inches in diameter. In a dead end cul-de-sac, smaller diameter mains may be installed from the last hydrant to remaining residences. Hydrant leads 50-feet or less may be 6-inch.

During peak-hour demand conditions, flow rates should be limited to less than 5-feet-per-second. During fire flow conditions, flow rates should be limited to less than 10-feet-per-second.

Looping

Dead-end lines shall be avoided unless extenuating circumstances require such installations. Approval of dead-end lines will be at the discretion of the Public Services Department.

Pipe Materials

Water mains shall be ductile iron meeting the requirements of AWWA C151, Special Thickness Class 52 or greater, except that water mains 8-inches in diameter and less with operating pressures less than 80 psi may be PVC or ductile iron. PVC pipe shall meet the requirements of AWWA C900, Pressure Class 235 (DR18) or greater

Service lines shall be high density polyethylene (HDPE) tubing meeting the requirements of AWWA C901. Tubing for ¾" meter assemblies shall have a minimum diameter of 1 inch and shall be SIDR 7 (iron pipe size, PE 3408 material with 200 psi rating). Tubing used for 1½ inch and 2 inch service lines shall be SDR 9 (copper tube size). Crosslinked polyethylene (PEX) tubing meeting the requirements of AWWA C904 may be used in lieu of HDPE where operating pressures are less than 100 psi.

Pipe Cover

The minimum depth of cover over all water mains is 48". The minimum depth of cover over all service lines is 30".

Isolation Valving

Valving shall be installed in a configuration that permits isolation of lines. Tees and crosses should be valved on each leg and branch of the tee or cross for redundancy. A valve is generally not required for short block lines of less than 100 feet. Unvalved lengths of pipe should not exceed 1,000 feet.

All water lines which will be extended in the future shall have installed a restrained valve with a mechanical joint plug. If a blowoff is required, a tapped plug may be used.

Air Valve Assemblies

Combination air and vacuum/air release valve assemblies shall be installed at all high points. When practical, high points shall be eliminated by adjusting pipe grades.

Blowoff Hydrants

Blowoff hydrants or fire hydrants shall be installed at all prominent low points and dead end pipes.

Fire Hydrants

Fire hydrants shall be a minimum of 40 feet and a maximum of 600 feet from the far end of residential structures and 400 feet from the far end of commercial structures. The maximum distance between fire hydrants shall be 500 feet in areas with fire flow requirements of 1,750 gpm or less. In areas with fire flow requirements greater than 1,750 gpm, the maximum distance between hydrants shall be 450 feet. Fire hydrants shall be located at road intersections whenever possible.

Fire Protection

Fire protection is required for all new residential construction, except the following:

- On properties where no land use action is required; or
- Urban Areas: two or less lots; or
- Rural Areas: four or less lots, or up to eight lots if all lots are more than 1/3 acre in size

The minimum fire flow and duration for one- and two-family dwellings is 1,000 gpm for 60 minutes.

Fire protection for nonresidential construction is established by the County Fire Marshall and is based on Tables B105.1(2) and B105.2 of the International Fire Code. Minimum fire flow requirements vary depending on (1) the type of construction, (2) the size of the building, (3) whether or not the building has an automatic fire sprinkler system and/or (4) a monitored fire alarm system. The maximum fire flow is 2,250 gpm for 120 minutes. The County requires that new construction be built in a way that satisfies the requirements of the International Fire Code with a fire flow of 2,250 gpm or less.

Construction Standards

Distribution main projects shall be constructed in accordance with the County's "Special Provisions for Water Main Construction" and standard plans. A copy of the Special Provisions and standard plans is included in Appendix A.

Construction Certification and Follow-up Procedures

Following construction and prior to County acceptance of the project, the project design engineer will be required to submit one copy of record drawings in digital or mylar form based on red line drawings provided by the County and the Developer's contractor.

The project design engineer or the County will complete and sign a Construction Report for Public Water System Projects prior to placing the project in service. Copies of the Reports will be kept on file and made available for Department of Health review.

Chapter 10
Improvement Program

This chapter includes the status of improvements identified in the December 2009 Water System Plan, a description of currently proposed improvements, and an implementation schedule and cost estimate for each proposed improvement. Proposed improvements are shown on Figure F-1 in Appendix F.

Improvements Identified in 2009 Water System Plan

Many of the improvements identified in the *2009 Water System Plan* have either been completed or at least partially completed. A summary of the improvements and their status are listed in Table 10-1.

Table 10-1
Status of Improvements Identified in 2009 Water System Plan

Item No.	Improvement	Completed or Resolved	Comments
1.	Rehabilitate Country Club Tower.		Electrical and pumping equipment have been replaced. Repairing the water tank and installing insulation and heating is under design.
2.	Install Automated Meter Reading System.	✓	This improvement has been completed.
3.	Replace Piping in Ridgeway Drive.	✓	This improvement has been completed.
4.	Increase Supply Capacity.		Increasing the supply capacity of Well 6 is under designed.
5.	Construct 2nd Reservoir in Zone 3.	✓	This improvement has been completed.
6.	Paint Reservoirs 1 and 2.		Reservoir 2 has been painted. Reservoir 1 still needs painting.
7.	Improve Fire Hydrant Access.	✓	This improvement was completed. Other hydrants now need better access.
8.	Install Fire Hydrants at Various Locations.		Ongoing.
9.	Replace 4” and Smaller Pipes.		Ongoing. Some pipe has been replaced including pipe in East Hillcrest and Kilgary Way. Piping is planned to be replaced in Maple and in Hillcrest this next year. Additional pipe still needs replacing.
10.	Replace Terrett Booster Station.		New pumps, variable speed drives, a flow meter and air conditioning have been installed. The remainder of the project has not been completed.

Table 10-1 Status of Improvements Identified in 2009 Water System Plan			
Item No.	Improvement	Completed or Resolved	Comments
11.	Construct Gravity Storage for Zone 4.		This improvement will be made when more of Zone 4 is developed.
12.	Construct Hillcrest Drive Loop.		Development has not occurred near the northwest end of Hillcrest Drive to provide a loop for this dead end line.
13.	Begin Meter Testing Program.		All source meters have been tested in the last year. All service meters have been replaced within the last 3 years. A formal meter testing program needs to be implemented.
14.	Increase Well 6 Water Rights.	✓	This has been completed.
25.	Prepare Detailed Operations Plan.		Operations and maintenance manuals have been prepared for each of the wellhouses and the Sycamore Booster. Additional details should be added to the manuals.

Existing System Improvements

Existing system improvements are those needed to improve service within the existing service area. Some improvements are needed immediately while others may be postponed. The following paragraphs describe the existing system improvements and their relative importance.

Capital Facility Improvements

1. **Rehabilitate Country Club Tower.** The Country Club Tower Reservoir needs to be drained, cleaned, inspected, and the cover replaced before returning it to service. Insulation and heating also need to be added to the building, and the roof needs to be repaired. Returning the Tower Reservoir to service will help to prevent surges when Well 5 starts and stops, will provide a means to control the booster at Well 5, and will help to prevent cavitation of the Well 5 booster. It will also enable the system to meet peak day demands in all pressure zones above Zone 1 if the Sycamore Booster Station is out of service. If the reservoir inspection reveals that the cost of returning the reservoir to service is too high, then a new ground level storage tank should be constructed at Well 5. This is considered a high priority improvement.

2. **Increase Supply Capacity.** Supply capacity for Zone 1 should be increased so the system can meet peak day demands with the largest source out of service. The least expensive option for increasing supply capacity is to increase the pumping capacity of Well 6. A pump test showed the pumping capacity could be increased from its current level of 340 gpm to 1,200 gpm. The diameter and straightness of the well is expected to limit the increase in capacity to approximately 900 gpm.

Installing a variable speed drive would allow the pump to be operated at a lower capacity to keep from pumping sand during normal operating conditions. If another well should be out of service, then the capacity could be increased to meet demands. This improvement would provide for an estimated 350 new single-family residential connections and would enable the system to meet peak day demands with the largest source out of service for the next 10 years.

3. **Paint Reservoir 1.** Reservoir 1 will need to be repainted within approximately five years. The County may paint the exterior first to better match Reservoir 4, and paint the interior later since most of the cost is for the interior.

4. **Improve Fire Hydrant Access.** Some fire hydrants need to be painted, raised, rotated, and the shrubs cleared from around the hydrant to improve accessibility in case of fire. Approximately six fire hydrants need to be raised.

