Rockwood Water PUD

# Water Master Plan Update

June 2025


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# Water Master Plan Update

## Rockwood Water PUD

*June 2025*

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# Acronyms & Abbreviations

| | |
|---|---|
| A | |
| AACE | Association for the Advancement of Cost Engineering International |
| ADD | Average Day Demand |
| AWWA | American Water Works Association |
| C | |
| CFU | Colony Forming Unit |
| CGA | Cascade Groundwater Alliance |
| CIP | Capital Improvement Program |
| CSSWF | Columbia South Shore Wellfield |
| CSZ | Cascadia Subduction Zone |
| D | |
| DOGAMI | Oregon Department of Geology and Mineral Industries |
| E | |
| ENR CCI | Engineering News-Record Construction Cost Index |
| G | |
| GDMP | 2020 Groundwater Development Master Plan |
| GIS | Geographic Information System |
| gpcd | Gallons per Capita per Day |
| gpm | Gallons per Minute |
| H | |
| HAA5 | Haloacetic Acids |
| HGL | Hydraulic Grade Line |
| hp | Horsepower |
| I | |
| I-84 | Interstate 84 |
| IGA | Intergovernmental Agreement |
| M | |
| MCL | Maximum Contaminant Level |
| MDD | Maximum Daily Demand |
| MG | Million Gallons |
| µg/L | Micrograms per Liter |
| mg/L | Milligrams per Liter |
| mgd | Million Gallons per Day |
| msl | Mean Sea Level |
| O | |
| OAR | Oregon Administrative Rules |
| ORP | Oregon Resilience Plan |
| P | |
| PGD | Permanent Ground Deformation |

| | |
|---|---|
| PGV | Peak Ground Velocity |
| PHD | Peak Hour Demand |
| ppb | Parts per Billion |
| PRV | Pressure Reducing Valve |
| psi | Pounds per Square Inch |
| PWB | Portland Water Bureau |
| **R** | |
| RTU | Remote Telemetry Unit |
| RWPUD | Rockwood Water People's Utility District |
| **S** | |
| SCADA | Supervisory Control and Data Acquisition |
| SDC | System Development Charge |
| SDWA | Safe Drinking Water Act |
| **T** | |
| TDS | Total Dissolved Solids |
| TOC | Total Organic Carbon |
| TTHMs | Total Trihalomethanes |
| **W** | |
| WMP | Water Master Plan Update |

CHAPTER 1

# Master Plan Summary

## 1.1 Purpose

The purpose of this study is to perform an updated analysis of the Rockwood Water People's Utility District's (RWPUD's) water system utilizing the comprehensive Water Master Plan Update (WMP) prepared by Consor (formerly Murray, Smith & Associates, Inc.) in 2013 and the 2020 Groundwater Development Master Plan (GDMP) as the foundation.

This updated analysis will determine future (20-year period) water distribution system requirements and recommend facility improvements that will meet water quality and capacity goals in alignment with the Oregon Health Authority.

The following key steps were part of the path of completing this WMP.

- Documentation of the existing water system, including improvements completed since the 2013 WMP
- Summarization of the supply analysis completed in the 2020 GDMP
- Development of future RWPUD population and water demand requirements
- Evaluation of the water system's seismic resilience
- Hydraulic analysis of the water system to accommodate future water demands.
- Development of recommendations and an updated water system Capital Improvement Program (CIP) with estimates of project costs and phasing.
- Development of a document which will support future review of System Development Charges (SDCs) and water rates based on the updated CIP

The recommended system improvements, evaluations, and projects presented in this plan are intended to provide RWPUD's staff with background information needed to inform long-term water infrastructure decisions and communicate with stakeholders.

Table 1-1 | Document Organization

| Chapter | Content |
| --- | --- |
| **Chapter 2** | RWPUD's existing water infrastructure inventory |
| **Chapter 3** | Water quality and capacity level of service goals for the water system |
| **Chapter 4** | Water use projections based on estimated population growth |
| **Chapter 5** | Existing system analysis for existing and future conditions |
| **Chapter 6** | Alternatives, basis for cost, and potential impacts of strategies to address deficiencies (summarized in **Chapter 5**) |
| **Chapter 7** | Summary of the CIP |
| **Chapter 8** | Seismic risk assessment and mitigation plan, focused on critical facilities |

## 1.2 Compliance

This plan complies with water system master planning requirements established under Oregon Administrative Rules (OAR) for Public Water Systems, Chapter 333, Division 61.

## 1.3 Existing Water System

The RWPUD provides potable water to approximately 64,000 people in northwest Gresham, a small area within Fairview and outer east Portland. Customers are supplied through approximately 13,805 residential, commercial, and industrial service connections.

The RWPUD is generally bounded by Interstate 84 (I-84) to the north, the cities of Fairview and Wood Village to the east, the former Powell Valley Road Water District service area to the south (now part of the Portland Water Bureau (PWB)), and SE 135th Avenue to the west. The RWPUD service area is entirely within Multnomah County and is adjacent to the PWB and the cities of Gresham and Fairview.

As of 2023, RWPUD draws its water supply directly from the PWB's Bull Run conduits through wholesale master metered connections. To reduce wholesale water costs, all peak water demand beyond the base flow from PWB is supplied to RWPUD customers from the Cascade groundwater system. RWPUD also maintains emergency water system interties with the cities of Fairview, Gresham, and Portland. RWPUD's goal for 2026 is to become independent of PWB and provide enough supply from its own wells to support all demand conditions. RWPUD, as part of the Cascade Groundwater Alliance (CGA) partnership with the City of Gresham, is currently implementing the improvements necessary to complete this goal. The groundwater supply system will be substantially complete in 2026 and will serve the CGA partners with 34.7 million gallons per day (mgd) of total groundwater supply through eight wells with three groundwater treatment facilities to remove iron and manganese and provide chlorine disinfection.

The RWPUD's distribution system is divided into four pressure zones; Main Pressure Zone, Cleveland Pressure Zone, Glendoveer Pressure Zone, and Bon-Al Pressure Zone, with five finished water storage reservoirs and a total effective storage capacity of approximately 23 million gallons (MG). The system contains six pump stations which deliver groundwater supply to the distribution system and provide constant pressure operation to serve three of the four pressure zones.

The water system contains over 165 miles of transmission and distribution piping, ranging from 4-inch to 36-inch diameter.

## 1.4 Present and Future Water Demands

Population and water demand forecasts are developed from historical growth trends in RWPUD and surrounding communities. Water demand records, regional planning data, land use designations and previous RWPUD water supply planning efforts are the base for future water use estimates. The service area boundary is expected to remain constant in the future. New customers and increased future water demands are expected primarily from expanded industrial and commercial development as well as high density residential re-development within the existing service area.

Existing water demands were developed from a review of historical water billing records and operations data, such as pump station flows, provided by RWPUD from their Supervisory Control and Data Acquisition (SCADA) system. Historical trends show the largest ratio of maximum day demand (MDD) to average day demand (ADD) as 1.51 and the average per capita water use factor as 112 gallons per capita per day (gpcd).

These parameters characterize existing water use in the RWPUD service area and were used to develop future water use projections.

The anticipated population through the year 2045 is estimated based on historical population estimates reported by the Population Research Center in 2024. Population forecasts at saturation development for the RWPUD's water service area were determined based on available developable land and zoning designations.

**Table 1-2** shows the future demands expected in the RWPUD service area.

Table 1-2 | RWPUD Future Demand Projection

| Year | Population | ADD (mgd) | ADD (gpm) | MDD (mgd) | MDD (gpm) | PHD (gpm) |
|---|---|---|---|---|---|---|
| 2023 | 64,071 | 7.0 | 4,860 | 9.9 | 6,898 | 10,348 |
| 2026 | 66,580 | 7.5 | 5,197 | 11.3 | 7,860 | 11,789 |
| 2030 | 68,974 | 9.7 | 6,059 | 13.1 | 9,117 | 13,676 |
| 2040 | 71,094 | 10.0 | 6,224 | 13.6 | 9,431 | 14,147 |
| 2045 | 71,865 | 10.1 | 6,284 | 13.7 | 9,489 | 14,233 |
| Saturation | 79,747 | 10.9 | 6,897 | 14.9 | 10,375 | 15,562 |

# 1.5 Service and Water Quality Goals Summary

Service goals and planning assumptions were identified for service pressures, storage volume (operational, fire, and emergency), pumping capacity, and fire flow requirements. Water demand forecasts were developed for the 20-year planning period. Water quality parameters were identified to ensure compliance with regulatory standards set by the Clean Water Act and the Safe Drinking Water Act (SDWA). These criteria were utilized for the analysis of the RWPUD's water system. The service goals are summarized in **Table 1-3**.

Table 1-3 | Water System Service Goals Summary

| Water System Component | Evaluation Criterion | Value |
|---|---|---|
| Water Supply | Source Capacity (System-wide) | MDD with largest well out of service |
| | Treatment Capacity (System-wide) | MDD |
| | Backup Power for Wells | Two independent power sources |
| Service Pressure | Normal Range | 45-100 psi @ service |
| | Maximum | 100 psi (with individual service PRVs above 80 psi) |
| | Minimum, during fire flow | 20 psi |
| Transmission Mains | Maximum Velocity | 4 feet per second (fps) |
| Storage | Operational Storage | Tank level set points |
| | Equalization Storage | PHD[1] - MDD for 24 hours |
| | Fire Storage | Required fire flow * flow duration |
| | Emergency Storage | 50% MDD |
| Pump Stations (with additional Gravity Storage for zone) | Total Capacity | MDD |
| | Backup Power | Recommended but not required |

| Water System Component | Evaluation Criterion | Value |
|---|---|---|
| Pump Stations (w/out additional Gravity Storage for zone) | Total Capacity | PHD + Fire Flow |
| | Backup Power | Transfer switch and on-site generator |
| Water Quality | SDWA Requirements | All contaminant levels below MCLs |
| | Manganese Scale Control | Less than 0.02 mg/L |

Notes:
1 PHD: Peak Hour Demand
2 PRV: Pressure Reducing Valve

# 1.6 Present and Future Water System Analysis and Findings

## 1.6.1 Supply

Based on the well testing completed to date and modeling completed by GSI Water Solutions, Inc., an estimated typical operating capacity and reduced operating capacity has been developed for each well. The reduced operating capacity is based on the evaluation of groundwater pumping level declines expected to occur in a year when the PWB operates their Columbia South Shore Wellfield (CSSWF) at high capacities for an extended duration throughout the year, which could occur if an emergency condition disrupts their primary Bull Run surface water supply. Typically, the PWB operates the CSSWF at reduced capacities during the summer season to supplement the surface water supply and this pumping rate and duration is not expected to have an impact on the CGA's groundwater capacities.

As presented above, the reliable supply source capacity must be adequate to meet the MDD, with the largest source out of service (firm capacity). **Table 1-4** illustrates the available supply capacity of the RWPUD's source versus water demands.

### Table 1-4 | Supply Capacity Analysis

| Planning Horizon | Projected MDD (mgd) | Firm Groundwater Supply Capacity | | Supply Capacity Surplus[1] Typical/Reduced (mgd) |
|---|---|---|---|---|
| | | Typical (mgd) | Reduced (mgd) | |
| 2026[1] | 11.3 | 13.5 | 10.0 | 2.2 / (1.3) |
| 2030 | 13.1 | 16.0 | 12.0 | 2.9 / (1.1) |
| 2040 | 13.6 | | | 2.4 / (1.6) |
| 2045 | 13.7 | | | 2.3 / (1.7) |
| Saturation | 14.9 | | | 1.1 / (2.9) |

Note:
1.The projected MDD for year 2026 does not include the additional 1 mgd of increased industrial demand projected for future years in the planning horizon. Firm capacity in 2026 assumes the Cascade Well 6 is not yet complete.

Based on this comparison of firm, reliable supply versus projected demands, the following conclusions can be drawn.

- The RWPUD has adequate firm supply capacity to meet system demands in the summer of 2026 as the PWB wholesale contract expires.
- The RWPUD has adequate firm supply capacity to meet the water supply needs through saturation development of the service area.

- The RWPUD can be expected to experience a supply shortfall throughout the planning horizon, if the PWB operates the CSSWF at high pumping rates year-round. Currently, this condition would only occur if there was an emergency that disrupted the Bull Run surface water supply for an extended period.

Based on this analysis, it is recommended that the RWPUD investigate groundwater expansion alternatives to meet the total supply need under reduced capacity conditions due to significant increases in overall groundwater use throughout East Multnomah County (primarily due to PWB CSSWF operation). There are two primary alternatives to increase the reliable groundwater capacity.

- Participation with the City of Gresham in the development of Cascade Well 10. The City is currently completing exploratory well development adjacent to the North Gresham Elementary School near the intersection of SE 217th Avenue and SE Yamhill Street.

- Initiate exploratory drilling for a future Cascade Well 11. Based on preliminary investigations and planning presented in the GDMP, investigation of sites for a future additional groundwater well should focus on potential properties east of NE 202nd Avenue and north of NE Glisan Street.

In order to select which of the two alternatives to pursue, the RWPUD should coordinate with the City of Gresham to determine the City's timing and total capacity needs beyond the existing developed infrastructure. Specifically, to understand if the City anticipates needing additional supply development beyond Cascade Well 10 in order to meet their future demands and how RWPUD participation in the development of this well could impact the City's future needs.

For the purposes of this WMP, it is anticipated that the RWPUD will construct Cascade Well 11 or participate in Gresham's Cascade Well 10in the future, as increasing demands warrant.

## 1.6.2 Storage Volume

Based on the evaluation of the storage required to serve the water system, there is no additional storage needed for existing (2026), near-term (2030), 2040 and in the next 20 years (2045), or for saturation conditions.

## 1.6.3 Pumping Capacity

The pumping analysis is based on the following key considerations.

1. The existing Glendoveer, Bon-Al, and Cleveland Zones are all served as constant pressure systems.

2. Water is supplied to Main Pressure Zone customers by gravity from the Bella Vista Reservoir. It is recommended that the Cascade Pump Station serving the Main Pressure Zone have adequate firm pumping capacity to supply the MDD for the system, as all pump stations draw supply from the Main Pressure Zone.

3. The Bella Vista Pump Station is not considered in the pumping capacity analysis for the Main Zone because it primarily functions to boost pressure and not as an independent supply to the zone.

The pumping system serving Bon-Al is deficient in capacity for existing (2026) conditions. In future scenarios the deficiencies intensify. This is consistent with prior master planning analyses and a capital improvement project is currently planned to upgrade the capacity of the Bon-Al Pump Station to meet pressure zone supply needs. To address this deficiency the recommendation will include the replacement of one of the

140 gallons per minute (gpm) pumps with a new unit of 820 gpm in the short term. Additionally, the 40 gpm unit should be replaced with a new unit of 100 gpm in the medium term planning horizon.

The Cleveland and 141st Avenue Pump Stations have adequate capacity to reliably serve their respective pressure zones through saturation development.

The Cascade Pump Station has adequate capacity to transmit the firm capacity of the well supplying the Cascade Reservoirs. A space for a sixth pump has been included in the pump station to accommodate an increase in pumping capacity to match the total supply capacities of the Cascade wells that pump to the site, as well as providing for expanded capacity in the event a future Cascade Well 11 is constructed that would also be pumped to the Cascade site.

### 1.6.4 Water Quality

The RWPUD's system is supplied completely from groundwater sources and currently meets all primary water quality standards. It is in compliance with the Lead and Copper Rule, with contaminant levels below the action level. Treatment for iron and manganese is provided for all of the groundwater sources (Cascade Wells 3, 4 and 5, 6, 7, 8, and 9) through three water treatment facilities (Cascade Well 6 treatment facility is currently in design).

### 1.6.5 Seismic Analysis

Water providers throughout the Pacific Northwest are increasingly aware of the risk to their infrastructure from potential seismic activity. Following recent seismic research which presented persuasive evidence on the imminent threat and extreme risk of a Cascadia Subduction Zone (CSZ) earthquake, the State of Oregon developed the Oregon Resilience Plan (ORP). The ORP established target timelines for water utilities to provide service following a seismic event. The ORP also recognized that, currently, water providers and existing water infrastructure are unable to meet these recovery goals. To improve existing water systems' seismic resilience, one of the ORP's key recommendations was for water utilities to complete a seismic risk assessment and mitigation plan as part of their periodic WMP update.

As part of this WMP, RWPUD has completed a seismic hazard evaluation (Delve Underground, 2023) of their existing water system. The scope of this evaluation included the review of the Oregon Department of Geology and Mineral Industries (DOGAMI) seismic hazard maps, available geological information, and available boring log and well log information to verify DOGAMI seismic hazard maps. With this information, estimates of strong ground shaking, liquefaction-induced settlement, lateral spreading displacement, and seismic landslide slope instability were developed. The main goal was to identify the geotechnical hazards along the backbone of the RWPUD system.

The RWPUD's critical facilities mainly consist of above-ground storage tanks, reservoirs, and wells. Based on available data, the liquefaction, lateral spreading, and seismic landslide hazards are considered to be low at these sites. Additionally, the structures and mechanical components will need to be evaluated to ensure resiliency under strong seismic ground shaking.

Site-specific studies were not performed because all the existing facilities have been constructed or retrofitted under the current building code within the last 20 years. It is recommended a site-specific study be conducted on the RWPUD offices.

In general, it's expected that the seismic hazards for a magnitude 9.0 CSZ event in the majority of the RWPUD's backbone water system are generally low.

### 1.6.6 Distribution System

The analysis concluded that distribution and transmission system improvements are needed to meet the RWPUD's pressure and fire flow criteria under existing and future demand conditions. The recommended improvements were categorized as high, medium, and low priority based on how close the deficiency location is to meet the pressure and fire flow requirements.

The improvements are also described based on the type of deficiency:

- Small diameter: where the pipes have a diameter of 6 inches or less, the minimum fire flow requirements will not be met due to the high friction losses through small diameter pipes. Also, these pipes are most likely 50-year old cast iron, ductile iron, steel mains. These pipes should be scheduled for replacement not only due to capacity but also assumed deteriorated condition due to their age.

- High fire flow requirements: the fire flow requirements in the system depend on land use and building type. The fire flow requirements have been updated in recent years, based on current land use and building type, which increased the required flows. The updated (2023) land use map and increased fire flow requirements caused several deficiencies in the system. The CIP improvements that this type of deficiency triggered are both of transmission and distribution nature. Improvements recommended to address this kind of deficiency should be validated once the design phase starts, to account for potential changes in the zoning type.

## 1.7 CIP Summary

The recommended CIP to address the deficiencies identified through the water system analysis and resulting findings focuses on three areas.

- Pipeline Renewal and Replacement
- Fire Flow Capacity Improvements
- Future Groundwater Capacity Expansion

It is recommended that the RWPUD continue investment in capital improvements at levels similar to the past several years, with the exception of the significant investment in groundwater development over the past 5 years, to continue addressing hydraulic deficiencies and replacement of aging infrastructure. As such, the CIP reflects an average annual budget of $2 million to $3 million, with ongoing capital investment continuing well beyond the 20-year planning horizon.

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CHAPTER 2

# Water System Description

This chapter describes the RWPUD's water service area and inventories the water distribution system facilities. It includes a discussion of existing supply and transmission facilities, groundwater wells, system interties, pressure zones, storage and pumping facilities, distribution system piping, and telemetry and supervisory control systems.

## 2.1 Study Area

The RWPUD provides potable water to approximately 64,000 people in northwest Gresham, a small area within Fairview and outer east Portland. Customers are supplied through approximately 13,805 residential, commercial, and industrial service connections.

The RWPUD is generally bounded by I-84 to the north, the cities of Fairview and Wood Village to the east, the former Powell Valley Road Water District service area (now part of PWB) to the south, and SE 135th Avenue to the west. The RWPUD service area is entirely within Multnomah County and is adjacent to the PWB and the cites of Gresham and Fairview. Due to these abutting providers, no expansion of the RWPUD service area is expected, though demand is anticipated to grow through infill development. The RWPUD water service area, supply connections, and existing water system facilities are illustrated in Figure 2-1.

There are four pressure zones in the RWPUD system. The largest is the Main Pressure Zone, with the other three serving higher elevation areas at the west, east, and south limits of the service area. These are the Glendoveer Pressure Zone, Cleveland Pressure Zone, and Bon-Al Pressure Zone. Figure 2-2 presents a hydraulic schematic of RWPUD's existing pressure zones and main water system infrastructure.

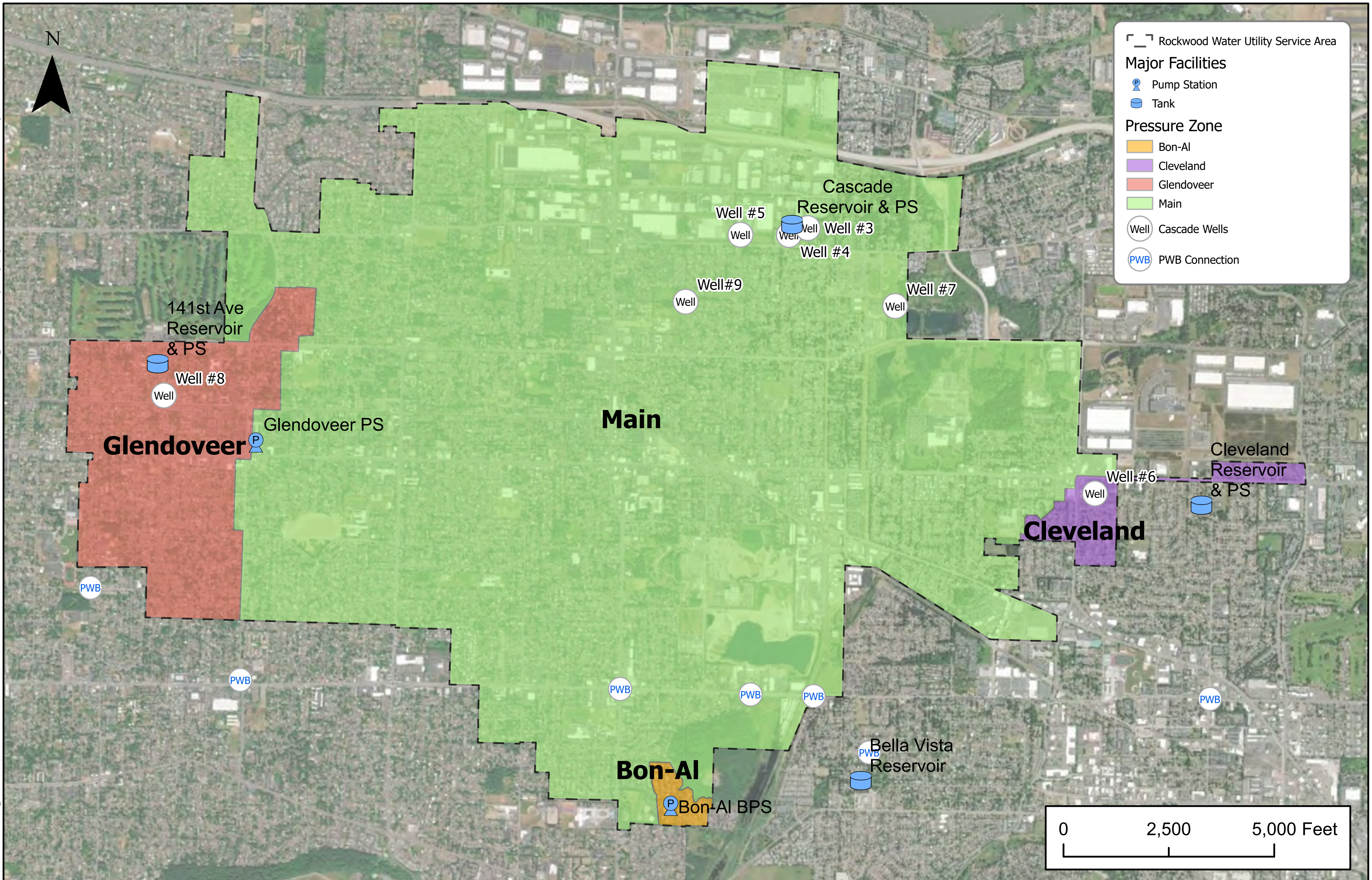
## 2.2 Water Supply

As of 2023, the RWPUD draws its water supply directly from the PWB's Bull Run conduits through wholesale master metered connections. To reduce wholesale water costs, all peak water demand beyond the base flow from PWB is supplied to RWPUD customers from the Cascade groundwater system. RWPUD also maintains emergency water system interties with the cities of Fairview, Gresham, and Portland. RWPUD's goal for 2026 is to become independent of PWB and provide enough supply from its own wells to support all demand conditions. As part of the CGA partnership with the City of Gresham, RWPUD is currently implementing the improvements necessary to complete this goal. For the purposes of this WMP, existing conditions assume the groundwater supply facilities currently in design and construction are on-line.

### 2.2.1 Portland Water Bureau Supply

The PWB operates three large-diameter steel supply conduits that carry water from the Bull Run watershed, located east of RWPUD, west through the City of Gresham to supply the City of Portland and wholesale customers throughout the Portland metro area.

The Bull Run watershed is a surface water supply located approximately 26 miles east of Portland at the base of the Cascade Mountains. The PWB's conduits are fed from Bull Run Lake and two surface water impoundments. Water produced from the Columbia South Shore Well Field is used to supplement the Bull Run watershed surface water supply during high demand periods.

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Rockwood Water
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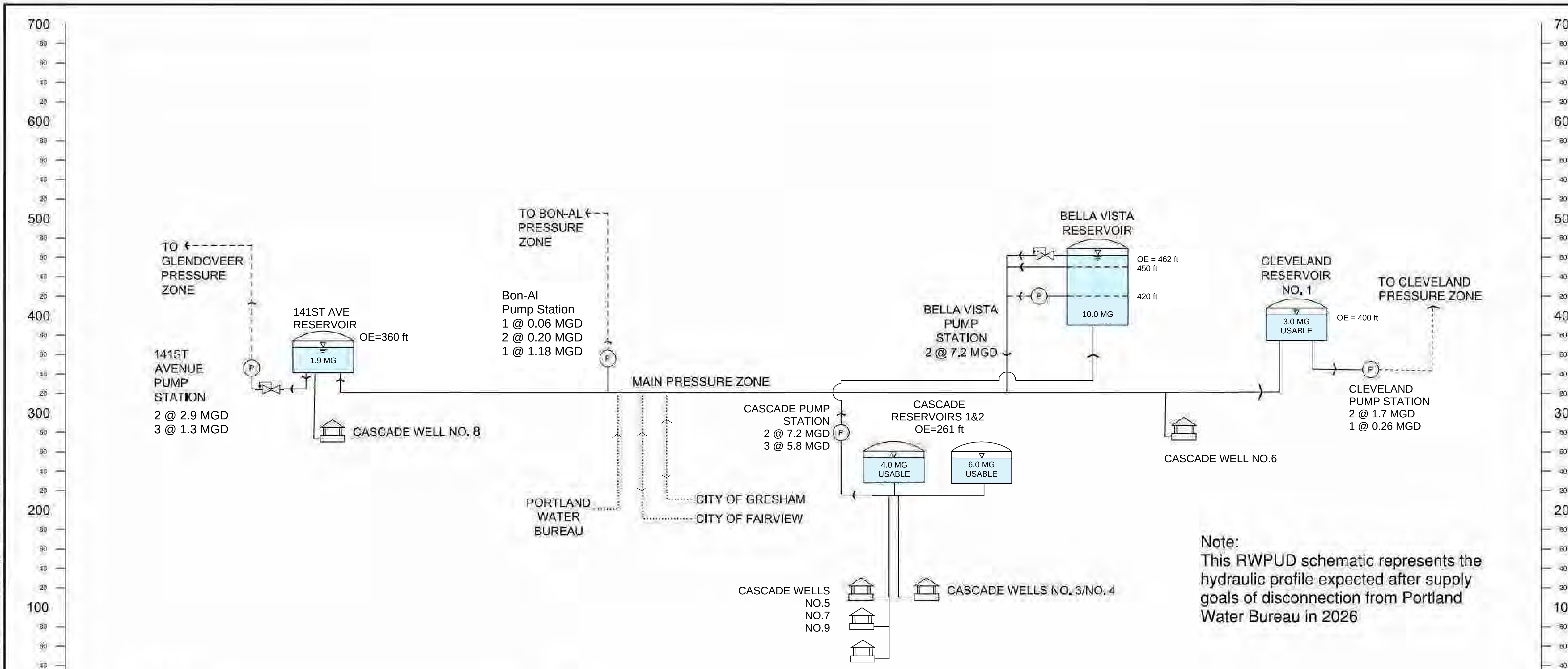
**RWPUD**
**2024 Water System Master Plan**

Figure 2-1
RWPUD Service Area

20-2870




## LEGEND

| | EXISTING |
|---|---|
| PUMP DISCHARGE WATER MAIN | |
| WATER MAIN | |
| RESERVOIR (CAPACITY INDICATED IN MILLION GALLONS, OVERFLOW ELEVATION IN FEET) | 1.0 MG OE=410' |
| GROUNDWATER WELL | |
| PRESSURE REDUCING VALVE | |
| CLOSED VALVE | |
| PUMP STATION (NUMBER OF PUMPS AND CAPACITY IN MILLION GALLONS PER DAY) | P |
| DISTRIBUTION SYSTEM EMERGENCY INTERTIES | |

## ABBREVIATIONS

| | |
|---|---|
| EA | EACH |
| MG | MILLION GALLONS |
| MGD | MILLION GALLONS PER DAY |
| OE | OVERFLOW ELEVATION |
| PRV | PRESSURE REDUCING VALVE |

**RWPUD 2024 Water System Master Plan**

Figure 2-2
RWPUD Hydraulic Profile

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Rockwood Water
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The RWPUD receives water from the conduits as they pass through Gresham and along RWPUD's southern service area boundary before reaching PWB storage facilities at Powell Butte and Kelly Butte. RWPUD can receive water through seven master metered connections owned and maintained by PWB, connecting to Conduit Nos. 2 and 4 primarily along SE Division Street on RWPUD's southern border. PWB master metered conduit connections are summarized in **Table 2-1**.

Further discussion of the future maintenance of these conduit connections is presented in **Chapter 5**.

Table 2-1 | Conduit Connection Summary

| Location | Meter Size (Inches) | PWB Conduit No. | Average HGL (feet) | Connection To RWPUD Facility |
|---|---|---|---|---|
| NE Cleveland Avenue (235th) & NE Division Street | 10 | 4 | 525 - 550 | Cleveland Reservoir |
| NW 5th Street & NW Riverview Way | 10 | 2 | 525 - 545 | Bella Vista Reservoir |
| SE 202nd Avenue & NW Division Street | 10 | 4 | 525 - 545 | Bella Vista Reservoir |
| SE 192nd Avenue & NW Division Street | 10 | 2 & 4 | 4131 | distribution system with PRV[2] |
| SE 182nd Avenue & NW Division Street | 8 | 4 | 4211 | distribution system with PRV[2] |
| SE 148th Avenue & NW Division Street | 8 | 2 | 430 - 450 | distribution system |
| SE 135th Avenue & SE Mill Street | 8 | 4 | | distribution system |

Notes:

1. The average hydraulic grade line (HGL) range is based on outlet setting of RWPUD's PRVs.

## 2.2.2 Cascade Groundwater System

The Cascade Groundwater System originally consisted of RWPUD's Cascade Well Nos. 3 and 4 and Cascade Well No. 5 which is jointly operated under an intergovernmental agreement (IGA) with the City of Gresham. The RWPUD and City of Gresham completed an assessment of long-term water supply options in 2020 and prepared the GDMP for development of an expanded groundwater supply system to fully replace the City of Portland wholesale supply. The CGA Groundwater Development Program is currently underway, with 10 project packages, including the development of Cascade Wells 6, 7,8, 9, and 10. Cascade Wells 7, 8, and 9 are included in the summary of existing groundwater production wells below (**Table 2-2**). Cascade Well 6 is currently in development and exploratory drilling for Cascade Well 10 has been completed, with the exploratory well currently being re-developed as a production well.

