City of Milwaukie

2021 Water System Master Plan
Volume 2 of 2—Appendices

TETRA TECH

November 2021

2021 Water System Master Plan

November 2021

PREPARED FOR

City of Milwaukie

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2021 Water System Master Plan

Appendix A. City Infrastructure Scenarios Memorandum

MEMORANDUM

Methodology and Initial Results (DRAFT)

City of Milwaukie Infrastructure Scenarios

DATE	October 8, 2019
TO	David Levitan and Denny Egner, City of Milwaukie
FROM	Andrew Parish and Matt Hastie, APG
CC	

INTRODUCTION

The City of Milwaukie is currently undertaking infrastructure planning that will look at the implications of long-term growth under various land use scenarios. This memorandum describes the methodology and initial results of updated residential capacity calculations for infrastructure scenario planning. The methodology described below updates and revisits the key assumptions from APG's 2016 Buildable Lands Inventory (BLI) work completed for the City of Milwaukie.

METHODOLOGY OF ANALYSIS

Key Steps and Assumptions from 2016 Buildable Lands Inventory (BLI)

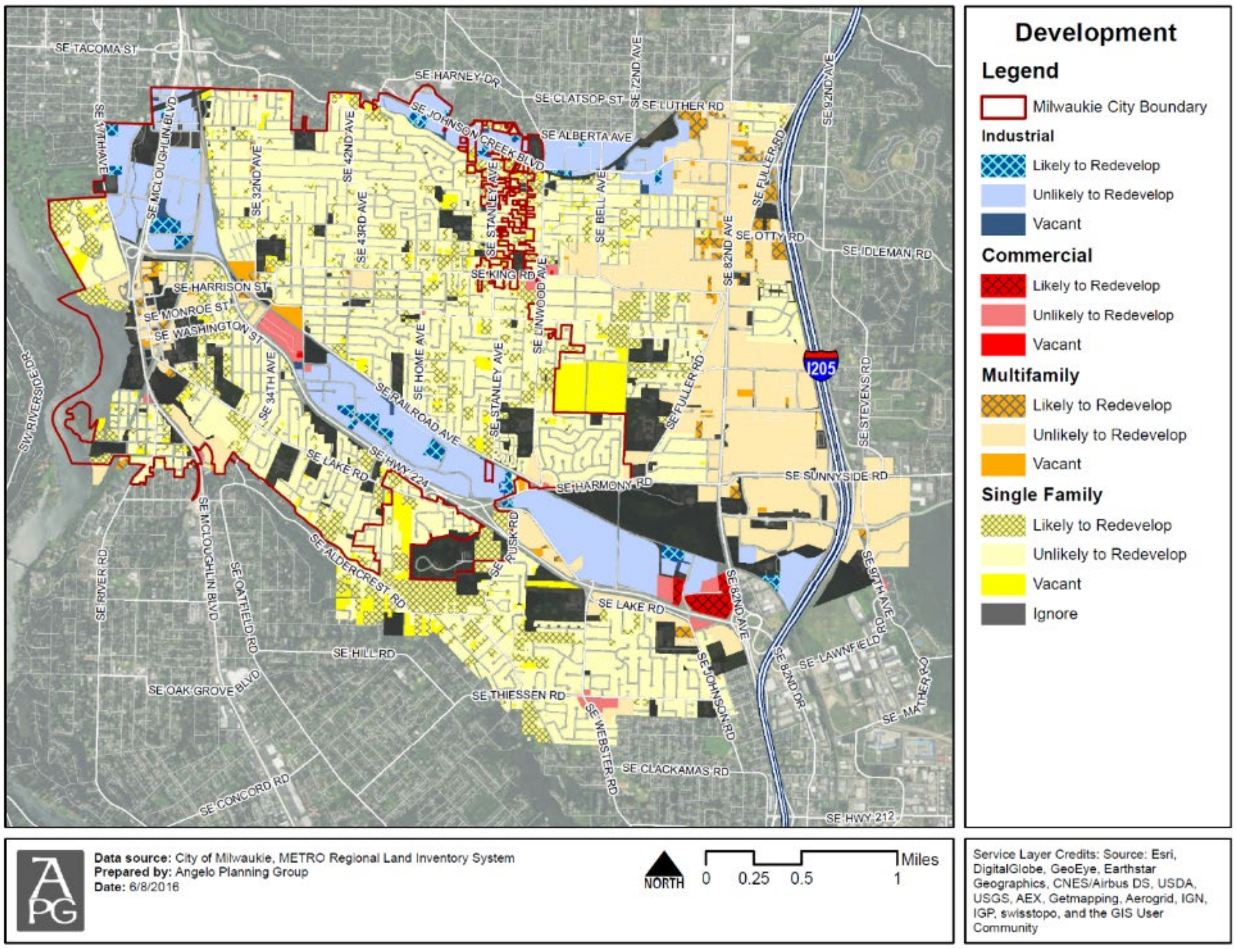
- **Step 1** of the 2016 BLI updated the data available through Metro and other sources to better reflect development activity and recent ordinances adopted by the City of Milwaukie. It also evaluated environmental constraints, including floodplains, steep slopes, Title 3 areas, and Title 13 areas and determined the developable acreage for each taxlot within the city.

  Environmental constraints and related GIS layers are assumed to be unchanged. Taxlot geographies and developable acreage from the previous effort will also be used and updated in specific areas where development activity is known to have occurred or where there have been other changes in land use since 2016.

- **Step 2** of the 2016 BLI calculated the following:
  - Right Of Way (ROW) set-asides for vacant property based on taxlot size and zoning designation
  - Development capacity of vacant taxlots in Single Family Residential (SFR) zones using the Metro BLI methodology

- Infill capacity of developed taxlots based on their current size and the minimum size for their zoning designation
- Development capacity of vacant parcels with multifamily and mixed-use zoning designations, depending upon the amount of environmental constraints on the land
- Redevelopment potential and capacity of developed properties with multifamily and mixed-use zoning, using filters of "strike price" per square-foot of taxlot area.
- Employment acreage for commercial and industrial zones

Figure 1. Map of 2016 Buildable Lands Inventory Results



Definition of 2019 Scenarios

The City of Milwaukie wishes to evaluate the potential impacts on needed infrastructure facilities (particularly water and wastewater distribution systems) of different development scenarios. The scenarios vary by the location and intensity of future development, as well as assumptions related to development of the Milwaukie Planning Area which is currently outside the city limits but which may be annexed into the City of Milwaukie in the future.

Following is a list of scenarios evaluated for this effort:

1. **Low Growth** – assumes partial buildout of Milwaukie's urban area with development occurring at existing allowed densities and current projected mix of housing types
2. **Medium Growth** – assumes full buildout at existing allowed densities and current projected mix of housing types
3. **Expanded Geography** – assumes full buildout at existing allowed densities and current projected mix of housing types within existing urban growth boundary and Milwaukie Planning Area
4. **Hubs and Corridors** – assumes full buildout, with more intensive development in hubs and corridors in terms of allowed densities and mix of housing types
5. **Dispersed Growth** – assumes full buildout, with more intensive development (compared to current zoning regulations) in existing single-family zones (e.g., R5, R7 and R10)

The following table summarizes how different types of development were distributed among different zoning designations in the city's 2016 Housing Needs Analysis. That analysis generally assumed the following:

1. All single-family detached units would be located in the R-5, R-7 and R-10 zones
2. All medium density housing, including duplexes, three-plexes, four-plexes, and townhouses would be located in the R-2, R-2.5 and R-3 zones.
3. All multi-family units (units in attached structures of 5 units or more, excluding townhomes) would be located in the R-1, R-1B and mixed use (DMU, GMU, and NMU) zones.

Table 1. Estimated Buildable Lands Capacity by Residential Unit, Milwaukie Housing Needs Analysis (2016)

	Unit Type			
CITY OF MILWAUKIE CAPACITY	Single Family Detached	Medium-Density Attached*	Multi-Family	TOTAL
SFR Zones				
R-5	244			244
R-7	680			680
R-7PD	0			0
R10	139			139
R-10PD	21			21
OS	6			6
MDR Zones				
R-2		608		608
R-2.5		0		0
R-3		473		473
R-3		0		0
MFR & MUR Zones				
R-1			0	0
R-1-B			52	52
DMU			441	441
GMU			181	181
NMU			74	74
Totals:	***1,090***	***1,081***	***748***	***2,919***

* Medium Density Residential (MDR) units include single-family attached (townhomes) to four-plexes. Multi-family Units (MFR) are defined as units in attached structures of 5 units or more.
Source: City of Milwaukie, Angelo Planning Group, Metro

The following tables summarize a potential set of assumptions related to the distribution of housing types for the scenarios described at the beginning of this section.

Table 2. Housing Distribution Assumptions, Low and Medium Growth Scenarios (P – Permitted use, CU – Conditional Use)

Zone	Single-family detached	Duplex	Tri-plex, Four-plex, cottage cluster housing	Townhomes	Multi-family
R-5, R-7, R-10	P	P			
R-2, R-2.5, R-3	P	P	P	P	P (CU)
R-1, R-1B	P	P	P	P	P[1]
NMU	CU	CU	CU	CU	P[1]
GMU			P	P	P
DMU			P	P	P

Notes:

1. Multi-family permitted as part of a mixed-use development

Table 3. Housing Distribution Assumptions, Hubs and Corridors Scenario (P – Permitted use, CU – Conditional Use)

Zone	Single-family detached	Duplex	Tri-plex, Four-plex, cottage cluster housing	Townhomes	Multi-family
R-5, R-7, R-10 [1]	P	P	P	P	
R-2, R-2.5, R-3 [2]	P	P	P	P	P
R-1, R-1B	P	P	P	P	P
NMU [3]		P	P	P	P[4]
GMU			P	P	P
DMU				P	P

Notes:

1. Attached housing types allowed within Hubs and Centers currently located in low density zones
2. Multi-family allowed within Hubs and Centers currently located in R-2, R-2.5 and R-3 zones, if applicable (as stand-alone residential or as part of mixed use developments)
3. Attached housing allowed within Hubs and Centers located in existing or proposed future NMU zones
4. Multi-family permitted as part of a mixed-use development

Table 4. Housing Distribution Assumptions, Dispersed Growth Scenario (P – Permitted use, CU – Conditional Use)

Zone	Single-family detached	Duplex	Tri-plex, Four-plex, cottage cluster housing	Townhomes	Multi-family
R-5, R-7, R-10 [1, 2]	P	P	P	P	
R-2, R-2.5, R-3	P	P	P	P	P (CU)
R-1, R-1B	P	P	P	P	P
NMU		P	P	P	P[3]
GMU			P	P	P
DMU				P	P

Notes:

1. Tri-plexes and four-plexes allowed in R-5, R-7 and R-10 zones under certain conditions related to location (e.g., corner lots, proximity to transit, etc.) and/or subject to unit size, floor area or other standards limiting overall size and bulk.
2. Townhomes allowed in R-5 zones.
3. Multi-family permitted as part of a mixed-use development

These policy-level assumptions will be translated into numerical assumptions as described in the following sections.

Changes to Infill Development Assumptions in Single Family Zones

Table 5 describes the methodology for assessing infill capacity in single-family zones for the 2016 BLI, and proposes changes for the 2019 evaluation.

Table 5. Infill Development Methodology for Single Family Zones

2016 Infill Methodology	2019 Infill Methodology
Screen out apartments in Metro Multifamily Inventory	The Metro Multifamily Inventory has been updated and now includes additional items such as duplexes, triplexes, and ADUs. This analysis has removed triplexes, quadplexes, apartments, manufactured homes, and condos.
Infill Trigger	
Establish size categories: Under 2.5x minimum lot size, between 2.5 and 5x minimum lot size, greater than 5x minimum lot size	Minimum lot sizes will change in Scenario 4 to address re-zoning of hubs and corridors, and Scenario 5 to approximate greater dispersed infill.
Redevelopment trigger of $150k building value in the 2.5-5x size category	Update building information from latest RLIS data. For Scenario 5, increase trigger price to $200k. This would mean large taxlots are assumed to redevelop even at a 33% higher building value.
Taxlots greater than 5x in size are within infill inventory	No change – large taxlots are still in the infill inventory
Infill Assumptions	
Number of new infill units was the lesser of: Number of lots allowed to be subdivided by the zone, or unconstrained area divided by 2000 sf.	The number of lots under these assumptions remains accurate. However, there is an increased likelihood that infill will take the form of middle housing with greater than one unit. Such infill development is an intended outcome of HB2001 and City policy changes.
	New 2019 Assumption: For Scenarios 3 and 4, assume 5% of single-family homes in the “Under 2.5x” category redevelop into duplexes. For scenario 5, assume 10%.

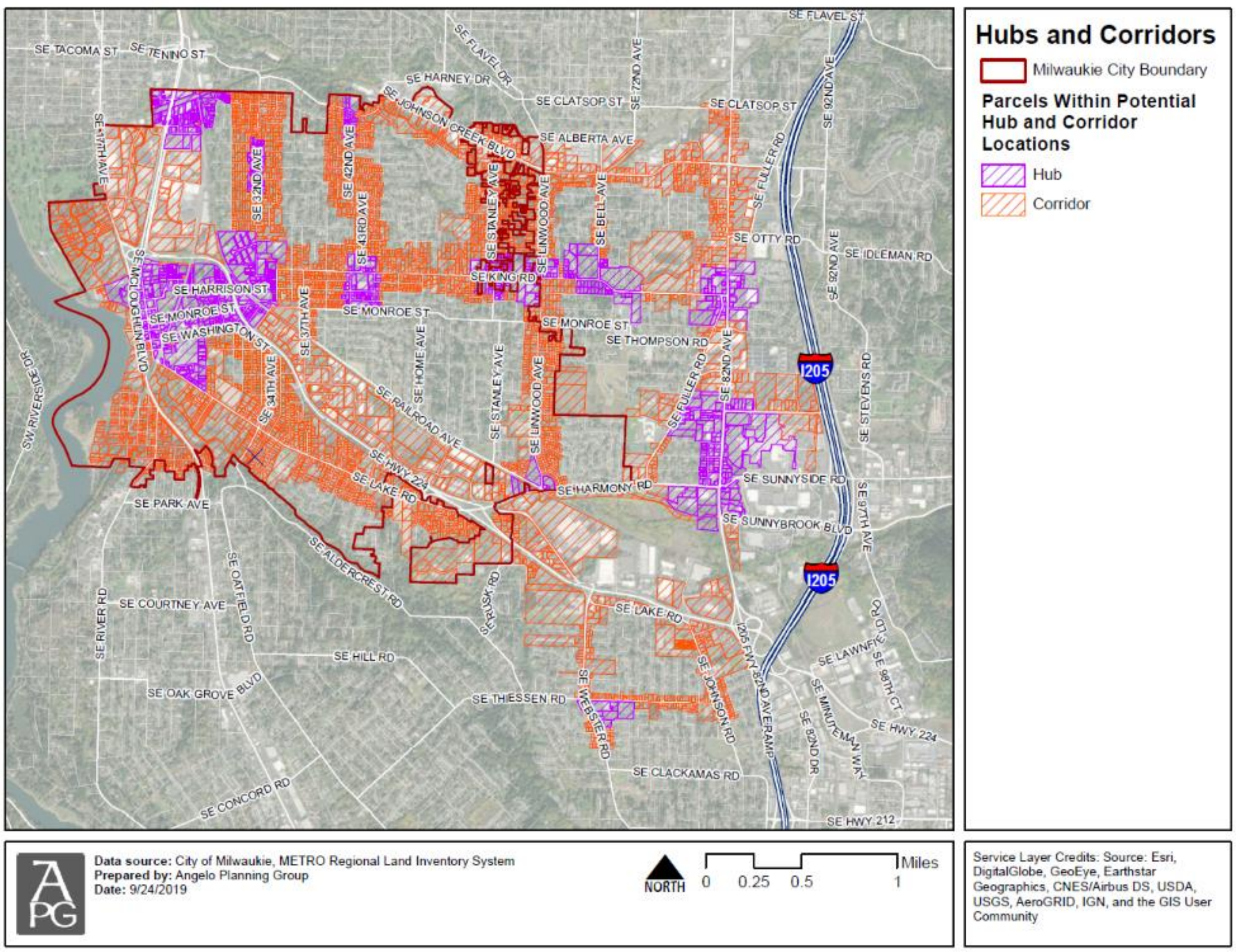
Up-zoning and development/redevelopment of Hubs and Corridors

City staff have helped identify parcels that may be subject to up-zoning or an overlay due to the “Neighborhood Hubs and Corridors” element of recent Comprehensive Plan Update work. The intent of these presumed changes is to enhance growth opportunities in areas that serve as neighborhood hubs for surrounding low-density residential areas in part to allow increased density along major corridors of the City that are accessible by transit and provide a higher level of other amenities.

For the purposes of this planning effort, areas within Neighborhood Hubs are assumed to have the characteristics of the **Neighborhood Mixed Use (NMU) zone**, and parcels within Corridors are assumed to have the characteristics of the **R-3 Zone** (where zones are categorized as Single Family - parcels that are already higher density are unchanged). The analysis uses lot sizes of roughly 3,000 sf to approximate this range. Note that rezoning, incentives, or some other combination of actions can be used to achieve this result, but the specific mechanisms to achieve these densities are not explored further as part of this analysis.

The map of neighborhood hubs and corridors is shown in Figure 1.

Figure 1. Map of Parcels within Potential Hub and Corridor Locations



INITIAL ANALYSIS RESULTS

Initial results of the scenario analysis are presented in the maps and tables in this section. GIS data, spreadsheets, and other materials will be provided to help City staff interpret these results and refine the analysis.

Figure 2 shows the development status of land within the study area. Vacant land is assumed to develop at densities determined by underlying zoning designations, while developed land is subject to further screening to evaluate whether there is potential for infill development or redevelopment. Parcels with a status of "Ignore" include parks and open space, religious or fraternal organizations, and government-held property.

Figure 3 depicts the type of land within the study area, grouped into general categories of residential, mixed use, commercial, industrial, and ignore.

Figure 2. Development Status of Land Within the Study Area

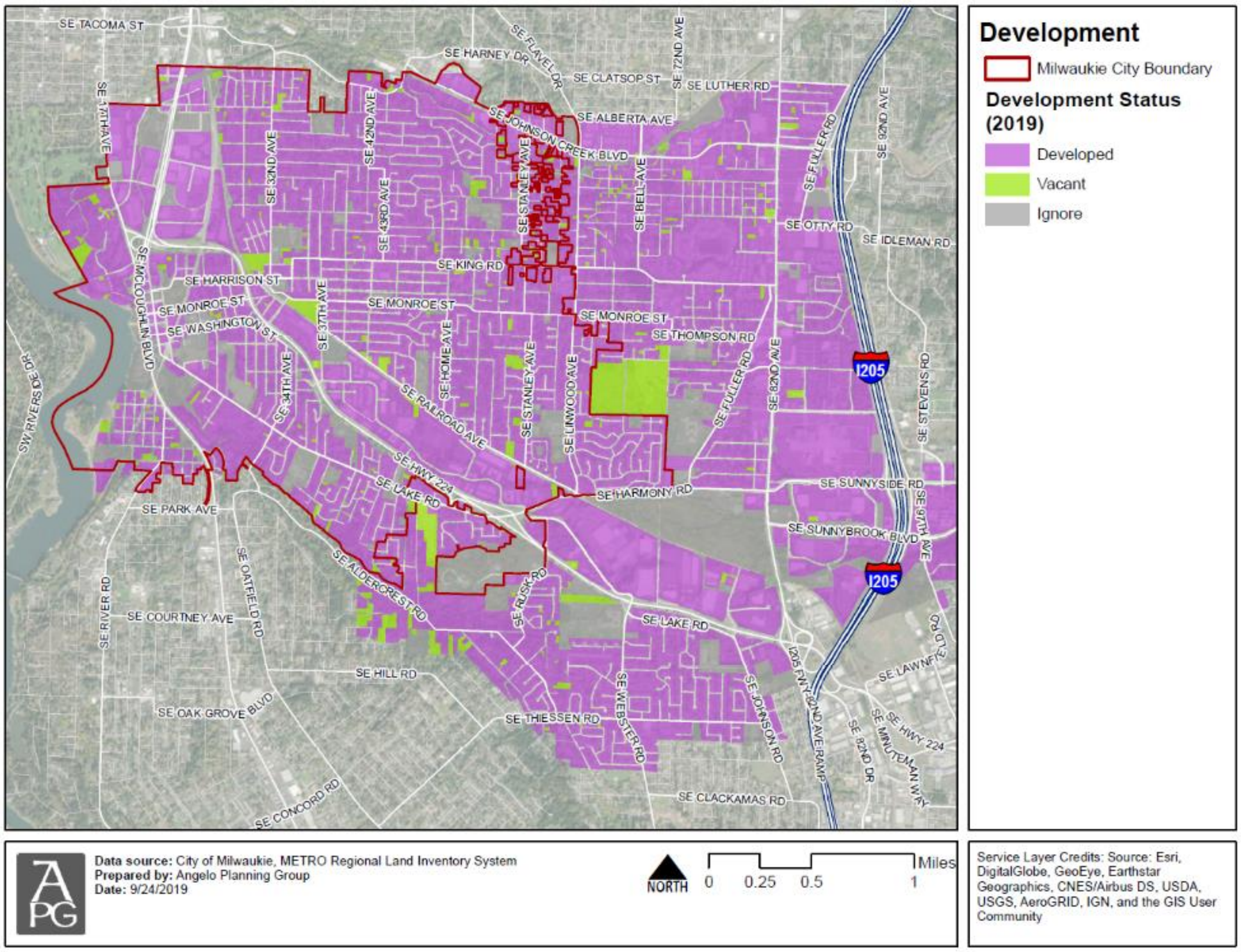
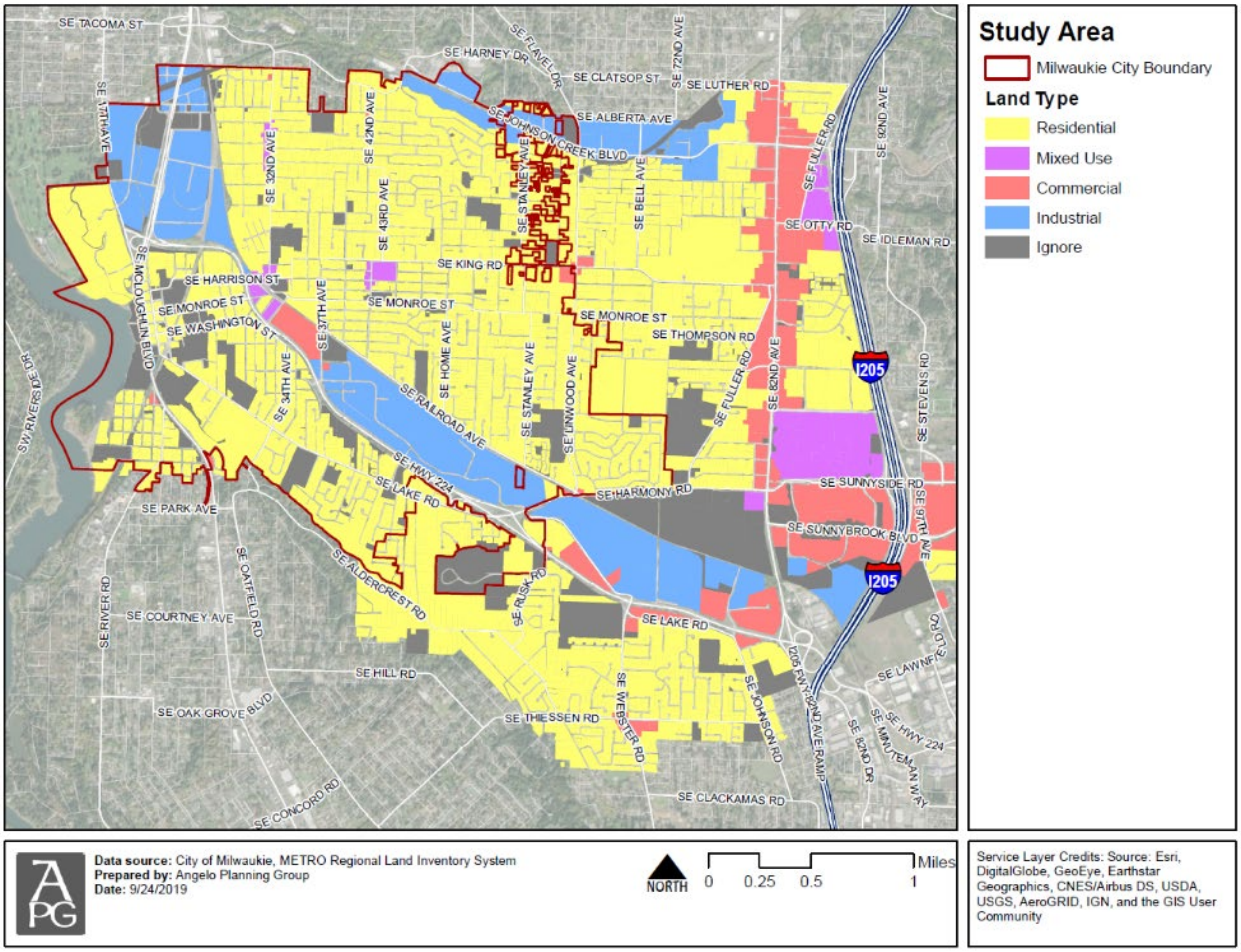


Figure 3. Existing Land Type



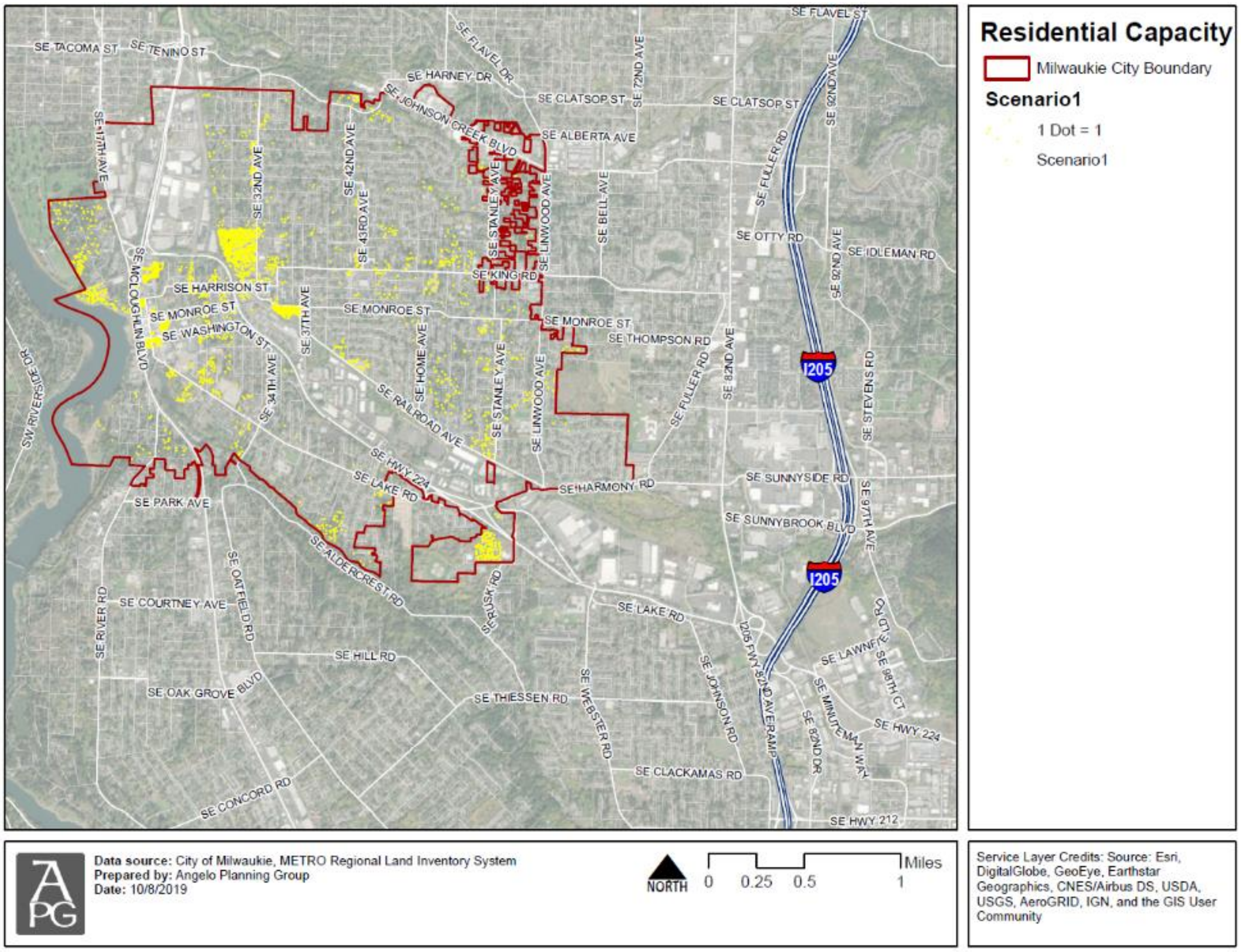
The following sections describe Scenarios 1 through 5 with illustrative maps and key findings from the analysis, followed by a summary table (Table 6) for all scenarios.

Scenario 1: Low Growth

Figure 4 depicts new growth, consistent with an assumed partial buildout of Milwaukie's urban area, where development is expected to occur at existing allowed densities and current projected mix of housing types.

Each yellow dot represents one new unit. Scenario 1 includes areas within the existing City Limits using the assumptions of the 2016 Buildable Lands Inventory, with minor updates. The capacity of parcels showing greater than one new unit in the Medium Growth Scenario (except for parcels with known development proposals) have been reduced by 20% across the board to arrive at this result.

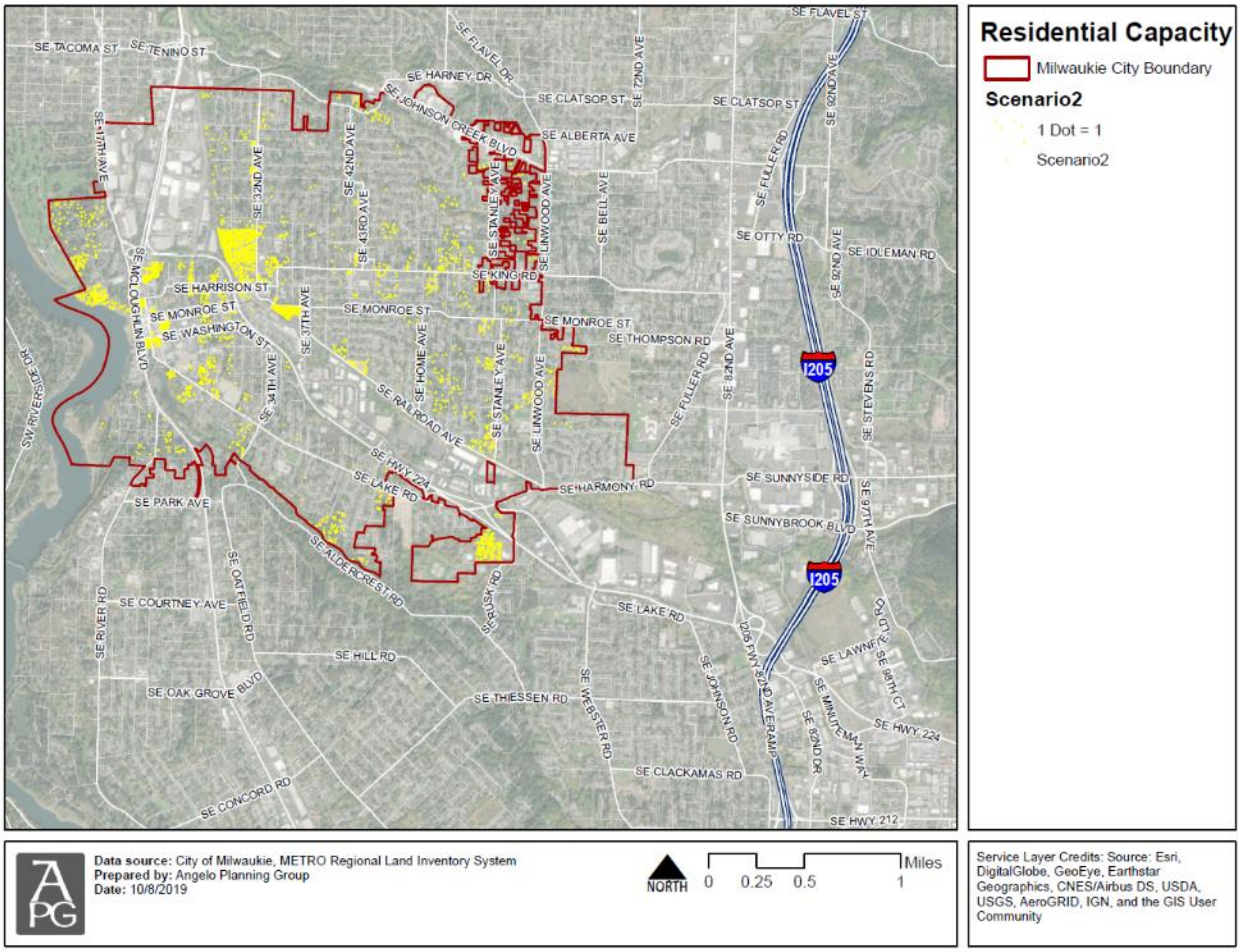
Figure 4. Initial Results Map of Scenario 1 – Low Growth



Scenario 2: Medium Growth

Scenario 2 assumes full buildout at existing allowed densities and current projected mix of housing types; Figure 5 reflects these assumptions. This includes areas within the existing City Limits using the assumptions of the 2016 Buildable Lands Inventory, with minor updates and the addition of several known development proposals.

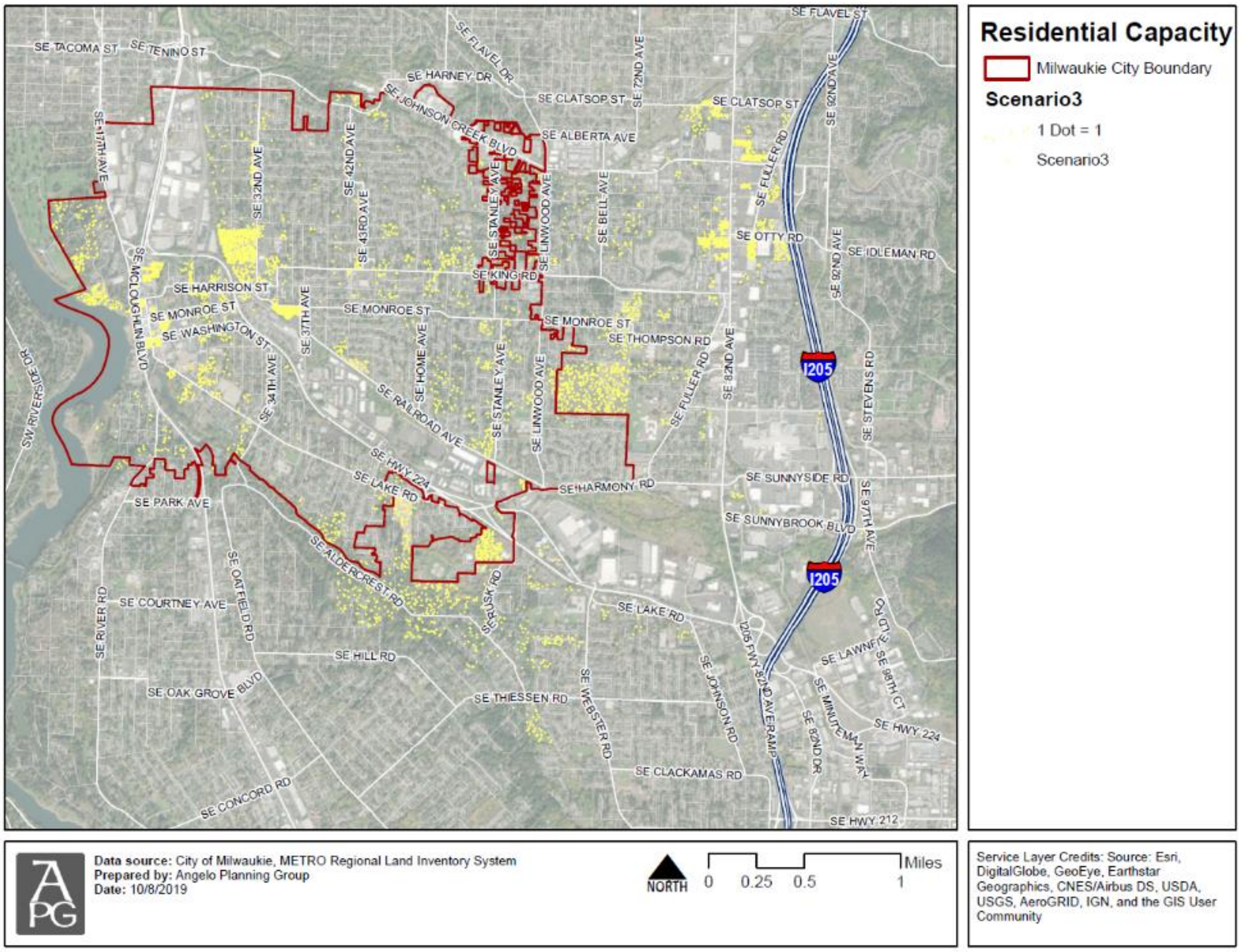
Figure 5. Initial Results Map of Scenario 2 – Moderate Growth



Scenario 3: Expanded Geography

This scenario assumes full buildout at existing allowed densities and current projected mix of housing types within the existing Milwaukie City Limits and the broader Milwaukie Planning Area. Figure 6 depicts new growth as part of Scenario 3 using the assumptions of the 2016 Buildable Lands Inventory, with minor updates.

Figure 6. Initial Results Map of Scenario 3 – Expanded Geography

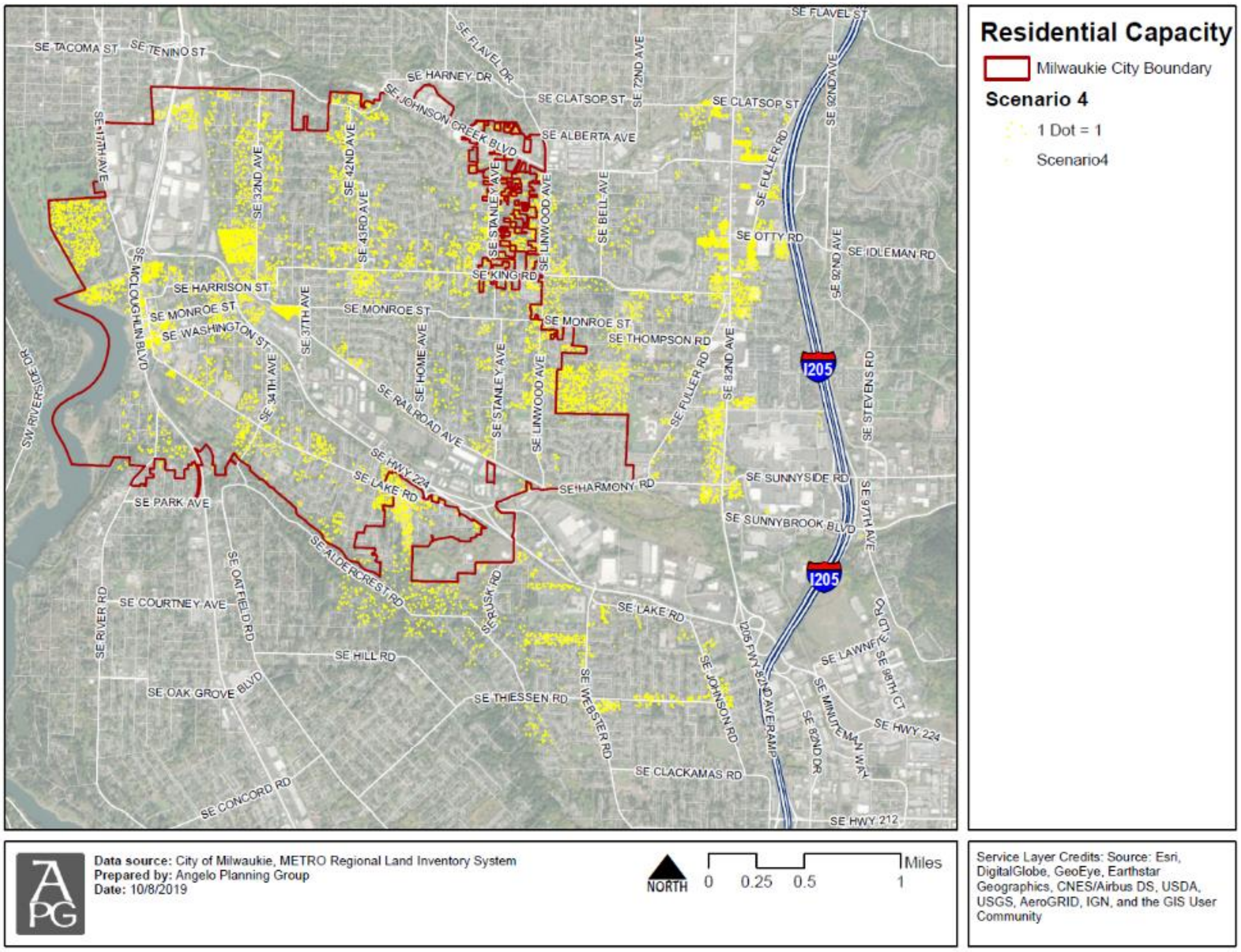


Scenario 4: Hubs and Corridors

This scenario assumes full buildout, with more intensive development in hubs and corridors related to allowed densities and mix of housing types. Figure 7 depicts new growth consistent with Scenario 4 assumptions. Significant changes are assumed to land abutting high-frequency transit corridors and specific hubs where those corridors intersect. The following assumptions were applied:

- Land within hubs and corridors with greater than .25 acres of unconstrained land is assumed to generate infill.
- Hubs are given a mix of 50% residential and 50% employment acreage. Residential uses and densities of the Neighborhood Mixed Use (NMU) zone are assumed.
- Corridors are given a mix of 100% residential; R-3 zone uses and densities are assumed.
- Mixed use lots are given the same number of units as in the 2016 inventory. Parcels in the Downtown Mixed Use (DMU) zone are unchanged from the 2016 inventory.

Figure 7. Initial Results Map of Scenario 4 – Hubs and Corridors

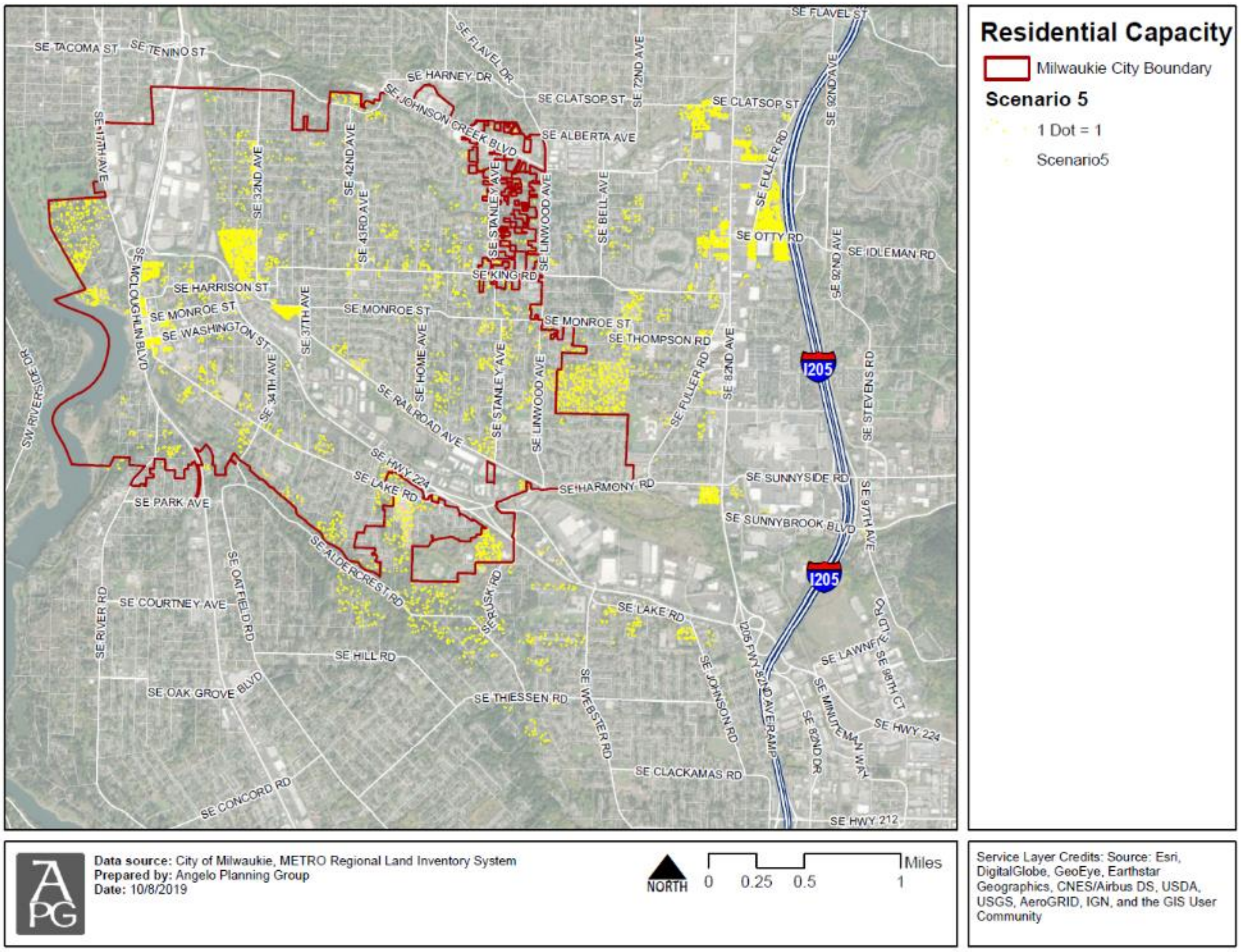


Scenario 5: Dispersed Growth

This scenario assumes full buildout, with more intensive development (compared to current zoning regulations) in existing single-family zones. Figure 8 depicts new growth as part of Scenario 5 – Dispersed Growth. This scenario is similar to Scenario 3 – Expanded Geography with the following changes:

- Building value cutoff for redevelopment is now at $200,000, rather than $150,000.
- Policy changes related to House Bill 2001 and other middle-housing policies are approximated by changing minimum lot sizes for the following zones:
    - R-10: 10,000 sf to 8,000 sf
    - R-8.5: 9,000 SF to 7,500 SF
    - R-7: 7,000 SF to 5,000 SF
    - R-5: 5,000 SF to 4,000 SF
- Size ratio above 2.5x min lot size and value below $200k is the trigger for redevelopment.
- Mixed use lots are given the same number of units as the 2016 inventory. Parcels in the DMU zone are unchanged from the 2016 inventory.

Figure 8. Initial Results Map of Scenario 5 – Dispersed Growth



Results are reported by Pressure Zones and Drainage Basins for infrastructure planning purposes. These zones are shown in Figure 9 and 10.

Figure 9. City of Milwaukie Pressure Zones

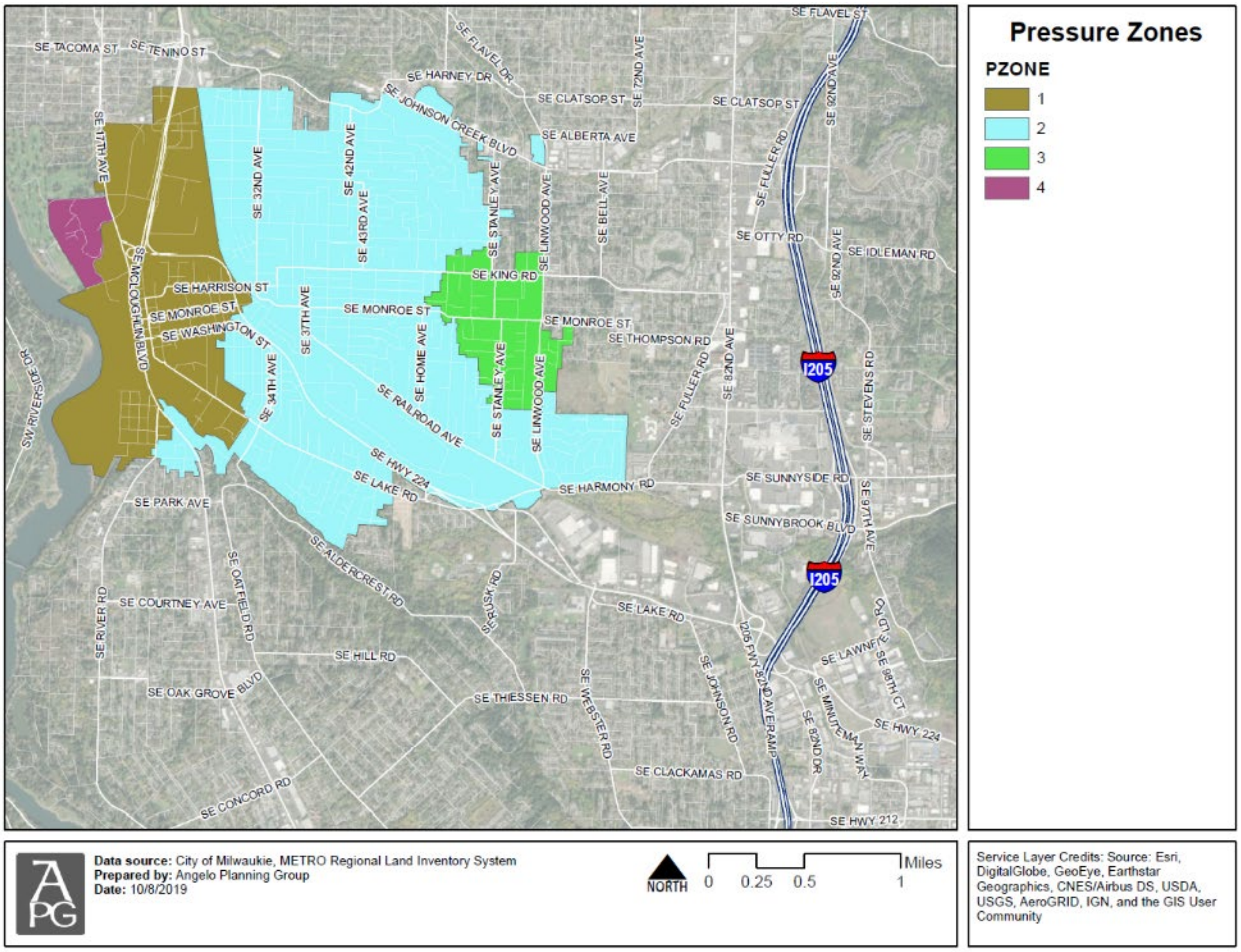
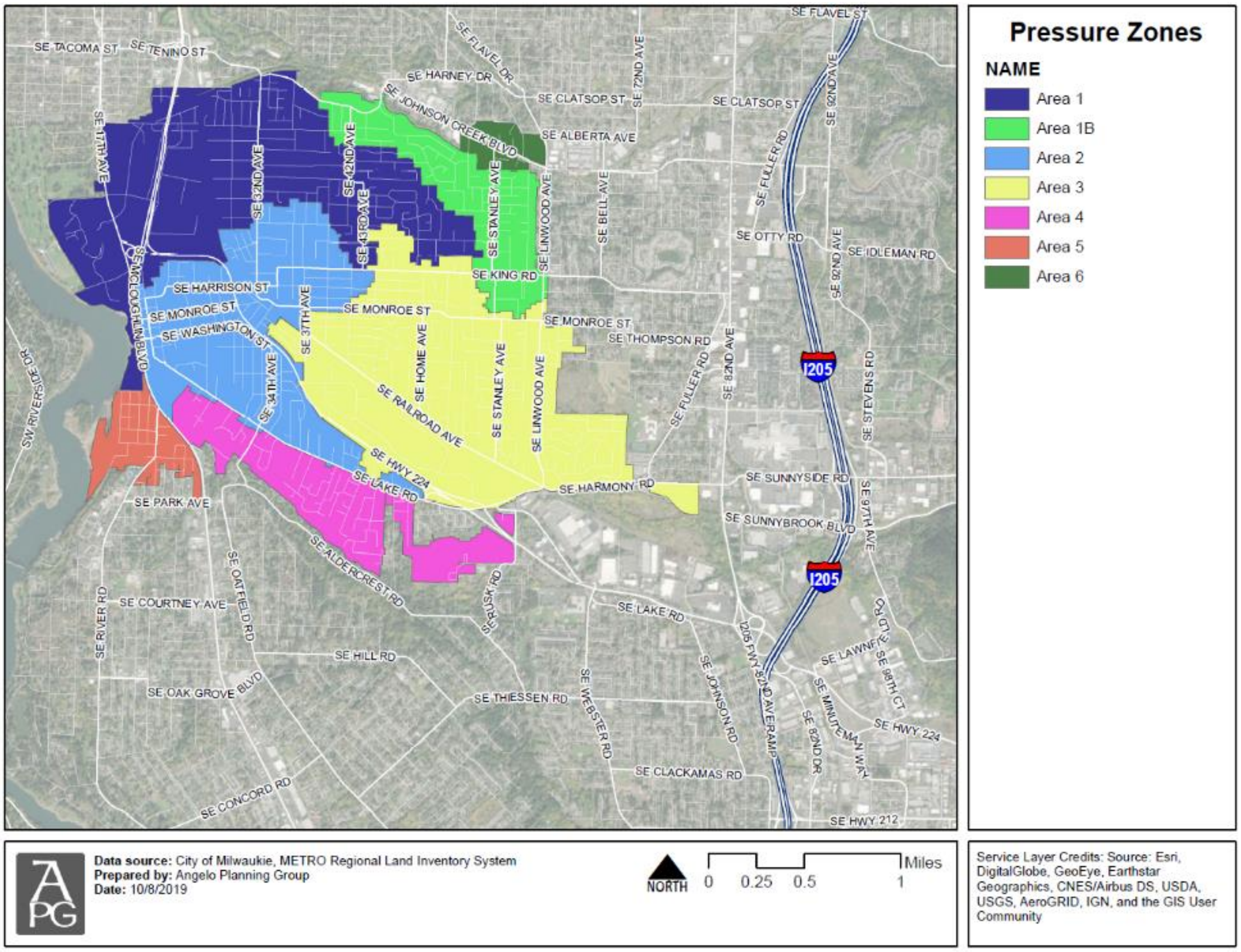


Figure 10. City of Milwaukie Drainage Basins



The overall draft results of the analysis are shown in Table 6.

Initial takeaways of the analysis are listed below:

- Scenario 1 and Scenario 2 show modest growth of approximately 3,000 units within the City under current trends.
- Vacant land comprises a small fraction of the available buildable land capacity within the City of Milwaukie – infill and redevelopment make up the majority of development in all scenarios.
- Scenario 4 shows the most growth, far exceeding the other Scenarios. Much of this growth occurs in the Milwaukie Planning Area outside city limits, where major corridors such as 82nd Ave. have significant capacity for residential development.
- The initial results, as shown in the previous maps, specific parcels and neighborhoods stand out as growth opportunities. These geographies can be critiqued in more detail to test and verify the assumptions; parcels can then be added/removed from the inventory on a case-by-case basis.

Table 6. Initial Results (No HB-2001 Duplexes Added)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Total Units	2,773	3,247	**5,584**	**10,368**	**6,924**
Units Within City Limits	2,773	3,247	3,247	5,872	3,501
Units within Milwaukie Planning Area	0	0	2,337	4,496	3,423
Pressure Zone 1	997	1,165	1,172	1,444	1,004
Pressure Zone 2	1,484	1,726	1,742	3,272	1,958
Pressure Zone 3	138	168	171	562	292
Pressure Zone 4	107	134	134	486	240
Outside Pressure Zones	47	54	2365	4604	3430
Basin Area 1	527	648	648	1767	771
Basin Area 1B	82	99	117	734	170
Basin Area 2	1,637	1,875	1,883	2,379	1,838
Basin Area 3	359	423	439	910	567
Basin Area 4	116	143	200	462	235
Basin Area 5	38	44	52	101	62
Basin Area 6	12	13	16	53	9
Outside Basin Areas	2	2	2,229	3,962	3,272

In order to approximate additional redevelopment of existing single-family properties into duplexes as allowed by HB2001, 5% of the housing inventory in the "<2.5x minimum lot size" category for each scenario's relevant geography was randomly designated as a duplex and given an additional infill unit. For Scenario 5, 10% of the inventory in the ""<2.5x minimum lot size" category was given an additional unit.

Table 7. Initial Results (HB-2001 Duplexes Added)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Total Units	**3,021**	**3,495**	**6,010**	**10,704**	**7,798**
Units Within City Limits	3,021	3,495	3,495	6,062	4,005
Units within Milwaukie Planning Area	0	0	2,515	4,642	3,793
Pressure Zone 1	1,011	1,179	1,186	1453	1,024
Pressure Zone 2	1,686	1,928	1,946	3428	2,376
Pressure Zone 3	163	193	198	579	347
Pressure Zone 4	107	134	134	486	240
Outside Pressure Zones	54	61	2,546	4,758	3,811
Basin Area 1	588	709	709	1,813	882
Basin Area 1B	104	121	146	752	243
Basin Area 2	1,692	1,930	1,939	2,410	1,943
Basin Area 3	447	511	529	987	760
Basin Area 4	131	158	216	478	265

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Basin Area 5	43	49	59	106	76
Basin Area 6	13	14	18	55	14
Outside Basin Areas	3	3	2,394	4,103	3,615

Locations of parcels flagged for duplexes are shown on the following maps. Scenarios 1-3 use the same set of parcels, while Scenarios 4 and 5 differ due to different zoning/minimum lot size assumptions.