5. **Install fire hydrants at various locations.** Additional fire hydrants are needed to reduce the distance between hydrants. Many areas of the system do not meet current hydrant spacing standards. Additional hydrants should be installed when new water lines are installed, or when other improvements enable the system to provide at least 1000 gpm for fire protection.

6. **Replace 4" and smaller pipes.** Most of the 4-inch diameter and smaller water lines need to be replaced. Water lines of this size severely limit the ability of the system to provide fire flow and should gradually be replaced when funding is available.

7. **Replace Terrett Booster Station.** The Terrett Booster Station needs to be replaced. The existing building is too small and pump operation is not monitored.

   The cost of this improvement is high for the number of customers served by the facility. Consequently, the County plans to wait on this improvement until additional development in Zone 4 occurs.

   When development justifies construction of a new booster station, the booster station should include space for multiple pumps to pump into a reservoir and serve the lower elevations of Zone 4, and space for the two existing booster pumps and a series of pressure tanks to serve the higher elevations of Zone 4. Customers at the east end of Bohoskey Drive are at too high of an elevation to be adequately served by the proposed reservoir.

8. **Construct Gravity Storage for Zone 4 (Terrett Pressure Zone).** Gravity storage is needed in Zone 4 to meet operational and standby storage requirements. One option is to move one of the existing 30,000 gallon tanks that is being used at Reservoir 2 to a piece of property owned by the County near the north end of 57th Street. Adding gravity storage to Zone 4 will require a new booster station to be constructed and a new water line to be installed between the booster station and storage tank. Telemetry will also be needed between the reservoir and booster station.

As noted above, the cost of providing storage for Zone 4 is high for the number of customers served by the facility. Consequently, the County plans to wait on this improvement until additional development in Zone 4 occurs.

9. **Construct Hillcrest Drive Loop.** To achieve an available fire flow of at least 500 gpm, the existing 4-inch line in Hillcrest Drive needs to be replaced with a minimum 8-inch line, or it will need to be looped through a line extension from future development.

10. **Construct Maple Avenue Water Line.** Yakima County is planning to replace a bridge on Maple Avenue. The County's main water line (10") between Pressure Zones 1 and 3 is suspended on the bridge. As part of the bridge project, the County plans to replace the 10" water line with a 16" water line. The work will require a temporary bypass to be installed around the work area. The project also includes replacing approximately 600-feet of 4" water line in Maple Avenue and approximately 600-feet of 4" water line in Hillcrest Drive.

Other Improvements

11. **Water Right Change Applications.** Water right change applications should be submitted to Ecology to consolidate existing water rights withdrawing water from the same aquifer. As a minimum, a water right change application needs to be submitted to Ecology to add additional points of withdrawal to the Well 1 water rights. The existing well no longer has capacity to fully utilize these rights. Because the well is located near a fault, a pump test may be needed to demonstrate which body of water the well is drawing from.

12. **Rate Study.** A rate study is needed to evaluate annual revenue requirements, recommended reserves, and the allocation of costs between the various charges. A study of the allocation of costs will help assure charges remain equitable between customer classifications.

13. **Leak Survey.** Leak surveys will be occasionally needed to keep water loss at an acceptable level.

14. **Storage Building.** A storage building is needed to store equipment, tools, and repair parts. The County plans to replace the quonset hut building at Well 5 with a new storage building.

Future System Improvements

Future system improvements are those needed to serve future development. The actual timing of future improvements will depend on the rate of growth in the system and in each zone. Future system improvements are shown on Figure F-1 in Appendix F.

Future Supply Improvements

Future System Supply. A new well site should be acquired to prepare for future system needs. Areas along University Parkway and along 41st Street are possibilities. The west side of Pacific Northwest University is one area being considered. Water rights for a future well should not be a problem as the water rights for Well 3 already include provisions for a second point of withdrawal with a combined capacity of up to 2,250 gpm.

Future Zone 3 Supply. Supply capacity can be increased by changing the programing of the controller in the Sycamore Booster Station to allow all 4 pumps to operate simultaneously. A surge analysis should be done prior to making the changes. This change would increase the capacity by approximately 400 gpm.

Increased capacity is also possible by making improvements to allow the booster at Well 5 to be operated under normal operating conditions. Improvements needed include returning the Tower Reservoir to service (or constructing a new reservoir at Well 5 for the booster to pump from) and increasing to the distribution system capacity. A variable speed drive could also be installed to keep the booster pump from over pumping the supply capacity available to the pump.

In the distant future, supply capacity could be further increased by constructing a third booster station. Because the booster station would be pumping from Zone 1, it would need to be below Reservoir 2. Placing the booster station at an elevation low enough to allow it to operate if Zone 1 was being supplied through an emergency intertie with the City of Yakima, would be desirable. A possible location for the booster station is shown on Figure F-1.

Future Zone 4 Supply. Future supply capacity for Zone 4 will be possible by adding additional pumps to the Terrett booster station after it is reconstructed. A second booster station is proposed for Zone 4 as part of the Highlands project.

Future Storage Improvements

Future Zone 1 Storage. A long term plan of the County is to construct a 0.5 mg reservoir next to Reservoir 2. Space is available on the site to construct a larger reservoir while keeping Reservoir 2 in service. A larger tank at this location would reduce pumping costs by reducing the volume of water that is currently pumped into Reservoirs 1 and 4 and subsequently brought back to Reservoir 2 through the dump valve. With a larger tank, one or more of the wells could be programmed to start and stop based on the water level in Reservoir 2. A reservoir could also be constructed at Well 5.

Future Zone 4 Storage. Storage beyond what can be provided by the 30,000 gallon tanks will be needed if development within Zone 4 exceeds the number of connections shown in Table 5-4, or the number of connections shown in Appendix D for various pumping capacities. When needed, a larger storage reservoir could be constructed on the County's property north of Reservoir 1. Additional storage is also proposed with the Highlands project.

Future Distribution System Improvements

Future distribution system improvements should provide for 12-inch lines approximately every half mile, with 8-inch lines in between. Eventually, 16-inch lines will be needed from Reservoir 1 to 33rd Street, and from Reservoir 1 to Bridle Way. The actual spacing of the larger diameter lines will depend on how well an area is looped. As the system develops, further refinement of the proposed grid will become necessary.

A new transmission main will need to be installed in conjunction with the storage described above for Zone 4. The new transmission main should be at least 12-inches in diameter between the booster station and the reservoir.

A 16-inch water line should be installed parallel to the existing 10-inch water line in Maple Avenue from North 41st Street to Hillcrest Drive. Velocities in the 10-inch line will exceed 5 feet per second if the discharge rate from Well 3 is increased to above 800 gpm with Wells 2, 5 and 6 operating. Placing the booster at Well 5 in service will delay the need for this improvement.

A 12-inch water line will also be needed between the 16-inch water line in Terrace Heights Drive and Well 5 to provide capacity for two boosters at Well 5 to operate.

The County is in the planning phase of a project to construct a new road between the City of Yakima and Terrace Heights known as the East-West Corridor. The project is planned to be constructed in several phases with the first phase being constructed in 2018. Ultimately, the new road would extend from the City of Yakima near East G Street all the way to 57th Street near Reservoirs 1 and 4. The project could include up to 4 miles of 12" and 16" diameter water line. The first phase includes reconstruction of Butterfield Road north of Terrace Heights Drive. A 12" water line will be included with the project if funding for the water line can be obtained.

Improvement Schedule and Costs

Order-of-magnitude cost estimates and a proposed implementation schedule for the recommended improvements are listed in Table 10-2. The cost estimates include a 7.9 percent sales tax, a 20 percent contingency, and 20 percent for engineering and administrative costs. Table 10-2 also shows a financing source for each improvement.

Cost estimates shown have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. Final project costs will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented. Because of this, project feasibility and funding needs must be carefully reviewed before making specific financial decisions to help ensure proper project evaluation and adequate funding.