Table 2-2 | Groundwater Production Well Summary

| Cascade Well | District Ownership | Treatment Facility | Nominal Production Capacity (gpm) |
|---|---|---|---|
| No. 3 | 50% | Cascade Site | 4.0 |
| No. 4 | 50% | Cascade Site | 3.0 |
| No. 5 | 50% | Cascade Site | 7.6 |
| No. 6[1] | 50% | 223rd and Stark Site | 4.4 |
| No. 7 | 50% | Cascade Site | 5.6 |
| No. 8 | 100% | 141st Avenue Site | 4.3 |
| No. 9 | 50% | Cascade Site | 5.8 |

Note:

1. Cascade Well 6 capacity is an estimate based on well development and testing currently underway.

As part of the groundwater development program, all of the groundwater well supplies are treated for removal of manganese and chlorine is added as a residual distribution system disinfectant.

Cascade Wells 3, 4, 5, 7, and 9 all are pumped through dedicated transmission piping to the Cascade site treatment facility and then into Cascade Reservoirs 1 and 2. Cascade Well 8 is treated on-site at the 141st Avenue treatment facility and then stored in the 141st Avenue Reservoir. Cascade Well 6 will be developed with an on-site treatment facility sized to treat both Cascade Well 6 and the future Cascade Well 10. Supply from this site will be pumped directly into the City of Gresham and RWPUD distribution systems.

RWPUD's water rights are summarized in **Exhibit 2-34** from Section 2.2.10 of the *Final Water Management and Conservation Plan for Rockwood Water People's Utility District and City of Greham*, *Oregon*, dated August 2023. It has been included as **Appendix A**.

### 2.2.3 Emergency Interties

In addition to the supply connections previously described, RWPUD has emergency water distribution system interties with the City of Fairview, the City of Gresham, and the PWB. **Table 2-3** summarizes the location, diameter, and direction of these interties.

Table 2-3 | Distribution System Emergency Intertie Summary

| Intertie Location | Diameter (Inches) | Connecting Water System | Supply Direction |
|---|---|---|---|
| NE 148th Avenue and NE Broadway | 12 | Portland Water Bureau | Bi-directional |
| SE 223rd Avenue & SE Stark Street | 12 | Gresham | Bi-directional |
| SE 223rd Avenue & SE Ash Street | 8 | Gresham | Bi-directional |
| SE 182nd (South of Haig) | 8 | Gresham | to RWPUD |
| SE 238th Avenue & SE Stark Street | 8 | Gresham | Bi-directional |
| NE 223rd Avenue & NE Glisan Street | 16 | Gresham & Fairview | to RWPUD |
| NW Burnside Road & NW Shattuck Way | 12 | Gresham | Bi-directional |
| NE Cleveland (235th) & Division Streets | 16 | Gresham | to RWPUD |
| NW Burnside Road & NW Fariss Street | 8 | Gresham | Bi-directional |
| NE 185th Avenue & Sandy Boulevard | 18 | Gresham | Bi-directional |
| NE 181st Avenue and NE Wilkes Street | 12 | Gresham | To RWPUD |
| SE 135th Avenue & SE Stark Street | 6 | Portland Water Bureau | Bi-directional |
| SE 132nd Avenue & SE Stark Street | 6 | Portland Water Bureau | Bi-directional |
| SE 131st Place and E Burnside Street | 6 | Portland Water Bureau | Bi-directional |
| SE 148th Avenue & SE Lincoln Street | 8 | Portland Water Bureau | Bi-directional |

## 2.3 Water System Operation

The RWPUD's distribution system is divided into four pressure zones; Main Pressure Zone, Cleveland Pressure Zone, Glendoveer Pressure Zone, and Bon-Al Pressure Zone. Pressure zone boundaries are defined by ground topography to provide adequate service pressure to all customers within each zone. The hydraulic grade of a zone is established by overflow elevations of water storage facilities, discharge settings of pump stations, or outlet settings of PRVs serving the zone. A description of each pressure zone is presented below.

### 2.3.1 Main Pressure Zone

The Main Pressure Zone is the largest in the service area. It serves all RWPUD customers below an approximate ground elevation of 300 feet above mean sea level (msl). The Bella Vista Reservoir provides gravity service to the Main Pressure Zone. Supply from the 62-foot tall reservoir can be delivered in three different ways to maintain adequate service pressure.

- When its water surface elevation is above approximately 437 feet, the reservoir can supply the Main Pressure Zone through modulating isolation valves (butterfly valves) to avoid over-pressurizing the zone.
- When the reservoir operates in the mid-range, between 425 and 437 feet, it supplies the system as gravity storage.
- When the water level falls below approximately 425 feet, the adjacent Bella Vista Pump Station can boost pressure from the reservoir to the Main Pressure Zone to maintain an approximate hydraulic grade of 427 feet with direct gravity feed to the system.

### 2.3.2 Cleveland Pressure Zone

The Cleveland Pressure Zone serves customers at the east end of the service area at ground elevations from approximately 260 to 370 feet. Water is pumped to this zone at constant pressure through the Cleveland Pump Station from the Cleveland Reservoir. The Cleveland Pressure Zone is served at an approximate HGL of 510 feet by the Cleveland Pump Station. The Cleveland Reservoir is filled by gravity from the Main Pressure Zone and can also be supplied by Cascade Well 6. This pressure zone is isolated from the Main Pressure Zone by a check valve to the north (at SE 228th Avenue and SE Stark Street) and a PRV to the west (at SE 217th Avenue and SE Yamhill Street).

### 2.3.3 Glendoveer Pressure Zone

The Glendoveer Pressure Zone, located between the PWB distribution system to the west and the Main Pressure Zone to the east, includes areas with ground elevations between approximately 300 and 340 feet on the western edge of the RWPUD. Glendoveer is served at an approximate HGL of 473 feet from the 141st Avenue Pump Station. Currently, the Glendoveer Pressure Zone is being expanded by closing existing valves in the Main Pressure Zone. This will bring the boundary between Glendoveer and Main Pressure Zones along SE 148th Avenue.

### 2.3.4 Bon-Al Pressure Zone

The Bon-Al Pressure Zone is a small service zone composed of a fifty-unit subdivision on the south side of Grant Butte at the RWPUD's southern boundary. Bon-Al customers are served by the Bon-Al Pump Station with water from the Main Pressure Zone at an approximate HGL between 470 and 480 feet.

## 2.4 Water System Facilities

### 2.4.1 Storage Reservoirs

The RWPUD water system contains five finished water storage reservoirs with a total effective storage capacity of approximately 23 MG. The storage facilities are described in the following paragraphs and summarized in **Table 2-4**.

### 2.4.1.1 Bella Vista Reservoir

Bella Vista Reservoir is a partially buried, cast in place, cylindrical prestressed concrete reservoir located on NW 1st Street just east of SE 202nd Avenue. This facility has a total volume of 10 MG with only 8.7 MG considered efficient volume.

The reservoir was constructed in 2001 and is the only one that provides gravity service to the distribution system. The facility is supplied water by the Cascade Pump Station through dedicated 30-inch and 36-inch diameter transmission mains.

### 2.4.1.2 Cascade Reservoirs

The Cascade Reservoirs (1 and 2) are located near RWPUD offices at NE 196th Avenue and Halsey Street. Cascade Reservoir 1 is a 4.0 MG at-grade, cylindrical welded steel tank. Cascade Reservoir 2 is a 6.0 MG at-grade prestressed concrete tank. Both tank inlets are configured to allow storing water from the groundwater wells, following treatment.

These reservoirs act as a clearwells for the groundwater supply, providing storage of the treated and chlorinated water from Cascade Well Nos. 3, 4, 5, 7, and 9.

Water from these reservoirs is pumped to Bella Vista Reservoir and/or the City of Gresham's Grant Butte Reservoir through a 30-inch diameter and 36-inch diameter transmission main from the Cascade Pump Station.

### 2.4.1.3 Cleveland Reservoir

Cleveland Reservoir is located at NE 28th Street and NE Cleveland Avenue. The reservoir is a 2.7 MG, at-grade cylindrical welded steel tank. The facility is supplied by gravity from the Main Pressure Zone or Cascade Well 6. Water is supplied from the reservoir to the Cleveland Pressure Zone through the Cleveland Pump Station, and can receive backup supply at a reduced hydraulic grade from the Main Pressure Zone through the check valve at SE 228th Avenue and SE Stark Street.

### 2.4.1.4 NE 141st Avenue Reservoir

The NE 141st Avenue Reservoir is located at NE 141st Avenue and NE Glisan Street. The original reservoir is a partially buried, cylindrical concrete reservoir currently being replaced as part of Package 3 of the CGA Groundwater Development Program. The new reservoir has a 1.9 MG effective volume.

The reservoir is filled from the Main Pressure Zone distribution piping and from Well 8. Water is supplied from the reservoir to customers in the Glendoveer Pressure Zone through the NE 141st Avenue Pump Station.

Table 2-4 | Reservoir Summary

| Reservoir | Location | Capacity[1] (MG) | Overflow Elevation (feet) | Supplies Water To |
|---|---|---|---|---|
| Bella Vista | NW 1st Street | 8.7 | 460 | Main Pressure Zone distribution piping |
| Cascade 1 | NE Halsey Street at RWPUD offices | 2.0[2] | 260 | Main and Gresham Pressure Zones through Cascade Pump Station |
| Cascade 2 | NE Halsey Street at RWPUD offices | 3.0[2] | 260 | Main and Gresham Pressure Zones through Cascade Pump Station |

| Reservoir | Location | Capacity[1] (MG) | Overflow Elevation (feet) | Supplies Water To |
|---|---|---|---|---|
| Cleveland | SE Stark and NE Cleveland Streets | 2.7 | 400 | Main Pressure Zone through Cleveland Pump Station |
| NE 141st Avenue | NE 141st Ave and SE Glisan Street | 1.9 | 360 | Glendoveer Pressure Zone through 141st Avenue Pump Station |
| | **Total Storage Capacity** | **18.3 MG** | | |

Notes:
1. Total effective volume
2. Capacity of Cascade 1 and Cascade 2 is 50% of total effective capacity. The other 50% is allocated to City of Gresham.

## 2.4.2 Pumping Systems

There are five pump stations in the RWPUD distribution system. A brief description of each station is presented below including the service zone supplied, station capacity, and existing individual pump horsepower (hp) and capacity ratings. **Table 2-5** summarizes existing RWPUD pumping facilities.

### 2.4.2.1 Cascade Pump Station

The Cascade Pump Station is located near the RWPUD's offices on NE Halsey Street adjacent to the Cascade Reservoir. The new station, which replaces the existing Cascade Pump Station located at the site, includes five 400-hp pumps, each with an approximate capacity of 4,120 gpm, with space for a future sixth pump. These pumps supply the Bella Vista Reservoir and the City of Gresham's North and South meter stations through dedicated transmission mains at an approximate hydraulic grade of 500 feet.

### 2.4.2.2 Cleveland Pump Station

The Cleveland Pump Station is located at SE Stark and NE Cleveland Streets. It was replaced in 2015 and houses two 75-hp pumps that pump approximately 1,200 gpm each and one 10-hp pump that supplies approximately 180 gpm to the Cleveland Pressure Zone distribution piping from the adjacent Cleveland Reservoir. The station boosts water to an approximate hydraulic grade of 510 feet.

### 2.4.2.3 NE 141st Avenue Pump Station

This station supplies the Glendoveer Pressure Zone from the Main Pressure Zone distribution piping. The NE 141st Avenue Pump Station is located at NE 141st Avenue and NE Glisan Street adjacent to the 141st Avenue Reservoir. The station, currently being upgraded as part of Package 3 of the CGA Groundwater Development Program, houses five pumps including two 2,000 gpm pumps and three 900 gpm pumps. It serves the constant-pressure Glendoveer Pressure Zone from the adjacent reservoir, as well as delivering surplus Cascade Well 8 water to the Main Pressure Zone.

### 2.4.2.4 Bon-Al Pump Station

The Bon-Al Pump Station is located on NW 1st Avenue and NW Phyllis Court on RWPUD's southern boundary. This station houses a 2-hp, 40 gpm pump, two 7.5-hp, 140 gpm pumps and one 30-hp, 820 gpm pump. The station operates continuously to supply water from the Main Pressure Zone to the Bon-Al Pressure Zone, which is served at an approximate HGL of 480 feet.

### 2.4.2.5 Bella Vista Pump Station

The Bella Vista Pump Station is located across NW 1st Avenue from the 10 MG Bella Vista Reservoir. Two 100-hp pumps, with approximate pumping capacities of 5,000 gpm each, are available to pump water into the Main Pressure Zone from the Bella Vista Reservoir when reservoir levels fall below approximately 425 feet. This pump station is rarely operated as the level in the Bella Vista Reservoir is maintained above 425 feet under all normal operating conditions. There is space for a future third unit (a third 100-hp pump).

Table 2-5 | Pump Station Capacity Summary

| Pump Station | Pump No. | Motor hp | Capacity (gpm) | Design Discharge HGL (feet) | Supply From | Supply To |
|---|---|---|---|---|---|---|
| Cascade | 1 | 400 | 4,120 | 500 | Cascade Reservoir | Bella Vista Reservoir and Gresham |
| | 2 | 400 | 4,120 | | | |
| | 3 | 400 | 4,120 | | | |
| | 4 | 400 | 4,120 | | | |
| | 5 | 400 | 4,120 | | | |
| Cleveland | 1 | 75 | 1,200 | 480 | Cleveland Reservoir | Cleveland Pressure Zone distribution |
| | 2 | 75 | 1,200 | | | |
| | 3 | 10 | 180 | | | |
| 141st Avenue | 1 | 130 | 2,000 | 480 | 141st Avenue Reservoir | Glendoveer Zone distribution |
| | 2 | 130 | 2,000 | | | |
| | 3 | 60 | 900 | | | |
| | 4 | 60 | 900 | | | |
| | 5 | 60 | 900 | | | |
| Bella Vista | 1 | 100 | 5,000 | 460 | Bella Vista Reservoir | Main Pressure Zone distribution |
| | 2 | 100 | 5,000 | | | |
| Bon-Al | 1 | 2 | 40 | 480 | Main Pressure Zone distribution | Bon-Al Pressure Zone distribution |
| | 2 | 7.5 | 140 | | | |
| | 3 | 7.5 | 140 | | | |
| | 4 | 30 | 820 | | | |

Notes:

1. Cascade Pump Station: discharge pipeline is isolated from Main Pressure Zone distribution piping by a manually operated valve.
2. Cleveland Pump Station: Open floor space available for a future low capacity Pump 4.
3. Bella Vista Pump Station: boosts pressure to Main Pressure Zone customers when Bella Vista Reservoir level drops below approximately 425 feet.

## 2.4.3 Distribution and Transmission System

The water distribution and transmission systems are composed of various pipe materials in sizes up to 36 inches in diameter. The total length of piping in the service area is approximately 165.1 miles.

Pipe materials in the distribution system include ductile iron, cast iron, and steel. The majority of RWPUD's system is composed of ductile iron piping. **Table 2-6** presents a summary of existing pipe lengths by diameter.

Table 2-6 | Distribution and Transmission System Pipe Summary

| Pipe Diameter | Estimated Length (miles) |
|---|---|
| Less than 4-inch | 0.2 |
| 4-inch | 17.0 |
| 6-inch | 49.6 |
| 8-inch | 40.4 |
| 10-inch | 2.9 |
| 12-inch | 34.0 |
| 14-inch | 1.4 |
| 16-inch | 8.0 |
| 18-inch | 2.9 |
| 20-inch | 5.0 |
| 24-inch | 5.7 |
| 30-inch | 4.8 |
| 42-inch | 0.21 |
| **Total Estimated Length** | **173.6** |

## 2.4.4 Telemetry and Supervisory Control System

The telemetry and supervisory control system monitors all storage reservoirs and pump stations within the RWPUD's water distribution system and provides for manual or automatic control of certain facilities and operations.

The telemetry system also collects and stores system status and performance data. All reservoirs and pump stations are equipped with remote telemetry units (RTUs) that monitor reservoir water levels, pump station on/off statuses, and pump station flow rates.

Signals from the RTUs at each site are collected and transmitted by telephone, cellular, data, and fiber optic lines to the RWPUD's offices where these data is interpreted and displayed on a computer terminal. The system is capable of automatically alerting RWPUD's staff 24 hours a day if an alarm is triggered at any of the sites.

CHAPTER 3

# Water System Service Goals

This section presents water quality and level of service goals used to analyze RWPUD's distribution system. Service goals and planning assumptions are presented for service pressures, storage and pumping capacity, and fire flow requirements. The water demand forecasts developed in **Chapter 4** are used with these criteria for the analysis of RWPUD's water system presented in **Chapter 5**.

Capacity needs related to water use and fire flow are described in terms of requirements for the distribution system, storage volume, and pumping capacity.

## 3.1 Distribution System Service Goals

The water distribution system should be capable of operating within certain system performance limits, or guidelines, under several varying demand and operational conditions. The recommendations of this WMP are based on the following performance guidelines, which have been developed through a review of State requirements, American Water Works Association (AWWA) Manual 32, acceptable practice guidelines, and operational practices of similar water providers. The recommendations are:

- The distribution system should be capable of supplying the PHD while maintaining minimum service pressures of not less than approximately 85 to 90 percent of normal system pressures. Reservoirs are assumed to be approximately 10 feet below overflow level during PHD conditions.

- The distribution system should be capable of providing the required fire flow to a given location while at the same time supplying the MDD and maintaining a minimum residual service pressure at any meter in the system of 20 pounds per square inch (psi). This is the minimum water system pressure required by the Oregon Health Authority Drinking Water Program. Reservoirs are assumed to be approximately 10 feet below overflow levels during fire flow events.

- New water mains should be a minimum of 8 inches in diameter to supply adequate fire flows. Ductile iron pipe is required for distribution mains.

### 3.1.1 Service Pressure

As discussed in **Chapter 2**, water distribution systems are separated into pressure zones to provide service pressures within an acceptable range to all customers. RWPUD's existing water service area is divided into four pressure zones. Pressure zones are usually defined by topography and designated by overflow elevations of water storage facilities, outlet settings of PRVs or discharge HGLs of pumping facilities serving the zone.

As a level of service goal, 100 psi generally is considered the desirable upper service pressure limit and 45 psi the lower limit. Whenever feasible, RWPUD expects to achieve the 45 psi lower limit at the point of the highest fixture within a given building being served. **Table 3-1** summarizes the service pressure goals used for this analysis.

Table 3-1 | Service Pressure Summary

| Condition | Pressure (psi) |
|---|---|
| Minimum Service Pressure Under Fire Flow Conditions | 20 |
| Minimum Normal Service Pressure | 45 |
| Maximum Service Pressure | 100 |

# 3.2 Storage Volume

Water storage facilities are typically provided for three purposes: operational or equalization storage, fire storage, and emergency storage. Total recommended storage is the sum of these three components. In RWPUD's system, the only zone that can be served by gravity from storage is the Main Pressure Zone, thus storage volume will be evaluated on a system wide basis rather than zone by zone. A brief discussion of each storage element is provided below.

## 3.2.1 Operational Storage

Operational or equalization storage is required to meet water system demands in excess of delivery capacity from the water supply source to system reservoirs. Operational storage volume should be sufficient to supply demand fluctuations throughout the day resulting from typical customer water use patterns and is generally considered as the difference between PHD and MDD.

## 3.2.2 Fire Storage

Fire storage should be provided to meet the most severe fire flow requirement within the service area. To limit redundancy, it is recommended that RWPUD's required fire storage be calculated based on the sum of the largest fire flows in the existing Main and Glendoveer Pressure Zones. This conservative volume of fire storage would allow for the scenario of a fire in each of these zones simultaneously.

## 3.2.3 Emergency Storage

Emergency storage is often provided to supply water from storage during emergencies such as pipeline failures, equipment failures, power outages, or natural disasters. The amount of emergency storage provided can be highly variable depending upon an assessment of risk and the desired degree of system reliability. A reasonable volume for emergency storage for RWPUD's water service area is approximately 50 percent of MDD. This amount of storage volume for emergency purposes is consistent with accepted industry practices and guidelines for water systems like RWPUD's which have redundant supply sources.

# 3.3 Pump Station Capacity

Pumping capacity requirements vary depending on available storage and the number of pumping facilities serving a particular pressure zone. When pumping to storage facilities that serve customers by gravity, a firm pumping capacity equal to or larger than the zone's MDD is recommended. Firm pumping capacity is defined as a system's pumping capacity with the largest pump out of service.

Pump stations providing constant service without the benefit of gravity storage should have firm pumping capacity to meet MDD while simultaneously supplying the largest fire flow demand in the zone. The existing Glendoveer, Cleveland, and Bon-Al zones are all served from pump stations as constant pressure zones. Additionally, each constant pressure pump station should be equipped with an emergency power source.

## 3.4 Fire Flow Recommendations

While RWPUD's distribution system provides water for domestic, commercial, and industrial uses, it is also expected to provide water for fire suppression. The amount of water recommended for fire suppression purposes is typically associated with the local building type or land use of a specific location within the distribution system. In this system, fire flow recommendations are typically much greater in magnitude than the normal maximum demand present in any local area. Therefore, adequate hydraulic capacity must be provided for these large occasional fire flow demands.

A summary of fire flow recommendations by land use designation is presented in **Table 3-2**. These recommendations were developed through a review of fire flow criteria adopted by similar communities, fire flow guidelines as developed by AWWA, and discussions with representatives of the Portland Fire Bureau and Gresham Fire and Emergency Services.

As discussed previously in this section, recommended fire storage volume is determined by multiplying the fire flow rate by the duration of that flow. **Table 3-2** includes fire flow durations consistent with the Oregon Fire Code, 2022.

Table 3-2 | Recommended Fire Flow Summary

| Land Use Designation | Recommended Fire Flow (gpm) | Fire Flow Duration (hours) |
|---|---|---|
| Single Family Residential | 1,000 | 2 |
| Multi-Family Residential | 2,000 | 2 |
| Commercial | 2,000 | 2 |
| Industrial (and Schools) | 3,000 | 3 |

## 3.5 Water Quality Health-based Standards

The RWPUD upholds stringent water quality regulatory requirements, adhering to standards set forth by the Clean Water Act and the SDWA to safeguard human health and the environment. Oversight of water quality regulations in Oregon is administered by the Department of Human Services, Drinking Water Program. These regulations encompass a range of contaminants including microbial agents, disinfection byproducts, heavy metals, and organic pollutants, among others.

**Table 3-3** outlines key contaminants and their corresponding maximum contaminant levels (MCLs) established to ensure the safety of drinking water in Oregon. These parameters represent essential aspects of water quality monitored to ensure compliance with regulatory standards and to protect public health and the environment. Water systems in Oregon rigorously monitor and manage these parameters to maintain the safety and integrity of their water supply.

Table 3-3 | Water Quality Service Goals

| Parameter | Maximum Contaminant Level (MCL), Action Level, Treatment Technique or Secondary MCL | Unit |
|---|---|---|
| Total Coliform Bacteria | 0 per 100 ml | Colony Forming Units (CFU) |
| Escherichia coli (E. coli) | 0 per 100 ml | Colony Forming Units (CFU) |
| Total Trihalomethanes (TTHMs) | 80 | parts per billion (ppb) |
| Haloacetic Acids (HAA5) | 60 | parts per billion (ppb) |
| Chlorine | 4 | milligrams per liter (mg/L) |

| Parameter | Maximum Contaminant Level (MCL), Action Level, Treatment Technique or Secondary MCL | Unit |
|---|---|---|
| Chloramines | 4 | milligrams per liter (mg/L) |
| Lead | 0.015 | milligrams per liter (mg/L) |
| Copper | 1.3 | milligrams per liter (mg/L) |
| Arsenic | 0.01 | milligrams per liter (mg/L) |
| Nitrate | 10 | milligrams per liter (mg/L) |
| Nitrite | 1 | milligrams per liter (mg/L) |
| Fluoride | 4 | milligrams per liter (mg/L) |
| Total Dissolved Solids (TDS) | 500 | milligrams per liter (mg/L) |
| pH | 6.5 - 8.5 | Units (pH) |
| Total Organic Carbon (TOC) | Dependent on treatment process | milligrams per liter (mg/L) |
| Microcystin-LR | 0.3 | micrograms per liter (µg/L) |
| Manganese | 0.05 | milligrams per liter (mg/L) |
| Iron | 0.3 | milligrams per liter (mg/L) |

## 3.6 Non-regulatory Water Quality Needs

In the RWPUD service area, the water quality needs of water users extend beyond regulatory compliance to encompass a spectrum of concerns vital to public health, industry, and environmental sustainability. Customers rely on water sources for drinking, irrigation, recreation, and ecological balance. Ensuring the safety of these waters is paramount to safeguarding public health and supporting various economic activities.

Water quality service goals in Oregon require comprehensive monitoring and management strategies that go beyond regulatory minimums, aiming to address emerging contaminants, maintain ecosystem health, and mitigate the impacts of pollution from various sources. Additionally, stakeholders prioritize initiatives that promote water conservation, enhance water efficiency, and foster collaborative approaches to water management, reflecting commitment to long-term sustainability and resilience in the face of evolving environmental challenges.

## 3.7 Service Goals Summary

The RWPUD's water system service goals are summarized in **Table 3-4**.

Table 3-4 | Water System Service Goals Summary

| Water System Component | Evaluation Criterion | Value |
|---|---|---|
| Water Supply | Source Capacity (System-wide) | MDD[1] with largest well out of service |
| | Treatment Capacity (System-wide) | MDD |
| | Backup Power for Wells | Two independent power sources |
| Service Pressure | Normal Range | 45-100 psi @ service |
| | Maximum | 100 psi (with individual service PRVs above 80 psi) |
| | Minimum, during fire flow | 20 psi |
| Transmission Mains | Maximum Velocity | 4 feet per second (fps) |

| Water System Component | Evaluation Criterion | Value |
|---|---|---|
| Storage | Operational Storage | Tank level set points |
| | Equalization Storage | PHD[2] - MDD for 24 hours |
| | Fire Storage | Required fire flow * flow duration |
| | Emergency Storage | 50% MDD |
| Pump Stations (with additional Gravity Storage for zone) | Total Capacity | MDD |
| | Backup Power | Recommended but not required |
| Pump Stations (w/out additional Gravity Storage for zone) | Total Capacity | PHD + Fire Flow |
| | Backup Power | Transfer switch and on-site generator |
| Water Quality | SDWA Requirements | All contaminant levels below MCLs |
| | Manganese Scale Control | Less than 0.02 mg/L |

Notes:

1 MDD: Maximum Daily Demand

2 PHD: Peak Hour Demand

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CHAPTER 4

# Water Use Projected Growth

This chapter presents population projections and water demand forecasts for the RWPUD service area. Population and water demand forecasts are developed from historical growth trends in RWPUD and surrounding communities. Water demand records, regional planning data, land use designations, and previous water supply planning efforts are the base for future water use estimates. Also included in this chapter are a description of the buildout water service area and a summary of the current land use and zoning designations.

## 4.1 Buildout Service Area

The RWPUD service area is located within the Cities of Portland, Fairview, and Gresham. It is generally bounded by I-84 to the north, the Cities of Fairview and Wood Village to the east, the PWB service area to the south and SE 135th Avenue to the west. The service area encompasses approximately 6,295 acres and is entirely within Multnomah County.

The service area is adjacent to several other water providers' service areas, including the PWB, and the cities of Gresham and Fairview.

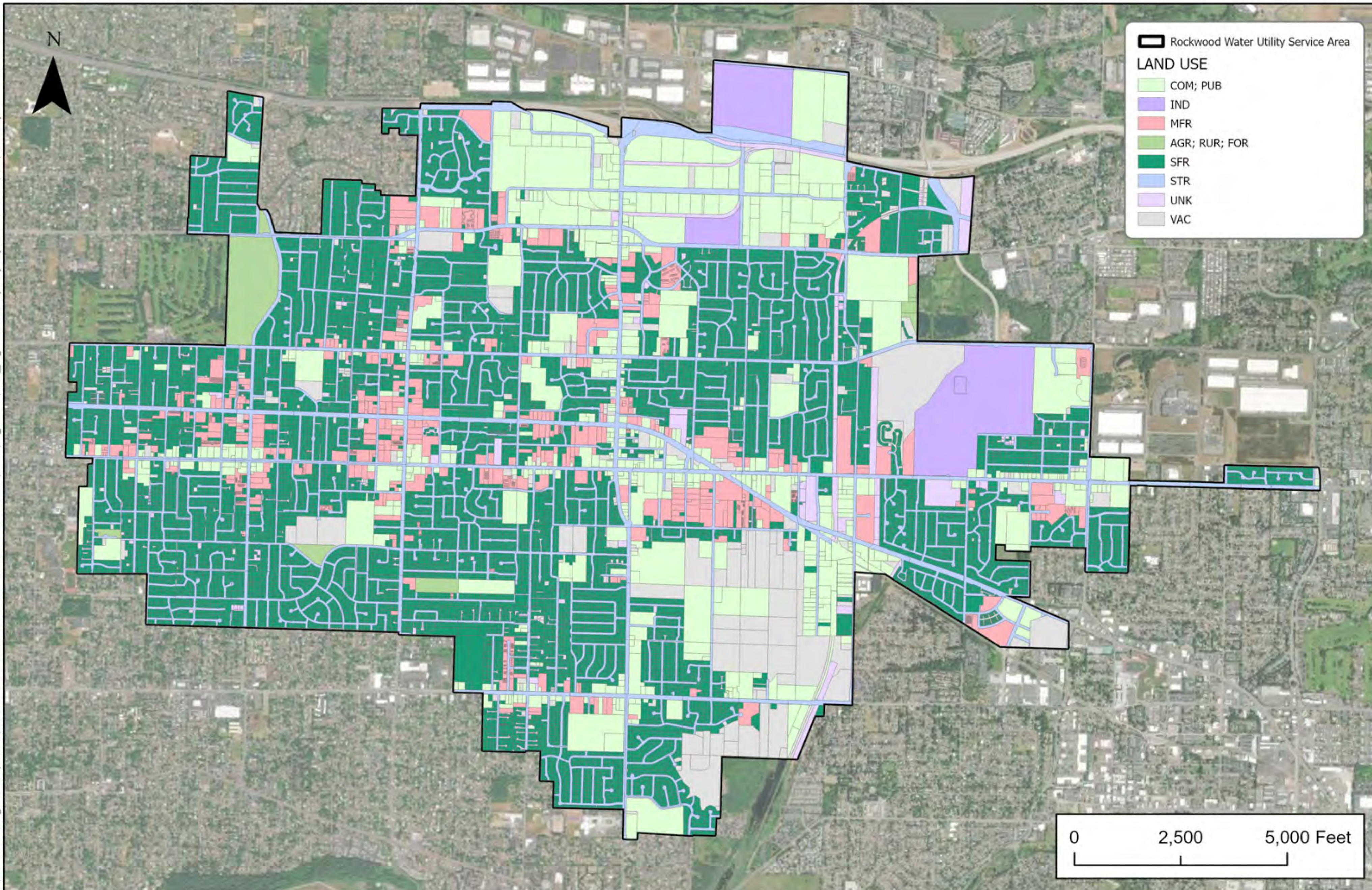
The service area boundary is expected to remain constant in the future. New customers and increased future water demands are expected primarily from expanded industrial and commercial development as well as high density residential re-development within the existing service area. **Figure 4-1** illustrates the service area.

### 4.1.1 Land Use

Current land use designations within the RWPUD boundaries are single-family residential with large areas designated for mixed use, multi-family, and industrial development. The service area also includes schools, parks, open space, and vacant land. **Table 4-1** summarizes land use classifications and **Figure 4-1** illustrates land use designations for the RWPUD service area.

Table 4-1 | Land Use Summary

| Land Use Identifier | Description | Area within RWPUD (acres) |
|---|---|---|
| IND | Industrial | 233 |
| COM; PUB | Commercial | 1233 |
| MFR | Multi-Family Residential | 483 |
| AGR; RUR; FOR | Rural | 82 |
| SFR | Single Family Residential | 2546 |
| STR | Streets | 1059 |
| VAC | Vacant | 526 |
| UNK | Unknown | 133 |
| | **Total** | **6295** |






consor

Rockwood Water
People's Utility District

**RWPUD**
**2024 Water System Master Plan**

Figure 4-1
RWPUD Land Use

# 4.2 Planning Period

The planning period for this WMP is 20 years; existing conditions are based on 2023 water production and demands, and the long-term planning horizon is year 2045. Facility sizing will be based on saturation conditions, as this dictates the ultimate size of the water system facilities.