Figure 11. Duplex Locations – Scenarios 1, 2, and 3

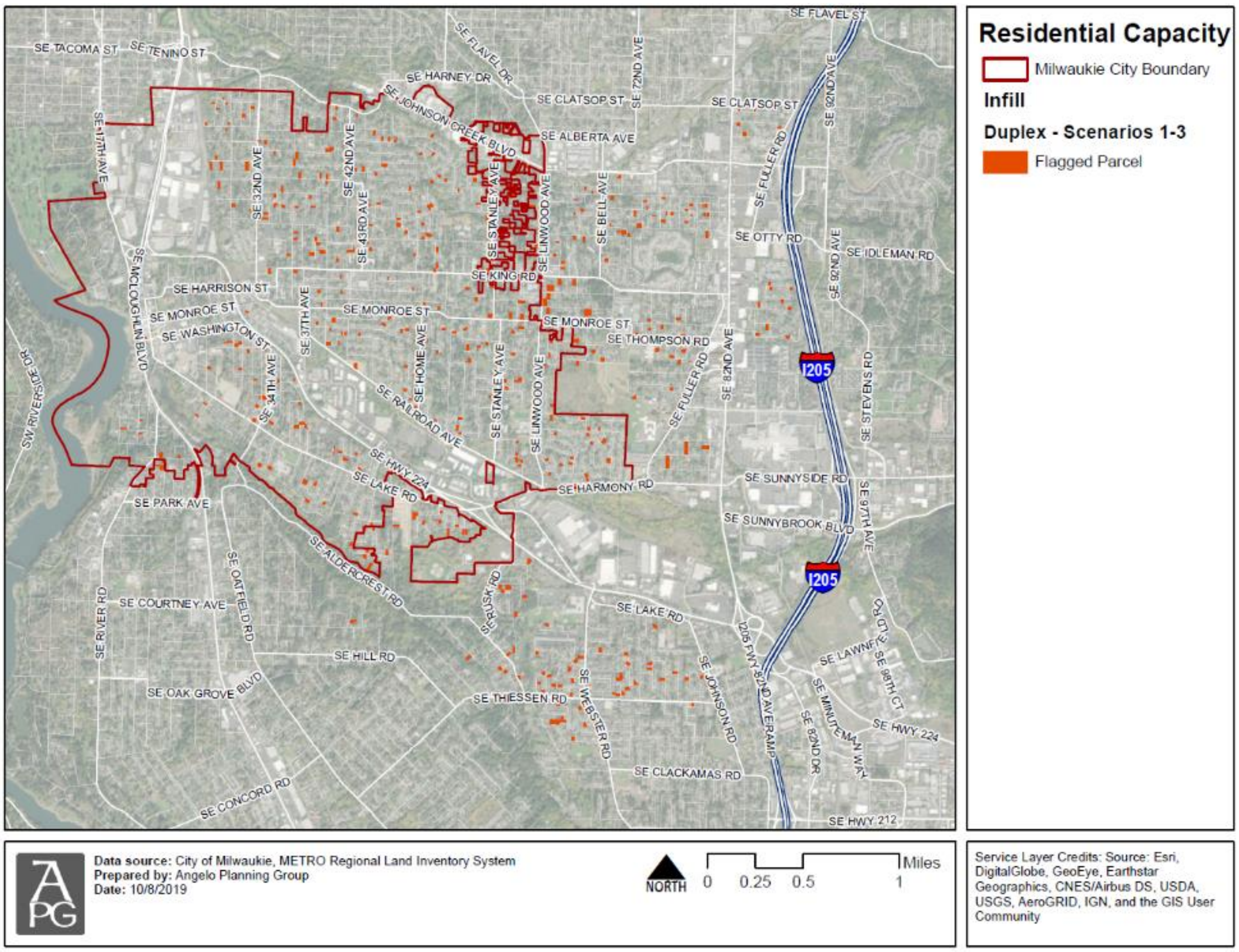


Figure 12. Duplex Locations, Scenario 4

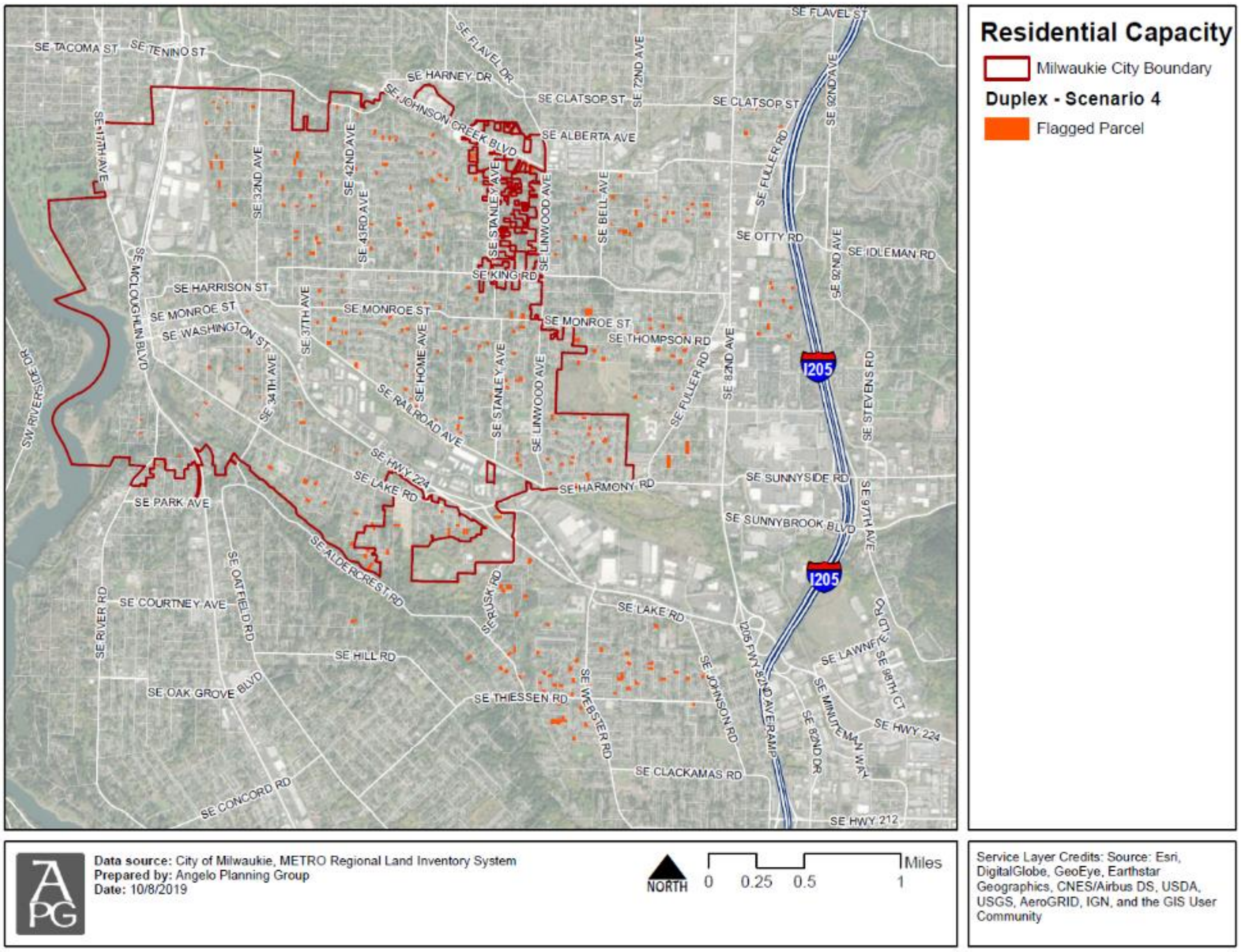
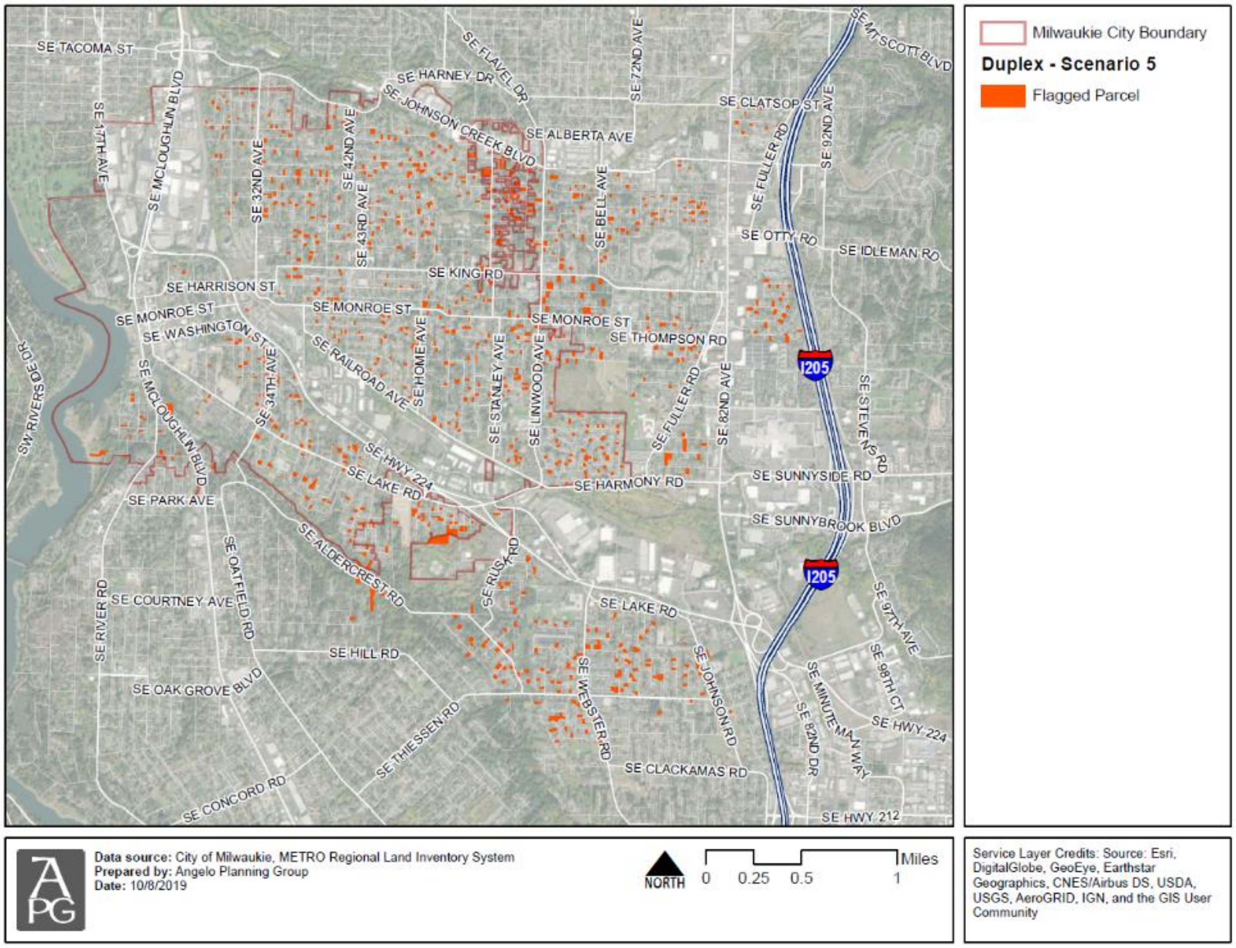


Figure 13. Duplex Locations, Scenario 5



NEXT STEPS

These initial results will be reviewed by City staff and updates to this analysis are expected. APG can provide GIS data, spreadsheets, or other information to help staff review.

2021 Water System Master Plan

Appendix B. Condition Assessment Evaluation Forms

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 01/09/2020

Facility Name: Lava Drive Pump Station **Facility Type:** Booster **Date Constructed:**

Location Description: 10505 SE 17th Ave parking lot
Asset Capacity: two pumps @ 300 gpm
two pumps @ 1750 gpm

Pumps From/To: Zone 1/Zone 4 **Service Zone:** 4

Pumps:

Pump	Size	Function	Manufacturer	Age
1	15 hp/3575 rpm/300 gpm	Zone 1 to Zone 4	Super E/Baldor Motor	
2	15 hp/3575 rpm/300 gpm	Zone 1 to Zone 4	Super E/Baldor Motor	
3	100 hp/1790 rpm/1750 gpm	High demand/fire	Super E/Baldor Motor	
4	100 hp/1790 rpm/1750 gpm	High demand/fire	Super E/Baldor Motor	

Overall Condition

Site	Parking lot and planter strip	**Doors**	Steel
Building	Concrete vault type	**Windows**	None
Roof	Flat, growing vegetation and trees	**Pumps**	Good condition, operating as designed
Communications	Good	**Coatings**	Good
Visible Damage	None		

Operational Criticality: **High** Medium Low

Construction Materials
Building: Concrete
Roof: Flat with vegetation and trees growing on it
Shape: Square
Grade: **On Grade** **Partially buried** Below grade

Security: Sensor switch at exterior doors
Perimeter: None

Locks: **Commercial** Residential Pad lock

Windows: Bars Steel grating None **No windows**
Alarms: **Remote** On-site None

Surveillance: Cameras Motion detection

Ladder security: N/A

Overall Condition: Poor Fair **Good** **Excellent**

Additional Notes: The building is in good condition, but vegetation and trees are growing on the roof.

The pump house is located in a private parking lot. If power goes down, a portable trailer mounted generator is brought to the site. This blocks any cars that may be parked next to the building (see photos).

BOOSTER PUMPS AND HIGH DEMAND PUMPS

LAVA DRIVE PUMP STATION SITE

LAVA DRIVE PUMP STATION ROOF

GENERATOR CONNECTION

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Stanley Reservoir **Facility Type:** Reservoir **Date Constructed:** 1970

Location Description: 11800 SE Stanley **Asset Capacity**: 3.0 MGal

Pumps From/To: Supplied by W6 and Pressure Zone 2 distribution **Service Zone:** Pressure Zone 3

Pumps:

Pump	Size	Function	Manufacturer	Age
1				
2				
3				
4				

Overall Condition

Site	Asphalt & landscaping in good condition	**Doors**	N/A
Building	N/A	**Windows**	N/A
Roof	Asphalt	**Pumps**	N/A
Communications	Telemetry	**Coatings**	
Visible Damage	None visible		

Operational Criticality: High Medium Low

Construction Materials Welded Steel
Building:
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security
Perimeter: Chain link fencing. Tall vegetation screening.

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

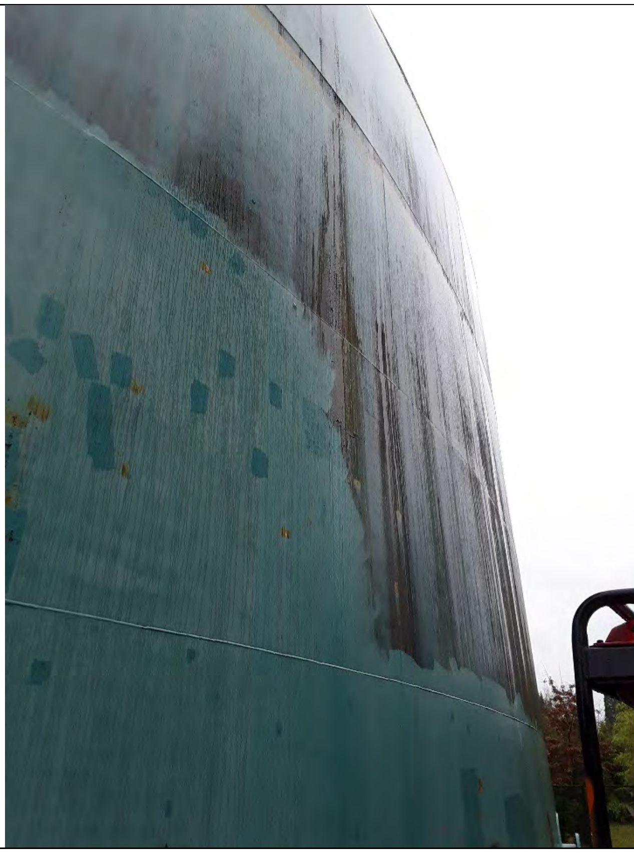
Surveillance: Cameras Motion detection

Ladder security: Elevated with locked cover.

Overall Condition: Poor Fair Good Excellent

Additional Notes: The City started pressure washing the exterior but was unable to complete. **The paint is flaking and is assumed to contain lead.**

Previous study also indicated that the tank mixer needs to be upgraded.

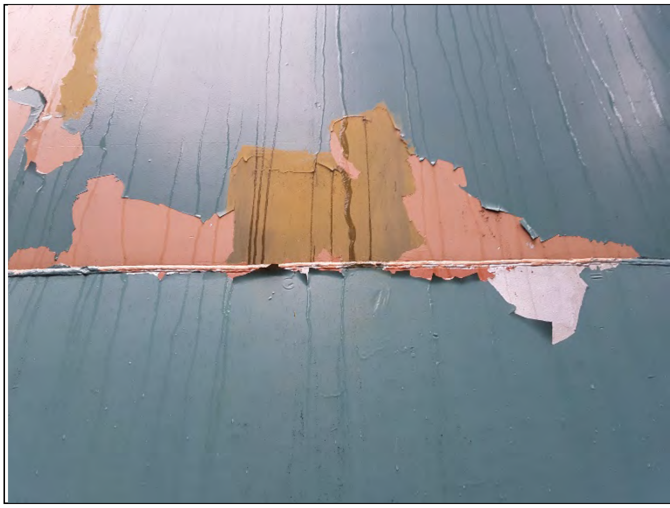


PRESSURE WASHED/UNWASHED SECTION

PRESSURE WASHED SECTION

LADDER ACCESS

HATCH OPENING


FLAKING PAINT


FLAKING PAINT


FLAKING PAINT


RESERVOIR SITE

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Well 6 **Facility Type:** Well **Date Constructed:** Constructed 1978
Pump installed 2007

Location Description: 11800 SE Stanley **Asset Capacity**: 605 gpm

Pumps From/To: From Well 6 to Stanley Reservoir **Service Zone:** Zones 2 and 3

Pumps:

Pump	Size	Function	Manufacturer	Age
1	75 HP		Peerless	
2				
3				
4				

Overall Condition

Site	Asphalt in good condition	**Doors**	Steel roll up and steel man door
Building		**Windows**	
Roof	Asphalt	**Pumps**	
Communications	Telemetry	**Coatings**	
Visible Damage	Exterior damage and rot at bottom of vertical siding and at exterior light fixture. Dangling electrical wiring. Damaged lower louver. Loose trim on exhaust louvers. Deferred maintenance on gutters.		

Operational Criticality: High Medium Low

Construction Materials
Building: Wood and steel
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security
Perimeter: Chain link fencing. Tall vegetation screening.

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security: N/A.

Overall Condition: Poor Fair Good Excellent

Additional Notes:

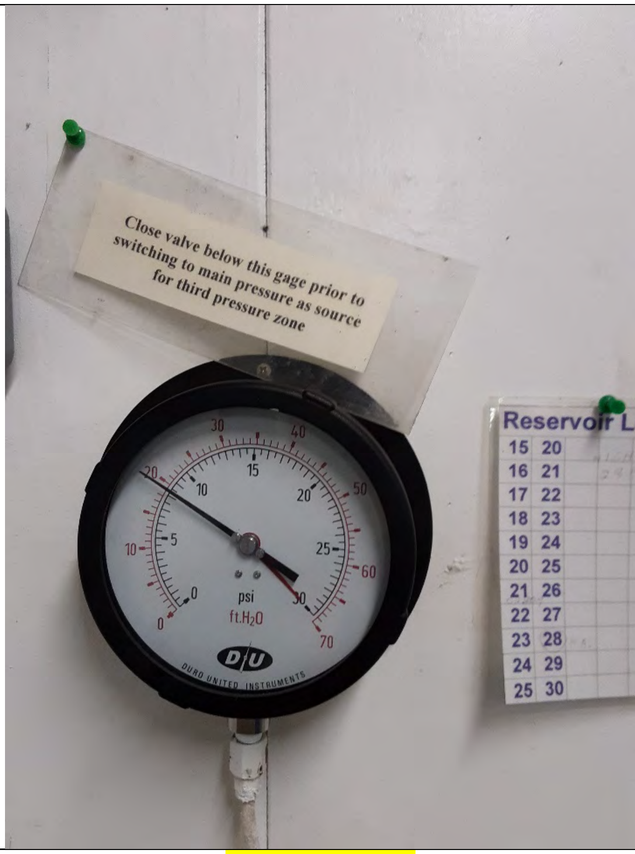
Static level well probe does not work. Has not been operational "for years".

FIRE PUMP DIESEL TANK

BUILDING EXTERIOR – DEFERRED MAINTENANCE LOUVERS

BUILDING EXTERIOR – DEFERRED MAINTENANCE GUTTER

BUILDING EXTERIOR – REPAIRED SIDING



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WELL 6 PUMP

Photo Caption Here

BUILDING EXTERIOR – DEFERRED MAINTENANCE LOUVERS

BUILDING EXTERIOR

BUILDING EXTERIOR – DEFERRED MAINTENANCE LOUVERS

BUILDING EXTERIOR

BUILDING EXTERIOR – DEFERRED MAINTENANCE LIGHTING

Photo Caption Here

BUILDING EXTERIOR – DEFERRED MAINTENANCE SIDING

BUILDING EXTERIOR – DEFERRED MAINTENANCE LOUVERS

BUILDING EXTERIOR – DEFERRED MAINTENANCE LOUVERS

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Well 6 Generator **Facility Type:** **Date Constructed:** XXXX

Location Description: 11800 SE Stanley **Asset Capacity**: XXXX

Pumps From/To: From Well 6 to Stanley Reservoir **Service Zone:** Zones 2 and 3

Pumps:

Pump	Size	Function	Manufacturer	Age
1	75 HP		Peerless	
2				
3				
4				

Overall Condition

Site	Asphalt in good condition	**Doors**	Steel roll up and steel man door
Building		**Windows**	
Roof	Asphalt	**Pumps**	
Communications	Telemetry	**Coatings**	
Visible Damage	Exterior damage and rot at bottom of vertical siding and at exterior light fixture. Dangling electrical wiring. Damaged lower louver. Loose trim on exhaust louvers. Deferred maintenance on gutters.		

Operational Criticality: High Medium Low

Construction Materials
Building: Wood and steel
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security
Perimeter: Chain link fencing. Tall vegetation screening.

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security: N/A.

Overall Condition: Poor Fair Good Excellent

Additional Notes:

Standby generator and ATS are tested on a weekly basis (Wednesdays at 10:00 a.m.).

AUTOMATIC TRANSFER SWITCH

STANDBY EMERGENCY GENJERATOR

STANDBY EMERGENCY GENJERATOR

AUTOMATIC TRANSFER SWITCH

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: W6 Chlorination **Facility Type:** Chlorination Injection **Date Constructed: XXXX**

Location Description: 11800 SE Stanley **Asset Capacity**: XXX

Pumps From/To: XXX **Service Zone:** XXX

Pumps:

Pump	Size	Function	Manufacturer	Age
1				
2				
3				
4				

Overall Condition

Site	Asphalt in good condition	**Doors**	Steel man door
Building		**Windows**	
Roof	Asphalt	**Pumps**	
Communications	Telemetry	**Coatings**	
Visible Damage	Exterior damage and rot at bottom of vertical siding and at exterior light fixture. Dangling electrical wiring. Damaged lower louver. Loose trim on exhaust louvers. Deferred maintenance on gutters.		

Operational Criticality: High Medium Low

Construction Materials
Building: Wood and steel
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security
Perimeter: Chain link fencing. Tall vegetation screening.

Locks: Commercial Residential Pad lock

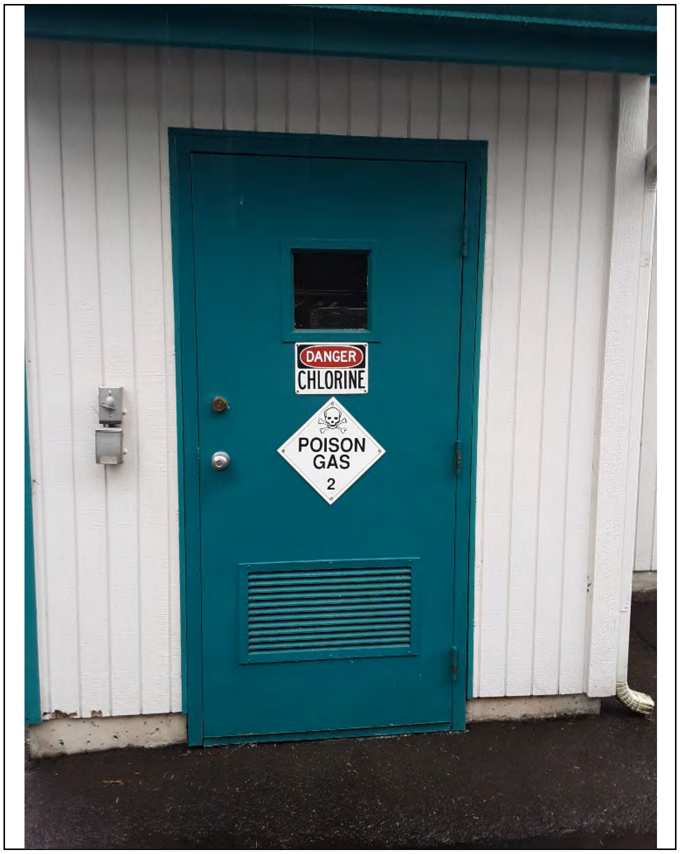
Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security: N/A.

Overall Condition: Poor Fair Good Excellent

Additional Notes:



BUILDING ENTRANCE AND SIGNAGE

CHLORINE SCALE

CHLORINE TANKS

CHLORINE INJECTION SYSTEM

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Pressure Zone 3 Booster Pumps
Facility Type: Booster PS
Date Constructed: XXXX

Location Description: 11800 SE Stanley

Asset Capacity: 2 @ 200 gpm
2 @ 600 gpm

Pumps From/To: Stanley Reservoir/Zone 3

Service Zone: Zone 3

Pumps:

Pump	Size	Function	Manufacturer	Age
1	20 HP	Pumps to Zone 3	Cornell/Hydronix Pkg System	
2	20 HP	Pumps to Zone 3	Cornell/Hydronix Pkg System	
3	100 HP	Pumps to Zone 3	Cornell/Hydronix Pkg System	
4	100 HP	Pumps to Zone 3	Cornell/Hydronix Pkg System	

Overall Condition

Site	Asphalt in good condition	**Doors**	Steel roll up and steel man door
Building		**Windows**	
Roof	Asphalt	**Pumps**	
Communications	Telemetry	**Coatings**	
Visible Damage	Exterior damage and rot at bottom of vertical siding and at exterior light fixture. Dangling electrical wiring. Damaged lower louver. Loose trim on exhaust louvers. Deferred maintenance on gutters.		

Operational Criticality: High Medium Low

Construction Materials
Building: Wood and steel
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security
Perimeter: Chain link fencing. Tall vegetation screening.

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security: N/A.

Overall Condition: Poor Fair Good Excellent

Additional Notes:

Standby generator and ATS are tested on a weekly basis (Wednesdays at 10:00 a.m.).

Equipped with obsolete mercury switches.

PRESSURE ZONE 3 BOOSTER PUMPS

MERCURY SWITCH

PRESSURE ZONE 3 BOOSTER PUMPS

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Well 6 Transfer Pumps **Facility Type:** Transfer PS

Date Constructed: XXXX

Location Description: 11800 SE Stanley

Asset Capacity: 2 @ 1300 gpm
2 @ 2250 gpm

Pumps From/To: Stanley Reservoir/Zone 2

Service Zone: Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1	50 HP	Pumps to Elevated Res		
2	50 HP	Pumps to Elevated Res		
3	125 HP	Fire (not used)		
4	125 HP	Fire (not used)		

Overall Condition

Site	Asphalt in good condition	**Doors**	Steel roll up and steel man door
Building		**Windows**	
Roof	Asphalt	**Pumps**	
Communications	Telemetry	**Coatings**	
Visible Damage	Exterior damage and rot at bottom of vertical siding and at exterior light fixture. Dangling electrical wiring. Damaged lower louver. Loose trim on exhaust louvers. Deferred maintenance on gutters.		

Operational Criticality: High | Medium | Low

Construction Materials
Building: Wood and steel
Roof:
Shape:
Grade: On Grade | Partially buried | Below grade

Security
Perimeter: Chain link fencing. Tall vegetation screening.

Locks: Commercial | Residential | Pad lock

Windows: Bars | Steel grating | None | No windows
Alarms: Remote | On-site | None

Surveillance: Cameras | Motion detection

Ladder security: N/A.

Overall Condition: Poor | Fair | Good | Excellent

Additional Notes:

Standby generator and ATS are tested on a weekly basis (Wednesdays at 10:00 a.m.).

Diesel tank located outside the building is dedicated to the fire pumps. Quantity and quality of diesel is unknown. The last time the pumps were operated is unknown.

Fire pumps probably are not necessary anymore.

WELL 6 TRANSFER PUMPS

CONTROL VALVE

FIRE PUMP

FIRE PUMPS

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Elevated Reservoir **Facility Type:** Reservoir **Date Constructed:** 1963

Location Description: Harvey & SE 40th (NE corner) **Asset Capacity**: 1.5 MGal

Pumps From/To: Supplied by TP47, Concrete Res. transfer pumps, and Stanley Res. Transfer pumps

Service Zone: Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1				
2				
3				
4				

Overall Condition

Site	Asphalt & landscaping in good condition	**Doors**	N/A
Building	N/A	**Windows**	N/A
Roof	N/A	**Pumps**	N/A
Communications	N/A	**Coatings**	Excellent condition
Visible Damage	None visible		

Operational Criticality: **High** Medium Low

Construction Materials Steel
Building:
Roof:
Shape:
Grade: **On Grade** Partially buried Below grade

Security
Perimeter: None, park-like setting

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security: Elevated entry, locked cover

Overall Condition: Poor Fair Good **Excellent**

Additional Notes: Reservoir is located next to a park. The area below the reservoir is frequently used for shade, cover, etc., by locals.

The interior and exterior of the tank was recoated in 2016 – 2017.

Seismic retro fit performed in 2004

ELEVATED RESERVOIR

ELEVATED RESERVOIR – HATCH OPENING

ELEVATED RESERVOIR SUPPORTS

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Well 4 **Facility Type:** Well PS

Date Constructed: Constructed 1960
Pump installed 2004

Location Description: Monroe/Railroad/Oak

Asset Capacity: 605 gpm

Pumps From/To: Tower 4 at TP47

Service Zone: Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1	75 hp		General Electric	
2				
3				
4				

Overall Condition

Site	Asphalt, good condition	**Doors**	Steel mandoor and double doors
Building		**Windows**	
Roof		**Blowers**	
Communications	Operation is controlled by levels in Elevated Reservoir	**Coatings**	
Visible Damage			

Operational Criticality: High Medium Low

Construction Materials
Building: Steel
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security Sensor switch at exterior doors
Perimeter: Chain link fencing at site, tall vegetation screening

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: **Remote** On-site None

Surveillance: Cameras Motion detection

Ladder security:

Overall Condition: Poor Fair Good Excellent

Additional Notes:

Static level well probe does not work. Has not been operational "for years".

Standby emergency generator on site. History of testing and maintenance is uncertain. There appeared to be a leak.

Druck Signal Conditioning Unit is obsolete. No parts or replacement available.

Several tall trees encroaching on structures. Potential to impact telemetry.

WELL 4 BUILDING EXTERIOR & PERIMETER FENCE

WELL 4 BUILDING EXTERIOR

WELL 4 PUMP

WELL 4 BUILDING ENTRANCE

WELL 4 BUILDING ENTRANCE

WELL 4 PERIMETER FENCE

WELL 4 PUMP

WELL 4 OBSOLETE INSTRUMENT

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: TP 47 Generator

Facility Type:

Date Constructed: XXXX

Location Description: TP 47 Site

Asset Capacity: Well No. 4 & TP 47 System

Pumps From/To: N/A

Service Zone: Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1				
2				
3				
4				

Overall Condition

Site		**Doors**	
Building		**Windows**	
Roof		**Blowers**	
Communications		**Coatings**	
Visible Damage			

Operational Criticality: High Medium Low

Construction Materials
Building: Steel
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security
Perimeter: Chain link fencing at site, tall vegetation screening

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: **Remote** On-site None

Surveillance: Cameras Motion detection

Ladder security:

Overall Condition: Poor Fair Good Excellent

Additional Notes:

Standby emergency generator on site. History of testing and maintenance is uncertain. There appeared to be a leak.

Equipped with ATS.

EMERGENCY GENERATOR

EMERGENCY GENERATOR – LEAK

EMERGENCY GENERATOR

EMERGENCY GENERATOR EXHAUST

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: TP 47 Air Stripping Towers **Facility Type:** Treatment **Date Constructed:** XXXX

Location Description: Monroe/Railroad/Oak **Asset Capacity**: 600 gpm

Pumps From/To: Removes VOC from wells 4 and 7 **Service Zone:** Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1				
2				
3				
4				

Overall Condition

Site	Asphalt, good condition	**Doors**	
Building		**Windows**	
Roof		**Pumps**	
Communications		**Coatings**	
Visible Damage			

Operational Criticality: High | Medium | Low

Construction Materials
Building: Steel
Roof:
Shape:
Grade: On Grade | Partially buried | Below grade

Security
Perimeter: Chain link fencing at site, tall vegetation screening

Locks: Commercial | Residential | Pad lock

Windows: Bars | Steel grating | None | No windows
Alarms: Remote | On-site | None

Surveillance: Cameras | Motion detection

Ladder security:

Overall Condition: Poor | Fair | Good | Excellent

Additional Notes: Media last replaced after it had been in operation approximately 20 years and was still in pretty good condition.

TP47 SITE

TP47 AIR STIPPING TOWERS

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: TP 47 Blowers **Facility Type:** Treatment **Date Constructed:** XXXX

Location Description: Monroe/Railroad/Oak **Asset Capacity**:

Pumps From/To: Provides air to towers to remove VOC from wells 4 and 7

Service Zone: Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1				
2				
3				
4				

Overall Condition

Site	Asphalt, good condition	**Doors**	Steel, double
Building		**Windows**	
Roof		**Blowers**	2, New York Blower Company
Communications		**Coatings**	
Visible Damage			

Operational Criticality: High Medium Low

Construction Materials
Building: Steel
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security Sensor switch at exterior doors
Perimeter: Chain link fencing at site, tall vegetation screening

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security:

Overall Condition: Poor Fair Good Excellent

Additional Notes: SCADA can detect if blowers are operating, it but cannot detect if they are running poorly. One example is when a bearing sleeve had to be replaced.

Air filters in the room are routinely changed about every 3 months.

Standby emergency generator on site. History of testing and maintenance is uncertain. There appeared to be a leak.

TP47 BLOWER ROOM AIR FILTERS

TP47 BLOWER

TP47 BLOWER ROOM AIR FILTERS

TP47 BLOWERS

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: TP 47 – Chlorination System **Facility Type:** Disinfection **Date Constructed: XXXX**

Location Description: Monroe/Railroad/Oak

Asset Capacity:

Pumps From/To: Disinfects Towers 4 and 7.

Service Zone: Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1		Well 4 pre-chlorination	Wallace & Tiernan	
2		Well 4 post-chlorination	Wallace & Tiernan	
3		Well 7 pre-chlorination	Wallace & Tiernan	
4		Well 7 post-chlorination	Wallace & Tiernan	

Overall Condition

Site	Asphalt, good condition	**Doors**	Double steel exterior doors
Building	Dedicated room for chlorine system	**Windows**	None
Roof		**Pumps**	Wallace & Tiernan injection system
Communications		**Coatings**	
Visible Damage			

Operational Criticality: High Medium Low

Construction Materials
Building: Steel and wood
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security Sensor switch at exterior doors
Perimeter: Chain link fencing at site

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security:

Overall Condition: Poor Fair Good Excellent

Additional Notes:

Standby emergency generator on site. History of testing and maintenance is uncertain. There appeared to be a leak

TP47 CHLORINE TANKS

TP37 CHLORINE INJECTION SYSTEM

TP47 CHLORINE STORAGE

TP47 CHLORINE RESIDUAL SENSOR

TP37 CHLORINE INJECTION SYSTEM

TP37 CHLORINE INJECTION SYSTEM

TP47 CHEMICAL ROOM ENTRANCE

City of Milwaukie | **Reviewer:** BHarrison
2020 WMP Water System Asset Condition Assessment Evaluation | **Date:** 12/11/19

Facility Name: TP 47 Transfer Pumps
"Lower Treatment Plant Booster Pumps"
Facility Type: Transfer PS
Date Constructed: XXXX
Location Description: Monroe/Railroad/Oak
Asset Capacity: Each @ 1000 gpm

Pumps From/To:
Service Zone: Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1	75 hp		General Electric	
2	75 hp		General Electric	
3				
4				

Overall Condition

Site	Asphalt, good condition	**Doors**	Steel, double
Building		**Windows**	
Roof		**Blowers**	
Communications		**Coatings**	
Visible Damage			

Operational Criticality: High Medium Low

Construction Materials
Building: Steel
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security
Perimeter: Chain link fencing at site, tall vegetation screening

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security:

Overall Condition: Poor Fair Good Excellent

Additional Notes:

Standby emergency generator on site. History of testing and maintenance is uncertain. There appeared to be a leak.

CLEARWELL LEVEL INDICATOR

TRANSFER PUMPS

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Concrete Reservoir **Facility Type:** Reservoir **Date Constructed:** 1923

Location Description: Harvey & SE 40th (SE corner) **Asset Capacity**: 1.5 MGal

Pumps From/To: Supplied by TP235 **Service Zone:** Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1				
2				
3				
4				

Overall Condition

Site	Asphalt & landscaping in good condition	**Doors**	N/A
Building	N/A	**Windows**	N/A
Roof	Asphalt	**Pumps**	N/A
Communications	Telemetry	**Coatings**	
Visible Damage	None visible		

Operational Criticality: High Medium Low

Construction Materials Concrete
Building:
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security
Perimeter: Chain link fencing

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security: Ladder is accessible at ground level, but has locked cover.

Overall Condition: Poor Fair Good Excellent

Additional Notes: Surveillance cameras at W2 wellhouse, not directly on reservoir.

Fencing between the reservoir and wellhouse, but not along the street side of the reservoir.

Locked cover over the ladder has some damage. Unsure if due to vandalism or wind load. See photo.

Leaks repaired with liner in 1995.

CONCRETE RESERVOIR

PERIMETER FENCING

CONCRETE RESERVOIR ROOF ACCESS

CONCRETE RESERVOIR ROOF

CONCRETE RESERVOIR LADDER

CONCRETE RESERVOIR LADDER COVER DAMAGE

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Well 2 **Facility Type:** Well **Date Constructed:** Original construction 1936
Overhauled in 2016

Location Description: Harvey & SE 40th (SE corner) 9951 SE Harvey **Asset Capacity**: 380 gpm

Pumps From/To: To Tower 2 at TP 235 **Service Zone:** Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1	50 HP		Jacuzzi	
2				
3				
4				

Overall Condition

Site	Asphalt and landscaping, good condition	**Doors**	Steel doors and roll up doors
Building	Old WWII era building	**Windows**	
Roof	Poor condition, chronic leaks	**Blowers**	
Communications	telemetry	**Coatings**	
Visible Damage			

Operational Criticality: High | Medium | Low

Construction Materials
Building: Unknown
Roof: Membrane
Shape:
Grade: On Grade | Partially buried | Below grade

Security Perimeter: Sensor switch at exterior doors

Locks: Commercial | Residential | Pad lock

Windows: Bars | Steel grating | None | No windows
Alarms: **Remote** | On-site | None

Surveillance: Cameras | Motion detection

Ladder security:

Overall Condition: Poor | Fair | Good | Excellent

Additional Notes: Casing at Well 2 was damaged at about 200 ft, so another well to replace Well 2 has been drilled, but is not in service.

Four security cameras installed to building exterior. Videos are rotated approximately every 2 weeks.

Onsite generator does not have an automatic transfer switch and must be started. Sized for a very large load so all equipment (Well 2 pump, transfer pumps, TP 235 equipment, and Well 3) must require backup power for the generator to be operated. The generator is not tested regularly and the age of diesel in the tank is unknown. Tank is filled through a port at the building exterior (is it locked?). Overfill alarm is in place at exterior.

No ventilation system in the building. The windows must be opened to vent air.

Old WWII era building with chronic leaking roof.

GENERATOR DEISEL FILL TAP

GENERATOR DEISEL FILL TAP

WELL 2 BUILDING EXTERIOR

WELL 2 BUILDING EXTERIOR

WELL 2 BUILDING EXTERIOR

LOUVERS

ELECTRICAL

ELECTRICAL

WELL 2 PUMP

TRANSFER SWITCH

BUILDING EXTERIOR AND SITE

BUILDING EXTERIOR AND SITE

OBSOLETE INSTRUMENT

PUMP EQUIPMENT TAG

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Well 3 Pump **Facility Type:** Well **Date Constructed:** 1980

Location Description: Harvey & SE 40th (SE corner) TP 235 Site **Asset Capacity**: 511 gpm

Pumps From/To: Well 3 to TP Tower 3 **Service Zone:** Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1	60 HP		Worthington	
2				
3				
4				

Overall Condition

Site		**Doors**	Steel man door
Building	Good	**Windows**	Small window
Roof	Good	**Pump**	
Communications	On/Off controlled by level in Concrete Reservoir	**Coatings**	
Visible Damage			

Operational Criticality: High | Medium | Low

Construction Materials
Building: Cinder Block
Roof:
Shape:
Grade: On Grade | Partially buried | Below grade

Security Sensor switch at exterior doors
Perimeter:

Locks: Commercial | Residential | Pad lock

Windows: Bars | Steel grating | None | No windows
Alarms: Remote | On-site | None

Surveillance: Cameras | Motion detection

Ladder security:

Overall Condition: Poor | **Fair** | Good | Excellent

Additional Notes:

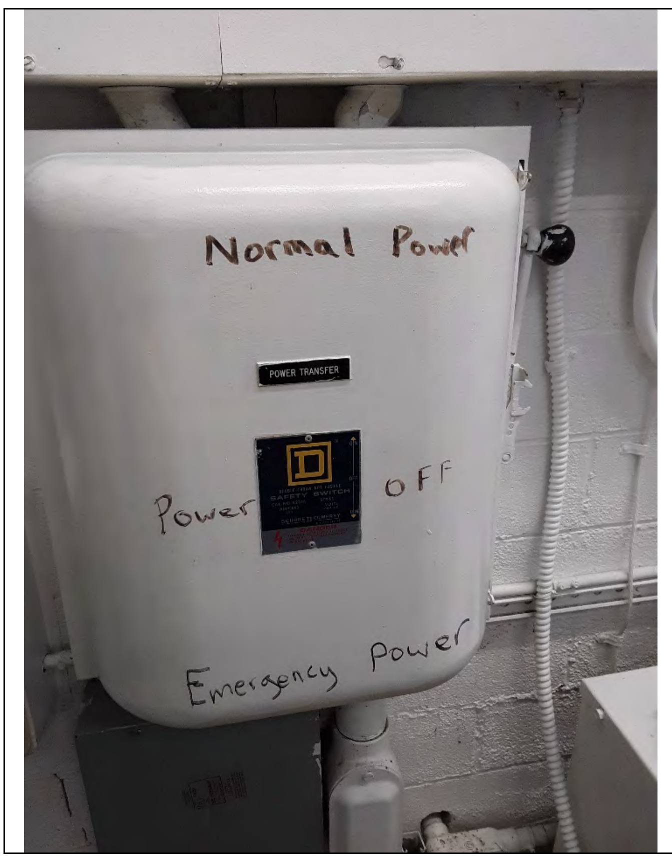
The well pump had been failing after it was in operation for a couple of hours. Packing was recently replaced – did this fix the problem?

Druck Signal Conditioning Unit is obsolete. No parts or replacement available.

Backup generator located in Well 2 pump house.

WELL 3 PUMP

WELL 3 PUMP



TRANSFER SWITCH

OBSOLETE INSTRUMENT

WELL 3 PUMP HOUSE

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Well 5 Pump **Facility Type:** Well **Date Constructed:** 1980

Location Description: Harvey & SE 40th (NE corner) Water Tower Park **Asset Capacity**: 900 gpm

Pumps From/To: Well 5 to TP Tower 5 **Service Zone:** Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1	75 HP		Johnson	
2				
3				
4				

Overall Condition

Site		**Doors**	Steel man door and roll up door
Building	Insulation damage under eaves, damaged gutter downspout, attic vent screen	**Windows**	None. Louvers.
Roof	Unknown condition	**Pump**	Oil leak, packing gland leak, high vibration
Communications	Telemetry, high vegetation could impact signal	**Coatings**	
Visible Damage			

Operational Criticality: High | Medium | Low

Construction Materials
Building: Wood
Roof:
Shape:
Grade: On Grade | Partially buried | Below grade

Security Sensor switch at exterior doors
Perimeter:

Locks: Commercial | Residential | Pad lock

Windows: Bars | Steel grating | None | No windows
Alarms: Remote | On-site | None

Surveillance: Cameras | Motion detection

Ladder security:

Overall Condition: Poor | Fair | Good | Excellent

Additional Notes: Packing gland is leaking water. Pump exhibits high vibration. Pump has an oil leak. Pump is capable of 900+ gpm, but the corresponding tower has capacity for only 600 gpm.
One of the ceiling fan vents may not be operable.
Security includes contact switch at door. Chainlink fence at driveway. Separate keys for fence and door.
Druck Signal Conditioning Unit is obsolete. No parts or replacement available.
Generator is only tested annually. No recent use and unsure if ATS would work during an outage. Fuel level is unknown, no visible level indicator. Fuel tank is at building exterior. Last maintenance unknown.

Vegetation is high with potential to impact telemetry. Relocate to power pole (adjacent to building)?
Abandoned natural gas connection at building exterior.

WELL 5 PUMP

WELL 5 PUMP

WELL 5 PUMP - LEAK

GENERATOR DIESEL STORAGE

BUILDING EXTERIOR **BUILDING EXTERIOR – DEFERRED MAINTENANCE**

BUILDING EXTERIOR **BUILDING EXTERIOR – DAMANGED SCREEN**

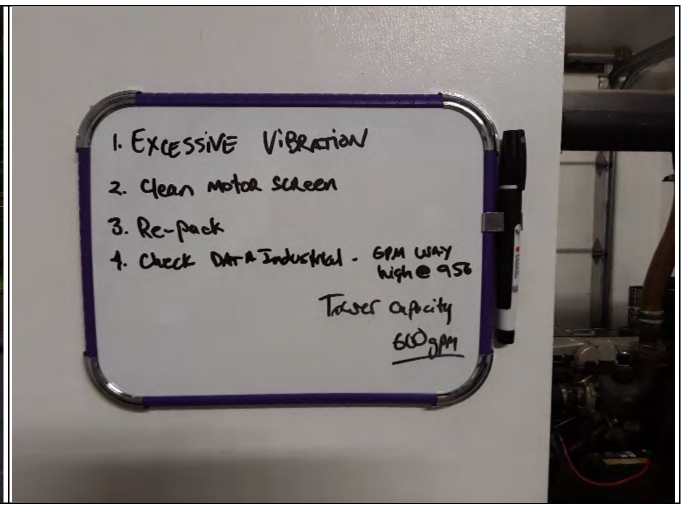
BUILDING EXTERIOR – DAMANGED DOWNSPOUT

BUILDING EXTERIOR – PERIMETER FENCE

OBSOLETE INSTRUMENT

Photo Caption Here

BUILDING EXTERIOR



PUMP MAINTENANCE SCHEDLE

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: TP 235 Generator (Well 2) **Facility Type:** Well **Date Constructed:** XXXX

Location Description: Harvey & SE 40th (NE corner)
Water Tower Park

Asset Capacity: Wells 2 & 3 & TP235 Systems

Pumps From/To: N/A

Service Zone: Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1				
2				
3				
4				

Overall Condition

Site		**Doors**	
Building		**Windows**	
Roof		**Pump**	
Communications		**Coatings**	
Visible Damage			

Operational Criticality: High Medium Low

Construction Materials
Building: Wood
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security Sensor switch at exterior doors
Perimeter:

Locks: Commercial Residential Pad lock

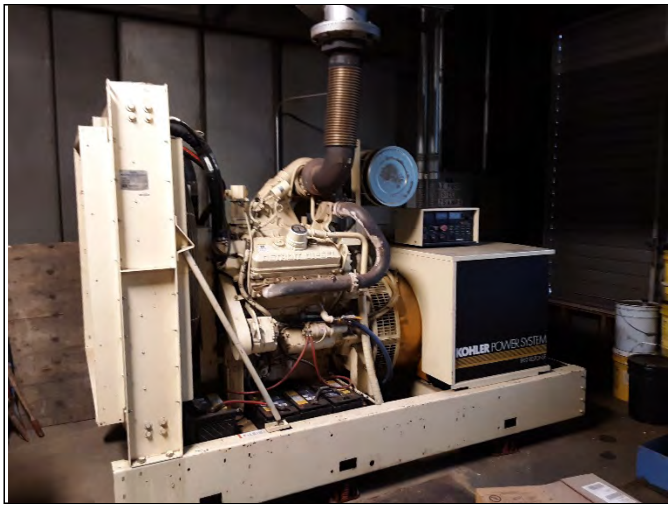
Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security:

Overall Condition: Poor Fair Good Excellent

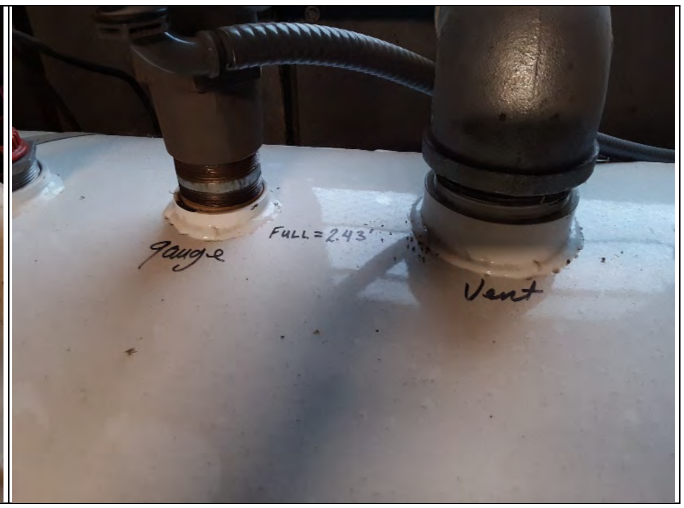
Additional Notes: Generator is only tested annually. No recent use and unsure if ATS would work during an outage. Fuel level is unknown, no visible level indicator. Fuel tank is at building exterior. Last maintenance unknown.



TP235 EMERGENCY GENERATOR

TP235 GENERATOR – DIESEL STORAGE

TP235 GENERATOR – DIESEL STORAGE



TP235 GENERATOR – DIESEL STORAGE

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: Well 5 Generator **Facility Type:** Generator **Date Constructed:** XXXX

Location Description: Harvey & SE 40th (NE corner)
Water Tower Park
Asset Capacity: Well 5

Pumps From/To: N/A
Service Zone: Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1				
2				
3				
4				

Overall Condition

Site		**Doors**	
Building		**Windows**	
Roof		**Pump**	
Communications		**Coatings**	
Visible Damage			

Operational Criticality: High | Medium | Low

Construction Materials
Building: Wood
Roof:
Shape:
Grade: On Grade | Partially buried | Below grade

Security Sensor switch at exterior doors
Perimeter:

Locks: Commercial | Residential | Pad lock

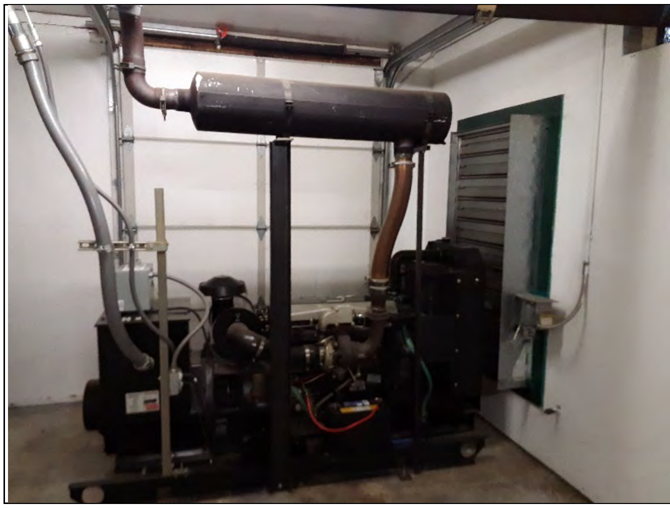
Windows: Bars | Steel grating | None | No windows
Alarms: Remote | On-site | None

Surveillance: Cameras | Motion detection

Ladder security:

Overall Condition: Poor | Fair | Good | Excellent

Additional Notes
Generator is only load tested on an annual basis. Unknown is automatic transfer switch works during an outage. No recent use. Fuel level and age is unknown. Diesel tank is located outside.



GENERATOR

AUTOMATIC TRANSFER SWITCH

DIESEL FUEL TANK

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: TP 235 Air Stripping Towers **Facility Type:** Treatment **Date Constructed:** 1990

Location Description: Harvey & SE 40th (SE corner) **Asset Capacity**: 600 gpm/tower

Pumps From/To: Removes VOC from wells 2, 3 & 5 **Service Zone:** Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1				
2				
3				
4				

Overall Condition

Site	Asphalt and landscaping, good condition	**Doors**	
Building		**Windows**	
Roof		**Pumps**	
Communications		**Coatings**	
Visible Damage			

Operational Criticality: High Medium Low

Construction Materials
Building: Steel
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security Sensor switch at exterior doors
Perimeter: Chain link fencing at site, tall vegetation screening

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security:

Overall Condition: Poor Fair Good Excellent

Additional Notes: City is preparing to replace the media in the next couple of years.

TP235 PERIMETER FENCE

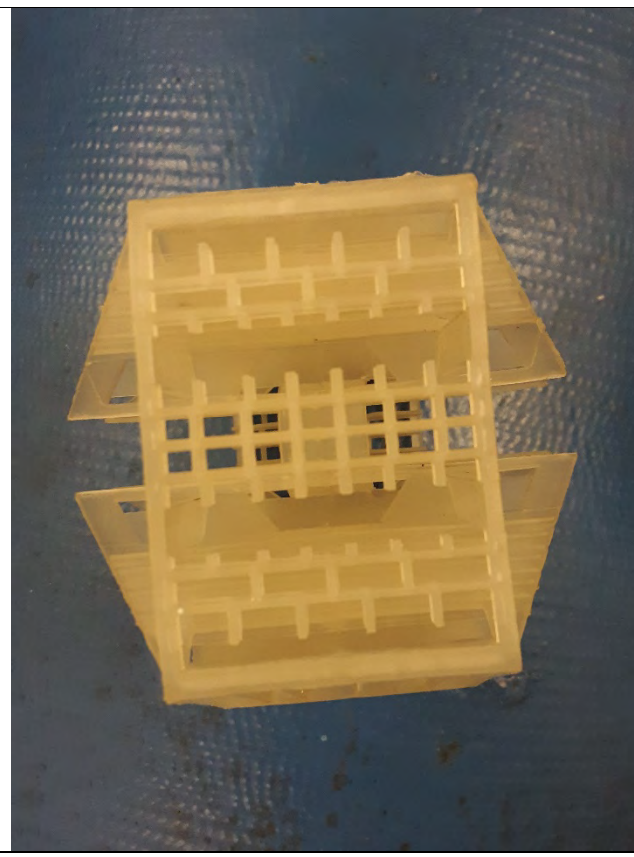

TP235 AIR STRIPPING TOWERS

TP235 SITE

TP235 AIR STRIPPING TOWER SITE

TP235 AIR STRIPPING TOWERS

TP235 AIR STRIPPING TOWER GAUGE



TP235 AIR STRIPPING TOWER MEDIA

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: TP 235 Blowers **Facility Type:** Treatment **Date Constructed:** 1990

Location Description: Harvey & SE 40th (SE corner) **Asset Capacity**:

Pumps From/To: Provides air to towers to removes VOC from wells 2, 3 & 5 **Service Zone:** Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1				
2				
3				
4				

Overall Condition

Site	Asphalt and landscaping, good condition	**Doors**	Steel, double
Building		**Windows**	
Roof		**Blowers**	3, New York Blower Company
Communications		**Coatings**	
Visible Damage			

Operational Criticality: High Medium Low

Construction Materials
Building: Steel
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security Sensor switch at exterior doors
Perimeter: Chain link fencing at site, tall vegetation screening

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security:

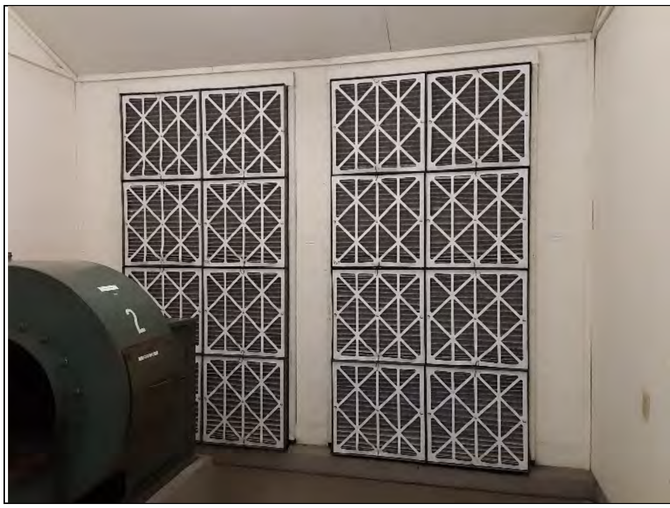
Overall Condition: Poor Fair Good Excellent

Additional Notes: SCADA can detect if blowers are operating, it but cannot detect if they are running poorly. One example is when a bearing sleeve had to be replaced.

Air filters in the room are routinely changed about every 3 months.


TP235 BLOWER


TP235 BLOWER SWITCHES


TP235 BLOWER BUILDING AIR FILTER


TP235 BLOWERS


TP235 BLOWER ROOM ENTRANCE

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: TP 235 – Chlorination System **Facility Type:** Disinfection **Date Constructed:** Unknown

Location Description: Harvey & SE 40th (SE corner) **Asset Capacity**:

Pumps From/To: Disinfects Towers 2, 3 & 5. **Service Zone:** Pressure Zone 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1		Well 2 pre-chlorination	Wallace & Tiernan	
2		Well 2 post-chlorination	Wallace & Tiernan	
3		Well 3 pre-chlorination	Wallace & Tiernan	
4		Well 3 post-chlorination	Wallace & Tiernan	
5		Well 5 pre-chlorination	Wallace & Tiernan	
6		Well 5 post-chlorination	Wallace & Tiernan	

Overall Condition

Site	Asphalt and landscaping, good condition	**Doors**	Steel exterior door
Building	Dedicated room for chlorine system	**Windows**	Window in door
Roof		**Pumps**	Wallace & Tiernan injection system
Communications		**Coatings**	
Visible Damage			

Operational Criticality: High Medium Low

Construction Materials
Building: Steel and wood
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security Sensor switch at exterior doors
Perimeter: Chain link fencing at site

Locks: Commercial Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: Remote On-site None

Surveillance: Cameras Motion detection

Ladder security:

Overall Condition: Poor Fair Good Excellent

Additional Notes: The chlorine gas corroded the metal on a gauge and rust blocked the PVC gas tubing to the injector. Public Works had to bypass the vacuum gage temporarily. Each injector is dedicated to a single well/tower.

Each well/tower system has an injector before and after the tower.

Exterior door has commercial locks and door entry contacts.

Chemical leak detection.

Cameras are located at the building exterior and site entrance.

Chlorine gas containers are onsite. Ventilation and signage installed.

One of the chlorine scales does not work. Staff has purchased a bathroom scale for temporary use.

Controls currently allow well pumps to run approx. 10 minutes after chlorine injection stops.

TP235 CHLORINE FEED SYSTEM

TP235 CHLORINE FEED SYSTEM

TP235 CHLORINE FEED IN USE AND SUPPLY

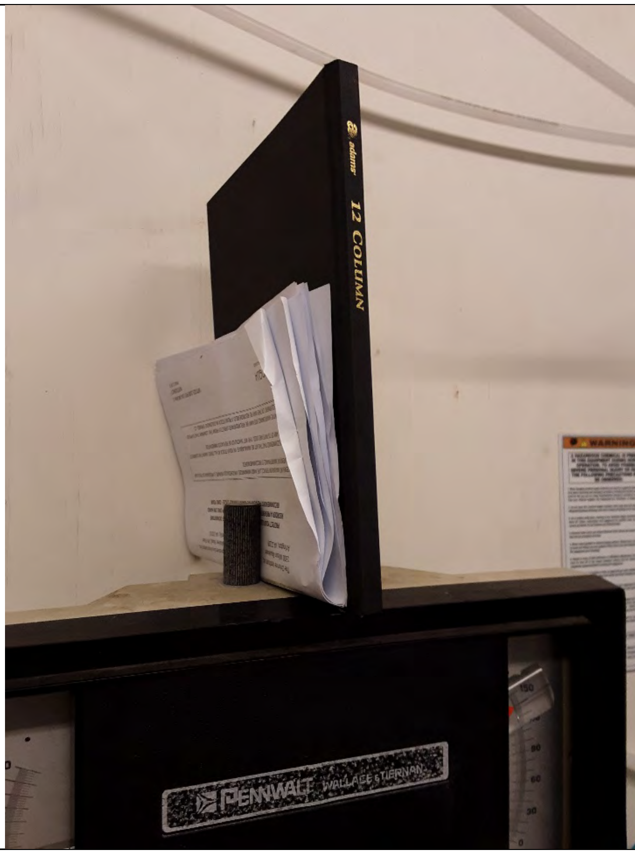
TP235 CHLORINE SCALE

TP235 CHLORINE FEED SYSTEM

TP235 CHLORINE FEED SYSTEM

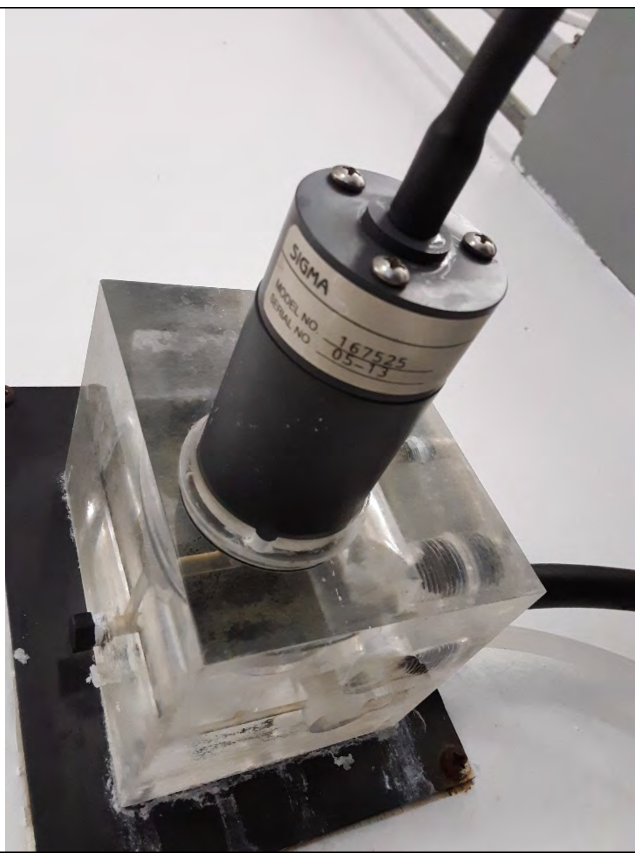
TP235 CHLORINE FEED SYSTEM

TP235 CHLORINE TANKS AND SCALE

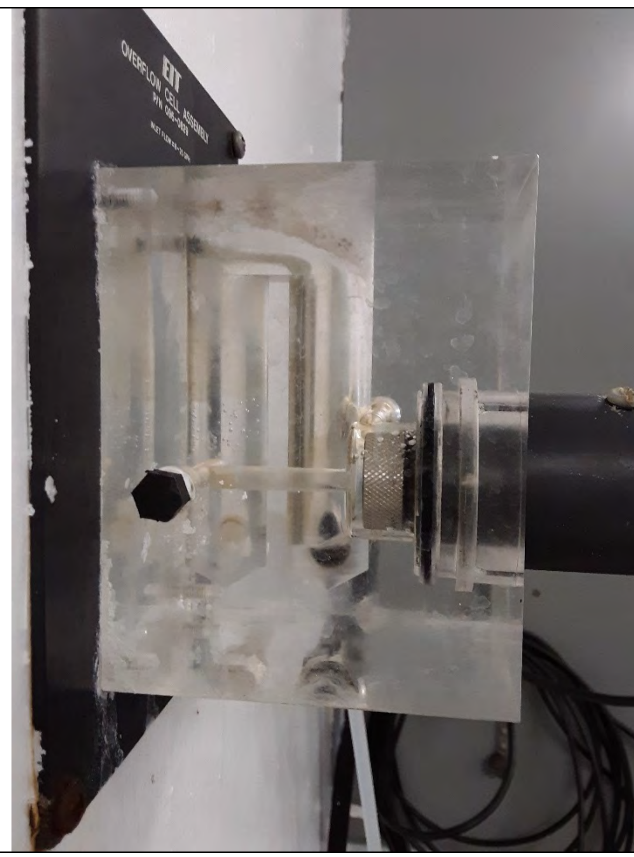


????????

CHLORINE FLOW VALVE



RESIDUAL CHLORINE SENSOR



RESIDUAL CHLORINE SENSOR

CHEMICAL ROOM ENTRANCE

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 12/11/19

Facility Name: W2 Transfer Pumps **Facility Type:** Transfer PS **Date Constructed:** 1990

Location Description: Harvey & SE 40th (SE corner) 9951 SE Harvey **Asset Capacity**: @ 900 gpm

Pumps From/To: Concrete Reservoir/Elevated Reservoir **Service Zone:** 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1	20 HP		Cornell (Baldor motor)	
2	20 HP		Cornell (Baldor motor)	
3				
4				

Overall Condition

Site	Asphalt and landscaping, good condition	**Doors**	Steel manholes and roll up doors
Building	Old WWII era building	**Windows**	
Roof	Poor condition, chronic leaks	**Blowers**	
Communications	telemetry	**Coatings**	
Visible Damage			

Operational Criticality: High | Medium | Low

Construction Materials
Building: Unknown
Roof: Membrane
Shape:
Grade: On Grade | Partially buried | Below grade

Security Perimeter: Sensor switch at exterior doors

Locks: Commercial | Residential | Pad lock

Windows: Bars | Steel grating | None | No windows
Alarms: Remote | On-site | None

Surveillance: Cameras | Motion detection

Ladder security:

Overall Condition: Poor | Fair | Good | Excellent

Additional Notes:

The pumps run hot with a potential to overheat (they are too hot to touch). The run typically 2 – 3 hours. Last date that maintenance was performed is unknown.

Current controls have both pumps starting at the same time per the setpoint.

Pumps are signaled to start by the float in the clearwell. The float system in clearwell can get stuck, however, and the room will flood because the booster pumps were not signaled to start.

TRANSFER PUMPS

TRANSFER PUMPS

CLEARWELL LEVEL INDICATOR

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 01/09/2020

Facility Name: Well 7 **Facility Type:** Well **Date Constructed:** Well installed 1984, pump installed 2000

Location Description: 11022 SE 37th Ave **Asset Capacity**: 1120 gpm @ 195 ft

Pumps From/To: Well 7 to TP47 **Service Zone:** 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1	125 hp/1730 rpm	turbine	Peerless	20 yr
2				
3				
4				

Overall Condition

Site	Asphalt and landscaping in good condition	**Doors**	Steel single and double
Building	Good/excellent	**Windows**	None, skylight
Roof	Asphalt, good condition	**Pumps**	Oil leak
Communications		**Coatings**	
Visible Damage			

Operational Criticality: High Medium Low

Construction Materials
Building: Wood, steel and concrete.
Roof:
Shape:
Grade: On Grade Partially buried Below grade

Security Sensor switch at exterior doors
Perimeter: None

Locks: **Commercial** Residential Pad lock

Windows: Bars Steel grating None No windows
Alarms: **Remote** On-site None

Surveillance: Cameras Motion detection

Ladder security:

Overall Condition: Poor Fair Good Excellent

Additional Notes: Located adjacent to a commercial/mixed use type building.