Table 10-2 Improvement Schedule (2018-2026)							
	Project Title	Type of Improvement	Description	Page Where Need is Identified	Cost Estimate	Financing Source	Year
1.	Country Club Tower Rehabilitation	Storage	Drain, Clean, inspect, and replace cover on reservoir. Add insulation and heating, repair roof and install more secure doors.	2-9, 2-11, 2-15, 5-2, 5-6, 5-11	$400,000	Water System Revenues	2018
2.	Well 6 Supply Improvements	Source	Increase pumping capacity from 340 to 900 gpm by installing a larger pump and motor and variable speed drive.	2-10, 5-1, 5-3, 5-5	$670,000	Water System Revenues & DWSRF Loan	2018
3.	Paint Reservoir 1	Storage	Sandblast and repaint reservoir interior. Pressure wash and paint exterior.	2-15	$350,000	Water System Revenues	2019
4.	Fire Hydrant Access Improvements	Distribution	Raise approximately 6 fire hydrants.	2-16	$10,000	Water System Revenues	2019
5.	Fire Protection Improvements	Distribution	Install Fire Hydrants at various locations	2-16	See Note 1	Water System Revenues	See Note 1
6.	Distribution System Improvements	Distribution	Replace 4" and smaller pipes with larger pipes	5-17	See Note 1	Water System Revenues	See Note 1
7.	Terrett Booster Station Improvements	Source	Replace Terrett Booster Station and increase pumping capacity.	2-12, 5-1	$500,000	Developer Contributions	See Note 3
8.	Zone 4 Storage	Storage	Install 30,000 gallon storage tank in Zone 4, along with telemetry and necessary piping.	5-10, 5-12	$530,000	Developer Contributions	See Note 3
9.	Hillcrest Drive Loop	Distribution	Replace or loop 4" line in Hillcrest Drive between Maple and Mountain View.	5-18	$250,000	Developer Contributions	See Note 3
10.	Maple Avenue Water Line	Distribution	Replace or loop 10" line in Maple Avenue between Roza Canal and Hillcrest Drive. Replace or loop 4" line in Maple and in Hillcrest Drive.	5-16, 10-4	$500,000	Water System Revenues	2018

Table 10-2
Improvement Schedule
(2018-2026)

	Project Title	Type of Improvement	Description	Page Where Need is Identified	Cost Estimate	Financing Source	Year
11.	Water Right Change Applications	Source	Consolidate water rights withdrawing from same aquifer.	6-7	$70,000	Water System Revenues	2019
12.	Rate Study	Operations	Evaluate annual revenue requirements, reserves and allocation of costs between various charges.	11-6	$25,000	Water System Revenues	2020
13.	Leak Survey	Distribution	Perform periodic leak surveys to keep water loss at an acceptable level.	6-5	$10,000	Water System Revenues	2024
14.	Storage Building	Operations	Construct storage building for equipment, tool, and repair parts.	10-4	$150,000	Water System Revenues	2019
15.	Butterfield Road Water Line	Distribution	Construct approximately 1,200 feet of 12" water line as part of a County Road project.	10-6	$400,000	Unfunded	2019

Notes:
1. Replacement of 4" and smaller lines and installation of additional fire hydrants will be done as funding becomes available.
2. Projects shown with no cost will be done by County staff.
3. Projects being funded by developer contributions will occur when development occurs.

Chapter 11
Financial Program

Available Revenue Sources

Revenue sources available to the County for financing water system operations and capital improvements include the following:

- Water Sales and Fees
- Investment Interest
- Contributing Capital-Local Sources
- Interagency Loans/Funds
- Developer Contributions
- Public Works Trust Fund (PWTF) Loans
- Drinking Water State Revolving Fund
- SIED Fund
- Municipal Bonds

A description of each of the funding sources is included in the paragraphs that follow. Other funding sources applicable to other County systems and not necessarily the Terrace Heights Water System are described in the County's *"Water System Satellite Management Plan."*

Water Sales and Fees

Water sales and fees include ready to serve charges, water consumption charges and reconnection fees. Fire protection and backflow prevention service charges are also included if a customer receives these services. Fire protection service charges only apply if a customer receives fire protection through a private unmetered water line. The amount for each of these charges is shown in the Chapter 12.08 of the County Code (see Appendix G for details).

Investment Interest

Investment interest includes interest earned on cash that is in a savings account or cash deposit.

Contributing Capital-Local Sources

Contributing capital-local sources is revenue generated from the sale of water connection permits. All new customers are required to purchase a water connection permit to help finance their share of the supply, storage, and distribution facilities. The cost of the water connection permit varies depending on the size of the service meter. A schedule of water connection permit charges is included in the County Code.

Interagency Loans/Funds

Interagency loans and funds include operating transfers from the County's General Fund, and loans from other County funds. Operating transfers include a percentage of the County's Real Estate Excise Tax.

Developer Contributions

Developer contributions are used to finance pipe extensions and other improvements necessary to serve a specific development.

Public Works Board

The Washington State Public Works Board offers low-interest loans for public infrastructure construction and rehabilitation. Eligible projects must improve public health and safety, respond to environmental issues, promote economic development, or upgrade system performance. Loans are generally available for up to $10 million with 1.66% interest and 20 year terms. The Public Works Board is currently not accepting funding requests due to the lack of a 2017-2019 biennium Capital Budget.

Drinking Water State Revolving Fund

The Drinking Water State Revolving Fund (DWSRF) offers low-interest loans for drinking water systems to fund infrastructure improvements aimed at increasing public health protection. Loan funds may be used for planning, design and construction. The DWSRF loans are administered by the Washington State Department of Health. Loans are available for up to $3 million with 1-1.5% interest and 20 year terms.

SIED Fund

Yakima County's Supporting Investments in Economic Development (SIED) fund provides grant and loan funds for public infrastructure projects that support economic and business development. Funds for the SIED program are provided through state sales tax generated in the County. State law allows rural distressed Counties, such as Yakima County, to retain 0.08% of the sales tax generated in the County to fund such a program. Yakima County contracts with New Vision to administer the SIED program. The funds have been used to finance a good portion of the waterline in University Parkway.

Municipal Bonds

Municipal bonds offer the County various avenues to acquire funds to assist in completing public works projects. The various municipal bonds available to the County are as follows:

1. Revenue Bonds

Revenue Bonds are most frequently used for financing utility construction improvements. The Bonds are repaid from system revenues generated by monthly user charges and assessments. The amount of Revenue Bonds that can be issued is limited by the system revenues, which in turn depend upon the level of rates that can be reasonably charged for the service provided. Revenue Bonds provide greater flexibility than General Obligation Bonds since they do not require a vote of the system customers each time bonds are issued.

2. General Obligation Bonds

General Obligation Bonds are mostly used for non-utility purposes. General Obligation Bonds usually lack the restrictive covenants of revenue bonds and normally result in lower interest rates and reduced total revenue requirements. The principal and interest on these bonds are usually paid from system revenues, but are also backed by the local taxing power of the system. Debt limitations may sometimes restrict the use of General Obligation Bonds. In addition, voter approval is generally required before the issuance of the Bonds.

3. Councilmanic Bonds

Councilmanic Bonds are general obligation bonds or short-term notes issued by the County that do not exceed an established limit and do not require a public vote for issuance.

4. LID Bonds

Another source of funding is through special assessments levied in Local Improvement Districts (LID). A special assessment bond is an immediate form of financing which is useful for small issuers and/or for limited purposes. A special assessment bond is payable only from the receipts of special benefit assessments, not from general tax revenues. Such bonds are issued only where certain properties are recipients of special benefits not accruing to other properties. The assessment is designed to apportion among the benefited property owners the cost of the improvement approximately in proportion to the direct and indirect benefits afforded by the improvement. The issuer is obligated only to collect the assessments and to apply them as promised.

Water Rates and Charges

Water Connection Permit Charges

A water connection permit charge is assessed to each new service connection. Water connection permit charges are listed in the Yakima County Water System Ordinance and are based on meter size. Current water connection permit charges are as follows:

Meter Size	Water Connection Permit Charge
3/4"	$ 2,500.00
1"	2,790.00

1-1/2”	4,000.00
2"	5,670.00
3"	9,670.00
4"	13,330.00
6"	26,990.00
8"	40,480.00
10"	53,970.00

Existing Rates and Rate Structure

The existing rate structure is the same for all customer classifications, and includes a ready to serve charge and a water consumption charge. The monthly ready to serve charge is based on meter size and is as follows:

Meter Size	Ready to Serve Charge
3/4"	$ 19.20
1"	34.30
1-1/2”	76.80
2"	136.00
3"	309.00
4"	548.00
6"	1,228.00
8"	2,188.00
10"	3,415.00

To encourage efficient water use, the water consumption charge is based on an increasing block-rate structure. Current rates are as follows:

First 1,000 cubic feet:	$1.58 per 100 cubic feet
Second 1,000 cubic feet:	$1.75 per 100 cubic feet
Over 2,000 cubic feet:	$1.92 per 100 cubic feet

Past and Present Financial Status

Historical Revenues and Expenses

A history of past revenues and expenditures for the Terrace Heights Water System for the past 6-years is presented in Table 11-1. As of the end of 2016, the water system cash balance was $1,560,000.