Saturation development occurs when all existing developable land within the buildout service area has been developed to the maximum density allowed by the zoning designation. If substantial improvements are required beyond the 20-year planning period to accommodate water demands at saturation development, staging is often recommended for facilities where incremental expansion is feasible and practical.

# 4.3 Existing Water Use

Estimates of the existing and anticipated population within the water service area were developed through a review of previous water supply planning efforts, the 2020 U.S. Census data, and land use designations.

Currently, RWPUD provides water to approximately 64,000 people through approximately 13,805 residential, commercial, and industrial service connections. Based on a review of existing population information, the average number of persons per dwelling unit is approximately 2.79 (2020 Census data). Table 4-2 summarizes historical and current populations within RWPUD's water service area.

Table 4-2 | Historical and Current Population Summary

| Year | RWPUD Population |
|---|---|
| 2018 | 64,816 |
| 2019 | 65,328 |
| 2020 | 65,453 |
| 2021 | 62,511 |
| 2022 | 62,999 |
| 2023 | 64,071 |

The term "water demand" refers to all the water requirements of the system including domestic, commercial, municipal, and institutional, as well as unaccounted-for water. Demands are discussed in terms of gallons per unit of time such as mgd or gpm. Demands are also related to per capita use as gpcd.

## 4.3.1 Historical Water Usage and Existing Demands

Existing water demands were developed from a review of historical water billing records and operations data, such as pump station flows, provided by RWPUD from their SCADA system. Table 4-3 summarizes historical average day demand (ADD) and MDD, derived from RWPUD's water operations and billing records. Historical trends show the largest MDD/ADD ratio as 1.51 and the average per capita water use factor as 112 gpcd. These parameters characterize existing water use in the RWPUD service area and were used to develop future water use projections.

Table 4-3 | Historical Water Demand Summary

| Year | Water Demand (mgd) | | | | |
|---|---|---|---|---|---|
| | Average Day (ADD) | Maximum Day (MDD) | MDD/ADD Ratio | Population | Per Capita Use (gpcd) |
| 2018 | 6.5 | 9.8 | 1.51 | 64,816 | 100.3 |
| 2019 | 6.2 | 8.6 | 1.39 | 65,328 | 94.9 |
| 2020 | 6.5 | 9.2 | 1.42 | 65,453 | 99.3 |
| 2021 | 7.2 | 10.9 | **1.51** | 62,511 | 115.2 |
| 2022 | 7.1 | 9.9 | 1.39 | 62,999 | 112.7 |
| 2023 | 7.0 | 9.94 | 1.42 | 64,071 | 109.3 |
| Average Per Capita Water Use 2021-2023 | | | | | 112 |

Note:

1. Population data source switched in 2021. The average per capita water use factor was calculated from data for 2021 through 2023.

# 4.4 Water Use Forecast

The anticipated population through the year 2045 is estimated based on historical population estimates reported by the Population Research Center in 2024. Population forecasts at saturation development for RWPUD's water service area were determined based on available developable land and zoning designations. Population estimates through saturation development are presented in **Table 4-4**.

For water system planning purposes, it is prudent to use the saturation development population to size proposed facilities for the ultimate anticipated water demand. This provides for economical construction of water system infrastructure by allowing development to progress without incurring additional costs for facility duplication.

Table 4-4 | Population Forecast Summary

| Year | Population |
|---|---|
| 2023 | 64,071 |
| 2026 | 66,580 |
| 2030 | 68,974 |
| 2040 | 71,094 |
| 2045 | 71,865 |
| Saturation | 79,747 |

# 4.5 Water Use Projection

**Table 4-5** shows the future demands expected in the RWPUD service area based on the following considerations.

- Future per capita demand is estimated to remain relatively consistent with the average between 2021 and 2023 at 112 gpcd.
- The MDD:ADD ratio for forecasting is based on the peak ratio over the past 6 years, from 2021, at 1.51.
- The PHD is estimated by applying a factor of 1.5 to MDDs.

- Current industrial customer demands are included in the per capita water usage rates described above. Non-residential demands can be expected to increase at a similar rate to population growth.

- An additional 1 mgd in industrial demand is included in the forecast beginning in 2030 to capture potential increased usage by existing large industrial customers, or new industrial customers. Since industrial usage does not typically peak the same as residential demand, this 1 mgd addition is expected to remain constant between ADD, MDD, and PHD conditions.

Table 4-5 | RWPUD Future Demand Projection

| Year | Population | ADD (mgd) | ADD (gpm) | MDD (mgd) | MDD (gpm) | PHD (gpm) |
|---|---|---|---|---|---|---|
| 2023 | 64,071 | 7.0 | 4,860 | 9.9 | 6,898 | 10,348 |
| 2026 | 66,580 | 7.5 | 5,197 | 11.3 | 7,860 | 11,789 |
| 2030 | 68,974 | 9.7 | 6,059 | 13.1 | 9,117 | 13,676 |
| 2040 | 71,094 | 10.0 | 6,224 | 13.6 | 9,431 | 14,147 |
| 2045 | 71,865 | 10.1 | 6,284 | 13.7 | 9,489 | 14,233 |
| Saturation | 79,747 | 10.9 | 6,897 | 14.9 | 10,375 | 15,562 |

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CHAPTER 5

# Water System Analysis

This chapter presents an analysis of RWPUD's water system based on the level of service goals presented in **Chapter 3** and water demand estimates developed in **Chapter 4**. The analysis includes an evaluation of the system's supply, storage, and pumping capacity and a hydraulic network analysis of the water distribution piping.

Through these capacity evaluations, deficiencies were identified and recommended improvements were developed. As discussed in **Chapter 4**, all recommended improvements are sized based on estimated demands at saturation conditions unless otherwise noted.

## 5.1 Groundwater Supply Capacity Analysis

As described in **Chapter 2**, RWPUD in partnership with the City of Gresham formed the CGA to expand the existing groundwater supply to meet the water supply needs of both water providers without the need for continued wholesale water purchases from the PWB. The current wholesale contract expires in 2026, and the Groundwater Development Program is on schedule to be operational and to provide the CGA partners' water supply needs before the expiration of the contract. For the purposes of this analysis, the facilities that will be constructed and on-line by 2026 are included. Where facilities are planned to be constructed at a later date or operational after the expiration of the wholesale contract, the facilities and capacities are included in the approximate timeframe they are expected to be completed.

Based on the well testing completed to date and modeling completed by GSI Water Solutions, Inc., an estimated typical operating capacity and reduced operating capacity has been developed for each well. The reduced operating capacity is based on the evaluation of groundwater pumping level declines expected to occur in a year when the PWB operates the CSSWF at high capacities for an extended duration throughout the year, which could occur if an emergency condition disrupts their primary Bull Run surface water supply. Typically, the PWB operates the CSSWF at reduced capacities during the summer season to supplement the surface water supply, and this pumping rate and duration is not expected to have an impact on the CGA's groundwater capacities.

As presented in **Chapter 4**, the reliable supply source capacity must be adequate to meet MDD with the largest source out of service (firm capacity). **Table 5-1** illustrates the current available supply capacity of RWPUD's source. Cascade Well 6 is currently in development and is expected to be completed beyond the 2026 deadline for transition from wholesale supply, so it is not included in the available supply capacity for this initial step in the planning horizon.

Table 5-1 | Water Supply Capacity

| Groundwater Source | Typical Operating Capacity (mgd)[1] | | Reduced Operating Capacity (mgd)[2] | |
|---|---|---|---|---|
| | Total Capacity | RWPUD Capacity | Total Capacity | RWPUD Capacity |
| Cascade 3 | 4.0 | 2.0 | 4.0 | 2.0 |
| Cascade 4[3] | 3.0 | 1.5 | 1.5 | 0.8 |
| Cascade 5 | 7.6 | 3.8 | 7.6 | 3.8 |

| Groundwater Source | Typical Operating Capacity (mgd)[1] | | Reduced Operating Capacity (mgd)[2] | |
|---|---|---|---|---|
| | Total Capacity | RWPUD Capacity | Total Capacity | RWPUD Capacity |
| Cascade 6 *(expected to be on-line between 2026 and 2030)* | 4.4 | 2.2 | 4.0 | 2.0 |
| Cascade 7 | 5.6 | 2.8 | 5.6 | 2.8 |
| Cascade 8 | 4.3 | 4.3 | 1.5 | 1.5 |
| Cascade 9 | 5.8 | 2.9 | 5.8 | 2.9 |
| **Total Capacity** | **34.7** | **19.5** | **30.0** | **15.8** |
| RWPUD Firm Capacity (2026)[4] | 13.5 | | 10.0 | |
| RWPUD Firm Capacity (2030)[4] | 15.7 | | 12.0 | |

Notes:

1. Typical operating capacity based on average regional groundwater pumping conditions and assumes 50% of well capacity allocated to the City of Gresham (except Cascade 8, which is allocated 100% to RWPUD).
2. Reduced operating capacity is based on analysis of potential reduced sustainable pumping capacity in a year that the PWB relies on significant supply from their Columbia South Shore Well Field.
3. Cascade Well 4 operating capacities based on improvements current in progress – deeper pump setting and installation of a variable frequency drive to allow pumping rate turndown to optimize pumping water levels.
4. Firm capacity based on Cascade Well 5 out of service (largest single source that will have the greatest impact to the total supply system).

**Table 5-2** presents an analysis of supply versus capacity through the 20-year planning horizon and at saturation development.

## Table 5-2 | Supply Capacity Analysis

| Planning Horizon | Projected MDD (mgd) | Firm Groundwater Supply Capacity | | Supply Capacity Surplus[1] Typical/Reduced (mgd) |
|---|---|---|---|---|
| | | Typical (mgd) | Reduced (mgd) | |
| 2026[1] | 11.3 | 13.5 | 10.0 | 2.2 / (1.3) |
| 2030 | 13.1 | 16.0 | 12.0 | 2.9 / (1.1) |
| 2040 | 13.6 | | | 2.4 / (1.6) |
| 2045 | 13.7 | | | 2.3 / (1.7) |
| Saturation | 14.9 | | | 1.1 / (2.9) |

Note:

1. The projected MDD for year 2026 does not include the additional 1 mgd of increased industrial demand projected for future years in the planning horizon. Firm capacity in 2026 assumes the Cascade Well 6 is not yet complete.

Based on this comparison of firm, reliable supply versus projected demands, the following conclusions can be drawn.

- The RWPUD has adequate firm supply capacity to meet system demands in the summer of 2026 as the PWB wholesale contract expires.
- The RWPUD has adequate firm supply capacity to meet the water supply needs through saturation development of the service area.
- The RWPUD can be expected to experience a supply shortfall throughout the planning horizon, if the PWB operates the CSSWF at high pumping rates year-round. Currently, this condition would only occur if there was an emergency that disrupted the Bull Run surface water supply for an extended period.

Based on this analysis, it is recommended that the RWPUD investigate groundwater expansion alternatives to meet the total supply need under reduced capacity conditions due to significant increases in overall groundwater use throughout East Multnomah County (primarily due to PWB CSSWF operation). There are two primary alternatives to increase the reliable groundwater capacity.

- Participation with the City of Gresham in the development of Cascade Well 10. The City is currently completing exploratory well development adjacent to the North Gresham Elementary School near the intersection of SE 217th Avenue and SE Yamhill Street. The proposed Cascade Well 10 supply will be transmitted through a raw water pipeline to the treatment facility at SE 223rd Avenue and SE Stark Street where it will be blended with Cascade Well 6 supply. Treated groundwater supply can be pumped into both water providers' distribution systems at this location. It is anticipated that RWPUD's share of Cascade Well 10 would be adequate to address the supply deficit through the 20-year planning horizon and beyond.
- Initiate exploratory drilling for a future Cascade Well 11. Based on preliminary investigations and planning presented in the GDMP, investigation of sites for a future additional groundwater well should focus on potential properties east of NE 202nd Avenue and north of NE Glisan Street. The raw water pipeline connecting Cascade Well 7 to the treatment facility at the RWPUD office property was configured with a tee at NE 202nd and NE Halsey Street to accommodate a connection for a future Cascade Well 11.

In order to select which of the two alternatives to pursue, RWPUD should coordinate with the City of Gresham to determine the City's timing and total capacity needs beyond the existing developed infrastructure. Specifically, to understand if the City anticipates needing additional supply development beyond Cascade 10 in order to meet their future demands and how RWPUD participation in the development of this well could impact the City's future needs.

For the purposes of this WMP, it is anticipated that RWPUD will construct Cascade Well 11 or participate in Gresham's Cascade Well 10 in the future, as increasing demands warrant.

### 5.1.1 Future Maintenance of Metered Conduit Connections with PWD

As RWPUD completes negotiations with the PWB for future emergency supply availability, consideration should be given to the maintenance of connections to the PWB supply conduits. While RWPUD currently has seven wholesale supply connections, it is recommended that at least three connections be maintained, if feasible. It is anticipated that the following conduit connections would not be maintained because of their location, condition or overall benefit to the system.

- NE Cleveland Avenue& NE Division Street – This conduit connection relies on a significant length of 14-inch outside diameter steel pipe to connect to PWB Conduit No. 4 at the east end of the RWPUD. With improvements completed since 2012 that increase the reliability of the Cleveland Reservoir and Pump Station and provide a feed to the Reservoir from the Main Zone, as well as the opportunity to supply the Cleveland Zone from Cascade Well 6, RWPUD should not be dependent on this supply connection for emergency needs.
- SE 148th Avenue & NW Division Street – This conduit connection requires the use of a booster pump, installed in a vault, to deliver supply at an adequate hydraulic grade to serve the system.
- SE 135th Avenue & SE Mill Street – This conduit connection provides limited value as the hydraulic grade in Conduit 4 often drops below the level needed to feed the system.
- SE 182nd Avenue and NW Division Street – Investment in maintaining this connection provides limited value due to the age, physical condition and poor accessibility of this facility.

Two of the three remaining conduit connections, NW 5th Street & NW Riverview Way, and SE 202nd Avenue & NW Division Street, are newer facilities configured to supply water from the PWB conduits directly to the Bella Vista Reservoir. Operating these facilities will result in the least disruption of normal operations and allow the change in water supply to be managed at the Bella Vista Reservoir before supplying customers.

# 5.2 Storage Capacity Analysis

Recommended storage volume is based on the sum of equalization, fire suppression, and emergency storage, as discussed in **Chapter 3**.

## 5.2.1 Fire Storage Requirements

Cleveland, Glendoveer, and Bon-Al Pressure Zones are all served through constant pressure pump stations which are sized, or will be improved, to meet fire flow requirements. It is assumed that fire storage volume is provided to meet simultaneous fire flow events within the Glendoveer and Main Pressure Zones.

Based on the largest fire flow requirement in each zone presented in **Chapter 3**, the fire flow storage requirements are summarized in **Table 5-3**. The fire storage required for the RWPUD system for existing and saturation conditions is 1.08 MG.

Table 5-3 | Fire Flow Requirements in the RWPUD Service Area

| Pressure Zone | Critical FF Land Use Type | Fire flow Requirement (gpm) | Duration (hrs) | Storage Volume (MG) |
|---|---|---|---|---|
| Main | School/Industrial | 3,000 | 3 | 0.54 |
| Glendoveer | School/Multifamily | 3,000 | 3 | 0.54 |
| Bon-Al | Residential | 1,000 | 2 | 0.12 |
| Cleveland | Residential | 1,000 | 2 | 0.12 |
| Multi-fire Event | School/Industrial + Multifamily | 3,000 + 3,000 | 3 | 1.08 |
| | | | **Required Fire Flow Volume (MG)** | **1.08** |

## 5.2.2 Operational Storage Requirements

Operational storage volume should be sufficient to supply demand fluctuations throughout the day resulting from typical customer water use patterns and is generally considered as the difference between PHD and MDD for a duration of 3 hours. The operational storage requirements for each planning horizon are summarized in **Table 5-4**.

Table 5-4 | Operational Storage Requirements

| Planning Horizon | Operational Storage Volume | |
|---|---|---|
| 2026 | MDD (gpm) | 7,860 |
| | PHD (gpm) | 11,947 |
| | PHD - MDD X 3 hrs (MG) | 0.7 |
| 2030 | MDD (gpm) | 9,117 |
| | PHD (gpm) | 13,858 |
| | PHD - MDD X 3 hrs (MG) | 0.9 |
| 2040 | MDD (gpm) | 9,431 |
| | PHD (gpm) | 14,336 |
| | PHD - MDD X 3 hrs (MG) | 0.9 |

| Planning Horizon | Operational Storage Volume | |
|---|---|---|
| 2045 | MDD (gpm) | 9,489 |
| | PHD (gpm) | 14,423 |
| | PHD - MDD X 3 hrs (MG) | 0.9 |
| Saturation | MDD (gpm) | 10,375 |
| | PHD (gpm) | 15,769 |
| | PHD - MDD X 3 hrs (MG) | 1.0 |

## 5.2.3 Emergency Storage Requirements

Emergency storage is often provided to supply water from storage during emergencies such as pipeline failures, equipment failures, power outages or natural disasters. A reasonable emergency storage volume for RWPUD's water service area is approximately 50 percent of MDD. The emergency storage requirements for each planning horizon are summarized in **Table 5-5**.

Table 5-5 | Emergency Storage Requirements

| Planning Horizon | Emergency Storage Volume (MG) | |
|---|---|---|
| 2026 | MDD (gpm) | 7,860 |
| | MDD x 50% (MG) | 5.7 |
| 2030 | MDD (gpm) | 9,117 |
| | MDD x 50% (MG) | 6.6 |
| 2040 | MDD (gpm) | 9,431 |
| | MDD x 50% (MG) | 6.8 |
| 2045 | MDD (gpm) | 9,489 |
| | MDD x 50% (MG) | 6.8 |
| Saturation | MDD (gpm) | 10,375 |
| | MDD x 50% (MG) | 7.5 |

## 5.2.4 System-wide Storage Requirements and Analysis Summary

The system-wide storage requirements are summarized in **Table 5-6**. The existing available storage volume is based on the following.

| | |
|---|---|
| 8.7 MG – | Effective storage volume of Bella Vista Reservoir |
| 1.9 MD – | Usable storage volume at the new 141st Avenue Reservoir |
| 2.7 MG – | Effective storage volume of Cleveland Reservoir |
| 0.0 MG – | The Cascade Reservoirs are assumed to be allocated to groundwater operations and emergency supply. |
| **13.3 MG –** | **Effective distribution system storage capacity** |

Based on the evaluation of the three types of storage required to serve the water system, there is no additional storage needed for existing (2026), near-term (2030), 2040 and in the next 20 years (2045), or for saturation conditions.

Table 5-6 | System-Wide Storage Requirements

| Planning Horizon | Storage Requirements (MG) | |
|---|---|---|
| 2026 | Fire Flow Storage Required | 1.08 |
| | Operational Storage Required | 0.7 |
| | Emergency Storage Required | 5.7 |
| | Total System Storage Required | 7.47 |

| Planning Horizon | Storage Requirements (MG) | |
|---|---|---|
| | Available Storage | 13.3 |
| | Deficit or Surplus | Surplus |
| 2030 | Fire Flow Storage Required | 1.08 |
| | Operational Storage Required | 0.9 |
| | Emergency Storage Required | 6.6 |
| | Total System Storage Required | 8.50 |
| | Available Storage | 13.3 |
| | Deficit or Surplus | Surplus |
| 2040 | Fire Flow Storage Required | 1.08 |
| | Operational Storage Required | 0.9 |
| | Emergency Storage Required | 6.8 |
| | Total System Storage Required | 8.75 |
| | Available Storage | 13.3 |
| | Deficit or Surplus | Surplus |
| 2045 | Fire Flow Storage Required | 1.08 |
| | Operational Storage Required | 0.9 |
| | Emergency Storage Required | 6.8 |
| | Total System Storage Required | 8.80 |
| | Available Storage | 13.3 |
| | Deficit or Surplus | Surplus |
| Saturation | Fire Flow Storage Required | 1.08 |
| | Operational Storage Required | 1.0 |
| | Emergency Storage Required | 7.5 |
| | Total System Storage Required | 9.52 |
| | Available Storage | 13.3 |
| | Deficit or Surplus | Surplus |

## 5.3 Pumping Capacity Analysis

As presented in **Chapter 3**, pump stations providing constant pressure service without the benefit of gravity supply from storage should have firm pumping capacity to meet MDD while simultaneously supplying the largest fire flow demand in the zone. Firm pumping capacity is defined as a pump system's capacity assuming the largest pump is out of service.

The pumping analysis is based on the following key considerations.

1. The existing Glendoveer, Bon-Al, and Cleveland Pressure Zones are all served as constant pressure systems.
2. Water is supplied to Main Pressure Zone customers by gravity from the Bella Vista Reservoir. It is recommended that the Cascade Pump Station serving the Main Pressure Zone have adequate firm pumping capacity to supply the MDD for the system, as all pump stations draw supply from the Main Pressure Zone.
3. The Bella Vista Pump Station is not considered in the pumping capacity analysis for the Main Zone because it primarily function is to boost pressure and not as an independent supply to the zone.

**Table 5-7** presents the firm capacity per pressure zone that was used for capacity evaluation, **Table 5-8** shows the total pumping capacity required per pressure zone, and **Table 5-9** summarizes the deficiencies in pumping capacity by pressure zone and by planning horizon.

As it can be observed, the pumping system serving Bon-Al is deficient in capacity for existing (2026) conditions. In future scenarios the deficiencies intensify. This is consistent with prior master planning analyses and a capital improvement project is currently planned to upgrade the capacity of the Bon-Al Pump Station to meet pressure zone supply needs. To address this deficiency the recommendation will include the replacement of one of the 140 gpm pumps with a new unit of 820 gpm in the short term. Additionally, the 40 gpm unit should be replaced with a new unit of 100 gpm in the medium term planning horizon.

Cleveland and 141st Avenue Pump Stations have adequate capacity to reliably serve their respective pressure zones through saturation development.

Cascade Pump Station has adequate capacity to transmit the firm capacity of the well supplying the Cascade Reservoirs. A space for a 6th pump has been included in the pump station to accommodate an increase in pumping capacity to match the total supply capacities of the Cascade wells that pump to the site, as well as providing for expanded capacity in the event a future Cascade Well 11 is constructed that would also be pumped to the Cascade site.

### Table 5-7 | Existing Available Pumping Capacity by Pressure Zone

| Pressure Zone | Pump Station | Unit | Unit Capacity (gpm) | Available Firm Capacity (gpm) | Pump Station Discharge |
|---|---|---|---|---|---|
| Cascade Supply | Cascade | 1 | 4,120 | 16,480 | Bella Vista Reservoir and Gresham – Cascade Site Supply |
| | | 2 | 4,120 | | |
| | | 3 | 4,120 | | |
| | | 4 | 4,120 | | |
| | | 5 | 4,120 | | |
| Cleveland | Cleveland | 1 | 1,200 | 1,380 | Cleveland Pressure Zone distribution |
| | | 2 | 1,200 | | |
| | | 3 | 180 | | |
| Glendoveer | 141st Avenue | 1 | 2,000 | 4,700 | Glendoveer Zone distribution |
| | | 2 | 2,000 | | |
| | | 3 | 900 | | |
| | | 4 | 900 | | |
| | | 5 | 900 | | |
| Bon-Al | Bon-Al | 1 | 40 | 320 | Bon-Al Pressure Zone distribution |
| | | 2 | 140 | | |
| | | 3 | 140 | | |
| | | 4 | 820 | | |

### Table 5-8 | Total Pumping Capacity Requirements by Pressure Zone and Planning Horizon

| Pressure Zone | Fire Flow (gpm) | MDD Required Pumping Capacity (gpm) | | | | Total Pumping Capacity Required (gpm) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2026 | 2030 | 2045 | Saturation | 2026 | 2030 | 2045 | Saturation |
| Cascade Supply | -- | 12,770[1] | | | | 12,770[1] | | | |
| Cleveland | 1,000 | 165 | 191 | 199 | 218 | 1,165 | 1,191 | 1,199 | 1,218 |
| Glendoveer | 3,000 | 700 | 813 | 846 | 925 | 3,700 | 3,813 | 3,846 | 3,925 |
| Bon-Al | 1,000 | 48 | 56 | 58 | 64 | 1,048 | 1,056 | 1,058 | 1,064 |

Note:
1. Cascade Pump Station supply requirement is equal to the firm capacity of Cascade Wells 3, 4, 5, 7, and 9. This is the required treated capacity required to be pumped to RWPUD's Bella Vista Reservoir and the City of Gresham's Grant Butte Reservoir.

Table 5-9 | Additional Firm Capacity Needed by Pressure Zone and Planning Horizon

| Pressure Zone | Available Firm Capacity (gpm) | Total Pumping Capacity Required (gpm) | | | | Capacity Deficiency - / Surplus + (gpm) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2026 | 2030 | 2045 | Saturation | 2026 | 2030 | 2045 | Saturation |
| Cascade Supply | 16,480 | 12,770 | | | | Surplus | | | |
| Cleveland | 1,380 | 1,165 | 1,191 | 1,199 | 1,218 | Surplus | | | |
| Glendoveer | 4,900 | 3,700 | 3,813 | 3,846 | 3,925 | Surplus | | | |
| Bon-Al | 320 | 1,048 | 1,056 | 1,058 | 1,064 | -722 | -728 | -736 | -738 |

# 5.4 Water Quality Analysis

The RWPUD service area is supplied completely from groundwater sources and currently meets all primary water quality standards. It is in compliance with the Lead and Copper Rule, with contaminant levels below the action level. Treatment for iron and manganese is provided for all of the groundwater sources (Cascade Wells 3, 4, 5, 6, 7, 8, and 9) through three water treatment facilities (the Cascade Well 6 treatment facility is currently in design).

# 5.5 Distribution System Analysis

A hydraulic network analysis model was used to evaluate the performance of the existing distribution system and to identify proposed system improvements. The InfoWater Pro network analysis software uses a Geographic Information System (GIS) based model of the water distribution system to calculate pressure and flow relationships throughout the system for a variety of critical hydraulic conditions.

All system pipes are modeled as “links” between “nodes” which represent pipeline junctions or changes in pipe size. Diameter, material type, and length are specified for each pipe, and an approximate ground elevation is specified for each node. Hydraulic elements such as closed valves, PRVs, pumps, and reservoirs are also incorporated into the model database. System performance and adequacy are evaluated based on water demand estimates developed in Chapter 4 and service level goals in Chapter 3.

## 5.5.1 Hydraulic Model Update

The hydraulic model used to complete distribution system analysis for this WMP was developed from the 2013 WMP hydraulic model. The 2013 hydraulic model included all piping shown on RWPUD’s distribution system map at that time. For this WMP, the model was updated to reflect current conditions by adding additional piping, storage, and pump station improvements completed since 2011, including the groundwater supply development projects planned for completion prior to 2026.

### 5.5.1.1 Model Calibration

For a hydraulic computer model to provide accurate results under forecast water demand conditions it must be calibrated with field measurements so that modeled conditions reflect actual system operation. Model calibration was previously performed using fire hydrant flow test data gathered by RWPUD staff for the 2013 WMP. Flow and pressure data from the hydrant flow tests were compared to results obtained from modeled flows placed at the same location. Calibration is generally considered successful when pressures measured during hydrant flow tests are within five to ten percent of the modeled values. For this current WMP, SCADA data was used to evaluate expected system performance under a variety of demand conditions to validate the model still accurately represented real-world conditions.

### 5.5.1.2 Water Demand Assignment

Water demands for 2021 were extracted from water billing records provided by RWPUD. These demands were distributed spatially throughout the model by converting the billing record addresses to GIS-based points through a process known as geocoding. This demand distribution, used for model calibration, represents ADD system-wide. Demand quantities were adjusted based on RWPUD's SCADA records.

These records account for all water flowing from PWB supply connections and the Cascade Groundwater Wells to the distribution system including unmetered uses such as main flushing and minor leaks. Based on master meter SCADA records point demands were also added to the model to represent gravity flow into RWPUD's system through interties from the PWB distribution system.

To analyze the performance of the water system under existing MDD conditions, the 2021 ADD used to calibrate the model are uniformly scaled based on peaking factors determined by analyzing current SCADA data. Forecast demands were established by scaling 2021 demands to preserve the existing water demand distribution.

## 5.5.2 Hydraulic Modeling Results

Model scenarios were simulated to evaluate existing system performance under:

- MDD plus fire flow conditions: Fire flow scenarios test the distribution system's ability to provide required fire flows while simultaneously supplying MDD and maintaining a minimum residual service pressure of 20 psi at all services. Required fire flows are assigned based on the zoning surrounding each node in the model. Fire flow evaluation was performed for existing demands and future conditions.

- PHD demand conditions: Pressure service goals at customer connections (maximum pressure of 100 psi and minimum pressure of 45 psi) were used as guidelines to determine if the existing infrastructure and conveyance system were adequate for current and future conditions.

**Figure 5-1** through **Figure 5-6** are located in **Appendix B** and show the model results with the existing infrastructure. These figures allow us to observe the location of service pressure deficiencies and where the system exceeds the velocity criteria.

# 5.6 Summary of Hydraulic Deficiencies and Solution Strategies

Based on the system analyses performed, the existing system infrastructure shows areas of deficiency. These are areas where the service goals are not met, due to growth, large fire flow requirements, or limitations in the existing system configuration. The system hydraulic deficiencies are summarized below.

Four areas in the system will not meet minimum pressure requirements by the Saturation Planning Horizon.

## 5.6.1 Deficiency Area 1

These service connections are located between NE 148th Avenue and NE 152nd Avenue and between E Burnside Street and NE Halsey Street. This area is adjacent to the pressure zone boundary between the Main and Glendoveer Pressure Zones. The elevation is at the upper limit of the main pressure zone. **Figure 5-7** shows Deficiency Area 1.

To address this deficiency, the Bella Vista tank should be operated in the higher range of water surface elevation. Alternatively, this area could be added to the Glendoveer Pressure Zone, which will require the installation of about six isolation or pressure reducing valves, and the removal of two pressure zone boundaries. However, it would require the addition of isolation valves and create new dead ends. This deficiency doesn't trigger an immediate CIP. It is recommended that RWPUD observe pressures in this area as the currently planned pressure zone expansion is completed over the next couple of years.

### 5.6.2 Deficiency Area 2

These service connections are located between SE Sandy Boulevard and the North Gresham boundary, and between NE 181st Avenue and NE 205th Avenue, within the Main Pressure Zone. This area is north of the Cascade wells and the pressure is high due to low terrain elevation. **Figure 5-8** shows Deficiency Area 2.

The high pressures in this area are currently addressed by individual PRVs at the service connections, therefore no CIP is recommended to address this deficiency.