Onsite standby generator last serviced in February 2019, per the service record. Testing schedule and last use are unknown.

Typical pressure switch at all doors. Signals intrusion alarm at SCADA if a switch is not activated within 60 seconds.

WELL NO. 6 PUMPHOUSE

NEIGHBORING PROPERTY

SITE

WELL NO. 6 PUMP

GENERATOR

DIESEL STORAGE

SAND FILTER AND BACKWASH

OIL LEAK

City of Milwaukie
2020 WMP Water System Asset Condition Assessment Evaluation

Reviewer: BHarrison
Date: 01/09/2020

Facility Name: Well 8 (Offline) **Facility Type:** Well **Date Constructed:** 2008-2009

Location Description: 5393 SE Lake Road **Asset Capacity**: 700 gpm

Pumps From/To: Well 8 to Zone 2 **Service Zone:** 2

Pumps:

Pump	Size	Function	Manufacturer	Age
1	700 gpm		Pratt	12 yrs
2				
3				
4				

Overall Condition

Site		**Doors**	Steel single and double
Building	Wood/steel/concrete Pump located in fiberglass bldg	**Windows**	
Roof	Good	**Pumps**	Unknown
Communications		**Coatings**	
Visible Damage			

Operational Criticality: **High** Medium **Low**

Construction Materials
Building: Wood, steel and concrete.
Roof:
Shape:
Grade: **On Grade** Partially buried Below grade

Security Sensor switch at exterior doors
Perimeter: 6 ft fence with barbed wire at perimeter

Locks: **Commercial** Residential **Pad lock**

Windows: Bars Steel grating None **No windows**
Alarms: **Remote** On-site None

Surveillance: Cameras Motion detection

Ladder security:

Overall Condition: Poor Fair Good Excellent

Additional Notes:

Typical pressure switch at all doors. Signals intrusion alarm at SCADA if a switch is not activated within 60 seconds.

Per service record, generator was load tested twice in 2011.

System has been offline for a number of years.

The pump is in a separate building than the sand filter, chemical system and generator.

Obsolete conditioning instrument

WELL NO. 8 LOCATION

PERIMETER FENCING

FILTER, GENERATOR & CHEM FEED BUJILDING

WELL NO. 8 PUMPHOUSE

CHEMICAL FEED ROOM

CHEMICAL FEED ROOM ENTRY

GENERATOR

TANK

SAND FILTER AND BACKWASH

WELL NO. 8 PUMP

OBSOLETE INSTRUMENT

CONTROLS

2021 Water System Master Plan

Appendix C. Well 8 Rehabilitation Memorandums

Water Solutions, Inc.

TECHNICAL MEMORANDUM

Evaluation of Current Conditions in Milwaukie Well 8

To: Peter Passarelli / Public Works Director, City of Milwaukie

From: Matt Kohlbecker, RG / Supervising Hydrogeologist, GSI Water Solutions, Inc.
Chris Wick / Consulting Hydrogeologist, GSI Water Solutions, Inc.

Date: September 1, 2021

1. Introduction

This technical memorandum (TM) summarizes the results of the City of Milwaukie (City) Water Supply Well 8 evaluation by GSI Water Solutions, Inc. (GSI), and provides conclusions and recommendations based on the review of previous well assessments and evaluations performed by GSI and others, as well as assessing existing conditions in the well based on the results of recent water quality sampling completed by GSI in April 2021.

We understand that the City's existing Well 8 (CLAC 64690), which was drilled in 2008 as a replacement well to the former (now decommissioned) Well 8 (CLAC 3990 and CLAC 64268), has experienced a decline in production from approximately 800 gallons per minute (gpm) at the time of construction to 300 gpm in 2013 when performance testing was last conducted an the well; the current pumping capacity of Well 8 is not known. Based on biological assessment of the former Well 8 in 2013, loss in production is likely related to biofouling of the well screens from populations of iron-related bacteria in the wellbore (GSI 2013). Although former Well 8 was unsuccessfully rehabilitated as a result of similarly noted declines, we understand that replacement Well 8 has never been rehabilitated since its construction in 2008. The City is currently reevaluating and considering whether to rehabilitate Well 8, and would like to understand the costs and benefits associated with well rehabilitation (coupled with development of an ongoing well maintenance program) versus drilling a new well at an alternative site.

2. Background Well Information

This section provides background information about former Well 8 (Subsection 2.1) and existing Well 8 (Subsection 2.2).

2.1 Former Well 8

In 1985, the City drilled a water supply (CLAC 3990) referred to as Well 8 (hereafter denoted as "former Well 8") to a total depth of 480 feet below ground surface (bgs); this well was perforated and completed within sediments of the Troutdale Gravel Aquifer. Former Well 8 originally produced 725 gpm[1] and had a reported specific capacity[2] of 4.4 gallons per minute per foot of water level drawdown (gpm/ft ddn). By 2005, production rates in former Well 8 had reportedly declined to approximately 350 gpm, with a specific capacity

[1] Based on a 24 hour pumping test documented on the well log for CLAC 3990.

[2] Well performance is typically evaluated by estimating a wells specific capacity using well yield and drawdown observed during pumping. Specific capacity is defined as the amount production or yield (i.e. pumping rate) per foot of water level drawdown, or gpm/ft ddn.

of 1.8 gpm/ft ddn (an approximately 60% decline in the well's original specific capacity). The cause of decline in the well's production capacity was determined to be a result of plugging (or biofouling) of the well screen apparently related to iron-related bacteria issues (PGG 2005). One potential contributor to biofouling at the well noted by a previous evaluation appears to be related to use of water from a Clackamas River Water (CRW) distribution line on Lake Road to provide pre-lube fluid for the pump in former Well 8 when it was not in operation. It has been suggested that introduction of oxygenated surface water from the CRW line may have created aerobic conditions in the well that contributed to the growth of iron-related bacteria (PGG 2005).

The City completed limited physical well rehabilitation of former Well 8 in an attempt to regain some of the well's reduced capacity, including water jetting in 1995 and sonar jetting in 2001. Unfortunately, these rehabilitation efforts did not improve the well's pumping capacity. Casing misalignment issues prevented rehabilitation tools and equipment from being employed within the well and well screen areas to remove debris that accumulated during previous well rehabilitations (PGG 2005). We also understand that well site access may have limited the feasibility of staging certain rigs and equipment over the well, and thus other rehabilitation methods such as mechanical surging were not recommended by previous consultants. Chemical rehabilitation was not performed during either of the reported rehabilitation efforts. Former Well 8 was permanently decommissioned in 2007 (CLAC 64268). Copies of the former Well 8 water well construction (i.e., well log) and abandonment reports are included in Attachment A.

2.2 Existing (Replacement) Well 8

In 2008, a new well (CLAC 64690 – hereafter referred to as "Well 8") was drilled as a replacement water-supply well for former Well 8. Well 8 is located approximately 150 east of former Well 8. Well 8 is drilled to total depth of 465 ft bgs and is screened within the same Troutdale Gravel Aquifer deposits in which former Well 8 was screened. A copy of the well log for Well 8 is included in Attachment A.

Well 8 had an original, post-construction pumping rate of 800 gpm[3] in 2008; the specific capacity was reported to be 4.9 gpm/ft ddn (which was approximately 10% higher than former Well 8 when constructed). Similar to the original well, Well 8 has reported well alignment issues. Based on alignment test data in the 2008 PGG report, Well 8 has a total deviation of about 10 inches at a depth of 200 ft (approximately 5 inches per 100 feet in well depth). However, the deviation predominantly occurs between 100 and 200 ft bgs. Below a depth of 200 ft bgs, the well deviation cannot be evaluated, as the plumb bob used to perform well alignment testing was reportedly rubbing the side of the casing (PGG 2008). Based on concerns from well misalignment and the biofouling potential from use of CRW surface water for pump pre-lube, the City elected to proceed with a submersible pump at Well 8.

A decline in production capacity between 2008 and 2013 and speculation of iron-related bacteria issues in the well prompted the City to proceed with an assessment by GSI to evaluate Well 8 in 2013; a copy of the 2013 GSI Technical Memorandum is included in Attachment B. This work included a performance test of the well and collection of water samples, including a "casing" sample from within the well casing and an "aquifer" sample from the water-bearing zone around the well that were analyzed for geochemical and bacterial assessment. Performance testing indicated short-term pumping capacity of Well 8 had declined to a rate of 300 gpm[4] with a specific capacity of 1.7 gpm/ft ddn (representing a decline in specific capacity of roughly 65% since the well was drilled in 2008). The bacterial assessment concluded that the presence of oxidizing organisms (*Gallionella*) and resulting iron oxide biofilm (biofouling) are likely the cause of loss of production and specific capacity in the well due to biofouling of the screens (GSI 2013).

As a result of the 2013 evaluation, GSI recommended a comprehensive mechanical and chemical rehabilitation program in Well 8 in an attempt to treat and remove biofouling from the well screens (GSI

[3] Based on a 24 hour pumping test documented on the well log for CLAC 64690.
[4] Based on a 2.25-hour pumping test documented in GSI's Technical Memorandum "Evaluation of City of Milwaukie Water Supply Well No. 8," 2013.

2013). In 2013, GSI met with the City to discuss the costs of well rehabilitation, the unlikeness to regain all lost well performance, and the need for on-going maintenance and rehabilitation efforts to continue use of Well 8. After these discussions, the City elected to forego options to rehabilitate Well 8 and use resources to perform studies for new well locations. To our knowledge, there have been no down-well video surveys performed in Well 8 and/or any types of mechanical or chemical redevelopment efforts performed in the well since its construction in 2008.

Well 8 was a primary source of water supply for the City since water treatment procedures for the well were minimal compared to the other existing City wells. When operational, Well 8 was reportedly pumped on a near continuous basis (daily) throughout the year. However, we understand that Well 8 has only been sporadically operated for short-term pumping intervals over the last several years. Opportunities for microorganism growth and biofouling can be exacerbated when wells are operated infrequently, which has potentially causing further plugging issues with the well screens in Well 8.

3. Well 8 Evaluation

This section summarizes GSI's review of previous evaluations and assessments performed on Well 8, including review of water quality results from sampling performed by GSI in 2013 and collection of water samples during the summer of 2021. The purpose of water quality sampling is to evaluate the nature of the clogging material (biofouling or precipitation of mineral scale) and/or the degree of biological activity.

On April 21, 2021, Well 8 was pumped for 70 minutes to collect water samples for a bacteriological profile and geochemical assessment. Pumping rates could not be monitored or recorded during sampling because there was no flowmeter installed at the wellhead. Thus, GSI could not evaluate current pumping rate and specific capacity of the well. Water levels were measured by GSI while pumping and sampling occurred. During the 70-minute pumping period water levels declined from 48 ft to 154 ft. Two samples were collected for the bacteriological profile and geochemical assessment and submitted to Water Systems Engineering (WSE) for analysis: (1) an initial sample of stagnate water within the well casing as the pump was started, and (2) a sample collected after pumping for 70 minutes that is representative of the aquifer. Results of the geochemical assessment are summarized in Subsection 3.1, and results of the bacteriological profile are summarized in Subsection 3.2. A copy of the lab report from WSE is included in Attachment C.

3.1 Geochemical Assessment

All analytes from the aquifer samples in 2013 and 2021 were within regulatory limits for drinking water. The following bullets summarize an analysis of the analytes that are used to evaluate potential causes of well clogging:

- **Iron.** Elevated iron (0.36 milligrams per liter, mg/L) was found in the casing sample in 2021, which is consistent with the results from the 2013 assessment (0.95 mg/L), and is likely related to elevated bacteriological activity.
- **Oxidation Reduction Potential (ORP) and Langelier Saturation Index (LSI).** ORP and LSI values were found to be similar in both the 2013 and 2021 samples. Negative LSI values for the casing and aquifer samples, as shown on Table 1, indicate an environment undersaturated in scale-forming minerals, suggesting a low potential for well clogging by mineral scale development. The high positive ORP values suggest an environment conducive to precipitation of metallic oxides (which is consistent with a biofouling mechanism).
- **Phosphate and Silica.** Phosphate and silica concentrations were elevated in Well 8. Elevated concentrations of phosphate, which is another known nutrient source for bacteria, and silica can be indicative of migration of formation materials or an indication of insufficient development efforts when the well was originally constructed, possibly contributing to the decline in well production.

Overall, the iron, ORP, LSI, phosphate and silica results are consistent with biofouling as a mechanism of performance reduction at Well 8.

3.2 Bacteriological Profile

Overall, WSE's interpretations of the 2021 bacteriological profile and well conditions have not shown significant changes from their 2013 analysis of the water quality data from Well 8. Results from 2021 indicated high visible bacterial activity in the casing sample, but low activity in the aquifer sample at the time of sampling. WSE's microscopic evaluation of the casing sample identified very low crystalline debris[5], very low number of protozoa, very low plant particulate matter, moderate iron oxide, moderate iron entrained biomass[6], and a moderate number of *Gallionella*.

Both the 2013 and 2021 bacterial assessments measured ATP, which is a component of cellular material often used to approximate the total bacterial population present. As shown in Table 2, the concentration of ATP in the 2021 casing sample (172,000 cells per milliliter) is significantly less in the casing sample that was collected in 2013 (1,100,000 cells per milliliter). The reduced ATP count in the 2021 sample (relative to 2013) may reflect the recent inactivity of Well 8 and a corresponding reduction in bacterial populations. Note that active potable water wells typically exhibit ATP values between 10,000 and 70,000 cells per milliliter for an active well sample, with values in excess of 100,000 cells per ml generally indicating biofouling.

The dominant organism identified in the April 2021 WSE bacterial assessments were the species of *Gallionella*. *Gallionella* are naturally occurring, iron-oxidizing bacteria that have been identified in a variety of different aquatic habitats, including groundwater. *Gallionella* are a generally aerobic group of bacteria that utilize iron and manganese as an energy source and secrete an iron-oxy-hydroxide byproduct commonly found in soils and shallow groundwater environments. *Gallionella*'s iron-oxy-hydroxide secretion is often a contributing factor to decreased well performance due to biofouling as it effectively plugs openings in the screen/liner assembly and formation adjacent to the wall. High levels of *Gallionella* can cause damage to iron-bearing well components and pit the metal in an effort to secure iron necessary for energy, referred to as "microbially-induced corrosion", or MIC. *Gallionella* was also identified in the casing sample collected in 2013, along with *Microbacterium saperdae* and *Curtobacterium pussilum*. Low numbers of protozoa, which are often associated with surface water bodies, were also present in the casing sample from April 2021. The presence of protozoa and plant material within the samples may indicate a possible breach in the upper well seal or some degree of connectivity to surface water influence, which may require further investigation into possible sources.

This bacteriological assessment concluded that oxidation of iron and the natural corrosive tendencies at the site, from either chemical or biological activity driven processes, is occurring within the well. Any biomass and iron-related bacteria present in Well 8 becomes a catalyst for continued iron oxide accumulation and further increases the degree of plugging of the well screens.

4. Conclusions

The results of the current Well 8 evaluation are consistent with prior observations of the well and that of former Well 8. Well 8 has experienced a significant decline in well performance (a decline in pumping rates and specific capacity of roughly 65% since it was constructed) likely impacted by biofouling and encrustation in the well screens by iron-related bacteria. The presence of *Gallionella* within the well casing creates conditions favorable for biofouling, and could make the casing, well screens, or metal pump components susceptible to corrosion. Similar trends and declines in pumping rates and specific capacity due to biofouling were observed in former Well 8 before it was decommissioned in 2005. Biofouling of former Well 8 was speculated to be related to the use of surface water for pre-lube operations with the line-shaft pump installed.

[5] Very fine mineral fragments; the presence and amount are used as an indicator of potential mechanical plugging.

[6] The presence and amount of biomass are used as an indicator of biological fouling.

However, when replacement Well 8 was constructed in 2008 and equipped with a submersible pump, which did not use a pre-lube system, similar biofouling issues occurred in the well.

Although a definitive source of contributions to bacterial growths are uncertain, biofouling appears to be persistent in wells in this area, as observed in both the former well and the replacement well. Biofouling is fairly common for wells constructed in shallow alluvial aquifers. GSI has observed similar issues in water supply wells constructed in similar geologic materials within the Troutdale Gravel Aquifer sediments and other alluvial aquifers within the Portland Basin.

Proper well operation and maintenance procedures, including well rehabilitation, are common practices to potentially reduce the rate of biofouling, extend the useful life of a water well, and reduce long-term pumping costs. An annual or biannual well maintenance program usually costs between 10%-20% of the cost required for a full scale (comprehensive) rehabilitation program, but a typical comprehensive well rehabilitation can cost up to 20%-30% of the cost for a new replacement well with the same size and depth (Butts, 2017). In general, a well should be rehabilitated if the specific capacity declines more than 15%-20% from its previous condition, and alluvial wells, such as Well 8, are recommended to be redeveloped every to 2 to 5 years to remove fine sediment and biofouling that tend to plug the screen and filter pack over time. Previous rehabilitation efforts in former Well 8, including water jetting in 1995 and sonar jetting in 2001, were not successful in helping to restore or improve pumping rates in the well. These physical rehabilitation efforts in the former well were performed roughly 10 years and 16 years after the well was constructed, respectively. However, the effectiveness of well rehabilitation in former Well 8 may have been compromised by the casing alignment and access issues, limiting the types of tools that could be used for redevelopment. In existing Well 8, well redevelopment efforts (via mechanical and/or chemical methods) have never been performed since the well was constructed in 2008. We also do not know the extent of screen plugging due to the lack of an available video survey [i.e., the interval(s) of the screen that are plugged]. Although there does not appear to be any access issues for placing a pumping rig over Well 8, it is unknown if the reported alignment issues in Well 8 will limit the types of tools and equipment that can be used to effectively redevelop the well casing and screens.

5. Recommendations and Costs

The following section provides recommendations and planning-level cost estimates to help the City evaluate options for recovering the lost yield at Well 8. These recommendations are based on our evaluation of Well 8 and assessment of the recent WSE water quality analysis, as well as review of previous evaluations and the reported history of well rehabilitation activities.

5.1 Well Rehabilitation or Replacement

The City's options for recovering the lost yield at Well 8 are to: (1) rehabilitate the existing well or (2) replace the existing well with a new well. The following sections provide a discussion and planning-level costs for each option. A cost comparison for each option is presented in Table 3. Planning-level costs are based on informal solicitations of cost estimates from contractors and our review of recent contractor bids for similar well rehabilitation projects.

Table 3. Summary of Planning-Level Cost Estimates for Well Rehabilitation and Replacement.

Description	Contractor Costs	Consulting Costs
Well Rehabilitation	$200,000 [7]	$50,000 to $60,000 [7]
Well Replacement	$900,000[8]	$100,000

[7] Includes Phase I through Phase III in the "Well Rehabilitation" discussion.

[8] Total costs for a new well could be on the order of $2,000,000 when including well siting assessments, property acquisition, final well equipping, and well site infrastructure.

Well Rehabilitation

Well rehabilitation involves removing clogging material from the well screen, filter pack, and/or aquifer using mechanical methods (e.g., brushing the screen with a nylon wire brush) and/or chemical methods (e.g., acidification of water in the well). Based on the results of physical redevelopment efforts in former Well 8 and the observed reduction in specific capacity in Well 8, it appears unlikely that rehabilitation would restore Well 8 to its original, post-construction pumping capacity.

Contractor costs for a comprehensive well rehabilitation can involve a one-time investment of **$200,000.** Consulting fees to develop technical specifications for well rehabilitation and provide contractor rehabilitation oversight are estimated to be on the order of **$50,000** to **$60,000.** Because biofouling has occurred in the past at Well 8, the City should also plan on implementing the maintenance program discussed in Subsection 5.2 to preserve well performance (each maintenance event involves a cost of **$50,000** in contractor costs and **$15,000** in consulting fees).

A three-phase approached to a comprehensive well rehabilitation could be implemented and would first investigate the existing well performance, existing casing condition and the feasibility and types of tools that can be used for well rehabilitation before investing heavily in a full-scale chemical and mechanical redevelopment program. Initial procedures to investigate the well conditions would include:

- **Phase I ($60,000).** Mobilize equipment to the site, and remove the pump to perform a down-well video survey to evaluate clogging extend and feasibility of using a brush and impulse generation to remove clogging material (from the perspectives of tooling access and well integrity). This phase also includes the costs to re-install the pump and disinfect the well.
- **Phase II ($80,000).** Depending on the results of the video, using a nylon brush and impulse generation to remove some of the surficial biofouling from the well casing and screens.
- **Phase III ($60,000).** Perform chemical treatment to help further remove some of the biological encrustation and coatings on the well casing and screen, and in the filter pack and aquifer outside of the well. Chemical treatment has never been performed on a City of Milwaukie well, and there may be value in attempting rehabilitation on Well 8 using chemical treatment methods to help to regain some lost production and extend the useful life of Well 8.

These planning-level costs for well rehabilitation assume the activities are performed by the pumping contractor and that costs for a new pump, pump appurtenances, and/or column pipe are not included. A generalized scope of work for a comprehensive well rehabilitation program is included in Attachment D.

Well Replacement

If well rehabilitations efforts, as described above, prove unsuccessful, or the City determines that rehabilitation of Well 8 is not cost-beneficial, and the City is in need of a reliable water-supply source to meet water demands then they should consider and plan to drill a new well at an alternative site. The estimated planning-level cost for a drilling contractor to drill, construct, and test a new water supply well at an alternative site is estimated to be on the order of **$900,000**, based on previous estimates for existing Milwaukie Well 2R, as well as review of recent contractor bids for similar well construction projects. Not included are additional costs for well siting assessments, property acquisition, final well equipping, and well site infrastructure that could increase the cost to **$2,000,000** (the approximate cost of existing Well 2R) or more. Consulting fees to develop technical specifications and construction oversight for a new replacement well are estimated to be **$100,000**. Contractor costs for future well rehabilitation and costs for on-going well operation and maintenance should always be factored when considering a cost for a new well.

Given the high costs to site and construct a new replacement well, and the City's desire to continue to use Well 8, attempting to rehabilitate Well 8 now via mechanical and chemical treatment methods could potentially regain some of the lost production capacity and extend the useful life of the well until a replacement well is needed.

5.2 Well Performance Monitoring and Routine Maintenance

For all City wells, we recommend regular monitoring of well performance. Well performance monitoring tasks generally include:

- On-going monitoring of water levels and pumping rates during well operation for early detection of well performance declines.
- Annual performance testing at the same time each year, involving:
  - Leaving the well idle for 12 hours,
  - Pumping the well for 4 hours and recording of flow and water level. Each year, it is important to use the same flow rate for the performance testing.
  - Analyzing the data to calculate specific capacity and determine if well rehabilitation is necessary.
- Annual water quality sampling (bacterial analysis). *Note that no additional water quality sampling is needed at Well 8 until it is returned to operation.*
- Documentation of operations and maintenance procedures performed

Depending on the results of well performance monitoring, routine maintenance may be necessary. The frequency of routine well maintenance can be evaluated based on the pumping data and bacterial analyses collected from the wells over time. If a significant decline in specific capacity is observed (20% or greater) during well performance monitoring, it is recommended that routine well maintenance be performed to reduce the potential for biofouling, well capacity declines, and to prolong the life of the well. The cost for routine well maintenance is on the order of $50,000 in contractor costs and $15,000 in consulting costs, and typically involves the minimum following tasks:

- Pump removal
- Well video survey
- Brushing and/or bailing of material from the bottom of the well
- Pump re-installation and post-rehabilitation well performance testing

Other options for routine well maintenance include: (1) annual carbon dioxide injections to freeze the well water and dislodge well-clogging materials, (2) replacement of well gases with an inert gas such as nitrogen to create a geochemical environment without the elements needed to thrive, and (3) installation of a chlorine drip system in the well. Application of these options in the Pacific Northwest is relatively rare, and the City should fully evaluate the options before implementing them. Additional costs would incur for the repair and/or replacement of any down-well equipment (pump, motor, etc.) at the recommendation of the pumping contractor.

References

Butts, 2017. Well and Pump Rehabilitation by Ed Butts, April 23, 2017. Water Well Journal. https://waterwelljournal.com/well-pump-rehabilitation-4/

GSI 2013. Draft Evaluation of City of Milwaukie Water Supply Well No. 8. Prepared by GSI Water Solutions, Inc., July 17, 2013.

PGG 2005. City of Milwaukie Well 8 Well Assessment. Prepared by Pacific Groundwater Group, December 2005.

PGG 2008. Well Construction and Testing Report, Production Well 8, City of Milwaukie, Oregon. Prepared by Pacific Groundwater Group, July 2008.

Table 1: Comparison of Milwaukie Well 8 Geochemical Properties

Analyte	Unit	Regulatory Criteria	Regulatory Standard	Well 8 6/12/2013		Well 8 4/21/2021	
				Casing	Aquifer	Casing	Aquifer
Alkalinity, as CaCO3	mg/l	SMCL	250	88	88	100	96
Phenolphthalein Alkalinity, as CaCO3	mg/L	--	--	ND	ND	4	ND
Carbonate (CO3)	mg/l	URC	--	72	68	8	ND
Total Hardness, as CaCO3	mg/l	SMCL	250	72	68	68	68
Bicarbonate (HCO3)	mg/l	--	--	88	88	92	96
Calcium	mg/l	--	--	36	36	28	32
Chloride	mg/l	SMCL	250	9.2	8.8	4	4
Chlorine	mg/l	--	--	ND	ND	ND	ND
Copper	mg/L	--	--	ND	ND	ND	ND
Potassium	mg/l	--	--	2.9	2.8	2.3	2
Phosphate	mg/L	--	--	1.13	0.65	--	--
Phosphorus, Reactive as PO4	mg/L	--	--	NA	NA	0.65	0.42
Magnesium	mg/l	--	--	36	32	40	36
Manganese	mg/l	SMCL	0.05	ND	ND	ND	ND
Iron Total	mg/l	SMCL	0.3	**0.95**	0.06	**0.36**	0.16
Iron Dissolved	mg/l	--	--	ND	ND	ND	ND
Suspended Iron		--	--	0.95	0.06	0.36	0.36
Iron Resuspended	mg/l	--	--	1.22	0.1	1.62	0.19
Sodium	mg/l	URC (advisory)	20	5.36	5.15	5.29	5.13
Nitrate as N	mg/l	MML	10	ND	ND	ND	ND
Silica	mg/l	--	--	42.1	43.8	34.2	42.4
Sulfate	mg/l	URC, SMCL	250	ND	ND	ND	4
Sulfide	mg/L	--	--	ND	ND	--	--
Tannin/Lignin		--	--	ND	ND	ND	ND
Total Dissolved Solids	mg/l	SMCL	500	138	128	115	115
Total Organic Carbon	mg/l	--	--	1.2	1.9	ND	ND
pH	Units	--	6 - 8.5	6.89	7.61	7.94	7.81
Conductivity	umho/cm	--	--	192	178	159.9	160
ORP	mV	--	--	188	188	250.8	252.5
Langalier Saturation Index	mg/L	Non-Corrosive	Non-Corrosive	**-2.01**	**-1.29**	**-0.68**	**-0.77**
Field pH	Units	--	--	ND	ND	7.29	7.71
Field Temperature	Celsius	--	--	--	--	12.85	12.94
Field Specific Conductance	umho/cm	--	--	--	--	166	ND
Field Dissolved Oxygen	mg/l	--	--	--	--	3.86	4.59
Field Dissolved Oxygen	%	--	--	--	--	36.6	43.5
Field ORP	mV	--	--	--	--	-30.9	76.1
Field Eh	mV	--	--	--	--	--	--

Note: Lab reports by Water Systems Engineeering Inc. included in Attachment C
Analytical data shown in **bold red** exceed the regulatory standard
ND = not detected
NT = not tested
SMCL = Secondary Maximum Contaminant Levels -- Federal Regulations
MCL = Maximum Contaminant Levels -- Federal Regulations
MML = Maximum Measurable Level -- Oregon Department of Environmental Quality
URC = Oregon Health Division Unregulated Contaminants
mg/l = milligrams per liter
umhos/cm = micromhos per centimeter
Celsius (C = 5/9 (F - 32))

Table 2: Biological Analysis of Casing and Aquifer Water Samples from Milwauke Well 8

Analyte	6/12/2013		4/21/2021	
	Casing	Formation	Casing	Formation
Plate Count (colonies/ml)	38	No growth	0	2
Anaerobic Growth (%)	<10	<10	<10	<10
Sulfate Reducing Bacteria	Negative	Negative	Negative	Negative
Fe/Mn Oxidizing Bacteria	Positive	Negative	Positive	Negative
ATP (cells per ml) Initial	1.1 Million	34,000	172,000	48,000
ATP (cells per ml) 24 Hour	745,000	122,000	90,000	16,000
Bacterial Identification	*Gallionella*	*No ID possible*	*Gallionella*	*Gallionella*
Bacterial Identification	*Microbacterium saperdae*	--	--	--
Bacterial Identification	*Curtobacterium pusillum*	--	--	--
Bacterial Identification	--	--	--	--

Note: Lab reports from Water Systems Engineering included in Attachment C

ATTACHMENT A

Water Well Reports

STATE OF OREGON

WATER WELL REPORT
(as required by ORS 537.765)

RECEIVED CLAC
OCT 17 1985
WATER RESOURCES DEPT
SALEM, OREGON

PLEASE TYPE or PRINT IN INK

CLAC 03950

25/2E-6aa

(for official use only)

(1) OWNER:
Name CITY OF MILWAUKIE
Address 10722 SE MAIN ST.
City MILWAUKIE State ORE 9722

(2) TYPE OF WORK (check): WELL NO 8
New Well [X] Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary Air ☐ Driven ☐
Rotary Mud ☐ Dug ☐
[X] Bored ☐

(4) PROPOSED USE (check):
Domestic ☐ Industrial ☐ Municipal [X]
Irrigation ☐ Thermal: Withdrawal ☐ Reinjection ☐
Other: Piezometric ☐ Grounding ☐ Test ☐

(5) CASING INSTALLED: Steel [X] Plastic ☐ Threaded ☐ Welded [X]
16" Diam. from +2 ft. to 350 ft. Gauge .375
10" Diam. from 322 ft. to 350 ft. Gauge .365
~~LINER INSTALLED:~~ Steel ☐ Plastic ☐ Threaded ☐ Welded ☐
10" 390 FT TO 430 .365
10" Diam. from 470 ft. to 480 ft. Gauge .365

(6) PERFORATIONS: Perforated? ☐ Yes [X] No
Size of perforations ______ in. by ______ in.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.

(7) SCREENS: Well screen installed? [X] Yes ☐ No
Manufacturer's Name UOP JOHNSON
Type STAINLESS STEEL Model No. ______
Diam. 10 Slot Size 40 Set from 350 ft. to 390 ft.
Diam. 10 Slot Size 40 Set from 430 ft. to 470 ft.

(8) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? [X] Yes ☐ No If yes, by whom? STRASSER
Yield: 725 gal./min. with 165 ft. drawdown after 24 hrs.
Air test ______ gal./min. with drill stem at ______ ft. ______ hrs.
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Artesian flow ______ g.p.m.
Temperature of water 54.5 Depth artesian flow encountered ______ ft.

(9) CONSTRUCTION: Special standards: Yes ☐ No [X]
Well seal—Material used CEMENT GROUT
Well sealed from land surface to 21' AND 73-85 ft.
Diameter of well bore to bottom of seal 24 AND 20 in.
Diameter of well bore below seal 16 in.
Amount of sealing material 90 sacks [X] pounds ☐
How was cement grout placed? GROUT WAS PUMPED IN FROM THE BOTTOM UP AS THE TEMPORARY CASING WAS REMOVED
Was pump installed? ______ Type ______ HP ______ Depth ______ ft.
Was a drive shoe used? [X] Yes ☐ No Plugs ______ Size: location ______ ft.
Did any strata contain unusable water? ☐ Yes [X] No
Type of Water? ______ depth of strata ______
Method of sealing strata off ______
Was well gravel packed? [X] Yes No Size of gravel: NO 8 SAND
Gravel placed from 325 ft. to 480 ft.

(10) LOCATION OF WELL by legal description:
County CLACKAMAS NE ¼ NE ¼ of Section 6 of
Township T2S (Township is North or South), Range 2E (Range is East or West) WM.
Tax Lot ______ Lot ______ Block ______ Subdivision ______
MAILING ADDRESS OF WELL (or nearest address) ______

(11) WATER LEVEL of COMPLETED WELL:
Depth at which water was first found 208 ft.
Static level 49 ft. below land surface. Date 9/26/85
Artesian pressure ______ lbs. per square inch. Date ______

(12) WELL LOG: Diameter of well below casing —
Depth drilled 482 ft. Depth of completed well 480 ft.
Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
SEE ATTACHED SHEET			

Date work started JULY 18 1985 completed OCT 8, 1985
Date well drilling machine moved off of well OCT 9, 1985

(unbonded) Water Well Constructor Certification (if applicable):
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] ______ Date ______, 19__

(bonded) Water Well Constructor Certification:
Bond 6373796 (number) Issued by: FIREMANS FUND INS. CO (Surety Company Name)
On behalf of ROBERT L. STRASSER (type or print name of Water Well Constructor)

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
(Signed) Robert L Strasser (Water Well Constructor)
(Dated) OCT. 15, 1985

NOTICE TO WATER WELL CONSTRUCTOR
The original and first copy of this report are to be filed with the

WATER RESOURCES DEPARTMENT,
SALEM, OREGON 97310
within 30 days from the date of well completion.

SP*46656-690

Phone: 771-2355

R. J. Strasser Drilling Co.

8110 S.E. Lindy Ave.
Portland, Oregon 97206

October 12, 1985

Log of City of Milwaukie well #8

brown silty clay	0 - 47
gravel, silt and brown clay	47 - 63
brown silt	63 - 66
brown silt and pea gravel	66 - 74
gravel, sand and grey silt	74 - 81
gravel, sand and brown clay	81 - 94
brown silt and gravel	94 - 132
silt, sand and gravel	132 - 141
brown sandy silt	141 - 156
grey and blue clay	156 - 186
clay and gravel	186 - 210
clay, blue, grey and brown	210 - 243
gravel, sand and clay	243 - 264
black silty gravel	264 - 270
clay and gravel	270 - 275
silty sand and gravel	275 - 282
sand, silt, and gravel	282 - 305
sand and large gravel	305 - 320
sand, silt and gravel	320 - 403
grey black silty sand	403 - 419
grey green silty sand	419 - 423
sand, silt and gravel	423 - 428
sand and gravel	428 - 455
loose sand and gravel	455 - 464
gravel, sand and silt	464 - 479
black rock	479 - 482

CLAC 64268

11-29-2007

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

WELL LABEL # L

START CARD # 194215

(1) LAND OWNER

Owner Well I.D.
First Name Last Name
Company CITY OF MILWAUKIE
Address 10722 SE MAIN ST
City MILWAUKIE State OR Zip 97222

(2) TYPE OF WORK

☐ New Well ☐ Deepening ☐ Conversion ☐ Alteration (repair/recondition) ☒ Abandonment

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger ☐ Cable Mud ☐ Reverse Rotary ☒ Other ABANDONMENT

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community ☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering ☐ Thermal ☐ Injection ☒ Other ABANDONMENT

(5) BORE HOLE CONSTRUCTION

Special Standard ☒ (Attach copy)

Depth of Completed Well 480.00 ft.

BORE HOLE Dia	From	To	SEAL Material	From	To	Amt	sacks/ lbs
20	0	480	Cement	0	480	467	S

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☐ Other
Backfill placed from ft. to ft. Material
Filter pack from ft. to ft. Material Size
Explosives used: ☐ Yes Type Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
◉	○	16	☒	.7	350	.375	◉	○	☒	☐
◉	○	10	☐	350	480	.365	◉	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☐ Outside ☐ Other Location of shoe(s)
Temp casing ☐ Yes Dia From To

(7) PERFORATIONS/SCREENS

Perforations Method Mills Knife
Screens Type Material

Perf/Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Casing	16	21	85	.25	3	448	
Perf	Casing	10	85	324	.25	3	1,673	
Perf	Liner	10	324	350	.25	3	182	

(8) WELL TESTS: Minimum testing time is 1 hour

○ Pump ○ Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Temperature °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below)

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County Clackamas Twp 2.00 S N/S Range 2.00 E E/W WM
Sec 6 NE 1/4 of the NE 1/4 Tax Lot 2200
Tax Map Number Lot
Lat ° ' " or DMS or DD
Long ° ' " or DMS or DD
◉ Street address of well ○ Nearest address

HWY 224 AND SE LAKE RD

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Predeepening			☐	
Completed Well			☐	

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
					☐	
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation

Material	From	To

Date Started 09-26-2007 Completed 10-31-2007

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

License Number 1786 Date 11-29-2007
Electronically Filed
Signed JOSEPH R STALOCH (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

License Number 1523 Date 11-29-2007
Electronically Filed
Signed ROBERT STADELI (E-filed)
Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK

Form Version: 0.89

WATER SUPPLY WELL REPORT - continuation page

CLAC 64268

11-29-2007

WELL I.D. # L ____________

START CARD # 194215

(5) BORE HOLE CONSTRUCTION

BORE HOLE

Dia	From	To

SEAL

Material	From	To	Amt	sacks/ lbs

FILTER PACK

From	To	Material	Size

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd

(7) PERFORATIONS/SCREENS

Perf/Screen	Casing/Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size

(8) WELL TESTS: Minimum testing time is 1 hour

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Water Quality Concerns

From	To	Description	Amount	Units

(10) STATIC WATER LEVEL

Water Bearing Zones

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(11) WELL LOG

Material	From	To

Comments/Remarks

Special Standards include not perforating below 350 ft. due to bends in the 10" casing.

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CLAC 64690

05-14-2008

WELL LABEL # L 89351

START CARD # 194214

(1) LAND OWNER

Owner Well I.D. L89351

First Name ____ Last Name ____

Company CITY OF MILWAUKIE

Address 10722 SE MAIN ST

City MILWAUKIE State OR Zip 97222

(2) TYPE OF WORK

[X] New Well [ ] Deepening [ ] Conversion [ ] Alteration (repair/recondition) [ ] Abandonment

(3) DRILL METHOD

[ ] Rotary Air [ ] Rotary Mud [X] Cable [ ] Auger [ ] Cable Mud [ ] Reverse Rotary [ ] Other

(4) PROPOSED USE

[ ] Domestic [ ] Irrigation [X] Community [ ] Industrial/ Commercial [ ] Livestock [ ] Dewatering [ ] Thermal [ ] Injection [ ] Other

(5) BORE HOLE CONSTRUCTION

Special Standard [X] (Attach copy)

Depth of Completed Well 481.00 ft.

BORE HOLE Dia	From	To
20	0	233.5
16	233.5	481

SEAL Material	From	To	Amt	sacks/ lbs
Cement	0	5	4	S
Bentonite Chips	5	29	78	S
Cement	29	38	133	S
Bentonite Chips	38	49.7	116	S

How was seal placed: Method [ ] A [ ] B [X] C [ ] D [ ] E [ ] Other

Backfill placed from 481 ft. to 465 ft. Material Pea Gravel/Sand

Filter pack from ____ ft. to ____ ft. Material ____ Size ____

Explosives used: [ ] Yes Type ____ Amount ____

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
(•)	( )	16	[X]	1	332	.375	(•)	( )	[X]	[ ]
(•)	( )	16	[ ]	332	476	.375	(•)	( )	[X]	[ ]

Shoe [ ] Inside [ ] Outside [ ] Other Location of shoe(s) ____

Temp casing [ ] Yes Dia ____ From ____ To ____

(7) PERFORATIONS/SCREENS

Perforations Method ____

Screens Type Johnson Material Stainless

Perf/Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Screen	Liner	10	312	328	.04			
Screen	Casing	10	328	382	.04			
Screen	Liner	10	382	393	.04			
Screen	Casing	10	393	416	.04			
Screen	Liner	10	416	432	.04			

(8) WELL TESTS: Minimum testing time is 1 hour

(•) Pump ( ) Bailer ( ) Air ( ) Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
800	142	273	24

Temperature 56 °F Lab analysis [ ] Yes By ____

Water quality concerns? [ ] Yes (describe below)

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County Clackamas Twp 2.00 S N/S Range 2.00 E E/W WM

Sec 6 NE 1/4 of the NE 1/4 Tax Lot 2200

Tax Map Number ____ Lot ____

Lat ____ ° ____ ' ____ " or ____ DMS or DD

Long ____ ° ____ ' ____ " or ____ DMS or DD

( ) Street address of well (•) Nearest address

HWY 224 AND SE LAKE RD

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Predeepening				
Completed Well				

Flowing Artesian? [ ] Dry Hole? [ ]

WATER BEARING ZONES Depth water was first found 61

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(11) WELL LOG

Ground Elevation ____

Material	From	To
Brown Silt	0	12
Brown Gravels, Silts	12	52
Gray Silt Brown Gravels	52	61
Large Cobbles, Gravel	61	101
Brown Silty Sand Cobbles	101	142
Brown Silty Sand, Small Gravels	142	151
Gray Gravely Silt	151	180
Brown Gray Silty Gravels	180	211
Sandy Silt, Organics	211	218
Blue Gray Silty Clay	218	235
Gray Silty Gravels	235	254
Gray Clayey Silt	254	257
Gray Silty Gravels	257	271
Gray Silt	271	276
Gray Silty Gravels, Cobbles	276	304
Clean Sand, Gravel	304	312
Fine Gray-Blk Sand	312	327
Gray Silt w/Gravel	327	329
Clean Sand, Small Gravels	329	349

Date Started 08-15-2007 Completed 04-17-2008

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

License Number 1786 Date 05-14-2008

Electronically Filed

Signed JOSEPH R STALOCH (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

License Number 1523 Date 05-14-2008

Electronically Filed

Signed ROBERT STADELI (E-filed)

Contact Info (optional)

WATER SUPPLY WELL REPORT - continuation page

CLAC 64690

05-14-2008

WELL I.D. # L 89351

START CARD # 194214

(5) BORE HOLE CONSTRUCTION

BORE HOLE

Dia	From	To

SEAL

Material	From	To	Amt	sacks/ lbs
Cement	49.7	229	205	S

FILTER PACK

From	To	Material	Size

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd

(7) PERFORATIONS/SCREENS

Perf/Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Screen	Casing	10	432	460	.04			
Screen	Liner	10	460	465	.04			

(8) WELL TESTS: Minimum testing time is 1 hour

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Water Quality Concerns

From	To	Description	Amount	Units

(10) STATIC WATER LEVEL

Water Bearing Zones

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(11) WELL LOG

Material	From	To
Clean Sand, Large Gravels	349	383
Silty Large Gravels, Cobbles	383	393
Black Sand Gravels, Cobbles	393	401
Fine Gray Sand, Small Gravels	401	411
Brown Sand Silty Gravels	411	418
Gray-Green Silty Sand Gravels	418	427
Large Silty Cobbles	427	432
Brown Sand, Gravel	432	443
Silty Large Cobbles	443	447
Clean Gravel Sand	447	460
Brown Sand, Small Gravels	460	474
Black Rock, Cobbles	474	481

Comments/Remarks

Map of well

Oregon

Theodore R. Kulongoski, Governor

Water Resources Department
North Mall Office Building
725 Summer Street NE, Suite A
Salem, OR 97301-1266
503-986-0900
FAX 503-986-0904

January 3, 2008

BOART LONGYEAR
ROBERT STADELI #1523
19700 SW TETON
TUALATIN OR 97062

FINAL ORDER

Dear Robert:

The Special Standard request you submitted for owner: City of Milwaukie, Start Card number 194214, is hereby approved for the following: You may move your drilling machine off of this well prior to completion of construction for up to 30 days in order to properly design, order and receive your well screen (from January 3, 2008 until February 2, 2008). The well shall be protected from damage and shall be properly covered so that contaminants do not enter the aquifer. Following February 2nd your drilling machine must be returned to the drill site and the well shall be either completed or abandoned per Oregon's minimum well construction standards (See OAR 690-210-0390). All other well construction requirements apply. Your Special Standard request form is enclosed.

The Well Construction Standards serve to protect ground water resources. By approving and issuing this special construction standard the Oregon Water Resources Department is not representing that a well constructed in accordance with this condition will maintain structural integrity or that it meets engineering standards. The well constructor/or landowner is responsible for ensuring that a well is constructed in a manner that protects ground water resources as required under Oregon Administrative Rules 690-200 through 690-240.

If you have any questions concerning this letter, please contact me at (503) 986-0851, or by e-mail at Kristopher.R.Byrd@wrd.state.or.us.

Sincerely,

Kristopher Byrd
Well Construction Program Coordinator
Well Construction and Compliance Section

enclosure

cc: Joel Jeffery, NW Region Well Inspector
File

This is a final order in other than contested case. This order is subject to judicial review under ORS 183.484. Any petition for judicial review must be filed within the 60 day time period specified by ORS 183.484(2). Pursuant to ORS 536.075 and OAR 137-004-0080 you may either petition for judicial review or petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

ATTACHMENT B

2013 GSI Technical Memorandum

GSI Water Solutions, Inc.

DRAFT Technical Memorandum

To: Don Simenson- Water Quality Coordinator, City of Milwaukie

From: Chris Augustine, RG - GSI Water Solutions, Inc

Date: July 17, 2013

Re: **Evaluation of City of Milwaukie Water Supply Well No. 8**

This memorandum presents a summary of the well assessment performed at the City of Milwaukie (City) water supply Well 8 and a targeted well rehabilitation program. The City installed replacement Well No. 8 in 2008 to replace the nearby original well that had experienced significant performance declines due to suspected iron related bacteria biofouling. Since that time, the replacement Well 8 had seen its yield decrease from 700 gpm to 300 gpm, and its well performance decrease by approximately 80 percent. On the basis of available information, iron related bacteria was suspected to be the likely cause for well performance declines observed at the old well 8 and replacement well 8.

GSI was contracted to assess the current well performance, bacterial populations and general water quality at Well No. 8 to determine if "red water" events in the distribution system were attributable to iron related bacteria being present in Well No. 8 mixing with distribution water super saturated with oxygen as a result of the air stripper treatment system. GSI performed the following tasks as part of this evaluation:

- Assess well performance
- Collect a water quality sample for bacterial assessment and chemical analysis from Well No. 8
- Collect a post chlorination distribution water quality sample for bacterial assessment
- Provide a targeted well redevelopment and rehabilitation program for Well No. 8

The results and observations for each task are discussed in detail below.

Well Performance of Well No. 8

Well performance is typically evaluated by estimating a wells specific capacity using well yield and drawdown observed during pumping. The specific capacity of a well is calculated as follows:

Specific Capacity (SC) = Q/s (in gpm/ft of drawdown)

Where:

Q = the yield (or flow rate) in gpm
s = observed drawdown at that flow rate (static water level – pumping water level) in feet.

The specific capacity accounts for both the aquifer hydraulic properties and the frictional losses as water flows into the well through the well screen. The greater the specific capacity the more effective the well is at producing groundwater.

During testing in 2013 the specific capacity of the Well No. 8 was observed to be 1.7 gpm/ft of drawdown at 300 gpm (Table 1). Previously, Well No. 8 was reported to have an operational specific capacity of 4.9 gpm/ft of dd at 885 gpm. Significant decreases in well performance such as those observed at Well No. 8 are generally attributable to four causes:

- Changes in aquifer conditions such as water levels, water quality or nearby pumping by other groundwater users (i.e. well interference).
- Physical plugging of the well due to poor well construction and/or design, inadequate well development or structural damage to the well screen or casing.
- Chemical precipitation or encrustation due to water quality conditions.
- Biological fouling of the well screen by iron-related, slime-forming or sulfate reducing bacteria.

On the basis of available information, it does not appear that aquifer conditions have changed since Well No. 8 was installed. Available drawdown or well interference do not appear to be a limitation for well performance Well No. 8. The City provided GSI with general water quality analyses for Well 8 which did not indicate significant concentrations of scale forming minerals. The installation report for Well 8 indicates that it was developed using standard methods in 2008. However, alluvial wells typically are recommended to be redeveloped every 2 to 5 years to remove fine sediment that may be plugging the filter pack. The previous fouling at the old Well No. 8 and lack of evidence for the other potential causes to decrease well performance suggest biological plugging is likely the main cause for well performance even though visual indications of bacterial populations such as slime buildup or discoloration were not observed on the wellhead and distribution system piping during site visits to Well No. 8, biofouling of the well. The bacterial assessment and water quality sampling was performed to confirm biological populations were present in Well No. 8 and is described in the section below.

Ground Water Quality

This section presents the general field parameters observed during well performance testing and the results for water quality and bacterial assessment samples collected at Well 8.

Field parameters

Field parameters observed during the pumping of Well No. 8 include pH, specific conductance, dissolved oxygen, temperature and oxidation-reduction potential. These data were collected over the approximately 3-hour pumping period using the YSI professional plus multi parameter meter. Field parameters in groundwater were observed during the pumping test at Well No. 8 and are summarized in Table 1.

Initial groundwater quality was observed to be slightly oxidizing and a strong hydrogen sulfide odor was noted at the well head. On the basis of the stabilized field parameter observations the alluvial aquifer has mildly reduced anoxic conditions with a slightly alkaline pH (7.38 to 7.84). Hydrogen sulfide odor was observed to noticeably decrease with increased pumping. Additionally, Well 8 had typical concentrations of dissolved solids (as estimated from specific conductance) for a shallow alluvial aquifer.

Water Quality and Bacterial Assessment Results

A bacterial assessment sample was collected during well performance testing at Well No. 8. The sample was submitted to Water Systems Engineering (WSE) in Ottowa, Kansas. A distribution water quality sample was collected and analyzed using the BART ™ (**B**iological **A**ctivity **R**eaction **T**ests) tester kit suite to qualitatively evaluate the biological load that could potentially be entering the distribution system.

Post Chlorination Bacterial Assessment

A BART™ tester kit suite for treated water was collected after the chlorination contact chamber and prior to entering the distribution system. The BART ™ tester kit was selected because they are economical and can test for specific bacteria types. The test kit consisted of three separate vials with culturing media specific to iron-related bacteria

(IRB), slime-forming bacteria (SLYM) and sulfate reducing bacteria (SRB) test kit. The aggressivity of the specific bacteria is indicated by the time lag (in days) between sample collection and the visual observations of changes in color, cloudiness or gas formation within the vial. Changes in the samples usually occur within the first 3 to 5 days if an aggressive population is present.

After collection of the samples, GSI monitored the test kits for changes in color, cloudiness, and gas production over an eight day period between June 13 and June 20, 2013. Visual changes to color, cloudiness or gas production were not observed in the distribution water samples, suggesting that an aggressive bacterial population was absent. Onsite disinfection of Well 8 groundwater using chlorination appears to effectively control bacteria iron-related bacteria prior to introduction into the distribution system.

WSE Bacterial Assessment

Bacterial assessment samples were collected in Well 8 during the initial start of pumping and again after approximately 1 hour of pumping. The initial sample (designated as "Casing") represents the bacterial population in the well casing, screen and filter pack. The second sample represents bacterial populations further from the well in the water bearing zone (designated as "Aquifer") sample. The bacteriological and water quality results for Well 8 "Casing" and "Aquifer" samples are included in Attachment B.

The following observations are made regarding the bacterial analysis:

- Microscopic evaluation indicated low visible bacterial activity with a moderate bacterial population of *Gallionella* in the "Casing" sample
- Iron and manganese oxidizing bacteria were not present in the "Aquifer"sample.
- Elevated adenosine triphosphate (ATP) values (>100,000) were observed in the initial and in the 24 hour incubation sample for the "Casing"
- Two other aerobic bacteria species common in groundwater were observed in the casing sample.
- Total iron and re-suspended iron (an indicator of biologically mobilized iron) was higher in the "Casing" sample than in the "Aquifer" sample.
- TOC was observed to be 1.2 mg/L and 1.9 mg/L in the casing and aquifer samples respectively, values greater than 1 mg/L can sustain a bacterial population.
- Sulfate reducing bacteria were not present in the Well 8 samples.

The bacterial assessment results confirm that iron related bacteria are likely the main cause of the diminished well performance at Well 8. The observed initial ATP values (approx. 1.1 million cells per ml) indicate a high active biological load in the water in Well No. 8. Typically, ATP values greater than 100,000 cells/ml are of concern for biofouling. The buildup biomass and polysaccharide biofilm in the well screen and filter pack is limiting the flow of water to the well. Although not observed in the water quality samples, the strong hydrogen sulfide odor also suggests the presence of sulfate reducing bacteria. Typically, sulfate reducing bacteria are present when iron related bacteria are present in the well and form tubercles of iron oxide and promote the corrosion of steel and iron equipment and distribution piping surfaces.

On the basis of the observed well performance decreases and the bacterial assessment results for Well No. 8, a comprehensive well redevelopment and rehabilitation program is recommended to improve well performance at Well No. 8. Prolonged operation of Well No. 8 without redevelopment will result in further performance declines and loss of using Well No. 8 as a groundwater supply well.

Proposed Well Redevelopment Program

Based on the advanced decline of Well 8, GSI has developed a stepwise approach to well rehabilitation that includes a combination of mechanical and chemical methods to increase the likelihood of successful rehabilitation Well 8. The proposed program is described below and a generalized bid sheet is included as Attachment C.

The proposed program consists of the following sequenced steps:

1. Remove and inspect column, pump and motor
2. Perform downhole video survey of well to confirm bacterial assessment and pre-rehabilitation conditions in the well.
3. Brush and bail the well screen and casing
4. Perform mechanical redevelopment including surging, swabbing, zonal isolation pumping and fluid impulse generation/induced resonance redevelopment
5. Specific capacity testing of the well for comparison to pre-mechanical development.
6. Perform downhole video survey of well
7. Assess if the well needs chemical treatment to further improve performance
8. Chemical treatment of the well (includes treatment of well, recovery and disposal of spent chemicals)

9. Specific capacity test of the well to determine effectiveness of chemical treatment.
10. Perform post-rehabilitation downhole video survey of well to confirm post-rehabilitation downhole conditions of casing and screen.
11. Reinstall pump, column and motor and additional 2 –inch access pipe for future preventative maintenance work.
12. Disinfection/super-chlorination of pump, column, motor and well

The proposed approach may need to be refined based on observations during the initial assessment and/or during the initial well video survey. At a minimum GSI recommends the City perform steps 1 through 7 and steps 11 and 12 as part of a mechanical redevelopment. Step 12 includes installation of additional access to the well to allow downhole video surveys of the well and fluid impulse generation redevelopment without removing the pump during future preventative maintenance events. Depending on the wells response to mechanical redevelopment, the City may want to consider the additional steps of 8 through 10. A brief description of the mechanical redevelopment and the recommended chemical treatment approach is described below.

Mechanical Redevelopment

Mechanical redevelopment includes brushing, surging, zonal isolation pumping and fluid impulse generation methods to physically remove encrustation and biofilm from the well screen, filter pack and alluvial aquifer near the well. In our experience the methods that are most effective are those that introduce the concentrated energy out into the formations through the screen and also remove dislodged sediment and encrustation out of the well simultaneously, such as zonal isolation pumping with fluid impulse generation. The zonal isolation tool screen area should be designed to promote screen entrance velocities. The removal of the near-well material will enhance the chemical treatment, which is designed to remove encrustation and deposits further away from the well screen in heavily biofouled wells.

Mechanical development should be performed until improvement of well performance and sediment load in the discharge indicate that further mechanical development is not warranted or will not enhance the chemical treatment. Short duration specific capacity tests should be used to evaluate well performance. A video of the well is performed to confirm effectiveness of the redevelopment and confirm that damage to the screen and casing did not occur during redevelopment.

Chemical Treatment

Depending on the results of the mechanical redevelopment, the City may consider chemical treatment using a strong inorganic acid such as hydrochloric acid to treat the well. The purpose of introducing the acid into the well is to dissolve iron hydroxide deposits formed by bacteria present in the well and aquifer and disrupt the biomass. The chemical treatment should also include polymer dispersants and chelating agents to enhance material removal and corrosion inhibitors to protect the well casing and screen. Phosphoric or organic acids (such as glycolic or hydroacetacetic acid) are not recommended because of the potential for residual chemical breakdown products to provide potential nutrients for the resident bacteria, which could enhance bacterial regrowth.

The chemical treatment should be mixed at the surface with potable water in an appropriately sized storage vessel. The initial chemical concentrations introduced into the borehole should be sufficient to treat approximately 1.5 times the standing well volume and reduce the pH to below 3 SU. It is critical to maintain the pH below 3 during the chemical treatment to prevent precipitation of dissolved iron and manganese oxides and iron hydroxides.

On the basis of the reported well construction at Well 8, the recommends a chemical treatment consisting of the following concentrations of acid and dispersants:

- 6 percent hydrochloric acid
- 1.5 percent polymer dispersant with corrosion inhibitor

The actual volumes of hydrochloric acid will depend on the blend of hydrochloric acid (percent active). If a proprietary blend of hydrochloric acid is used (such as Baroid's Aqua-Clear®) than the manufacturer's instructions should be followed to match the recommended treatment volumes. The chemical treatment should be tremied into the well and evenly distributed in the standing water column and worked into the screen sections evenly. The distribution of the chemical may be modified depending on observations of biofilm concentration during the video survey and response to mechanical redevelopment.

Once the chemical treatment is introduced into the well, it will be agitated by surging and allowed a maximum 24 hour contact time. It should be agitated again using the fluid impulse generation tool after the 24 hour contact time. The chemical treatment should then be pumped out and neutralized using appropriate volumes of soda ash or magnesium hydroxide slurry prior to disposal to a sanitary sewer. Pumping of the well will continue until the pH of the discharge is approximately equal to the original pH of the groundwater prior to treatment. In GSI's experience requires pumping 20 to 40 standing well volumes (or more). An appropriately sized pump, temporary piping and storage vessel (such as a Baker Tank) to neutralize the spent chemicals and allow sediment to be removed is recommended prior to disposal in the sanitary sewer.

A final disinfection of the well with sodium hypochlorite mixture with a concentration of up to 250 ppm is performed after the pump, motor and column is reinstalled in the well. Calcium hypochlorite is not allowed as a disinfectant due to potential precipitation of calcium carbonate in the well. GSI also recommends that a larger diameter access pipe be installed, if sufficient annular space is present and the well and pump alignment are sufficient. The access pipe would allow periodic video surveying of the well and performing periodic redevelopment using Hydropulse™ or a similar fluid -impulse generation tool.

Table 1. Field Observations and Water Quality Field Parameters at Well No. 8
City of Milwaukie Well No. 8 Evaluation, 2013

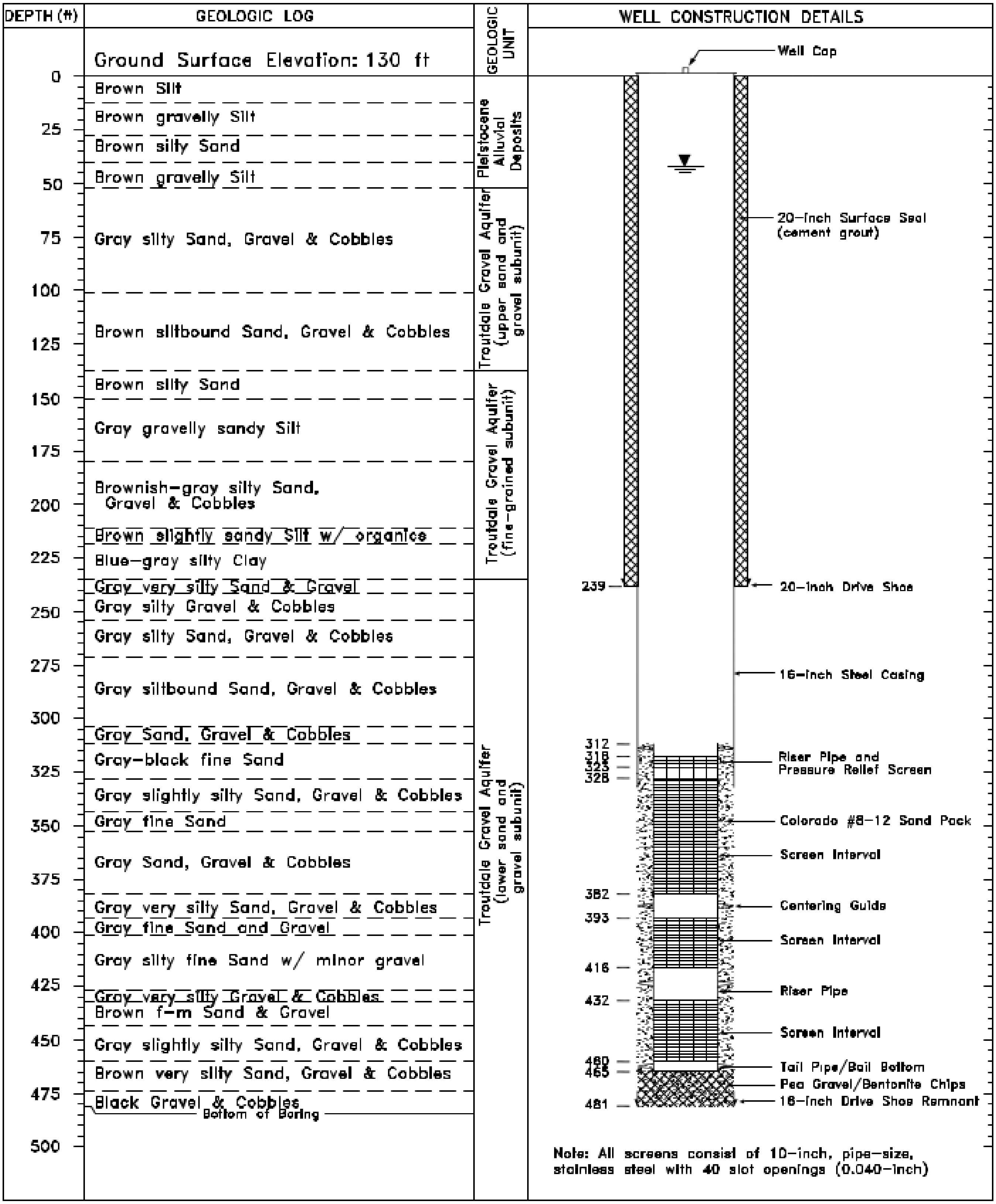
Time	Duration of Pumping (minutes)	Pumping Rate (gpm)	Water Level (feet bgs)	Specific Capacity (gpm/ft of drawdown)	Temperature (degrees C)	Specific Conductance (uS/cm)	ORP (millivolts)	Dissolved Oxygen (mg/L)	pH (SU)	Comments
9:04	Initial	~300	46.1	--	13.07	162	71.3	2.05	7.38	Strong sulfide odor
9:25	21	230	188.21	1.6	13.07	162	-72.7	0.44	7.81	--
9:38	34	230	187.63	1.6	13.08	163	-68.8	0.44	7.82	Sulfide odor less prominent
10:09	65	230	187.39	1.6	13.2	163	-43.6	3.12	7.77	Adjust dissolved oxygen sensor
11:00	116	280	208.69	1.7	13.43	164	-48.5	0.51	7.83	--
11:21	137	300	220.12	1.7	13.26	165	-47.7	0.43	7.84	Sulfide odor less prominent

Notes:
All water quality field parameters were measured using a YSI 556 mulitparameter and a modified flow through cell
ORP = oxidation reduction potential measured using an Ag/AgCl electrode
gpm = gallons per minute
gpm/ ft of drawdown = gallons per minute per foot of drawdown
uS/cm = microsiemens per centimeter
mg/L = milligrams per liter
SU = standard units

Water Solutions, Inc.