Projected Revenues and Expenses

Projected revenues and expenses through 2026 are included in Table 11-2. The projections include revenue increases of 3% per year. Revenue increases are projected due to an increase in the number of customers and periodic rate increases. Operating expenses are projected to increase at 3%. The projections indicate that revenues, with anticipated increases, should be adequate through the year 2026.

Yakima County annually reviews the water system's financial ability to meet its annual operating expenses and fund reserves. Findings are presented to the Board of Yakima County Commissioners by September of each year. The findings include a recommendation for any charge adjustment deemed necessary for the system to meet its annual operating expenses and fund reserves. Based on the findings, the Board of Yakima County Commissioners may adjust the water system's ready to serve charges, consumption charges and fire protection service charges up to an amount equal to the consumer price index for water and sewerage maintenance. Annual adjustments are provided for under Section 12.08.395 of the Yakima County Code.

Projected end of year cash balances are based on receiving an additional $634,000 in Drinking Water State Revolving Fund loan dollars. These funds are from an existing loan awarded in 2013.

Reserves

Reserves are a critical component of the financial program. Reserve goals for the Terrace Heights Water System include:

1. Operating reserve equal to 1/8th of the annual operating expenses (or approximately 45 days) to meet cash flow needs and provide contingency funds for unforeseen operating emergencies.
2. Emergency reserve equal to the cost of replacing the most expensive critical system component. This is considered to be replacement of the pump and motor in Well #3. The bid price to install the original pump and motor in 1994 was $92,000. The current estimated cost is $220,000.
3. A replacement reserve with 50% of the depreciation set aside each year. This is estimated to be the minimum amount needed to cover the engineering and administration costs of an improvement plus 10%-20% of the construction cost. It is assumed that loan funds will be used to fund the remainder of the construction cost. This results in future customers having to cover the expense of replacing facilities that will ultimately benefit them. Setting aside 100% of the depreciation each year into a replacement reserve would result in today's customers paying for future improvements that may only benefit the next generation of customers.
4. A capital expansion reserve equal to 50% of the connection fee revenue. This is used to help fund system improvements needed to serve additional customers such additional supply and storage facilities.

The reserves are considered additive. As a general rule, the total reserve balance should not fall below the sum of the operating and emergency reserves. Only under emergency circumstances when a critical component of the system has failed should reserves fall below approximately $350,000.

Rate Structure

Other than periodic rate increases for ready to serve, consumption and fire protection charges, the existing rate structure has not changed in the last 20-years. The County intends to do a rate study to further evaluate annual revenue requirements, recommended reserves, and the allocation of costs between the various charges. A study of the allocation of costs will help assure charges remain equitable between customer classifications, meter sizes, and fire services versus domestic services.

Table 11-1
Terrace Heights Water System
Historical Revenues and Expenses

	426 Terrace Heights	2009	2010	2011	2012	2013	2014	2015	2016
	OPERATING REVENUES								
	EPA - Grant	-							
	Sale of Plans		260	20				180	
	Water Sales	692,095	693,020	743,956	802,536	880,998	962,003	1,127,620	1,103,218
	Residential Inspections	17,920	18,095	17,290	16,870	18,025	16,555	18,935	20,860
	Fire Protection	22,310	23,488	26,190	27,824	34,719	46,500	49,223	55,944
	Penalties	10,576	9,873	11,789	13,457	14,019	16,786	19,188	19,983
	Reconnection Charges	7,665	7,525	8,435	8,645	8,960	6,265	8,785	8,155
	Permit Fees	25,000	59,670	-	24,000	138,710	54,040	81,580	314,850
	Investment Interest	13,525	8,802	6,846	7,139	8,230	6,667	5,490	8,535
	Unrealized Gain/Loss on Investment	(1,555)	(2,235)	2,799	298	(6,055)	2,734	209	(6,765)
	Interfund Interest	1,303	1,012	976	1,850	1,446	430	313	394
	Cashiers Over/Short	5		0	-	-	(18)	-	(1)
	Miscellaneous	40	630	30	50	8,080	70	250	593
	Contributed Capital	154,477		57420	167,614	-	122,040	57,599	-
	Prior year Correction						24,693	-	-
	PWT Loan	-	-	-	-	-	-	-	-
A	**Total Revenues**	943,361	820,140	875,751	1,070,283	1,107,132	1,258,765	1,369,372	1,525,766
					312,367				
	OPERATING EXPENSES								
	General & Administrative Expenses								
	Operating Transfer Out	-	-				40,911	40,124	-
	Salaries & Wages	158,568	163,670	139,659	105,108	162,808	134,286	132,021	164,423
	Salaries-Overtime	1,961	(1,031)	1,076	(1,279)	-	277	25	532
	Salaries-Extra Help	174	244	(1,231)	30	1,799	-	106	
	Accrued Comp Time	(1,421)	602	-		3,771	-	-	-
	Accrued Annual Leave	20,566	3,040	(2,197)	5,751	-	5,545	(606)	24,572
	Accrued Comp Leave			(109)	590	-	-	-	-
	Benefits-Direct	47,771	43,833	36,948	21,268	45,614	40,412	39,305	54,049
	Benefits-Indirec	(8,182)	(13,301)	(13,299)	(22,762)	(13,379)	(19,963)	(23,272)	(19,055)
	Benefit bank accrual	(1,094)	1,152	699	1,689	(2,044)	(1,251)	1,093	(304)
	Benefit Pension Expense	-	-	-	-	-	-	(2,880)	96,039
	Office & Operati	1,389	1,432	1,343	2,128	3,318	2,833	17,967	22,182
	Small Tools & Mi	199	388	55	-	320	27	-	13
	Small Attrac-Tracked Inventory	-	-	-	-	2,370	125	(2)	359
	Computer Software	-	-	-	-	16	8	440	2
	Professional Ser	18,141	9,037	490	442	15,556	(3,043)	2,603	655
	Professional Ser Indirect		11,998	11,750	9,712	14,229	13,078	11,564	11,349
	Prof Serv-Purcha	776	771	1,393	1,738	1,331	1,184	1,473	2,931
	Prof Serv-Info S	6,814	6,551	6,788	13,976	23,550	26,331	32,178	30,049
	Prof Serv-GIS		15,050	13,662	14,760	14,573	14,915	16,194	16,935
	Prof Serv-DOS			522	548	442	446	482	441
	Communication-Telephone	-	461		659	272	458	58	1,103
	Communication -Postage	7,884	8,594	8,293	7,966	8,206	9,105	7,861	4,876