### 5.6.3 Deficiency Area 3

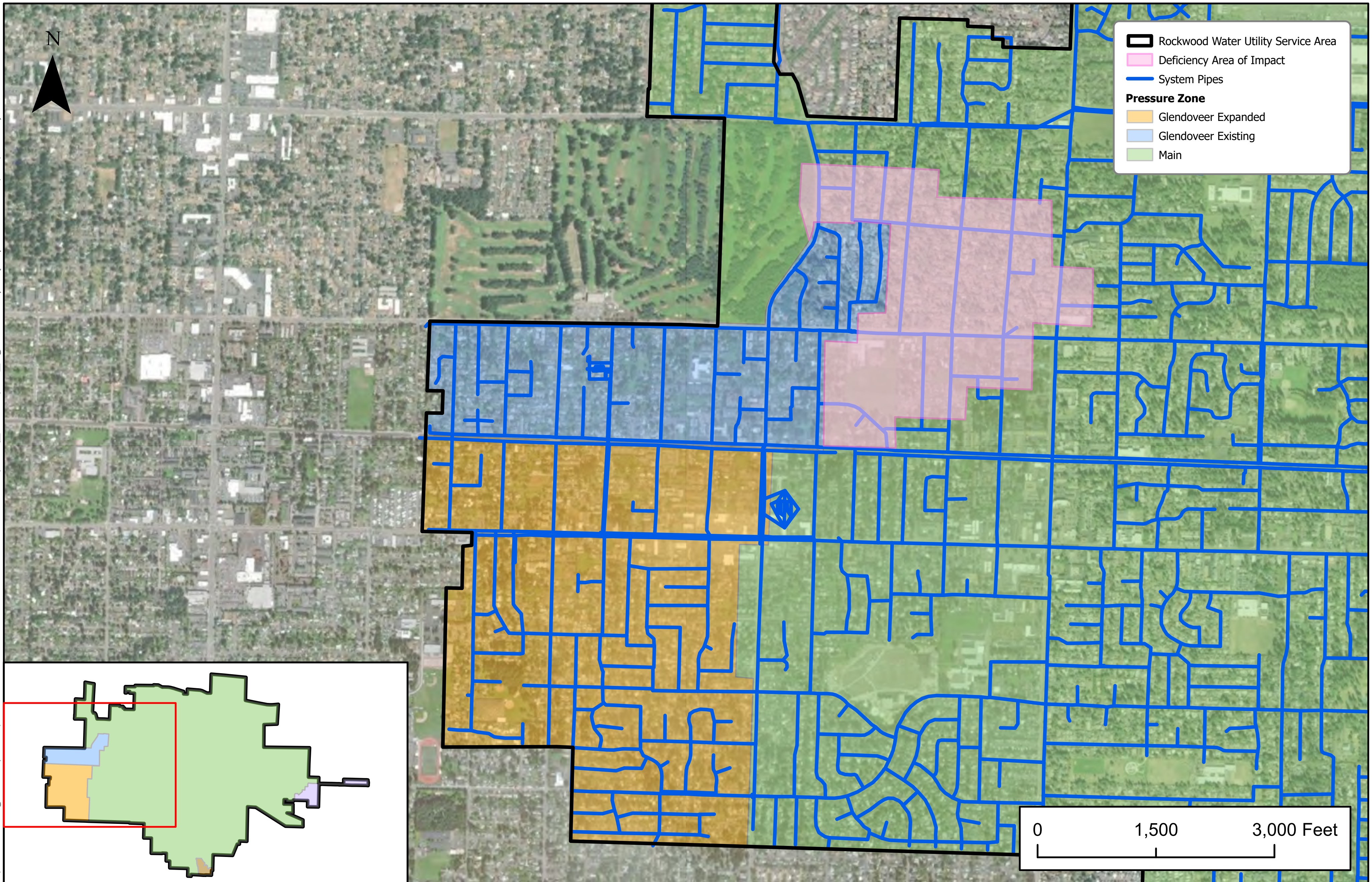
This area is located between SE Stark Street and NW 19th Street, around North Gresham Park and is near the boundary of the Main Pressure Zone with the Cleveland Pressure Zone. The terrain elevation is too high for the HGL of the Main Pressure Zone. **Figure 5-9** shows Deficiency Area 3.

To address this area the water level of the Bella Vista Reservoir should be kept in the high range, between a hydraulic grade line (HGL) of 432 and 437 ft. This area could also be added to the Cleveland Pressure Zone for stability. The pressure in this area is less than 45psi but more than 40 psi. This deficiency doesn't trigger an immediate CIP.

### 5.6.4 Deficiency Area 4

This area is located between NW 3rd Street and NW 1st Street, around Portland Adventist Elementary School and is near the boundary of the Main and Bon-Al Pressure Zones. The terrain elevation is in the high range for the Main Pressure Zone HGL; the observed minimum pressures reach 40 psi. **Figure 5-10** shows Deficiency Area 4.

This area could be added to the Bon-Al Pressure Zone, by closing two existing isolation valves. This pressure zone boundary modification does not trigger a CIP improvement.




**RWPUD**
**2024 Water System Master Plan**

Figure 5-7
Deficiency Area 1

20-2870

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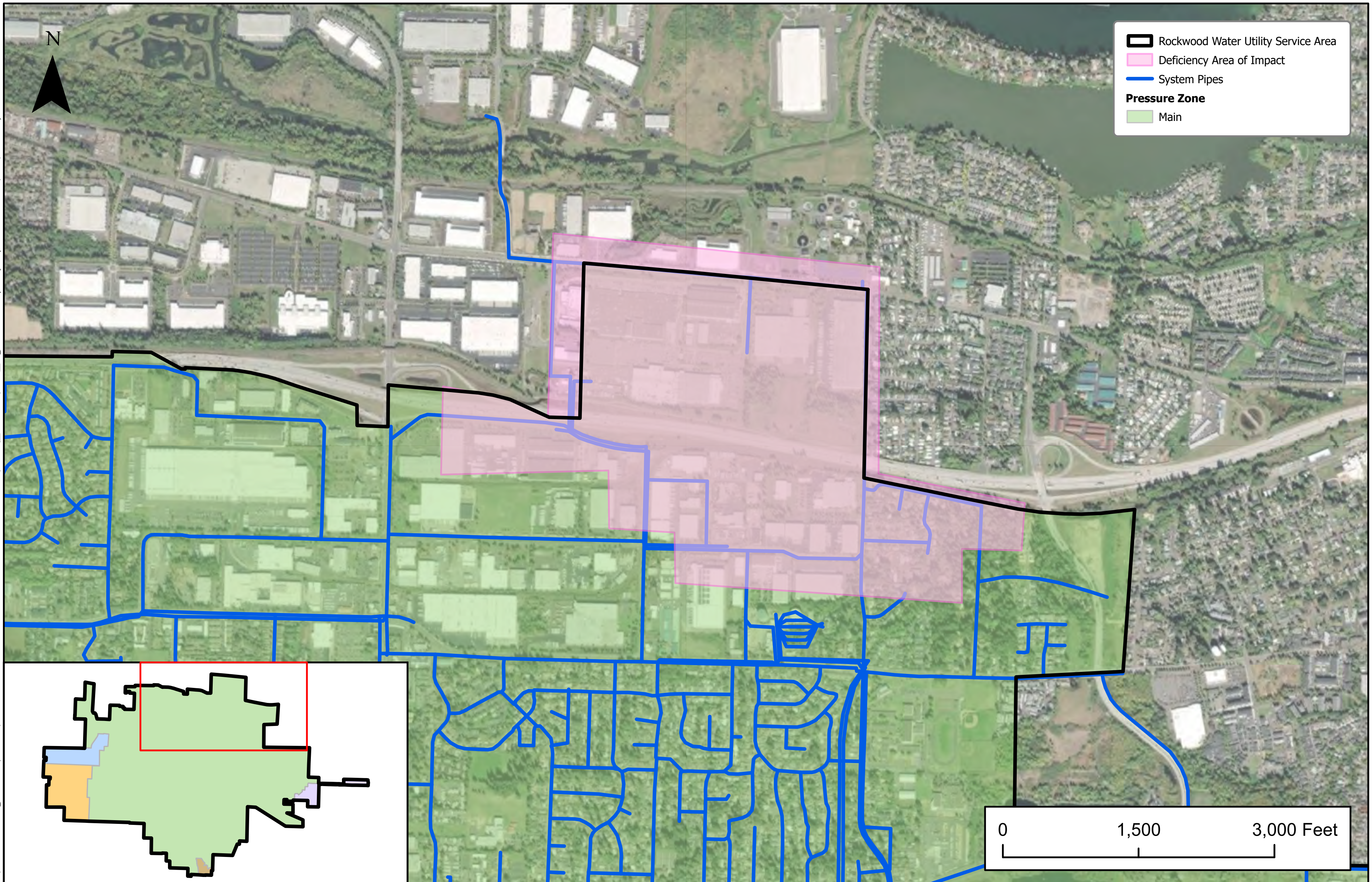




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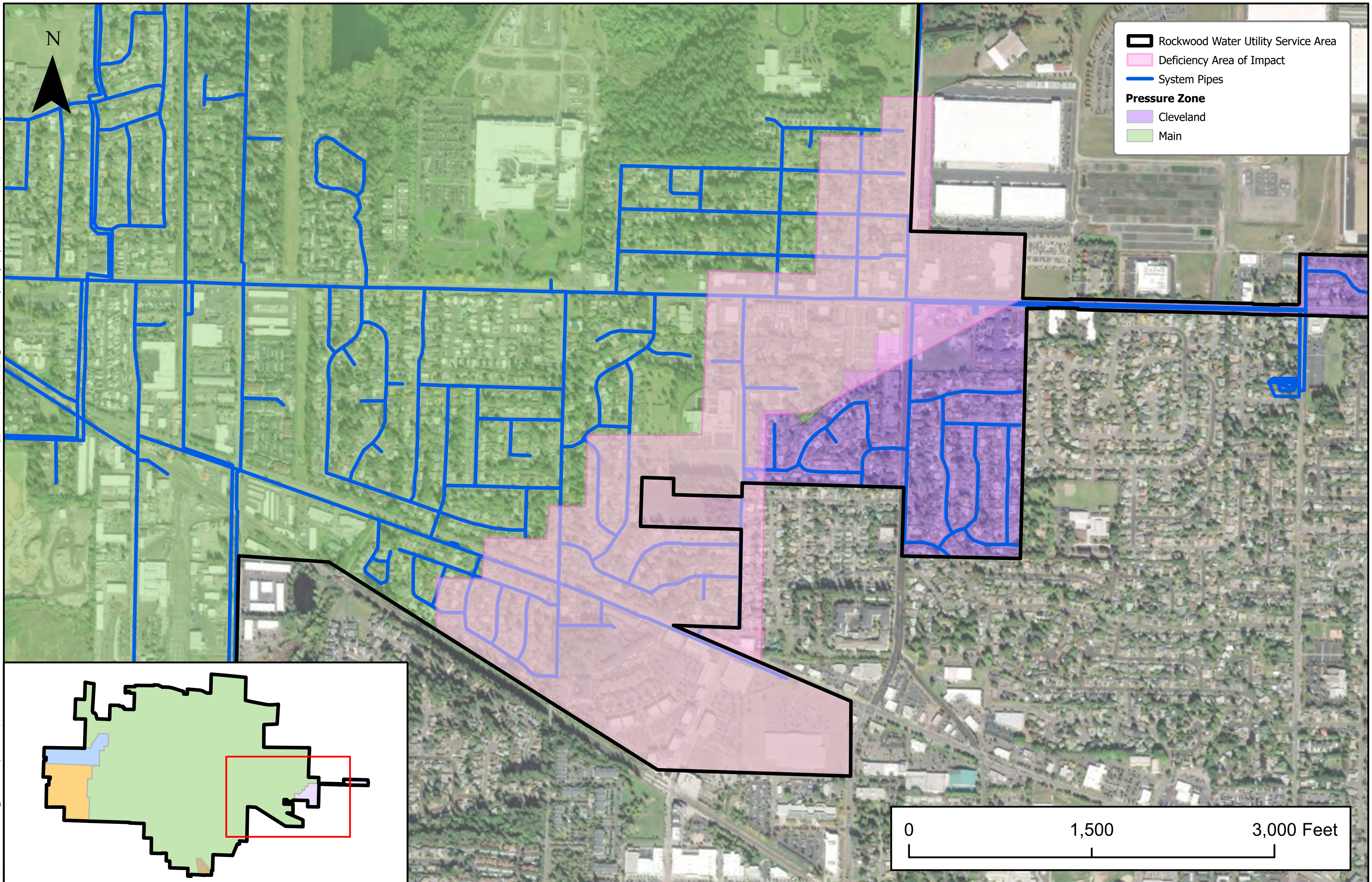
**2024 Water System Master Plan**

Figure 5-8
Deficiency Area 2



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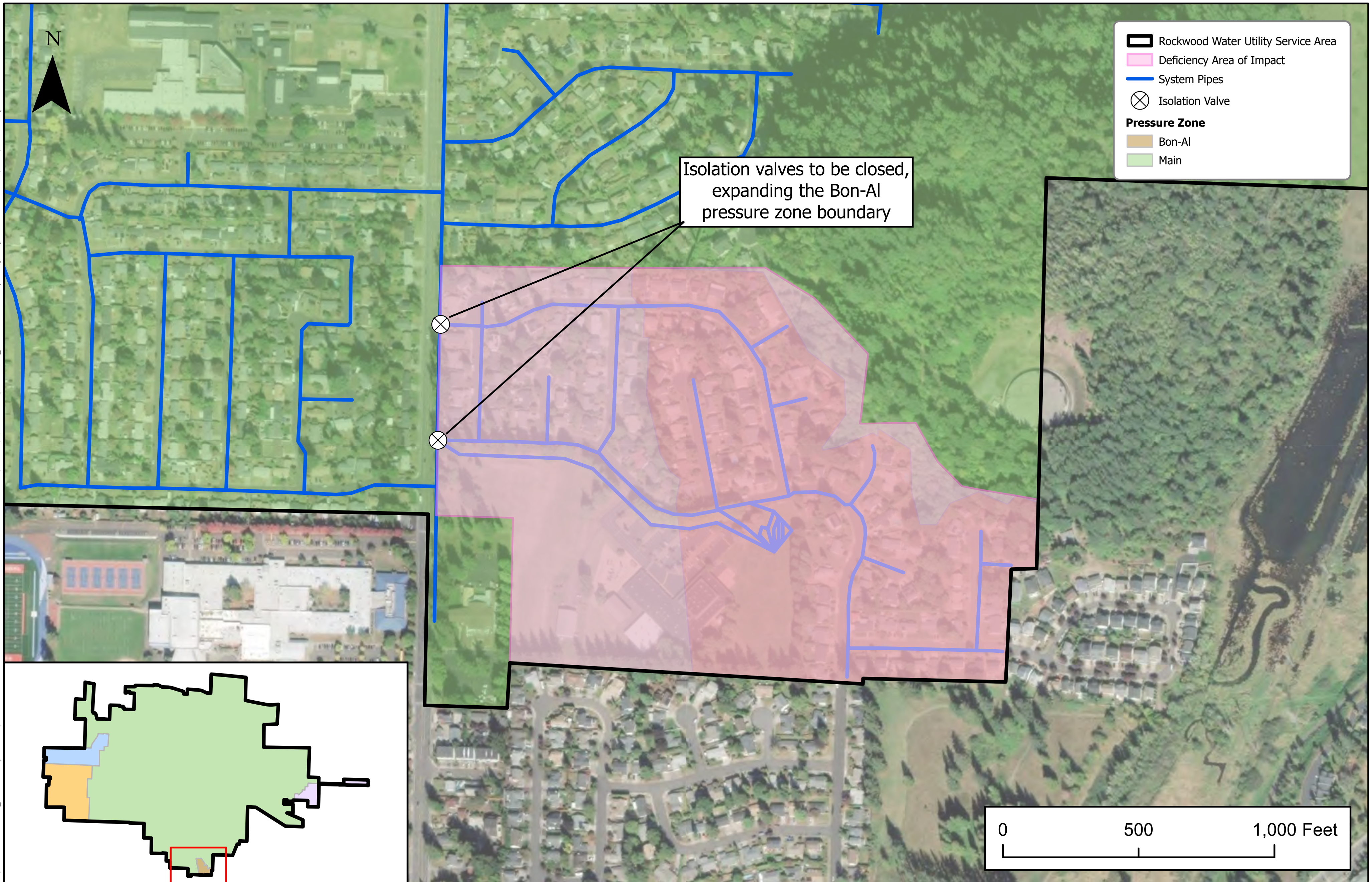
Rockwood Water
People's Utility District

**RWPUD**
**2024 Water System Master Plan**

Figure 5-9
Deficiency Area 3

20-2870

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Rockwood Water
People's Utility District

**RWPUD**
**2024 Water System Master Plan**

Figure 5-10
Deficiency Area 4

### 5.6.5 Fire Flow Deficiencies

Minimum fire flow requirements were not achieved in several locations in the system. The fire flow requirements are determined by the Oregon Fire Code and follow a land use type approach. These requirements were compared to available fire flow while maintaining a minimum pressure of 20 psi in the system, during maximum demand conditions. **Figure 5-11** shows the land use types for fire flow requirements in the RWPUD service area. **Figure 5-12** shows the fire flow requirements assigned to the system junctions.

**Figure 5-13** shows if the fire flow requirements are met at each junction representing hydrants or pipe connections in the system. The below list summarizes this information for Saturation conditions.

- Met fire flow requirements: 76 percent
- Did not meet fire flow requirements but are in close vicinity (less than 500 feet) of a hydrant that meets the flow required: 20 percent
- Did not meet fire flow requirements and are not in close vicinity of a hydrant that meets requirements: 4 percent

The junctions or hydrants that did not meet requirements were categorized into two different groups, based on the main reason for not meeting the fire flow requirement.

- Small pipe diameter: where the pipes have a diameter of 6 inches or less, the minimum fire flow requirements will not be met due to the high friction losses through small diameter pipes. Also, these pipes are most likely 50-year old cast iron, ductile iron or steel mains. These pipes should be scheduled for replacement not only due to capacity but also assumed deteriorated condition due to their age.
- High fire flow requirements: the fire flow requirements in the system depend on land use and building type. The fire flow requirements have been updated in the last years based on current land use and building type, which increased the required flows. The updated (2023) land use map and increased fire flow requirements caused several deficiencies in the system. The CIP improvements that this type of deficiency triggered are both of transmission and distribution nature. Improvements recommended to address this kind of deficiency should be validated once the design phase starts, to account for potential changes in the zoning type.

The small diameter pipes with deficiencies will be replaced as part of the Pipeline Renewal and Replacement Program, which is discussed further in **Chapter 7**.

The junctions that did not meet requirements due to high fire flow were categorized based on how close or far the location is to meeting the requirements.

- Meets 90 percent or more of the required fire flow
- Meets between 70 and 90 percent of the required fire flow
- Meets less than 70 percent of the required fire flow

These categories will help to determine the priority of each improvement and the need for implementation. **Low Priority** are those that meet more than 90 percent of required fire flow, **Medium Priority** are those that meet 70-90 percent of the required fire flow, and **High Priority** are those that meet less than 70 percent.

**Figure 5-14**, located in **Appendix B**, shows the junctions graded by how close the available fire flow is to the fire flow requirement.

Deficient pipes larger than 6-inch will be replaced as part of the CIP as further explained in Chapter 7. **Table 5-10** summarizes the length of pipe deficient, by pressure zone, and by priority. From the simulations, it was found that of the 28,090 feet of pipe found to be deficient, 62 percent doesn't meet at least 70 percent of the required fire flow (high priority) and 38 percent meets at least 90 percent (medium priority) of the required fire flow. None of the deficient pipe have a low priority. The diameter for the pipes proposed to address the deficiencies range from 8 inch to 24 inch.

### Table 5-10 | Summary of Pipe Larger than 6-inch Diameter with Deficiencies

| Zone | Length (ft) | Pipe Size (n) |
|---|---|---|
| **High Priority** | | |
| Glendoveer | 0 | - |
| Main | 15,419 | 12 |
| Cleveland | 813 | 8 |
| **Total** | **16,232** | |
| **Medium Priority** | | |
| Glendoveer | 2,508 | 12 |
| Main | 7,661 | 12 |
| Cleveland | 0 | - |
| **Total** | **10,169** | |
| **Overall Total** | **26,402** | |

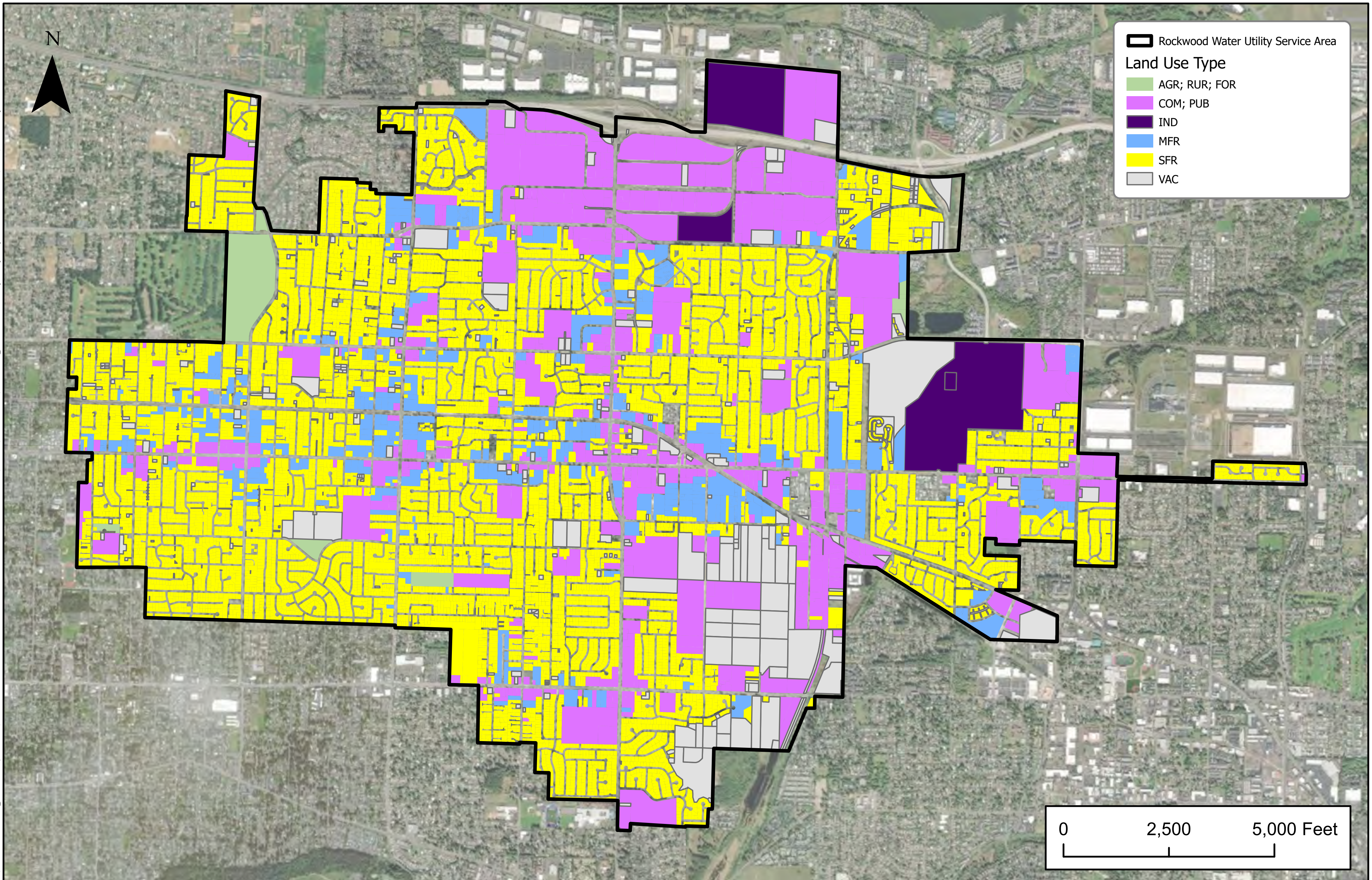


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Figure 5-11
RWPUD Land Use Type

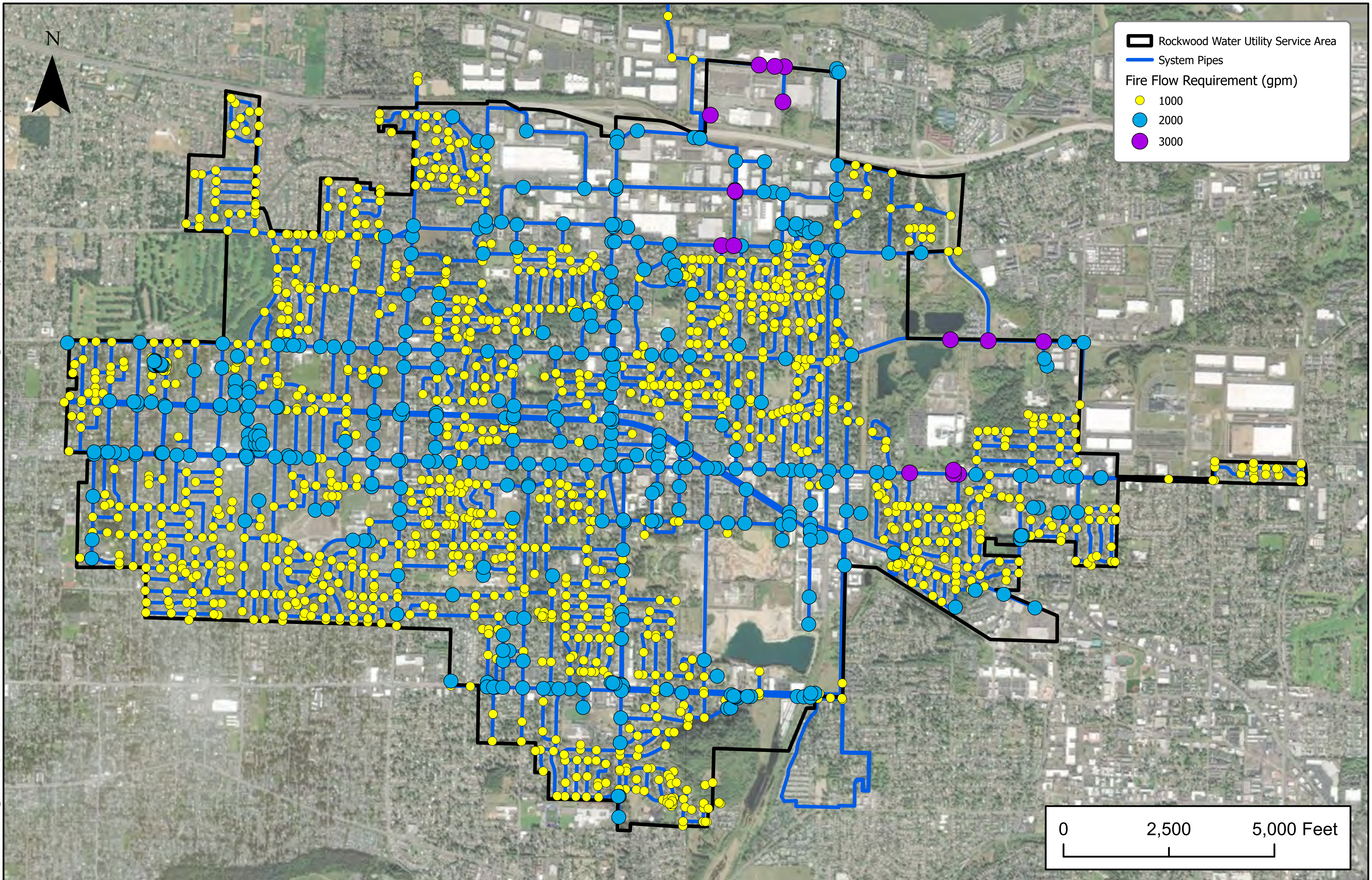


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Figure 5-12
RWPUD Fire Flow Requirements at Junctions

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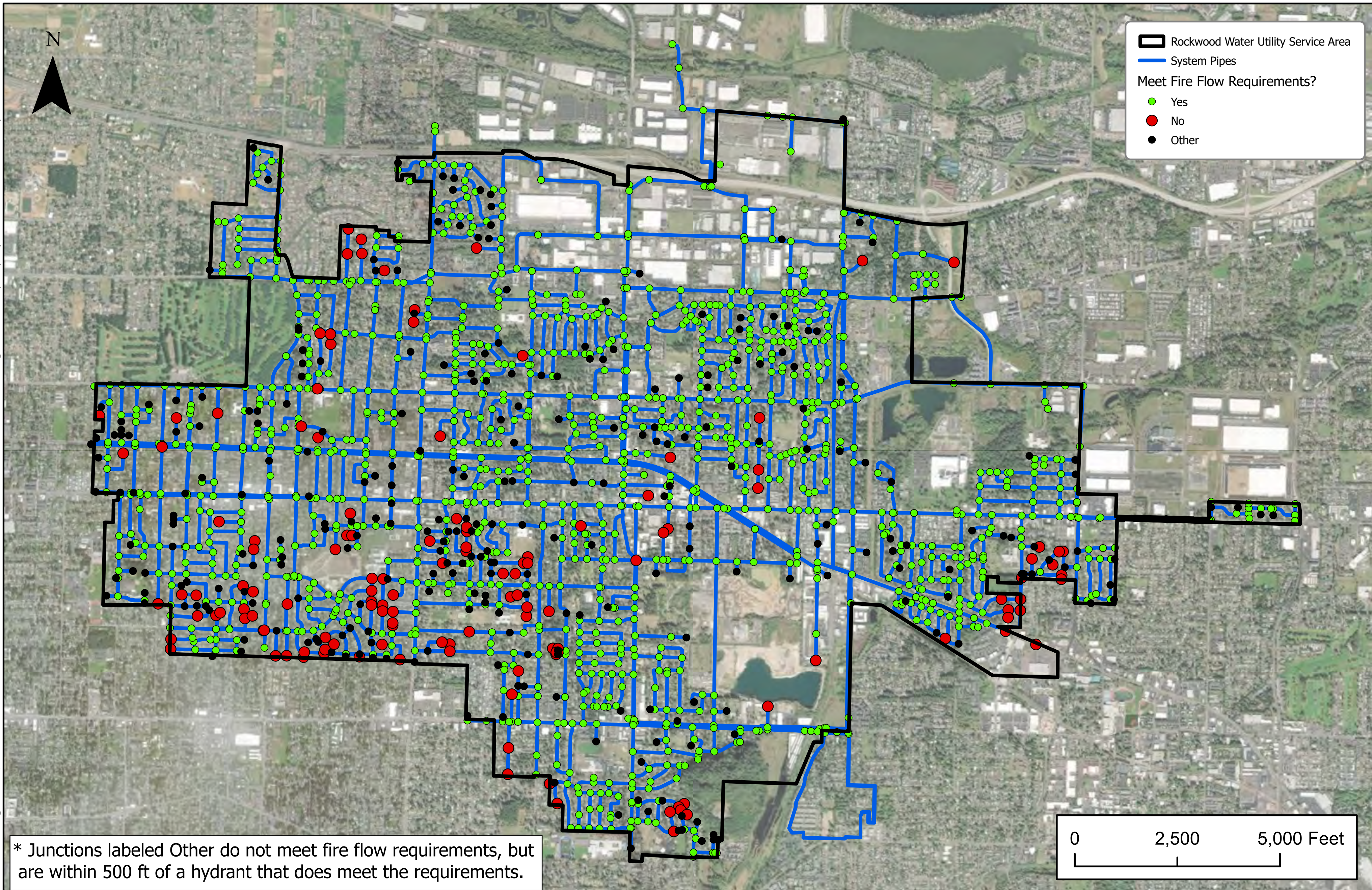


* Junctions labeled Other do not meet fire flow requirements, but are within 500 ft of a hydrant that does meet the requirements.

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Figure 5-13
System Ability to Meet
Fire Flow Requirements

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CHAPTER 6

# Cost Estimation Approach

Once the deficiencies and solution strategies were identified, the cost estimation for the implementation of the projects and solutions was developed. Unit cost for piping, new wells, and pump station upgrades were obtained from recent experience with similar work in Oregon and Washington and public cost databases, assuming all improvements will be accomplished by private contractors.

The cost estimates represent opinions of cost only, acknowledging that final costs of individual projects will vary depending on actual labor and material costs, market conditions for construction, regulatory factors, final project scope, project schedule, and other factors.

The Association for the Advancement of Cost Engineering International (AACE) classifies cost estimates depending on project definition, end usage, and other factors. The cost estimates presented in this document are considered Class V with an end use being a study or feasibility evaluation and an expected accuracy range of -30 to +50 percent. As projects are better defined, the accuracy level of the estimates can be narrowed.

Estimated project costs include:

- Cost of materials, labor, equipment, site preparation, installation, and removal of material if necessary
- Pavement or surface restoration
- Allowance for administrative, engineering, and other project related costs.

Estimates do not include:

- Cost of property acquisition
- Environmental compliance studies
- Permitting and legal fees
- Use of temporary facilities
- Security or insurance cost

Since construction costs change periodically, an indexing method to adjust present estimates in the future is useful. The Engineering News-Record Construction Cost Index (ENR CCI) is a commonly used index for this purpose. For purposes of future cost estimate updating, the ENR CCI for Seattle, Washington was 15,737.84 when the cost estimation was prepared in November 2024.

## 6.1 New Piping and Pipe Replacement Project Unit Cost

Table 6-1 summarizes the unit cost per foot of new pipe or pipe replacement. The table shows costs for urban or developed areas and includes the contingencies listed in Table 6-2. Projects where a highway, railroad, or creek crossing is part of the alignment, will have that additional cost included in the estimate.

Table 6-1 | Unit Cost for Pipe Projects

| Ductile Iron Piping Diameter (in) | Unit Cost ($/LF) |
|---|---|
| 8 | $584.64 |
| 10 | $730.80 |
| 12 | $941.12 |
| 16 | $1,101.55 |
| 18 | $1,315.44 |
| 20 | $1,461.60 |
| 24 | $1,753.92 |
| 30 | $2,192.40 |
| 36 | $2,630.88 |

Note:
1. Unit Costs include contingencies listed in Table 6-2.