Attachment A – Well Construction of Well No. 8

Figure 2 Geologic Log and Well Design for Milwaukie Well 8



PROJECT NAME: Milwaukie Well 8
WELL INDENTIFICATION NUMBER: Well 8
LOCATION: NW ¼ NE ¼ Sec. 6, T2S., R2E.
CONSULTING FIRM: Pacific Groundwater Group
REPRESENTATIVE: Dan Matlock/Steve Swope
DATUM: NGVD

WATER LEVEL ELEVATION: 87.5 ft, msl
WATER LEVEL DATE: 3/17/08
START CARD NO.: 194214
WELL ID: XXX-XXX
DRILLING METHOD: Cable Tool
DRILLING FIRM: Boart-Longyear

Attachment B – Water Systems Engineering Analytical Laboratory Report

Water Systems Engineering Inc.
3201 Labette Terrace Phone: 785-242-6166
P.O. Box 700 Fax: 785-242-9411
Ottawa, KS 66067-0700

WATER TREATMENT ANALYSIS AND CONTROL REPORT

Chris Augustine
GSI Water Solutions, Inc.
55 SW Yamhill St. – Suite 300
Portland, OR 97204

Date: July 1, 2013

Lab Report No. 19546

Re: Milwaukie, OR, Well No. 8R; Samples dates 06/12/2013
Complete Profile (1); PO# 393.003

NA - Not Applicable
ND - Not Detected
*(as $CaCO_3$)

	Well No. 8R Casing 9:00 mg/l	Well No. 8R Aquifer 10:00 mg/l	Detection Limits
pH Value	6.89	7.61	NA
Phenolphthalein Alkalinity*	ND	ND	4 mg/L
Total Alkalinity*	88	88	4 mg/L
Hydroxide Alkalinity	ND	ND	4 mg/L
Carbonate Alkalinity	ND	ND	4 mg/L
Bicarbonate Alkalinity	88	88	4 mg/L
Total Dissolved Solids	138	128	1.0 mg/l
Conductivity (μm or μS/cm)	192	178	NA
ORP (mV)	188	188	0.1 mV
Langelier Saturation Index	- 2.01	- 1.29	NA
Total Hardness*	72	68	4 mg/L
Carbonate Hardness	72	68	4 mg/L
Non Carbonate Hardness	0	0	4 mg/L
Calcium*	36	36	4 mg/L
Magnesium*	36	32	4 mg/L
Sodium (as Na)	5.36	5.15	5.0 mg/L
Potassium (as K)	2.9	2.8	0.1 mg/L
Chlorides (as Cl)	9.2	8.8	2 mg/L
Nitrate (Nitrogen)	ND	ND	0.3 mg/L
Chlorine (as Cl)	ND	ND	0.02 mg/L
Dissolved Iron (as Fe^{2+})	ND	ND	0.02 mg/L
Suspended Iron (as Fe^{3+})	0.95	0.06	0.02 mg/L
Iron Total (as Fe)	0.95	0.06	0.02 mg/l
Iron (resuspended)	1.22	0.10	0.02 mg/l
Copper (as Cu)	ND	ND	0.04 mg/L
Manganese (as Mn)	ND	ND	0.1 mg/L
Phosphate (as PO_4)	1.13	0.65	0.06 mg/L
Sulfate (as SO_4)	ND	ND	2 mg/L
Silica (as SiO_2)	42.1	43.8	1.0 mg/L
Tannin/Lignin	ND	ND	0.1 mg/L
Total Organic Carbon (C)	1.2	1.9	0.0 mg/l
Sulfide	ND	ND	5 μg/l

Bacterial Analysis:

	Well No. 8R	
	Casing 9:00	**Aquifer 10:00**
Plate Count (colonies/ml)	38	No growth
Anaerobic Growth	<10%	<10%
Sulfate Reducing Bacteria	Negative	Negative
Fe / Mn Oxidizing Bacteria	Positive	Negative
ATP (cells per ml) Initial	1.1 M 138,000 (F)	34,000
ATP (cells per ml) 24 hour	745,000 308,000 (F)	122,000
Bacterial Identification	*Gallionella, Microbacterium saperdae, Curtobacterium pusillum*	*No ID Possible*

Microscopic Evaluation:

Casing: Low visible bacterial activity, trace of crystals, minor iron oxide with moderate number of Gallionella.

Aquifer: No visible bacterial activity, no sheathed or stalked bacteria noted.

Observations and Interpretations:

When received in the lab the casing sample was slightly yellowish in color. The aquifer sample was clear and free of sediment. The inorganic chemical analysis found low alkalinity and hardness, and low total dissolved solids along with a low associated conductivity value. The casing sample displayed a slightly acidic pH while the aquifer sample was slightly alkaline although both represented a nearly neutral condition. The oxidation-reduction potential is positive indicating a moderately oxidative condition with a tendency for metal oxide deposition in the presence of metal ions.

The Langelier Saturation Index, which is a calculation of the amount of dissolved calcium carbonate in the water and an indication of the potential for calcium carbonate mineral deposition, was negative, implying an under saturated condition with limited potential for carbonate scale deposition although other mineral scale may form. The negative saturation index also indicates a moderate corrosion potential for metallic well and pump components.

Overall there appears to be a relatively low level of dissolved mineralization present in the groundwater at this site. With the exception of elevated levels of potassium, silica, and total organic carbon in both samples and elevated resuspended iron in the casing sample all other chemical components analyzed for from both samples were within average groundwater values.

Organic carbon is of concern since the carbon serves as a food source for micro-organisms and contributes significantly to their growth, Source of organic carbon include the natural decay of organic material as well as from sources such as synthetic fertilizers, pesticides, and herbicides.

The presence of resuspended iron in the casing sample is an indication of a significant bacterial population present within the casing.

Adenosine triphosphate (ATP) concentrations were at an extreme level in the casing sample at over one million cells per milliliter and remained at a level of concern even after filtering the sample through a 3 micron filter to remove biomass and larger organisms. ATP levels for a properly functioning well system not experiencing fouling typically fall within the range of 20,000 to 60,000 cells per milliliter. In general, any value in excess of 100,000 is of concern for bacterial congestion and biofouling. The ATP levels recorded in the aquifer sample were within acceptable levels. The fact that the heavy biological concentrations were confined to the casing sample and not present in the aquifer sample is an indication that the heavy microbial populations have not spread into the surrounding formations.

The level of heterotrophic plate growth was low with 38 colony forming units in the casing sample and none in the aquifer sample; although it should be pointed out that over 95% of all micro-organisms do not grow on culture media under laboratory conditions. Anaerobic growth represented less than 10% of the total microbial growth in both samples. No sulfate reducing bacteria were found in either sample.

The dominant organisms identified in the microscopic evaluation consisted of *Curtobacterium* and *Microbacterium* species. *Curtobacterium pusillium* are non-pathogenic and are prolific throughout the environment, including soil and groundwater as well as on plants. It is pathogenic to certain plants. *Microbacterium saperdae* are gram positive, non spore forming, predominantly aerobic bacteria commonly found in soils and shallow groundwater environments.

The microscopic evaluation of the casing sample found a low level of visible bacterial activity present along with a low level of biofilm. Also, observed under the microscope was a moderate population of the iron oxidizing organism *Gallionella*

Gallionella are naturally occurring, iron-oxidizing chemolithotrophic bacteria that have been identified in a variety of different aquatic habitats, including groundwater. *Gallionella* are a generally aerobic group of bacteria that utilize iron as an energy source and secrete an iron-oxy-hydroxide byproduct. This secretion is often responsible for accumulations of iron oxide in wells and piping systems. The presence of iron oxidizing organisms and the resulting iron oxide biofilm would be the cause of the discoloration in the casing sample.

The microscopic evaluation of the aquifer sample found no visible bacterial activity, biofilm, or iron oxidizing organisms.

The high level of bacterial congestion as indicated by the high amount of ATP present as well as the elevated level of resuspended iron, and the presence of *Gallionella*, are the likely cause of the loss of specific capacity in well no. 8.

This is the result of the organisms present having the ability to produce polysacride biofilm (slime) which can block flow paths into the well, as well as the ability of *Gallionella* to cause a buildup of iron oxide as well as being corrosive to metallic parts.

Considering the bacterial congestion present with its potential for causing a decrease in well production, it would be advisable to conduct a multi-phase well cleaning to control bacterial growth.

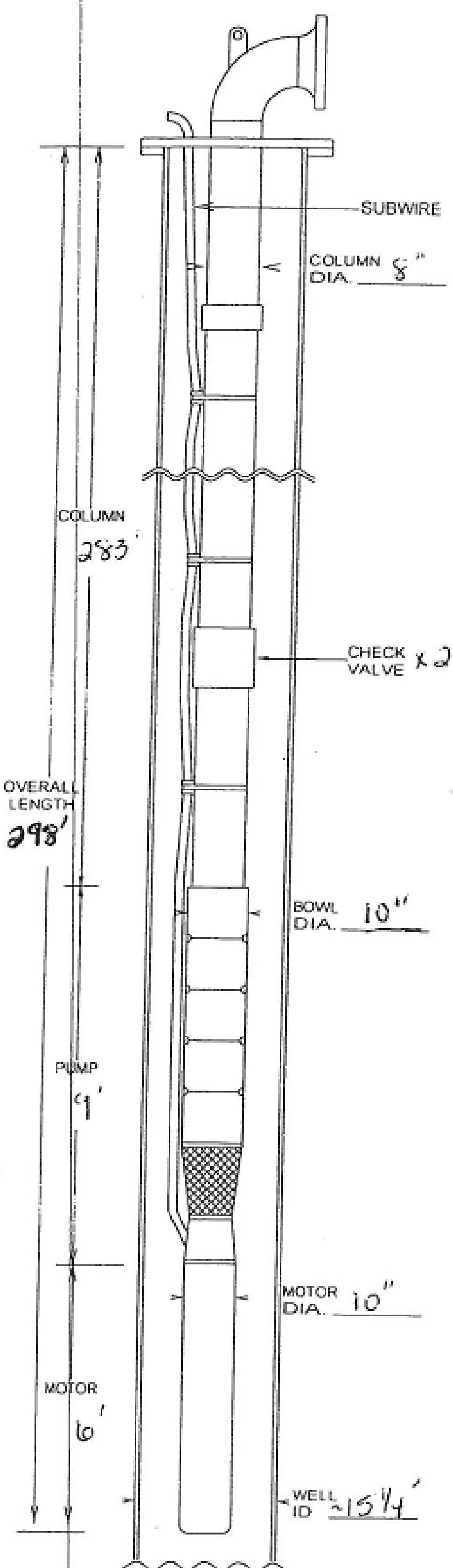
The observations and interpretations presented are based on an evaluation of the water samples and submitted data. Further investigative efforts or other evaluation methods are encouraged and may offer additional insight into the well's condition and the degree of fouling present.

If you have any questions regarding the analyses or the information presented, please contact our office.

Paul D. Buozis
Professional Geologist

SUBMERSIBLE PUMP

DATA SHEET



CUSTOMER: City of Milwaukie
PROJECT: Well #8
DATE: 1-10-08 (set date)

CONDITIONS:

LIQUID PUMPED Water
WELL SIZE 16" pump chamber DEPTH 481'
PUMP SET DEPTH 298' (bottom of motor)

PUMP DATA:

MANUFACTURER Goulds STAGES 11
MODEL 10RJHC-11 DISCHARGE SIZE 8"
SERIAL NO. 553798 12/08 6.56" dia. imp.
DESIGN POINT - 700 GPM 400 TDH

MOTOR DATA:

MANUFACTURER Hitachi 10" - 4 pole
H.P. 100 MODEL NO. 521932 H
RPM 1750 SERIAL NO. C2856801 H
PH 3 VOLTS 480 AMPS 145
CODE F S.F. 1.15 S.F. AMPS 166

ACCESSORIES SUPPLIED:

CHECK VALVE - MANUFACTURER Flomatic
MODEL 80 DI SIZE 8" LENGTH 16"
CABLE - SIZE 2/0 LENGTH 285' DIAMETER Flat
SURFACE PLATE/SEAL - TYPE Fabricated
SIZE 16" PORTS 3 (2½", 1¼", 1¼")
COLUMN - SIZE 8" NO. 14 LENGTH 20'
TYPE Epoxy Coated ~~NO.~~ .322 wall ~~LENGTH~~ T&C
TOTAL 280'
AIRLINE/ACCESS TUBE - TYPE PVC Sch 80 Flush Joint
SIZE 1" (2 runs) DEPTH 280' (Top of pump)

COMMENTS: Pump was set placing the probe tubes on either side of the wire, securing every 10' w/ SS Banding & 10 mil tape. Any scratches & marks put in the epoxy were 10 mil tape covered. Pump & well were chlorinated before & as the setting occurred.

FILE: SUBPUMP

Attachment C – Generalize Bid Sheet for Well Redevelopment of Well No. 8

Budget Level Cost Estimate City of Milwaukee Well 8 Redevelopment and Rehabilitation

Item No.	Description	Estimated Quantity	Unit*	Unit Price	Total Price
1	Mobilization and demobilization, including bond, insurance, site preparation, security fencing, and incidental work and materials not included in other bid items	1	LS		
2	Erosion control	1	LS		
3	Turbidity reduction and water management	1	LS		
4	Remove/Install Exisiting Pump	1	LS		
5	Video survey of well	3	EA		
6	Well brushing and bailing	12	HR		
7	Mechanical well redevelopment	32	HR		
8	Fluid impulse generation and submersible pumping using zonal isolation tool	4	CYCLE		
9	Chemical treatment of well	1	LS		
10	Final well bailing	4	HR		
11	Specific capacity testing of well	2	EA		
12	Superchlorination/Disinfection of well	1	LS		
13	Standby time and delay time	12	HR		
14	Install Access Port for Fluid Impulse Generation Tool and Video Camera	1	LS		
15	Authorized rig hourly time	8	HR		
Mechanical Redevelopment (Items 1-7, 10-14) SUBTOTAL					
Chemical Treatment (Item No 8) SUBTOTAL					
Budget Level Estimate TOTAL					

Assumptions:

Assume prevailing wage /BOLI does not Apply. Buy American does not apply.

Pump, motor and controls will be removed, pressure washed, stored and reinstalled. See attached sheet for pump installation specfications

Assumes good access to the well and pump and to perform various stages of work.

Mechanical redevelopment consists of surging and airlifiting using a zonal isolation tool. Contractor will measure and replenish filter pack periodically to maintain filter pack above screen intervals, if required.

Fluid impulse generation consists of Hydropuls, AirShock or AirBurst technologies coupled with zonal airlffting or submersible pumping following impulse agitation of the well. One cycle consists of starting from the sump and hydropulsing the individual screen intervals (bottom to top) to the uppermost screen interval. Two Cycles will be used for mechanical redevelopment. Two cycles will be used to agitate the chemical treatment. Cost should include all necessary hosing, tools, and gas cylinders for redevelopment of the screened interval of the well.

For costing purposes assume the chemical treatment consists of a 6% acid mix of HCL at 31% strength and a 1.5% concentration biodispersant will be introduced to treat 1.5 time the standing borehole volume (or equivalent treatment chemical mix) and any addtional volume required to maintain a pH of 3 during the 24 hour contact time.For superchlorination/disinfection assume a 250 ppm concentration of sodium hypochlorite mixed with a chlorine enhancer/pH buffering agent. All chemicals need to be NSF approved. Johnson Screen, Layne Christenson, Bariod or Cetco are preferred vendors. Phosphoric acid will not be alllowed.

Chemical treatment will include costs to introduce the chemical into the screen portions of the well, agitate the chemical using a surge block or fluid impulse generation, chemicals ato neutralize the pH of the recovered chemical treatment fluids and to neutralize the superchlorinated water and any additional storage vessels needed to manage the waste prior to disposal to the sanitary sewer main located onsite. For estimating purposes assume that 20 standing water column volumes at a pH of 3 will need to be neutralized using soda ash.

Video survey will be performed before work, after mechanical redevelopment and after chemical treatment. Specific capacity (SC) testing will occur after mechanical redevelopment and after chemical treatment and will consist of one hour of testing at approximately 800 gpm or the highest yield possible using a temporary submersible pump. Provide 3 digital copies of each video.

Please list all assumptions (including fuel and materials costs) as the schedule for the work is not finalized and may be delayed

*Abbreviations
LS - Lump sum
EA – Each
HR - Hour

ATTACHMENT C

Water Systems Engineering Laboratory Report – April 2021 Groundwater Sampling

Date: May 12, 2021

Lab Report No. 22120

Chris Wick
GSI Water Solutions
55 SW Yamhill Street, Suite 200
Portland, OR 97204

Project Description: City of Milwaukie, Well No. 8R; Samples dated 04/21/2021
Complete Well Profile (1); GSI# 393.005

Test Description:

The Complete Well Profile analysis is designed for comparative analysis of two samples, typically one static and one pumping sample. The Complete Well Profile utilizes a series of inorganic chemical and microbiological tests to identify fouling and corrosion issues with potential impacts on the operation of the sampled well. The tests include a number of inorganic chemical parameters such as pH, total dissolved solids/conductivity, hardness, alkalinity, oxidation reduction potential (ORP), bicarbonate, carbonates, silica, sodium, potassium, chloride, iron, manganese, phosphate, nitrate, sulfate, and total organic carbon (TOC). Biological assessment is designed to quantify the total bacterial population, identify two dominant populations of bacteria, assess anaerobic conditions, and identify the presence of iron related bacteria and sulfate reducing organisms. Also included are tests for Adenosine triphosphate (ATP), heterotrophic plate count (HPC), total coliform and E. coli coliform, and a microscopic evaluation.

Testing Procedures:

All laboratory testing procedures are performed according to the guidelines set forth in *Standard Methods for the Examination of Water and Wastewater* as established by the American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF). Corrosion analyses are performed in accordance with the guidelines as set forth by the National Association of Corrosion Engineers (NACE). In general, these methods are approved by both the Environmental Protection Agency (EPA) and AWWA for the reporting of water and/or wastewater data.

Sample collection and shipment is the responsibility of the customer, performed according to protocol and procedures defined by the laboratory in advance of the sampling event with regards to the specific project and nature of the problem.

Disclaimer:

The data and interpretations presented are based on an evaluation of the samples and submitted data. Conclusions reached in this report are based upon the data available at the time of submittal and the accuracy of the report depends upon the validity of information submitted. Any recommendations presented are based on laboratory and field evaluations of similar fouling occurrences within potable water systems. Further investigative efforts, such as efficiency testing, site inspection, video survey, or other evaluation methods may offer additional insight into the system's condition and the degree of fouling present.

Client: GSI Water Solutions
Date: May 12, 2021
Lab Report No. 22120

Re: City of Milwaukie, Well No. 8R; Samples dated 04/21/2021
Complete Well Profile (1); GSI# 393.005

ND - Not Detected NA - Not Applicable * as $CaCO_3$	**Well No.8R Casing**	**Well No.8R Aquifer**	**Detection Limits**
pH Value	7.94	7.81	NA
Phenolphthalein Alkalinity*	4	ND	4 mg/l
Total Alkalinity*	100	96	4 mg/l
Hydroxide Alkalinity	ND	ND	4 mg/l
Carbonate Alkalinity	8	ND	4 mg/l
Bicarbonate Alkalinity	92	96	4 mg/l
Total Dissolved Solids	115	115	1.0 mg/l
Conductivity (µm or µS/cm)	159.9	160	NA
ORP (mV)	250.8	252.5	NA
Langelier Saturation Index (at 16°C)	- 0.68	- 0.77	NA
Total Hardness*	68	68	4 mg/l
Carbonate Hardness	68	68	4 mg/l
Non Carbonate Hardness	ND	ND	4 mg/l
Calcium*	28	32	4 mg/l
Magnesium*	40	36	4 mg/l
Sodium (as Na)	5.29	5.13	0.02 mg/l
Potassium (as K)	2.3	2.0	0.1 mg/l
Phosphorus, Reactive (as PO_4^{3-})	0.65	0.42	0.06 mg/l
Chlorides (as Cl)	4.0	4.0	2 mg/l
Nitrate (Nitrogen)	ND	ND	0.3 mg/l
Chlorine (as Cl)	ND	ND	0.02 mg/l
Dissolved Iron (as Fe^{2+})	ND	ND	0.02 mg/l
Suspended Iron (as Fe^{3+})	0.36	0.16	0.02 mg/l
Iron Total (as Fe)	0.36	0.16	0.02 mg/l
Iron (resuspended)	1.62	0.19	0.02 mg/l
Copper (as Cu)	ND	ND	0.04 mg/l
Manganese (as Mn)	ND	ND	0.1 mg/l
Sulfate (as SO_4)	ND	4	2 mg/l
Silica (as SiO_2)	34.2	42.4	1.0 mg/l
Tannin/Lignin	ND	ND	0.1 mg/l
Total Organic Carbon (C)	ND	ND	0.3 mg/l

Biological Analysis

	Well No.8R Casing	Well No. 8R Aquifer	Detection Limit
Plate Count (CFU/ml)	0	2	NA
Anaerobic Growth (%)	<10	<10	NA
Sulfate Reducing Bacteria	Negative	Negative	NA
Fe/Mn Oxidizing Bacteria	Positive	Positive	NA
ATP (cells per ml) Initial	172,000	48,000	10,000
ATP (cells per ml) 24 Hour	90,000	16,000	10,000
Total Coliform	Negative	Negative	NA
E. Coli	Negative	Negative	NA
Bacterial Identification	*Gallionella*	*Gallionella*	NA

Microscopic Evaluation:

Casing: Heavy visible bacterial activity, very low crystalline debris, very low number of protozoa, very low plant particulate matter, moderate iron oxide, moderate iron oxide entrained biomass with moderate number of *Gallionella*.

Aquifer: Low visible bacterial activity, very low crystalline debris, very low plant particulate matter, very low iron oxide entrained biomass with very low number of *Gallionella.*

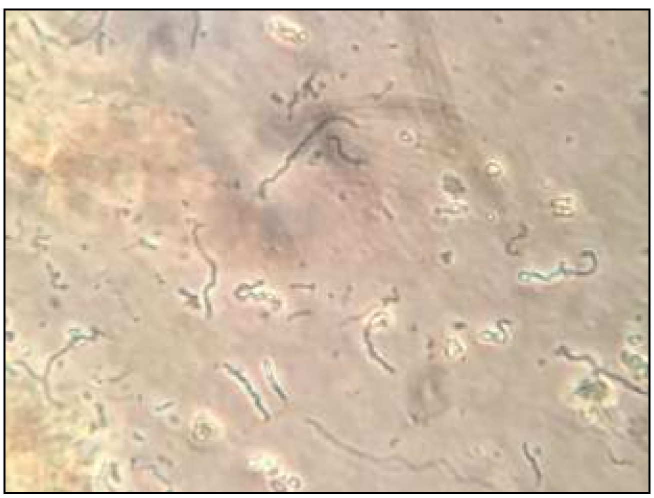


Fig.1: Centrifuged sediment of casing sample showing presence of *Gallionella* (200x magnification)

Observations:

Water samples representing static and active pumping conditions, casing and aquifer, from Well No. 8R were sent to the lab for chemical and biological analysis with regards to operation and maintenance.

Chemical analysis identified neutral pH values that decreased slightly with pumping. Alkalinity levels were somewhat low in each sample indicating a reduced natural capacity of the water to buffer against acidic conditions. Conductivity and total dissolved solids (TDS) levels were considered moderate in each sample and well within the EPA Secondary Drinking Water level of 500 mg/l preferred for domestic water supplies.

The oxidation-reduction potential (ORP) was highly positive over the sampling interval and at a level which is indicative of an oxidative groundwater environment trending toward the deposition of metal oxides in the presence of metal ions.

The calculated Langelier Saturation Index (LSI), which is an indication of the calcium carbonate mineral deposition potential, noted negative values in each of the water samples. Negative LSI values indicate a decreased potential for mineral scale development with a tendency for corrosive conditions within the well system. Hardness levels were low in each of the samples, with predominant scale forming ions, calcium and magnesium, also measured at low levels. Other scale forming ions, such as, sodium, potassium, chlorides, and sulfate, were also at acceptable levels. Results such as these further signify a decreased potential for mineral scale development.

Testing and analysis of iron content included testing for suspended, resuspended, and dissolved iron. Used as an indication of active corrosion, background iron, and chemically and biologically mobilized iron, results from these analyses revealed moderate levels in the casing sample. Iron levels declined further with pumping to minimal levels. As a point of reference, levels above 1.5 mg/l are typically associated with more significant iron presence and the potential for accumulation. Manganese, a mineral which is often viewed similarly to iron in its function as a fouling mechanism, was absent from each sample.

Total organic carbon (TOC), often used as a non-specific indicator of water quality and as a representation of the amount of carbon bound in organic, was absent from each of the samples.

Testing for phosphate, another known nutrient source for bacteria, recorded elevated levels in each sample with levels declining slightly over the sampling interval. Reactive phosphorus, representing phosphorus that is available to chemically or biologically responsive, was consistently high. This value can signify orthophosphates that are found naturally in the environment and in water which are used by plants, bacteria, and algae, but are also those which are artificially added in fertilizers and other products. While the presence of phosphate is common in groundwater resources, typically concentrations fall within a range of 0.0 to 0.2 mg/L. In some cases, the intrusion of phosphate based sequestrants into the well or influences from remnant drilling materials, can cause the phosphate level to increase above naturally occurring levels.

Silica levels, serving as an indication of the propensity for migration of formation materials or as an indication of insufficient development efforts, were elevated in the casing sample and increased with pumping. All other major ions were found to be at suitably low levels in each of the submitted samples.

Biological testing conducted quantitative analysis of the bacterial populations present. Heterotrophic plate counts, a traditional measure of the available bacterial response to growth media in a laboratory setting, recorded no growth within the initial casing sample and just two colony forming units (cfu's). Adenosine triphosphate (ATP) testing, another quantitative method based on measurement of a component of cellular material and a means of evaluating the total bacterial population, also noted elevated levels in the casing sample which declined to more moderate levels with pumping. As a point of reference, active potable water wells typically exhibit ATP values between 10,000 and 70,000 cells per milliliter for an active well sample, with values in excess of 100,000 cells per milliliter generally indicating biofouling. Further monitoring of ATP levels over a 24-hour period showed a decline in each sample during that period, suggesting conditions were not favorable for continued bacterial growth and expansion.

Anaerobic growth, as a percentage of the total population, was very low in the each sample at less than ten percent. Testing for sulfate reducing bacteria (SRB's), a group of nuisance anaerobic bacteria, was also negative. Measurement of anaerobic growth and sulfate reducing bacteria is important since positive results can indicate a more established resident population in the lower regions of the well where low flow, anoxic conditions typically occur.

Additional testing for iron related bacteria, another group of nuisance bacteria associated with microbially induced corrosion (MIC), was positive in each of the samples. Gallionella, identified in each sample, represent a group of iron oxidizing bacteria which utilize iron and manganese as energy sources. These bacteria produce sheaths and stalked structures in which they store accumulated oxidized iron and manganese. Their elongated structures are often shed during cycling of the well, resulting in surges of red water and spikes in total iron readings, and can become a very effective fouling mechanism when they become matted and intertwined. These bacteria can generally be found in a variety of aquatic environments with sufficient organic matter present. Oxidation, resulting from aeration including cascading water or rapid recharge, can stimulate the growth and activity of these bacteria. In its attachment to iron bearing surfaces, these bacteria do pose additional corrosion concerns as they will actually pit the metal in an effort to secure the iron necessary for energy. All iron bearing structures, including stainless steel, are susceptible to this form of pitting.

Testing for total coliform bacteria, was negative in each sample. Additional coliform testing for E. coli specific organisms, was also negative. Coliform testing is a widely accepted regulatory method for determining drinking water's sanitary quality. Coliforms are a group of closely related bacteria that behave much like a variety of other bacteria, parasites, and viruses known to be harmful if consumed in drinking water.

Portions of each of the samples were extracted and centrifuged for microscopic evaluation. Heavy amounts of visible bacterial activity were noted in the casing sample compared to low levels in the aquifer. Results such as these are consistent with bacterial counts described during quantitative analysis. Moderate numbers of the previously described iron oxidizing bacteria were also noted in the initial casing sample with very low counts in the corresponding aquifer sample. Biomass, a natural expression of bacteria and a chief mechanism of biofouling, was at a moderate level in the initial casing sample with very low levels in the aquifer sample.

A very low number of protozoa, a single-celled eukaryotic organism, were also present in the initial casing sample. Protozoa are most often associated with surface water bodies, indicating large, diverse, and mature microbiological communities. Protozoa occurrence is a concern as some are parasitic and some, like Giardia and Cryptosporidium, are pathogenic. The identification of Protozoa within a water sample is dependent on microscopic evaluation, with neither heterotrophic plate tests nor total coliform tests indicating their presence.

Moderate accumulations of iron oxide, as a mineral precipitant were observed in the initial casing sample. Very low amounts of crystalline debris were also noted in each sample, further suggesting potential migration of formation materials into the well setting.

Microscopic examination of the samples also noted very low amounts of plant particulate matter in each of the samples. Examples of plant particulate matter include miscellaneous fine root material, mold hyphae, organic fibrous material, and other unidentifiable organic matter. Typically, very limited amounts of plant particulate matter may be expected in a ground water sample; when noted in large amounts, plant particulate matter could be an indication of significant biofouling, potential surface influence on a well, or a breach of the well structure, and should be investigated.

Interpretations:

Laboratory analysis of the submitted water samples found the water to be aggressive in nature with calculated LSI values signaling naturally corrosive tendencies. While iron levels were not found to be excessive within the submitted samples, problematic levels of iron accumulation could be present within the well given the presence of iron oxidizing bacteria coupled with the oxygen content and generally aggressive nature of the water. The occurrence of iron oxidizing bacteria significantly increases the likelihood of microbial induced corrosion (MIC). Furthermore, the stalked nature of these bacteria can rapidly clog flow pathways and pump intakes, reducing flow into and out of wells.

Biological testing found the overall bacterial population was elevated in the immediate well structure which included iron oxidizing bacteria and a moderate amount of biomass. Biofilm, or biomass, is a naturally occurring expression of bacteria resulting from the extrusion of a slimy polysaccharide exopolymer. Bacteria exude this slime to attach themselves to a smooth surface for propagation, nutrient capture and growth. Biofilms act as suburban communities within a well system, developing in numerous locations, sustaining life and rapidly expanding throughout the well environment. Present throughout nature, biofilms are an excellent source for the development of mineral scale within a well system aiding in the entrainment of precipitating minerals, colloidal material, and sediment, limiting effective flushing and compounding fouling potential.

Elevated levels of silica, phosphates, and the occurrence of crystalline debris during microscopic evaluation are all strong indications of sediments and/or drilling remnants which are sufficient to impact performance. The corresponding presence of these materials within the samples suggest that the well would benefit from a redevelopment effort. This would help open pore spaces within the borehole and near well formation by removing any detritus that may have accumulated overtime.

Overall testing of the samples suggests that oxidation of available iron and the natural corrosive tendencies at the site, from either chemical or biologically driven processes, is occurring within the well; likely resulting in the decreased performance of the well noted within the submitted paperwork. Any biomass and iron oxidizing bacteria present within the well would likely serve as a catalyst for iron oxide accumulation, enhancing the level of build-up downhole. Extended periods of inactivity or sporadic use of the well could also result in advancement of the identified fouling mechanisms. The presence of protozoa and plant material within the samples also indicates a possible breach in the upper well seal or some degree of connectivity to surface water influence. Further investigation into possible sources of these materials appears warranted.

Recommendations:

Based on the laboratory data, Well No. 8Rwould benefit from a combined chemical and mechanical rehabilitation effort, with an added redevelopment step, followed by a pH adjusted disinfection. The chemical and mechanical cleaning would help dislodge accumulations of iron and biomass while the redevelopment effort would act to open occluded pore spaces on the borehole interface. A final pH adjusted disinfection would assist in sanitization to minimize the size of the resident bacterial population and reduce the number of Gallionella present.

The recommended multi-phase treatment utilizes successive phases of cleaning to address the fouling present, and is outlined below.

Well No. 8R Specifications:

Total depth:	465-ft.
Casing diameter:	16 inches (0-328 ft.), 10 inches (312-465 ft.)
Age:	13 years
Static water level:	48-ft.
Pump placement:	289-ft.
Well Completion:	Screened

Start by removing the permanent pump and column pipe from the well, service as needed, clean. Disassembly of the pump is recommended for effective cleaning. Following cleaning, the pump should be evaluated for corrosion and material degradation that may have occurred over time. The motor should be evaluated for excessive wear and the need for repair or replacement.

With the pumping equipment removed, a video survey of the well is recommended to identify any signs of structural failure, particularly in the upper portion of the well, which could be contributing to surface water influences. A video survey is also encouraged to help identify any areas of significant accumulation of biomass or other fouling which can be targeted during treatment. Additionally, conduct a thorough site inspection evaluating the well head and surrounding areas for signs of damage, influence, vandalism, erosion or subsidence that could impact the well. The goal of this examination is to ensure a good seal is in place for preventing shallow or surface water influences on the well structure.

Pretreatment: Mechanical Agitation

Prior to chemical treatment, the well should be thoroughly agitated to remove bulk material that has accumulated on the casing, within the production zone, and in the bottom of the well. The agitation should utilize a stiff nylon brush to disrupt and dislodge biological growth within the well column. The tool used should complement the inner diameter of the well in size, allowing sufficient tool material to contact the well structure and aid in removal of accumulated material without influencing or damaging the wells.

Immediately following the pretreatment agitation efforts, it is very important to thoroughly purge the well of debris and disrupted material, beginning at the very bottom of the well and working upwards until thoroughly evacuated. Given the hydrogen sulfide odor noted within the submitted paperwork, extra effort should be placed in evacuating material within the lowest extensions of the well which are often associated with anoxic or anaerobic bacteria known for hydrogen sulfide production. Purge until visible turbidity is removed. Evacuated material should be collected above ground and disposed of according to local and state regulations.

Chemical Treatment Phase

Following the pre-treatment phase, the chemical treatment phase will be used to further clean the well column while allowing cleaning efforts to extend into the near-well formation to open fissures and flow paths. This treatment step is designed to primarily target iron oxide accumulations, any biological deposits within the well, and potential fouling within the near-well formation. This step should incorporate 6% phosphoric acid and 2% NW-310 biodispersant by Johnson Screens calculated on a volume equivalent to 1.5 times the standing well volume.

The use of phosphoric acid is recommended for the cleaning of the well over other, more aggressive acids due to several factors. Besides being a (chemically) cleaner product, phosphoric acid has been chosen to facilitate the safety of well rehabilitation efforts – reducing impacts on both the well structure and the crew. The use of more aggressive acids, such as hydrochloric acid, is not advised as it is inclined to cause both chloride and hydrogen attack of any metal components within the well structure, increasing the chance of damage.

In consideration of the targeted biological fouling within the well, the addition of biodispersant chemistry is also recommended in conjunction with mechanical. “Biodispersants” are polymeric organic acids with strong dispersants, penetrating agents, and sludge and solids control properties. The organic acid portion of the chemistry effectively dissolves any biological component of the scale matrix which often times is not dissolved by strong mineral acids. Long chain polymers help with sludge control and removal from the well as well as prevent its adhesion so that it can be removed during flushing and subsequent washout. Based on supplied data, the treatment should utilize the following chemicals:

Phosphoric acid (75% strength)	270 gallons
NW-310 biodispersant	90 gallons
Potable Water (for blending)	1,000 gallons

Blend the solution above ground, mixing the chemicals in this order: water, phosphoric acid, biodispersant. Add the chemicals evenly throughout the entire well column via a tremie pipe or similar delivery mechanism. Once the solution has been introduced, lightly agitate the solution throughout the entire well for 4 to 6 hours. Following agitation, allow the solution to remain downhole overnight.

To ensure the reaction has not slowed and to prevent to reprecipitation of dissolved materials, monitor the pH of the downhole solution and keep it at 3.0 or below during the entire treatment process. If, during acid treatment, the pH rises to a level above 3.0, add additional acid and water in small increments to bring the pH back down. No additional dispersant should be needed.

The following day, mechanically agitate the well again for 2 to 4 hours, again monitoring the pH and keeping it at 3.0 or below, adding additional acid if needed to maintain pH. Following surging of the treatment solution, the well should be thoroughly purged of the chemicals and disrupted material. Pump the well until the pH has returned to normal (7 or greater), visible turbidity is zero, and the well is pumping clear. Collect and neutralize the evacuated material above ground according to state and local regulations.

Redevelopment Phase

Following the chemical treatment efforts (including evacuation), a solution two times the size of the standing water column, that incorporates NW-220 clay dispersant by Johnson Screens and

potable water, should be placed evenly into the well and jetted. Johnson Screens' NW-220 is a non-phosphate based dispersant chemical used in the development of new and older wells for the removal of drilling fluids and to target fine grained sediments existing in and around the borehole. Utilizing a jetting tool or surge block, lightly work the solution throughout the screened section for approximately 4 hours following placement.

Following the initial surging, allow the well to sit idle overnight prior to the second round of surging. Following this period, surge the screened zone aggressively, spending approximately 30 minutes per 15 section of screen. This treatment should incorporate the following chemicals:

NW-220 clay dispersant	14 gallons
Potable Water (approximately)	3,500 gallons

Once the final surging is complete, thoroughly pump the well until the conductivity has returned to normal levels (approximately 100 µS/cm), visible turbidity is zero, and the well is pumping clear. The removed chemical solution should be neutralized above ground and disposed of according to local and state regulations.

Disinfection

Following chemical treatment, the well should be disinfected. The use of chlorine enhancing products designed to control pH levels and provide maximum efficiency of the disinfection solution is recommended. Such products should also contain surface acting agents to assist in penetrating sediment, deposits and gravel pack material providing increased effectiveness against hidden or protected bacteria.

Disinfection should utilize a pH-adjusted chlorination treatment of a 300 ppm chlorine level in a pH range of 6.5 to 7.0. The volume of the disinfection solution should be equivalent to 3 times the standing well volume. This larger volume is utilized to flood the borehole with the disinfection solution in order to increase the effectiveness of treatment, as well as increasing the treatment area. Utilization of NSF approved chlorine enhancing chemicals Johnson Screens NW-410 is strongly encouraged to aid in both effective disinfection as well as to increase the treatment area. Based on the supplied well data, the chlorination treatment should incorporate the following chemicals:

Sodium Hypochlorite (12% strength)	26 gallons
NW-410 chlorine enhancer	16 gallons
Potable Water (approximately)	7,000 gallons

The disinfection solution should be blended above ground and introduced into the well by a tremie pipe or similar treatment line. For the chlorine treatment, mix the chemicals in this order: water, chlorine enhancer, check the pH (above 5), then add chlorine. Mix lightly.

Efforts should be made to disperse the disinfection solution evenly throughout the well column. Adequate volumes and delivery of the disinfection solution should also be placed in the lower zone to target any heavier biofilm accumulations that often form in less active areas such as this. Once the solution is placed into the well, it should be lightly agitated with a jetting tool or surge block, to supply agitation and dispersion throughout the well column and borehole. Following agitation, check the chlorine residual within the well to ensure sufficient strength is present. If the chlorine residual has diminished below 200 ppm, add additional sodium hypochlorite to raise it to that level.

Allow the chlorine solution to remain downhole for 12 to 24 hours. Following this period, begin evacuation of the well from the bottom, working upwards, until a minor residual (~ 50 ppm) is present and all debris has been evacuated from the well, as identified by visible turbidity. With evacuation, all fluids produced during the cleaning operation should be neutralized and disposed of in accordance with on-site and state regulations. At this time, the permanent pump and column pipe can be placed back into the well and utilized to purge the remaining chlorine solution from the well.

Post Treatment

Once disinfection efforts are completed, the well should be returned to an active operating schedule as soon as possible. Maintaining an active operating schedule for the well is recommended to discourage future bacterial growth. Follow up sampling of the well to evaluate cleaning efforts and to establish a new baseline could aid in establishing long term well operation and maintenance procedures. A monitoring program that includes periodic submittal of water samples to the lab to assess conditions within the system would be beneficial to ensure the long-term operating efficiency and identify fouling before it reaches severe levels. A post-treatment video survey and pump test for comparison purposes may be also be valuable.

Please feel free to contact our office with any questions pertaining to this report or the information presented.

Eric Duderstadt
Water Chemist and Microbiologist

ATTACHMENT D

General Scope for Well Rehabilitation

General Scope of Well Rehabilitation Program

The general scope of work below provides some preliminary guidelines regarding the execution of a comprehensive well rehabilitation program.

Initial Redevelopment Tasks

- Remove existing pump and motor assembly from the well and inspect pump, pump column (i.e., drop pipe), motor and other pump appurtenances. The contractor should take measures to protect the pump, column, power cable and instrumentation from abrasion because of the misalignment of the well during installation and removal to ensure reliable operation.
- Perform a downhole video survey of well to evaluate pre-rehabilitation conditions in the well (i.e., check for degree of plugging in well screens caused by biofouling or sediments).
- Perform an alignment survey to the total depth of the well casing to determine the total deviation of the well casing and assess potential limitations to specific rehabilitation methods and tools.
- Initially, use a stiff nylon brush to carefully remove some of the surficial biofouling from the well casing and screens.
- In conjunction with brushing, perform an initial round of chemical cleaning using hydrogen peroxide (H_2O_2) to help remove any surficial biological encrustations from the well casing and screens. This H_2O_2 effectively oxidizes such biofouling.
- Conduct bailing or airlifting to remove debris from the bottom of the well casing.
- Perform a downhole video survey of the well to evaluate effectiveness of the initial pre-treatment chemical cleaning and brushing operations and check for holes in the well casing and screens and possible damage from tools used in the steps above.

Additional Redevelopment Tasks

After the initial redevelopment tasks have been completed, further evaluation can be performed and additional procedures can be recommended based on those results, as described below.

- Use a high-pressure jetting tool or high-energy impulse generation tool (i.e., airburst, hydropuls, or similar methods) with zonal isolation, and pumping system (airlift tool or submersible pump) to clear residual biomass and encrustations from the perforated intervals of casing.
- Conduct chemical treatment of the well with acid cleaning solutions (acids combined with hydrogen peroxide) to break up and suspend remnant biomass in the well and aquifer. These acid cleaning solutions can be determined later.
- Conduct mechanical redevelopment of the well by simultaneous airlifting and swabbing of the well casing.

- Perform a downhole video survey of the well to evaluate effectiveness of the chemical and mechanical redevelopment operations and check for possible damage from tools deployed during mechanical and chemical redevelopment.
- Install a temporary test pump to remove, neutralize, and dispose of any residual acid solution and biomass. It is critical that this step be completed at a high pumping rate (ideally with zonal isolation) to remove the low pH water quickly, and remove as much suspended biomass and solids as possible. During this pumping redevelopment, monitor water levels, pumping rates/volumes, and sand production and determine an appropriate pumping rate for 24-hour constant rate pumping test.
- Perform a maximum 24-hour constant rate pumping test to determine the new (current) specific capacity of the well. Water levels, pumping rates/volumes, and sand production shall be monitored during this test.
- Re-install permanent pump and disinfect the pump, pump column, motor, and well by introducing a chlorine solution with a chlorine enhancer throughout the water column, with particular attention to the production intervals; maintain the chlorine residual throughout the disinfection process to ensure complete disinfection. Once disinfection is complete, remove and dechlorinate the solution.

2021 Water System Master Plan

Appendix D. Concrete Tank Cleaning and Inspection Report

866-789-3483

City of Milwaukie
Field Report

2-Jul-20

Underwater Cleaning / Inspection
1,500,000
Concrete Tank
Potable Water Storage Tank

Submitted To:

City of Milwaukie
Ronelle Sears
6101 SE Johnson Creek Blvd.
Milwaukie, OR 97206

Phone: 503-786-7615

Submitted By:

Potable Divers Inc.
PO Box 474
Vernal, UT 84078-0474

Phone: (866) 789-3483
Fax: (866) 913-4905
E-mail david@potabledivers.com

David Harvey Dive Supervisor

EXTERIOR ROOF

Concrete				
Satisfactory	Y	X	N	
Earth Covered	Y		N	X
Cracking	Y	X	N	
Efflorescence Present	Y	X	N	
Spalling	Y		N	X
Scaling	Y		N	X
Exposed Aggregate	Y		N	X
Strength Members				
Exposed	Y		N	X
Seams/Joints	Good / fair			
Low Areas	None			

Conclusion/Discrepancies: Stressed concrete roof is in good condition. The roof to wall seam does exhibit previously repaired cracks some with efflorescence present.

ACCESS HATCH

Satisfactory		Y		N	X
Construction		Aluminum			
Coating					
Corrosion	%	Y		N	X
Proper Design		Y	X	N	
Locked		Y	X	N	
Gasket		Y		N	X
Hinge		N/A			
Hatch Size		2 FT	X	2 FT	

Conclusion/Discrepancies: No gasket present
Aluminum lid in good condition but does not seal. Locked and secured.

VENTS

Satisfactory	Y		N	X
Construction	Aluminum			
Coating				
Corrosion	Y		N	X
Proper Design	Y	X	N	
Screens	Y	X	N	X
Sealed Edges & Seams	Y		N	X
Cap/Cover	Y	X	N	

Conclusion/Discrepancies: Screen needs to be smaller gauge. The edges are not sealed.
Replace the screen and seal the edges

EXTERIOR SHELL

Concrete					
Satisfactory		Y	X	N	
Earth Embanked		Y		N	X
Cracking		Y	X	N	
Efflorescence Present		Y	X	N	
Spalling		Y		N	X
Scaling		Y		N	X
Exposed Aggregate		Y		N	X
Strength Members					
Exposed		Y		N	X
Seams/Joints	Good				
Honeycombing		Y		N	X

Conclusion/Discrepancies: Several cracks with efflorescence build up two appear to be damp.
Horizontal cracking 12 feet below the roof that sporadically but consistently around the entire circumference of the tank

EXTERIOR LADDER

Construction	Galvanized				
Satisfactory		Y	X	N	
Coating					
Satisfactory		Y	X	N	
Oxidized		Y		N	X
Pitting		Y		N	X
Delamination		Y		N	X
Corrosion	%	Y		N	X
Welds/Joints	Good				
Supports	Good				
Safety Cage/Climb		Y	X	N	

Conclusion/Discrepancies Locked and secured ladder and braces are in good condition

OVERFLOW STRUCTURE

Coating	Internal				
Satisfactory		Y		N	
Oxidized		Y		N	
Pitting		Y		N	
Delamination		Y		N	
Corrosion	%	Y		N	
Welds/Joints					
Supports					
Screens		Y		N	
Attachments					
Foundation					

Conclusion/Discrepancies Overflow pipe and funnel are on the interior

POTABLE DIVERS INC.
866-789-3483

FOUNDATION

Concrete					
Satisfactory	Y	X	N		
Cracking	Y		N	X	
Spalling	Y		N	X	
Exposed Aggregate	Y		N	X	
Erosion / Undermining	Y		N	X	
Seismic Restraints	None				
Corrosion	Y		N		
Tight	Y		N		

Conclusion/Discrepancies Foundation appears to be in good condition with no undermining or erosion noted

MANWAY ENTRIES

Locations None

Coating					
Satisfactory		Y		N	
Oxidized		Y		N	
Pitting		Y		N	
Delamination		Y		N	
Corrosion	%	Y		N	
Welds/Joints					

Conclusion/Discrepancies
No other man way entries other than the roof access

POTABLE DIVERS INC.

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INTERIOR ROOF

Concrete				
Satisfactory	Y	X	N	
Cracking	Y	X	N	
Efflorescence Present	Y	X	N	
Spalling	Y		N	X
Scaling	Y		N	X
Exposed Aggregate	Y		N	X
Strength Members				
Exposed / Corrosion	Y		N	X
Seams/Joints	Good			
Honeycombing	Y		N	X
Vent Penetration	Good			
Roof Hatch	Good			

Conclusion/Discrepancies: Cracking with efflorescence present. Cracking at the divers 7:30 position is the most problematic. No indications of surface water leaching in.

INTERIOR SHELL

Concrete				
Satisfactory	Y	X	N	
Cracking	Y	X	N	
Efflorescence Present	Y		N	X
Spalling	Y		N	X
Scaling	Y		N	X
Exposed Aggregate	Y		N	X
Strength Members				
Exposed / Corrosion	Y		N	X
Seams/Joints	Good			
Honeycombing	Y		N	X
Wall to Roof Seam	Good			
Baffle/Support Walls	None			

Conclusion/Discrepancies: Concrete walls are lined. Liner is in fair condition chalky to the touch, with cracks along the wrinkles

SUPPORT COLUMNS

Construction		None			
Satisfactory		Y		N	
Spalling		Y		N	
Cracking		Y		N	
Scaling		Y		N	
Honeycombing		Y		N	
Coating		Y		N	
Corrosion	%	Y		N	
Seams/Welds					
Floor/Base Plates					

Conclusion/Discrepancies:
No support columns

866-789-3483

FLOOR

Concrete	Lined				
Satisfactory	Fair	X	N		
Cracking	Y	X	N		
Efflorescence Present	Y		N	X	
Spalling	Y		N	X	
Scaling	Y		N	X	
Exposed Aggregate	Y		N	X	
Strength Members					
Exposed / Corrosion	Y		N	X	
Seams/Joints	good				
Honeycombing	Y		N	X	
Floor to Wall Seam	good				

Conclusion/Discrepancies: Liner exhibits slight cracking and fraying on the wrinkles

One small hole in liner next to wall @ 5:30

Sediment depth on average was 1/8 inch

MANWAY ENTRIES

Coating	None				
Satisfactory		Y		N	
Blistering		Y		N	
Cracking		Y		N	
Peeling		Y		N	
Holidays		Y		N	
Pitting		Y		N	
Corrosion	%	Y		N	
Seams/Welds					

Conclusion/Discrepancies:

No other access than the roof entry

866-789-3483

LADDER

Construction	Stainless				
Satisfactory	Y	X	N		
Coating					
Satisfactory	Y	X	N		
Blistering	Y		N	X	
Cracking	Y		N	X	
Peeling	Y		N	X	
Holidays	Y		N	X	
Pitting	Y		N	X	
Corrosion	Y		N	X	
Seams/Welds	Good				
Safety Cage/Climb	Y	X	N		

Conclusion/Discrepancies: Ladder, braces and fall protection all in good condition with no problematic concerns

APPURTENANCES

Influent					
Construction	Steel				
Coating					
Satisfactory		Y	X	N	
Blistering		Y		N	X
Cracking		Y		N	X
Peeling		Y		N	X
Holidays		Y		N	X
Pitting		Y		N	X
Corrosion		Y	X	N	
Seams/Welds	Good				
Conclusion/Discrepancies:	Minor spots of rust				
on the funnel and interior of the pipe					

Effluent					
Construction	Steel				
Coating					
Satisfactory		Y	X	N	
Blistering		Y		N	X
Cracking		Y		N	X
Peeling		Y		N	X
Holidays		Y		N	X
Pitting		Y		N	X
Corrosion		Y	X	N	
Seams/Welds	Good				
Conclusion/Discrepancies:	Minor corrosion on				
the steel pipe with no obstructions					

Drain					
Construction					
Coating					
Satisfactory		Y	X	N	
Blistering		Y		N	X
Cracking		Y		N	X
Peeling		Y		N	X
Holidays		Y		N	X
Pitting		Y		N	X
Corrosion	%	Y		N	X
Seams/Welds	Good				
Conclusion/Discrepancies:	Drain line is in good				
condition					

OVERFLOW

Location	10:00				
Coating					
Satisfactory	Y	X	N		
Blistering	Y		N	X	
Cracking	Y		N	X	
Peeling	Y		N	X	
Holidays	Y		N	X	
Pitting	Y		N	X	
Corrosion	Y	X	N		
Seams/Welds	Good				

Conclusion/Discrepancies: Surface corrosion noted on the pipe and the braces. The supports are acting as a sacrificial anode. Rubber needs to be placed between the metal surfaces

Conclusion

Based on the results of this underwater inspection and the cleaning which took place, it appears this tank is in full operational condition and should continue to provide a reliable water storage capacity for potable water use with proper maintenance.
Interior liner is at the end of its service life and needs to be replaced in the very near future.

Recommendations

PDI concurs with the recommendations of AWWA that all potable water reservoirs or storage tanks be cleaned and inspected at least every five years and in some cases, depending upon source waters, type and quantities of sediment, and presence (or lack thereof) of cathodic protection systems, more frequently.
The following recommendations are made to provide continued, uninterrupted service of your water storage tank:

1. Your tank should be inspected and cleaned every five years, as suggested by the AWWA. Routine inspections and cleanings provide ample time to perform remedial repairs to abnormalities discovered before having a chance to become problematic.
2. Roof vent needs a new smaller gauge screen in addition to the edges being sealed. Numerous pine needles and other organics found near the center of the tank on the floor
3. Roof entry way needs to have a rubber gasket put in place to create a good seal and keep out insects and debris from wind and elements
4. Exterior shell has minor cracking noted with efflorescence present. Monitor these cracks for change and correct as needed.
5. Interior liner exhibits cracking with fibers exposed. Liner is at the end of its service life
   Surface of the liner rubs off to the touch.
   Consideration and planning for a new liner and or coating the interior of the tank should be implemented now and replaced at the earliest convenience
   One small hole in the liner found at the divers 5:30 position right next to the wall floor seam.
   No indications of leaks.
6. Overflow pipe needs to have rubber against the braces and pipe to separate the two metal

surfaces. The braces are acting as a sacrificial anode to the pipe. The pipe itself has minor surface corrosion present. Braces should be replaced

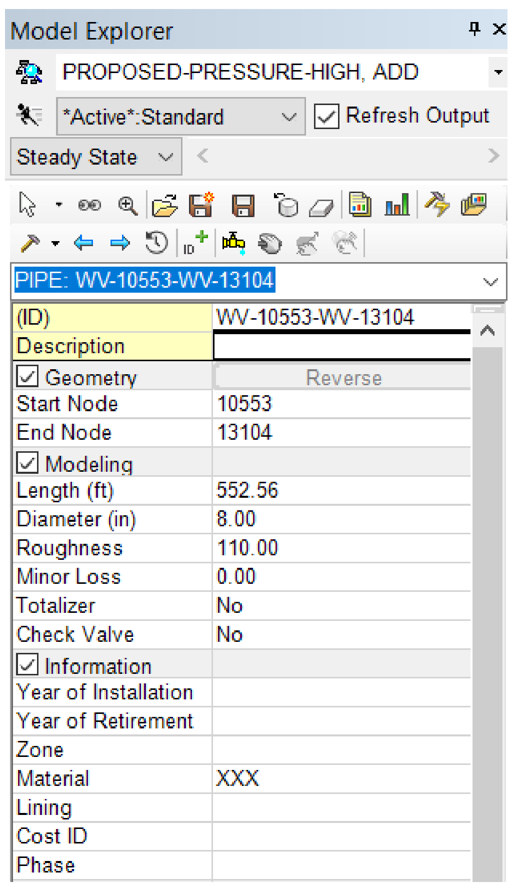
2021 Water System Master Plan

Appendix E. Instructions to Access System Analysis Assumptions

E. Instructions to Access System Analysis Assumptions

Retrieving Element Data from InfoWater

__Step 1:__ To view the settings of a single element, select the element. Open the ***Model Explorer*** (Figure E-1) and view the settings in the ***Geometry***, ***Modeling***, and ***Information*** sections (Figure E-2).



Step 2: To view all settings for an element type, select the ***DB Editor*** (Figure E-3) and choose the category of interest (Figure E-4).

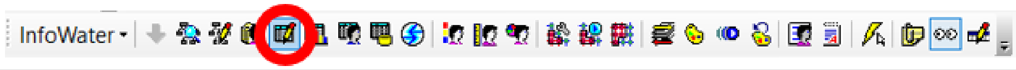


Figure E-3: *Database Explorer* icon

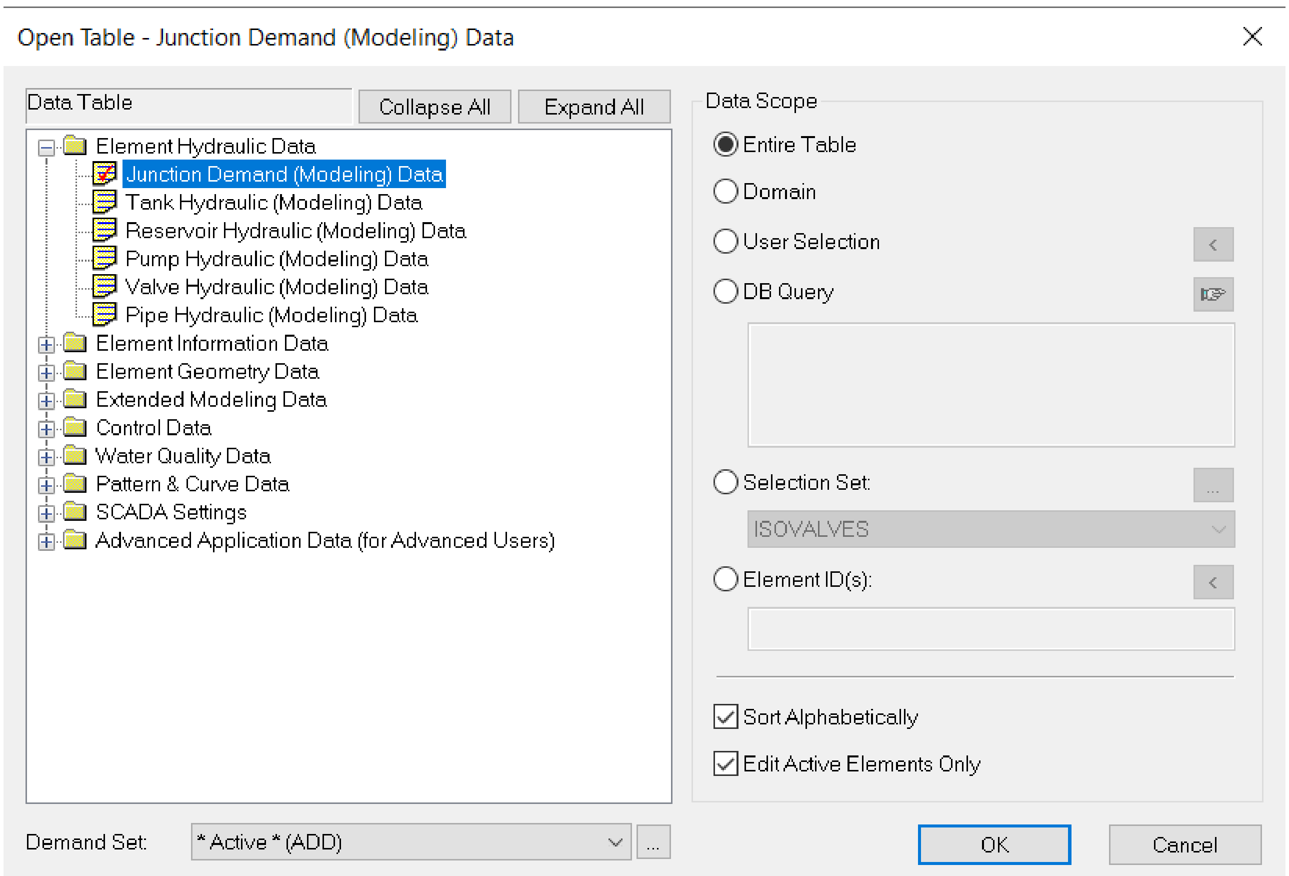


Figure E-4: *Database Explorer* categories

2021 Water System Master Plan

Appendix F. Instructions to Access Analysis Results; Pressure at PHD

F. Instructions to Access Analysis Results; Pressure at PHD

Retrieving Results from InfoWater

Step 1: Open the ***Scenario Explorer*** from the InfoWater task bar (Figure F-1).

Figure F-1: *Scenario Explorer* icon

Step 2: Select the scenario from the ***Scenario Explorer*** (Figure F-2) and click ***Activate***. See Table F-1 for the InfoWater scenario names.

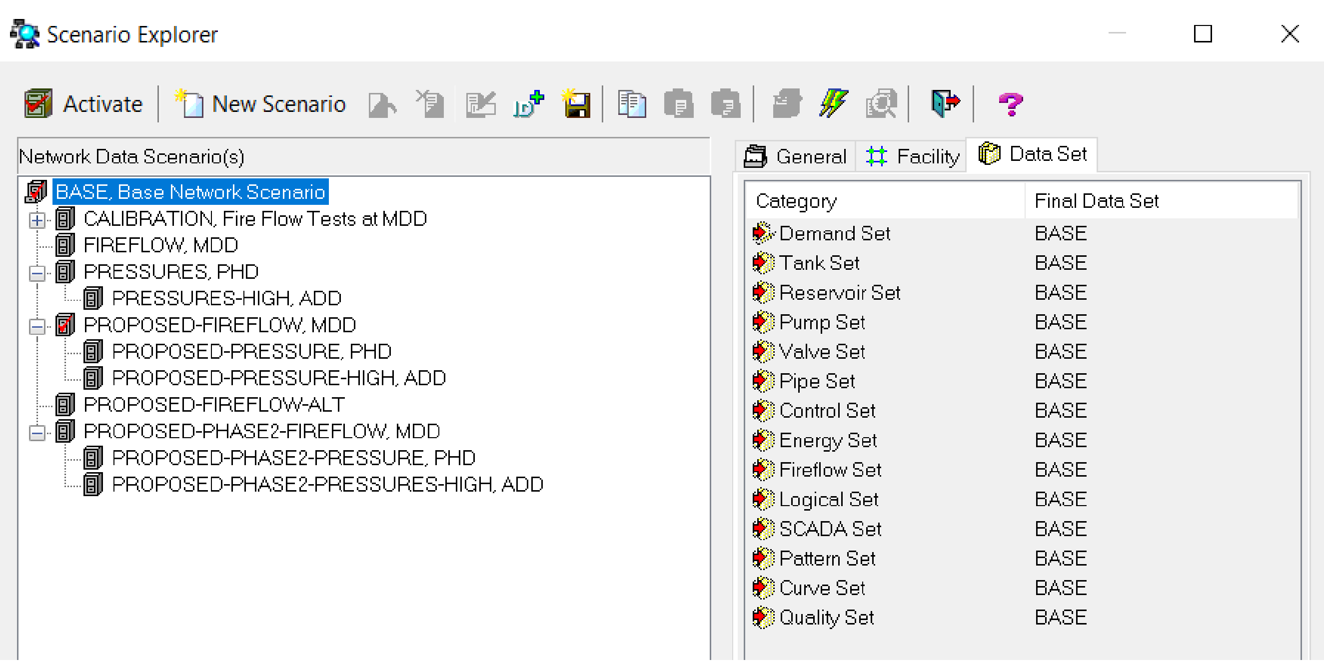


Figure F-2: Modelled scenarios as listed in the ***Scenario Explorer***

Table F-1: Model Scenario Names

Scenario Description	InfoWater Scenario Name
Existing Pressure at Peak Hour Demand	PRESSURES, PHD
Phase 1 Pressure at Peak Hour Demand	PROPOSED-PRESSURE, PHD
Phase 2 Pressure at Peak Hour Demand	PROPOSED-PHASE2-PRESSURE, PHD

Step 3: From the ***Model Explorer*** (Figure F-3), open the ***Run Manager*** (Figure F-4).