Table 11-1
Terrace Heights Water System
Historical Revenues and Expenses

	426 Terrace Heights	2009	2010	2011	2012	2013	2014	2015	2016
	Communication-TS Phones							272	291
	Advertising	1,450	-	-		-	-	1,878	-
	Travel	333	-	731	1,430	35	66	711	375
	Operating Rental	5,102	5,067	3,851	4,406	8,860	5,713	4,872	4,045
	Liability Insura	11,053	16,090	23,661	11,312	164,444	110,595	117,811	46,512
	Repairs & Mainte					632	1,033	1,059	576
	Miscellaneous	1,536	1,291	1,008	678	4,353	2,174	3,774	3,184
	Intergov Prof Serv	-	-	-		-	-	-	-
	Rent	4,135	4,280	4,371	3,579	4,360	4,597	4,607	2,322
	External Taxes &	22,094	19,109	20,246	20,041	25,325	25,810	30,429	33,880
	Salaries & Wages			54	26,099	(25,497)	2,289	1,935	3,678
	Salaries Overtime					(438)	-	-	-
	Benefits-Direct			20	9,719	(9,586)	938	831	1,563
	Benefits-Indirec			10	4,402	(4,372)	366	271	457
	Office & Operati				32	85	28	-	67
	Small Tools & Mi					(521)	-	-	-
	Computer Software				200	4,555	-	-	-
	Small Attrac-Tracked Inventory					149	2	-	-
	Professional Ser			1		(5,735)	(54)	-	358
	Prof Serv-Indirect								234
	Prof Serv-Purcha				82	588	-	-	60
	Prof Serv-Info S				4,510	63	-	-	619
	Communication-Telephone							-	77
	Communication -Postage					(5)	141	-	193
	Travel					7	-	-	19
	Operating Rental					(4,667)	31	-	32
	Rent				1,155	(144)	-	-	94
	Liability Insura				3,650			-	1,294
	Pro Serv-Indirect				3,134			-	-
	Utility Services				260	(260)	-	-	-
	Repairs & Mainte					345	-	-	-
	Miscellaneous			2	1,166	(1,419)	24	-	(47)
B	**Total General & Administrative Expenses**	299,249	298,328	259,797	258,179	443,909	419,437	445,184	511,034
	Depreciation	91,844	110,832	118,553	186,639	134,562	(24,693)	172,996	136,278
	Operation & Maintenance Expenses								
	Debt Issue Costs	-	-	-	-	-	-	-	-
	Salaries & Wages	122,334	126,420	119,285	134,075	135,889	137,732	130,569	125,449
	Salaries-Overtime	5,064	6,861	6,060	9,857	14,066	9,534	6,720	6,970
	Salaries-Extra Help	4,112	3,936	-	2,251	-	2,066	3,752	41
	Call Out/Standby	19,120	18,033	19,163	18,910	19,759	19,646	20,214	19,044
	Benefits-Direct	47,955	50,733	47,943	56,453	61,333	61,662	61,383	60,065
	Benefits-Indirec	12,515	14,210	11,565	15,483	14,971	16,115	15,904	13,693
	Benefits-Bank Accruals							-	(527)
	Office & Operati	32,293	33,846	25,169	20,511	34,002	26,517	30,792	33,025
	Fuel Consumed							6	-

Table 11-1
Terrace Heights Water System
Historical Revenues and Expenses

	426 Terrace Heights	2009	2010	2011	2012	2013	2014	2015	2016
	Small Tools & Mi	987	629	455	2,764	1,841	4,657	1,553	2,404
	Computer Software					1,299	3,364	-	-
	Small Attrac-Tracked Inventory	889	3,058	540	944	-	140	215	-
	Professional Ser	24,901	24,513	12,584	12,961	15,383	13,253	7,719	11,204
	Communication -Telephone	2,425	2,301	2,125	2,051	2,523	2,732	3,464	2,532
	Communication -Postage	-	-	-	-	13	5	18	28
	Travel	-	-	-	-	-	-	-	-
	Advertising	-	-	-	-	244	612	-	-
	Operating Rental	28,820	38,944	36,465	45,127	44,713	44,960	46,360	39,507
	Utility Services	60,928	59,438	64,105	69,117	73,225	84,405	80,868	81,968
	Repairs & Mainte	8,747	33,198	44,445	101,278	68,981	139,510	72,683	37,066
	Miscellaneous	11,950	(9,985)	(12,941)	(4,777)	(16,130)	(14,918)	(7,091)	(7,711)
	Intergov Prof Se	1,866	3,693	2,000	1,073	1,498	2,293	2,904	-
	External Taxes	-	-	-	50	56	247	254	267
	Other Debt	6,000	-	-	-	20,192	4,000	6,116	19,000
	Debt Service Principal		4,000	6,536	1,000	-	-	-	-
	Interest on L-T Ext Debt	-	-	-	-	-	-	-	-
	Capital Salaries & Wages		27,414	1,882	1,059	1,913	17,813	17,291	-
	Capital Salaries-Overtime							1,296	-
	Capital Salaries-Extra Help							27	-
	Capital Benefits-Direct		10,257	711	382	734	6,688	7,736	-
	Capital Benefits-Indirec		4,578	333	159	275	2,694	2,659	-
	Capital Office & Operati		891				9,287	2,515	-
	Capital 'Professional Ser		53		48,526	30,910	8,995	31,873	-
	Capital Advertising		714					1,262	-
	Capital Operating Rental		4,430	339	8	-	2,532	1,555	-
	Capital 'Repairs & Mainte	-	-	-	-	-	4,722	-	-
	Capital 'Miscellaneous						2,935	1,652	-
	Intergov Prof Services							1,984	-
	Construction In Progress				-	-	-	108,184	-
	Machinery & Eequipment					-	-	-	-
	Capital Improvements	-	-	-	17,497	-	-	-	-
	Other Improvements	-	-	-	-	-	-	-	-
C	**Total Operation & Maintenance Expenses**	390,906	462,165	388,764	556,759	527,690	614,198	662,437	444,025
D	**TOTAL OPERATING EXPENSES (B + C)**	690,155	760,493	648,561	814,938	971,599	1,033,635	1,107,621	955,059
	CAPITAL IMPROVEMENT PROGRAM								
	Existing Loans								
	Total Outstanding Debt (Principal as of Dec 31)	932,923	632,468	486,490	340,512	194,534	155,196	155,196	155,196
E	Annual Debt Payments (Principal)	145,978	145,978	145,978	145,978	145,978	39,338	-	
F	Annual Debt Payments (Interest)	16,171	13,251	10,332	7,413	4,493	767	-	
	Debt Reduction Due to Expiration of Developer Agreements	154,477							
	Future Loans								
	Total Outstanding Debt (Principal as of Dec 31)	-	-	-	-	-	-	-	1,970,721
G	Annual Debt Payments (Principal on future loans)	-	-	-	-	-	-	-	-

Table 11-1
Terrace Heights Water System
Historical Revenues and Expenses

	426 Terrace Heights	2009	2010	2011	2012	2013	2014	2015	2016
H	Annual Debt Payments (Interest on future loans)	-	-	-	-	-	-	-	25,220
I	**Total Debt Payments (E + F + G + H)**	316,626	159,229	156,310	153,391	150,471	40,105	-	25,220
	Completed Capital Expenditures								
	TH Water - Phase II P/E	-			-	-	-	-	-
	TH Water - Phase II Engineering		-	-	-	-	-	-	-
	TH Water - Phase II Admin					-	-	-	-
	TH Water - Phase II Construction	-			-	-	-	-	-
	TH O & M Improvements (426)	-	-	-	-		-	-	-
	Operating Transfer Out	-			-	-	-	-	-
	33rd Street Water Line	-	-	-	-	-	-	-	-
	Miscellaneous	-	-	-	-	-	-	-	-
	Well 2 Repairs		-	-	-	-	-	-	-
	East Hillcrest Dr. & Canyon Rd Water Lines	-	-	-	-	-	-	-	-
	Pacific NW University	-	-	-	-	-	-	-	-
	Well #3 Repairs	73,825	3,275	-	-	-	-	-	-
	Well #4		5,053	-	-	-	-	-	-
	Future Capital Expenditures							-	
	Well 6 Supply Improvements	-			-	-	-	-	-
	Ridgeway Drive Improvements		59,168	-	-	-	-	-	-
	AMR Implementation						443,200	-	-
	Country Club Tower Rehabilitation	-	-	-		-			-
	Zone 3 Storage	-	-	-	-				1,926,438
	Fire Hydrant Access Improvements	-	-	-	-	-	-	-	-
	Fire Protection Improvements	-	-	-	-	-	-	-	-
	Distribution System Improvements	-	-	-	-			-	
	Maple Avenue Waterline				-				
	Butterfield Road Waterline				-				
	Meter Testing Program				-				
	Reservoir #1 Painting								
	Well 7								
	Storage Building								-
	Well 1 Water Rights								-
		-	-		-	-	-	-	-
J	**Total Capital Expenditures**	73,825	67,496	-	-	-	443,200	-	1,926,438
	Capital Sources								
	CDBG Grant	-							
	PWTF/SRF Proceeds	-			-				1,970,721
	Bonds		-						
	Construction Fund - Investment Interest	-							
	Miscellaneous	-			-				
	Assessment Principal LID #2								
	Assessment Principal LID # 3								
	Special Assessment Bond Proc								
	Operating Transfer In (SEID)		23,548						