Table 6-2 | Pipe Project Contingencies

| Transmission/Distribution Mains | Percent Markup |
|---|---|
| Direct | |
| Connections To Existing Mains | 3% |
| Construction Surveying | 0.50% |
| Dewatering | 1.50% |
| Rock Excavation | 0.20% |
| Traffic Control | 4% |
| Erosion Control | 0.50% |
| Mobilization | 10% |
| Contractor Overhead & Profit | 25% |
| **Total** | **45%** |
| Indirect | |
| Contingencies | 50% |
| Engineering Design | 20% |
| Legal/Admin, Coordination | 10% |
| **Total** | **80%** |

## 6.2 Pump Capacity Upgrade

Table 6-3 summarizes the unit cost per pumped gpm for pump replacement projects. The unit cost reflects the cost of replacing existing pumps with new units of greater capacity. The cost includes necessary retrofits to the existing pump station to accommodate the new pump units. The mechanical and electrical installation of pumps, motors, piping, and control systems were included, ensuring that the entire system is built to design specifications. Costs for structural retrofits or additional building space are not included.

Table 6-3 | Unit Cost for Pump Station Projects

| Pump Project | Unit Cost ($/GPM) |
|---|---|
| Pump Replacement/Retrofit in Existing Pump Station | $1,973.39 |

Note:
1. Unit Costs include contingencies listed in Table 6-4.

Table 6-4 | Pump Project Contingencies

| Pump Station | Percent Markup |
|---|---|
| **Direct** | |
| Mobilization | 10% |
| Contractor Overhead & Profit | 25% |
| **Total** | **35%** |
| **Indirect** | |
| Contingencies | 50% |
| Engineering Design | 20% |
| Legal/Admin, Coordination | 10% |
| **Total** | **80%** |

## 6.3 Ground Water Well Development

Table 6-5 summarizes the unit cost for development of a new groundwater well. The well construction cost is based on recent construction bids from well development projects within RWPUD.

Table 6-5 | Unit Cost for Supply Well Projects

| Supply Well Project | Unit Cost ($/GPM) |
|---|---|
| New Well Development | $1,600.00 |

## 6.4 Maintenance and Abandonment of PWB Conduits

A placeholder of $50,000 was used for the cost of abandonment of each PWB supply conduit. There is uncertainty of maintenance responsibility of the supply conduits recommended to remain in service for emergency supply.

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CHAPTER 7

# Capital Improvement Program

This chapter presents recommended water system improvements based on the analysis, assumptions, and findings in the previous chapters. These improvements include new sources of water supply, pump station upgrades, new water pipes, and pipe replacement improvements. The recommendations include the abandonment of PWB supply conduits. Also presented in this chapter is a CIP schedule.

All proposed system improvements are illustrated in Figure 7-1.

An estimated project cost has been developed for each improvement project recommended following the assumptions presented in Chapter 6. Cost estimates represent current opinions of cost, acknowledging that final costs of individual projects will depend on actual labor and material costs, market conditions for construction, regulatory factors, final project scope, project schedule, and other factors at the time of final design and construction.

## 7.1 Recommended Improvements

A summary of recommended improvements is presented in Table 7-1 which also provides the implementation timeframe as follows.

- *Immediate* are those improvements suggested to be completed in the next year (2025-2026).
- *High Priority* improvements suggested to be completed in the next five to 10 years (2026 to 2035).
- *Medium-Priority* improvements suggested to be completed in the next 11 to 20 years (2036 to 2045).
- *Low Priority* improvements suggested to be completed beyond 20 years in the future (beyond 2046).

Estimated project costs are also presented in Table 7-1. It is recommended that the RWPUD continue investment in capital improvements at levels similar to the past several years, with the exception of the significant investment in groundwater development over the past 5 years, to continue addressing hydraulic deficiencies and replacement of aging infrastructure. As such, the CIP reflects an average annual budget of $2 million to $3 million, with ongoing capital investment continuing well beyond the 20-year planning horizon. This annual budget includes pipe upgrade projects that overlap with the pipe rehabilitation and replacement program. While the funding needed for some projects may exceed the annual amount, the time of development, design, and implementation can be distributed over a longer period.

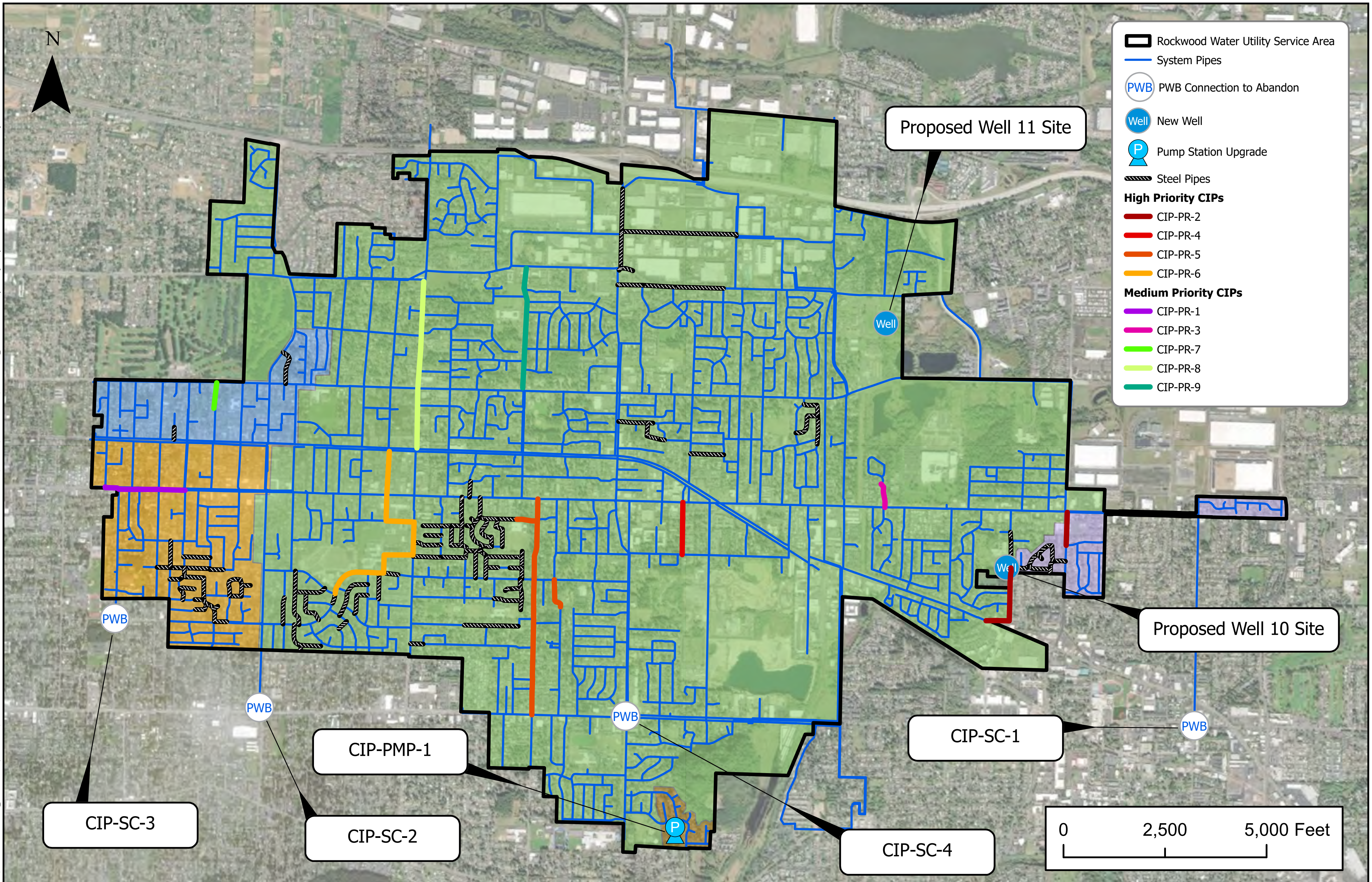


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Figure 7-1
CIP Project Overview

Table 7-1 | Capital Improvement Program Summary

| Improvement Category | Project ID | Project Description | Quantity | | | | Pipe Dia. | Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2025-2034 High Priority | 2035-2044 Medium Priority | 2046-2055 Low Priority | Beyond 2055 | | 2025-2034 High Priority | 2035-2044 Medium Priority | 2046-2055 Low Priority | Beyond 2055 | Total CIP Cost |
| Pump Upgrade | CIP-PMP-1 | Bon-Al PS Capacity Upgrade, Replacement of Unit 1 with 100 gpm and Unit 3 with 820 gpm | 820 | 100 | | | | $1,618,200 | $197,300 | $0 | $0 | $1,815,500 |
| | | **Subtotal** | | | | | | **$1,618,200** | **$197,300** | **$0** | $0 | **$1,815,500** |
| Pipe Replacement | CIP-PR-1 | 12 inch pipe replacement, SE Stark St, from SE 141St Ave to SE 133th Ave, abandon existing 6 and 8 inch pipes. New crossing at SE 139th Ave. | | 1,880 | | | 12 | $0 | $2,653,900 | $0 | $0 | $2,653,900 |
| | CIP-PR-2 | 12 inch pipe replacement, SE 217th Ave, from SE Yamhill St to NW Fariss Rd, NW Fariss Rd to NW Burnside Rd | 2,527 | | | | 12 | $3,567,500 | $0 | $0 | $0 | $3,567,500 |
| | CIP-PR-3 | 12 inch pipe replacement, SE 205th Pl, from SE Stark St to SE 205th Dr | | 604 | | | 12 | $0 | $852,000 | $0 | $0 | $852,000 |
| | CIP-PR-4 | 12 inch pipe replacement, SE 187th Ave from SE Yamhill St to SE Stark St | 1,285 | | | | 12 | $1,813,300 | $0 | $0 | $0 | $1,813,300 |
| | CIP-PR-5 | 12 inch pipe replacement, SE 174th Ave from SE Division St to SE Stark St | 6,541 | | | | 12 | $9,233,100 | $0 | $0 | $0 | $9,233,100 |
| | CIP-PR-6 | 12 inch pipe replacement, SE 160th Ave from E Burnside St to SE Alder St / SE Alder St from SE 160th Ave to SE 162nd Ave / SE 162nd Ave from AE Alder St to SE Main St / SE Main St from SE 162nd Ave to SE 158th Ave / SE Millman Dr from SE 158th Ave to SE Main St at Parklane Park | 5,880 | | | | 12 | $8,300,900 | $0 | $0 | $0 | $8,300,900 |
| | CIP-PR-7 | 12 inch pipe replacement, NE 143rd Ave from NE Glisan St halfway to E Burnside St | | 631 | | | 12 | $0 | $890,800 | $0 | $0 | $890,800 |
| | CIP-PR-8 | 12 inch pipe replacement, NE 162nd Ave from E Burnside St to NE Halsey St | | 4,102 | | | 12 | $0 | $5,790,800 | $0 | $0 | $5,790,800 |
| | CIP-PR-9 | 12 inch pipe replacement, NE 172nd Ave from NE Glisan St to Wilkes East | | 2,956 | | | 12 | $0 | $4,172,500 | $0 | $0 | $4,172,500 |
| | | **Subtotal** | | | | | | **$22,914,800** | **$14,360,000** | **$0** | **$0** | **$37,274,800** |
| Pipe Renewal & Replacement | | Steel Pipe Replacements | 380 | 19,585 | 26,987 | | 6 to 20 | $91,300 | $5,581,700 | $6,322,800 | $0 | $11,995,800 |
| | | Small Pipe Replacements | 668 | 15,394 | 39,340 | 120,072 | 8 | $390,400 | $9,000,000 | $23,000,000 | $70,199,100 | $102,589,500 |
| | | **Subtotal** | | | | | | **$481,700** | **$14,581,700** | **$29,322,800** | **$70,199,100** | **$114,585,300** |
| New Ground Water Well | CIP-Well-1 | Develop Cascade Well 10 and/or Future Well 11 with 4 MGD | 4 | | | | | $4,441,600 | $0 | $0 | $0 | $4,441,600 |
| | | **Subtotal** | | | | | | **$4,441,600** | **$0** | **$0** | **$0** | **$4,441,600** |
| Abandonment of PWD Supply Conduit | CIP-SC-1 | Abandonment of PWB Supply Conduit at NE Cleveland Ave & NE Division St | 1 | | | | | $50,000 | $0 | $0 | $0 | $50,000 |
| | CIP-SC-2 | Abandonment of PWB Supply Conduit at SE 148th Ave & NW Division St | 1 | | | | | $50,000 | $0 | $0 | $0 | $50,000 |
| | CIP-SC-3 | Abandonment of PWB Supply Conduit at SE 135th Ave & SE Mill St | 1 | | | | | $50,000 | $0 | $0 | $0 | $50,000 |
| | CIP-SC-4 | Abandonment of PWB Supply Conduit at SE 182nd Ave & NW Division St | 1 | | | | | $50,000 | $0 | $0 | $0 | $50,000 |
| | | **Subtotal** | | | | | | **$200,000** | **$0** | **$0** | **$0** | **$200,000** |
| | | **Total** | | | | | | **$29,656,300** | **$29,139,000** | **$29,322,800** | **$70,199,100** | **$158,317,200** |
| | | **Annual Average CIP Budget** | | | | | | **$2,965,630** | **$2,913,900** | **$2,932,280** | | |

# 7.2 Supply Source Recommendations

## 7.2.1 Development of Cascade Well 11

Based on the supply analysis described in Chapter 5 and the goal of relying on its own sources, it is recommended that RWPUD continue with the development of additional groundwater supply.

The CIP presented in this report includes the development of one additional groundwater supply well with a groundwater supply capacity of 4 mgd (2,776 gpm). After the new wells that are currently in development has been running at full capacity, the timing of the development of the supply well should be confirmed with validation with the groundwater model.

The estimated project cost of the new groundwater supply well is approximately $4,441,000, including exploratory well drilling, production well drilling, wellhead improvements, and other miscellaneous improvements to integrate the new source into RWPUD's system. It is anticipated that RWPUD will construct Cascade Well 11 or participate in Gresham's new Cascade Well 10. The proposed Cascade Well 11 will be located near the intersection of NE Halsey Street and NE Fairview Parkway. Cascade Well 10 is located near the intersection of SE 217th Avenue and SE Yamhill Street. The additional supply will be transmitted through a raw water pipeline to the treatment facility at SE 223rd Avenue and SE Stark Street where it will be blended with Cascade Well 6 supply. Treated groundwater supply can be pumped into both water provider's distribution systems at this location. Figure 7-2 shows the possible locations of the new groundwater well.

## 7.2.2 Abandonment of PWB Supply Conduits

As RWPUD completes negotiations with the PWB for future emergency supply availability, consideration should be given to the maintenance of connections to the PWB supply conduits. While there are currently seven wholesale supply connections, it is recommended that at least three connections be maintained, if feasible. It is recommended the following conduit connections would not be maintained because of their location, condition, or overall benefit to the system.

- NE Cleveland Avenue& NE Division Street
- SE 148th Avenue & NW Division Street
- SE 135th Avenue & SE Mill Street
- SE 182nd Avenue and NW Division Street

The estimated project cost to abandon each of the supply conduits is $50,000. Figure 7-3 identifies the conduits recommended for abandonment.

The three remaining conduit connections to remain in service are:

- NW 5th Street & NW Riverview Way
- SE 202nd Avenue & NW Division Street
- SE 192nd Avenue & NE Division Street

There is uncertainty of maintenance responsibility of the supply conduits intended to remain in service. Operation and maintenance costs for the three supply conduits will be determined during negotiations with the PWB for future emergency supply.

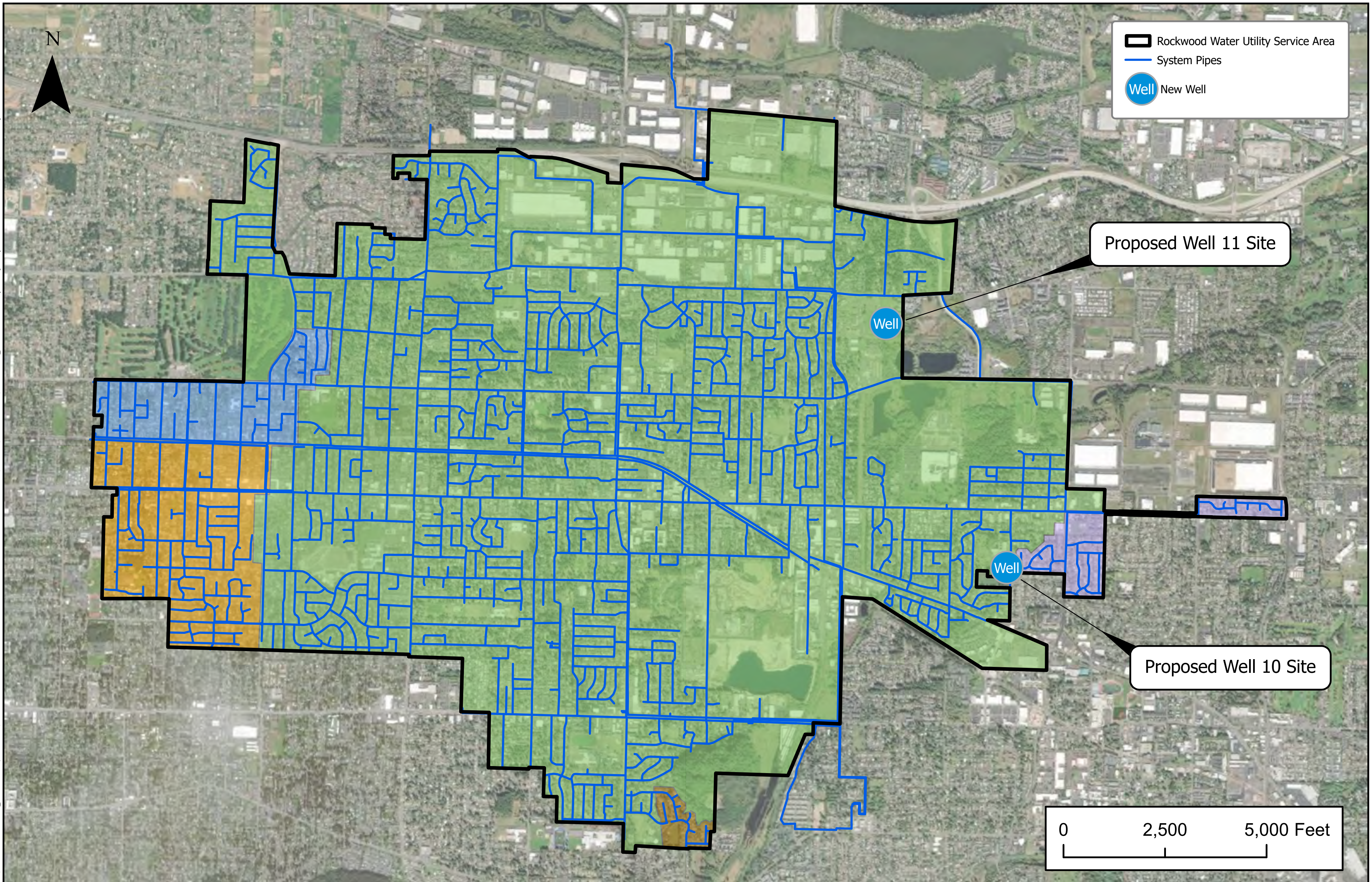


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Figure 7-2
New Groundwater Well
Possible Locations

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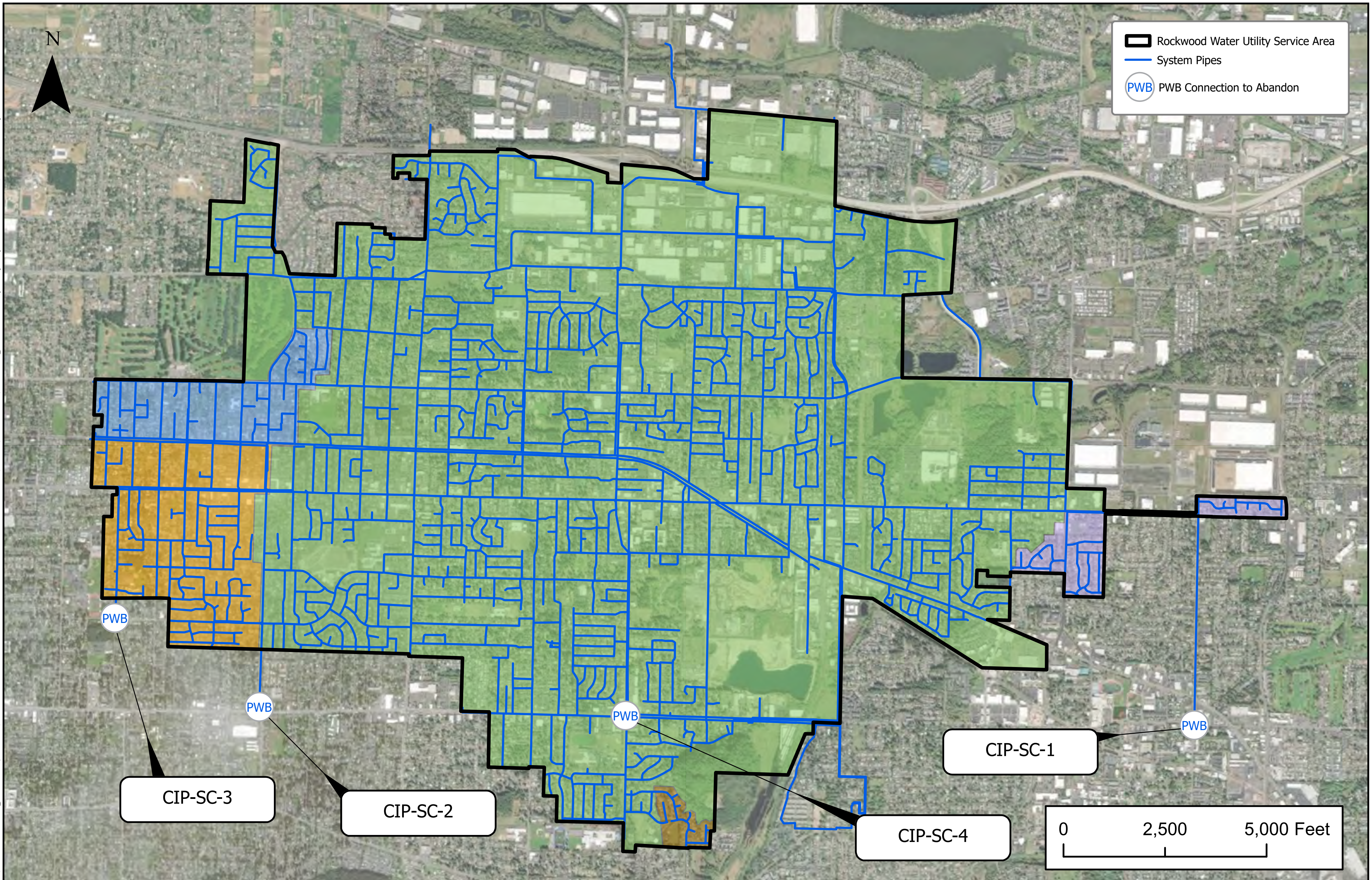


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Figure 7-3
PWB Connections to be Abandoned

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## 7.3 Storage Reservoirs

Based on the findings of the storage analysis presented in **Chapter 5**, RWPUD has adequate storage capacity to meet demands through the 20-year planning horizon.

It is recommended that RWPUD continue its current program for routine maintenance and repairs on existing reservoirs including leak repair, cleaning, and painting. These programs are budgeted separately from the CIP.

## 7.4 Pump Stations

As discussed in **Chapter 5**, the pump stations serving pressure zones without storage should have a firm pumping capacity capable of supplying the MDD simultaneously with the largest fire flow in the zone. Additionally, it is recommended that all constant pressure pump stations be equipped with an emergency power supply. The deficiencies related to pumping capacity can be addressed with the projects listed in the following sections.

### 7.4.1 Bon-Al Pump Station Upgrade

The Bon-Al Pump Station supplies a pressure zone that doesn't have gravity storage. Currently this pump station has four units with a capacity of 40, 140, 140, and 820 gpm, for a total pumping capacity of 1,140 gpm, and a firm capacity (assuming the largest unit out-of-service) of 320 gpm. With this configuration, the station is deficient in capacity for existing (2026) conditions. In future scenarios the deficiencies intensify.

To upgrade the Bon-Al Pump Station, the CIP recommendation includes the replacement of one of the 140 gpm pumps with a new unit of 820 gpm in the short term. Additionally, the 40 gpm unit should be replaced with a new unit of 100 gpm in the medium term planning horizon. The estimated project cost to install the 820 gpm pump is $1,618,200 and the estimated project cost to install the 100 gpm pump is $197,300. Both projects include necessary retrofits to the existing pump station to accommodate the new pump units. The mechanical and electrical installation of pumps, motors, piping, and control systems were included, ensuring that the entire system is built to design specifications. Costs for structural retrofits or additional building space are not included. The existing standby generator will have sufficient capacity for the proposed pump station upgrades. **Figure 7-4** shows the location of the Bon-Al Pump Station.

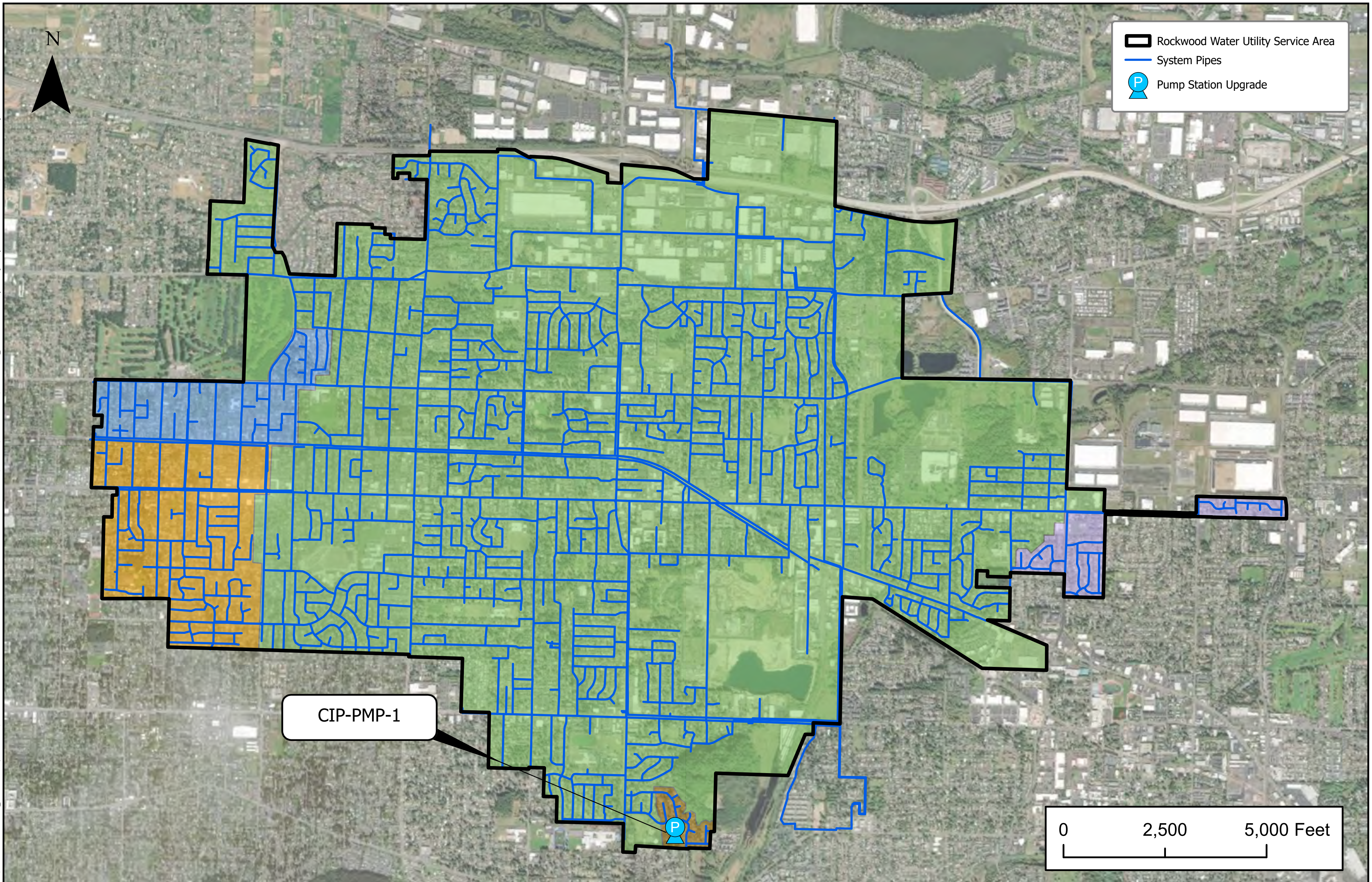


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Figure 7-4
Bon-Al Booster Pump Station Upgrade

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## 7.5 Distribution and Transmission System Improvements

The analysis presented in **Chapter 5** concluded that distribution and transmission system improvements are needed to meet the pressure and fire flow criteria under existing and future demand conditions. The recommended improvements were categorized as high, medium, and low priority based on how close the deficiency location is to meet the pressure and fire flow requirements.

High Priority Pipe Improvements: this set of pipes will improve the conveyance capacity to locations where the fire flow or pressure in the system met less than 70 percent of the requirement.

Medium Priority Pipe Improvements: when the fire flow or pressure in the system without improvements met between 70 and 90 percent of the requirement.

Low Priority Pipe Improvements: when the fire flow or pressure in the system without improvements met at least 90 percent of the requirement.

**Table 7-2** summarizes the length of pipe deficient, by pressure zone, and by priority. **Figure 7-5** presents recommended new and upgraded pipes by priority.

Included in the CIPs approximately 3,900 feet of new pipe is recommended to increase fire flow availability. Low priority projects are not included in the proposed CIP.