Figure F-3: ***Model Explorer*** icon

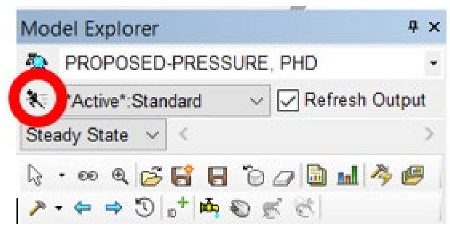


Figure F-4: ***Run Manager*** icon

Step 4: Select the ***Standard*** tab and ensure the settings match those shown in Figure F-5. Select the ***Run*** icon.

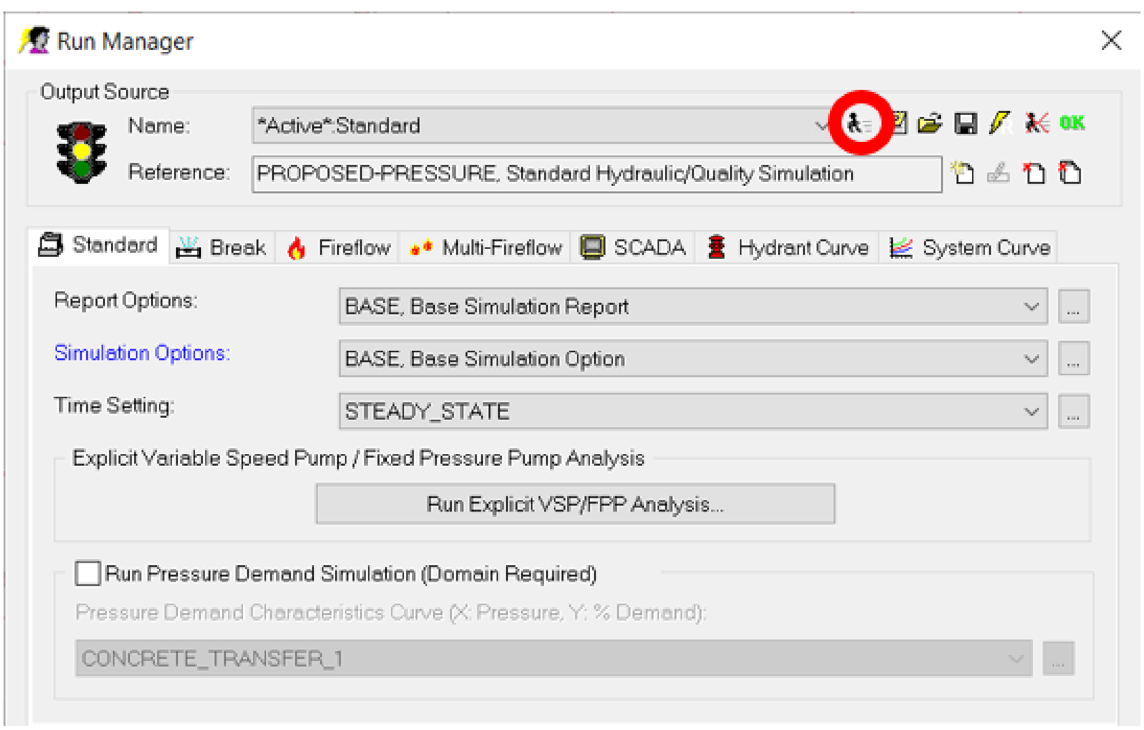


Figure F-5: ***Run Manager*** settings and ***Run*** icon

Step 5: To view results at a single location, select a pipe or junction. The results are displayed in the ***Output*** section of the ***Model Explorer*** (Figure F-6).

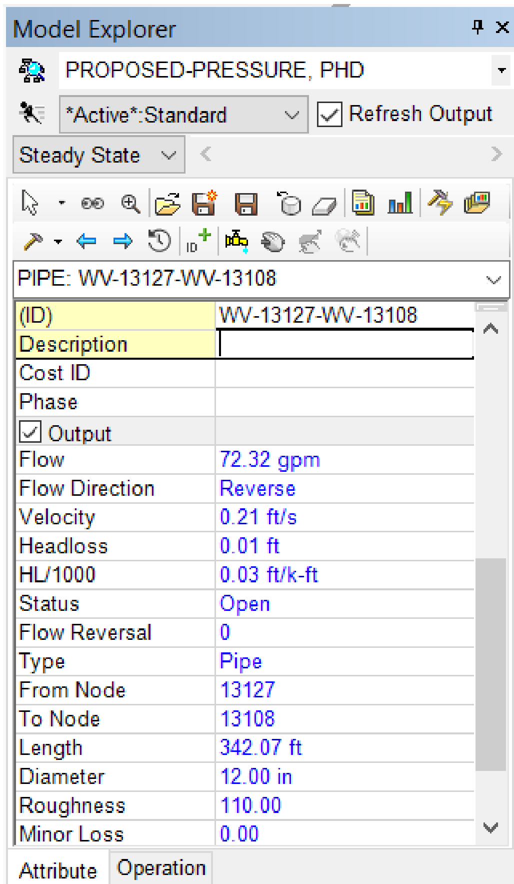


Figure F-6: Model results in the ***Model Explorer***

Step 6: To view all results, select the ***Report Manager*** icon (Figure F-7).

Figure F-7: ***Report Manager*** icon

2021 Water System Master Plan

Appendix G. Instructions to Access Analysis Results; Pressure at ADD

G. Instructions to Access Analysis Results; Pressure at ADD

Retrieving Results from InfoWater

Step 1: Open the ***Scenario Explorer*** from the InfoWater task bar (Figure G-1)

Figure G-1: ***Scenario Explorer*** icon

Step 2: Select the scenario from the ***Scenario Explorer*** (Figure G-2) and click ***Activate***. See Table G-1 for the InfoWater scenario names.

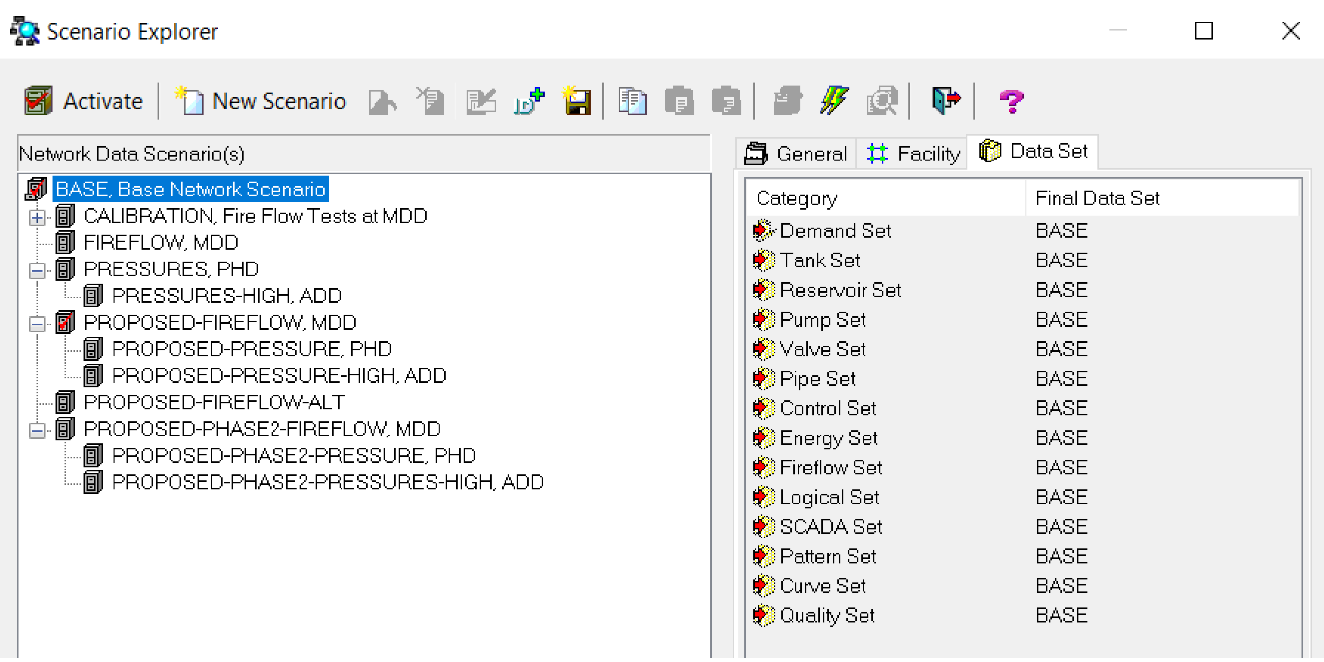


Figure G-2: Modelled scenarios as listed in the ***Scenario Explorer***

Table G-1: Model Scenario Names

Scenario Description	InfoWater Scenario Name
Existing Pressure at Average Day Demand	PRESSURES-HIGH, ADD
Phase 1 Pressure at Average Day Demand	PROPOSED-PRESSURE-HIGH, ADD
Phase 2 Pressure at Average Day Demand	PROPOSED-PHASE2-PRESSURES-HIGH, ADD

Step 3: From the ***Model Explorer*** (Figure G-3), open the ***Run Manager*** (Figure G-4).

Figure G-3: ***Model Explorer*** icon

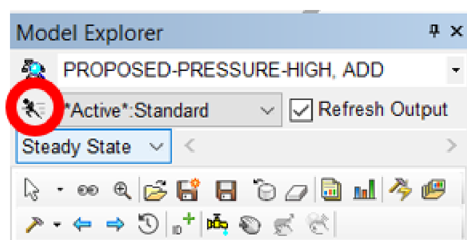


Figure G-4: ***Run Manager*** icon

Step 4: Select the ***Standard*** tab and ensure the settings match those shown in Figure G-5. Select the ***Run*** icon.

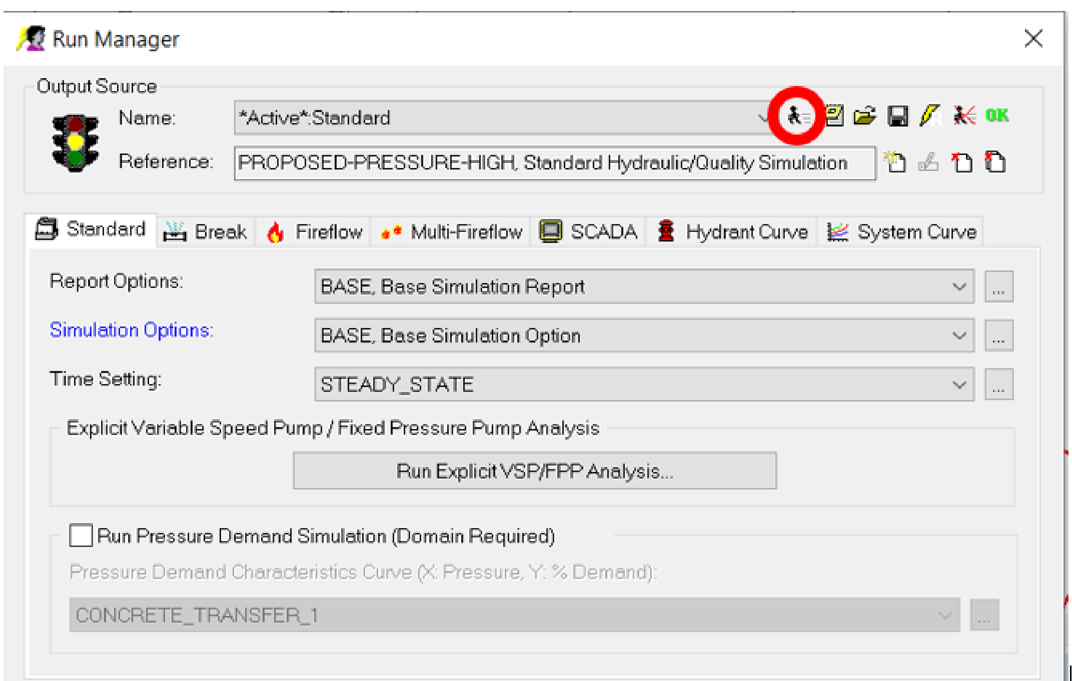


Figure G-5: ***Run Manager*** settings and ***Run*** icon

Step 5: To view results at a single location, select a pipe or junction. The results are displayed in the ***Output*** section of the ***Model Explorer*** (Figure G-6).

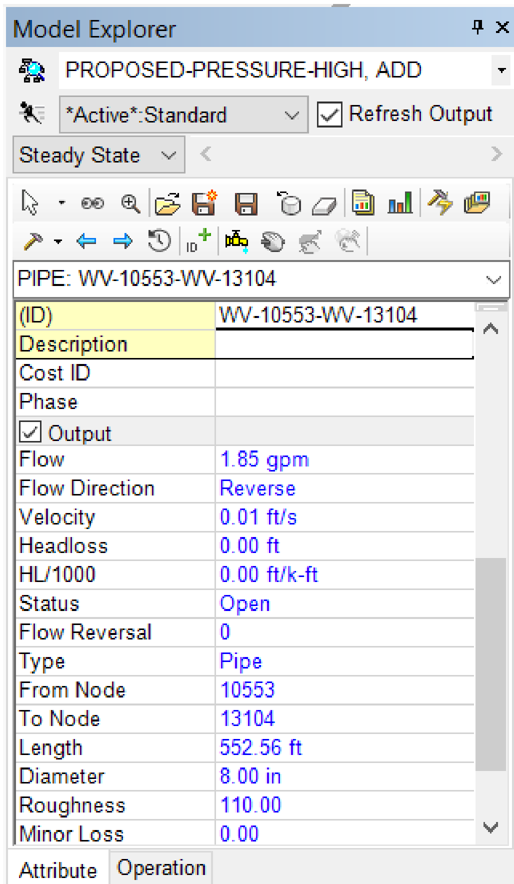


Figure G-6: Model results in the ***Model Explorer***

Step 6: To view all results, select the ***Report Manager*** icon (Figure G-7).

Figure G-7: ***Report Manager*** icon

2021 Water System Master Plan

Appendix H. Instructions to Access Analysis Results; Fire Flow at MDD

H. Instructions to Access Analysis Results; Fire Flow at MDD

Retrieving Results from InfoWater

Step 1: Open the ***Scenario Explorer*** from the InfoWater task bar (Figure H-1).

Figure H-1: *Scenario Explorer* icon

Step 2: Select the scenario from the ***Scenario Explorer*** (Figure H-2) and click ***Activate***. See Table H-1 for the InfoWater scenario names.

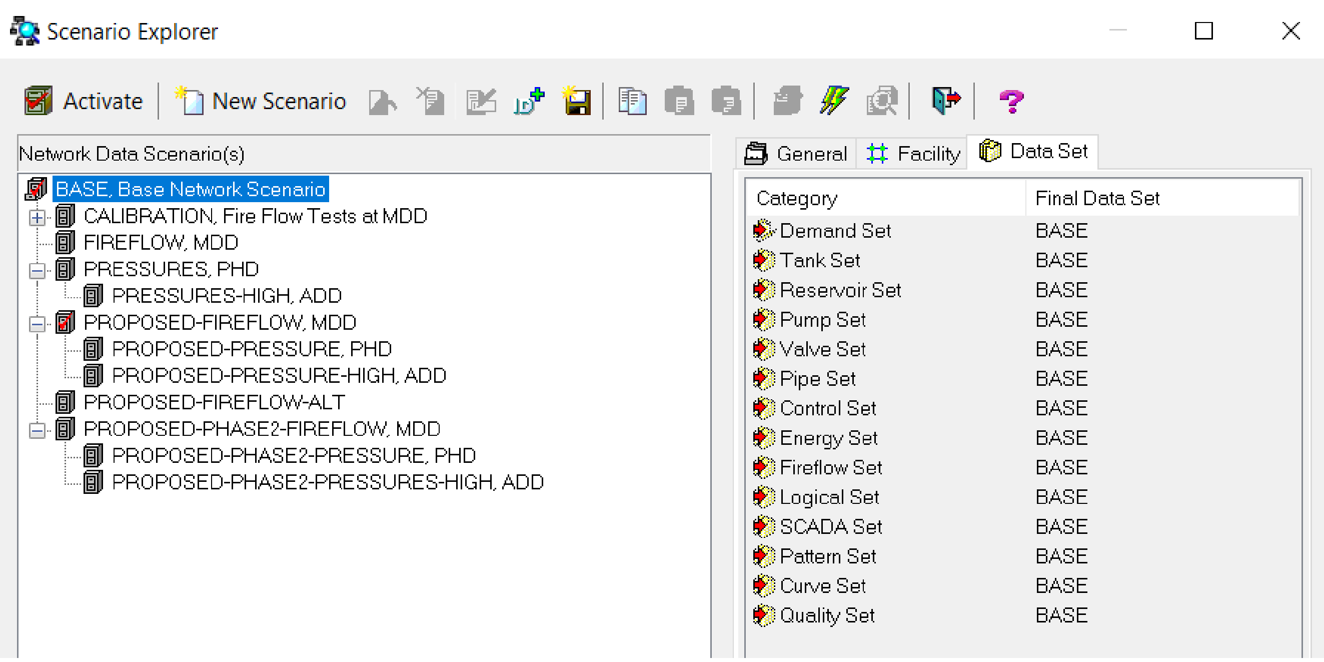


Figure H-2: Modelled scenarios as listed in the ***Scenario Explorer***

Table H-1: Model Scenario Names

Scenario Description	InfoWater Scenario Name
Existing Fire Flow at Maximum Day Demand	FIREFLOW, MDD
Phase 1 Fire Flow at Maximum Day Demand	PROPOSED-FIREFLOW, MDD
Phase 2 Fire Flow at Maximum Day Demand	PROPOSED-PHASE2-FIREFLOW, MDD

Step 3: From the ***Model Explorer*** (Figure H-3), open the ***Run Manager*** (Figure H-4).

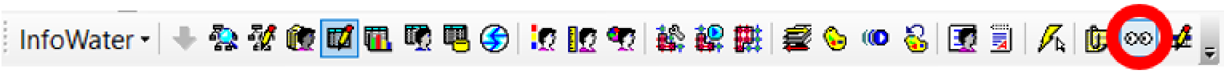


Figure H-3: ***Model Explorer*** icon

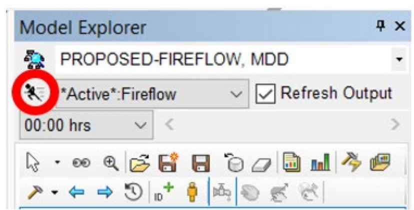


Figure H-4: ***Run Manager*** icon

Step 4: Select the ***Fireflow*** tab and ensure the settings match those shown in Figure H-5. Select the ***Run*** icon.

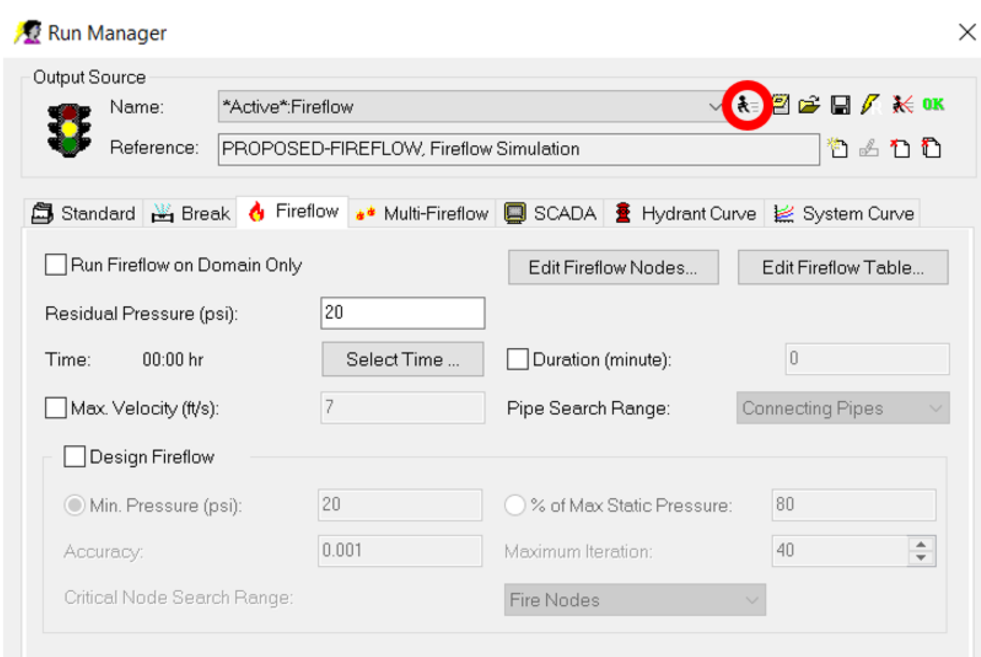


Figure H-5: ***Run Manager*** settings and ***Run*** icon

<u>Step 5:</u> To view results at a single location, select a hydrant node. The results are displayed in the ***Output*** section of the ***Model Explorer*** (Figure H-6).

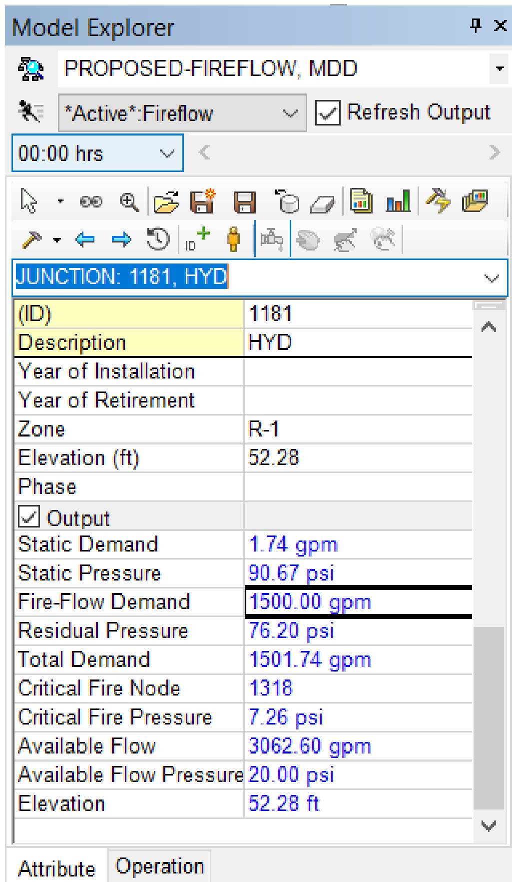


Figure H-6: Model results in the ***Model Explorer***

<u>Step 6:</u> To view all results, select the ***Report Manager*** icon (Figure H-7).

Figure H-7: ***Report Manager*** icon

2021 Water System Master Plan

Appendix I. Well Replacement Site Assessment

TECHNICAL MEMORANDUM

Screening-Level Assessment of City-Owned Parks as Sites for a Replacement Well, Milwaukie, Oregon

To: Peter Passarelli / City of Milwaukie

From: Matt Kohlbecker, RG / GSI Water Solutions, Inc.
Jack Dahl, PE / GSI Water Solutions, Inc.
Owen McMurtrey / GSI Water Solutions, Inc.
Kenny Janssen, RG / GSI Water Solutions, Inc.

Date: July 14, 2020

Executive Summary

This technical memorandum summarizes results from a screening-level analysis of the groundwater development potential at city-owned parks located within the City of Milwaukie, Oregon (City). This work was conducted by GSI Water Solutions, Inc., (GSI) under subcontract to Tetra Tech, Inc. as an element of the City's Well No. 2 Re-Establishment project.

This technical memorandum is organized as follows:

- Section 1 – Introduction. Describes the purpose and objectives of the screening-level analysis.
- Section 2 – Geology and Hydrogeology. Provides a brief overview of the geology and hydrogeology in the Milwaukie area, which is the basis for evaluating which parks have aquifer characteristics that are favorable from the perspectives of meeting groundwater demand and having a relatively low risk of groundwater contamination potential.
- Section 3 – Well Site Evaluation. Presents an evaluation of the potential for parks in the City to be future municipal well sites based on the following evaluation criteria: (1) aquifer characteristics, (2) potential water rights fatal flaws related to Johnson Creek, (3) proximity to existing City water infrastructure, (4) land use, and (5) Oregon Health Authority (OHA) setback requirements for municipal supply wells. Results of this evaluation identify five parks that are the best candidates for a new well.
- Section 4 – Conclusions and Recommendations. Summarizes results from the well site evaluation, identifies data gaps and uncertainties, and provides recommendations for next steps.

1 Introduction

The City uses eight municipal wells to supply its residents and businesses with potable water. Of the eight wells, six are active (Wells 2-7), one is for emergency supply purposes (Well 8), and one is inactive and planned for decommissioning (Well 1). All of the wells are completed in and obtain water from unconsolidated sediments of the Troutdale Gravel Aquifer. Locations of the City's wells are shown in Figure 1.

Well 8 was originally constructed in the mid-1980s (CLAC 3990) and was replaced in 2008 (CLAC 64690) because of lost performance due to biofouling and clogging of the well screen. Attempts to regain its lost capacity through chemical and mechanical rehabilitation have not been successful, and the City has decided to identify a potential new site for a replacement well. Because there are fewer constraints to siting new municipal wells on property owned by the City, this screening level analysis evaluates City-owned parks as potential new well sites.

2 Geology and Hydrogeology

The City is located on the southwestern edge of the Portland Basin, a 1,300 square mile topographic and structural depression bounded by the Portland Hills to the west and the Cascade Range to the north, east and south. The walls and sides of the Portland Basin are comprised of older Eocene to Miocene volcanic rocks (deposited from about 56 to 5 million years ago), and the basin is filled by up to 1,800 feet of consolidated and unconsolidated sediments of the late Miocene, Pliocene, and Pleistocene age (deposited from 5 million years ago to 11,700 years ago), called the Basin Fill Sediments (Swanson et al., 1993). This geology discussion focuses on the Basin Fill Sediments, which are the target for groundwater development by the City of Milwaukie[1].

A surficial geologic map of the City of Milwaukie is provided in Figure 1, and a cross section showing subsurface geology is provided in Figure 2. With the exception of the southwest and west part of the City where the volcanic rocks crop out at ground surface, the Basin Fill Sediments are present throughout the City. The Basin Fill Sediments rapidly thicken to the east, reaching over 500 feet on the east and northeast part of the City (Swanson et al., 1993).

As shown in the Figure 2 cross section, the Basin Fill Sediments consist of a complex sequence of geologic units that include the Sandy River Mudstone, Troutdale Formation, and Missoula Flood Deposits (which consists of the Coarse-Grained Facies, Channel Deposits, and Willamette Silt). The Troutdale Formation and Missoula Flood Channel Deposits are the primary water-bearing units in the City, and are comprised of permeable gravels and sands. The clay and silt layers of the Sandy River Mudstone separate deeper portions of the Troutdale Formation, which partially confines the formation and provides some degree of protection from surficial sources of contamination. The Missoula Flood Channel Deposits do not contain the silt and clay layers, and are therefore not as protected from potential surface contaminants.

In Milwaukie, sediments in the Troutdale Formation are classified by the United States Geological Survey (USGS) as belonging to the Troutdale Gravel Aquifer (TGA) (Swanson et al., 1993). Groundwater in the deep TGA generally flows west towards the Willamette River. Deviations from the westward direction of groundwater flow occur in the shallow portions of the TGA, where groundwater flows towards surface water bodies (e.g., Kellogg Creek and Johnson Creek) and towards the Missoula Flood Channel Deposits (see Figure 1, which shows shallow groundwater flow directions in the TGA).

3 Well Site Evaluation

This section presents methods and results from a screening level evaluation of the groundwater development potential at city-owned parks within the City of Milwaukie. Section 3.1 provides an overview of the criteria used to assess site suitability at each of the parks. Section 3.2 summarizes results of the screening-level assessment based on the evaluation criteria. Section 3.3 discussions limitations to the findings presented in Section 3.2.

3.1 Criteria for Evaluating and Ranking Parks

City-owned parks were categorized and ranked using the following evaluation criteria:

[1] Because the City plans to transfer the existing water right for Well No. 8 to the new well, the new well will need to be completed in the same aquifer as Well No. 8. Well No. 8 is completed in the Basin Fill Sediments.

- Aquifer Characteristics
- Proximity to Existing Water Infrastructure
- Water Rights Fatal Flaws Related to Johnson Creek
- Land Use
- Ability to Meet Oregon Health Authority (OHA) Setbacks

The following sections discuss the methods that were used to categorize and rank City-owned parks according to these criteria.

3.1.1 Aquifer Characteristics

The aquifer must be able to sustainably produce the required amount of water. The City's existing wells produce over 500 gpm. Therefore, for the purpose of this assessment of potential well sites, we are assuming a target production rate of at least 500 gpm for the new well.

GSI obtained approximately 500 water well logs located within and surrounding the City from OWRD's on-line well log database (OWRD, 2018). The well logs were used to compile observed well testing data (e.g., well yields) within the City. Wells were included if they met the following criteria: (1) well construction is similar to the likely construction of a new City well (i.e., over 200 feet deep and completed with perforations or screens), (2) the well log includes well testing data using pumping test or air test methods (no bailer tests), and (3) wells could be located accurately to a quarter-quarter section. No wells in the Missoula Flood Channel Deposits met the criteria of being over 200 feet deep, so all wells discussed in this technical memorandum are completed in the Troutdale Formation.

A total of 13 wells met the above criteria. Table 1 summarizes the yield and specific capacity reported on the well logs after the wells were constructed. The aerial distribution of well yields is shown in Figure 3. The reported well yield and specific capacity data for each well are provided in Appendix A. Well yield is the amount of water that a well produces. Specific capacity is an indicator of well performance (i.e., well yield per foot that the groundwater level is drawn down when pumping in units of gallons per minute per foot of drawdown).

Table 1. Well Yield and Specific Capacity in the Troutdale Gravel.

	Number of Tests	Minimum	Average	Maximum
Well Yield	13	150 gpm	700 gpm	1,190 gpm
Specific Capacity	13	2.5 gpm/ft	7.4 gpm/ft	16.7 gpm/ft

NOTES:
gpm = gallons per minute   gpm/ft = gallons per minute per foot of drawdown

The data in Table 1 indicate that the TGA in Milwaukie is a fairly productive aquifer. The yield of most wells (85%) exceeds 500 gpm. The lowest-yielding wells may be influenced by well construction, with the lower yields (i.e., 200 gpm at CLAC 368 and 150 GPM at CLAC 382) observed at wells that (1) do not penetrate the entire thickness of the Troutdale Gravel Aquifer[2], (2) are completed with perforations instead of screens, or (3) are completed with small (8-inch diameter) casing. Based on the well yields shown in Figure 3, a well that utilizes the entire saturated thickness of the Troutdale Gravel is anticipated to produce 500 gpm, though aquifer heterogeneity could have localized impacts on well performance and yield where low-permeability or flow-limiting hydraulic boundary conditions are present. Well yields are more likely to significantly exceed 500

[2] See the cross section in Figure 2

gpm near the Catastrophic Flood Deposit Channel, where the Troutdale Formation appears to be more permeable.

3.1.2 Proximity to Existing Water Infrastructure

Significant cost savings can be realized if the City develops a groundwater source near existing water conveyance piping that is sufficiently large to convey the additional flow of water from a new well. For the purpose of this screening level analysis, an 8-inch water main was deemed sufficient to convey the added capacity from a new well site without having to upgrade the existing water system infrastructure to accommodate the additional flow, and a park was considered to be near existing piping if it was within 500 feet of the 8-inch water main. Note that the 8-inch piping diameter is used for screening purposes only; local water demands (for example, a large volume water-user near a park) could cause a larger pipe diameter to be necessary. The location of the City's 8-inch water mains are shown on Figure 4. Most City parks are within 500 feet of an 8-inch water main.

3.1.3 Water Rights Fatal Flaws Related to Johnson Creek

When evaluating the transfer of a groundwater right, OWRD considers whether the proposed transfer would cause injury to other existing water rights, would result in enlargement of the water right to be transferred, and would be from the same or a different water source (e.g., aquifer). Because the City's transfer would involve the same aquifer (the Troutdale Gravel Aquifer) and would not enlarge the water right, OWRD's evaluation primarily would consider whether adding another well would cause injury, either by increasing impacts on other groundwater users or increasing impacts on water rights for nearby surface water bodies. We recommend that the City conduct an in-depth evaluation of water rights permitting challenges as a first step in selecting a park for the future site of a new well.

One potential fatal flaw to water rights permitting is related to Johnson Creek. Because the Oregon legislature has withdrawn Johnson Creek from further surface water appropriation [see OAR 690-502-0150(1)(a)], a transfer that modifies the City's water right for Well 8 in order to add a well of closer proximity to Johnson Creek may be found to cause injury if it were found to increase the impact of groundwater pumping on Johnson Creek. For the purposes of this evaluation, GSI has assumed that parks must be greater than one-quarter mile from Johnson Creek to be favorable for groundwater development[3]. Well sites within up to one mile of Johnson Creek are not considered to be fatally flawed, but further investigation is needed to assess whether OWRD would find that a proposed transfer would cause injury.

3.1.4 Land Use

The City has several zoning designations, which GSI grouped into the broad categories of industrial, commercial, parks/open space, and residential (which includes multi-use residential, multi-family residential, and single family residential). A zoning map for the City of Milwaukie is provided in Figure 5. The zoning designations in the City provide insight as to the types of activities that occur at a particular location and, by extension, the potential risk of adversely affecting groundwater quality at a particular location. Areas zoned residential are predominantly made up of single-family and multi-family uses, and pose a relatively low risk of water quality impacts to the aquifer. Parks and open space areas are undeveloped, and also pose a relatively low risk of water quality impacts. Areas zoned industrial and commercial represent properties where large quantities of hazardous materials may be used, handled or stored and pose a relatively higher risk of water quality impacts. Consequently, parks located in residential zoned areas are more favorable for groundwater development than parks located in industrial and commercial zoned areas. The evaluation of land use also considered groundwater flow direction. Potential well sites located downgradient of industrial areas are less favorable for development because contamination from an industrial area may be carried towards the potential well site by groundwater.

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[3] OWRD may find PSI with Johnson Creek for wells located up to 1.0 miles from the creek. Further investigation is needed to evaluate whether OWRD will find PSI for new or replacement wells located between one-quarter mile and 1.0 miles from Johnson Creek.

3.1.5 Ability to Meet OHA Setbacks

OHA does not allow several features (sewage drain fields, underground storage tanks, stormwater drainage facilities, etc.) or activities (vehicle maintenance, chemical storage or use, etc.) within 100 feet of a municipal supply well [see OAR 333-061-0050(2)]. In order to ensure that these features do not exist and activities do not occur, the municipality must own the property within a 100-foot radius of the well. If the City does not control ownership within the 100-foot radius setback, then they must obtain an easement from the neighboring property owners that lie within any portion of the 100-foot radius of control. Some parks in the City are too small to accommodate this setback requirement. City parks sufficiently large to meet the ownership setback requirement are considered favorable future well sites.

3.2 Well Site Evaluation

GSI's screening-level analysis of whether parks meet the criteria for groundwater development in Section 3.1 is summarized in Table 2. A check mark indicates that the park meets the screening criteria; no check mark indicates that the park does not meet the screening criteria.

Table 2. Park Suitability as a Well Site

Park	Within 500 feet of ≥8-Inch Water Main?	More Than ¼ Mile From Johnson Creek	Troutdale Formation Likely to Yield > 500 GPM	Not Downgradient or Adjacent to Indus./Comm. Land Use	Meet OHA 100' Ownership Requirement
Furnberg Park	✓	✓	✓	✓	✓
Milwaukie Center		✓	✓	✓	✓
Wichita Park	✓	✓	✓	✓	
Bowman & Brae Property	✓	✓	✓	✓	
Homewood Park	✓	✓	✓		✓
Willow Place Natural Area		✓	✓	✓	
Balfour Park	✓	✓	✓		
Minthorn Natural Area	✓	✓	✓		
Century Park		✓	✓		
Homewood Park	✓	✓	✓		✓
Weber Open Space	✓	✓	✓		
Scott Park	✓		✓		
Roswell Pond Open Space	✓		✓		
Ardenwald Park	✓		✓	✓	
Ball-Michel Park	✓		✓	✓	

NOTES:
gpm = gallons per minute gpm/ft = gallons per minute per foot of drawdown

Table 2 does not include parks that are already the site of a City well so that the yield of the new well can be maximized (i.e., installing additional wells in the Water Tower Park and Stanley Park, which are already sites of City wells, would interfere with pumping of the existing wells) and does not include parks that are adjacent to the Willamette River (i.e., Spring Park and Milwaukie Bay Park).

Table 2 shows that the most important criteria for distinguishing which potential sites are favorable for future wells are land use, ability meet the OHA requirement to own land within 100 feet of the well, and being more than one-quarter mile from Johnson Creek. Likely yield from the Troutdale Formation is not as important a criterion because the Troutdale Formation appears capable of producing about 500 gpm of groundwater from a properly-constructed well (i.e., large diameter and penetrating the entire thickness of the Troutdale Formation) throughout the City. In addition, proximity to water conveyance piping is not as important a criterion because almost all parks are within 500 feet of water conveyance piping that is equal to or greater than 8-inches in diameter.

The scoring in Table 2 indicates that Furnberg Park is the most favorable for development of a municipal supply well because it meets all five evaluation criteria. Wichita Park, the Bowman & Brae Property, Milwaukie Center, and Homewood Park are also favorable parks for groundwater development because they meet four of the five evaluation criteria. At Wichita Park and the Bowman & Brae Property, an easement would be necessary to meet OHA's requirement to own property within 100 feet of the well. At Homewood Park, the City would need to confirm that use of a commercial property near the does not pose a risk of contaminating groundwater. At Milwaukie Center, the City would need to invest in about several thousand feet of new conveyance piping.

The parks that are favorable to groundwater development are shown in orange in Figure 5 (other parks are shown in green). Additional information about the five parks that are most favorable for groundwater development, and the pressure zone that each park is located in, are provided in Table 3.

Table 3. Best Future Well Site Candidates Based on Screening Level Analysis.

Park (Pressure Zone)	Distance to ≥8-Inch Water Main (feet along streets)	Distance From Johnson Creek	Park Dimensions	Aquifer Production Notes
Furnberg Park (Zone 2)	~460 feet	> 1.0 miles	340'by >250'	CLAC 382 (0.2 miles from Park) produces 150 GPM, does not fully-penetrate Troutdale Formation; Well No. 6 (~0.5 miles west of Furnberg Park) produces 800 GPM
Milwaukie Center (Zone 2)	~3,200	> 1.0 miles	>1000' by >1000'	~0.3 Miles south of Well No. 8 (produces 800 GPM)
Wichita Park (Zone 3)	Adjacent	~0.70 miles	220' by 175'	Well No. 6 (~0.4 miles north of Wichita Park) produces 800 GPM
Bowman & Brae Property (Zone 2)	Adjacent	> 1.0 miles	120' by 250'	~0.5 Miles southwest of Well No. 8 (produces 800 GPM)
Homewood Park (Zone 2)	~250 feet	~0.85 miles	340' by 475'	~0.5 miles east of Well No. 7

Each park may face some unique challenges for groundwater development:

- Furnberg Park will require additional investment in water conveyance piping. In addition, an evaluation would need to be made to assess the potential for a well in Furnberg Park to cause injury to CLAC 382, and existing irrigation well located about 1,000 feet northeast of the park.
- Milwaukie Center is within 0.3 miles of Well No. 8, which has experienced reduced well yield due to biofouling. If the biofouling is due to local aquifer conditions, then a well at Milwaukie Center may experience similar biofouling issues (note that the cause of the biofouling at Well No. 8 is not known). Milwaukie Center will also require additional investment in water conveyance piping.
- Wichita Park and Homewood Park are within 1.0 miles of Johnson Creek and, therefore, OWRD may find that transferring the water right from Well No. 8 to a new well results in an increase in PSI. We recommend an in-depth evaluation of PSI and other water rights challenges as a first step for selecting a park for development of a municipal groundwater source. In addition:
  - The City would need to obtain an easement at Wichita Park to meet the OHA requirement to own land within 100 feet of the well.

  - The City would need to confirm that commercial land use adjacent to Homewood Park does not pose a risk of groundwater contamination, and research DEQ records to confirm that no chemical releases to soil or groundwater have been reported at the property. In addition, the property is barely large enough to accommodate the 100 foot radius ownership requirement from OHA; the property will need to be evaluated further to confirm that the 100 foot radius ownership requirement can be met.
- The City would need to obtain an easement to meet the OHA requirement to own land within 100 feet of a well developed at the Bowman & Brae Property site.

3.3 Limitations

There are several important limitations associated with the scoring of the potential well locations listed in Table 2:

- Well yields and specific capacities reported on drillers' logs after the well was first constructed were used to characterize existing aquifer conditions and assess whether the aquifer could meet the targeted pumping demand. Aquifer performance and well yield can only be confirmed by conducting a drilling and testing program.
- OWRD may find that groundwater has PSI with Johnson Creek even if the well is located more than one-quarter mile from a the Creek. OWRD may not find PSI for parks located within one quarter mile of Johnson Creek if the Park is located closer to the Willamette River.
- Current land use assesses the relative risk of adversely affecting groundwater quality; it is not an indicator of the actual presence/absence of groundwater quality concerns or contamination. Specifically, areas of residential land use may have been contaminated due to historical land use, septic systems, illicit dumping, etc.

4 Recommendations and Next Steps

Results of this evaluation support the following recommendations and next steps:

- Further evaluate potential water rights challenges or limitations, particularly evaluating the potential for OWRD to determine PSI at locations between one-quarter and one mile from Johnson Creek prior to selecting a park for groundwater supply development.
- Research DEQ records of environmental contamination at the preferred park sites to refine which parks are best candidate sites for installing a new municipal supply well.
- The City of Milwaukie uses drywells (also known as Underground Injection Controls or UICs) to infiltrate stormwater runoff from municipal rights of way into underground soils. The City's UICs were authorized by a UIC Water Pollution Control Facilities (WPCF) permit from DEQ. The permit requires that the City's UICs are located outside of the two-year time of travel zone of a municipal groundwater well, *or* have at least five feet of vertical separation between the bottom of the UIC and seasonal high groundwater. The City should evaluate which parks are the best candidate sites for maintaining compliance with its UIC permit.
- Assess the potential for wells located near Milwaukie Center to experience biofouling to determine if other wells exhibit similar conditions or if biofouling is an aquifer issue.
- If a test well or production well is drilled, collect a groundwater sample and analyze water quality in a lab to inform any treatment requirements.
- As the City conducts further evaluation of the five parks which are the most favorable for groundwater development, the City may learn new information that makes the parks unfavorable. In this case, the City should revisit other parks that scored highly but were not considered one of the five most favorable parks in this analysis. For example, Willow Place Natural Area did not meet the OHA 100 foot radius criterion or

the proximity to water infrastructure criterion. However, the City may find that an easement could be easily obtained for the property (to meet the OHA requirement) and that the 1,000 foot distance to 8-inch diameter conveyance piping is not a significant barrier to development of a well.

5 References

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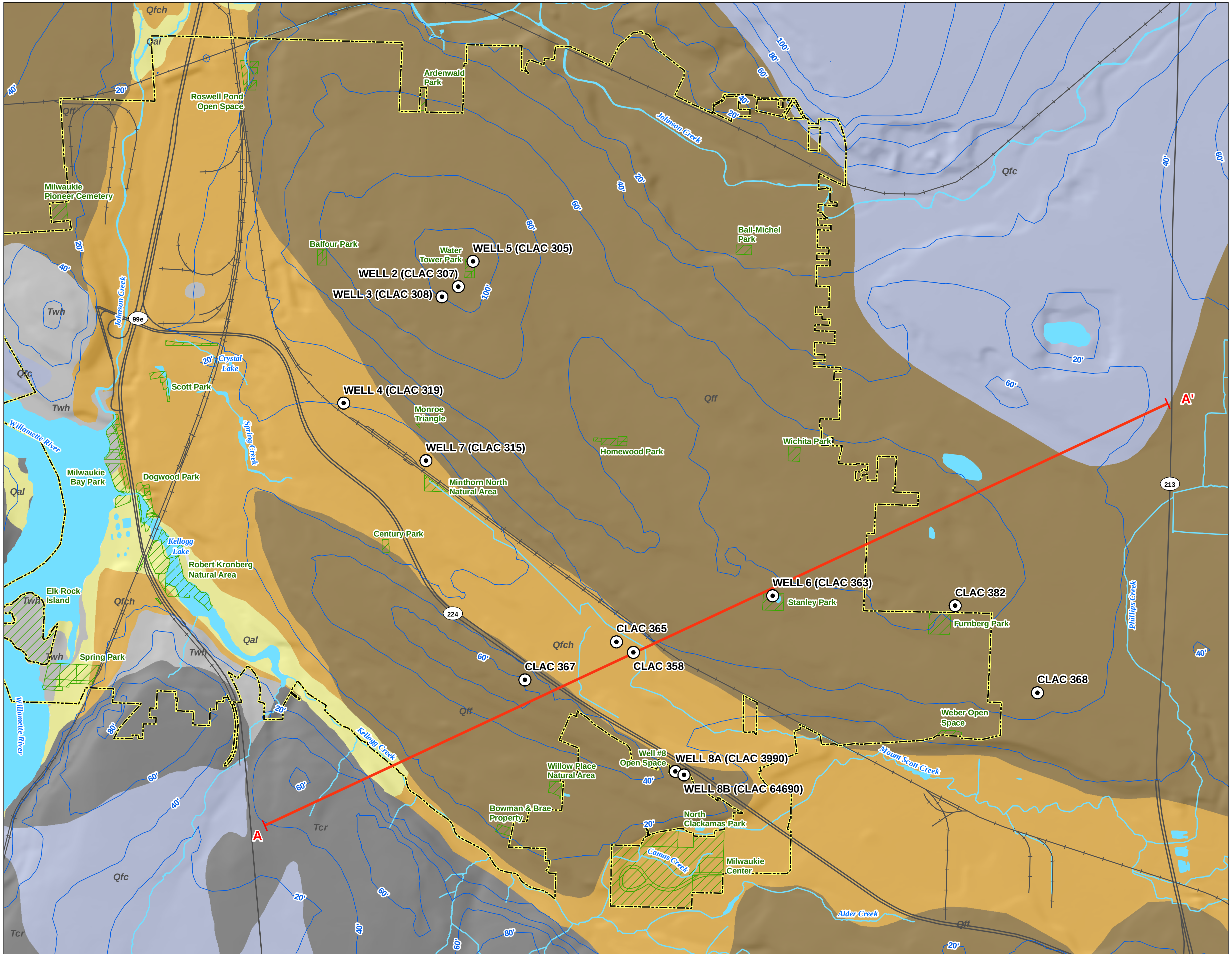
FIGURE 1

Surficial Geology

Evaluation of Groundwater Supply Expansion Potential at City Parks

City of Milwaukie



LEGEND

- Well
- Cross Section Line
- Water Table Elevation
- City of Milwaukie Park

Basin Fill Sediments

- Qal - Alluvium
- Qfch - Missoula Flood Deposits, Channel Deposits
- Qff - Missoula Flood Deposits, Willamette Silt
- Qfc - Missoula Flood Deposits, Coarse Grained Facies

Volcanic Rocks

- Tcr - Columbia River Basalt Group
- Twh - Basalt of Waverly Heights and associated undifferentiated sedimentary rocks

All Other Features

- City Boundary (generalized)
- Railroad
- Major Road
- Watercourse
- Waterbody

N

0 750 1,500 2,250

Feet

Date: November 15, 2018
Data Sources: METRO, Clackamas Co., DOGAMI, Snyder 2008

GSI Water Solutions, Inc.

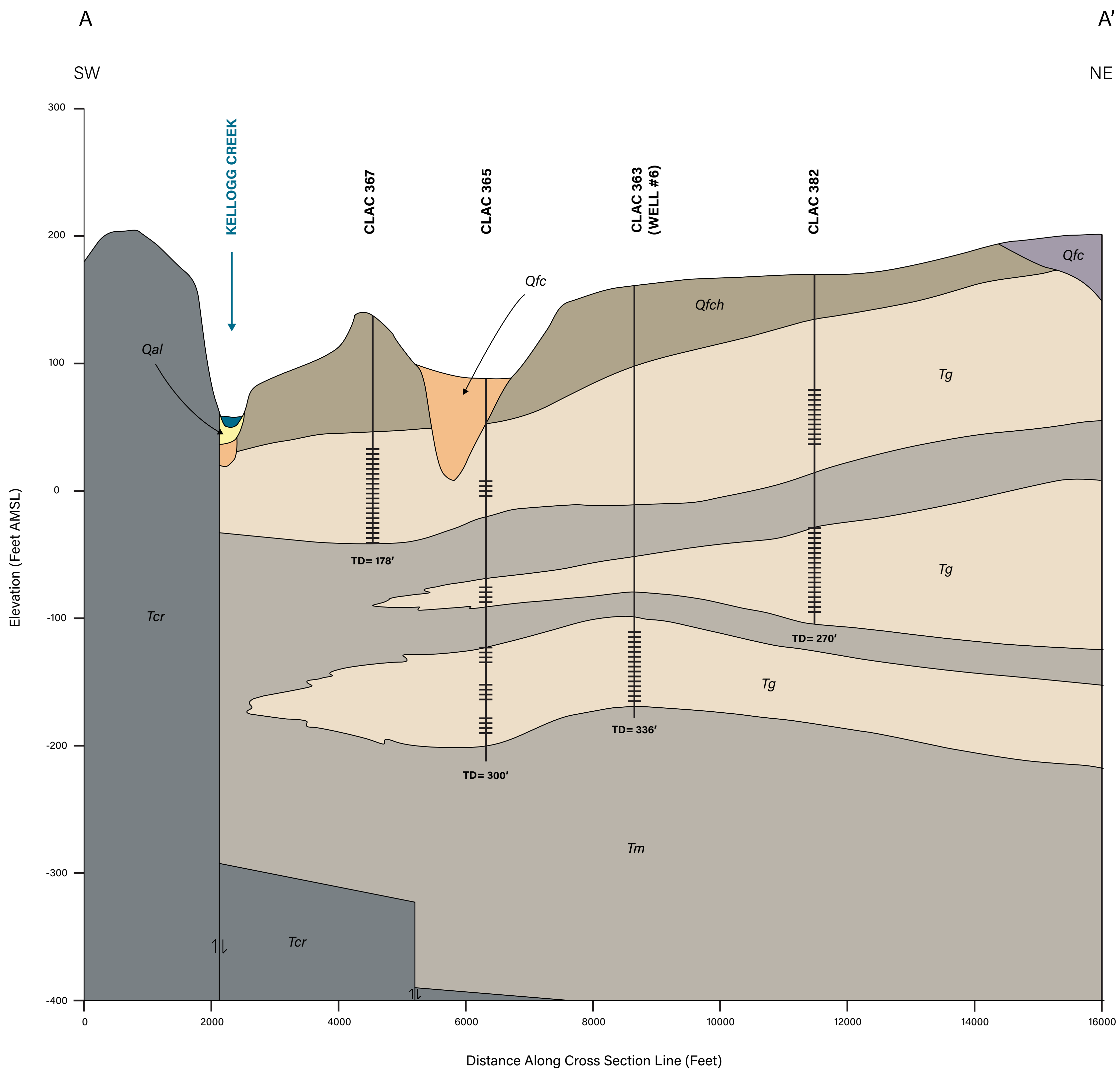


FIGURE 2

Cross Section A

Evaluation of Groundwater Supply Expansion Potential at City Parks

City of Milwaukie

LEGEND

Basin Fill Sediments

- Qal - Alluvium
- Qfc - Missoula Flood Deposits, Channel Deposits
- Qfch - Missoula Flood Deposits, Willamette Silt
- Qfc - Missoula Flood Deposits, Course Grained Facies
- Tm - Sandy River Mudstone
- Tg - Troutdale Formation

Volcanic Rocks

- Tcr - Columbia River Basalt Group

WELL (Screen denoted by horizontal lines)

NOTES:

20X Vertical Exaggeration

AMSL = Above mean sea level

TD = Total Depth

Date: November 14, 2018

GSI Water Solutions, Inc.

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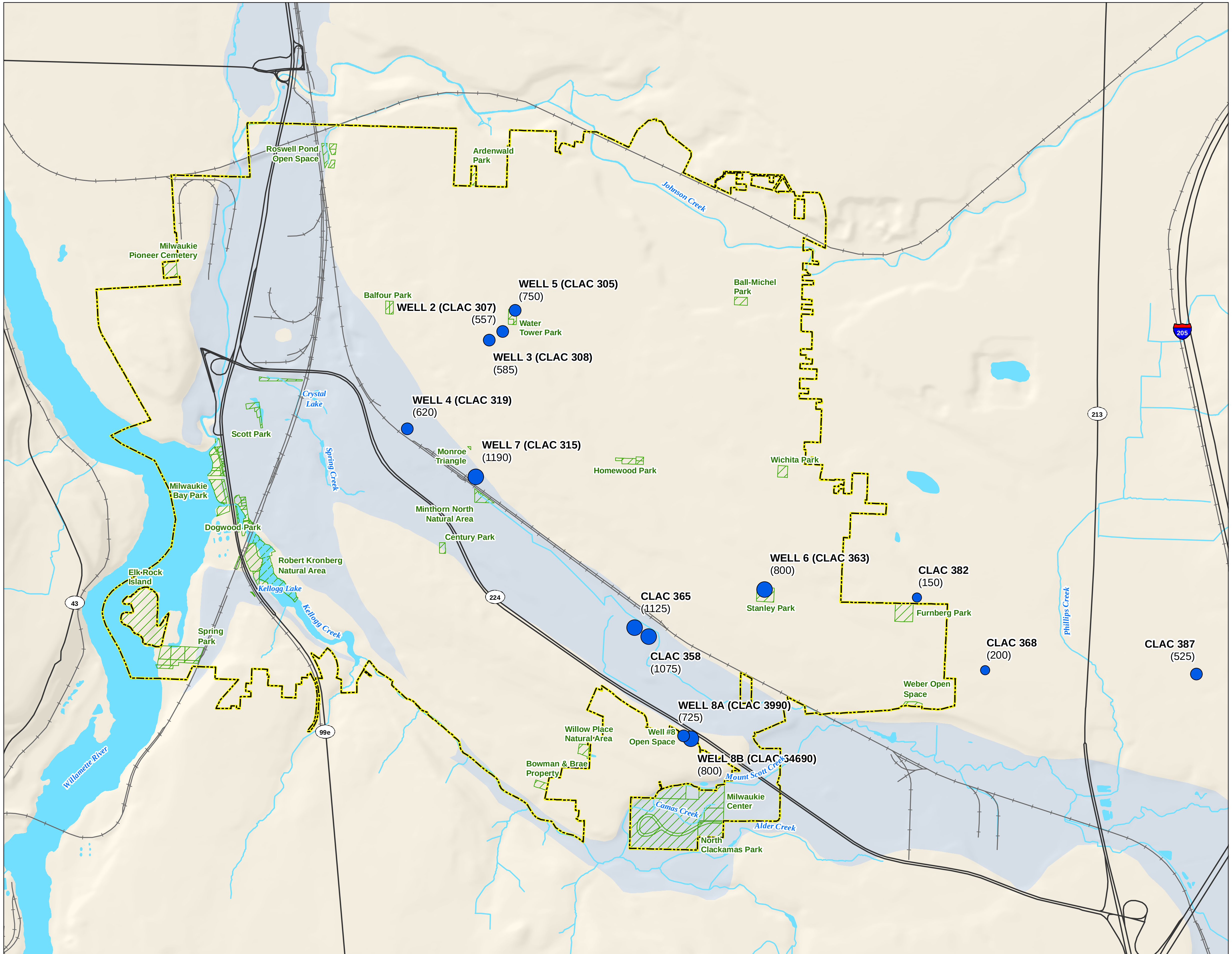

FIGURE 3

Well Yields From the Troudale Gravel

Evaluation of Groundwater Supply Expansion Potential at City Parks

City of Milwaukie

LEGEND

Well (with yield)

- < 250 gpm
- 250 - 750 gpm
- > 750 gpm
- Location of Catastrophic Flood Channel Deposits (Qfch)
- City of Milwaukie Park

All Other Features

- City Boundary (generalized)
- Railroad
- Major Road
- Watercourse
- Waterbody

NOTE:
gpm = gallons per minute

N

0 900 1,800 2,700
Feet

Date: November 15, 2018
Data Sources: ESRI, USGS, DOGAMI, METRO

GSI Water Solutions, Inc.

Document Path: Y:\0312_Tetra_Tech\Source_Figures\002_City_of_Milwaukie\Figure3_Well_Yields.mxd

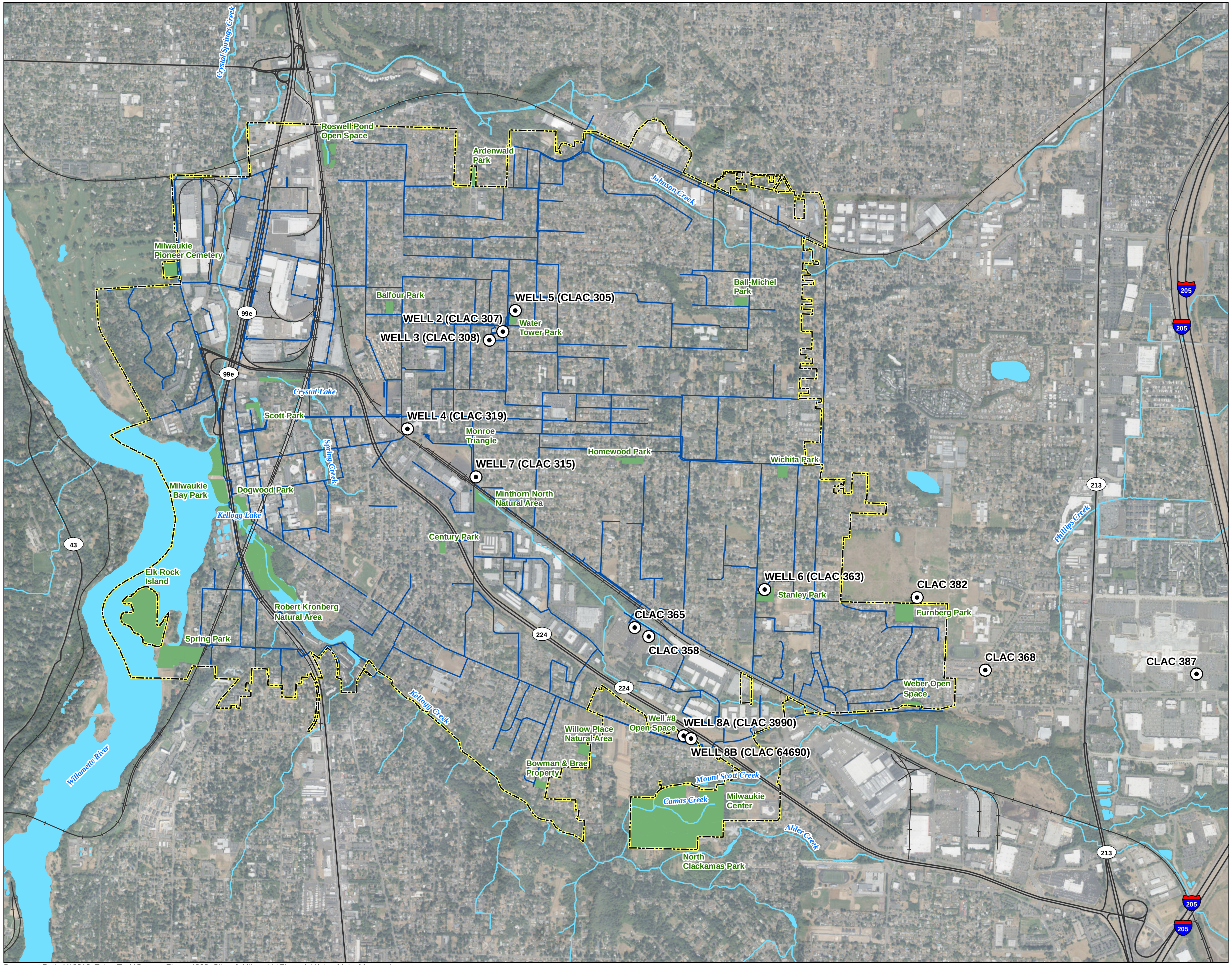

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FIGURE 4

Water Main Distribution System

Evaluation of Groundwater Supply Expansion Potential at City Parks

City of Milwaukie

LEGEND

- Well
- Water Main (diameter greater than or equal to 8 inches)
- City of Milwaukie Park

All Other Features

- City Boundary (generalized)
- Railroad
- Major Road
- Watercourse
- Waterbody

N

0 900 1,800 2,700
Feet

Date: November 15, 2018
Data Sources: METRO, DOGAMI, Clackamas Co., City of Milwaukie, City of Portland Areal Imagery Taken Summer 2015

GSI Water Solutions, Inc.