Table 11-1
Terrace Heights Water System
Historical Revenues and Expenses

	426 Terrace Heights	2009	2010	2011	2012	2013	2014	2015	2016
	Operating Transfer In (Includes REET Trns In)	115,229	111,997	121,270	121,265	124,845	40,105	-	-
K	Total Capital Sources	115,229	135,545	121,270	121,265	124,845	40,105	-	1,970,721
L	**NET CAPITAL COSTS (-K + I + J)**	275,222	91,180	35,040	32,126	25,626	443,200	-	(19,063)
	RESERVES								
	Operating Reserve								
M	Annual Installment (Withdrawal)	4,000	8,800	(14,000)	20,800	19,500	7,800	9,300	(19,100)
N	Running Balance	86,300	95,100	81,100	101,900	121,400	129,200	138,500	119,400
	Emergency Reserve								
O	Annual Installment (Withdrawal)	4,920	5,060	5,220	5,370	5,530	5,700	5,870	6,050
P	Running Balance	168,830	173,890	179,110	184,480	190,010	195,710	201,580	207,630
	Replacement Reserve								
Q	Annual Installment (Withdrawal)	45,922	55,416	59,277	93,320	67,281	(442,347)	4,471	44,471
R	Running Balance	646,954	702,370	761,647	854,967	922,248	479,901	484,372	528,842
	Capital Expansion Reserve								
S	Annual Installment (Withdrawal)	9,500	29,000	28,710	11,500	69,355	13,820	(29,210)	157,425
T	Running Balance	185,179	214,179	242,889	254,389	323,744	337,564	308,354	465,779
	Other Reserves								
U	Annual Installment (Withdrawal)	-	-	-	-	-			
V	Running Balance	72,100	72,100	72,100	72,100	72,100	72,100	72,100	72,100
W	**TOTAL RESERVE RUNNING BALANCE (N + P + R + T + V)**	1,159,363	1,257,639	1,336,846	1,467,836	1,629,502	1,214,475	1,204,906	1,393,751
X	**TOTAL ANNUAL RESERVE INSTALLMENT (M + O + Q + S + U)**	64,342	98,276	79,207	130,990	161,666	(415,027)	(9,570)	188,846
Y	**TOTAL REVENUE REQUIREMENT (D + L + X)**	1,029,719	949,949	762,808	978,054	1,158,891	1,061,808	1,098,052	1,124,842
	ADJUSTMENTS								
	(Increase) Decrease in Accounts Receivable	1166	(36,822)	14,041	13,960	(9,962)	(671,618)	(76,955)	(2,050,241)
	Increase (Decrease) in Accounts Payable	54079	(47,138)	(11,303)	(146,980)	20,175	520,328	208,513	2,171,371
	Depreciation-Non Cash							(172,996)	(136,278)
Z	**TOTAL ADJUSTMENTS**	55,245	(83,960)	2,738	(133,020)	10,213	(151,290)	(41,438)	(15,148)
AA	**BUDGET SURPLUS (DEFICIT) (-Y + A + Z)**	(31,113)	(213,769)	115,681	(40,791)	(41,546)	45,667	229,883	385,777
AB	**RUNNING BUDGET SURPLUS (AA + Plug #)**	(314,283)	(528,052)	(412,371)	(453,162)	(494,708)	(449,041)	(219,159)	166,618
AC	**ENDING CASH BALANCE (W + AB)**	**845,080**	**729,587**	**924,475**	**1,014,674**	**1,134,794**	**765,434**	**985,747**	**1,560,369**
	(Cash & Cash Equivalents for Operating and Construction Funds)								

Table 11-2
Terrace Heights Water System
Projected Revenues and Expenses

426 Terrace Heights	*2017	*2018	*2019	*2020	*2021	*2022	*2023	*2024	*2025	*2026
OPERATING REVENUES										
EPA - Grant										
Sale of Plans										
Water Sales	1,136,315	1,170,404	1,205,516	1,241,681	1,278,931	1,317,299	1,356,818	1,397,523	1,439,449	1,482,632
Residential Inspections	21,486	22,131	22,795	23,479	24,183	24,908	25,655	26,425	27,218	28,035
Fire Protection	57,622	59,351	61,132	62,966	64,855	66,801	68,805	70,869	72,995	75,185
Penalties	20,582	21,199	21,835	22,490	23,165	23,860	24,576	25,313	26,072	26,854
Reconnection Charges	8,400	8,652	8,912	9,179	9,454	9,738	10,030	10,331	10,641	10,960
Permit Fees	174,296	179,525	184,911	190,458	196,172	202,057	208,119	214,363	220,794	227,418
Investment Interest	8,791	9,055	9,327	9,607	9,895	10,192	10,498	10,813	11,137	11,471
Unrealized Gain/Loss on Investment	(6,968)	(7,177)	(7,392)	(7,614)	(7,842)	(8,077)	(8,319)	(8,569)	(8,826)	(9,091)
Interfund Interest	406	418	431	444	457	471	485	500	515	530
Cashiers Over/Short	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Miscellaneous	611	629	648	667	687	708	729	751	774	797
Contributed Capital	-	-	-	-	-	-	-	-	-	-
Prior year Correction	-	-	-	-	-	-	-	-	-	-
PWT Loan	-	-	-	-	-	-	-	-	-	-
A **Total Revenues**	1,421,540	1,464,186	1,508,114	1,553,356	1,599,956	1,647,956	1,697,395	1,748,318	1,800,768	1,854,790
OPERATING EXPENSES										
General & Administrative Expenses										
Operating Transfer Out	-	-	-	-	-	-	-	-	-	-
Salaries & Wages	177,577	182,904	188,391	194,043	199,864	205,860	212,036	218,397	224,949	231,697
Salaries-Overtime	575	592	610	628	647	666	686	707	728	750
Salaries-Extra Help	-	-	-	-	-	-	-	-	-	-
Accrued Comp Time	-	-	-	-	-	-	-	-	-	-
Accrued Annual Leave	26,538	27,334	28,154	28,999	29,869	30,765	31,688	32,639	33,618	34,627
Accrued Comp Leave	-	-	-	-	-	-	-	-	-	-
Benefits-Direct	58,373	60,124	61,928	63,786	65,700	67,671	69,701	71,792	73,946	76,164
Benefits-Indirec	(20,579)	(21,196)	(21,832)	(22,487)	(23,162)	(23,857)	(24,573)	(25,310)	(26,069)	(26,851)
Benefit bank accrual	(328)	(338)	(348)	(358)	(369)	(380)	(391)	(403)	(415)	(427)
Benefit Pension Expense	103,722	106,834	110,039	113,340	116,740	120,242	123,849	127,564	131,391	135,333
Office & Operati	23,957	24,676	25,416	26,178	26,963	27,772	28,605	29,463	30,347	31,257
Small Tools & Mi	14	14	14	14	14	14	14	14	14	14
Small Attrac-Tracked Inventory	388	400	412	424	437	450	464	478	492	507
Computer Software	2	2	2	2	2	2	2	2	2	2
Professional Ser	707	728	750	773	796	820	845	870	896	923
Professional Ser Indirect	12,257	12,625	13,004	13,394	13,796	14,210	14,636	15,075	15,527	15,993
Prof Serv-Purcha	3,165	3,260	3,358	3,459	3,563	3,670	3,780	3,893	4,010	4,130
Prof Serv-Info S	32,453	33,427	34,430	35,463	36,527	37,623	38,752	39,915	41,112	42,345
Prof Serv-GIS	18,290	18,839	19,404	19,986	20,586	21,204	21,840	22,495	23,170	23,865
Prof Serv-DOS	476	490	505	520	536	552	569	586	604	622
Communication-Telephone	1,191	1,227	1,264	1,302	1,341	1,381	1,422	1,465	1,509	1,554
Communication -Postage	5,266	5,424	5,587	5,755	5,928	6,106	6,289	6,478	6,672	6,872
Communication-TS Phones	314	323	333	343	353	364	375	386	398	410
Advertising	-	-	-	-	-	-	-	-	-	-
Travel	405	417	430	443	456	470	484	499	514	529
Operating Rental	4,369	4,500	4,635	4,774	4,917	5,065	5,217	5,374	5,535	5,701