Table 7-2 | Pipe Replacements by Pressure Zone

| CIP-ID | Length (ft) | Priority | Zone | CIP Diameter |
|---|---|---|---|---|
| CIP-PR-1 | 1,880 | Medium | Glendoveer | 12 |
| CIP-PR-2 | 2,527 | High | Main | 12 |
| CIP-PR-3 | 604 | Medium | Main | 12 |
| CIP-PR-4 | 1,285 | High | Main | 12 |
| CIP-PR-5 | 6,541 | High | Main | 12 |
| CIP-PR-6 | 5,880 | High | Main | 12 |
| CIP-PR-7 | 631 | Medium | Glendoveer | 12 |
| CIP-PR-8 | 4,102 | Medium | Main | 12 |
| CIP-PR-9 | 2,956 | Medium | Main | 12 |
| **Total** | **26,405** | | | |
| **Total Priority 1** | **16,232** | | | |
| **Total Priority 2** | **10,172** | | | |

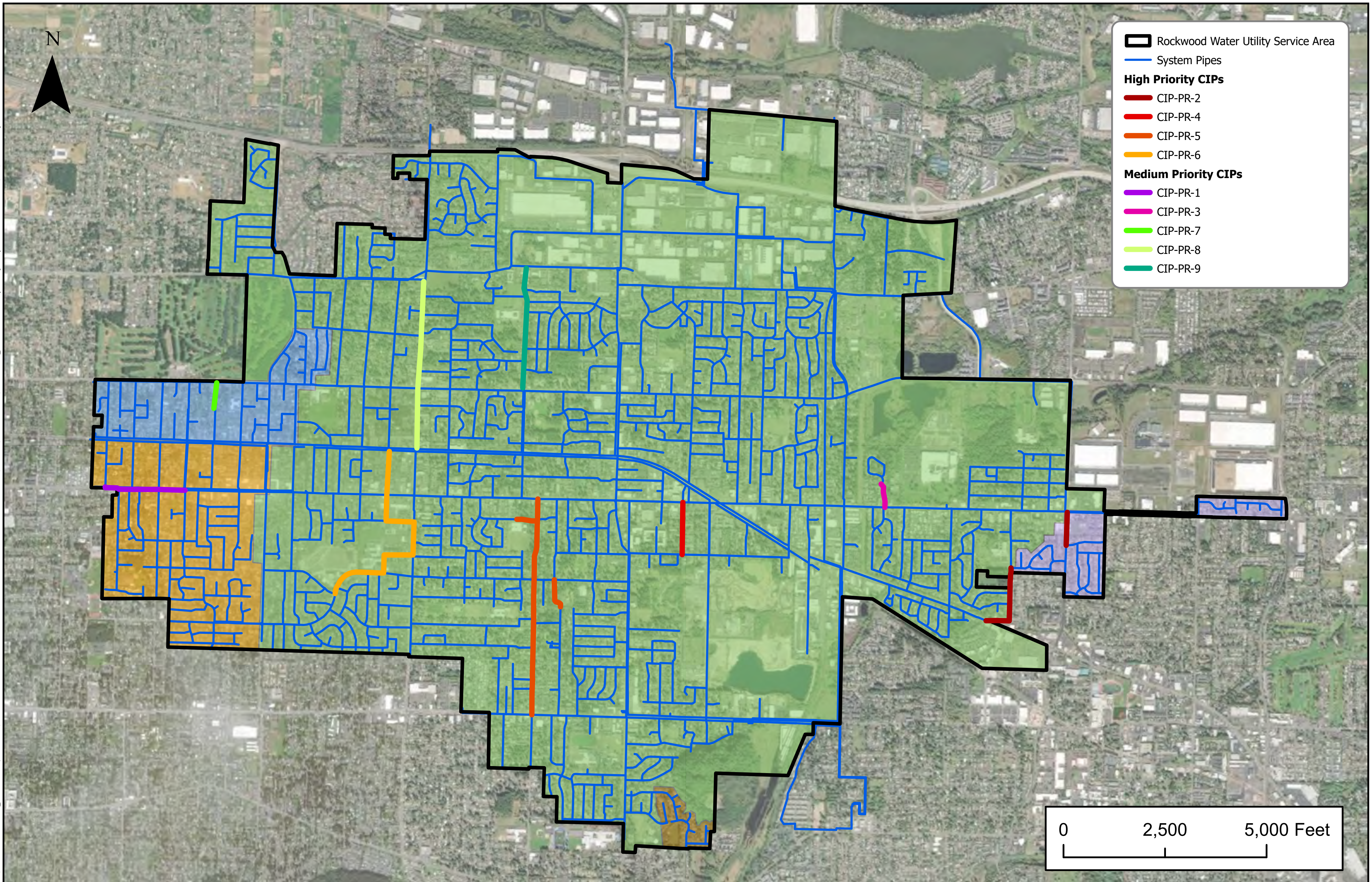


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Figure 7-5
New and Upgraded Pipes

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## 7.6 On-going Pipeline Renewal and Replacement Program

Pipes with diameters of 6-inch or less were identified in **Chapter 5** to not meet fire flow requirements. These pipes are most likely 50-year-old cast iron,ductile iron or steel mains. These pipes should be scheduled for replacement not only due to capacity but also assumed deteriorated condition due to their age as part of the RWPUD Pipeline Renewal and Replacement Program. This program provides for the replacement of all 6-inch diameter and smaller waterlines, cast iron waterlines, steel waterlines, and older waterlines throughout the service area. The total length of all small diameter pipes within the RWPUD water system, with and without deficiencies, is approximately 313,000 feet of pipe. **Figure 7-6** presents all the small diameter pipes within the RWPUD water system.

The *Water Master Plan Update for Rockwood Water PUD*, Oregon, by Murray, Smith & Associates, Inc., dated February 2013 identified CIPs for the replacement of all steel pipe within the RWPUD system. Many of the CIPs have not been completed at the time this report was prepared. The remaining 2013 steel CIPs are summarized in **Table 7-4,** the project IDs and details have been maintained from the 2013 Master Plan Update. This includes a couple CIPs identified as a fire flow deficiency. The project costs from the 2013 Master Plan Update have been escalated to 2025 dollars. Project costs for steel CIPs with a proposed replacement of 6 inch pipe were revised for 8 inch pipe replacements, unless the pipe segment was located at a dead end. **Figure 7-7** presents all the steel pipe CIPs. The cost of this program have been incorporated within the budget of the recommended CIP.

It is recommended cast iron and steel pipes be prioritized over pipes of other materials. Additionally, it is recommended replacement of pipes with diameters less than 6-inch be prioritized over pipes with diameters equal to 6-inch. **Table 7-3** summarizes the lengths of small pipe within the different prioritization categories, with the exception of steel pipes which are listed separately in **Table 7-4**. The cost of this program have been incorporated within the budget of the recommended CIP.

Table 7-3 | Small Diameter Pipe Summary

| Pipe Material | Pipe Size (in) | Length (ft) | | | Cost[3] | | |
|---|---|---|---|---|---|---|---|
| | | High Priority | Medium Priority | Low Priority | High Priority | Medium Priority | Low Priority |
| Cast Iron[1] | 2 | 668 | | | $390,448 | | |
| | 4 | 48,706 | | | $28,475,620 | | |
| | 6 | | | 120,588 | | | $70,500,297 |
| Other[2] | 4 | | 5,513 | | | $3,223,100 | |
| | 6 | | | 137,449 | | | $80,358,335 |
| **Total** | | 49,374 | 5,513 | 258,037 | $28,866,068 | $3,223,100 | $150,858,632 |
| **Overall Total** | | | | **312,924** | | | **$182,947,801** |

Notes:
1. Cast Iron = 43%, Galvanized Iron = 0.2%, Unknown = 8%
2. Other: Ductile Iron = 48%, PVC = 0.2%
3. All pipe replaced with 8 inch ductile iron pipe

Table 7-4 | Steel Pipe CIPs from 2013 Water Master Plan Update

| Project ID | Location | From | To | Existing Pipe Dia. (in) | Proposed Pipe Dia. (in) | Length (ft) | Estimated Project Cost[1] |
|---|---|---|---|---|---|---|---|
| Short Term Piping Improvements | | | | | | | |
| ST6 | NE Halsey Street | NE 181st Avenue | Existing dead-end to the east | 8 | 8 | 380 | $91,300 |
| | | | | | **Subtotal** | **380** | **$91,300** |
| Medium Term Piping Improvements | | | | | | | |
| ST1 | NE Halsey Street | NE 181st Avenue | NE 196th Avenue | 12 | 12 | 2,605 | $899,800 |
| ST2 | NE 181st Avenue | NE Halsey Street | NE Wilkes Road | 12 | 12 | 1,951 | $673,900 |
| ST3 | NE San Rafael Street | NE 181st Avenue | NE 192nd Avenue | 12 | 12 | 2,862 | $988,600 |
| ST11 | SE 217th Avenue | SE Stark Street | NW 25th Street | 8 | 12 | 972 | $335,700 |
| ST13 | SE Yamhill Street | SE 217th Avenue | SE 223rd Avenue | 6 | 8 | 885 | $812,100 |
| | | | | 6 | 6 | 2,495 | $18,000 |
| ST14 | SE Mill Street | SE 167th Avenue | SE 172nd Avenue | 4 | 8 | 1,326 | $318,600 |
| ST15 | SE Millmain Drive | SE Clay Court | SE 160th Place | 6 | 8 | 1,982 | $289,500 |
| ST16 | Neighborhood Streets near SE 151st Avenue | SE Millmain Drive | SE Main Street | 4 | 8 | 3,027 | $727,300 |
| ST17 | NE 197th & 199th Avenues | NE Glisan Street | NE Davis Street | 6 | 8 | 2,157 | $518,200 |
| | | | | | **Subtotal** | **20,576** | **$5,581,700** |
| Long Term Piping Improvements | | | | | | | |
| ST18 | NE Couch Lane | NE 188th Avenue | NE 190th Place | 4 | 8 | 825 | $198,200 |
| ST24 | NE 150th Place | NE Glisan Street | NE 148th Avenue | 4 | 8 | 858 | $206,100 |
| ST25 | Neighborhood Streets near SE 141st Avenue | SE Taylor Street | SE Mill Street | 4 | 8 | 6,965 | $1,673,400 |
| | Neighborhood Streets near SE 141st Avenue | SE Taylor Street | SE Mill Street | 4 | 6 | 474 | $85,400 |
| ST26 | SE 150th Avenue | SE Mill Street | 1604 SE 150th Avenue | 4 | 8 | 653 | $156,900 |
| ST27 | Neighborhood Streets along SE Harrison Street | SE Mill Street | SE 154th Avenue | 4 | 8 | 1,087 | $261,200 |
| | Neighborhood Streets along SE Harrison Street | SE Mill Street | SE 154th Avenue | 4 | 6 | 247 | $44,500 |
| ST28 | Neighborhood Streets near SE 172nd Avenue | SE 169th Place | SE Main Street | 4 | 8 | 1,221 | $293,400 |

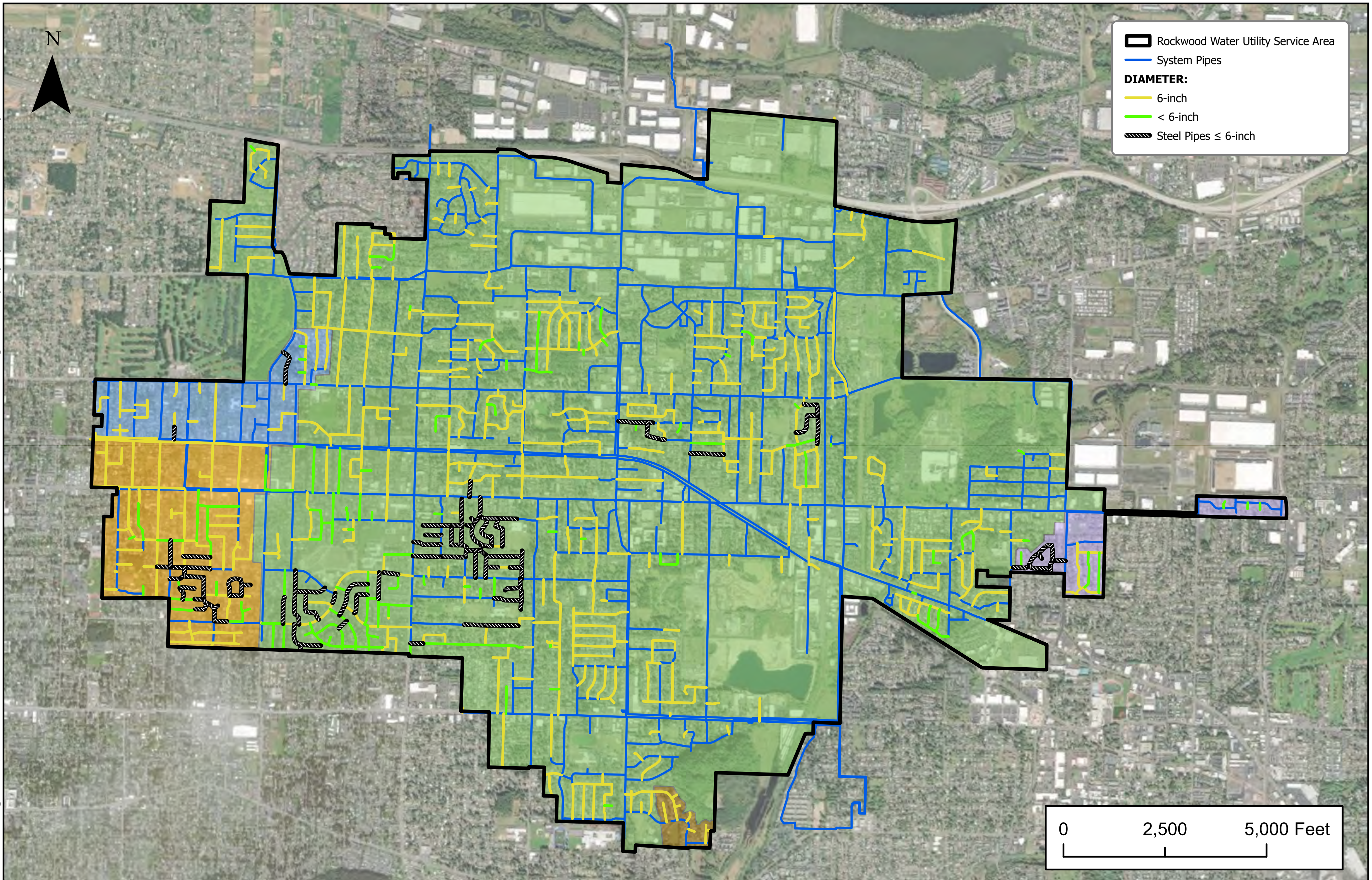
| Project ID | Location | From | To | Existing Pipe Dia. (in) | Proposed Pipe Dia. (in) | Length (ft) | Estimated Project Cost[1] |
|---|---|---|---|---|---|---|---|
| | Neighborhood Streets near SE 172nd Avenue | SE 169th Place | SE Main Street | 4 | 6 | 612 | $110,300 |
| ST29 | Neighborhood Streets near SE 166th Place | SE Main Street | SE Stark Street | 4 | 6 | 1,133 | $204,200 |
| | Neighborhood Streets near SE 167th Avenue | SE Salmon Street | SE Taylor Street | 4 | 8 | 6,931 | $1,665,300 |
| ST31 | SE 145th Avenue, SE Madison Street, SE 146th Place | SE Market Court | SE Hawthorne Court | 4 | 6 | 217 | $39,100 |
| | SE 145th Avenue, SE Madison Street, SE 146th Place | SE Market Court | SE Hawthorne Court | 4 | 8 | 1,346 | $323,400 |
| ST32 | SE 156th Avenue | SE 157th Drive | SE Mill Street | 4 | 8 | 1,208 | $290,200 |
| | SE 156th Avenue | SE Mill Street | SE Madison Court | 4 | 8 | | |
| | SE Madison Court | SE 156th Avenue | SE 158th Avenue | 4 | 8 | | |
| ST33 | SE Stephens Court | SE 157th Drive | SE 156th Avenue | 4 | 8 | 257 | $61,700 |
| ST34 | SE Stephens Street | SE 162nd Avenue | SE 164th Avenue | 4 | 8 | 311 | $74,700 |
| FF28 | NE Everett Court | NE 181st Avenue | NE 183rd Place | 4 | 8 | 852 | $204,700 |
| | NE 183rd Place | NE Everett Court | 18356 NE Davis Street | 4 | 8 | 395 | $94,900 |
| | NE Davis Street | 18356 NE Davis Street | 18436 NE Davis Street | 4 | 8 | 272 | $65,400 |
| | NE Davis Street | 18436 NE Davis Street | NE 184th Place | 4 | 8 | 102 | $24,500 |
| FF43 | SE Hawthorne Court | SE 58th Avenue | SE 157th Avenue | 4 | 8 | 719 | $172,700 |
| FF33 | NE 140th Avenue | E Burnside Street | 104 NE 140th Avenue | 4 | 8 | 302 | $72,600 |
| | | | | | Subtotal | 26,987 | $6,322,800 |
| | | | | | Total | 47,943 | $11,995,800 |

Notes:

1. Project Costs escalated from 2013 Master Plan Update

## 7.7 Financing Alternatives

The RWPUD completes regular analysis of water user rates and will update the rate model following completion of this WMP.

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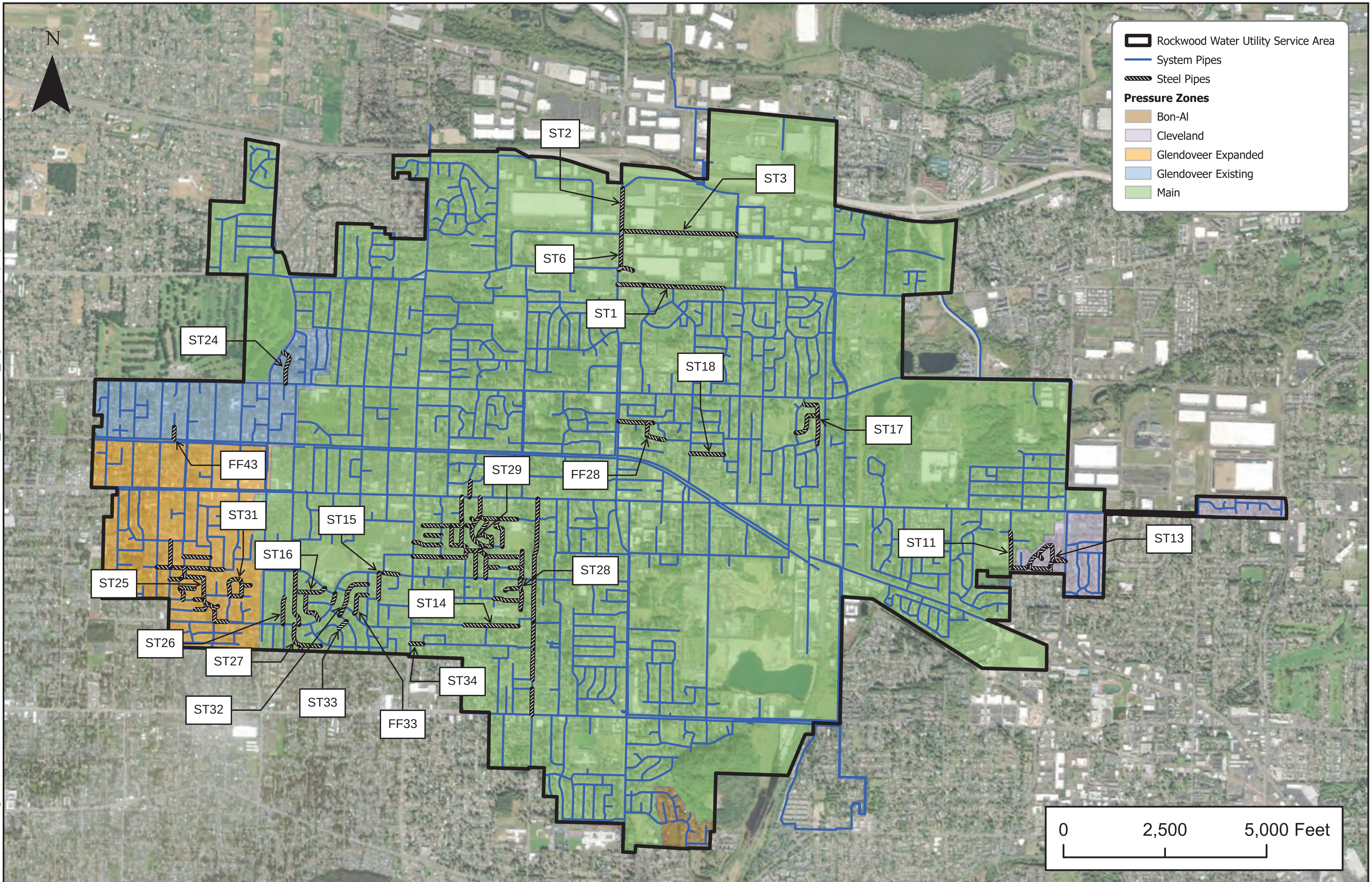
**RWPUD**
**2024 Water System Master Plan**

Figure 7-6
Small System Pipes

20-2870

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**RWPUD**
**2024 Water System Master Plan**

Figure 7-7
Steel Pipe CIPs

CHAPTER 8

# Seismic Evaluation

Water providers throughout the Pacific Northwest are increasingly aware of the risk to their infrastructure from potential seismic activity. Following recent seismic research which presented persuasive evidence on the imminent threat and extreme risk of a CSZ earthquake, the State of Oregon developed the ORP which established target timelines for water utilities to provide service following a seismic event.

The ORP also recognized that, currently, water providers and existing water infrastructure are unable to meet these recovery goals. To improve existing water systems' seismic resilience, one of the ORP's key recommendations was for water utilities to complete a seismic risk assessment and mitigation plan as part of their periodic WSMP update.

As part of this WMP, RWPUD has completed a seismic hazard evaluation in January 2023 (Delve Underground, 2023) of their existing water system. The scope of this evaluation included the review of the DOGAMI seismic hazard maps, available geological information, and available boring log and well log information to verify DOGAMI seismic hazard maps. With this information, develop estimates of strong ground shaking, liquefaction-induced settlement, lateral spreading displacement, and seismic landslide slope instability. The main goal was to identify the geotechnical hazards along the backbone of the RWPUD system. The summarized approach and conclusions presented below are from the Delve Underground report. Appendix C includes the technical memorandum by Delve Underground.

## 8.1 Seismic Hazards Evaluation

Sources for the seismic hazard evaluation included mapped seismic hazards, geologic and seismic hazards literature, historic well logs, various construction drawings, and reports for the RWPUD and in adjacent areas. The key findings of this review are in the following sections.

### 8.1.1 Geologic Setting

The RWPUD is located in the Portland Basin on the south bank of the Columbia River. The Portland Basin is a globally unique geological setting created by the combination of the Volcanic Cascadia subduction forearc system and the Columbia River (Evarts, et al. 2009). Along the southern shore of the Columbia River, fine to coarse grained sediments deposited by the catastrophic floods of Pleistocene Lake Missoula predominate.

The surficial geologic units in the vicinity are Mixed Grained Sediments of Missoula Flood Deposits, and Mixed Lithologies, which occur in isolated areas, such as Grant Butte. Mixed-grained facies consist of silts, sands, and gravels deposited from within the flood channel.

### 8.1.2 Subsurface Data

Geotechnical boring and site-specific geotechnical exploration data available was used to confirm or revise the extents of mapped geologic and hazard layers and to conduct soil liquefaction potential evaluation.

Available historical geotechnical and well logs in the vicinity of the backbone of RWPUD's water system were used to provide an estimated range of depth non-liquefiable material, typically described as gravel, with varying amounts of cobbles, sand, and silt.

## 8.2 Seismic Hazard Evaluation

The goal of the ORP is to set policy direction for protecting lives and maintaining economic and commercial activity following a magnitude 9.0 CSZ earthquake. Studies by the United States Geological Survey indicate that there is a 7 to 12 percent probability of a great CSZ event impacting the entire Pacific Northwest region. A more recent study by University of Oregon estimates that a CSZ earthquake with a magnitude greater than 8.5 has a probability of occurrence on the order of 16 to 22 percent over the next 50 years.

Potential seismic hazards within the area include earthquakes generated from several sources.

- Crustal faults
- Within the deep subducted portion of the Juan de Fuca Plate, along the CSZ
- Along the locked zone of the CSZ fault interface capable of producing great, megathrust events

Large subduction zone earthquakes are characterized by a long duration of significant ground shaking. Due to the long duration of ground shaking, a CSZ earthquake is expected to cause higher levels of permanent ground deformation (PGD) than crustal and intraslab sources.

There are critical seismic risks posed to RWPUD's water system seismic backbone by PGD. As part of the ORP, The Oregon Seismic Safety Policy Advisory Commission developed a description and maps of the likely ground motions (velocity and accelerations) and PGDs to be expected from a magnitude 9.0 CSZ event.

Seismic hazards that pose the most risk to RWPUD's water system include strong ground shaking (peak ground velocity (PGV) and accelerations), liquefaction, lateral spreading, and seismic-induced landslides. RWPUD's seismic backbone was overlaid onto the DOGAMI maps as a starting point. The DOGAMI maps were updated in areas that were found appropriate based on field observations, subsurface data, and geotechnical engineering analysis.

## 8.3 Seismic Hazard Evaluation Findings

The ODGC-7 geology map shows three types of soils in the vicinity. However, the backbone and major facilities are all within the area mapped as Mixed Grained Sediments. Also present, to a smaller extent, are the Portland Basin Volcanics, shown on the map as "Mixed Lithologies" and Fine Grained Sediments.

Based on the review of boring data, the DOGAMI's classification of the soils in the area was revised. Where DOGAMI identifies fine, coarse, and mixed grained sediments of Missoula flood deposits, and occasional recent alluvial deposits, all borings in the vicinity of the backbone pipe showed deep, dense to very dense gravel, mixed with clay, silt, and/or sand. In some areas the gravel is overlain by up to 5 feet of medium dense to dense silt with various amounts of sand. The entire area was reclassified as "Mixed Grained Sediments" to reflect the data.

### 8.3.1 Peak Ground Velocity

The intensity of ground shaking at a site is known as PGV. The magnitude of PGV is dependent on the magnitude and distance from the seismic source, and the ground material through which seismic waves pass. The rapid and extreme shaking during an earthquake can cause transient stress and strain in pipelines that can be damaging if the pipe material and joints are not strong enough to withstand the transient ground deformations.

Damage from ground shaking occurs even when there is no PGD. The Peak Ground Velocity Map shows estimated PGV ranges for a magnitude 9.0 CSZ event in the vicinity.

The intensity of shaking generally corresponds to the mapped geologic units with PGV values ranging from 10-16 inches per second, across the area.

In the vicinity of RWPUD's backbone; PGV of 10-13 inches per second in Mixed Grained Missoula Flood Deposits and Mixed Lithologies, and 13-16 inches per second in Fine Grained Missoula Flood Deposits. All backbone pipe zones are within the lower range.

### 8.3.2 Liquefaction Settlement

Liquefaction is a phenomenon in which ground shaking from an earthquake transforms soil from a solid state to a viscous fluid state. Soils that are susceptible to liquefaction are generally sands and non-plastic to low-plastic silts that are saturated (below groundwater level). Silts and silty soils with a plasticity index less than 7 are generally considered to be susceptible to liquefaction.

The results of soil liquefaction include loss of shear strength, loss of soil materials through sand boils or flow, flotation of buried chambers/pipes, and post-liquefaction reconsolidation (settlement).

The Liquefaction Settlement Map shows the location of the water system backbone compared to seismic liquefaction settlement hazards. Within the study area, geotechnical boring logs and historic well logs were used to confirm that the seismic liquefaction settlement hazard in a magnitude 9.0 CSV event is very low. No seismic vertical settlement is expected at tanks, reservoirs, or along the system backbone.

### 8.3.3 Lateral Spreading

Liquefaction can result in progressive ground deformation known as lateral spreading. Lateral spreading generally occurs along river/creek banks and within sloping ground areas. The lateral movement and loss of support of the liquefied soil breaks the overlying non-liquefied soil "crust" into blocks that progressively move downslope or toward a free face in response to the earthquake generated ground accelerations. Each cycle of loading from the earthquake incrementally pushes these blocks downslope.

The potential and magnitude of lateral spreading depends on the liquefaction potential of the soil, the magnitude and duration of earthquake ground accelerations, the site topography, and the post-liquefaction strength of the soil. Lateral spreading can result in both vertical and horizontal components of PGD, but for discussion purposes and this screening-level of analysis, the reported estimates of PGD can be considered horizontal.

The Liquefaction Lateral Spreading Map shows the location of the water system backbone compared to seismic liquefaction lateral spread hazards. Within the study area, geotechnical boring logs and historic well logs were used to confirm that the liquefaction lateral spreading estimates presented by DOGAMI are reasonable for this area. Based on a review of available borings, lateral spreading PGD in the Missoula Flood deposit zones is generally low to non-existent.

### 8.3.4 Seismic Landslides

Earthquake-induced landslides can occur on slopes due to the inertial force from an earthquake adding load to a slope. The ground movement due to landslides can be extremely large and damaging to pipelines and other structures. Although the DOGAMI mapping identifies a small seismic landslide hazard in the area north of Grant Butte, along SE 190th Avenue, between SE Yamhill and SE Glisan Streets, this is a quarry and seismic landslide hazard is not expected in the vicinity of the RWPUD backbone or storage facilities.

## 8.4 Seismic Hazard Assessment and Recommendations for Critical Facilities

The RWPUD's critical facilities mainly consist of above ground storage tanks, reservoirs, and wells. Based on available data, the liquefaction, lateral spreading, and seismic landslide hazards are considered to be low at these sites. Additionally, the seismic performance of the structures and mechanical components will need to be evaluated to ensure resiliency under strong seismic ground shaking.

Site specific studies were not performed because all the existing facilities have been constructed or retrofitted under the current building code within the last 20 years. It is recommended a site specific study be conducted on the RWPUD offices.

## 8.5 Conclusions and Recommendations

In general, it's expected that the seismic hazards for a magnitude 9.0 CSZ event in the majority of RWPUD's backbone water system are generally low. However, site specific seismic hazard studies and structural evaluations for critical facilities (reservoirs and tanks) were not conducted along with this study. It is recommended that these studies be conducted to develop mitigation strategies, if needed.

APPENDIX A

2023 WATER MANAGEMENT AND CONSERVATION PLAN EXHIBIT 2-34

**Exhibit 2-34. City of Gresham Water Rights for Potable Municipal Water Use**

| Source | Priority Date | Application | Permit | Transfer or Permit Amend-ment | Certificate | Type of Beneficial Use | Authorized Rate (cfs) | Authorized Volume (acre-feet) | Maximum Rate of Withdrawal to Date | | 2021 Average Combined (District and City) Withdrawal(1) | | Five-Year (2017–2021) Average Combined (District and City) Withdrawal(1) | | Authorized Date for Completion | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Instantaneous (cfs) | Annual (MG)(1) | Daily (mgd) | Monthly (MG) | Daily (mgd) | Monthly (MG) | | |
| Groundwater; Well 1 (Cascade Well 5), Well 2, Well 3 (Cascade Well 6), Well 4, Well 5, Well 6 (Cascade Well 3), Well 7, Well 8 (Cascade Well 8), Cascade Well 4 | 12/21/1977 | G-8585 | ~~G-8719~~ G-16917 | T-10554 T-13274 (Pending)[2] | — | Municipal | 53.50 (from up to 9 wells, including Cascade 3, 4, and 5) | — | 11.8 cfs (3) | 666.6 | 4.3 | 128.8 | 3.2 | 95.6 | 10/1/2047 | Rockwood Water People's Utility District and City of Gresham's shared right—Rockwood assigned Gresham 18 mgd of this right. Following approval of Permit Amendment T-10554, OWRD issued superseding Permit G-16917 |

**Footnotes**

(1) This value is the combined withdrawal under the District's Certificate 83629 and the District's and City's jointly held Permit G-16917.

(2) Permit amendment T-13274 (currently under review at OWRD) proposes to change the location of one existing point of appropriation (Well 4) and to add three new points of appropriation to the permit (Cascade 7, Well 9, and Well 10)

(3) Based on the maximum pumping capacity of Cascade Well 5 of 7.6 mgd (11.8 cfs).

**Note**

The City (and District) expect to fully exercise Permit G-16917 by 2080, as noted in Section 5.3.