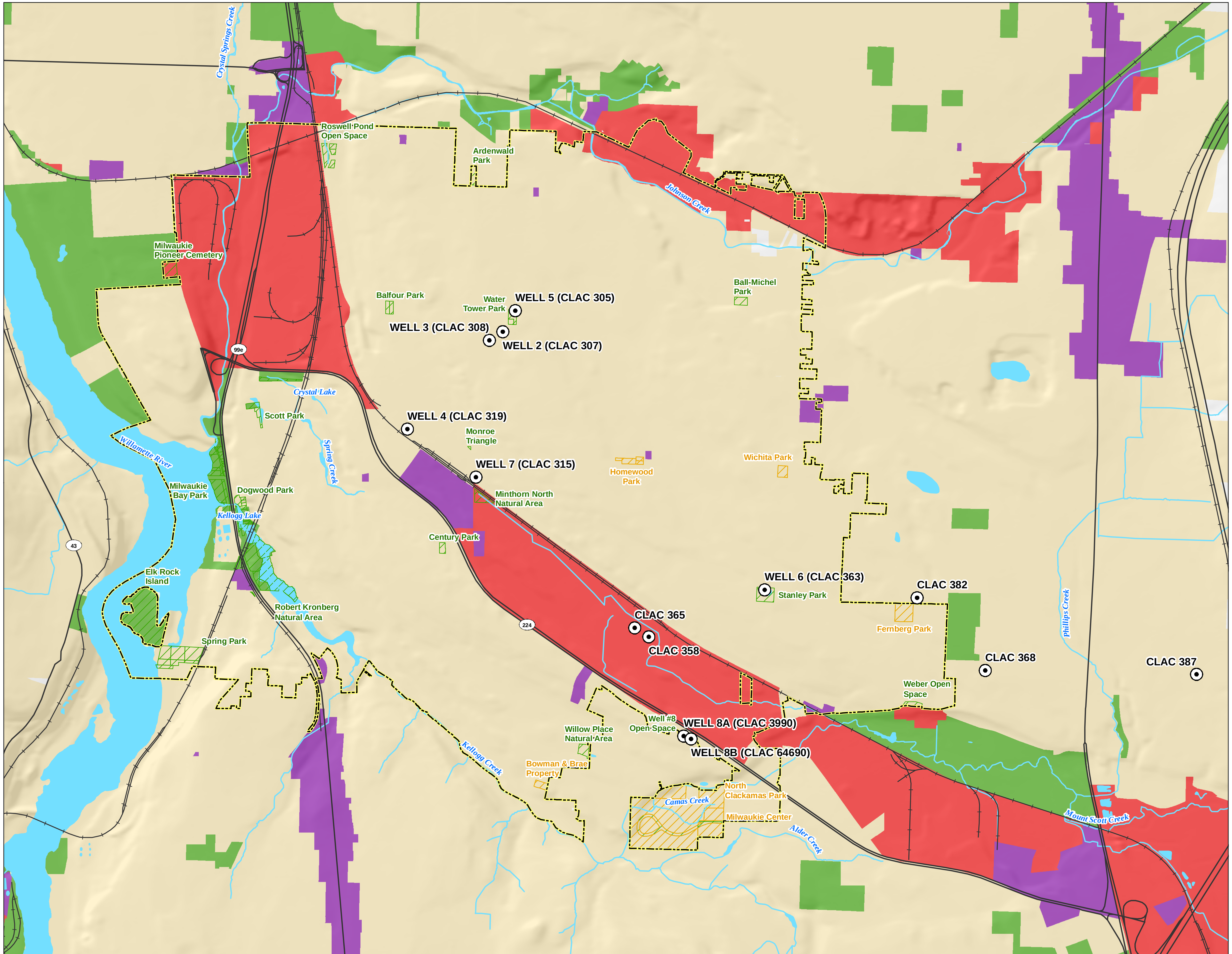

FIGURE 5

Zoning Map

Evaluation of Groundwater Supply Expansion Potential at City Parks

City of Milwaukie

LEGEND

Well

Community Parks

Less Favorable for Groundwater Development

Most Favorable for Groundwater Development

Zoning

Industrial

Commercial

Parks and Open Spaces

Residential[1]

All Other Features

City Boundary (generalized)

Railroad

Major Road

Watercourse

Waterbody

NOTE:
[1]Includes Multi-Use residential, Multi-Family residential, and Single-Family residential.

N

0 900 1,800 2,700
Feet

Date: November 28, 2018
Data Sources: METRO, DOGAMI, Clackamas Co., City of Milwaukie

GSI Water Solutions, Inc.

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2021 Water System Master Plan

Appendix J. Water Quality Sampling Plan

CITY OF MILWAUKIE

Water Quality Sampling Plan

Public Water System ID #OR4100528

Stanley Avenue Reservoir 3.0 million gallons

Prepared by City of Milwaukie Staff

Table of Contents

Section 1

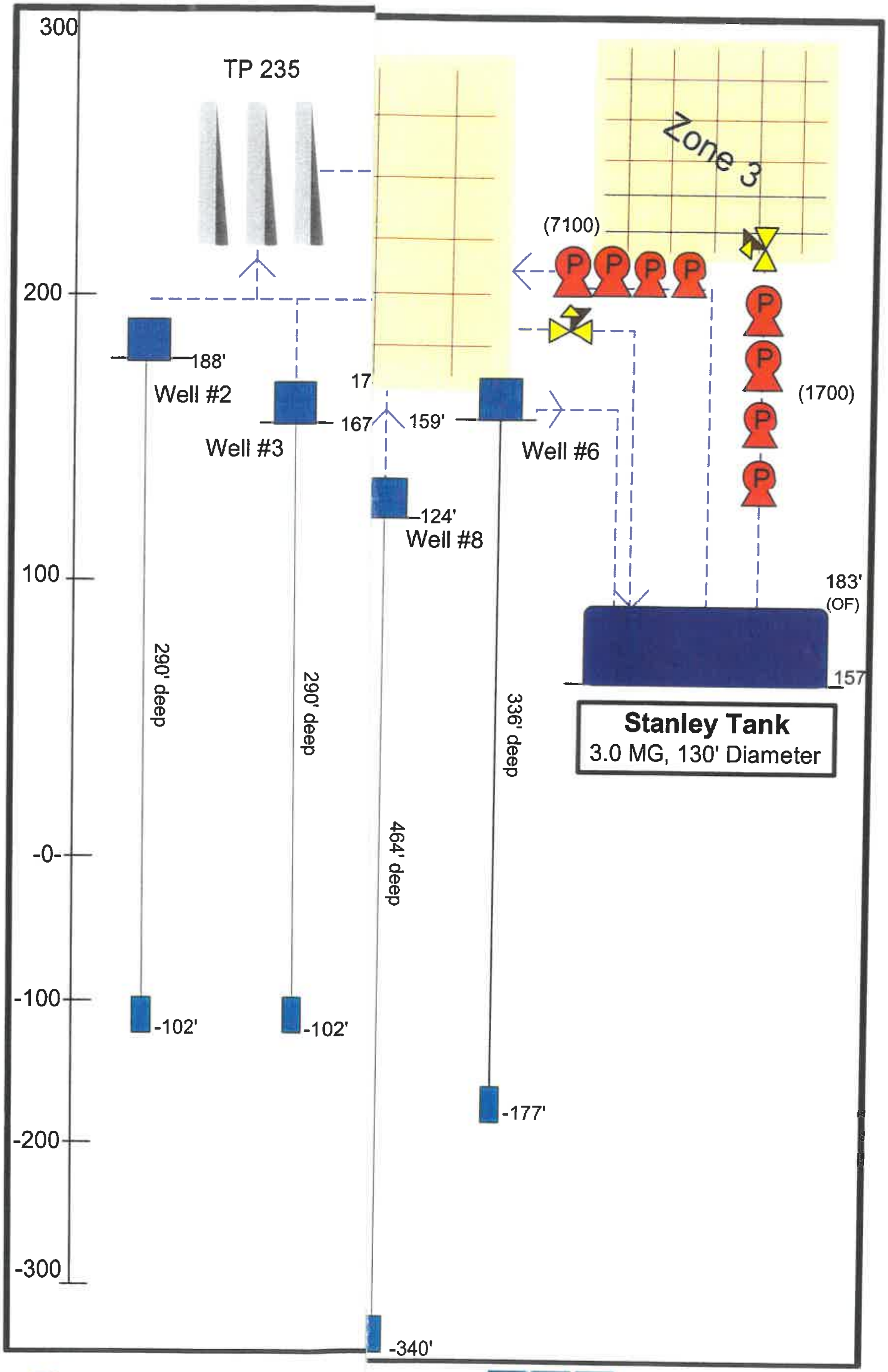
System Description

The Milwaukie water system delivers a daily average of 2.6 million gallons to nearly 7,000 service connections ranging in size from 5/8" to 10". Seven wells, drawing from the Troutdale gravel aquifer, are capable of supplying 6.2 million gallons every day. To ensure our future supply, the City of Milwaukie complements the daily pumping with ½ million gallons from Clackamas River Water (CRW). Storage is accomplished by 3 reservoirs with a shared capacity of 6 million gallons. An emergency intertie with Portland Water Bureau augments emergency capacity. The City distribution system includes approximately 100 miles of pipeline, 4 pressure zones controlled by pressure-regulating valves, and 2 booster stations.

Five of the 7 wells carry volatile organic chemicals that are stripped out of the water by means of packed aeration towers. Cl_2 gas is injected into the flow stream prior to the treatment towers and a polishing dose is added after the aeration. Water from 2 wells is pumped directly into the distribution piping after disinfection by Cl_2 gas injection. The surface water from CRW is disinfected by means of sodium hypochlorite. Minimum system pressure is 43 PSIG directly below the elevated tank at maximum drawdown. Pressure and disinfectant residual levels are continuously monitored and controlled via the City of Milwaukie's system control and data acquisition (SCADA) system.

Typical installation of Eclipse #88 sample station

Distribution system coliform monitoring is accomplished 4 times per month for a total of 20 samples drawn from a list of about 90 sites.



MONTGOMERY WATSON

CITY OF MILWAUKIE

Distribution Sampling map (color, oversized)—map omitted for now

Section 2

Purpose

This manual is prepared to inform, educate, and provide standard procedures for trained and certified staff of the City of Milwaukie Water Division, in order to consistently monitor the quality of drinking water in relation to microbiological and disinfection by-product (DBP) sample collection.

The procedures outlined herein are for reference only and are not to be considered as the only correct way to collect a sample. This manual is not intended to take the place of staying current with accepted practices or standards. This manual outlines the required certifications and procedures for personnel engaged in coliform monitoring.

Sample site lists for coliform and DBP are maintained within Section 7 and must be kept current. The senior treatment plant operator DRC (Utility Specialist) is responsible for the maintenance of this manual.

All maps, drawings, and lists are subject to change and will be updated a minimum of once per compliance period. *(Every 2 years as set by Oregon Department of Human Services.)*

Section 3

Scope

Sampling of the distribution system for coliform and disinfection by-products (DBP) is only one part of the multibarrier approach to ensure that our delivered water is safe and free of pollutants. This sampling plan will not cover related security, treatment techniques, or production schemes that are the precursors to an effective sampling plan.

This manual provides the reader with personnel requirements, site selection, sample collection technique, and proper recording and reporting of coliform and DBP results. Water system maps and schematics are included to aid in the sample site selection and emergency response planning. Samples of chain of custody, lab reporting slips, and mandatory reports and a quick reference to the Total Coliform Rule are included.

Section 4

Personnel

Personnel Requirements and Responsibilities

All persons that will be collecting, reporting, or otherwise affecting any portion of this sample plan must be certified at minimum Water Distribution 1 or Treatment 1 by the State of Oregon Department of Human Services Drinking Water Division (DHS). Employees enrolled in a training program may perform tasks associated with this plan under the direction of the DRC.

The sampler is required to follow all steps in collecting, recording, and preserving the samples. Any sampler may be required, at the request of the DRC, to enter data and submit the appropriate monthly or quarterly report to DHS.

The Treatment DRC is responsible for maintaining all records and ensuring that all tools and training necessary are in place to accomplish the tasks as set by this plan.

Furthermore, it is the responsibility of the person collecting samples to be clearly identifiable as an employee of the City of Milwaukie; they must carry City-issued identification. At no time does the collecting of samples warrant entry into a fenced yard or backyard. The sampler must remain in plain view of the street or observant neighbor.

The below-listed personnel currently meet the requirements of this plan and may collect and submit samples. The monthly report may only be submitted by the Treatment DRC or the Distribution DRC.

Jay Saatkamp	Supervisor	Water Distribution III	DRC
Don Simenson	Utility Specialist	Water Distribution III Water Treatment I	Alt. DRC DRC
Dick Torpey	Utility Worker	Water Distribution II	
Tyler McCune	Utility Worker	Water Distribution II Water Treatment I	 Alt. DRC

It is the responsibility of the above-listed persons to collect samples and maintain records in accordance with this manual and State of Oregon Department of Human Services Drinking Water Division rules as specified in OAR 333-061-0036-0040.

Personnel Acknowledgment

All personnel engaged in the activity of coliform monitoring must sign and date this form. The placement of signature to this document denotes employee understanding and acceptance of proper methods and best practice as set forth within this manual.

Print Name	Certification	Cert. #	Signature	Date
~~Jay Saatkamp~~	~~WD III~~	~~1465~~	Wm Jay Saatkamp	6-28-04
Don Simenson	WT I, WD III CCS	2872 3064		
~~Dick Torpey~~	~~WD II~~	~~3155~~		
~~Tyler McCune~~	~~WT I, WD II~~	~~6230~~		

Mike Clark WD 1

Jamie Clark WD 3

Sean Flye WD 1

Michael Cunningham WD 1

Cross-Connection Specialist

Section 5

Sample Site Selection

Careful selection of sample sites is extremely important and cannot be left merely to chance. The overall list of monthly sample sites must take into consideration the overall complexity of the distribution system. The plan goal is to accomplish coverage of potential low-flow areas and sites near potential contaminants and cross-connections. Generally, sites must reflect all pressure zones and pipe diameters.

Hose bibs at customer services and specially designed sample taps are both acceptable sample locations. Caution must be taken to avoid sites that promote bacterial growth. The following should be avoided.

1. Single-lever faucets that control both hot and cold.
2. Faucets with leaking packing around the stem.
3. Faucets in areas of high bacterial growth such as janitor closets and industrial hand and part cleaning.
4. Faucets with an opening pointing up or too close to the ground.
5. Faucets with "Y" attachments to garden hose or other unknown use. Never collect samples from drinking fountains, bubblers, or faucets with aerators attached or through a hose.

Routine sample sites should be located based on the following questions.

1. Are repeat sample sites available within 5 service connections both up- and downstream? **ANSWER:** Yes.
2. Is the sample tap clear-flowing at least 1 foot off the ground without obstruction such as shrubbery or guard dog? **ANSWER:** Yes.
3. Is there any undue plumbing such as unprotected irrigation or home water treatment? **ANSWER:** No.
4. In general, will the water from the faucet reflect the water in the main? **ANSWER:** The water must reflect the same attributes as the water from the main within a 1-minute flush.
5. Will the site be available year-round? **ANSWER:** Preferably.

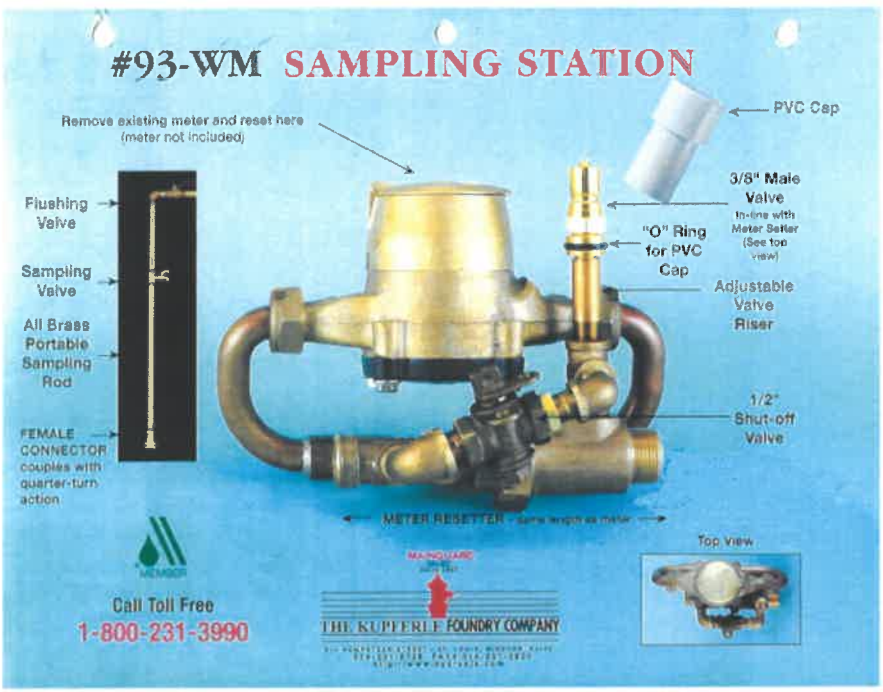
Repeat sample sites must be located within 5 service connections both up- and downstream of the original sample site and be tapped from the same main. Keep in mind that a home located just across the street is not necessarily on the same main line.

Sample Point Improvements

Routine sampling at customer service hose bibs, while satisfactory, is not the best practice. City staff is implementing an ongoing program and has set standards for the inclusion of permanent, dedicated sample stations.

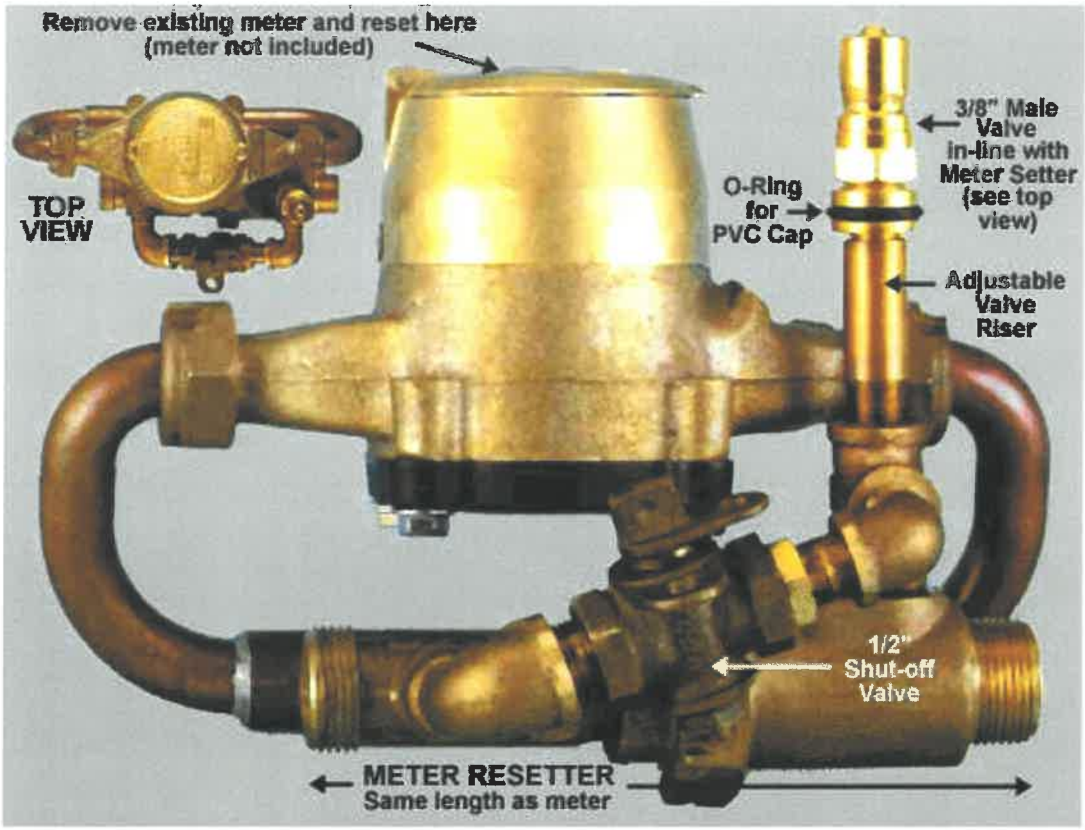
Sample stations are to be included on all new, replacement, or major repairs to water mains. The new sample stations shall be Eclipse Model #88 with all brass waterways, freeze-proof piping arrangement, locking enclosure, and above-ground sample port.

Existing meter setters will be equipped with #93-WM sample stations wherever possible.



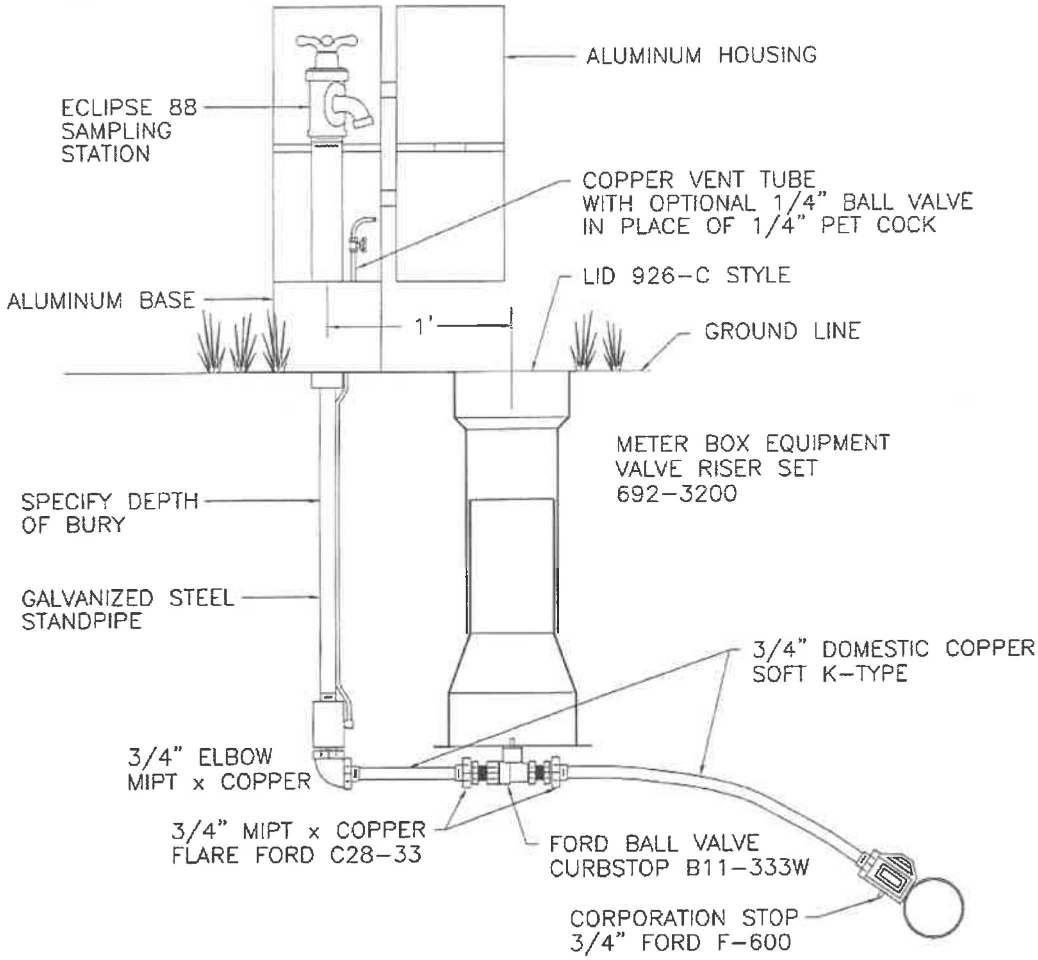
Retrofit sampling station for existing meter setter locations

#93-WM sample station typical installations



#93-WM sample station (close-up)

ECLIPSE NO. 88 SAMPLING STATION



Sampling Stations shall be ' bury, with a 3/4" FIP inlet, and a (3/4" hose or unthreaded) nozzle.

All stations shall be enclosed in a lockable, nonremovable, aluminum-cast housing.

When opened, the station shall require no key for operation, and the water will flow in an all brass waterway.

All working parts will also be of brass and be removable from above ground with no digging. Exterior piping shall be galvanized steel (brass pipe also available).

A copper vent tube will enable each station to be pumped free of standing water to prevent freezing and to minimize bacteria growth.

Eclipse No. 88 Sampling Station shall be manufactured by Kupferle Foundry, St. Louis, MO 63102.

Sample Collection Technique

The methods set forth in this section are intended to prevent false positive results. Setting basic guidelines for the collection of microbiological samples ensures that all personnel will collect, record, and sample using the same methods. Any variance to these collection methods must be approved by the Treatment DRC and noted in the appendix of this manual.

Proper technique in sampling is only as good as the paperwork submitted that must accompany the sample. Below is a sample of a properly completed analysis form.

Enter Public Water System ID # in boxes below:

4	1	0	0	5	2	8

Name of Water System: CITY OF MILWAUKIE

Phone 503-786-7622 County CLACKAMAS

Collection date and time: 01 / 03 / 03 (Month Day Year) 10 : 57 (Hour Min) a.m. p.m.

Type of sample: ☒ Routine ☐ *Repeat ☐ Special

*If repeat, date of initial positive

If repeat, location: ☐ Upstream ☐ Same ☐ Downstream ☐ Other

Collected by: John SAMPLES

Sample point: 11226 SE 37TH AVE.

Chlorinated? ☒ Yes ☐ No Free chlorine mg/l .22

DHS

MICROBIOLOGICAL ANALYSIS

PUBLIC WATER SUPPLIES

DRINKING WATER PROGRAM

LABORATORY RESULTS

Total coliforms: ☐ Present* ☐ Absent

Fecal coliforms/*E.coli*: ☐ Present* ☐ Absent

*see back of pink copy for interpretation

Test Methods:

Total coliforms: ☐ MTF ☐ MF ☐ P-A ☐ CF

Fecal coliforms: ☐ EC

E. coli: ☐ CF ☐ EC+MUG ☐ Nutrient Agar + MUG

☐ cytochrome oxidase/Beta-galactosidase

*If repeat, sample ID of initial positive:

☐ Sample invalid: resample immediately

Return address for report:

Name CITY OF MILWAUKIE

Address 6101 SE JohnsonCreek BLVD.

City, state, zip MILWAUKIE, OR 97206

Copy Distribution:

White: Lab

Yellow: Dept. of Human Services

Pink: Water System

Form # 50-90 (Rev. 1/02)

303778-02

The following page is a sample of the chain of custody that must accompany the Quarterly Haloacetic Acids (HAA5) and Trihalomethanes (TTHM). It is recommended to collect HAA5 and TTHM at the same time as coliform samples.

Project Manager: Don Simonson = DRC

Company Name: City of Milwaukie

Address: 6101 SE Johnson Creek Blvd

City, State, ZIP: Milwaukie, OR 97206

Phone: 503-786-7622

FAX: 503-786-7635

Tigard, OR 97223

Tel. 503-639-9311

Fax 503-684-1588

Lab Project Number

P.O. # or Project #

Project Name: 1st QTR 2004

Sampling Location: City of Milwaukie

Sampling Date: 1-23-04

Lab Location

Sample Composition: Treated / Distribution

Sampled By: Tyler McCune = Cert. operator WD1 or WT1

PWSID #: 4100528

RUSH?** YES NO

LAB USE ONLY	SAMPLE IDENTIFICATION	Sample Number	Time	CL_2	TYPE	ANALYSIS REQUIRED
	6101 SE Johnson Creek Water Quality	1	10:20 AM	.21	DW	HAA/TTHM
	2100 SE Ochoco Pharmacy sink	2	10:37 AM	.18	DW	
	3426 SE Kathryn Court Hose bib front	3	10:51	.22	DW	
	12200 SE McLoughlin Blvd. Building 1 north bib	4	11:16	.30	DW	
	10500 SE Waverly Court south end garage	5	11:28	.17	DW	
		6				
		7				
		8				
		9				
		10				

Additional Analyses:

# of Bottles:

Requested By:

Date:

Relinquished By: Tyler McCune	Date/Time: 1/23/04 12:31 pm	Received By	Date/Time
Relinquished By	Date/Time	Received By	Date/Time
Relinquished By	Date/Time	Received By	Date/Time

Proper Microbiological Sampling Techniques

Proper sampling techniques are extremely important in obtaining accurate water quality information. An improperly taken coliform sample may indicate bacteriological contamination of your water when the water is actually safe. You can avoid the cost of additional testing by using good sampling procedures.

Carefully follow these steps in taking a sample for bacteriological testing.

1. Select the sampling point. The sampling point must be a faucet from which water is commonly taken for public use.
   - The sampling point should be a nonswivel faucet.
   - Remove any aerator or screen and flush.
   - It should not be a faucet that leaks, permitting water to run over the outside of the faucet. Leaking faucets can promote bacterial growth.
   - If an outside faucet must be used, disconnect any hoses or other attachments and be sure to flush the line thoroughly (see step 4).
   - Do not use fire hydrants as sampling points. Do not dip the bottle in reservoirs, spring boxes, or storage tanks in order to collect the sample.

   If you have any questions about proper sampling points, please contact your certified laboratory, county health department, or the DHS.

2. Use only sample bottles provided by the lab specifically for bacteriological sampling. Coliform bacteria tests require specially prepared sample bottles. These bottles should not be rinsed before sampling. A chemical placed in the bottles by the lab is necessary for correct test results. Keep several bottles on hand.

3. Don't open the sample bottle until the moment of filling. This helps prevent contamination of the sterile sample bottle.

4. Flush the line. Run the water through the faucet for 3 to 5 minutes before opening the bottle to take the sample. If your water system is chlorinated, measure the free chlorine (Cl_2) residual before collecting the sample and record the residual on the lab form.

5. Uncap the sample bottle. As you do this, hold the bottle near the base and be sure not to put your fingers inside the sample bottle or on the inside of the lid. Do not set the lid down while taking the sample. Any of these things can contaminate the sample.

6. Reduce the water flow to a steady stream and gently fill the bottle, leaving an air space of at least ½" at the top. Remember, don't rinse the bottle before filling it. And be careful not to splash out the chemical already in the bottle.

7. Replace the cap immediately. Be sure that it's tight so it can't leak. If you drop the lid or think you have contaminated the sample, do not use it. Use another bottle and collect a new sample.

8. Label the sample bottle. Completely fill out the form provided by the lab. The information accompanying the sample must include the following information.
   - Public Water System identification number.
   - Date and time sampled.
   - Location sampled.
   - Name of person collecting sample.
   - The sample type: "routine," "repeat," or "special."

     Routine: Samples collected on a regular basis to monitor for contamination.

     Repeat: Samples collected following a "present" (positive) routine sample. Usually 4 repeat samples must be collected. This figure is based on system size.

     It is important to include the date of the initial positive routine sample for which the repeat samples were taken. A space is provided for this in the middle section of most forms.

     Special: Samples collected for other reasons. Examples: a sample collected after repairs to the system and before it is placed back into operation, or a sample collected at a wellhead prior to disinfection.
   - Free Cl_2 residual, if your system is chlorinated. The residual should be measured at the time of sample collection.

9. Package the sample for delivery to the lab. Be sure to include the lab form. The samples should be kept cool at all times. If mailing, use the container provided by the lab.

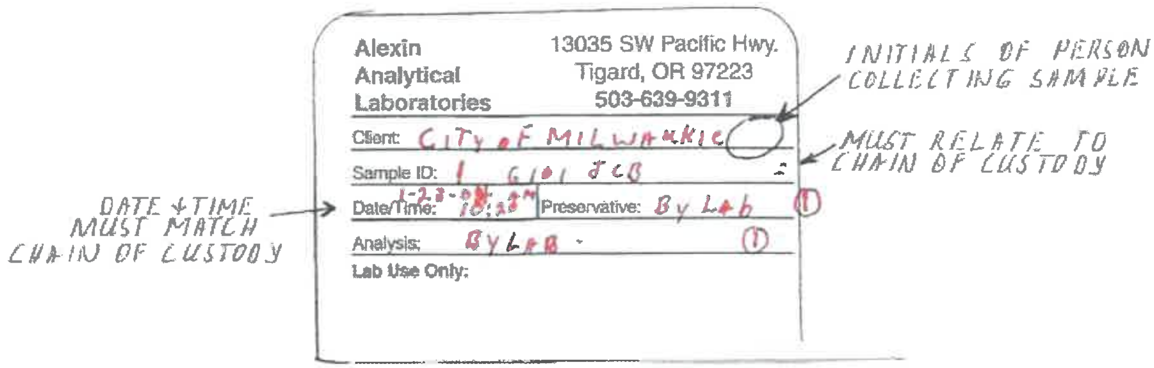
10. Mail or deliver the sample to the lab immediately. The lab cannot accept samples older than 30 hours. The water quality of the sample has changed too much by then to give correct results.

Procedures taken from AWWA manual entitled "Safe Water: A Fact Book on the Safe Drinking Water Act for Non-Community Water Systems"

Collection of Disinfection By-Product Samples—HAA5 and TTHM

Collecting the 5 quarterly DBP samples should be accomplished at the same time as coliform samples. The list of maximum residence time coliform sites is the same for both coliform and DBP. Sampling of DBPs requires the use of specially designed sample vials that allow the sample to be collected minus any air in the sample vial. Use extreme caution when filling the sample vials to ensure that no air has been trapped in the vial.

Vials must be labeled with a sample identification that correlates with the line number of the chain of custody. Note the sample below.



① LABORATORY PROVIDING VIALS PRE-LABLES VIAL WITH PRESERVATIVE AND ANALYSIS

Upon completion of coliform sample collection, record the free Cl_2 result and time on the chain of custody.

Reduce flow to a slow, clean, uniform flow and carefully fill vial to overflow slightly. The water level must be slightly above the rim of the vial before replacing the cap. Cap must be snug. Do not overtighten the cap. The center portion of the cap will appear slightly distended. Visually check vial for air. Place samples in cooler with ice and prepare for transport to laboratory.

Section 7

Sample Site Locations

Coliform Sites

The address list provided in this section represents routine, alternate, and repeat sample sites. This list is to be utilized as a general guideline and shall be followed as much as deemed possible. The intention is not to limit the ability or required flexibility of the sampler but to guide decisions on sample locations best suited to match current system operating parameters.

The sampler is required to request use of an alternate sample site if said site is not included as an alternate in the published list. The Treatment DRC will decide whether or not to sample this site and include the site in the published list.

Disinfection By-Product Sites (DBP)

The list of DBP sites is based on maximum residence time in the distribution system. The sampling sites were developed over time based on free Cl_2, historical DBP results, and pressure zone influence over residence time. Sampler may not deviate from this list without prior approval from the Treatment DRC.

General

The sample site lists are subject to change as treatment and supply parameters change. It is the responsibility of the Treatment DRC to keep the lists up-to-date and submit changes to DHS. The sampler is required to notify the DRC of any change to the sample site that would effect a negative change to the quality or use of the site.

	Coliform Sample Sites	Disinfection By-Product Sites in Red
1	10030 SE Waverly Court	Hose bib south end garage
2	10050 SE Waverly Court	hose bib below power meter bank left of entrance
3	10203 SE Hillside Court	Hose bib below maint room of laundry
4	10400 SE Main Street	Coffee sink between vault door and rest rooms
5	10435 SE 42nd Avenue	Front counter sink
6	11001 SE 54th Avenue	M 93 Sample station in meter box
7	10618 SE Linwood Avenue	Hose bib front
8	10722 SE Main Street	Hose bib left side of back door

9	10892 SE 60th Avenue	Hose bib front
10	11022 SE 37th Avenue	In Building hose bib west wall
11	11552 SE 32 Avenue	Hose bib front
12	11706 SE 60th Avenue	Hose bib front
13	11733 SE Stanley Avenue	Hose bib front
14	11800 SE Stanley Avenue	Ball valve on suction manifold
15	11909 SE Linwood Avenue	Hose bib front
16	12012 SE 70th Avenue	Hose bib front
17	12031 SE Kehrli Drive	Hose bib front
18	**12200 SE McLoughlin Blvd**	**Building 1 hose bib on nw corner**
19	12201 SE 41st Court	Hose bib front
20	12356 SE Oatfield Road	Hose bib right side garage
21	12359 SE 43rd Avenue	Hose bib front
22	12360 SE Oatfield Road	Hose bib front next to garage
23	12423 SE 71st Avenue	Hose bib front right side of garage
24	12425 SE Ash Court	Hose bib front right side of garage
25	12432 SE Ash Court	Hose bib front of house NE corner
26	12887 SE Linnwood Avenue	Hose bib front
27	1400 SE Lava Drive	Hose bib south end of building C
28	1991 SE Bobwhite	Hose bib under front door decking
29	**2100 SE Ochoco**	**Pharmacy sink**
30	2412 SE Lark Street	Hose bib next to garage and front door
31	2425 SE Moores	Hose bib front
32	2425 SE Ochoco	Coffee sink
33	3012 SE Lake Road	Hose bib at lower level corner of building
34	3028 SE Lake Road	Hose bib at lower level corner of building
35	3200 SE Harrison	Public mens room lower level right sink
36	3424 SE Kathryn Court	Hose big right side of garage
37	**3426 SE Kathryn Court**	**Hose bib left side of garage**
38	3484 SE Jobes Court	Hose bib left side of garage
39	3701 SE Intrnational Way	Hose bib front
40	3830 SE Railroad Avenue	Hose bib front
41	4016 SE Roswell Street	Hose bib front
42	4060 SE Licyentra Lane	Hose bib front of garage
43	4071 SE Angela Way	Hose bib on front walk 2steps down fron front door
44	4115 SE Johnson Creek Blvd.	Hose bib front
45	4203 SE Franklin	Hose bib front
46	4206 SE Somewhere	Hose bib left side of house
47	4231 SE Northridge Court	Hose bib front
48	4244 SE Harvey Street	Hose bib between front door and garage
49	4244 SE Northridge Drive	Hose bib front left of front door
50	4252 SE Monroe Street	Hose bib front

51	4300 SE Logus Road	Hose bib front
52	4321 SE Meadowcrest	Hose bib front
53	4330 SE International Way	Inside front counter sink left side
54	4384 SE Jobes Court	Hose bib front
55	4415 SE Franklin Street	Hose bib front
56	4507 SE Monroe Street	Hose bib front
57	4512 SE Meadowcrest	Hose bib right side of garage door
58	4550 SE Mason Lane	Hose bib left of garage door
59	4606 SE Logus Road	Hose bib front
60	4617 SE Brookside Drive	Hose bib front
61	4626 SE Adams Street	Hose bib front left of garage door
62	4647 SE Brookside Drive	Hose bib front right of front door
63	4647 SE Jackson Street	Hose bib front
64	4949 SE Monroe	Hose bib front
65	4960 SE Harvey	Hose bib front
66	4967 SE Logus Road	Hose bib front
67	5000 SE International Way	Hose bib front
68	5159 SE Monroe	Hose bib front
69	5206 SE Logus Road	Hose bib front
70	5620 SE Harlow	Hose bib front
71	5810 SE Kent Street	Hose bib front
72	5825 SE Kent Street	Hose bib right of garage door
73	**6101 SE Johnson Creek Blvd.**	**Water Quality office sink**
74	6145 SE Hunter	Hose bib front
75	6278 SE Deering Court	Hose bib left side of garage
76	6367 SE Deering Court	Hose bib left side of garage
77	8844 SE 30th Avenue	Hose bib left of front door
78	8905 SE Regents Drive	Hose bib front
79	9000 SE 42nd Avenue	Eclipse 88 sample station
80	9000 SE Mc Brod	Hose bib west side of building next ot service door
81	9790 SE 40th Avenue	Hose bib front
82	9851 SE 50th Avenue	Hose bib front
83	9909 SE 40th Avenue	Hose bib front
84	9919 SE Stanley Avenue	Hose bib front
85	9941 SE Stanley Avenue	Hose bib front
86	9945 SE 49th Avenue	Hose bib front
87	9951 SE 40th Avenue	Work room sink
	~~5411 SE Firwood~~	~~Model 93~~ Riser. DO NOT Sample

Reporting and Record-Keeping

(b) Records of bacteriological analyses shall be kept for at least 5 years and records of chemical analyses; secondary contaminants, turbidity and radioactive substances shall be kept for at least 10 years. Data may be transferred to tabular summaries provided the following information is included:

(A) Date, place and time of sampling, and the name of the person who collected the sample;

(B) Identification of the sample as to whether it was a routine finished water sample, repeat sample, raw water sample or special purpose sample;

(C) Date and time of the analysis, the laboratory and person performing the analysis; and,

(D) Analytical method used and results of the analysis.

Reference OAR 333-061-0040 (2) b

City staff is required to report the monthly average summary of disinfectant residual and the microbiological results from coliform monitoring. The disinfectant residual summary may be reported quarterly with the TTHM and HAA5 (DBP) results.

The reports and records are entered and maintained by the water quality utility specialist. The reports must be received by the 10th day of the month following sample collection.

Monthly coliform summary report sample is displayed followed by the disinfectant residual report.

OREGON DEPARTMENT OF HUMAN SERVICES—DRINKING WATER SECTION *FEBRUARY 2004*
PUBLIC WATER SYSTEM MICROBIOLOGICAL ANALYSIS SUMMARY

PWS ID#: 4100528
System Name: City of Milwaukie
Address: 6101 SE Johnson Creek Blvd, Milwaukie OR 97206

Lab: Alexin Analytical Laboratories Cert # 31
Contact Person: Don Simenson
Phone and Pager: 503-786-7622 and 503-301-6650

Test Method
☐ MTF ☐ PA
☐ MF ☑ CF
☐ EC ☐ EC & MUG
☐ Nitrient Agar & MUG

Sample Types
R = Routine
P* = Repeat
S = Special
*provide date & sample # of positive routine

Analysis
TC = Total Coliform
FC/EC = Fecal Coliform/E. coli

Results
P = Present
A = Absent

#	Sample Date	Time	Sample Point	Cl_2	Sample ID#	Sample Type R	Sample Type P*	Sample Type S	Results TC	Results FC/EC	*Repeat Samples Date of Positive Routine	*Repeat Samples ID# of Positive Routine
1	02/03/04	10:14 AM	3200 SE Harrison	.17	362563	X			A	A		
2	02/03/04	10:50 AM	9951 SE 40th Avenue	.18	362564	X			A	A		
3	02/03/04	8:47 AM	12423 SE 71st Avenue	.65	362565	X			A	A		
4	02/03/04	10:23 AM	3426 SE Kathryn Court	.15	362566	X			A	A		
5	02/03/04	8:10 AM	10722 SE Main Street	.26	362567	X			A	A		
6	02/03/04	8:35 AM	4538 SE Jobes Court	.55	362568	X			A	A		
7	02/10/04	10:11 AM	5825 SE Kent Street	.19	362969	X			A	A		
8	02/10/04	9:40 AM	3028 SE Lake Road	.38	362970	X			A	A		
9	02/10/04	9:18 AM	9000 SE McBrod Avenue	.24	362971	X			A	A		
10	02/10/04	10:27 AM	6101 SE Johnson Creek Blvd.	.09	362972	X			A	A		
11	02/10/04	9:56 AM	4060 SE Lycentra Lane	.45	362973	X			A	A		
12	02/10/04	8:59 AM	8844 SE 30th Avenue	.20	362974	X			A	A		
13	02/17/04	9:38 AM	4617 SE Brookside Drive	.16	363311	X			A	A		
14	02/17/04	10:10 AM	10030 SE Waverly Court	.24	363312	X			A	A		

Oregon DHS | **Disinfectant Residual Monitoring for Samples Collected in the Distribution System**

Summary Report Form

PWS ID# 4100528 PWS Name: City of Milwaukie

Month/Year: January 2004

- Number of samples collected in the distribution system during the current month (must = # coliform samples collected) — 23 (A)
- Arithmetic average of the disinfectant residual for the current month plus the average from the previous 11 months

February	0.26	(B)
March	0.27	
April	0.29	
May	0.22	
June	0.22	
July	0.21	
August	0.23	
September	0.20	
October	0.22	
November	0.24	
December	0.31	
current month>> January	0.29	

- Running Annual arithmetic average of all 12 averages listed in (B) — 0.25 (C)
- Is the Running Annual Average (from C) greater than the Maximum Residual Disinfectant level (MRDL)*? ____ yes x ____ no (D)

**MRDL = 4.0 mg/l for Chlorine*
4.0 mg/l for Chloramines
0.8 mg/l for Chlorine dioxide

Print Name: Donald J Simenson

Signature: ________________

Date: 01/30/04

Form can be submitted each month with coliform test results
OR
Submit all 3 monthly reports with the quarterly Disinfection Byproduct data.

Send form:
DHS/DWP P.O. Box 14350
Portland, OR 97293-0350
Phone (503)731-4381

NOTE: All reports must be signed, dated, and received at DHS Drinking Water Division prior to the 10th of the month following collection.

Section 9

Interpretation of Coliform Test Results

The microbiological, coliform, bacteriological, or potability test is performed on a sample of water to test for the presence or absence of coliform bacteria. The presence of coliform bacteria indicates that other disease-causing organisms may be in the water and that it may be unsafe to drink.

If coliforms are found, the lab will further analyze the sample to determine if fecal coliforms or E. coli are present. Fecal coliforms and E. coli are definite indicators that the water is unsafe to drink and that immediate action must be taken.

Compliance with Oregon's drinking water standards are determined by the results of routine and any repeat samples collected during a sampling period (a month or a quarter). If any 2 samples taken during the sample period have coliform bacteria, then the system is in violation.

If the laboratory reports that the sample was too old (you only have 30 hours between collecting a sample and when it must be tested by the lab), leaked in transit, or had "heavy noncoliform growth," you must send in another sample immediately. This is especially important if you collect your samples toward the end of the month or quarter. We can only credit samples collected in the month or quarter for that month or quarter.

After being notified by your lab that coliforms are present in a sample, you must in the next 24 hours or business day:

1. contact the local health department (731-4317) and tell them the details;
2. collect 3 repeat samples; and
3. take steps to locate and determine the cause of the coliform contamination and work to correct it.

The repeat samples must be collected: 1 at location of the positive sample, 1 within 5 connections upstream, and 1 within 5 connections downstream of positive location.

The month or quarter following the positive sample, you need to collect 5 routines even if the repeats were all clean.

Section 10

ODHS Bulletin "Coliform Bacteria"

ODHS Bulletin "Coliform Bacteria"

Oregon Department of Human Services

Office of Public Health Systems	**(503) 731-4030**	**Emergency**
800 NE Oregon Street #611	**(503) 731-4381**	
Portland, OR 97232-2162	**(503) 731-4077**	**FAX**
	(503) 731-4031	**TTY-Nonvoice**

TECHNICAL BULLETIN

HEALTH EFFECTS INFORMATION

Prepared by:
Department of Human Services
ENVIRONMENTAL TOXICOLOGY SECTION
September 2002

COLIFORM BACTERIA

For More Information Contact:

Department of Human Services
Environmental Toxicology Section
(503) 731-4015

Drinking Water Section
(503) 731-4010

WATERBORNE DISEASE AND MICROORGANISMS

Microorganisms are widely spread over the earth and throughout its atmosphere. Microorganisms include bacteria, viruses, and protozoan parasites; they are microscopic and therefore invisible to the naked eye. They are found in all surface waters, including lakes, streams, and rivers. They can be found in shallow and unprotected wells and springs and, less often, in deep and protected well waters. Many microorganisms can survive extremes of climate. Most microorganisms in the environment and found in water are not harmful, but enough of them are harmful that we try to keep drinking water nearly microorganism-free.

The microorganisms that have the most significance to human health are those that cause disease, which are called pathogens. Examples of common pathogens include bacteria such as *Salmonella* and *Shigella*, protozoans such as *Giardia* and *Cryptosporidium*, and viruses such as hepatitis A and Norwalk. Most of these pathogens are transmitted by what is called the fecal-oral route of exposure; this means that feces from an infected person or animal somehow (directly or indirectly) get into a person's mouth. An example of direct transmission would be changing diapers and then not washing your hands before sticking your finger in your mouth. An example of indirect transmission might be drinking water from a stream contaminated with runoff from a field being grazed by cows upstream

It is not possible to test drinking water regularly for the presence of disease-causing organisms because they exist in very low numbers in water, are hard to isolate and detect, and there are so many different kinds it would be impractical and expensive to test for them all. Consequently, public health agencies and water suppliers in this country generally test only for certain kinds of bacteria that are known as "indicator organisms". These indicators do not themselves cause disease, but are markers for fecal pollution that are easier to test for.

The most common of these test organisms is the broad class of bacteria called coliforms. The presence of coliforms in drinking water suggests microbiological contamination of the source water, a failure of the water treatment system, a break or leak in the water mains, or contamination of the water distribution system by backflow from households or commercial establishments. When coliforms are detected in drinking water, immediate action should be taken to identify the source or sources of the bacteria and eliminate them.

TOTAL COLIFORM BACTERIA

Total coliform bacteria, often called merely "coliforms", are very widely distributed in nature. Most coliforms live in the intestinal tract of man and other warm-blooded animals, so they are found in significant numbers wherever fecal (intestinal) waste or contamination is present. A few of the bacteria in this class are associated with natural plant material and therefore may be found even where fecal contamination is absent. Coliforms are the most commonly used indicators of contamination in drinking water. Water that contains total coliforms should immediately be tested further for fecal coliforms or *E. coli* (see below). If total coliforms persist in the absence of fecal coliforms or *E. coli*, steps should be taken promptly to identify and eliminate the source of the total coliforms.

FECAL COLIFORM BACTERIA

This is a subgroup of total coliform bacteria consisting of those that can grow at a temperature too warm for most coliforms (44.5 degrees C, or 112 degrees F.). The organisms found by this method are more likely to be associated with fecal contamination than are total coliforms, although again it is not a perfect marker. Some fecal coliforms are associated with woody plant material. But in general, fecal coliforms are a better indicator of fecal contamination than total coliforms in drinking water. Although it doesn't necessarily imply that pathogens are present, water containing fecal coliform is risky to drink unless it is disinfected. Bringing contaminated water to a boil for one minute is a reliable way of disinfecting it.

Escherichia coli (E. coli)

E. coli is one of the fecal coliforms. It lives in the digestive tract of warm-blooded animals and humans. It is present in the feces of almost all warm-blooded animals and humans. Its presence in drinking water is a clear indication of fecal contamination and that the organisms in that waste are still living in the water. Water that tests positive for *E. coli* could contain pathogens and would be risky to drink without adequate disinfection. Bringing contaminated water to a boil for one minute is a reliable way of disinfecting it.

PATHOGENIC *E. coli*

There are hundreds of different kinds of *E. coli*. Most are harmless, but some can cause illness. The most well-known pathogenic *E. coli* is called *E. coli* O157:H7. Outbreaks caused by this organism often make the news, and are often linked to undercooked meat, raw milk, or other foods contaminated by cattle feces. There have been several outbreaks in the U.S. of *E. coli* caused by contaminated drinking water. All occurred either when people drank untreated water or where water disinfection procedures were not followed properly. Routine water testing methods do not distinguish between pathogenic *E. coli* and the harmless indicator strains. Water containing any *E. coli* is risky to drink without water disinfection. Bringing contaminated water to a boil for one minute is a reliable way of disinfecting it.

ELIMINATING COLIFORMS FROM WELLS

Construction or maintenance work, such as pump replacement in an existing well, can temporarily contaminate well water with coliform bacteria. Bacteria from soil, vegetation, and the tools and hands of the maintenance crew could enter the well. Before using the water, disinfect and flush the entire system and then sample for coliform. The safest temporary measure to kill coliform and other microorganisms in drinking water is to bring water to a rolling boil for one full minute. Chlorination or other chemical disinfection techniques can eliminate coliforms from properly constructed wells.

The procedure for chlorinating a well to eliminate coliforms follows:

For each 100 gallons of well water, add two cups (16 ounces) of household bleach (5% sodium hypochlorite) available from grocery stores.

> EXAMPLE: *How much bleach is needed to disinfect a well with a 6 inch diameter casing and now has 65 feet of water? Answer: The table below shows there are 1.5 gallons of water for each foot of water depth for a 6" diameter well. Multiply the total water depth of 65 feet X 1.50 gallons per foot = 97.5 gallons of water in this 6" diameter well. Since 97.5 feet is about 100 gallons, add 2 cups of 5% bleach to the well to disinfect it.*

Calculate the gallons of water in the well by using the following table:

Well Casing Diameter (inches)	Gallons of Water per Foot of Depth
4	0.65
6	1.50
8	2.60
10	4.10
12	5.90
14	8.00

1. Add the bleach to 4-5 gallons of water and pour in the well. Use a plug or casing vent hole in the top of the sanitary seal.
2. Be sure the bleach mixes thoroughly with the well water. Attach a hose from pump or service line and run water into the well. Use the same hole in the top of the sanitary seal used to add the bleach.
3. After 15 or 20 minutes, open each fixture served by the well until you can detect a bleach smell in the water then close the valves. Let the bleach stand in the well and plumbing for adequate contact time - at least 8 hours.
4. **Thoroughly flush the system.**
5. Sample for total coliform. A good sample location is a bathroom faucet with the aerator removed. Wait until lab results are negative for total coliforms before using the water.

It is difficult to flush an entire system when it is large. The well should be isolated, disinfected, flushed and sampled for total coliform. If total coliform samples are positive, repeat the disinfection process until samples are negative. The repeat procedure must be followed in sequence: disinfect, flush all bleach, and wait for sample results before resuming service. Schedule maintenance in advance so there is adequate time to disinfect and be sure water is safe for use. Warning: Be sure bleach used in this process is flushed thoroughly from all service lines. Remember that bleach contains chlorine and chlorine is harmful to aquarium fish.

If repeated efforts to disinfect a well fail to eliminate coliform organisms or if the organisms return, there could be problems with its construction or protection. Consult a well construction professional for advice on correcting these problems. Identifying and correcting well construction problems is generally a better long-term solution than installing and relying on permanent water treatment equipment.

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Section 11

EPA "Total Coliform Rule: A Quick Reference Guide"

EPA "Total Coliform Rule: A Quick Reference Guide"

United States Environmental Protection Agency | Office of Water (4606) | EPA 816-F-01-035 November 2001 www.epa.gov/safewater

EPA

Total Coliform Rule: A Quick Reference Guide

Overview of the Rule

Title	Total Coliform Rule (TCR) 54 FR 27544-27568, June 29, 1989, Vol. 54, No. 124[1]
Purpose	Improve public health protection by reducing fecal pathogens to minimal levels through control of total coliform bacteria, including fecal coliforms and *Escherichia coli (E. coli).*
General Description	Establishes a maximum contaminant level (MCL) based on the presence or absence of total coliforms, modifies monitoring requirements including testing for fecal coliforms or *E. coli,* requires use of a sample siting plan, and also requires sanitary surveys for systems collecting fewer than five samples per month.
Utilities Covered	The TCR applies to all public water systems.

Public Health Benefits

Implementation of the TCR has resulted in . . .	▸ Reduction in risk of illness from disease causing organisms associated with sewage or animal wastes. Disease symptoms may include diarrhea, cramps, nausea, and possibly jaundice, and associated headaches and fatigue.

What are the Major Provisions?

ROUTINE Sampling Requirements

- Total coliform samples must be collected at sites which are representative of water quality throughout the distribution system according to a written sample siting plan subject to state review and revision.
- Samples must be collected at regular time intervals throughout the month except groundwater systems serving 4,900 persons or fewer may collect them on the same day.
- Monthly sampling requirements are based on population served (see table on next page for the minimum sampling frequency).
- A reduced monitoring frequency may be available for systems serving 1,000 persons or fewer and using only ground water if a sanitary survey within the past 5 years shows the system is free of sanitary defects (the frequency may be no less than 1 sample/quarter for community and 1 sample/year for non-community systems).
- Each total coliform-positive routine sample must be tested for the presence of fecal coliforms or *E. coli.*
- If any routine sample is total coliform-positive, repeat samples are required.

REPEAT Sampling Requirements

- Within 24 hours of learning of a total coliform-positive ROUTINE sample result, at least 3 REPEAT samples must be collected and analyzed for total coliforms:
  - One REPEAT sample must be collected from the same tap as the original sample.
  - One REPEAT sample must be collected within five service connections upstream.
  - One REPEAT sample must be collected within five service connections downstream.
  - Systems that collect 1 ROUTINE sample per month or fewer must collect a 4th REPEAT sample.
- If any REPEAT sample is total coliform-positive:
  - The system must analyze that total coliform-positive culture for fecal coliforms or *E.coli.*
  - The system must collect another set of REPEAT samples, as before, unless the MCL has been violated and the system has notified the state.

Additional ROUTINE Sample Requirements

- A positive ROUTINE or REPEAT total coliform result requires a minimum of five ROUTINE samples be collected the following month the system provides water to the public unless waived by the state.

[1] The June 1989 Rule was revised as follows: Corrections and Technical Amendments, 6/19/90 and Partial Stay of Certain Provisions (Variance Criteria) 56 FR 1556-1557, Vol 56, No 10.

e: The TCR is currently ergoing the 6 year review ocess and may be subject to change.

Public Water System ROUTINE Monitoring Frequencies

Population	Minimum Samples/ Month	Population	Minimum Samples/ Month	Population	Minimum Samples/ Month
25-1,000*	1	21,501-25,000	25	450,001-600,000	210
1,001-2,500	2	25,001-33,000	30	600,001-780,000	240
2,501-3,300	3	33,001-41,000	40	780,001-970,000	270
3,301-4,100	4	41,001-50,000	50	970,001-1,230,000	300
4,101-4,900	5	50,001-59,000	60	1,230,001-1,520,000	330
4,901-5,800	6	59,001-70,000	70	1,520,001-1,850,000	360
5,801-6,700	7	70,001-83,000	80	1,850,001-2,270,000	390
6,701-7,600	8	83,001-96,000	90	2,270,001-3,020,000	420
7,601-8,500	9	96,001-130,000	100	3,020,001-3,960,000	450
8,501-12,900	10	130,001-220,000	120	≥ 3,960,001	480
12,901-17,200	15	220,001-320,000	150		
17,201-21,500	20	320,001-450,000	180		

*Includes PWSs which have at least 15 service connections, but serve <25 people.

What are the Other Provisions?

Systems collecting fewer than 5 ROUTINE samples per month . . .	Must have a sanitary survey every 5 years (or every 10 years if it is a non-community water system using protected and disinfected ground water).**
Systems using surface water or ground water under the direct influence of surface water (GWUDI) and meeting filtration avoidance criteria . . .	Must collect and have analyzed one coliform sample each day the turbidity of the source water exceeds 1 NTU. This sample must be collected from a tap near the first service connection.

** As per the IESWTR, states must conduct sanitary surveys for community surface water and GWUDI systems in this category every 3 years (unless reduced by the state based on outstanding performance).

How is Compliance Determined?

- Compliance is based on the presence or absence of total coliforms.
- Compliance is determined each calendar month the system serves water to the public (or each calendar month that sampling occurs for systems on reduced monitoring).
- The results of ROUTINE and REPEAT samples are used to calculate compliance.

A Monthly MCL Violation is Triggered if:

A system collecting fewer than 40 samples per month . . .	Has greater than 1 ROUTINE/REPEAT sample per month which is total coliform-positive.
A system collecting at least 40 samples per month . . .	Has greater than 5.0 percent of the ROUTINE/REPEAT samples in a month total coliform-positive.

An Acute MCL Violation is Triggered if:

Any public water system . . .	Has any fecal coliform- or *E. coli*-positive REPEAT sample <u>or</u> has a fecal coliform- or *E. coli*-positive ROUTINE sample followed by a total coliform-positive REPEAT sample.

What are the Public Notification and Reporting Requirements?

For a Monthly MCL Violation	▸ The violation must be reported to the state no later than the end of the next business day after the system learns of the violation. ▸ The public must be notified within 14 days.[2]
For an Acute MCL Violation	▸ The violation must be reported to the state no later than the end of the next business day after the system learns of the violation. ▸ The public must be notified within 72 hours.[2]
Systems with ROUTINE or REPEAT samples that are fecal coliform- or *E. coli*-positive . . .	Must notify the state by the end of the day they are notified of the result or by the end of the next business day if the state office is already closed.

For additional information on the TCR

Call the Safe Drinking Water Hotline at 1-800-426-4791; visit the EPA web site at www.epa.gov/safewater/mdbp/mdbp.html; or contact your state drinking water representative.

[2] The revised Public Notification Rule will extend the period allowed for public notice of monthly violations 30 days and shorten the period for e violations to 24 hours. These sions are effective for all systems by May 6, 2002 and are detailed in 40 CFR Subpart Q.

2021 Water System Master Plan

Appendix K. Water Quality Reports

Water Quality Data Table

2015 Report

Regulated Substances							
Substance	Year sampled	MCL (MRDL)	MCLG (MRDL)	Amount Detected	Range	Violation	Typical Source
Chlorine	2015	4	2	0.23	0.19-0.41	No	Disinfection chemical used in drinking water.
Fecal Coliform and E.Coli (number of Positive samples)	2015	0	0	0	NA		E. coli is a type of fecal coliform bacteria commonly found in the intestines of animals and humans. E. coli is short for Escherichia coli. The presence of E. coli in water is a strong indication of recent sewage or animal waste contamination. Sewage may contain many types of disease-causing organisms.
Total Coliform Bacteria	2015	0	0	2	NA	NO	Repeat sampling revealed false positive or sampling error.
5 Haloacetic Acids (HAA5) (ppb) Stage 2	2015	60	NA	1.3	0-1.3	NO	By Product of the disinfection process when organic matter is present in the raw water.
Total Trihalomethanes (TTHMs) (ppb) Stage 2	2015	80	NA	1.78	0-1.78	NO	By Product of the disinfection process when organic matter is present in the raw water.
Barium	2015	2		0.00495	0.0033-0.00495	NO	Discharge from Drilling wastes:Discharge from metal refineries and erosion of natural deposits
Fluoride	2015	4	4	0.17			Naturaly occuring in ground water
Nitrates	2015	10		5.2	3.7-5.2	No	Nitrate is an essential component of living things and is a major part of animal manure, human sewage waste and commercial fertilizers. Nitrates and nitrites can be associated with septic systems and have been used for centuries as fertilizers, in explosives and as food preservatives.

Tap Water Samples collected for Lead and Copper analysis from throughout the system. Lead and copper Will be sampled again summer 2016

Substance	Year sampled	Action Level (AL)	MCLG	Amount Detected (90th percentile)	Sites Above AL	Violation	Typical Source
Copper	2013	1.3	1.3	0	0	No	Corrosion of Household plumbing systems; Erosion of natural deposits
Lead	2013	15	0	0	0	No	Corrosion of Household plumbing systems; Erosion of natural deposits

Unregulated Substances					
Contaminant	2013	Result of sampling from 8 locations	MCL Regulatory limit	Major Sources in Drinking Water	Health Effects Language
Chromium	2013	0.080 Average Range 0.002-00.16	1	See Chromimum 6 for use or source information.	See Chromimum 6 for health effects information
Strontium	2013	100.88 Average Range 79 to 130	NA	Naturally occurring element: historically, commercial use of strontium has been in the faceplate glass of cathode-ray tube televisions to block x-ray emissions	Rfd: 0.6 mg/kg/day associated with rachitic bone (rickets) (IRIS) EPA CANCER CLASS D not classifiable as to human carcinogenicity
Vanadium	2013	9.18 Average Range 7.9 to 120	NA	Naturally occurring elemental metal used as vanadium penoxide which is a chemical intermeiadate and a catalyst.	Associated with altered kidney function indicated by increased blood urea and mild tissue changes
Hexavalent Chromium Chromium 6	2013	1.23 Average Range .97 to 1.7	NA	Naturally-occuring element; used in making steel and other alloys; chromium-3 or 6 forms are used for chrome plating, dyes and pigments, leather tanning, and wood preservation.	RfD: -0.005mg/kg/day (IRIS, 1998) (basis for MCL) -0.003 mg/kg/day (IRIS, 2005) (basis for HRL) Draft RfD; 0.0009mg/kg/day associated with intestinal lesions (IRIS, Draft 75 FR 60454) Draft Slpoe Factor: 0.5 (mg/KG/) (IRIS, Draft75 FR 60454)
1,4-Dioxane	2013	1 Sample positive 7.8	NA	Cyclic aliphatic ether: used as a solvent or solvent stablizer in manufacturing and processing of paper, cotton,textile products, automotive coolant, cosmetics and shampoos.	RfD: 0.003mg.kg/day associated with liver and kidney toxicity (IRIS) EPA 10-4 Lifetime cancer risk: 0.2mg/L Slpoe factor: -0.11 (mg/kg/day)-1 -0.19 (mg/kg/day)-1(IRIS Draft; 74FR 21361) EPA CANCER CLASS: B2 - probable human carcinogen (suffcient evidence from anaimal studies and inadequate/no epidemiologic studies)

DEFINITIONS

AL: Action level: The concentration of the contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.