Table 11-2
Terrace Heights Water System
Projected Revenues and Expenses

	426 Terrace Heights	*2017	*2018	*2019	*2020	*2021	*2022	*2023	*2024	*2025	*2026
	Liability Insura	50,233	51,740	53,292	54,891	56,538	58,234	59,981	61,780	63,633	65,542
	Repairs & Mainte	622	641	660	680	700	721	743	765	788	812
	Miscellaneous	3,439	3,542	3,648	3,757	3,870	3,986	4,106	4,229	4,356	4,487
	Intergov Prof Serv	-	-	-	-	-	-	-	-	-	-
	Rent	2,508	2,583	2,660	2,740	2,822	2,907	2,994	3,084	3,177	3,272
	External Taxes &	36,590	37,688	38,819	39,984	41,184	42,420	43,693	45,004	46,354	47,745
	Salaries & Wages	3,972	4,091	4,214	4,340	4,470	4,604	4,742	4,884	5,031	5,182
	Salaries Overtime	-	-	-	-	-	-	-	-	-	-
	Benefits-Direct	1,688	1,739	1,791	1,845	1,900	1,957	2,016	2,076	2,138	2,202
	Benefits-Indirec	494	509	524	540	556	573	590	608	626	645
	Office & Operati	72	74	76	78	80	82	84	87	90	93
	Small Tools & Mi	-	-	-	-	-	-	-	-	-	-
	Computer Software	-	-	-	-	-	-	-	-	-	-
	Small Attrac-Tracked Inventory	-	-	-	-	-	-	-	-	-	-
	Professional Ser	387	399	411	423	436	449	462	476	490	505
	Prof Serv-Indirect	253	261	269	277	285	294	303	312	321	331
	Prof Serv-Purcha	65	67	69	71	73	75	77	79	81	83
	Prof Serv-Info S	669	689	710	731	753	776	799	823	848	873
	Communication-Telephone	83	85	88	91	94	97	100	103	106	109
	Communication -Postage	208	214	220	227	234	241	248	255	263	271
	Travel	21	22	23	24	25	26	27	28	29	30
	Operating Rental	35	36	37	38	39	40	41	42	43	44
	Rent	102	105	108	111	114	117	121	125	129	133
	Liability Insura	1,398	1,440	1,483	1,527	1,573	1,620	1,669	1,719	1,771	1,824
	Pro Serv-Indirect	-	-	-	-	-	-	-	-	-	-
	Utility Services	-	-	-	-	-	-	-	-	-	-
	Repairs & Mainte	-	-	-	-	-	-	-	-	-	-
	Miscellaneous	(51)	(53)	(55)	(57)	(59)	(61)	(63)	(65)	(67)	(69)
B	**Total General & Administrative Expenses**	551,920	568,478	585,533	603,099	621,191	639,828	659,023	678,793	699,157	720,131
	Depreciation	-	118,553	118,553	118,553	118,553	118,553	118,553	118,553	118,553	118,553
	Operation & Maintenance Expenses										
	Debt Issue Costs	-	-	-	-	-	-	-	-	-	-
	Salaries & Wages	135,485	139,550	143,737	148,049	152,490	157,065	161,777	166,630	171,629	176,778
	Salaries-Overtime	7,528	7,754	7,987	8,227	8,474	8,728	8,990	9,260	9,538	9,824
	Salaries-Extra Help	44	45	46	47	48	49	50	52	54	56
	Call Out/Standby	20,568	21,185	21,821	22,476	23,150	23,845	24,560	25,297	26,056	26,838
	Benefits-Direct	64,870	66,816	68,820	70,885	73,012	75,202	77,458	79,782	82,175	84,640
	Benefits-Indirec	14,788	15,232	15,689	16,160	16,645	17,144	17,658	18,188	18,734	19,296
	Benefits-Bank Accruals	(569)	(586)	(604)	(622)	(641)	(660)	(680)	(700)	(721)	(743)
	Office & Operati	35,667	36,737	37,839	38,974	40,143	41,347	42,587	43,865	45,181	46,536
	Fuel Consumed	-	-	-	-	-	-	-	-	-	-
	Small Tools & Mi	2,596	2,674	2,754	2,837	2,922	3,010	3,100	3,193	3,289	3,388
	Computer Software	-	-	-	-	-	-	-	-	-	-
	Small Attrac-Tracked Inventory	-	-	-	-	-	-	-	-	-	-
	Professional Ser	12,100	12,463	12,837	13,222	13,619	14,028	14,449	14,882	15,328	15,788
	Communication -Telephone	2,735	2,817	2,902	2,989	3,079	3,171	3,266	3,364	3,465	3,569
	Communication -Postage	30	31	32	33	34	35	36	37	38	39
	Travel	-	-	-	-	-	-	-	-	-	-
	Advertising	-	-	-	-	-	-	-	-	-	-

Table 11-2
Terrace Heights Water System
Projected Revenues and Expenses

	426 Terrace Heights	*2017	*2018	*2019	*2020	*2021	*2022	*2023	*2024	*2025	*2026
	Operating Rental	42,668	43,948	45,266	46,624	48,023	49,464	50,948	52,476	54,050	55,672
	Utility Services	88,525	91,181	93,916	96,733	99,635	102,624	105,703	108,874	112,140	115,504
	Repairs & Mainte	40,031	41,232	42,469	43,743	45,055	46,407	47,799	49,233	50,710	52,231
	Miscellaneous	(8,328)	(8,578)	(8,835)	(9,100)	(9,373)	(9,654)	(9,944)	(10,242)	(10,549)	(10,865)
	Intergov Prof Se	-	-	-	-	-	-	-	-	-	-
	External Taxes	288	297	306	315	324	334	344	354	365	376
	Other Debt	20,520	21,136	21,770	22,423	23,096	23,789	24,503	25,238	25,995	26,775
	Debt Service Principal	-	-	-	-	-	-	-	-	-	-
	Interest on L-T Ext Debt	-	-	-	-	-	-	-	-	-	-
	Capital Salaries & Wages	-	-	-	-	-	-	-	-	-	-
	Capital Salaries-Overtime	-	-	-	-	-	-	-	-	-	-
	Capital Salaries-Extra Help	-	-	-	-	-	-	-	-	-	-
	Capital Benefits-Direct	-	-	-	-	-	-	-	-	-	-
	Capital Benefits-Indirec	-	-	-	-	-	-	-	-	-	-
	Capital Office & Operati	-	-	-	-	-	-	-	-	-	-
	Capital 'Professional Ser	-	-	-	-	-	-	-	-	-	-
	Capital Advertising	-	-	-	-	-	-	-	-	-	-
	Capital Operating Rental	-	-	-	-	-	-	-	-	-	-
	Capital 'Repairs & Mainte	-	-	-	-	-	-	-	-	-	-
	Capital 'Miscellaneous	-	-	-	-	-	-	-	-	-	-
	Intergov Prof Services	-	-	-	-	-	-	-	-	-	-
	Construction In Progress	-	-	-	-	-	-	-	-	-	-
	Machinery & Eequipment	-	-	-	-	-	-	-	-	-	-
	Capital Improvements	-	-	-	-	-	-	-	-	-	-
	Other Improvements	-	-	-	-	-	-	-	-	-	-
C	**Total Operation & Maintenance Expenses**	479,546	493,934	508,752	524,015	539,735	555,928	572,604	589,783	607,477	625,702
D	**TOTAL OPERATING EXPENSES (B + C)**	1,031,466	1,062,412	1,094,285	1,127,114	1,160,926	1,195,756	1,231,627	1,268,576	1,306,634	1,345,833
	CAPITAL IMPROVEMENT PROGRAM										
	Existing Loans										
	Total Outstanding Debt (Principal as of Dec 31)	155,196	155,196	155,196	155,196	155,196	155,196	155,196	155,196	155,196	155,196
E	Annual Debt Payments (Principal)										
F	Annual Debt Payments (Interest)										
	Debt Reduction Due to Expiration of Developer Agreements										
	Future Loans										
	Total Outstanding Debt (Principal as of Dec 31)	1,970,721	2,604,721	2,573,021	2,541,321	2,509,621	2,477,921	2,446,221	2,414,521	2,382,821	2,351,121
G	Annual Debt Payments (Principal on future loans)	-	-	31,700	31,700	31,700	31,700	31,700	31,700	31,700	31,700
H	Annual Debt Payments (Interest on future loans)		29,561	39,071	38,595	38,120	37,644	37,169	36,693	36,218	35,742
I	**Total Debt Payments (E + F + G + H)**	-	29,561	70,771	70,295	69,820	69,344	68,869	68,393	67,918	67,442
	Completed Capital Expenditures										
	TH Water - Phase II P/E	-	-	-	-	-	-	-	-	-	-
	TH Water - Phase II Engineering	-	-	-	-	-	-	-	-	-	-
	TH Water - Phase II Admin	-	-	-	-	-	-	-	-	-	-
	TH Water - Phase II Construction	-	-	-	-	-	-	-	-	-	-
	TH O & M Improvements (426)	-	-	-	-	-	-	-	-	-	-
	Operating Transfer Out	-	-	-	-	-	-	-	-	-	-
	33rd Street Water Line	-	-	-	-	-	-	-	-	-	-
	Miscellaneous	-	-	-	-	-	-	-	-	-	-
	Well 2 Repairs	-	-	-	-	-	-	-	-	-	-