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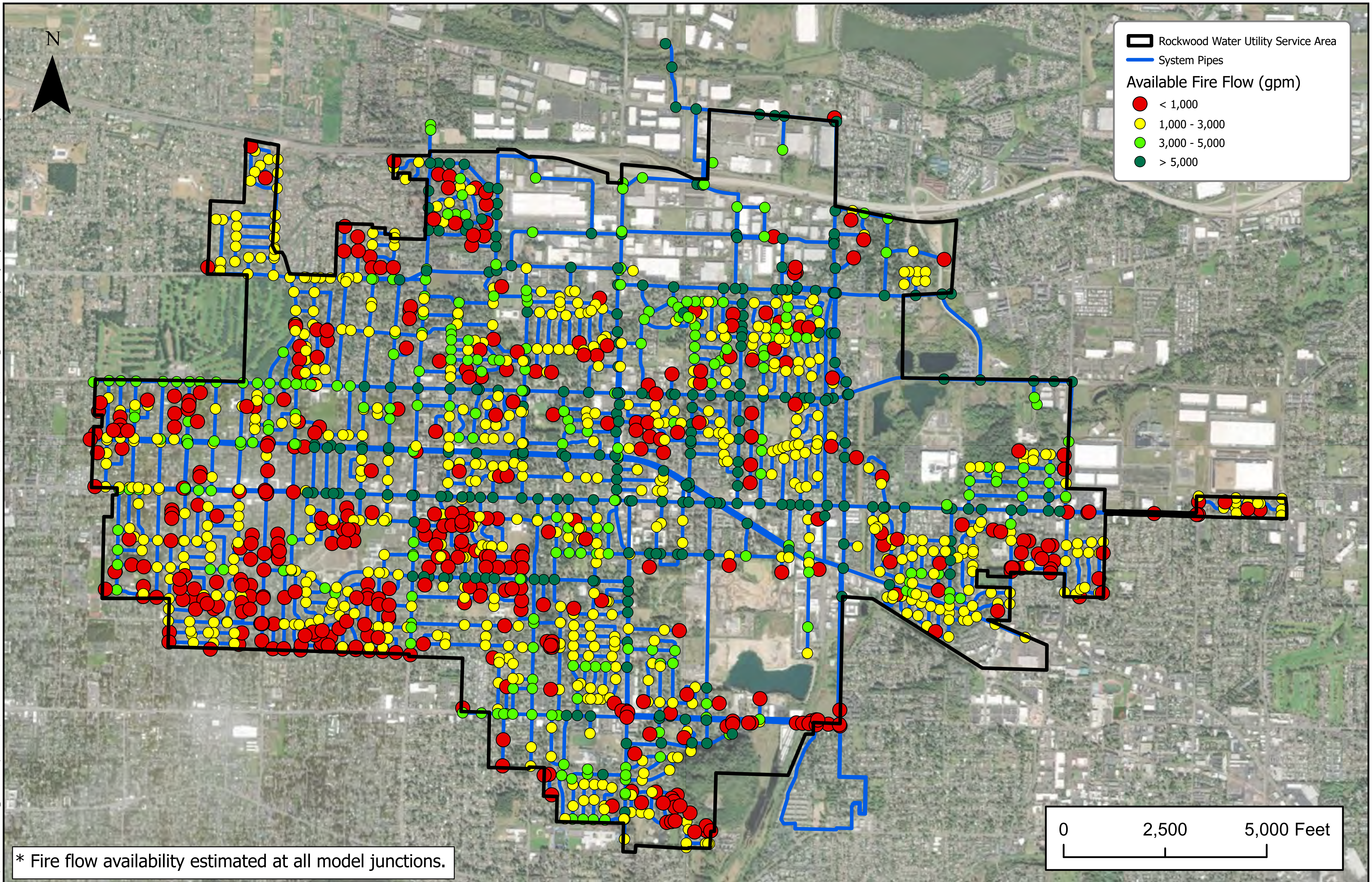
# APPENDIX B
# HYDRAULIC MODELING RESULTS

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**RWPUD**
**2024 Water System Master Plan**

Figure 5-1
Scenario 1: 2026 MDD + FF

20-2870

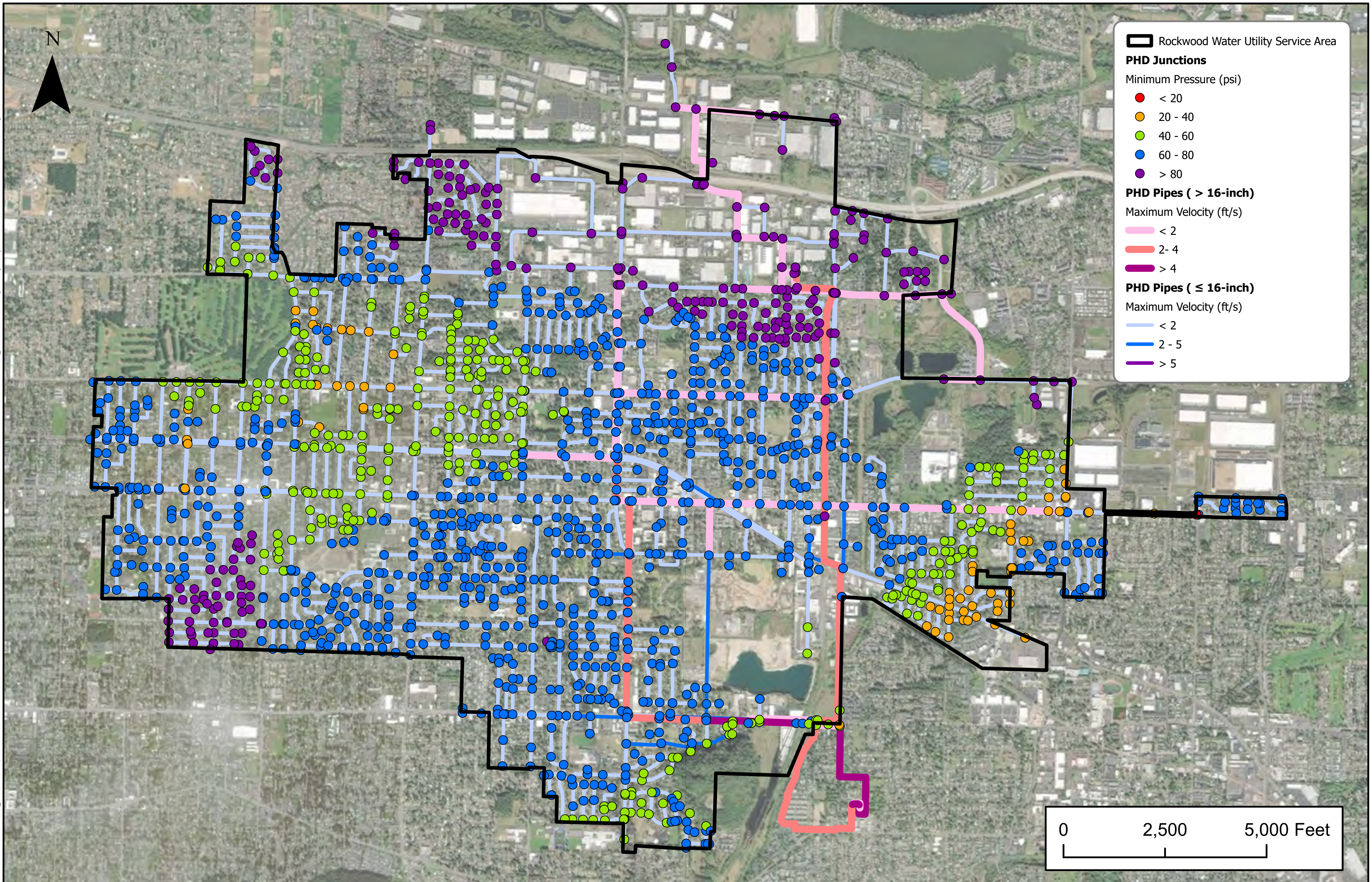


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Figure 5-2
Scenario 2: 2026 PHD Demand

20-2870

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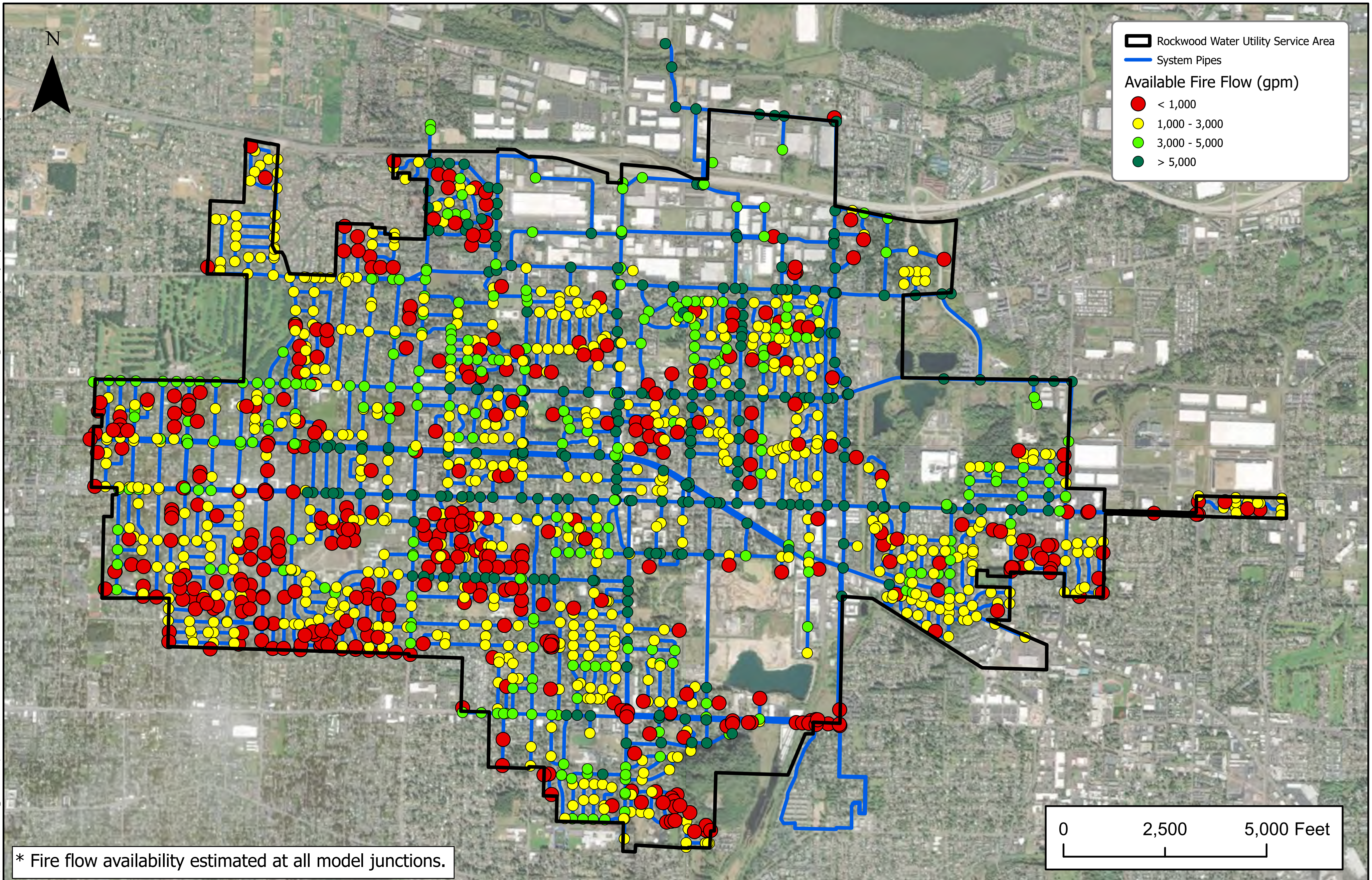


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Figure 5-3
Scenario 3: 2044 MDD + FF

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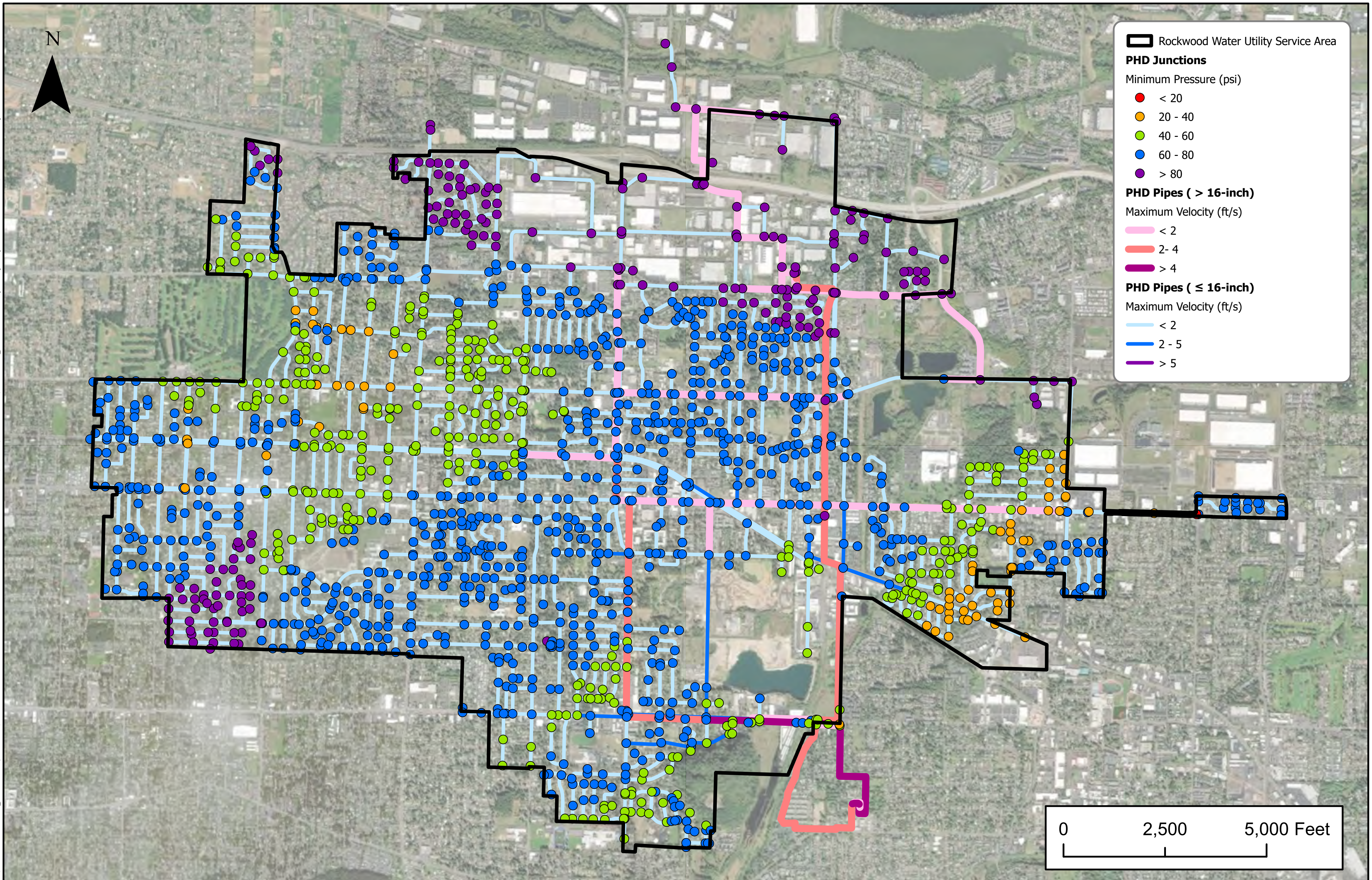


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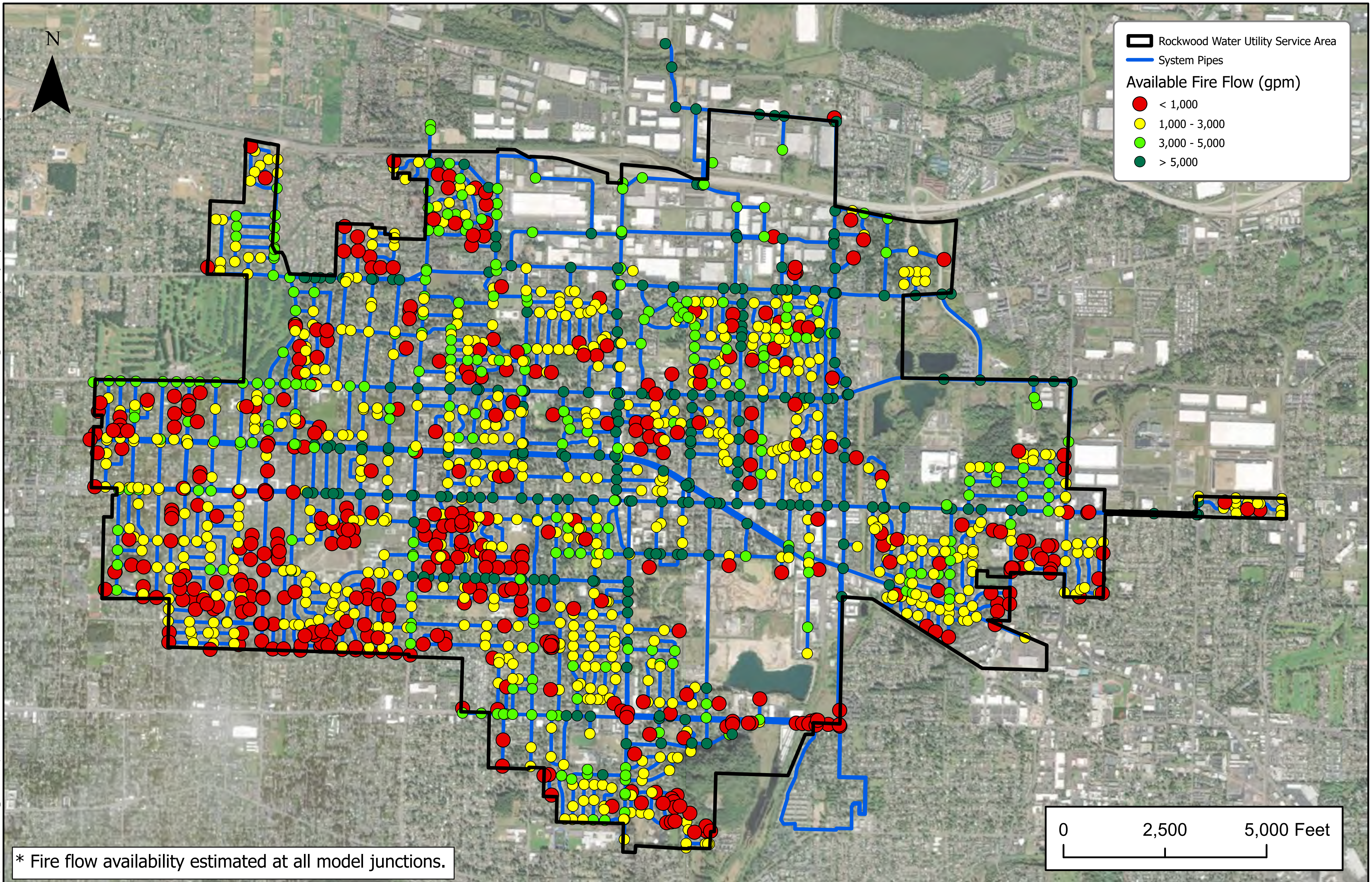
Figure 5-4
Scenario 4: 2044 PHD Demand

20-2870

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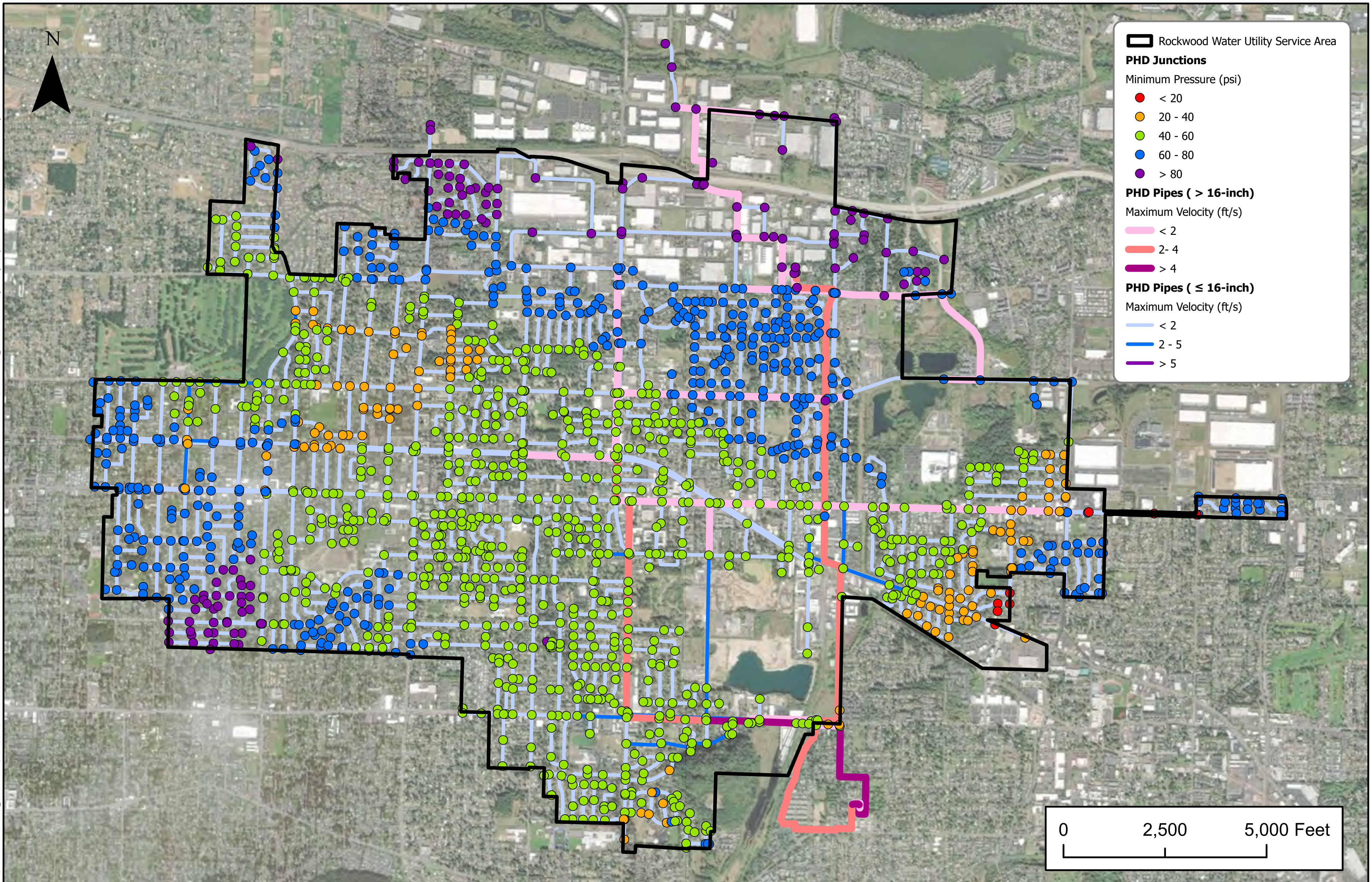
**RWPUD**
**2024 Water System Master Plan**

Figure 5-5
Scenario 5: Saturation
MDD + FF



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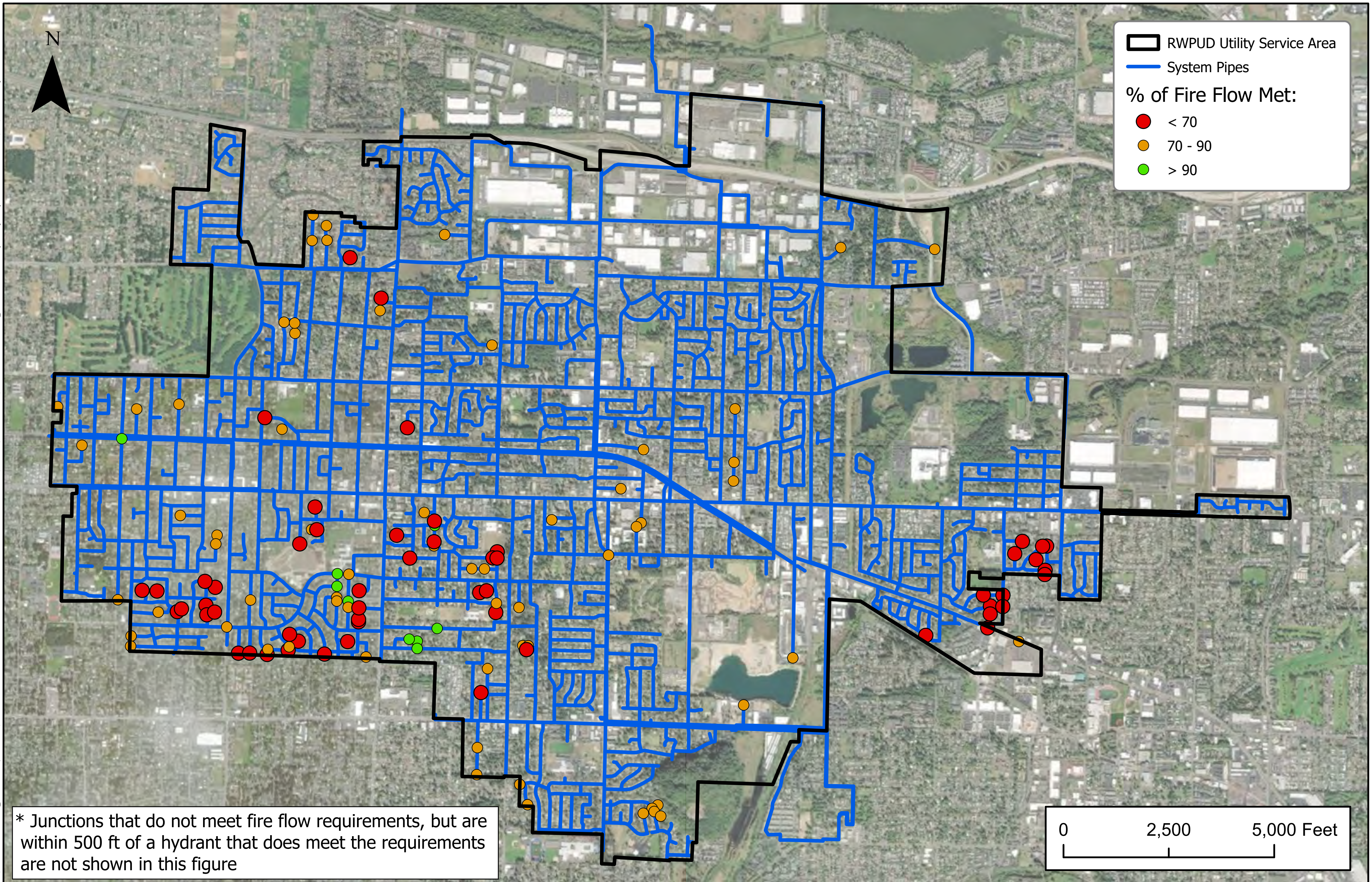
**RWPUD**
**2024 Water System Master Plan**

Figure 5-6
Scenario 6: Saturation PHD Demand

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**2024 Water System Master Plan**

Figure 5-14
Deficient Junctions
Categorized by % of Fire
Flow Requirement Met

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# APPENDIX C
# SEISMIC HAZARDS EVALUATION

# Technical Memorandum

| | | | |
|---|---|---|---|
| To: | Brian Ginter, PE | Project: | Rockwood Water District Master Plan Update |
| From: | Wolfe Lang, PE, GE, & Devin Roth, PE | cc: | |
| Date: | January 6, 2023 | Job No.: | 6173.0 |
| Subject: | Seismic Hazards Evaluation | | |

## 1.0 Introduction

The Rockwood Water District (District) is updating their water system master plans. The District has contracted Consor North America, Inc. (Consor), formerly known as Murraysmith, Inc. to provide professional services for the master plan updates and resilience study. As part of the study, a seismic resiliency evaluation of the water system is required in conjunction with the Oregon Resilience Plan (ORP). Murraysmith has retained Delve Underground., formerly known as (McMillen Delve Underground) to conduct seismic hazard evaluation.

This memorandum presents the results of our evaluation. Delve Underground, Inc. completed the following tasks in accordance with our scope of work:

1. Review of DOGAMI seismic hazard maps for a magnitude 9.0 Cascadia Subduction Zone (CSZ)I event in the District's service area;
2. Review of available geological information;
3. Review of available boring log and well log information to verify DOGAMI seismic hazard maps;
4. Develop estimates of strong ground shaking, liquefaction-induced settlement, lateral spreading displacement, seismic landslide slope instability, and develop maps illustrating these hazards in relation to the District's backbone system and;
5. Develop this memorandum summarizing the results of our evaluations and including seismic hazards and fragility maps.

Delve Underground completed these tasks for the identified backbone facilities and pipes as shown on Figures 1 to 5, at the end of this memo. In the following sections, we present the results of the data review, seismic hazards evaluation, and a summary of geotechnical hazards along the backbone system.

# 2.0 Background Information Review

Delve Underground performed background information review in the vicinity of the Rockwood Water District. These tasks included review of mapped seismic hazards, geologic and seismic hazards literature, historic well logs, various construction drawings and reports for the Rockwood Water District and in adjacent areas.

## 2.1 Geologic Setting

The Rockwood Water District is located in the Portland Basin on the south bank of the Columbia River. The Portland Basin is a globally unique geological setting created by the combination of the Volcanic Cascadia subduction forearc system and the Columbia River (Evarts, et al. 2009). Along the southern shore of the Columbia River, fine to coarse grained sediments deposited by the catastrophic floods of Pleistocene Lake Missoula predominate.

The surficial geologic units in the vicinity of the District are Mixed Grained Sediments of Missoula Flood Deposits, and Mixed Lithologies, which occurs in isolated areas, such as Grant Butte. These units are briefly described below from oldest to youngest.

**Mixed Lithologies**
Mixed Lithologies soils in the District vicinity are composed mostly of Troutdale Formation – alluvial gravel, sand and silt formed 8 – 2 million years ago.

**Missoula Flood Deposits**
The Catastrophic Missoula Floods innundtated the Portland Basin with boulders, gravel, sand, and silt up to the end of the last ice age, 12,000 years ago. Missoula Flood Deposits are typically split into three different facies; coarse-grained, fine-grained, and mixed-grained or channel facies. Mixed-grained facies consist of silts, sands, gravels deposited from within the flood channel.

Local surficial geologic units in the vicinity of the District's backbone are discussed below in Section 3.1 and shown on the Geologic Map (Figure 1).

## 2.2 Subsurface Data

Delve Underground, Inc. reviewed published geologic maps and available subsurface condition information in the vicinity of the water system. We have referred to geotechnical boring and site-specific geotechnical exploration data available for the water system service area. Where possible, we used this data to confirm or revise the extents of mapped geologic and hazard layers from the (Bauer 2018) and to conduct soil liquefaction potential evaluation.

We also reviewed available historical geotechnical and well logs in the vicinity of the backbone of the District's water system. These logs provide an estimated range of depth non-liquefiable material, typically described as gravel, with varying amounts of cobbles, sand, and silt. We show a summary of these documents in Figures 1 – 5 show the locations of these borings. Table 1, with a list of sources below. Figures 1 – 5 show the locations of these borings.

**Table 1: Geotechnical and ORWD Well Logs**

| # | Boring ID | Source | Max. Depth (Feet bgs) | Notes | Liq. Probability |
|---|---|---|---|---|---|
| **1** | GT006076: B-1 – B-2 | A | 65, 30 | Dense to v. dense GRAVEL with Sand | Very Low |
| **2** | GRES 1: B-9 | B | 90 | Dense to v. dense GRAVEL with Sand | Very Low |
| **3** | ODOT 17212 (49753) TB-506, etc. | C | ~36 | Sandy GRAVEL with Silt and Cobbles | Very Low |
| **4** | MTL-1561-1610: B-24 (1586) | D | 18 | GRAVEL with Sand and Cobbles | Very Low |
| **5** | GDPP2B B-1 – B-4 | E | 21.5 | Very Dense Silty GRAVEL w/Sand to Very Dense Clayey GRAVEL | Very Low |
| **6** | GDI 2010_B-1 | F | 14 | Soft SILT near surface to V. Dense Silty GRAVEL at pipe depth. This boring is in a zone of recent alluvial deposits somewhat downslope from the closest pipe. The thick, soft layer encountered here would not be present along pipeline in this area. | Low |
| **7** | GRI 2004 B-1 & B-10 | F | 8.5 | Stiff SILT to Dense GRAVEL & V. Dense SAND | Very Low |
| **8** | SW 2012 B-2 | G | 45.1 | ~3' layer of soft SILT over Very Dense GRAVEL to Gravelly SAND | Very Low |
| **9** | GDPP6 B-01 – B-03 | H | 41.5 | Dense to V. Dense Silty GRAVEL | Very Low |
| **10** | CSIW7 B-1 – B-5 | I | 25.4 | Med. Stiff SILT to approx. 5 ft to Dense to Very Dense Silty/Sandy GRAVEL | Very Low |
| **11** | CSIW7 TP-8 0– TP-11 | I | 10 | Med. Stiff SILT to max depth 5 ft to Dense to Very Dense Silty/Sandy GRAVEL | Very Low |
| **12** | CR_B-1 – B-3 | J | 13.5 | Med. Stiff to Stiff SILT with Sand to ~8 ft to med. To dense Silty GRAVEL | Very Low |

Boring data sourced from the following (Client, Project, Author, Date):

A. Rockwood Water PUD, 141st Ave Res. Retrofit (GT006076), CH2Mhill, 2008.
B. DOGAMI, GRES 1, GRI, 1995 (NEHRP Database Log).
C. ODOT, ODOT 17212 (49753) – 201st Ave. O'Xing, ODOT, 1993.
D. City of Portland Bureau of Environmental Services, MTL-1561-1610, Century West, 1987
E. City of Gresham, Groundwater Development Project Package 2B, McMillen Delve Underground, 2022.
F. City of Gresham/Brown and Caldwell, Linneman PS Expansion Improvements, GeoDesign, 2010
G. Rockwood Water PUD, Cleveland Reservoir Seismic Improvements, Shannon & Wilson, 2013.
H. City of Gresham, Groundwater Development Project Package 6, McMillen Delve Underground, 2022.
I. Rockwood Water PUD, Cascade Site Improvements and Well No. 7 Site, GeoDesign, 2021.
J. Rockwood Water PUD, RWPUD Cleveland Reservoir, Shannon & Wilson, 2013.