AVG: Regulatory compliance with some MCLs are based on running annual average of monthly samples.

Highest Compliance Level: The highest level of that contaminant used to determine compliance with a National Drinking Water Regulation

MCL: Maximum Contaminant Level: The highest level of contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.

MCLG: Maximum Contaminant Level Goal: The level of contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for margin and safety.

MFL: Million fibers per liter (a measure of asbestos)

mg/L: Number of milligrams of substance in one liter of water

MRDL: Maximum Residual Disinfectant Level: The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

MRDLG: Maximum Residual Disinfectant Level Goal: The level of a drinking water disinfectant below which there is no known or expected risk to health.
MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.

MRL: Minimum Reporting Level: The lowest concentration of a contaminant that can be measured by a laboratory.

NA: Not applicable.

ND: none detected

NTU: Nephelometric Turbidity Unit: A measure of water turbidity and clarity.

pCi/L: Picocuries Per Liter: A measure of radioactivity.

ppb: Parts Per Billion or micrograms per liter (μg/L)

ppm: Part Per Million or milligrams per liter (mg/L)

ppq: Parts per quadrillion, or pictograms per liter (pg/L)

ppt: Parts per trillion, or nanograms per liter (ng/L)

Range of Detections: The lowest to the highest result value recorded during the required monitoring timeframe for systems with multiple entry points.

TT: Treatment Technique: a required process intended to reduce the level of a contaminant in drinking water.

SOURCE WATER ASSESSMENT.
In 2004 a drinking water source assessment was conducted by Oregon DEQ and Oregon Health Division Drinking Water Program with assistance from Milwaukie staff. The assessment report indicates that the water system would be moderately to highly susceptible to a contamination event inside the drinking water protection area. The drinking water protection area is defined in the Source Water Assessment Report based on the distance water migrates toward a well over a specified period of time.
The presence of several high and moderate risk potential contaminant sources within the protection area was confirmed through a potential contaminant source inventory.

Under a "worst case" scenario, where it is assumed that nothing is being done to protect groundwater quality at the identified potential contaminant sources, the assessment results indicate that the water system would be highly susceptible to several of the identified potential contaminant sources.

In 2010 the drinking water protection area around well 4 was reevaluated and the area was expanded slightly to the north and west. Oregon DEQ is currently working to update source assessments and we will publish any changes to the City of Milwaukie assessment when it is complete.
In addition, the assessment results indicate that, at this time, the water system is considered susceptible to viral contamination. Viral contamination is typically caused by failed septic systems. You may view a copy of the source assessment at the Public Works and Community Development Facility located at 6101 SE Johnson Creek Blvd. If you would like your own copy one can be provided for a fee.

WHAT MAKES UP OUR DRINKING WATER?
Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the Environmental Protection Agency's (EPA) Safe Drinking Water Hotline (800-426-4791).
The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity:

Contaminants that may be present in source water include:

Microbial contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.

Inorganic contaminants, such as salts and metals, which can be naturally-occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining or farming.

Pesticides and herbicides, which may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses.

Organic chemical contaminants, including synthetic and volatile organic chemicals, which are byproducts of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, and septic systems.

Radioactive contaminants, which can be naturally-occurring or be the result of oil and gas production and mining activities.

In order to ensure that tap water is safe to drink, EPA prescribes regulations which limit the amount of certain contaminants in water provided by public water systems. Food and Drug Administration regulations establish limits for contaminants in bottled water which must provide the same protection for public health.

Additional Information for Lead
If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. The City of Milwaukie is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. Use water from cold tap for drinking and cooking. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

By the Numbers: Milwaukie Water Quality Data

2016 Report

The table below shows the results of the city's most recent water quality analyses. Staff examine Milwaukie's water at each of the city's wells and entry points, which are points where treated water enters the drinking water system. The city doesn't test for every contaminant each year. Some pose greater risks than others and, therefore, tested more frequently. Others are less harmful and tested for sporadically. Each regulated contaminant, no matter how small the trace, is listed in this table. The name of each substance, highest level allowed by regulation, ideal goal for public health, amount detected and usual sources for contamination are presented in this data table.

Substance	MCL	MCLG	Results	Violation?	Primary Source	Possible Health Effects
CHEMICALS						
Nitrate	10	0	0-3.67	No	Runoff from fertilizer use, leaching from septic tanks, sewage, erosion of natural deposits	Infants younger than 6 months old who drink water in excess of the MCL could become seriously ill and, if untreated, die. Symptoms include shortness of breath and blue baby syndrome.
Arsenic	10	N/A	0	No	Erosion of natural deposits; runoff from orchards, glass & electronics production wastes	Drinking water containing arsenic in excess of the MCL over many years could cause skin damage or problems with the circulatory system, and may increase the risk of getting cancer.
DISINFECTION BY-PRODUCTS						
TTHM's (Total Trihalomethanes)	80	N/A	0.14 **Range** 0-0.14	No	By-product of drinking water chlorination	Drinking water containing Trihalomethanes in excess of the MCL over many years may cause problems with the liver, kidneys or central nervous system. It may also increase the risk of getting cancer.
Haloacetic acids HAA5	60	N/A	0	No	By-product of drinking water disinfection	Some people who drink water containing haloacetic acids in excess of the MCL over many years may have an increased risk of getting cancer.
MICROBIAL CONTAMINANTS						
Total Coliform bacteria	Presence of coliform bacteria in 5% of samples	0	2	No	Naturally present in the environment	Coliforms are bacteria naturally present in the environment, and used as an indicator that other potentially harmful bacteria may be present. **Repeat sampling revealed false positive or sampling error.**
Fecal coliform & E. coli	If routine sample and repeat sample are total coliform positive, and one is also fecal coliform or E. coli positive	0	1	No	Human & animal fecal waste	Fecal coliforms and E. coli are bacteria whose presence indicates that the water may be contaominated with human or animal waste. Microbes in these wastes can cause diarrhea, cramps, nausea, headaches or other symptoms. They may pose a special health risk for infants, young children and people with severely compromised immune systems. **Repeat sampling revealed false positive or sampling error.**

Substance	Units	Goal	Action Level	90th Percentile	Homes Exceeding Action Level	Violation?	Source of Contaminate
COPPER & LEAD							
Copper	ppb	1,300	1,300	0	0	No	Corrosion of household plumbing
Lead	ppb	0	1,500	0	0	No	Corrosion of household plumbing

UNREGULATED CONTAMINANTS

This data reports on Milwaukie's Unregulated Contaminant Monitoring Rule 3 (UCMR3) sampling. UCMR3 is a requirement set by the EPA for public water systems to monitor for a list of 21 contaminants that don't yet have a drinking water standard. The purpose of monitoring for them is to help the EPA decide whether the contaminants should have a standard and set Maximum Contaminant Level (MCL). From the list of 21, five contaminants were found in the city's water with the results listed below.

Substance	Results of Sampling	MCL Limit	Primary Sources in Drinking Water
Chromium	1.08 average **Range** .74-1.6	N/A	See Chromium 6 for use or source information
Strontium	100.88 average **Range** 79-130	N/A	Naturally-occuring element. Historically, commercial use of strontium was used in the faceplate glass of cathode-ray tube televisions to block x-ray emissions.
Vanadium	9.18 average **Range** 7.9-120	N/A	Naturally-occuring elemental metal used as vanadium penoxide, which is a chemical intermediate and a catalyst.
Hexavalent Chromium • Chromium 6	1.23 average **Range** .97-1.7	N/A	Naturally-occuring element used in making steel and other alloys. Forms of Chromium-3 or 6 are used for chrome plating, dyes and pigments, leather tanning and wood preservation.
1,4-Dioxane	1 positive sample 7.8	0 to 17.8	Cyclic aliphatic ether used as a solvent or solvent stabilizer in the manufacturing and processing of paper, cotton, textile products, automotive coolant, cosmetics & shampoos.

KEY

MCL: maximum contaminant level
MCLG: maximum contaminant level goal
ND: none detected
PPM: parts per million, or milligrams per liter
PPB: parts per billion, or micrograms per liter
PPT: parts per trillion, or nanograms per liter

Maximum Contaminant Level (MCL):
The highest level of a contaminant that is allowed in drinking water. MCL's are set as close to the MCLG as feasibly possibly using the best available treatment technology.

Maximum Contaminant Level Goal (MCLG):
The level of contaminant in drinking water below which there is no known or expected risk to health. MCLG's allow for a margin of safety.

By the Numbers: Milwaukie Water Quality Data

2017 Report

The table below shows the results of the city's most recent water quality analyses. Staff examine Milwaukie's water at each of the city's wells and entry points, which are points where treated water enters the drinking water system. The city doesn't test for every contaminant each year. Some pose greater risks than others and, therefore, tested more frequently. Others are less harmful and tested for sporadically. Each regulated contaminant, no matter how small the trace, is listed in this table. The name of each substance, highest level allowed by regulation, ideal goal for public health, amount detected and usual sources for contamination are presented in this data table.

Substance	MCL	MCLG	Results	Violation?	Primary Source	Possible Health Effects
CHEMICALS						
Nitrate	10	0	3.59 **Range** 0.12-3.59	No	Runoff from fertilizer use, leaching from septic tanks, sewage, erosion of natural deposits	Infants younger than 6 months old who drink water in excess of the MCL could become seriously ill and, if untreated, die. Symptoms include shortness of breath and blue baby syndrome.
Barium	2	0	.00495 **Range** 0.0033-0.00495	No	Discharge from drilling waste, discharge from metal refineries, and erosion of natural deposits.	Drinking water containing barium in excess of the MCL can cause an increase in blood pressure, gastrointestinal problems, muscle weakness, and have affects on the nervous and circulatory systems.
Fluoride	4	4	.17	No	Naturally occuring in ground water	For children, drinking water with fluoride in excess of the MCL can have adverse affects on tooth enamel. For adults, it can increase the likelihood of bone fractures, or lead to bone pain and/or tenderness.
Chlorine	4	2	.23 **Range** 0.19-0.41	No	Disinfection chemical used to remove bacteria and prevent waterborne illnesses.	Drinking water containing chlorine in excess of the MCL could lead to irritating effects to the eyes and nose, as well as stomach discomfort.
DISINFECTION BYPRODUCTS						
TTHM's (Total Trihalomethanes)	80	N/A	0.09 **Range** 0-0.09	No	Byproduct of the disinfection process when organic matter is present in the raw water	Drinking water containing Trihalomethanes in excess of the MCL over many years may cause problems with the liver, kidneys or central nervous system. It may also increase the risk of getting cancer.
Haloacetic acids HAA5	60	N/A	0	No	Byproduct of drinking water disinfection	Some people who drink water containing haloacetic acids in excess of the MCL over many years may have an increased risk of getting cancer.
MICROBIAL CONTAMINANTS						
Total Coliform bacteria	Presence of coliform bacteria in 5% of samples	0	2	No	Naturally present in the environment	Coliforms are bacteria naturally present in the environment, and used as an indicator that other potentially harmful bacteria may be present. **Repeat sampling revealed false positive or sampling error.**
Fecal coliform & E. coli	If routine sample and repeat sample are total coliform positive, and one is also fecal coliform or E. coli positive	0	1	No	Human & animal fecal waste	Fecal coliforms and E. coli are bacteria whose presence indicates that the water may be contaominated with human or animal waste. Microbes in these wastes can cause diarrhea, cramps, nausea, headaches or other symptoms. They may pose a special health risk for infants, young children and people with severely compromised immune systems. **Repeat sampling revealed false positive or sampling error.**

Substance	Units	Goal	Action Level	90th Percentile	Homes Exceeding Action Level	Violation?	Source of Contaminate
COPPER & LEAD							
Copper	mclg	1.3	1.3	0	0	No	Corrosion of household plumbing
Lead	ppb	0	15	0	0	No	Corrosion of household plumbing

UNREGULATED CONTAMINANTS

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Substance	Results of Sampling	MCL Limit	Primary Sources in Drinking Water
Chromium	1.08 **Range** .74-1.60	N/A	See Chromium 6 for use or source information
Strontium	100.88 **Range** 79-130	N/A	Naturally-occuring element. Historically, commercial use of strontium was used in the faceplate glass of cathode-ray tube televisions to block x-ray emissions.
Vanadium	9.18 **Range** 79-120	N/A	Naturally-occuring elemental metal used as vanadium penoxide, which is a chemical intermediate and a catalyst.
Hexavalent Chromium • Chromium 6	1.123 **Range** .97-1.7	N/A	Naturally-occuring element used in making steel and other alloys. Forms of Chromium-3 or 6 are used for chrome plating, dyes and pigments, leather tanning and wood preservation.
1.4-Dioxane	1 positive sample 7.8	0 to 17.8	Cyclic aliphatic ether used as a solvent or solvent stabilizer in the manufacturing and processing of paper, cotton, textile products, automotive coolant, cosmetics & shampoos.

KEY

MCL: maximum contaminant level
MCLG: maximum contaminant level goal
ND: none detected
PPM: parts per million, or milligrams per liter
PPB: parts per billion, or micrograms per liter
PPT: parts per trillion, or nanograms per liter

Maximum Contaminant Level (MCL):
The highest level of a contaminant that is allowed in drinking water. MCL's are set as close to the MCLG as feasibly possibly using the best available treatment technology.

Maximum Contaminant Level Goal (MCLG):
The level of contaminant in drinking water below which there is no known or expected risk to health. MCLG's allow for a margin of safety.

By the Numbers: Milwaukie Water Quality Data

2018 Report

The table below shows the results of the city's most recent water quality analyses. Staff examine Milwaukie's water at each of the city's wells and entry points, which are points where treated water enters the drinking water system. The city doesn't test for every contaminant each year. Some pose greater risks than others and, therefore, tested more frequently. Others are less harmful and tested for sporadically. Each regulated contaminant, no matter how small the trace, is listed in this table. The name of each substance, highest level allowed by regulation, ideal goal for public health, amount detected and usual sources for contamination are presented in this data table.

Substance	MCL	MCLG	Results	Violation?	Primary Source	Possible Health Effects
CHEMICALS						
Nitrate	10	0	3.59 **Range** 0.12-3.59	No	Runoff from fertilizer use, leaching from septic tanks, sewage, erosion of natural deposits	Infants younger than 6 months old who drink water in excess of the MCL could become seriously ill and, if untreated, die. Symptoms include shortness of breath and blue baby syndrome.
Barium	2	0	.00495 **Range** 0.0033-0.00495	No	Discharge from drilling waste, discharge from metal refineries, and erosion of natural deposits.	Drinking water containing barium in excess of the MCL can cause an increase in blood pressure, gastrointestinal problems, muscle weakness, and have affects on the nervous and circulatory systems.
Fluoride	4	4	.17	No	Naturally occuring in ground water	For children, drinking water with fluoride in excess of the MCL can have adverse affects on tooth enamel. For adults, it can increase the likelihood of bone fractures, or lead to bone pain and/or tenderness.
Chlorine	4	2	.23 **Range** 0.19-0.41	No	Disinfection chemical used to remove bacteria and prevent waterborne illnesses.	Drinking water containing chlorine in excess of the MCL could lead to irritating effects to the eyes and nose, as well as stomach discomfort.
DISINFECTION BYPRODUCTS						
TTHM's (Total Trihalomethanes)	80	N/A	0.09 **Range** 0-0.09	No	Byproduct of the disinfection process when organic matter is present in the raw water	Drinking water containing Trihalomethanes in excess of the MCL over many years may cause problems with the liver, kidneys or central nervous system. It may also increase the risk of getting cancer.
Haloacetic acids HAA5	60	N/A	0	No	Byproduct of drinking water disinfection	Some people who drink water containing haloacetic acids in excess of the MCL over many years may have an increased risk of getting cancer.
MICROBIAL CONTAMINANTS						
Total Coliform bacteria	Presence of coliform bacteria in 5% of samples	0	2	No	Naturally present in the environment	Coliforms are bacteria naturally present in the environment, and used as an indicator that other potentially harmful bacteria may be present. **Repeat sampling revealed false positive or sampling error.**
Fecal coliform & E. coli	If routine sample and repeat sample are total coliform positive, and one is also fecal coliform or E. coli positive	0	1	No	Human & animal fecal waste	Fecal coliforms and E. coli are bacteria whose presence indicates that the water may be contaominated with human or animal waste. Microbes in these wastes can cause diarrhea, cramps, nausea, headaches or other symptoms. They may pose a special health risk for infants, young children and people with severely compromised immune systems. **Repeat sampling revealed false positive or sampling error.**

Substance	Units	Goal	Action Level	90th Percentile	Homes Exceeding Action Level	Violation?	Source of Contaminate
COPPER & LEAD							
Copper	mclg	1.3	1.3	0	0	No	Corrosion of household plumbing
Lead	ppb	0	15	0	0	No	Corrosion of household plumbing

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Strontium	100.88 **Range** 79-130	N/A	Naturally-occuring element. Historically, commercial use of strontium was used in the faceplate glass of cathode-ray tube televisions to block x-ray emissions.
Vanadium	9.18 **Range** 79-120	N/A	Naturally-occuring elemental metal used as vanadium penoxide, which is a chemical intermediate and a catalyst.
Hexavalent Chromium • Chromium 6	1.123 **Range** .97-1.7	N/A	Naturally-occuring element used in making steel and other alloys. Forms of Chromium-3 or 6 are used for chrome plating, dyes and pigments, leather tanning and wood preservation.
1.4-Dioxane	1 positive sample 7.8	0 to 17.8	Cyclic aliphatic ether used as a solvent or solvent stabilizer in the manufacturing and processing of paper, cotton, textile products, automotive coolant, cosmetics & shampoos.

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Substance	MCL	MCLG	Results	Violation?	Primary Source	Possible Health Effects
CHEMICALS						
Nitrate	10	0	1.97 **Range** 0.115-4.57	No	Runoff from fertilizer use, leaching from septic tanks, sewage, erosion of natural deposits	Infants younger than 6 months old who drink water in excess of the MCL could become seriously ill and, if untreated, die. Symptoms include shortness of breath and blue baby syndrome.
Barium	2	0	.00495 **Range** 0.0033-0.00495	No	Discharge from drilling waste, discharge from metal refineries, and erosion of natural deposits.	Drinking water containing barium in excess of the MCL can cause an increase in blood pressure, gastrointestinal problems, muscle weakness, and have affects on the nervous and circulatory systems.
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DISINFECTION BYPRODUCTS						
TTHM's (Total Trihalomethanes)	80	N/A	0.49 **Range** 0.11-1.09	No	Byproduct of the disinfection process when organic matter is present in the raw water	Drinking water containing Trihalomethanes in excess of the MCL over many years may cause problems with the liver, kidneys or central nervous system. It may also increase the risk of getting cancer.
Haloacetic acids HAA5	60	N/A	0.01 **Range** .011-.016	No	Byproduct of drinking water disinfection	Some people who drink water containing haloacetic acids in excess of the MCL over many years may have an increased risk of getting cancer.
MICROBIAL CONTAMINANTS						
Total Coliform bacteria	Presence of coliform bacteria in 5% of samples	0	0	No	Naturally present in the environment	Coliforms are bacteria naturally present in the environment, and used as an indicator that other potentially harmful bacteria may be present. **Repeat sampling revealed false positive or sampling error.**
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Appendix L. O&M Manuals for TP235 and TP47

CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE
OF THE
WATER TREATMENT FACILITY
FOR WELLS NO. 4 AND 7
VOLUME I

JUNE 1991

CUNNINGHAM ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
MILWAUKIE, OREGON

CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE
OF THE WATER TREATMENT FACILITY FOR WELLS NO. 4 AND 7

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CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE
OF THE WATER TREATMENT FACILITY FOR WELLS NO. 4 AND 7

CHAPTER 1 - INTRODUCTION

A. PURPOSE OF PROJECT

The packed tower aeration treatment facility, located at 3329 SE Railroad Avenue, Milwaukie, Oregon, was constructed to remove the following volatile organic chemicals recently found in the ground water pumped from Milwaukie Wells No. 4 and 7:

Trichloroethylene
1,1-Dichloroethylene
1,1,1-Trichloroethane
Tetrachloroethylene

B. PROJECT DESCRIPTION

The treatment facility consists of an operations building and two towers for air stripping of volatile organic chemicals from well water. The well pumps at Wells No. 4 and 7 pump well water directly to each packed tower. The well water is chlorinated by solution injection prior to entering the tower, where it falls by gravity through the tower packing media as air is blown upward through the tower. Volatile organic chemicals are evaporated from the cascading water and exhausted through the tower stack. The air stripped water drains from the bottom of each tower to a main clearwell beneath the treatment building. Chlorination by solution injection also occurs in the main drain system between the towers and the clearwell. The air stripped and chlorinated well water is then pumped from the clearwell into the City's water distribution system. The treatment building contains the chlorination equipment, tower blowers, control center, tower backwashing equipment, and distribution pumps. The system operates automatically through the City of Milwaukie's main well control panel at Wellhouse No. 2. Tower backwashing to remove bacterial growth from the packing media as well as system configuration changes must be done manually.

C. TREATMENT OBJECTIVES AND DESIGN CRITERIA

The treatment objective of the packed tower aeration system is to reduce the well discharge concentrations of volatile organic chemicals to the levels listed in Table No. 1-1 prior to discharge into the City's distribution system.

TABLE 1-1

DESIGN CRITERIA FOR VOC REMOVAL

	CONCENTRATION IN WATER (ug/l)	
COMPOUND	INFLUENT	EFFLUENT
Trichloroethylene	20	<0.2
1,1-Dichloroethylene	5	<0.2
1,1,1-Trichloroethane	5	<0.2
Tetrachloroethylene	5	<0.2

Treatment Tower No. 4 was designed to achieve the volatile organic concentration reductions listed in Table 1-1 under the following conditions:

> Treatment capacity = 600 GPM from Well No. 4
> Minimum design water temperature = 55°F
> Packing depth = 19 feet
> Minimum air/water ratio = 40:1
> Tower diameter = 6 feet
> Tower material = Fiber-reinforced plastic

Treatment Tower No. 7 was designed to achieve the volatile organic concentration reductions listed in Table 1-1 under the following conditions:

> Treatment capacity = 1,000 gpm from Well No. 7
> Minimum design water temperature = 55°F
> Packing depth = 19 feet
> Minimum air/water ratio = 40:1
> Tower diameter = 8 feet
> Tower material = Fiber-reinforced plastic

Flows from either well may be treated by either tower, although Well No. 7 discharge must be reduced to 600 gpm to be treated effectively by Tower No. 4.

D. OREGON HEALTH DIVISION REQUIREMENTS

Maximum volatile organic chemical concentrations allowed in community and municipal water systems are regulated by the Oregon Department of Human Resources, Health Division, Office of Environment and Health Systems. Oregon Administrative Rules, Chapter 333, list maximum volatile organic chemical concentrations in public water systems as follows:

TABLE 1-2

MAXIMUM CONTAMINANT LEVELS (MCL)
FOR REGULATED VOC'S

CONTAMINANT	MCL,mg/l	MCL,ug/l
Benzene	0.005	5.0
Vinyl chloride	0.002	2.0
Carbon tetrachloride	0.005	5.0
1,2-Dichloroethane	0.005	5.0
Trichloroethylene	0.005	5.0
1,1-Dichloroethylene	0.007	7.0
1,1,1-Trichloroethane	0.200	200.0
para-Dichlorobenzene	0.075	75.0

(Tetrachloroethylene Not Listed)

Comparison of the tower design criteria in Table 1-1 with the state health requirements in Table 1-2 shows a strong factor of safety, as well as future satisfactory treatment if the contaminant levels exceed the design criteria and/or lower maximum contaminant levels (MCL) are adopted by the State.

Chlorination requirements by the State Health Division require continuous disinfection to achieve a free chlorine residual of 0.2 mg/l under all flow conditions throughout the distribution system. The chlorination system at the treatment facility is designed to provide this residual in two steps. Step 1 is the chlorination of the tower influent water to prevent bacterial growth on the tower media; and Step 2 is the re-chlorination of the tower treated water prior to discharge into the City's distribution system.

CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE
OF THE WATER TREATMENT FACILITY FOR WELLS NO. 4 AND 7

CHAPTER 2 - UNIT PROCESSES

A. AIR STRIPPING TOWERS

Air stripping towers No. 4 and 7 operate virtually identically. When the City's water system requires water from a particular well, the telemetry equipment signals the start-up of the treatment process for that well. The blower is activated, the tower inlet pipe drain is closed, and the well pump is activated. When a flow switch signals that water is flowing to the tower, the inlet chlorinator is started and, after an adjustable time delay, the outlet chlorinator is started.

Water enters the top of the tower, where it is directed into a distribution weir trough. The trough distributes the inflow evenly over the tower packing. The water is broken into small droplets as it falls through the packing media, while air is blown up from the bottom of the tower. The volatile organic chemicals evaporate and are exhausted with the air through the tower stack. A demister, consisting of an additional foot of packing material, is installed above the inlet pipe to prevent water droplets from being blown out the tower stack. The treated water is collected at the bottom of the tower and directed through a drain system into the clearwell.

Over time the tower packing may accumulate a biological film which may reduce treatment efficiency. The backwash cycle is designed to suppress this biological layer by super-chlorinating the influent water to each tower. The super-chlorinated backwash water drains from each tower through a separate drain system to the backwash sump. The backwash water is neutralized and pumped back into the tower inflow system when normal tower operation resumes.

Uniform distribution of the raw well water by the inlet weir trough is critical to attaining uniform VOC removal. The air/water ratio of 40:1 is equally important to attain optimum removal efficiency from each tower. Blower air flow rate within the tower must be sufficient to maintain the air/water ratio. Plugged tower media, plugged louver filters, or incorrectly adjusted duct control dampers will lead to poor tower performance.

Two valved drain lines from each tower direct flow to either the clearwell or backwash sump, depending on which operation mode the tower is in. In the event of drain line stoppage, a high water alarm sensor in the tower will direct the motor control center (MCC) to shut down all affected units, including well pumps, blowers, chlorination, etc.

Three access hatches are provided on each tower to access:

1. Demister unit, inlet piping and the weir trough liquid distributor.

2. The tower packing media for replacement.

3. The tower outlets and lower packing media support grate.

These access hatches are to remain securely bolted shut during normal and backwash tower operations.

B. AIR FLOW SYSTEM

The air flow system provides the air quantity required for VOC removal in the treatment towers. The system consists of two blowers, which draw filtered air from the north and west sides of the treatment building, and transmit this air through the duct system into each treatment tower. Blower No. 4 supplies air to Tower No. 4 and Blower No. 7 supplies air to Tower No. 7 under normal operating conditions. Since the two towers are designed for two different treatment capacities (Tower No. 4 for 600 GPM and Tower No. 7 for 1,000 GPM) Blowers No. 4 and 7 are designed for different delivery capacities. In the event of blower failure, Blower No. 7 will supply Tower No. 4 with no loss of water treatment capacity. However, if Blower No. 4 is required to supply Tower No. 7, the water flow rate through Tower No. 7 must be reduced to 600 GPM.

Blowers No. 4 and 7 are located in the fan room within the new treatment building. Air enters the room through acoustical louvers mounted in the north and west walls of the treatment building. Replaceable air filters mount in a filter rack attached to the louvers. These filters remove foreign material from the air used for VOC removal within the tower. Periodic inspection and replacement of the filters is required to maintain blower efficiency and effective VOC removal performance.

The air duct system channels the blower air to each tower. An air flow switch is mounted immediately downstream of each blower as a fail-safe check of blower start-up and operation during tower operation. Back draft dampers are located following the air flow switches. Control dampers allow air flow direction to be regulated during manual over-riding of the system. By opening and closing dampers, air flow from either blower may be directed into either tower. Adjustment of the control dampers is a manual operation, which will affect tower VOC removal efficiency if done improperly. Control dampers should be set at normal tower operation settings at all times, except during periods of special manual override operation.

Start-up and shut down of the blowers is controlled by the MCC in the new treatment building. It is a critical component of the tower start-up and shut down sequence. The blower supplying its respective tower will operate only during operation of that tower. Blower failure will cause the MCC in the treatment building to shut down the well/tower system served by the failed blower.

Each blower may be switched from "AUTO" to "MANUAL" control at the MCC. This allows the operator to control either blower during manual tower operation. A safety power shut-off switch for each blower is located in the fan room to positively deactivate power to either blower during maintenance work.

C. CHLORINATION SYSTEM

The chlorination system performs three functions at the treatment facility:

1. Injection of chlorine solution into each tower inlet pipe pre-chlorinates the raw influent well water and helps deter biological film growth on the tower media.

2. Injection of chlorine solution into the main tower drain system boosts the free chlorine residual of the treated water to the level required in the City's distribution system.

3. Injection of a concentrated chlorine solution into the inlet pipe of a tower being backwashed will kill biological film which may foul the tower media.

During the tower start-up sequence, the chlorination system normally activates immediately following well pump start-up. The MCC in the new treatment building calls for well pump start-up and confirms flow by the tower inlet flow switch. The MCC then opens the solenoid valve feeding water to the corresponding Wallace & Tiernan V-100D chlorinator assigned to the operating tower's inlet pipe. Chlorine gas is drawn by the chlorinator through a Sch. 80 PVC manifold from two 150 lb. chlorine gas cylinders with vacuum regulation valves. The chlorinator proportionally mixes chlorine gas with feed water supplied through a 2" manifold. The resulting solution is delivered to the tower inlet pipe injector by a 1½" Sch. 80 solution line. The V-100D chlorinator is adjustable from 0 to 10 pounds per day of chlorine gas. Solution concentrations above 10 PPD will require modification of the chlorinator and gas injector. Chlorination feed rates into each tower inlet pipe will be field adjusted following a period of tower operation to determine the bacterial film growth rate on the weir trough liquid distributor and tower packing media.

Chlorination of the tower effluent water will begin following an adjustable time delay to allow water to flow through the tower. Associated with each tower is a Wallace & Tiernan V-75VA2 Chlorinator with an individual solenoid valve for start/stop control. The chlorine solution from each V-75 chlorinator is fed into a single 1½" solution line which is connected to the 18" tower drain system just ahead of the clearwell. When both towers are operating, both V-75VA2 chlorinators are contributing to the single solution injector. Each chlorinator unit is capable of supplying from 0 to 10 pounds per day of chlorine gas. Each V-75VA2 chlorinator feeding the tower drain system solution injector will be set to achieve satisfactory free chlorine residual in the treated water pumped into the City's distribution system (0.2 mg/l throughout).

Tower flow shut down begins with well pump shut-off, followed by opening of tower inlet pipe drain lines, then solenoid valve shut-off of feed water to the operating V-100D chlorinators. Following an adjustable time delay to allow each tower to drain, the solenoid valve on the feed water line to each V-75VA2 chlorinator closes.

Backwashing either Tower No. 4 or 7 requires an extra strong chlorination dose. This is provided by two V-75VA5 chlorinators with a solenoid start/stop valve on the feed water line to each chlorinator. The backwash sequence requires manual change of the tower drain direction and overriding the normal tower operation sequence at the MCC. One of the chlorine solution directing ball valves in the chlorine room must be opened to direct chlorine solution to the tower being backwashed. Following well pump start-up and tower flow switch confirmation, both backwash chlorinator feed solenoid valves are opened. The extra strong chlorine dose from each chlorinator is combined and delivered to the tower inlet pipe through the normal solution supply line and solution injector. Ending the backwash cycle involves stopping the well pump, opening the tower inlet pipe drain lines, then closing the solenoid valve on the feed water line to each V-75VA5 chlorinator. This sequence is part of the automatic shut down operation controlled by the MCC.

Each V-75VA5 chlorinator is capable of supplying from 0 to 500 pounds per day of chlorine gas. Normal backwashing of a single tower will utilize both chlorinators with a combined feed rate of approximately 360 PPD to Tower No. 4 and 600 PPD to Tower No. 7. At these feed rates, the chlorine residual will be approximately 50 mg/l.

Chlorine gas is supplied to all chlorinators through a single 3/4" Sch. 80 PVC supply manifold with draw-offs through one-half inch PVC shut-off valves and gas tubing to the control units. The source and monitoring of the chlorine gas supply is accomplished by two 150 lb.

chlorine cylinders on a Wallace & Tiernan Model 50-345 tank scale with a pair of 500 C automatic switchover vacuum cylinder valves.

Check and ball valves, as well as PVC unions, on all chlorination piping allow isolation of system components for maintenance without shutting the entire system down. A strainer and backflow preventer on the chlorinator feed water supply manifold functions to prevent clogging of the chlorinators and backflow of chlorine injection water.

A chlorine leak detector is mounted on the east wall in the chlorine room with its sensor set at nearly floor level. A chlorine leak will trip the detector causing an alarm light on the MCC panel and on the detector unit. This MCC alarm condition will also be transmitted to the Milwaukie police station.

The chlorine room in the treatment building contains all chlorination equipment. The room air supply fan turns on every time the door is opened to clear the room air. Two auxiliary chlorine tank wall bumpers with safety chains allow storage of three extra chlorine gas tanks in the room.

D. BOOSTER PUMP SYSTEM

Two 900 GPM vertical turbine pumps, located in the treatment building above the clearwell, transfer treated water into the distribution system. Each pump is powered by a three-phase, 460 volt, 75 HP motor operating at 1,800 RPM. Each three stage pump generates 213 feet TDH at 900 GPM.

The booster pump system is controlled by the MCC in the treatment building. The pumps start and stop in response to selected water levels in the clearwell, which are transmitted to the MCC by the float control system. Emergency low water pump cutout and high water system cutout switches are also provided in the clearwell as extra safety measures. The order of pump operation is alternated after each cycle to provide even wear on both pumps. An adjustable time delay is also provided to control the starting of each booster pump. A single tower running may only require operation of a single booster pump, but as the clearwell water level rises with two towers operating, the second booster pump will be activated. If a pump fails to start and the clearwell water level reaches the high water alarm level, the well pumps and towers will be shut down automatically by the MCC. If a pump fails to stop and the clearwell water level drops to the low water alarm level, the booster pumps will turn off.

A pump control valve controls the start-up and shut down of each booster pump to prevent surges in the distribution system. The valve is wide open when the pump is off. When the pump is started, a solenoid is energized and the valve starts closing. The closing speed is adjustable. While the valve is open, it discharges air and the initial rush of water from the pump column back into the clearwell. The valve closes slowly, so pump pressure increases gradually until the check valve opens, preventing starting surges. On shut down, the solenoid is de-energized and the valve starts to open slowly. The opening speed is adjustable. While the valve is opening, a micro-switch keeps the pump motor circuit closed so the pump continues to operate. As the valve continues to open, the pressure decreases gradually and the check valve closes slowly, preventing pump stopping surges. When the pump control valve is almost fully open, the micro-switch is activated to stop the pump.

The booster pump system is automatically controlled and will normally not require manual overriding except during maintenance work. The butterfly and check valves on each pump discharge line facilitate rapid isolation of the pumps and pump appurtenances for such maintenance.

E. TOWER BACKWASH (RINSE) SYSTEM

The backwash or rinsing system functions to suppress the growth of bacteria and other unwanted biological films inside the stripping towers, which could plug the packing media and hinder VOC removal efficiency.

Rinsing of the media is accomplished by mixing raw well water and a high dose of chlorine, and placing the resulting solution into the backwash sump. The solution is then recirculated through each tower for an extended period of time to contact all the media with the disinfecting dose of chlorine. At the completion of the rinsing cycle, the towers are rinsed with clear water and placed back into service. The chlorine solution is diluted and fed slowly back through the towers while they are in normal operation. Excess chlorine in the water is stripped out along with the VOCs.

The backwash pump is a single stage vertical turbine pump powered by a 5HP, three-phase, 460 volt motor operating at 1,800 RPM. This pump generates 250 GPM at 39 feet TDH. When rinsing the towers, the backwash pump is run manually. The backwash pump is also used to pump water back through Tower No. 4 which has accumulated in the sump when the towers are placed in "WINTER" mode. See Chapter 3 for a description of the summer/winter operation modes. Low water and high water cutout switches are also found in the backwash sump to prevent pump damage from low water levels and overfilling the sump in the event of pump failure.

F. MOTOR CONTROL CENTER

The motor control center (MCC) in the City's Well No. 4 treatment building controls the complete operation sequence through a Texas

Instruments programmable logic controller to produce treated water from Wells No. 4 and 7 and supply this treated water into the City's high level distribution system. The MCC acts on telemetry signals from the control center located in the Milwaukie Well No. 2 building. This control center monitors the water level in the elevated tank at 40th and Harvey street by use of a liquid level float control system. When the elevated tank requires inflow, the control center at Well No. 2 sends a telemetry signal to the MCC calling for start-up of Well No. 4 and/or Well No. 7. The MCC in the Well No. 4 treatment building translates the telemetry signal and commences start-up of the requested well and corresponding treatment tower system. A satisfactory treatment system start-up signal will be sent from the MCC back to the control center at Well No. 2 when normal tower operation commences. If any start-up operation in the sequence leading to normal tower operation fails, the MCC will send an alarm signal to the Milwaukie police station. Positive tower start-up will produce run lights on both the MCC panel at Well No. 4 and control panel at Well No. 2.

Manual override of the automatic tower control system is not possible, as the chlorinator solenoid valves are controlled only by the MCC. Each tower and corresponding well operate independently of the other. Therefore, it is possible to backwash one tower while the other is contributing to the distribution system.

Failure of the blower, well pump or chlorination system causes immediate shut down of the respective well. Alarm lights are activated on the MCC and an alarm signal is sent to the Milwaukie police station. A reset button is provided to clear the alarms. Push once to silence alarm at the police station and reactivate controls. The system will now operate in fail mode to facilitate troubleshooting. Push the reset button again to clear and reset the alarm system. If the button is not pushed again within 15 minutes (900 seconds) of the first push, the alarm system will reset itself.

G. TELEMETRY SYSTEM

The telemetry system functions to transmit operational commands, system status signals, and alarms to receivers/controllers in the treatment system.

Start-up telemetry signals originate from the control center at Milwaukie Wellhouse No. 2. These signals call for start-up of Well No. 4 and/or No. 7 based on water levels in the City's elevated reservoir located at 40th and Harvey street. Two telephone lines connect the control center at Well No. 2 to the MCC in the treatment building at Well No. 4. One line carries the telemetry control signal for Well No. 4 and the other for Well No. 7. The MCC interprets the signals and initiates the appropriate action. No telemetry signal confirming successful operation will be sent back to the control center at Well No. 2 if system failure occurs and the respective well stops running. The MCC, in the event of system failure, will send a telemetry signal on a third telephone line to the Milwaukie police station. The monitor at the Milwaukie police station is a receiving unit only. Operation switches and auto controls for the treatment facility exist only in the control center at Wellhouse No. 2 and the MCC in the treatment building. The well buildings themselves contain only well pump controls.

The telemetry system for controlling the treatment facility for Well No. 4 and 7 should not be altered without careful system redesign. Any telemetry system adjustments should be coordinated with U.S. West Communications. Alterations of the system whether accidental or willful may result in system failure and public endangerment.

H. SENSORS AND ANALYZERS

The treatment facility at Well No. 4 monitors unit processes by use of sensors, meters, and float instruments. The instruments detect whether critical unit processes start, operate, and/or shut down correctly. Failure of a critical process component will be sensed and the system shut down to prevent distribution of untreated water. The type, location, and number of monitoring instruments is described below.

1. <u>Tower Inlet Flow Switch</u>

A tower inlet flow switch is tapped into each tower inlet pipe just above the chlorine injection tap. Access to the switch is from the meter box at the base of each tower. The tower inlet flow switch functions to confirm well pump start-up, inflow during tower operation, and well pump shut down. The switch contact is normally open and is closed by flow in the pipe.

During tower start-up, the MCC in the treatment building waits for the flow switch contact signal for an adjustable delay period. This delay period is required to allow for well pump start-up and filling the tower supply line. If the MCC receives a positive flow switch contact signal during the delay period, normal tower start-up operations continue. If a contact signal is not received by the MCC during the delay period, the MCC will assume well start-up failure, shut down the tower system, activate the well fail light and send an alarm signal to the Milwaukie police station. Chlorination equipment is only activated if the flow switch closes.

During normal tower operation, the inlet flow switch functions to monitor tower inflow. If inflow stops for any reason, the MCC will shut down the tower system and send an alarm signal to the police station.

When the tower system shuts down normally, the inlet flow switch functions to verify well pump shut down. After flow stops and the flow switch opens, the chlorination and blower shut down sequences are performed.

2. Air Flow Switch

An air flow switch is mounted in each blower discharge duct to monitor blower start-up, continuous operation, and shut-off. Air flow switch contact signals will be sent to the MCC continuously during tower operation. If a blower fails to start during the tower start-up sequence, the air flow switch will not send a contact signal to the MCC. The MCC will react by shutting the tower system down, activating the blower fail light and sending an alarm signal to the Milwaukie police station.

When the tower system is operating, the air flow switch will send a continuous contact signal to the MCC. If a blower fails or air flow falls below the minimum pressure required to activate the switch, then the contact signal will stop. The MCC will react to the air flow signal loss by shutting the tower system down and sending an alarm signal to the Milwaukie police station.

During the tower shut down sequence, the blower system is the last unit process to terminate. The air flow switch is deactivated when the blower stops and the pressure in the duct system drops back to atmospheric.

Since the blower system is a critical unit process in the tower operation system, failure signals from the air flow switch should be investigated immediately. Periodic checks to confirm correct switch operation should be considered as part of the routine treatment plant inspection.

3. Flow Monitors

A panel mount flow monitor is located in the treatment building MCC to display quantity of flow from the treatment facility to the distribution system. A brass flow sensor to measure outflow is tapped into the 12" distribution supply pipe in the vault south of the SE corner of the treatment building. This flow sensor is linked to the monitor in the MCC by shielded cable in conduit. The flow monitor and sensor are not linked to the treatment plant operation sequence, and function solely to measure plant outflow.

Wall mount flow monitors with flow sensors in the pump discharge lines are installed in the Well No. 4 and 7 pump houses. These units function to measure the well discharge volumes and are not related to the treatment facility operations.

4. Residual Chlorine Monitor

A free chlorine residual monitor to provide accurate monitoring of the chlorine concentration in treated water being pumped into the distribution system is located in the MCC panel. A ½" copper line, tapped into the 12" distribution main in the vault south of the SE corner of the treatment building, provides sample water to the monitor's flow cell assembly. The flow cell assembly, located on the south wall of the pump room, utilizes constant head overflow past a chlorine sensor probe. Treated discharge water continuously supplied to the overflow assembly is tested by the sensor and discharged through a 1/2" drain line back into the clearwell. The sensor signals are sent to the residual monitor in the MCC and converted to direct readout values on the panel.

The MCC monitors the free chlorine residual for high or low levels. If the chlorine residual falls outside of the pre-set operating range, the MCC directs complete system shut down, activates the chlorine residual alarm light and an alarm signal is sent to the Milwaukie police station.

5. Tower High Water Sensor

A tower high water sensor is located in the side of each tower 2'-6" above the base. The cylindrical, side-mounted sensor functions to alert the MCC of high water build-up in the tower if the normal and backwash drain valves are inadvertently left closed or the tower outlet pipe becomes plugged. If water build-up in a tower causes the high water sensor to trip, the MCC will shut down the well/tower system, activate the tower high level alarm light and send an alarm signal to the Milwaukie police station. The high water sensor is set so that the system will shut down before the tower water level overflows into the blower duct system.

6. Liquid Level Float Controls

Liquid level float control units monitor the clearwell and backwash sump water levels. Each unit consists of a float, operating a pulley and worm gear assembly. The worm gear shaft has trip paddles to activate and de-activate mercury switches at preset water depths.

During normal clearwell operation, the first level switch will close when the water rises to a preset level. This switch initiates start-up of the lead booster pump through the MCC. If the clearwell level rises further, tripping the second level switch, the MCC will start the second booster pump. When the water level in the clearwell falls, the second level switch is tripped off first and the second booster pump is shut down. As the water level continues to fall, the first level switch eventually trips off and the booster pump system completely shuts down. An automatic alternator changes the lead pump after each cycle.

The backwash sump pump is directly controlled through the MCC by the float control unit assigned to the backwash sump. The level switch will initiate sump pump start-up through the MCC when the water rises to a preset level. When the water drops to a preset level due to pumping, the level switch opens and the pump stops. The backwash sump pump is automatically started/stopped by the MCC only when Well No. 4 is running in normal treatment mode.

Both float control units have a level indicator dial to provide clearwell and backwash sump liquid levels at a glance. Once set to trip at specific water levels, the float control units will operate automatically.

7. <u>High and Low Water Alarm Floats</u>

High water and low water float switches are provided in the clearwell and backwash sumps. The high water float switches function to alert the MCC of any one of the following conditions:

a. Booster or sump pump start-up circuit failure
b. Inflow exceeds pump capacity
c. Pump float control unit failure
d. Incorrect manual pump override operation

The high water float switch in the clearwell will activate if the water level rises to 15" below the bottom of the floor slab. High water float switch activation in the backwash sump will occur if the water level rises to 36" below the bottom of the floor slab. During a clearwell high water alarm situation, all well/tower systems will be shut down. The booster pump system will remain activated to lower the water level in the clearwell. During a backwash sump high water alarm situation, all well/tower systems will be shut down. Appropriate alarm lights will be activated on the control panel and an alarm signal sent to the Milwaukie police station if either high water condition occurs.

The low water float switches function to shut down the booster pumps and/or backwash sump pump if any one of the following conditions occurs:

a. Pump float control unit failure,
b. Pump shut-off circuit failure,
c. Incorrect manual pump override operation.

Activation of the low water float switch in the clearwell will occur if the water level drops to 32" above the clearwell floor. Activation of the low water float switch in the backwash sump will occur if the water level drops to 12" above the sump floor. Appropriate alarm lights will be activated on the control panel and an alarm signal will be sent to the Milwaukie police station if either low water condition occurs.

The well pump and tower systems will continue to operate normally during a low water alarm to bring the clearwell and/or backwash sump levels back to non-alarm levels.

The high and low water alarm floats are mounted on vertical pipe supports in both the clearwell and the backwash sump. Each system functions to override the auto and manual controls to prevent serious treatment plant damage from system failure. Separate alarm lights to indicate high/low water levels in either the clearwell or the backwash sump are provided on the control panel. Following an alarm condition and correction of the problem, the reset button must be pressed twice to bring the system back "on line".

I. STANDBY ENGINE GENERATOR

A 200 KW engine-generator unit is located in the pump room of the new treatment building at the Well No. 4 site. This unit will power both tower systems, Well Pump No. 4, and all interior treatment building components, including the booster pumps. The MCC unit is designed to be manually switched over to the engine-generator as a power source in the event of utility power loss.

A 550 gallon diesel fuel tank is located in the pump room to supply the engine unit. A tank filler pipe with locking cap is accessible on the east wall of the treatment building. The tank is also vented to the outside by a vent tube through the east wall. Fuel lines run across the floor from the tank to the engine-generator unit.

The operation sequence to start and operate the engine-generator unit is outlined in the emergency system operation mode section. Operators should be thoroughly familiar with the engine-generator safety and operation procedures before attempting to operate the unit. Extreme care should be exercised around the engine-generator when it is operating.

J. SAND SEPARATOR

A sand separator is located on the pump discharge piping from Well No. 4. The separator functions to prevent sand carried in the well discharge from entering and depositing in either tower. The separator unit is mounted in a 22½° profile and bolted to the floor in Wellhouse No. 4. The operation range of the separator is from 480 GPM to 880 GPM.

As well water passes through the separator, a vortex forms spiralling the sand particles into the separator's collection chamber. This collection chamber must be manually purged at regular intervals while the well pump is running. A ball valve on the purge line from the separator is opened and accumulated sand is blown out into a collection drum near the unit. The purged water is allowed to drain from the collection drum through a ½" line. This functions to de-water the sand, making it more manageable for disposal. Purging frequency will depend on the run time of Well No. 4.

K. WELLHOUSE NO. 4

Wellhouse No. 4, located approximately 25 feet west of the new treatment plant, contains the electrical controls, well pump, flow meter, sand separator, and associated piping to direct the Well No. 4 discharge to Tower No. 4. The original pump start/stop control system is now linked to the MCC in the treatment building. Automatic pump start-up and shut down signals originate from the control center at Well No. 2 and are channelled to Well Pump No. 4 through the MCC at the treatment plant. The automatic controller for Well Pump No. 4 can be manually over-ridden at the well pump control panel.

Well Pump No. 4 is designed to pump against full distribution system pressure. This full discharge pressure must be throttled down by valves on the well discharge line to prevent excessive flow to the treatment tower. The well pump discharge is directed past a 2" air valve and check valve before being directed upward past a flow meter probe and into the sand separator inlet. Flow straightening tubes in the vertical pipe section reduce vortexing before the flow passes the flow meter probe. Following the flow meter probe, the well discharge enters the sand separator. A second air valve is located on the highest pipe section exiting the sand separator. The 8" line then turns downward, passing through an 8" X 4" tee with a 4" gate valve on the branch and an in-line 8" butterfly valve. This arrangement provides blow-off capability for Well Pump No. 4. The butterfly valve functions to isolate the system during pump blow-off and also regulate pump discharge during normal tower operation.

A digital readout flow meter is located on the north wall of the wellhouse to monitor flow from Well No. 4. The meter probe is tapped into the discharge line prior to the sand separator. The purpose of this unit is to provide an individual flow reading for the well.

L. WELLHOUSE NO. 7

Well No. 7, located at 11022 SE 37th Avenue, provides raw well water to the treatment plant at Well No. 4 through an independent 10" supply line. The motor and pump assembly at Well No. 7 were designed to pump directly into the distribution system. This capacity must be throttled down to prevent excessive flow to the treatment tower. Throttling is accomplished by the butterfly valve on the pump discharge piping and gate valves in the 10" supply line.

The well pump electrical controls are original equipment and mounted on the west wall inside the well building. The original pump START/STOP control system is now linked to the MCC in the treatment building at Well No. 4. Automatic pump start-up and shut down signals, originating from the control center at Well No. 2, are channelled to Well Pump No. 7 through the MCC at the treatment plant. The automatic controller for Well Pump No. 7 can be manually over-ridden at the well control panel.

Well pump start-up is controlled by a solenoid actuated pump control valve. A check valve downstream of the pump control valve prevents the 10" line from draining and functions in conjunction with the pump control valve during start-up. The flow meter probe is tapped into the discharge piping following the check valve. A butterfly valve is then positioned on the discharge line following the meter probe.

A digital readout flow meter is located on the west wall of the well house to monitor flow from Well No. 7. The meter probe, downstream of the check valve, provides flow measurement signals to the meter. The purpose of this unit is to provide an individual flow reading for the well.

A diesel engine unit is located in Well No. 7 to power the well pump in the event of utility power loss. All start-up, monitoring, and shut down operations of the engine unit are manual functions. In the event of power failure, a city crew member will be required to manually set up and control the engine unit. Fuel for this unit is contained in a tank below the engine. Well No. 4 can operate with only limited manual input during utility power loss because it is powered by the engine-generator in the treatment building. Well No. 7, on the other hand, is completely dependent on manual operation.

CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE
OF THE WATER TREATMENT FACILITIES FOR WELLS NO. 4 AND 7

CHAPTER 3 - SYSTEM OPERATION

A. SYSTEM FLOW DIAGRAM

Figure 1 illustrates the on-site pipe flow network for operation of the treatment facility for Wells No. 4 and 7. The major operational components are labeled and the valves requiring manual operation to change flow operations are numbered. Note that Figure 1 is a simplified illustration and the complete system is shown on the construction drawings.

B. NORMAL SYSTEM OPERATION

1. Well and Tower No. 4 Operation

a. Valve Settings

A complete description of automatic start-up of the Well and Tower No. 4 system will be discussed in this section. Figure No. 1 will be used to identify correct valve positions for normal tower operation.

For operation of Well and Tower No. 4, the following valves shown on Figure No. 1 shall be placed in the following positions:

Close valves: 9, 11

Open valves: 1, 2, 3, 10, 12, 13, 14, 15, 16, 18.

The 12" gate valve located in the intersection of 37th Avenue and Monroe Street, which ties the treatment plant discharge line to an existing 18" primary feeder main, must remain open at all times to allow the booster pumps to supply treated water into the system.

b. Automatic Start-Up

The water level in the elevated reservoir drops, closing the Well No. 4 cam switch at the control center at Wellhouse No. 2. The control center then sends a telemetry signal to the telemetry receiver in the treatment plant at Well No. 4 calling for Well Pump No. 4 to start.

The programmable controller in the MCC reacts to the telemetry signal with the following sequence:

Step 1) Start blower No. 4. If the air flow switch at the blower does not trip after a 5 second delay, the system will automatically shutdown and send an alarm signal to Milwaukie police station.

Step 2) Close solenoid valve on Tower No. 4 inlet pipe drain system.

Step 3) When air flow switch activates, start Well No. 4. If water flow switch in tower inlet does not trip following a 30 second delay, the system will automatically shutdown and send an alarm signal to the Milwaukie police station.

Step 4) When water flow switch activates, open solenoid valve on solution supply line to V-100D chlorine feeder for Tower No. 4 inlet.

Step 5) After 30 second delay, open solenoid valve on solution supply line to V-75 chlorine feeder for Tower No. 4 outlet.

The system is now in normal operating mode. If the tower fails to drain properly and the tower high water sensor activates, the system will shut down automatically and send an alarm signal to Milwaukie police station.

c. Automatic Shutdown

The Well and Tower No. 4 treatment system automatically shuts down in the following sequence:

The water level in the elevated reservoir rises, opening the Well No. 4 cam switch at the control center at Wellhouse No. 2. The control center then sends a telemetry signal to the receiver in the treatment plant at Well No. 4 calling for Well Pump No. 4 shutdown. The programmable controller in the MCC reacts to the telemetry signal with the following sequence:

Step 6) Stop Well Pump No. 4 and open solenoid valve on Tower inlet pipe drain system.

Step 7) Close solenoid valve on solution supply line to V-100D chlorine solution to Tower No. 4 inlet.

Step 8) Following a 30 second delay, close solenoid valve on solution supply line to V-75 chlorinator feeding Tower No. 4 outlet.

Step 9) Following an additional 90 second delay, stop Blower No. 4. System is now de-activated and ready to return to Step 1 when telemetry calls.

2. Well and Tower No. 7 Operation

a. Valve Settings

A complete description of automatic start-up of the Well and Tower No. 7 system will be discussed in this section. Figure No. 1 will be used to identify correct valve positions for normal tower operation.

For automatic operation of Well and Tower No. 7, the following valves shown on Figure No. 1 shall be placed in the following positions:

Close valves: 8, 11

Open valves: 5, 6, 7, 13, 14, 15, 16, 18

The 12" gate valve located in the intersection of 37th Avenue and Monroe Street, which ties the treatment plant effluent line to an existing 18" primary feeder main, must remain open at all times to allow the booster pumps to supply treated water into the system.

b. Automatic Start-up

The water level in the elevated reservoir drops, closing the Well No. 7 cam switch at the control center at Wellhouse No. 2. The control center then sends a telemetry signal to the receiver in the treatment plant at Well No. 4 calling for Well Pump No. 7 to start.

The programmable controller in the MCC reacts to the telemetry signal with the following sequence:

Step 1) Start Blower No. 7. If the air flow switch at the blower does not trip after a 5 second delay, the system will automatically shut down and send an alarm signal to the Milwaukie police station.

Step 2) Close solenoid valve on Tower No. 7 inlet pipe drain system.

Step 3) When the air flow switch activates, start Well No. 7. If water flow switch in tower inlet does not trip following a 480 second delay, the system will automatically shut down and send an alarm signal to the Milwaukie police station.

Step 4) When water flow switch activates, open solenoid valve on solution supply line to V-100D chlorine feeder for Tower No. 7 inlet.

Step 5) After a 30 second delay, open solenoid valve on solution supply line to V-75 chlorine feeder for Tower No. 7 outlet.

The system is now in normal operating mode. If the tower fails to drain properly and the tower high water sensor trips, the system will shut down automatically and send an alarm signal to the Milwaukie police station.

c. Automatic Shutdown

The Well and Tower No. 7 treatment system automatically shuts down in the following sequence:

The water level in the elevated reservoir rises, opening the Well No. 7 cam switch at the control center at Wellhouse No. 2. The control center then sends a telemetry signal to the receiver in the treatment plant at Well No. 4 calling for Well Pump No. 7 shutdown. The programmable controller in the MCC reacts to the telemetry signal with the following sequence:

Step 6) Stop Well Pump No. 7 and open solenoid valve on Tower inlet pipe drain system.

Step 7) Close solenoid valve on solution supply line to V-100D chlorine solution to Tower No. 7 inlet.

Step 8) Following a 30 second delay, close solenoid valve on solution supply to V-75 chlorinator feeding Tower No. 7 outlet.

Step 9) Following additional 90 second delay, stop Blower No. 7. System is now de-activated and ready to return to Step 1 when telemetry calls.

3. <u>Backwashing (Rinsing) Towers No. 4 and 7</u>

To prevent the growth of bacteria and other unwanted organisms in the towers, they should be rinsed with a disinfecting chlorine solution every six to eight weeks. If scale buildup occurs, a mild acid solution can be rinsed through the towers in a similar manner. The rinsing procedure consists of the following steps:

a. Stop Wells No. 4 and 7

b. Drain backwash sump

c. Place a 25 to 50 mg/l chlorine solution in the backwash sump by running Well No. 4 in the backwash mode and feeding chlorine through the Backwash Chlorinators.

d. Rinse the solution through Tower No. 4 for 60 minutes using the sump pump.

e. Rinse the solution through Tower No. 7 for 60 minutes using the sump pump.

f. Rinse fresh water through Tower No. 4 and 7 to remove solution and dilute it in the backwash sump to approximately 10-20 mg/l chlorine residual.

g. Return Wells No. 4 and 7 to normal operating mode, and feed solution through Tower No. 4 at a low flow rate to strip excess chlorine before entering the system.

A more detailed 29 step checklist for rinsing Towers No. 4 and 7 is contained in Appendix B.

4. Booster Pump Operation

The two vertical turbine booster pumps located in the treatment building constitute a separate system from the well and tower systems. Water level changes in the clearwell trip pump start and stop floats. A high water alarm float serves to prevent clearwell overflow in the event of booster pump failure. This alarm situation will cause shutdown of all operating well and tower systems. A low water alarm float serves to prevent loss of impeller submergence. This low water alarm situation will not affect tower or well operation, but will stop the booster pumps.

Normal operation of the booster pumps consists of the following sequence:

a. Well and tower system in operation causes water level in clearwell to rise. Float control unit trips the first level switch sending signal to MCC.

b. MCC receives float signal and activates lead pump relay. NOTE: MCC alternates lead pump with each ON/OFF cycle.

c. After an adjustable time delay, the lead booster pump starts and its pump control valve solenoid is activated to slowly open check valve and begin pumping into distribution system.

d. Clearwell water level will either fall or continue to rise depending on volume of tower discharge.

e. If clearwell water level falls to pump shut-off depth, float will trip level switch sending signal to MCC.

f. MCC receives float signal and deactivates lead pump relay. The pump control valve solenoid is deactivated causing the check valve to slowly close. When closed, the pump is stopped.

g. If clearwell water level continues to rise, the second float switch will trip activating the second booster pump relay through the MCC.

h. After an adjustable time delay, the second booster pump starts and its pump control valve solenoid is activated to slowly open check valve and begin pumping into distribution system.

i. Clearwell water level will fall with both booster pumps operating.

j. If clearwell water level falls to second pump shut-off depth, float will trip level switch sending signal to MCC.

k. MCC receives float signal and deactivates second pump relay. The pump control valve solenoid is deactivated, causing the check valve to slowly close. When closed, the pump is stopped.

l. If clearwell water level continues to rise when both booster pumps are operating, high water alarm float will trip. MCC will then shutdown the operating well and tower system(s). The booster pump system will remain activated to bring the clearwell liquid level to pump shut-off depth.

m. To reactivate system following alarm condition and correction of the problem, press reset button once to allow system to operate, but keeping alarm light on. Press reset button a second time to clear alarm light.

If the lead booster pump fails to start, the clearwell water level will eventually trip the second float switch. If the second booster pump does start and pump discharge exceeds inflow, the pump will empty the clearwell. The failed booster pump run light will not activate on the MCC panel, although the second booster pump will run normally. When the clearwell level rises again, the second booster pump will start again. If the clearwell water level does not rise to the high water alarm level before tower system shutdown, then the booster pump system will cycle again. Only by comparing pump run times, having a high water alarm condition, or observing a booster pump not running when it should, can the operator discover this cycle is occurring. Failure of either booster pump will initiate this cycle or a variation of it.

All well and tower systems are shut down if the chlorine residual rises above or falls below a field set operating range. The booster pump system is also shut down in this case to prevent discharge of improperly chlorinated water.

All booster pump automatic operations are a result of the programmable controller operation program. This program can be manually overridden or changed. Alteration of the controller program should only be undertaken by knowledgeable operators or factory representatives. Manually overriding the booster pump's automatic controls is easily accomplished at the MCC panel by setting the pump selector switches in "HAND" mode.

5. <u>Summer/Winter Tower Operation</u>

A summer/winter selector switch is located on the MCC panel to control the tower inlet pipe drain system. A PVC drain line is tapped into each tower inlet pipe below ground to drain the inlet pipe to the backwash sump. One solenoid valve is located on each tower PVC drain line and controlled by the programmable controller in the MCC. Both solenoid valves are located in the vault at the NW corner of the tower landing slab.

When the selector switch is set to "WINTER", the solenoid valves are only closed when the well system is running. When each well stops, the respective solenoid valve opens, draining the inlet piping. When the selector switch is set to "SUMMER", the solenoid valves are held closed at all times and the tower inlet piping remains full to the top of the towers.

Winter season operation requires each tower inlet pipe to drain following well and tower shutdown. This prevents a full tower inlet pipe from freezing when flow has stopped. The Tower No. 7 inlet pipe drain system will also drain the 10" supply line from the air valve at the intersection of 37th and Monroe Street to the tower itself. Frequent Tower No. 7 start/stop cycles during the winter season will result in more frequent sump pump operation due to this increased inflow. As a general rule, the tower inlet drain system should be set to winter mode prior to the season's first frost.