Table 11-2
Terrace Heights Water System
Projected Revenues and Expenses

	426 Terrace Heights	*2017	*2018	*2019	*2020	*2021	*2022	*2023	*2024	*2025	*2026
	East Hillcrest Dr. & Canyon Rd Water Lines	-	-	-	-	-	-	-	-	-	-
	Pacific NW University	-	-	-	-	-	-	-	-	-	-
	Well #3 Repairs	-	-	-	-	-	-	-	-	-	-
	Well #4	-	-	-	-	-	-	-	-	-	-
	Future Capital Expenditures										
	Well 6 Supply Improvements	-	670,000	-	-	-	-	-	-	-	-
	Ridgeway Drive Improvements	-	-	-	-	-	-	-	-	-	-
	AMR Implementation	-	-	-	-	-	-	-	-	-	-
	Country Club Tower Rehabilitation	-	400,000	-	-	-	-	-	-	-	-
	Zone 3 Storage	-	-	-	-	-	-	-	-	-	-
	Fire Hydrant Access Improvements	-	-	10,000	-	-	-	-	-	-	-
	Fire Protection Improvements	-	-	-	-	-	-	-	-	-	-
	Distribution System Improvements				100,000	100,000	100,000	100,000	100,000	100,000	100,000
	Maple Avenue Waterline		500,000								
	Butterfield Road Waterline			400,000							
	Meter Testing Program										
	Reservoir #1 Painting		-	350,000							
	Well 7					-	800,000				
	Storage Building	-		150,000							
	Well 1 Water Rights	-		-	70,000						
		-	-	-	-	-	-	-	-	-	-
J	**Total Capital Expenditures**	-	1,570,000	910,000	170,000	100,000	900,000	100,000	100,000	100,000	100,000
	Capital Sources										
	CDBG Grant										
	PWTF/SRF Proceeds		634,000								
	Bonds										
	Construction Fund - Investment Interest										
	Miscellaneous										
	Assessment Principal LID #2										
	Assessment Principal LID # 3										
	Special Assessment Bond Proc										
	Operating Transfer In (SEID)										
	Operating Transfer In (Includes REET Trns In)	-	-	-	-	-	-	-	-	-	-
K	Total Capital Sources	-	634,000	-	-	-	-	-	-	-	-
L	**NET CAPITAL COSTS (-K + I + J)**	-	965,561	980,771	240,295	169,820	969,344	168,869	168,393	167,918	167,442
	RESERVES										
	Operating Reserve										
M	Annual Installment (Withdrawal)	65,800	3,900	4,000	4,100	4,200	4,400	4,500	4,600	4,700	4,900
N	Running Balance	128,900	132,800	136,800	140,900	145,100	149,500	154,000	158,600	163,300	168,200
	Emergency Reserve										
O	Annual Installment (Withdrawal)	6,420	6,610	6,810	7,010	7,220	7,440	7,660	7,890	8,130	8,370
P	Running Balance	220,280	226,890	233,700	240,710	247,930	255,370	263,030	270,920	279,050	287,420
	Replacement Reserve										
Q	Annual Installment (Withdrawal)	44,471	(355,530)	(455,530)	(55,530)	(55,530)	(55,530)	(55,530)	(55,530)	(55,530)	(55,530)
R	Running Balance	617,783	262,254	(193,276)	(248,806)	(304,335)	(359,865)	(415,394)	(470,924)	(526,453)	(581,983)
	Capital Expansion Reserve										
S	Annual Installment (Withdrawal)	87,148	(446,237.50)	92,456	95,229	98,086	(698,972)	104,060	107,182	110,397	113,709

Table 11-2
Terrace Heights Water System
Projected Revenues and Expenses

	426 Terrace Heights	*2017	*2018	*2019	*2020	*2021	*2022	*2023	*2024	*2025	*2026
T	Running Balance	594,247	148,010	240,465	335,694	433,780	(265,192)	(161,132)	(53,951)	56,447	170,156
	Other Reserves										
U	Annual Installment (Withdrawal)		-	(10,000)							
V	Running Balance	72,100	72,100	62,100	62,100	62,100	62,100	62,100	62,100	62,100	62,100
W	**TOTAL RESERVE RUNNING BALANCE (N + P + R + T + V)**	1,633,310	842,053	479,789	530,599	584,575	(158,086)	(97,396)	(33,254)	34,444	105,893
X	**TOTAL ANNUAL RESERVE INSTALLMENT (M + O + Q + S + U)**	203,839	(791,257)	(362,264)	50,810	53,977	(742,661)	60,690	64,142	67,698	71,450
Y	**TOTAL REVENUE REQUIREMENT (D + L + X)**	1,235,305	1,236,716	1,712,792	1,418,219	1,384,722	1,422,439	1,461,186	1,501,111	1,542,249	1,584,725
	ADJUSTMENTS										
	(Increase) Decrease in Accounts Receivable	-	-	-	-	-	-	-	-	-	-
	Increase (Decrease) in Accounts Payable	-	-	-	-	-	-	-	-	-	-
	Depreciation-Non Cash										
Z	**TOTAL ADJUSTMENTS**	-	-	-	-	-	-	-	-	-	-
AA	**BUDGET SURPLUS (DEFICIT) (-Y + A + Z)**	186,236	227,470	(204,678)	135,137	215,234	225,517	236,209	247,207	258,519	270,065
AB	**RUNNING BUDGET SURPLUS (AA + Plug #)**	455,591	683,061	478,383	613,520	828,754	1,054,271	1,290,480	1,537,687	1,796,205	2,066,271
AC	**ENDING CASH BALANCE (W + AB)**	**2,088,901**	**1,525,114**	**958,172**	**1,144,119**	**1,413,329**	**896,185**	**1,193,084**	**1,504,433**	**1,830,649**	**2,172,164**
	(Cash & Cash Equivalents for Operating and Construction Funds)										

Chapter 12
Relationship with Other Plans

Compatibility with Other Related Plans

Water systems adjacent to the Terrace Heights Water System that are required to prepare a water system plan include the City of Yakima and the City of Moxee. Moxee's plan was updated in 2016 and the City of Yakima's in 2017. Service area boundaries between these systems are depicted the same in each of the Cities' water plans as in this plan. An electronic copy of the Terrace Heights water plan was provided to both Cities for comment. Comments received are included in Appendix J.

In 2010, Yakima County and the City of Moxee completed a study to evaluate the ability of Terrace Heights and Moxee to provide water service to future development within the State Route 24 Corridor. The Study recommended each system move forward with planning for pipeline extensions along State Route 24 with no changes to the service areas. The Study also suggested an intertie comprised of both a pressure reducing valve (for conveyance of water from Moxee to Terrace Heights), and a booster pump station (for conveyance of water from Terrace Heights to Moxee).

The Terrace Heights Sewer District provides sewer service within the Terrace Heights Water System service area. The District's future service area includes all of the water system service area that lies within the Urban Growth Area. The District's 2005 Amendment to their 1998 General Sewer Plan was reviewed for compatibility with population projections. An average annual growth rate of 4.32 percent was used in the Amendment. Growth rates predicted in this water plan (1.3 percent per year) are noticeably less than those in the General Sewer Plan.

In 1999, Yakima County and the City of Yakima adopted a subarea plan of the Yakima Urban Area Comprehensive Plan known as the Terrace Heights Neighborhood Plan (THNP). The THNP was repealed by the Board of Yakima County Commissioners in 2017 simultaneously with the adoption of Horizon 2040 (Ord. 4-2017). Appropriate portions of the THNP were merged into Horizon 2040 (including the Future Land Use Map, and particular Goals & Policies). Yakima County uses Horizon 2040 as a guide when writing staff reports and land use decisions, and in the design of future public improvements in the area. Water service areas, future land use and population projections from Horizon 2040 were considered when developing this water system plan update.

In 1988, the County prepared a document entitled "*Utilities Manual Guidelines.*" Included in the document are developer construction and extension policies, design standards, and operation procedures. Wherever inconsistencies are encountered, the policies, standards and procedures described in this water plan will take precedence over those in the Utilities Manual Guidelines.

County Response on Compatibility with Land Use Plans and Growth Policies

A copy of the water system plan was submitted to the Yakima County Planning Division for consistency review with the County's growth management plan (Horizon 2040). A copy of the Planning Department's review comments are included in Appendix J.