## 3.0 Seismic Hazard Evaluation and Mapping

Recent earthquakes in Japan, New Zealand, Chile and elsewhere, and an increased understanding of the Cascadia Subduction Zone (CSZ), have increased the recognition of the earthquake hazard in Oregon. In 2011, Oregon legislature passed a resolution directing the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) to prepare the Oregon Resilience Plan (ORP). The purpose of the ORP is to set policy direction for protecting lives and maintaining economic and commercial activity following a magnitude 9.0 CSZ earthquake (Oregon Resilience Plan 2013). In 2020 DOGAMI published Open File Report O-18-02, which includes updated hazard maps for Multnomah County, Oregon (Bauer 2018).

Recent studies indicate that there have been numerous large-magnitude earthquakes generated from the CSZ (Goldfinger et al., 2012). These records extend as far back as approximately 10,000 years and indicate an average recurrence of about 500 to 530 years for great earthquakes (larger than M 8.0) that rupture along the entire length of the CSZ (from Cape Mendocino, California to Northern Vancouver Island, British Columbia). The previous CSZ earthquake occurred in January 1700 (Satake, et al., 1996) and is estimated to have been a M 9.0 event. Studies by the USGS (Goldfinger et al., 2012; OSSPAC, 2013) indicate that there is a 7 to 12 percent probability of a great CSZ event impacting the entire Pacific Northwest region. A more recent study by University of Oregon (Goldfinger et al., 2016) estimates that a CSZ earthquake with a magnitude greater than 8.5 has a probability of occurrence on the order of 16 to 22 percent over the next 50 years.

Earthquake hazards within the Project area include earthquakes generated from several sources:

- Crustal faults;
- Within the deep subducted portion of the Juan de Fuca Plate, along the CSZ (referred to as intraslab sources); and
- Along the locked zone of the Cascadia Subduction Zone fault interface capable of producing great, megathrust events.

Large subduction zone earthquakes are characterized by a long duration of significant ground shaking. The 2010 subduction zone earthquake in Maule, Chile resulted in approximately 100 seconds of significant ground shaking. The 2011 subduction zone earthquake in Tohoku, Japan resulted in between about 2 to 3 minutes of significant ground shaking. For comparison, crustal earthquakes with similar seismogenic characteristics exhibited significant ground shaking for about 10 to 20 seconds (specifically the 2010-2011 Christ Church, New Zealand sequences, 1999 Chi-Chi, Taiwan, and 1983 Coalinga, California earthquakes).

Due to the long duration of ground shaking, a CSZ earthquake is expected to cause higher levels of permanent ground deformation (PGD) than crustal and intraslab sources. Permanent ground deformations pose critical seismic risks to the District’s water system seismic backbone.

In some instances, for structures and facilities (pump stations, treatment plants, reservoir, dam), the seismic design criteria are governed by other code-based procedures (ASCE 7-16, OSSC 2014, Oregon Dam Safety). Typically, these code-based procedures require use of the Maximum Considered Earthquake (MCE) ground motion. The MCE ground motion is derived from USGS Seismic Hazard Maps and represents the most server earthquake effects. The MCE is a probabilistically derived composite event that is aggregated from all potential earthquake sources that could impact a site and having a return interval of 2,475 years. For comparison, the ORP M9.0 scenario is roughly analogous to a 500-year return interval event.

As part of the ORP, The OSSPAC created a Cascadia Earthquake Scenario workgroup which was charged with developing a description of the likely ground motions (velocity and accelerations) and permanent ground deformations (PGD) to be expected from a M9.0 CSZ event. The workgroup, along with the Oregon Department of Geology and Mineral Industries (DOGAMI), developed M9.0 earthquake scenario maps, which are included in the DOGAMI Open-File Report O-13-06. In 2018, DOGAMI released Open File Report O-18-02, with more detailed hazard maps of Multnomah County, Oregon (Bauer 2018). Of primary interest in these earthquake scenario maps are the seismic hazards of Peak Ground Acceleration (PGA), Peak Ground Velocity (PGV), Peak Ground Deformation (PGD), and Liquefaction and Seismic Landslide Probability, which formed the baseline levels in our evaluations of seismic hazards. These data are included in a geodata:

- Peak Ground Acceleration (DOGAMI O-18-02 Plate 4)
- Lateral Spreading PGD (DOGAMI O-18-02 Plate 8)
- Liquefaction and Seismic Landslide Probability (DOGAMI O-18-02 Plate 9)

We used the M9.0 CSZ event as the basis of our analyses to be consistent with the ORP and the District's approach. Seismic hazards that pose the most risk to the District's water system include strong ground shaking (peak ground velocity and accelerations), liquefaction, lateral spreading, and seismic-induced landslides. In our hazard evaluations, we overlaid the District's seismic backbone onto the DOGAMI maps as a starting point. As discussed subsequently, we refined and updated the DOGAMI maps in areas that we found appropriate based on field observations, subsurface data and geotechnical engineering analysis.

### 3.1 Geologic Map

The Geologic Map (Figure 1) describes the mapped surficial geologic units in the vicinity of the District's Water System backbone and is based on the DOGAMI Oregon Geologic Data Compilation Release 7 (OGDC-7). These mapped units correspond to the generalized descriptions discussed in Section 2.1.

DOGAMI's ODGC-7 geology map shows 3 types of soils in the vicinity of the District's system. However, the backbone and major facilities are all with the area mapped as Mixed Grained Sediments. Also, present to a smaller extent are the Portland Basin Volcanics, shown on the map as "Mixed Lithologies" and Fine Grained Sediments.

Based on the review of boring data listed in Table 1, we have changed DOGAMI's classification of the soils in the area. Where DOGAMI identifies fine, coarse, and mixed grained sediments of Missoula flood deposits, and occasional recent alluvial deposits, all borings in the vicinity of the backbone pipe show deep, dense to very dense gravel, mixed with clay, silt and/or sand. In some areas the gravel is overlain by up to 5 feet of medium dense to dense silt with various amounts of sand. We have reclassified the entire area as “Mixed Grained Sediments” to reflect the data.

### 3.2 Peak Ground Velocity

The intensity of ground shaking at a site is known as peak ground velocity (PGV). The magnitude of PGV is dependent on the magnitude and distance from the seismic source, and the ground material through which seismic waves pass. The rapid and extreme shaking during an earthquake can cause transient stress and strain in pipelines that can be damaging if the pipe material and joints are not strong enough to withstand the transient ground deformations. Damage from ground shaking occurs even when there is no permanent ground deformation.

The Peak Ground Velocity Map (Figure 2) shows estimated PGV ranges for a CSZ 9.0 event in District vicinity. The intensity of shaking generally corresponds to the mapped geologic units with PGV values of ranging from 10-16 in/sec across the area. In the vicinity of the District’s backbone; PGV of 10-13 in/sec in Mixed Grained Missoula Flood Deposits and Mixed Lithologies, and 13-16 in/sec in Fine Grained Missoula Flood Deposits. All District backbone pipe zones are within the lower range. These ranges have been adjusted slightly to correspond to the modifications to the geological classification discussed in Section 3.1.

### 3.3 Liquefaction Settlement

Liquefaction is a phenomenon in which ground shaking from an earthquake transforms soil from a solid state to a viscous fluid state. Soils that are susceptible to liquefaction are generally sands and non-plastic to low-plastic silts that are saturated (below groundwater level). Silts and silty soils with a plasticity index less than 7 are generally considered to be susceptible to liquefaction. The results of soil liquefaction include loss of shear strength, loss of soil materials through sand boils or flow, flotation of buried chambers/pipes, and post-liquefaction reconsolidation (settlement).

The Liquefaction Settlement Map (Figure 3) shows the location of the water system backbone compared to seismic liquefaction settlement hazards. Within the study area, we used geotechnical boring logs and historic well logs to confirm that the seismic liquefaction settlement hazard in a CSV 9.0 event is very low. No seismic vertical settlement is expected at tanks, reservoirs, or along the system backbone.

### 3.4 Lateral Spreading

Liquefaction can result in progressive ground deformation known as lateral spreading. Lateral spreading generally occurs along river/creek banks and within sloping ground areas. The lateral movement and loss of support of the liquefied soil breaks the overlying non-liquefied soil “crust” into blocks that progressively move downslope or toward a free face in response to the earthquake generated ground accelerations. Each cycle of loading from the earthquake incrementally pushes these blocks downslope. The potential and magnitude of lateral spreading depends on the liquefaction potential of the soil, the magnitude and duration of earthquake ground accelerations, the site topography, and the post-liquefaction strength of the soil. Lateral spreading can result in both vertical and horizontal components of PGD, but for discussion purposes and this screening-level of analysis, the reported estimates of PGD can be considered horizontal.

The Liquefaction Lateral Spreading Map (Figure 4) shows the location of the water system backbone compared to seismic liquefaction lateral spread hazards.

Within the study area, we used geotechnical boring logs and historic well logs to confirm that the liquefaction lateral spreading estimates presented by DOGAMI are reasonable for this area. Based on a review of available borings (shown on map and listed in Table 1, lateral spreading PGD in the Missoula Flood deposit zones is generally low to non-existent.

### 3.5 Seismic Landslides

Earthquake induced landslides can occur on slopes due to the inertial force from an earthquake adding load to a slope. The ground movement due to landslides can be extremely large and damaging to pipelines and other structures.

The Seismic Landslide PGD map (Figure 5) shows the estimated levels of seismic landslide PGD in the vicinity of the District. Although the DOGAMI mapping identifies a small seismic landslide hazard in the area north of Grant Butte, along SE 190th Ave, between SE Yamhill St and SE Glisan St, this is a quarry and seismic landslide hazard is not expected in the vicinity of the District backbone or storage facilities.

## 4.0 Seismic Hazard Assessment and Recommendations for Critical Facilities

The Rockwood Water District's critical facilities mainly consist of above ground storage tanks, reservoirs and wells. . Based on available data, we consider the liquefaction, lateral spreading, and seismic landslide hazards to be low at these sites. Additionally, the seismic performance of the structures and mechanical components will need to be evaluated to ensure seismic resiliency under strong seismic ground shaking.

## 5.0 Conclusions and Recommendations

In general, we expect the seismic hazards for a magnitude 9.0 CSZ event in the majority of the Rockwood Water District's backbone water system are generally low. However, site specific seismic hazard studies and structural evaluations for critical facilities (reservoirs and tanks) are not conducted along with this study. We recommend that these studies be conducted to develop mitigation strategies if needed.

**DELVE UNDERGROUND, INC.**

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Principal Engineer

Devin Roth, P.E.
Project Engineer

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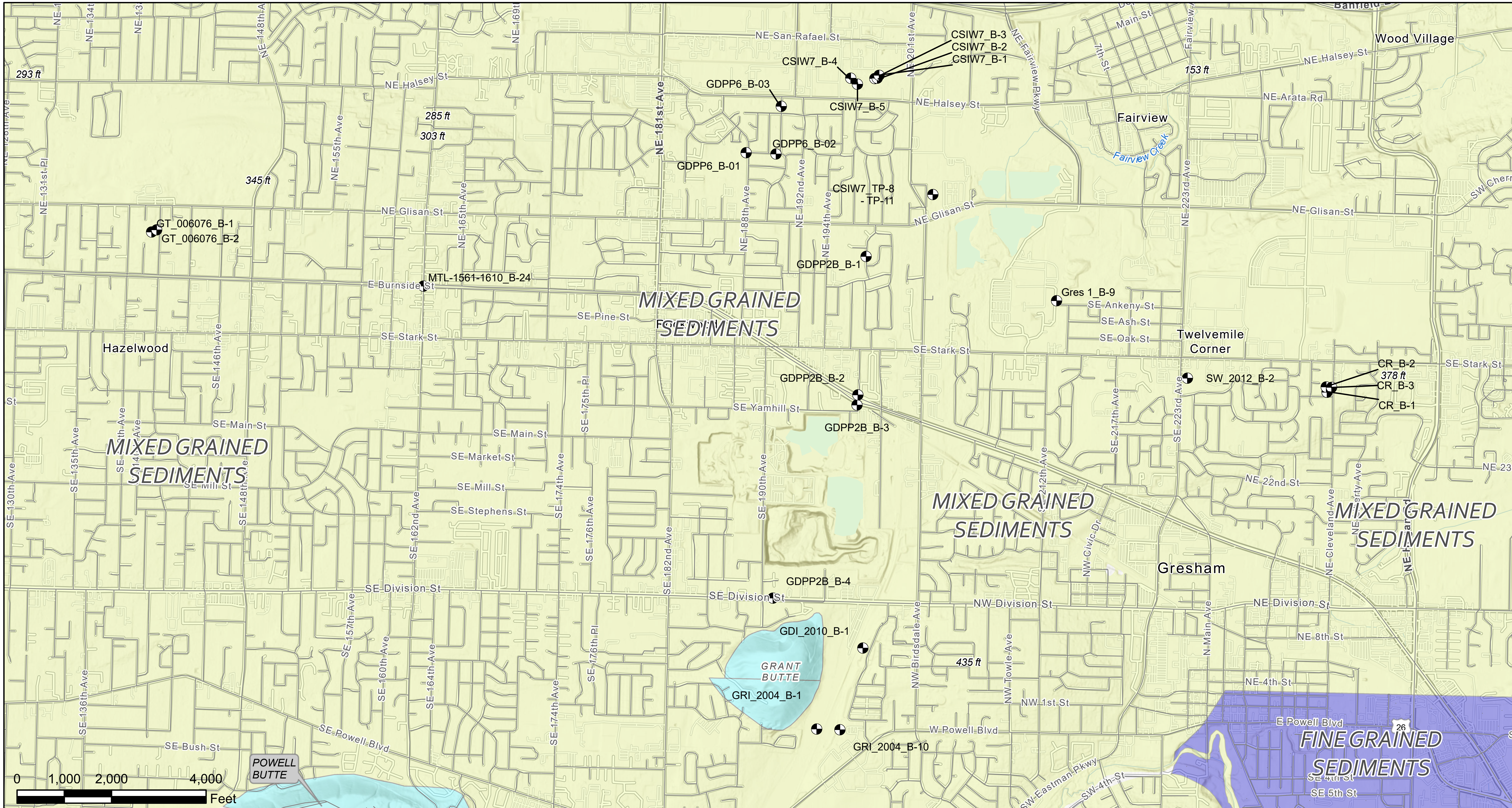
# Figures




NOTES:
SCALE: 1 INCH : 2,000 FEET
DATA SHOWN ARE BASED ON DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND ODGC7 AND HAVE NOT BEEN VERIFIED.

NEHRP Boring Data

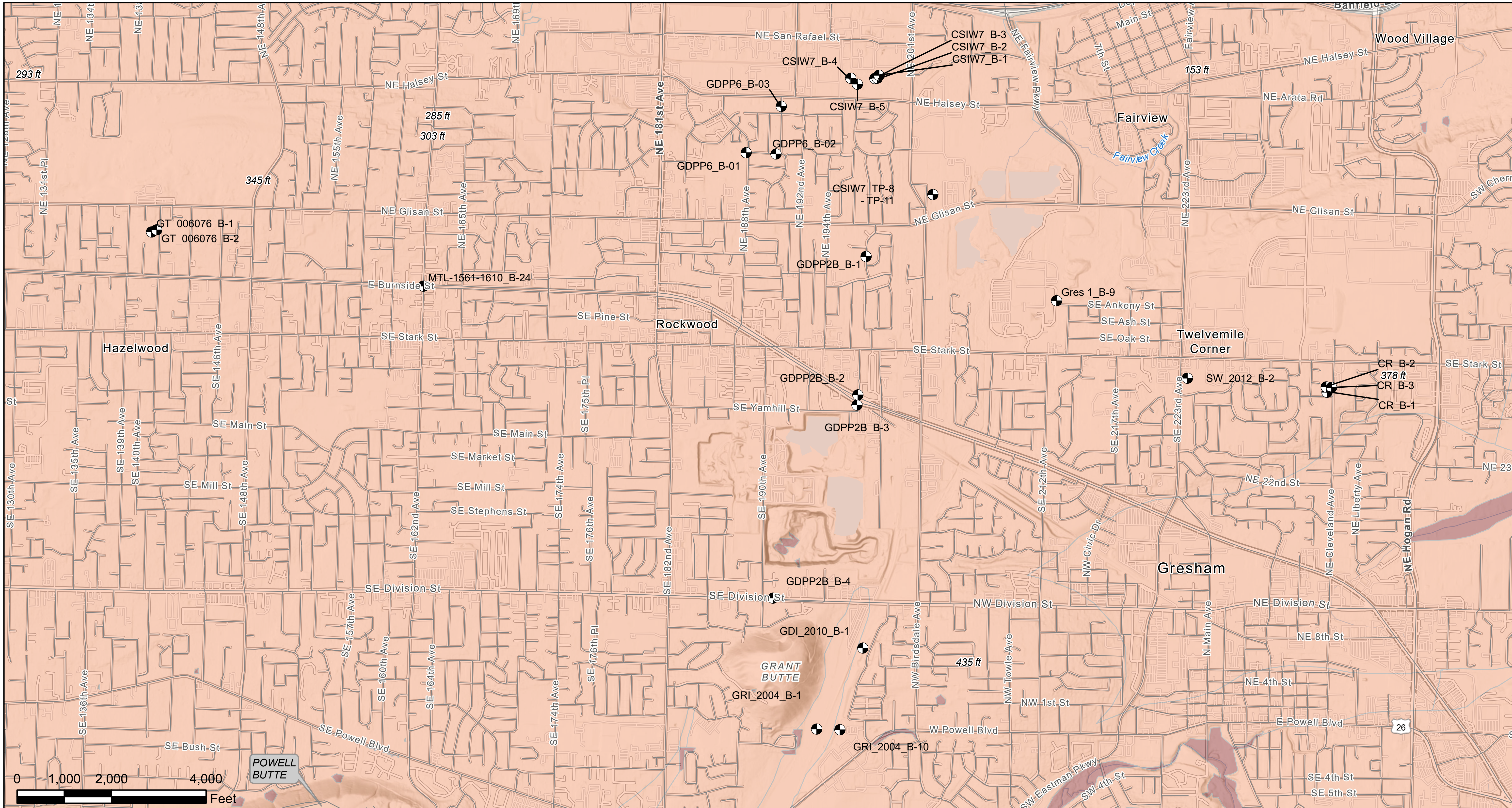
**GEOLOGY**
- MIXED LITHOLOGIES
- MIXED GRAINED SEDIMENTS
- FINE GRAINED SEDIMENTS

ROCKWOOD WATER DISTRICT
SEISMIC RESILIENCE EVALUATION

McMILLEN JACOBS ASSOCIATES

JAN 2023

FIGURE 1




NOTES:
SCALE: 1 INCH : 2,000 FEET
DATA SHOWN ARE BASED ON DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND ODGC7 AND HAVE NOT BEEN VERIFIED.

NEHRP Boring Data

**PGV_inPerSec**

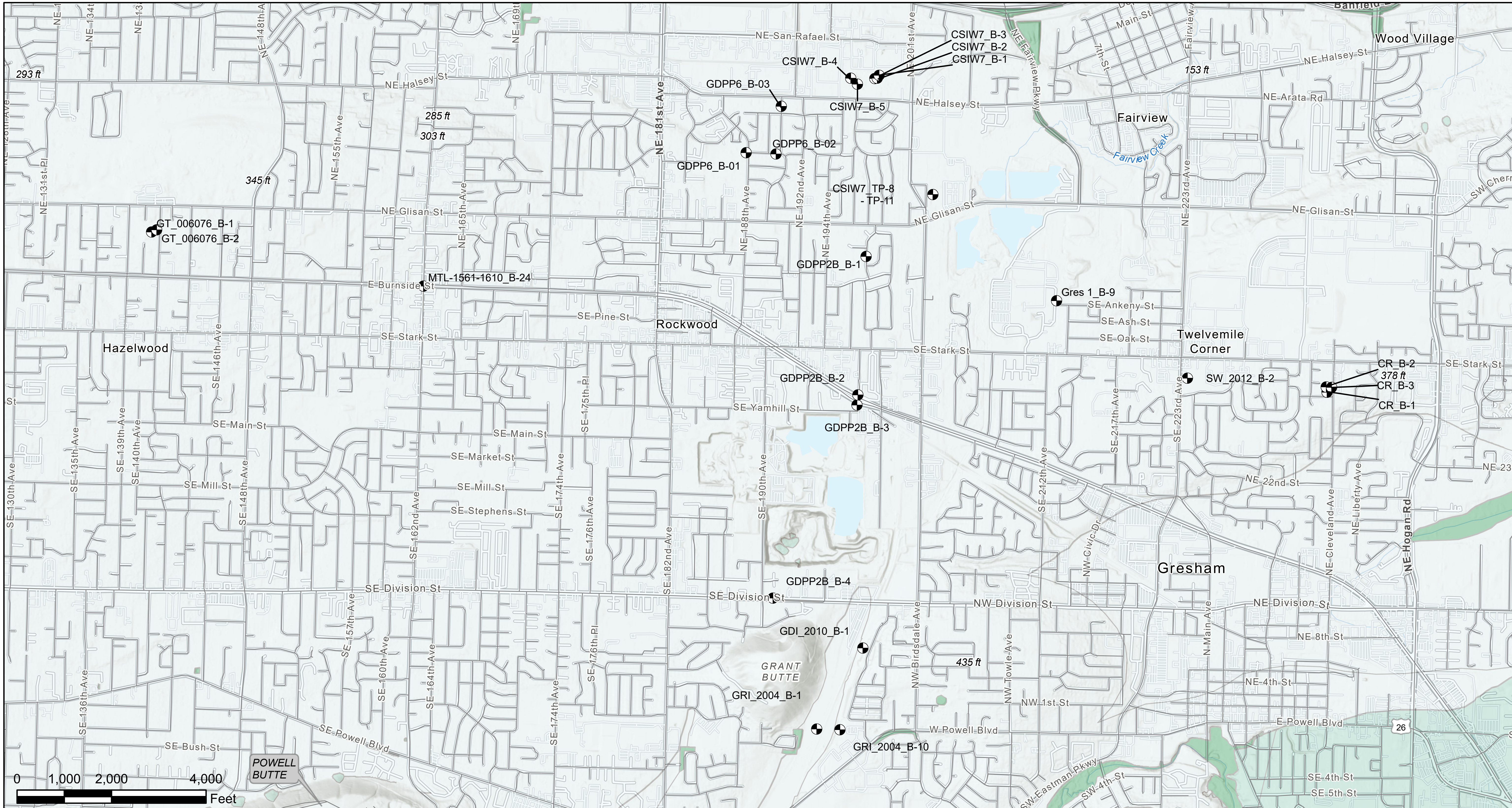
- 8.000000 - 10.000000
- 10.000001 - 13.000000
- 11.000001 - 16.000000

ROCKWOOD WATER DISTRICT
SEISMIC RESILIENCE EVALUATION

McMILLEN JACOBS ASSOCIATES

**JAN 2023**

**FIGURE 2**




NOTES:
SCALE: 1 INCH : 2,000 FEET
DATA SHOWN ARE BASED ON DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND ODGC7 AND HAVE NOT BEEN VERIFIED.

NEHRP Boring Data

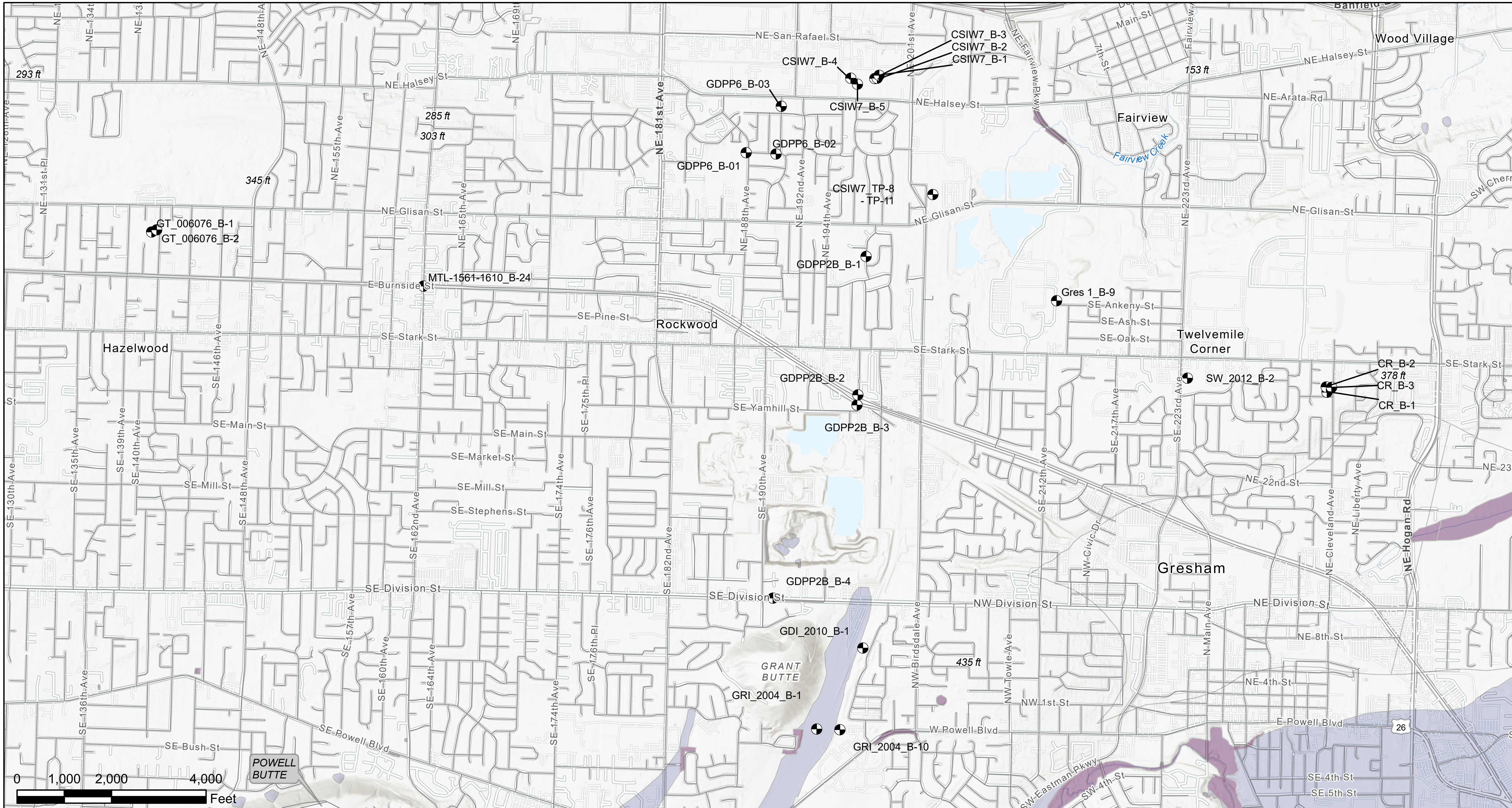
**Settlement**
- Low (No Settlement)
- Medium (Not Verified)
- High (Not Verified)

ROCKWOOD WATER DISTRICT
SEISMIC RESILIENCE EVALUATION

McMILLEN JACOBS ASSOCIATES

**JAN 2023**

**FIGURE 3**




NOTES:
SCALE: 1 INCH : 2,000 FEET
DATA SHOWN ARE BASED ON DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND ODGC7 AND HAVE NOT BEEN VERIFIED.

NEHRP Boring Data

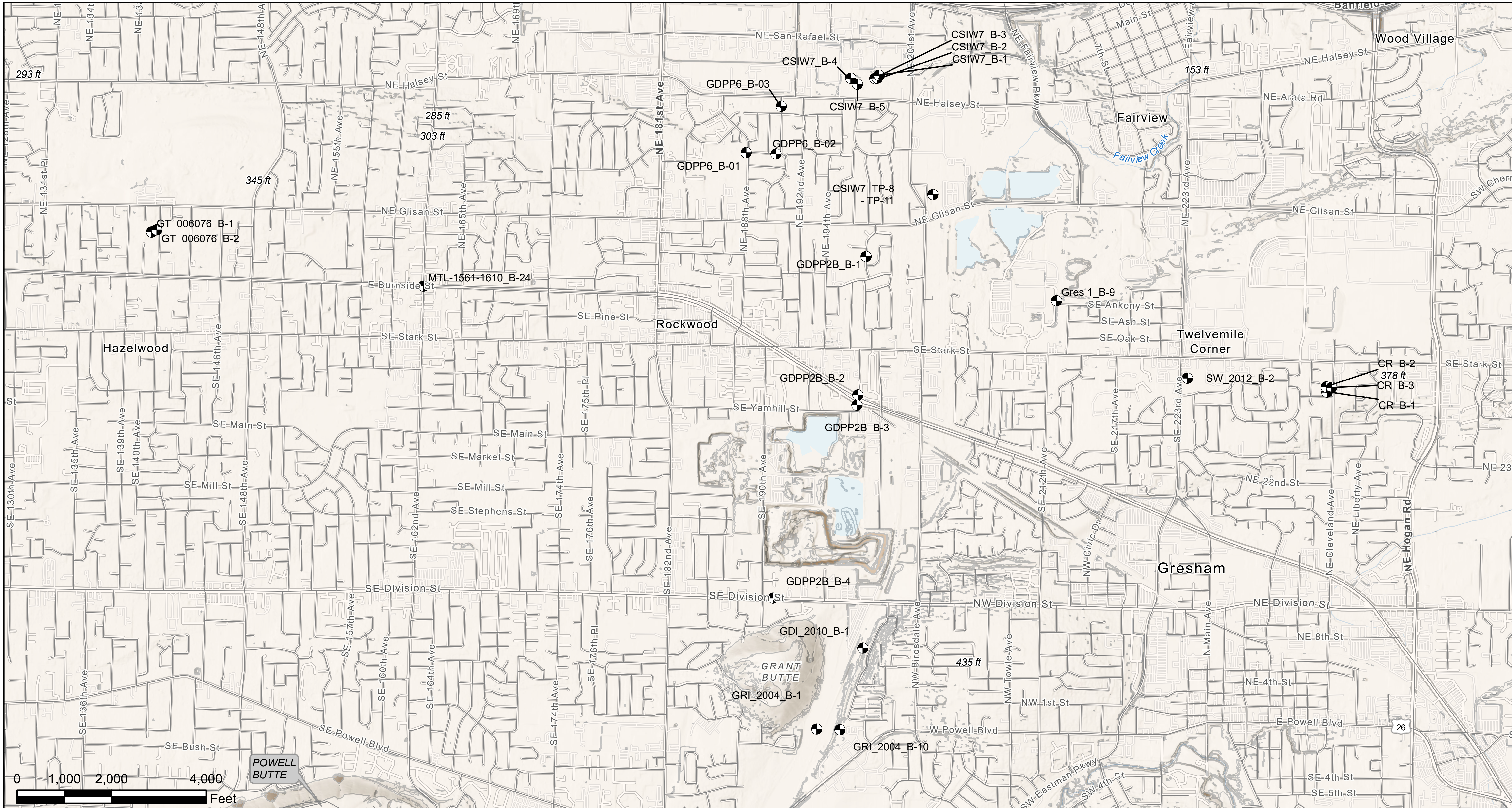
**Lateral Spreading**
- 0.000000
- 0.000001 - 24.000000
- 24.000001 - 72.000000

ROCKWOOD WATER DISTRICT
SEISMIC RESILIENCE EVALUATION

McMILLEN JACOBS ASSOCIATES

**JAN 2023**

**FIGURE 4**




*NOTES:*
*SCALE: 1 INCH : 2,000 FEET*
*DATA SHOWN ARE BASED ON DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND ODGC7 AND HAVE NOT BEEN VERIFIED.*

NEHRP Boring Data

**Slide_In**
- 0 feet
- 4 - 10 feet
- 10 - 20 feet

ROCKWOOD WATER DISTRICT
SEISMIC RESILIENCE EVALUATION

McMILLEN JACOBS ASSOCIATES

**JAN 2023**

**FIGURE 5**