Summer season operation does not require the tower inlet pipes to drain. Thus, the solenoid valves in the tower inlet drain system will remain closed after the selector switch on the MCC is set to the summer mode. The operator should exercise caution when deciding to set the drain system to summer mode. The threat of freezing temperatures should be long past before the summer mode is activated.

C. OPERATION DURING POWER OUTAGE

In the event of electrical power failure anticipated to last more than a few hours or during a high water demand period, the standby engine/generator will be utilized to supply electrical power to run the treatment plant and Well No. 4. The engine generator and it's 550 gallon diesel fuel supply tank are located in the pump room of the new treatment facility at Well No. 4.

1. Standby Power Activation

The operation sequence to disconnect the plant from utility power, start-up the engine generator, and switch power sources to the engine-generator unit is given below:

a. Set main MCC manual transfer switch to "neutral" position.

b. Set starter selector switch for each component to "OFF" position.

   1) Blower No. 4
   2) Blower No. 7
   3) Booster Pump No. 1
   4) Booster Pump No. 2
   5) Sump Pump

c. Switch both Well No. 4 and 7 operation levers on the MCC panel to "BACKWASH".

d. Set main breaker to Well No. 4 panel to "OFF" position.

e. Perform engine/generator pre-start inspection.

   1) Oil Level - at or near full mark.
   2) Fuel level - sufficient fuel for anticipated run duration, fuel line connection tight.
   3) Battery - check connections and level of electrolyte.
   4) Coolant level - within 1/2-1 inch below radiator cap. Use 50/50 ethylene glycol/soft water coolant solution. Recovery tank should be 1/3 full (cold) and 2/3 full (hot), if provided.
   5) Air cleaner - clean and properly installed.
   6) Drive belts - visually inspect radiator fan, water pump, and alternator belts. They should be tight and in good condition.
   7) Operating area - check no obstructions exist around generator which may block cooling air flow. Make certain radiator fan duct is open towards door.

8) Exhaust system - check silencer and piping for tightness and condition. Exhaust outlet must be unobstructed.
9) Lamp test - check controller lamps by pressing lamp test button.

f. Start engine-generator set manual start - move generator master switch to run position. NOTE: The not in auto lamp will light and alarm horn will sound when the master switch is in the "OFF" position.

g. Allow engine/generator to run with no load for 5 minutes before applying system load.

h. Switch MCC manual transfer switch to "generator position" to utilize the generator to power the treatment plant and Well No. 4.

i. Set starter selector switches for each component to "AUTO" position:

1) Blower No. 4
2) Blower No. 7
3) Booster Pump No. 1
4) Booster Pump No. 2
5) Sump Pump

j. Set main breaker to Well No. 4 panel to "ON" position.

k. Set Well No. 4 operation lever on the MCC panel to "AUTO". Well No. 4 will start if it is being called by the telemetry line from the control panel in Wellhouse No. 2. If telemetry is also out, see section on Operation During Telephone Outage for instructions on providing start signal for Well No. 4.

l. If electric power is available at Well No. 7, turn operation lever on MCC panel for Well No. 7 to "AUTO". Well No. 7 will start if it is being called by the telemetry line from the control panel in Wellhouse No. 2. If electric power is not available at Well No. 7, see section on Operation of Well No. 7 During Power Outage.

2. Standby Power De-activation

When utility power becomes available again, the standby engine-generator can be disconnected and the treatment plant reconnected to the utility. The operation sequence to disconnect the plant from standby power and switch power source to the utility is given below:

a. Switch both Well No. 4 and 7 operation levers on the MCC panel to "BACKWASH". Wait for any running wells, blowers and booster pumps to cycle off.

b. Set starter selector switch for each component to "OFF" position:

   1) Blower No. 4
   2) Blower No. 7
   3) Booster Pump No. 1
   4) Booster Pump No. 2
   5) Sump Pump

c. Set main breaker to Well No. 4 panel to "OFF" position.

d. Switch MCC manual transfer switch to "utility position". Normal power is now restored to the treatment plant.

e. Allow engine/generator to continue running at no load condition for 5 minutes to cool the unit.

f. Set starter selector switches for each component to "AUTO" position:

   1) Blower No. 4
   2) Blower No. 7
   3) Booster Pump No. 1
   4) Booster Pump No. 2
   5) Sump Pump

g. Set main breaker to Well No. 4 panel to "ON" position.

h. Set Well No. 4 and 7 operation levers on the MCC panel to "AUTO". Wells No. 4 and 7 will start if they are being called by the telemetry line from the control panel in Wellhouse No. 2.

i. Set master switch to "AUTO" POSITION.

3. <u>Operation of Well No. 7 During Power Outage</u>

Well No. 7 is equipped with an angle drive below the motor to allow for direct connection of a diesel drive unit to operate the pump. In the event of electrical power failure at Well No. 7, the diesel drive must be connected to the pump and the pump start and stop operations must be performed manually. Radio contact between Wellhouse No. 7 and the treatment building will be required to relay start and stop commands. The operation sequence to activate the Well and Tower No. 7 system using the Well No. 7 diesel drive is as follows:

a. Set Well No. 7 system switch to "BACKWASH" at MCC panel in treatment building.

b. Set main breaker at Wellhouse No. 7 to "OFF" position.

c. Attach drive line from diesel engine to angle drive connection on Well No. 7.

d. Keeping clutch in and drive line de-activated, start diesel drive and run in no load position for 5 minutes to bring engine to operating temperature.

e. Radio operator at treatment building to set Well No. 7 system switch to "AUTO" position.

f. As soon as Blower No. 7 starts, radio back to Wellhouse No. 7 to engage the drive line and begin pumping from Well No. 7. Upon confirmation of water flowing into Tower No. 7, chlorination equipment will start and system run light will turn on.

g. When telemetry to treatment building indicates that Well No. 7 should be turned off, radio to Wellhouse No. 7 to disengage the drive line from the diesel engine. Allow engine to run for 5 minutes to cool the unit.

h. When normal power has been restored, detach drive line from diesel engine.

i. Set main breaker at Wellhouse No. 7 to "ON" position. System is now ready to run automatically when called by programmable controller in MCC at treatment building.

D. OPERATION OF WELLS NO. 4 AND 7 DURING TELEPHONE OUTAGE

In order to operate Tower No. 4 and Tower No. 7, the respective telemetry signals from Wellhouse No. 2 must be received. If the signal is broken due to a telephone outage, the start sequence for each tower can not be initiated.

To run the towers when the telephone service is out, the appropriate input contacts to the programmable controller must be manually closed to fool the programmable controller into believing that the start signal has been received. The procedure to start Well No. 4 or No. 7 when telephone outage occurs should only be performed by a certified electrician following standard safety procedures. Improper actions may result in costly equipment damage and/or lethal electric shock.

To start Well No. 4 during a telephone outage, the following steps are needed:

1. Set Well No. 4 system switch to "BACKWASH".

2. Turn off breaker number 9 in the distribution panel, disabling the programmable controller.

3. Attach a jumper wire between terminals 1 and 3.

4. Turn on breaker number 9 in the distribution panel, which will turn programmable controller back on. Note that input 0 in Column I of Module 0 is now lit.

5. To run Well No. 4, set Well No. 4 system switch to "AUTO". System will now run until switch is placed to "BACKWASH". Operator will have to monitor elevated tank level to make sure tank does not overflow.

6. When telephone service is restored, turn off breaker 9, remove jumper wire, and turn breaker 9 back on. If well is being called, input 0 in Column I of Module 0 will be lit, and Well No. 4 will start if in "AUTO" mode.

To start Well No. 7 during a telephone outage, the following steps are needed:

1. Set Well No. 7 system switch to "BACKWASH".

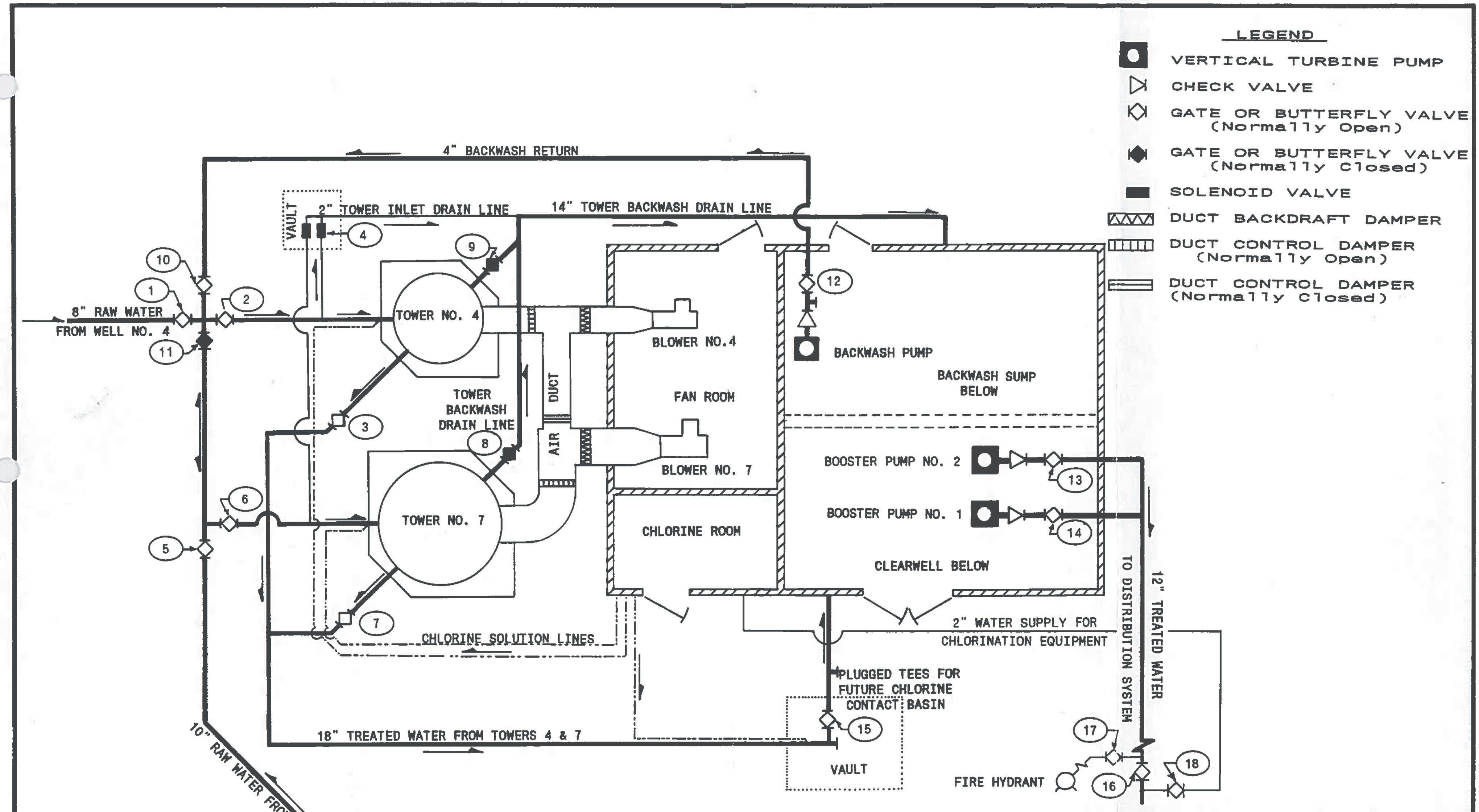
2. Turn off breaker number 9 in the distribution panel, disabling the programmable controller.

3. Attach a jumper wire between terminals 1 and 6.

4. Turn on breaker number 9 in the distribution panel, which will turn programmable controller back on. Note that input 3 in Column I of Module 0 is now lit.

5. To run Well No. 7, set Well No. 7 system switch to "AUTO". System will now run until switch is placed to "BACKWASH". Operator will have to monitor elevated tank level to make sure tank does not overflow.

6. When telephone service is restored, turn off breaker 9, remove jumper wire, and turn breaker 9 back on. If well is being called, input 3 in Column I of Module 0 will be lit, and Well No. 7 will start if in "AUTO" mode.



CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITY FOR WELLS 4 & 7

FIGURE 1 – FLOW DIAGRAM

CUNNINGHAM ASSOCIATES, INC. MILWAUKIE, OREGON

CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE
OF THE WATER TREATMENT FACILITY FOR WELLS NO. 4 AND 7

CHAPTER 4 - PERFORMANCE EVALUATION AND SAMPLING

A. PROCESS CONTROL TESTS

1. Flow Meters

Comparison of well pump flow volumes with treatment plant discharge volumes will constitute a control test for the flow meters. If a discrepancy between pump discharge and treatment plant discharge is discovered, the fault may lie with one or more of the following factors:

a. Well pump discharge flow meter out of calibration (test Well No. 4 and No. 7 separately)

b. Treatment plant discharge flow meter out of calibration.

c. Leak in supply pipeline from either well.

d. Leak in the tower drain piping.

Comparisons of flow volumes for a specific test period is preferred rather than comparison of total to date flow volumes. The procedure to test flow meter accuracy is as follows:

a. Switch both No. 4 and No. 7 well/tower systems to "BACKWASH" mode.

b. Check clearwell liquid depth and adjust to booster pump shut-off depth.

c. Take well pump meter reading and plant output meter reading.

d. Activate well/tower system for 30 minutes if testing Well No. 4, or 15 minutes if testing Well No. 7.

e. Take well pump meter reading and treatment plant output meter reading after well pump and booster pumps have stopped.

f. Repeat test for other well/tower system following steps (a. through e.)

Volume difference measured includes $\pm$ 1% deviation in flow sensor accuracy.

In the event of significant flow volume discrepancy, the flow meters tested should be recalibrated by the manufacturer's instructions. A re-test should follow recalibration of the flow meters. If continued flow discrepancy occurs, the cause may be a leak in the system.

2. Free Chlorine Residual Monitor

Recalibration of the chlorine residual analyzer should occur every time the sensor membrane is changed. Sensor membrane maintenance is recommended every 4-8 weeks depending on sample water purity. The procedure for replacing the membrane, electrolyte solution, and re-calibration of the analyzer is found in the E.I.T. Free Chlorine Monitor Operation and Maintenance Manual in the appendix. An additional sensor probe with charger has been provided to allow the operator to install the auxiliary probe containing a new membrane and charged electrolyte without shutting the treatment plant down for the electrolyte 6-8 hour stabilization period. The old probe is then available to be refitted and restabilized for future probe replacement.

Calibration of the monitor involves resetting the calibration factor to approximately 80.0, checking the zero reading, and using a preset chlorine solution as a calibration sample. The preset low/high chlorine residual alarm levels should also be checked. These checks in conjunction with the calibration procedures given in the Monitor O & M Manual will assure trouble free operation.

3. Air Flow Pressure

Air flow resistance in the tower system will increase as the tower packing media fouls with biological growth and the louver filters become plugged. Plugging of the louver filters can be determined by visual inspection. Fouling of the tower media, on the other hand, will cause increased air resistance and increased blower amperage at start-up. Field testing by coordinating blower amperage measurement with quantity of media fouling will give the operator a guide to determining when tower backwashing is required.

Calcium and mineral fouling on the tower packing media will also cause air flow resistance. The normal tower backwash operation will not remove these deposits. This type of fouling problem is anticipated to develop slowly over a long period of tower operation. Two solutions to this mineral deposition problem exist:

a. Rinse tower with mild acid solution for sufficient time to dissolve mineral deposits.

b. Replace existing packing media with new packing.

4. Engine-Generator

The engine-generator unit should be run for thirty minutes every two weeks to keep the unit in a ready state. The thirty minute run duration will allow the unit to reach operating temperature and oil pressure. Diesel fuel consumption during this 30 minute, no-load test will be roughly 2-3 gallons. The diesel fuel tank level should be maintained a minimum 3/4 full at all times.

The operator should follow all starting and safety procedures listed in the operation and service manuals provided by Kohler Power Systems. These Kohler Power System manuals may be found in the appendix of this manual. Any problems arising during a thirty minute run test should be promptly investigated.

5. Process Control Schedule

The schedule of monitoring unit control tests should follow the chart below. Unusual operating conditions may necessitate deviation from this schedule as required.

Meter/Monitor Unit	Recommended Test Frequency
Flow Meters at Wells #4 and #7 and Treatment Plant	Yearly
Chlorine Residual Monitor Calibration	4-8 Weeks
Air Flow Pressure	Monthly
Engine-Generator	2 Weeks

B. SAMPLING

Municipal water supply sampling will be conducted by certified City personnel following the most current State and Federal requirements. Additional sampling at the treatment plant will involve testing for free-chlorine residual in plant discharge water, and inorganic contaminant removal efficiency.

1. Sampling for Volatile Organic Chemicals

Volatile organic chemical concentration testing is required quarterly when detectable VOC levels are found. Initial pre and post tower treatment sampling will be required bi-weekly for six months and then monthly for six months. Following this one year performance test period, the quarterly testing schedule may be resumed unless state or federal requirements indicate otherwise.

2. Sampling for Chlorine Residual

Free-chlorine residual sampling requirements call for one sample per month per 800 residences (OAR 333, Public Water Systems, 1990). A chlorine residual reading at the point of plant discharge will be taken daily. Sampling for laboratory analysis will be taken monthly or more frequently when chlorine residual analyzer calibration is required.

C. RECORD KEEPING

1. Operational Data

Operation monitoring data should be kept in the notebook in the treatment plant. Daily, weekly, and monthly operation data and notes should be recorded in this notebook. Operation data should include:

a. Treatment plant total flow quantity
b. Chlorine residual monitor readings
c. Total booster pump run times (1 & 2)
d. Backwash sump pump run time
e. Chlorine tank supply (scale reading)
f. Condition of blower filters

The Public Works Department should maintain a permanent file of the plant monitoring data. This information will be used to evaluate performance, maintenance costs, and staffing requirements.

2. Regulatory Requirements

Oregon Administrative Rules, Chapter 333, for Public Water Systems (1990), lists operation and testing requirements for public water systems in the State of Oregon. OAR Chapter 333 also includes requirements issued by the U.S. Environmental Protection Agency. The City of Milwaukie should continuously monitor state and federal drinking water requirements to assure compliance. This monitoring program should assess existing water quality and future quality expectations.

3. Corrective Actions

Corrective actions taken to mitigate deficiencies in plant operations and treated water quality should be recorded immediately in the plant operations notebook. A description of the action taken, dated and initialized by a certified operator, will satisfy this requirement.

4. Maintenance Records

Maintenance records are to be kept for every operating unit in each well/tower system. Routine as well as major overhaul work for each unit should be recorded. Manufacturer recommended maintenance schedules for each operating unit are summarized in Chapter 8. For routine and non-routine maintenance work, always consult the manufacturer's operation and maintenance manuals found in the appendix of this manual. The City of Milwaukie Public Works Department should develop a maintenance schedule for the treatment facility. This schedule should integrate into the existing maintenance program.

5. Inventory and Supply Listing

An inventory and supplies listing should be developed by the Milwaukie Public Works Department. This listing should include all preventative maintenance parts as well as safety equipment. Inventory and supplies required for sustained plant operation will be modified on a continuing basis.

6. Operational Costs

The City of Milwaukie Public Works Department should develop a cost accounting program for the operation and maintenance of the treatment facility. The cost of all materials and maintenance for the treatment facility will be totalled at the end of each operating year. Sales receipts and work order forms shall be listed and retained for annual totalling.

7. Annual O & M Performance Review

An annual operation and maintenance review will be conducted by the City of Milwaukie Public Works Division. The purpose of this review is to critique plant operation, review operating costs, and make recommendations for more efficient plant operation. New Federal and State requirements for plant operations and MCL's should also be addressed.

CHAPTER 5 - PERSONNEL

A. MANPOWER RECOMMENDATIONS

Manpower requirements to operate and maintain the treatment plant/wells system will be determined by the Public Works Department. A minimum suggested staffing guide is given below:

Position	Manpower
Certified Plant Operator	One designated operator making daily operations inspection and periodic performance testing. One replacement operator trained to fully operate the treatment plant as a temporary replacement.
Field Support Personnel	One part-time operator assistant with on-call status. One designated replacement assistant with similar status.
Maintenance Personnel	Two mechanical maintenance staff with chlorination system experience with on-call status. One electrician with on-call status.
Office Personnel	One part-time secretary to handle forms, filing, and administration.

B. CERTIFICATION REQUIREMENTS

The State of Oregon Administrative Rules Chapter 333 require all personnel directly involved with the operations of a public water system be certified by the state. All water department supervisory and field personnel must be certified in one of the three categories listed below:

1. Water Treatment Operator
2. Water Distribution Operator
3. Operator-In-Training (OIT)

Certification level requirements for the water treatment plant operator should be developed in consultation with the State Health

Division Drinking Water Section. Field and maintenance personnel subordinate to the designated plant operator should meet the minimum state classification of Operator-In-Training.

Education and experience requirements to meet each operator grade level for water treatment and distribution system certification is available from the Oregon State Health Division. Grade advancement requires successful completion of a written examination in addition to experience and education requirements. For complete requirements, contact the Oregon State Health Division at 1400 SW 5th Avenue, Portland, Oregon 97201, Telephone (503) 229-6309.

C. ADMINISTRATION AND SUPERVISION

Management of the water treatment facility will be integrated into the existing public works organization structure. Supervision of facility operations will be the responsibility of the water department. Compliance with State and Federal regulations will be an important ongoing management and field personnel function. Development of a management and supervisory program for the treatment facility operations should be initiated immediately.

CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE
OF THE WATER TREATMENT FACILITY FOR WELLS NO. 4 AND 7

CHAPTER 6 - SAFETY

A. SAFETY

Safety should be a critical consideration during operation and maintenance of the water treatment facility at Well No. 4. Safety hazards are always present and take many diverse forms. All personnel assigned to operate and maintain the water treatment facility should be apprised of all safety hazards present and emergency procedures in case of accident. A safety program designating supervisory responsibilities, operator training, accident investigation, and record keeping for the treatment facility should be developed. This program will be integrated into the existing City of Milwaukie Public Works Safety Program. This program is required to incorporate all State and Federal guidelines for safety and accident reporting.

This chapter outlines the potential hazards associated with the main components of the treatment plant. Its purpose is to outline safety hazards and safety procedures to help prevent accidents.

B. WATER SYSTEM

Potable water is available from five sources at the treatment plant. All other sources are to be considered untreated water unless otherwise marked. The potable water source locations are listed below:

1. Fire hydrant facing Monroe Street.

2. Frost free yard hydrants at NE and SW corners of treatment building.

3. Sampling tap on south wall of pump room.

4. Faucet on capped pipe in No. 4 Wellhouse.

5. Faucet on interior west wall of Well No. 7 building.

No modifications of existing piping should be undertaken without clear understanding of the system flow layout.

The sand separator at Well No. 4 will discharge a slurry of untreated water and sand into a collection barrel when purged. The barrel contains a one-half inch poly-tubing drain system to dewater the sand and return the untreated well water back into the well casing. The drain line valve should remain open to facilitate sand dewatering and be closed only when the barrel is removed for emptying.

The backwash sump contains a mixture of untreated well water and super-chlorinated tower backwash water. Potentially high chlorine levels in the backwash sump water may cause injury if skin contact occurs. Chlorine gases may also accumulate to lethal levels in the backwash sump. Proper safety equipment and procedures for entry into a chlorine gas environment must be followed by ALL personnel entering the backwash sump at ANY time. The treatment plant must be completely shut down prior to worker entry into the backwash sump.

Complete liquid evacuation is strongly recommended prior to backwash sump entry. Full disinfection to prevent sump contamination is also required each time the backwash sump is accessed. The access cover to the backwash sump must remain closed at all times during the treatment plant operation for contamination prevention and safety.

The clearwell contains treated chlorinated water for system distribution. Lethal levels of chlorine gas may also accumulate in the clearwell. Proper safety equipment and procedures for entry into a chlorine gas environment must be followed by ALL personnel entering the clearwell at ANY time. The treatment plant must be completely shut down prior to worker entry into the clearwell. Complete liquid evacuation by submersible pump is strongly advised prior to clearwell entry. Full disinfection to prevent clearwell contamination is required each time the clearwell is accessed. The access cover to the clearwell must remain closed at all times during treatment plant operation for contamination prevention and safety.

Tower access hatches provide a means to check media condition and the inlet weir troughs. These hatches must remain securely bolted shut during tower operation for safety and contamination prevention. Full treatment plant shut down is required prior to any access into either tower. Full disinfection procedures are to be followed to prevent contamination within the tower.

Milwaukie City Wells No. 4 and 7 are linked directly to the treatment facility to avoid cross-connection contamination. A special water separation assembly on the Well No. 7 discharge piping directs all Well No. 7 flow to the treatment plant. The well pump prelube and faucet assemblies in well buildings No. 4 and 7 have been tapped into the City's distribution system. Check valves or backflow preventers exist on all treatment plant piping where cross-connections could occur. Revision of, or new connections to any piping in the well/tower treatment system should be undertaken with extreme care to prevent cross connections. An individual residence sewer line crosses the treatment plant site between the tower slab and the Well No. 4 building. The location of this sewer service is shown on the site plan in the Construction Drawings. A cleanout stub with cap exists in the landscaping near the NW corner of the treatment building.

C. ELECTRICAL EQUIPMENT

Proper electrical safety procedures must be followed when operating or performing maintenance on electrical equipment in the treatment plant system. Overriding or manually operating any electrical component should only be attempted by plant operator(s) thoroughly familiar with the system operating procedures. Any work on electrical equipment requires complete manual power isolation to remove all electrical shock hazard. Failure to manually isolate the electrical component being worked on may result in a lethal shock if automatic controls engage. Electrical system work should be performed by a certified electrician familiar with the plant system. Tagging all locked out breakers should be done in all instances prior to commencing any electrical work.

Primary power to the treatment plant is provided at 480 volts, three phase, from Portland General Electric. Well building No. 4 also has primary power at 480 volts, three phase. Single phase, 120/240 volt, power is provided to run minor electrical components in the treatment building. Well building No. 7 has primary power at 480 volts, three phase, provided by Portland General Electric.

All electrical equipment in the pump room from the booster pumps to the overhead lighting is tied to the MCC. Power isolation of any electrical component in the pump room will require tripping circuit breakers and/or main power switches in or on the MCC panel. The booster and backwash sump pumps are automatically controlled by the programmable controller in the MCC. Manual overriding the automatic controls should be an integral part of the de-energizing process.

Electrical equipment in the chlorine room is wired through the main breakers or, in the case of the solenoid valves, through the automatic controller in the MCC. Power isolation of any of these components will require work by a certified electrician.

Electrical equipment in the fan room is wired through the main breaker and/or the automatic controller in the MCC in the case of the blowers themselves. A power isolation switch for each blower is mounted on the east wall of the fan room. This switch isolates the blowers from the automatic controller and disconnects power to each blower. The blower controls on the MCC panel should also be switched to "OFF" to prevent surprise start-up when the room breaker is reactivated.

Electrical equipment found on the exterior of the treatment building such as lights are wired through the main breaker. Process control and monitoring equipment such as the tower inlet drain system solenoid valves or high water alarm floats found in the towers are wired to the automatic controller in the MCC. Alarm lights and reset switches for each alarm condition are found on the MCC panel.

Electrical equipment found in Well No. 4 consists of the controls and wiring to operate the well pump, heater, lights, and flow meter. The pump control system is linked by a telemetry wired from the MCC to the pump control circuits in the Well No. 4 building. Isolation of the No. 4 well pump requires manual disengaging at the MCC and manual disengaging of the pump starter in the Well No. 4 building. Electrical power to the well pump must be deactivated prior to any work affecting the motor assembly.

Electrical equipment found in Well No. 7 was not altered as a part of this project. The telemetry system controlling Well No. 7 was revised to move the telemetry control center to the MCC in the treatment building at Well No. 4. The telemetry control wiring follows the 10 inch supply line from the Well No. 7 building to the treatment building at Well No. 4. The location of the telemetry wire is below the supply pipe invert in most cases and flagged with locator tape.

D. MECHANICAL EQUIPMENT

Booster and backwash sump pumps in the treatment building may pose a safety hazard to the unaware worker. When the treatment system is in automatic mode these pumps will start and stop automatically and without pre-warning. Maintenance and pump removal should only be undertaken by experienced employees after securely disengaging the automatic controls and electrically isolating the affected pump(s). Prior to beginning work on the booster pumps or backwash pump, the discharge valves should be fully closed and tagged. Tagging will also serve as a reminder to open the valve(s) when work has been completed.

The engine-generator can only be operated manually and all safety precautions given in the manufacturer's operation manual should be followed. Care should be exercised when working on or around the engine-generator and its fuel supply system. The fuel tank should be kept full at all times. The fuel supply and return lines running from the fuel tank to the engine unit cross the floor, creating a possible tripping hazard. Care should be exercised in this area to avoid personal injury and/or damage to these lines.

Fans found in all rooms of the treatment building for exhaust or ventilation are protected by dampers or screens. The blowers supplying air to the treatment towers have safety screens and motor housings to prevent injury from fan blades or pulley drive systems. These safety features should not be altered without the consent of the manufacturer. Any maintenance work on the fans should only be undertaken after positive electrical isolation. Automatic controls to any of these units must also be positively disengaged.

E. HEALTH HAZARDS

Health hazards associated with the treatment plant and its operation are to be outlined to each employee during his/her orientation of plant operations. Safe procedures to mitigate these hazards should also be presented as well as emergency procedures in the event of injury. Health hazards associates with four components of the treatment system will be discussed in this section. This section does not attempt to address all potential health hazards.

Backwash sump water poses two health hazards:

1. Untreated well water containing volatile organic chemicals is not safe for consumption.

2. Potentially high chlorine residual from tower backwashing operations may cause injury if skin contact occurs.

Safety procedures for handling contaminated liquids should be followed when handling any equipment in contact with the backwash sump liquid. Unauthorized entry into the backwash sump should not be allowed. Any accidents and/or injuries caused by exposure to backwash sump water should be treated immediately.

The diesel fuel for the engine-generator and its battery system pose potential health hazards to the plant operator. Skin contact with diesel fuel should be avoided and affected clothing washed thoroughly. Batteries required to start the engine-generator produce dangerous fumes which will normally be exhausted from the room by open doors. These fumes are also explosive and spark sources should be kept a safe distance from the batteries. Safety procedures outlined on the O & M manual from the engine-generator manufacturer must be followed.

Untreated water is considered any water discharged from Wells No. 4 and 7 prior to discharge into the City's distribution system. This water many contain volatile organic chemicals and harmful bacteria making it unfit for consumption. Cross-contamination prevention is very important when working with system components exposed to untreated water. Indiscriminate discharge of untreated water should be avoided, if possible.

Chlorine gas is used in the treatment plant for water disinfection. When released into the atmosphere it gives off an odor similar to household bleach. Physical symptoms of exposure include irritation of the respiratory tract, mucus membranes, and eyes. If skin contact occurs, flush with clean water for a minimum of 15 minutes and seek immediate medical attention if irritation persists. If eye contact occurs, flush eyes with clean water for a minimum of 15 minutes, and seek emergency medical assistance immediately. All personnel responsible for the chlorination system should be certified and trained in first aid.

F. CHLORINE HANDLING

Chlorination by solution injection is used for disinfection and backwashing operations at the treatment plant. Two 150 lb. chlorine gas cylinders actively supply the chlorination system at any one time. Two backup 150 lb. chlorine gas cylinders are also located in the chlorine room to facilitate expended cylinder replacement. Chlorine gas poses a serious health risk if handled improperly. Only certified maintenance personnel should be allowed to operate and maintain the chlorination equipment.

For the protection of the operator, the chlorine room door is hinged to open out. There is a louver in the door near floor level to allow heavy chlorine gas to escape and a ventilation fan is located near the ceiling to draw fresh air into the room. When working in the chlorine room, the operator should leave the door open and the ventilation supply fan should be on. A chlorine leak detector is positioned on the east wall of the chlorine room with a chlorine leak alarm light on the MCC panel. This alarm light should always be checked prior to entry into the chlorine room.

A serious chlorine leak will initiate a chlorine leak alarm light on the MCC panel and odor may detected outside the chlorine room. In the event of a chlorine leak, two certified personnel familiar with the chlorination system and equipped with proper respiratory protection should investigate. A Chlorine Institute Emergency Kit or equal should be available in the treatment building in the same location as the respirators.

Additional chlorine gas handling information is available in The Chlorine Manual published by the Chlorine Institute, Inc. and found in the back of each chlorinator instruction book.

G. SAFETY EQUIPMENT

Safety equipment for the treatment plant varies depending on the task to be accomplished. Storage of all safety equipment required for all tasks at the plant is not possible due to the storage constraints. Safety equipment not stored at the treatment plant should be easily accessible to personnel responsible for maintenance and operation of the plant. A preliminary listing of recommended safety equipment is included in this section as a guide only. Treatment plant operations personnel should draw up the final safety equipment list based on previous experience and current OSHA Standards.

Suggested Safety Equipment:

1. Portable fresh air blower and flex hose for clearwell and sump ventilation.

2. Portable chlorine gas detector and atmospheric testing equipment.

3. Self contained breathing apparatus for each person going into the clearwell or backwash sump and for standby rescue crew.

4. First aid kit(s)

5. Fire extinquishers.

6. Safety harnesses and life lines.

7. Safety kit for chlorine room, including gas masks or breathing apparatus.

8. Portable non-conductive ladder.

9. Protective clothing, rubber gloves, hard hats, and safety goggles.

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CHAPTER 7 - EMERGENCY PLANS AND PROCEDURES

A. EMERGENCY RESPONSE

Table 7-1 lists nine emergency conditions and their effects on the treatment system. Table 7-2 lists the general response procedures which might be taken to mitigate the condition. Operations during emergencies require excellent communication and coordination of all personnel involved. The operator(s) is responsible for the safe and effective operation of the treatment plant. A rigorous maintenance and plant performance monitoring program will result in safe and trouble free plant operation.

1. Power Failure

In the event of utility power failure, the plant operator and support personnel should evaluate the need to activate the treatment system on standby power. If system demand requires treatment plant operation, the procedures to activate these standby power sources and operate the treatment plant are given in Chapter 3. Depending on the severity of the outage and the operational status of the telemetry system, personnel may be required to manually operate the major system components on a continuous basis. Mobile communications may be required to coordinate reservoir levels with well and plant operations. Communication links with police and fire agencies should be maintained to assess distribution system demands. Emergency coordination with local water districts may also be sought to solve special distribution problems.

An emergency response program to respond to a major utility power outage should be developed. Drills testing the response and performance of the personnel assigned to this program should be conducted on a regular basis. The City of Milwaukie Public Works Department should develop this program as an extension of its existing emergency response program.

2. Natural Disasters

Natural disasters including earthquake, fire, and severe cold weather will require a well coordinated response by the designated plant operator and support personnel. A system damage survey in the event of earthquake should be taken prior to restarting the treatment system. A system demand survey in the case of fire will provide the operator with a level of production expected from the treatment plant. Severe cold weather may necessitate more frequent plant inspection and system demand monitoring. Communication links with police and fire agencies should be maintained in the event of natural disaster to assess distribution system demands. Emergency coordination with local water districts may also be sought to solve special distribution problems.

An emergency response program designed to respond to specific natural disasters should be developed. Drills testing the response and performance of the personnel assigned to this program should be conducted on a regular basis. The City of Milwaukie Public Works Department should develop this program as an extension of its existing emergency response program.

3. <u>Health Hazards</u>

Accident injury or illness of the plant operator or support personnel will require substitution of alternate personnel into the plant operation team. These substitute individuals should be properly certified and have thorough knowledge of the treatment plant operations. State certification is required of the backup operator, and substitute support personnel should be thoroughly familiar with hands-on plant operations. All personnel assigned to the plant operation team should have current Red Cross first-aid training. Immediate first aid and medical assistance must always be sought in the case of accident or illness at the treatment facility.

An emergency response program designed to respond to accident or illness of a member of the plant operations team should be developed. Plant operation instruction seminars for the personnel assigned to this program should be conducted on a regular basis. The City of Milwaukie Public Works Department should develop this program as an extension of its emergency response program. Substitute personnel should also be included in any professional training programs given to the primary plant personnel.

4. <u>Equipment and Process Failures</u>

Equipment and process failures will result in decreased supply to the City's high level distribution system. The plant operator(s) should respond immediately in coordination with maintenance personnel to trouble shoot and repair the system. Substitute personnel should be available to assist with repairs if so required. A list facilitating immediate access to suppliers and manufacturer representatives should be available at the treatment facility. Adequate inventory of standard repair parts for equipment found in the plant should be kept on hand at all times. System supply and demand should be carefully monitored during plant down-time and public announcement of conservation measures be made promptly, if required.

An emergency response program to respond to critical equipment or process failure in the treatment system should be developed. Testing of the response and performance of the maintenance personnel assigned to this program should be conducted on a regular basis. The City of Milwaukie Public Works Department should develop this program as an extension of its existing emergency response program.

5. Emergency Notification

An emergency notification schedule listing the supervisory personnel to contact and telephone or mobile numbers in the event of an emergency should be posted in the well buildings and treatment building. This listing must be periodically updated to reflect changes in personnel location and duties. All personnel assigned to the treatment plant operation team should be aware of this notification listing. The City of Milwaukie Public Works Department should develop and maintain this listing as part of its emergency response program.

Emergency Agencies:

Police Department: 911 (Emergency), 659-2389 (Non-Emergency)
Fire Department: 911 (Emergency), 659-4042 (Non-Emergency)
Ambulance Service: 911

Hospitals:

Providence Milwaukie Hospital	652-8300
Eastmoreland General Hospital	234-0411
Portland Adventist Medical Center	257-2500

B. EMERGENCY READINESS

1. Equipment, Parts and Supply Inventory

Emergency equipment required by certified personnel responding to a chlorine leak should be stored in the treatment building separate from the chlorine room. Maintenance equipment required in response to a mechanical or electrical equipment failure should be readily available to maintenance crews dispatched from the Public Works Center on Johnson Creek Blvd. A suggested safety equipment guide is provided in Chapter 6. This list is not complete and the City's own safety program should dictate the types and location of safety equipment available to personnel assigned to the operation of the treatment plant.

Spare parts for common maintenance repairs should be part of the supply inventory kept at the Water Department Maintenance Center. Routine maintenance will dictate the types and quantities of parts required for each piece of equipment. A current listing of suppliers and manufacturer representatives should also be kept with the inventory to facilitate rapid replacement of parts not normally stocked. Personnel assigned to monitor and order inventory should tailor the inventory to match field equipment and safety requirements. An annual review of the inventory program should be conducted by the Public Works Department to assess its effectiveness and update inventory requirements.

2. Personnel Training

The Department of Public Works should develop a water treatment plant emergency operations program. This program should list emergency response procedures and responsible personnel for a minimum of the nine emergency conditions listed in Table 7-1. Designated primary and backup personnel should be trained to operate the treatment plant during an emergency situation.

Training drills to gage the effectiveness of the response program should be conducted on a regular basis. These drills should be incorporated into the existing emergency response program for the Water Department. Coordination with all public works departments, as well as police and fire agencies, is strongly recommended.

The Department of Public Works should conduct a yearly review of the emergency response program. This review should incorporate changes in personnel, equipment, and facilities. Emergency drill response performance should also be evaluated. The objectives of the emergency response program should be:

a. Early detection
b. Effective response time
c. Control of emergency situation
d. Correction/mitigation of situation
e. Review/improvement of program based on experience from actual emergencies.

3. Alarm Conditions

A series of alarm conditions may occur at the treatment plant if an equipment or process failure occurs. A major component or process failure will cause the treatment plant to shut-down, while a minor system upset may only cause activation of a warning light on the MCC panel. Plant shut-down will activate an alarm light on a special monitor in the Milwaukie Police Station. The operational status of Wells No. 4 and No. 7 is also available at the master control center at Wellhouse No. 2. The operational status of the major treatment facility components is continuously displayed on the MCC panel in the treatment plant. A listing of alarm conditions and recommended courses of action for responding personnel is given below:

ALARM	ACTION
Well No. 4 Fail	Notify maintenance personnel to trouble shoot well pump failure.
Well No. 7 Fail	Notify maintenance personnel to trouble shoot well pump failure.
Blower No. 4 Fail	Check breaker in fan room. Notify maintenance personnel to trouble shoot blower failure.
Blower No. 7 Fail	Check breaker in fan room Notify maintenance personnel to trouble shoot blower failure.
Tower No. 4 High Water Alarm	Check position of Tower No. 4 drain valves. Check 18" tower drain system valve position. Contact maintenance personnel to trouble shoot system.
Tower No. 7 High Water Alarm	Check position of Tower No. 7 drain valves. Check 18" tower drain system valve position. Contact maintenance personnel to trouble shoot system.
Clearwell High Water Alarm	Check operation status of booster pumps. If pumps will not start, contact maintenance personnel to trouble shoot system.
Clearwell Low Water Alarm	Activate either well/tower system to raise water level. Trouble-shoot float control system. Booster pumps will not start during alarm condition.
Chlorine Residual Alarm	Check residual analyzer for high or low residual. Low residual may indicate empty tanks. Contact maintenance personnel to trouble shoot system.
Chlorine Leak Alarm	Immediately notify supervisor. Certified maintenance personnel with proper safety equipment should respond immediately. Notify police and fire agencies if problem is serious.

Backwash Sump High Water Alarm	Activate Well/Tower No. 4 system. If backwash pump fails to start, contact maintenance personnl to trouble-shoot system.
Backwash Sump Low Water Alarm	Switch operation mode to "WINTER", or backwash either tower to fill sump. Trouble-shoot float control system. Backwash pump will not activate during alarm condition.

CONDITION	COMMUNICATION	RESERVOIRS	REPAIR INVENTORY
Accident or Illness to Operator(s).	No immediate effec May be needed in t event of an accident.	No effect.	No short term effect
Bomb Threat	Calm and concise co munication to emergen agency required.	Potential target.	Unlikely target.
Chlorine Gas Leak	Notify fire & poli departments immediat ly.	Supply to reservoirs reduced due to treat- ment plant shutdown.	Respirators and emergency repair kits will be required.
Civil Disorder	Emergency agencies m be difficult to conta due to overloaded co munication lines.	Vandalism and/or mali- cious contamination possible.	No short term ef- fect.
Earthquake	Telemetry and telepho system may be inoper tive. Mobile co munications may required.	Structural damage possible and high demand may cause rapid drawdown.	Pipe, repair fit- tings, and chlo- rine disinfectant required in large quantities.
Fire	Communicate with fi fighters to advise the status of availab pressure.	High demand may cause drawdown.	Hydrant usage may necessitate repair.
Extensive Utility Power Outage	Telemetry circuits m or may not be operabl Plant controls und auxiliary power.	Long term outage may cause drawdown.	Generator fuel, maintenance parts, & portable lights required.
Mechanical Equipment Failure	Reduced supply of wat may require reduc consumption notific tions.	Lost or reduced supply will result in reser- voir drawdown.	Repair parts for failed mechanical equipment required
Severe Weather (snow or ice storm)	Telemetry and telepho system may be inoper tive. Mobile communic tions may be require	No short term effect. Broken pipes may increase demand.	Pipe repair parts may be required.

CONDITION	COMMUNICATION	RESERVOIRS	REPAIR INVENTORY
Accident or Illness to Operator(s)	Utilize portable fixed communications immediately summon me ical assistance.	Utilize temporary replacement staff to monitor and maintain system.	Utilize temporary replacement staff to maintain inventory.
Bomb Threat	Immediately conta police and fire age cies. Coordina response with poli and fire.	Immediately notify police & fire agencies. Coordinate response and reservoir draining procedures, if required.	Maintain adequate inventory for damage repair.
Chlorine Gas Leak	Notify superior police & fire agenc: with mobile radio telephone. Coordina emergency response.	No action required.	Maintain respirator and emergency repair kits in good condition.
Civil Disorder	Utilize mobile commur cations for operatic coordination. Establi police & fire depar ment communicati channel.	Same response as for treatment plant.	Maintain adequate inventory for damage repair.
Earthquake	Utilize mobile commur cations for operatic coordination. Conta public broadcasti agencies to initia public service annou cements.	Emergency crew performs immediate structural and operation status inspection. System status reported to command center.	Maintain stock and/or source of large quantities of pipe, fittings, and chlorine disinfectant.
Fire	Maintain communicat: with fire and poli agencies to coordina supply and demand.	Monitor supply and demand. Prepare to run treatment system at full capacity to meet demand.	Maintain adequate supply of hydrant and coupling parts
Extensive Utility Power Outage	Utilize mobile commur cations for operatic coordination. Mainta communication capab: ity with police a fire agencies.	Monitor reservoir levels closely. Coordinate system supply with mobile communication if telemetry down.	Maintain ample supply of generator fuel, maintenance parts and portable lights.
Mechanical Equipment Failure	Utilize mobile & fi: communications to coo dinate repair respons Utilize public serv: announcements, required.	Monitor reservoir demand and utilize alternative supply sources, if required.	Maintain supply of common equipment replacement parts and listing of local supplier(s).
Severe Weather (Snow or ice storm)	Utilize mobile commur cations to coordina operations. Mainta communications wi police & fire agencie	No action required.	No action required.

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CHAPTER 8 - MAJOR EQUIPMENT SPECIFICATIONS AND MAINTENANCE

A. AIR STRIPPING TOWERS

1. <u>Manufacturer</u> - National Environmental Systems
36 Maple Avenue
Seekonk, MA 02771
(508) 761-6611

2. <u>Supplier</u> - EMA Marketing, Inc.
PO Box 30
Philomath, OR 97370
(503) 929-2277

3. <u>Operating Parameters</u>

a. Tower No. 4

Tower Diameter = 6 Feet
Water Flow Rate = 600 gpm
Liquid Loading = 21 gpm per sq.ft.
Air/Water Ratio = 40:1
Min. Air Flow Rate = 3,200 cfm
Packing Material = Lanpac (3.5")
Packing Depth = 19 Feet
TCE Removal = 99% Minimum
Design Water Temperature = 55° F.

b. Tower No. 7

Tower Diameter = 8 Feet
Water Flow Rate = 1,000 gpm
Liquid Loading = 20 gpm per sq.ft.
Air/Water Ratio = 40:1
Minimum Air Flow Rate = 5,350 cfm
Packing Material = Lanpac (3.5")
Packing Depth = 19 Feet
TCE Removal = 99% Minimum
Design Water Temperature = 55° F.

4. <u>Maintenance</u>

The air stripping Towers require minor maintenance to assure continuous trouble-free operation. Tower backwashing (rinsing) is recommended every 6-8 weeks to deter bacterial growth on the packing media. This procedure is outlined in Chapter 3 of this manual. Removal of the upper and lower access hatches for inspection of the interior tower components is recommended on an annual basis to determine effectiveness of rinsing and to assess mineral buildup on packing. The tower exterior should be painted with a gel-coat enamel paint containing an ultraviolet inhibitor to prevent deterioration of the fiberglass towers by ultraviolet radiation. Tower repainting frequency will depend on local climatic conditions and visual appearance requirements.

B. BLOWERS

1. Manufacturer - Central Fan Co.
132 Sidney Street
Cambridge, MA 02139
(617) 547-3581

2. Supplier - Part of equipment package supplied with stripping towers.

3. Operating Parameters

a. Blower No. 4 - Model 150HTE

Air Flow Rate = 3,200 CFM
Static Pressure = 2" W.C.
Blower Speed = 1876 rpm
Blower HP = 1.68 BHP
Motor Speed = 1725 rpm
Motor Size = 2 HP
Belt Size = A-35

b. Blower No. 7 - Model 222JTE

Air Flow Rate = 5,350 CFM
Static Pressure = 2" W.C.
Blower Speed = 1105 rpm
Blower HP = 2.42 BHP
Motor Speed = 1750 rpm
Motor Size = 3 HP
Belt Size = A-53 (2 required)

4. Maintenance

Peerless Electric Belt Drive Utility Blowers size 150 and 222 provide air flow to Towers No. 4 and No. 7. Regular blower inspection and bearing lubrication is required to maintain trouble-free operation. Fan bearings should be lubricated with a high grade bearing grease while the fan is running. A slight bead of grease should appear around the bearing when proper grease volume has been injected. Fan belts should be inspected quarterly for condition and wear. Belts for both 150 and 222 blowers should be replaced bi-annually as a preventative maintenance measure. Major overhaul maintenance will include bearing replacement, shaft replacement, and fan wheel removal. Consult Peerless-Winsmith installation, maintenance, and operating instructions for additional information. If parts or further assistance is required, contact Central Fan Co. at (617) 547-3581.

Eco-Air pleated air filters, Model C35-H-24242, are mounted behind both louvers in the fan room. These filters should be inspected monthly and replaced when clogging becomes evident. Replacement frequency will depend on local air quality, but annual replacement of all filter units should be considered mandatory. Replacement filters are available through Smith-Trueb & Associates at (503) 238-6900.

Flex expansion joints are located at each tower/duct connection. Periodic inspection of the Durolon flex fabric for tears which may cause air leakage should be part of the monthly inspection routine. Replacement of the 24 oz./SY Durolon flex fabric and silicone joint sealing should be undertaken by an air duct specialist.

C. CHLORINATION EQUIPMENT

1. <u>Manufacturer</u> - Wallace & Tiernan, Inc.
   25 Main Street
   Belleville, NJ 07109
   (201) 759-8000

2. <u>Supplier</u> - Pacific Service & Supply Co., Inc.
   28525 NW Fern Flat Rd.
   Cornelius, OR 97113
   (503) 647-5869

3. <u>Operating Parameters</u>

   a. Series V75VA2 V-Notch Chlorinators

      Maximum Capacity = 200 PPD
      Rotameter Size = 0 to 10 PPD
      Injector = 3/4" with 140 F throat and tailpiece
      Injector Capacity = 20 PPD
      Minimum Water Supply = 3.8 GPM at 15 psi
      Chlorine Application Point = Tower Outlet

b. Series V75VA5 V-Notch Chlorinators

Maximum Capacity = 500 PPD
Rotameter Size = 0 to 500 PPD
Injector = 1" with 312L throat and tailpiece
Injector Capacity = 500 PPD
Minimum Water Supply = 23 GPM at 61 psi
Chlorine Application Point = Tower Inlet

c. Series V-100D V-Notch Chlorinators

Maximum Capacity = 100 PPD
Rotameter Size = 0 to 10 PPD
Injector = 3/4 with 140F throat and tailpiece
Injector Capacity = 20 PPD
Minimum Water Supply = 3.8 GPM at 40 psi
Chlorine Application Point = Tower Inlet

d. Series 500C Vacuum Regulators

Maximum Capacity = 500 PPD
Special Features = Automatic Switchover

e. Series 50-345 Two Cylinder Scale

Maximum Capacity = 2 - 150# Chlorine Cylinders
Features = Dual Independent Mechanical Scales
Accuracy = 1% of Full Scale

f. Series 50-135 Chlorine Gas Detector

Warning Level = 1 PPM Chlorine Gas
Alarm Level = 3 PPM Chlorine Gas
Note - (Detector Furnished by City)

4. <u>Maintenance</u>

a. Series V75VA2 V-Notch Chlorinators

Chlorinator cleaning is recommended when deposits are visible in the rotameter tube or the float sticks. The V-notch plug should also be cleaned when rotameter maintenance is performed. The injector and tailway should be cleaned every six months (minimum). More frequent maintenance may be required if operating conditions are more adverse. At two year intervals, a preventative maintenance overhaul of each V-75V chlorinator is recommended. Preventative maintenance kits containing replacement parts and instructions for this two year overhaul are available through Wallace & Tiernan. The instructions for operating, maintaining, and testing this unit may be found in the

Wallace & Tiernan Series V-75V Chlorinator instruction booklet found in the appendix of this manual.

b. Series V75VA5 V-Notch Chlorinators

Chlorinator cleaning is recommended when deposits are visible in the rotameter tube or the float sticks. The V-notch plug should also be cleaned when rotameter maintenance is performed. The injector and tailway should be cleaned every six months (minimum). More frequent maintenance may be required if operating conditions are more adverse. At two year intervals, a preventative maintenance overhaul of each V-75V chlorinator is recommended. Preventative maintenance kits containing replacement parts and instructions for this two year overhaul are available through Wallace & Tiernan. The instructions for operating, maintaining and testing this unit may be found in the Wallace & Tiernan Series V-75V Chlorinator instruction booklet found in the appendix of this manual.

c. Series V-100D V-Notch Chlorinators

Chlorinator cleaning is recommended when deposits are visible in the rotameter tube or the float sticks. The V-notch plug should also be cleaned when rotameter maintenance is performed. The injector and tailway should be cleaned every six months (minimum). More frequent maintenance may be required if operating conditions are more adverse. At two year intervals, a preventative maintenance overhaul of each V-100D Chlorinator is recommended. Preventative maintenance kits containing replacement parts and instructions for this two year overhaul are available through Wallace & Tiernan. The instructions for operating, maintaining and testing this unit may be found in the Wallace & Tiernan Series V-100D Chlorinator instruction booklet found in the appendix of this manual.

d. Series 500C Vacuum Regulators

The vacuum regulators on the chlorine cylinders should be reconditioned with a preventative maintenance kit at two year intervals. Periodic cleaning of the vacuum regulator should occur at intervals of 12,000 pounds of chlorine gas dispensed. This 12,000 pound cleaning interval involves checking the regulator stems, springs, and passageways for contaminant accumulation. Consult the Wallace & Tiernan instruction booklet for maintenance and operation instructions for the Series 500C vacuum check regulator. This operation and maintenance booklet is found in the appendix of this manual.

e. Series 50-345 Two Cylinder Scale

No regularly scheduled maintenance is required for the series 50-345 two cylinder scale.

f. Series 50-135 Chlorine Gas Detector

The Series 50-135 chlorine leak detector is positioned in the chlorine room to monitor the chlorination system for leaks. The unit requires replacement of the electrolyte capsule in the sensor on an annual basis. Two integral batteries run the detector during utility power loss periods and are automatically charged when utility power is resumed.

D. VERTICAL TURBINE PUMPS

1. <u>Manufacturer</u> - American Industrial Pump, Inc.
   5727 Luce Street
   Houston, TX 77087
   (713) 641-6818

2. <u>Supplier</u> - Hydronix, Inc.
   2425 SE Ochoco Street
   Milwaukie, OR 97222
   (503) 659-6230

3. <u>Operating Parameters</u>

a. Booster Pumps - Model 12-M-100

Capacity = 900 GPM
Head = 213 Feet
Stages = 3
Speed = 1800 RPM
Motor = 75 HP General Electric
Column Assembly = 8" X 1"
Discharge Head = AT30-8" C.I.
Features = Water Lubricated

b. Sump Pump - Model 10-L-20

Capacity = 250 GPM
Head = 39 Feet
Stages = 1
Speed = 1800 RPM
Motor = 5 HP General Electric
Column Assembly = 4" X 1"
Discharge Head = AT 10-4" C.I.
Features = Water Lubricated

4. Maintenance

Check oil or grease level in motor bearings. Fill as required. Change oil at manufacturers recommended interval (minimum annually). Apply grease to stuffing box at the rate of one turn for each 24 hours of operation. Refill grease box as required. Adjust packing gland - tighten sufficiently to throttle leakage, but not to prevent all leakage. Always adjust packing gland with the pump running.

E. SAND SEPARATOR - LAKOS MODEL LTS-0502-B

1. Manufacturer - Claude Laval Corporation
   1911 N. Helm
   Fresno, CA 93703
   (209) 255-1601

2. Supplier - Flow Components, Inc.
   12004 NE 95th St., #800
   Vancouver, WA 98682
   (206) 256-0345

3. Operating Parameters

   Minimum Flow = 480 GPM
   Maximum Flow = 880 GPM
   Minimum Inlet Pressure = 15 psi
   Collection Chamber Capacity = 8 Gallons
   Features = 22½° Profile, Counterclockwise Inlet

4. Maintenance

The sand separator requires regular manual purging during well pump operation. Purging is accomplished by opening the PVC ball valve on the separator purge outlet. Always close this outlet ball valve tightly to prevent overflowing the collection drum following purging. No other regular maintenance is required.

F. FLOW MONITORS

1. Manufacturer - Data Industrial Corporation
   53 Portside Drive
   Pocasset, MA 02559
   (617) 563-7196

2. Supplier - J. N. Murrell & Associates, Inc.
   4991 SE Winworth Ct.
   Milwaukie, OR 97222
   (503) 654-9066

3. <u>Operating Parameters</u>

a. Panel Mount - Model 950 TAS

Sensor Location = 12" Treatment Plant Discharge Pipe
Monitor Location = MCC Control Panel
Units of Measure = Gallons per Minute
Flow Sensor = 2" Model 220B Brass
Accuracy = +/-1% of Full Scale
Special Features = Three Independent Alarm Relays
One 4-20 mA Analog Output

b. Surface Mount - Model 900 TAS

Sensor Location = Well #4 Discharge Line
Monitor Location = Wellhouse No. 4
Units of Measure = Gallons per Minute
Flow Sensor = 2" Model 220B Brass
Accuracy = +/-1% of Full Scale
Special Features = Three Independent Alarm Relays
One 4-20 mA Analog Output

4. <u>Maintenance</u>

Neither unit requires regular scheduled maintenance following initial installation and calibration. If a problem develops, consult the trouble-shooting section of the flow sensor Owner's Manual found in the appendix of this manual.

G. CHLORINE RESIDUAL MONITOR

1. <u>Manufacturer</u> - EIT
251 - E Welsh Pool Road
Exton, PA 19341
(800) 634-4046

2. <u>Supplier</u> - J. N. Murrell & Associates, Inc.
4991 SE Winworth Ct.
Milwaukie, OR 97222
(503) 654-9066

3. <u>Operating Parameters</u>

a. Model 5150 Free Chlorine Monitor

Parameter = Free Chlorine
Sensor Location = 12" Treatment Plant Discharge Pipe
Monitor Location = MCC Control Panel
Special Features = Two Independent Alarm Relays
One 4-20mA Analog Output
Accessories = Constant Head Flow Cell
Sensor Polarizer

4. Maintenance

Periodic maintenance of the chlorine sensor is required, while the electronics are maintenance free. Every 4-8 weeks the sensor membrane and electrolyte should be replaced. A spare sensor is provided to allow immediate installation of a reconditioned unit to minimize plant downtime. The original sensor can then be reconditioned for the next replacement.

Sensor maintenance requires replacement of the membrane and electrolyte. O-rings in the sensor and flow-cell assembly should also be checked during sensor maintenance. Any nicked or damaged O-rings should be replaced immediately. Following sensor maintenance, the system should be zeroed and calibrated before being placed back on-line. Sensor membrane cleaning between maintenance overhauls is possible by immersing the tip of the sensor (disconnected from the monitor) in a 1N Nitric acid solution for about 5 minutes. The sensor should then be rinsed with distilled water and reinstalled. Allow 5-10 minutes for probe stabilization before recalibrating the cleaned sensor. For complete maintenance instructions and procedures, see the operation and maintenance manual for the EIT Free Chlorine Monitor found in the appendix of this manual.

H. MOTOR CONTROL CENTER

1. Manufacturer - Furnas Electric Co.
1000 McKee Street
Batavia, IL 60510
(708) 879-6000

2. Supplier - United Pacific Controls, Inc.
410 NW 14th Avenue
Portland, OR 97208
(503) 224-6944

3. Operating Parameters

a. System 89 MCC

Power = 480 volts, 3 ph, 60 Hz, 3 wire
Enclosure Type = Nema 1
Enclosure Model = 83BS 15" Deep
Minimum Short Circuit Rating = 30,000 Amps Comb. Units
18,000 Amps Feeder Units
Main Horizontal Bus = 600 Amp
Vertical Bus = 300 Amp

b. Programmable Controller - TI Series 305

Model = TI 325 PLC
Discrete I/O = 168
Analog I/O = 24
Control Relays = 140
Timers/Counters = 64

4. Maintenance

No regular maintenance required.

I. STANDBY GENERATOR

1. Manufacturer - Kohler Co.
Kohler, Wisconsin 53044

2. Supplier - Pacific Detroit Diesel Allison, Inc.
5061 N. Lagoon
Portland, OR 97217
(503) 283-0505

3. Operating Parameters

a. Kohler Generator Model 200 ROZD

Engine = Detroit Diesel In-Line 71
Type = 2-Cycle Turbocharged
Cylinder Arrangement = 6-In Line
Maximum Power = 315 HP at 1800 RPM
Generator Rating = 200 KW/250 KVA
Electrical = 480 Volts, 3 ph, 60 Hz
Accessories = Block Heater
Critical Silencer
Battery Pack and Charger
1% Voltage Regulation
Dec-3 Controller
Fuel Tank Capacity = 550 Gallons
Fuel Consumption = 17 gal/hr - at full load

4. Maintenance

The Kohler/Detroit Diesel engine-generator requires pre-start fluid and mechanical checks in addition to periodic maintenance. The schedule and narrative description of preventative maintenance required for the Detroit-Diesel In-Line 71 engine is described in the following manuals:

a. Detroit Diesel In-Line 71 Service Manual, Section 4-15.
b. Detroit Diesel Series 53, 71, 92 Operators Guide.
c. Scheduled Maintenance Record Insert Publication No. ES-527 (387).

These manual may be found in the Detroit Diesel manuals accompanying this O & M manual.

The schedule and narrative description of preventative maintenance required for the Kohler Fast Response II Generator is described in the following manuals:

a. Kohler Fast Response II Generators Service Manual.
b. Scheduled Maintenance Record Insert Publication No. ES-527 (387).

These manuals may be found in the Kohler Power Systems manuals accompanying this O & M manual.

J. OTHER EQUIPMENT

For information on all other equipment, consult submittal data and manufacturer's operation and maintenance instructions provided with this manual. A detailed equipment listing with names of manufacturers and suppliers is contained in Appendix A.

APPENDIX A

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITY FOR WELLS NO. 4 AND 7

SYSTEM COMPONENT MANUFACTURERS AND SUPPLIERS LISTING

SUBMITTAL NO. & COMPONENT		MANUFACTURER	SUPPLIER/REPRESENTATIVE
1.	Butterfly Valves, Wafer Style	Dezurik 250 Riverside Ave. N. Sartell, MN 56377-1743 (612) 259-2000	Tourangeau Nor Wes Corp. 11040 SW Allen Blvd. Beaverton, OR 97005-4821 (503) 644-2010
2.	Flex Pipe Expansion Joints	Unaflex Fort Lauderdale, FL	Tourangeau Nor Wes Corp. 11040 SW Allen Blvd. Beaverton, OR 97005-4821 (503) 644-2010
3.	Silent Check Valves	Val-Matic Valve & Manuf. Corp. 905 Riverside Drive Elmhurst, IL 60126 (312) 941-7600	J.N. Murrell & Assoc., Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066
4.	Deep Well Service Air Valve	Val-Matic Valve & Manuf. Corp. 8448 West 45th St. Lyons, IL 60534 (312) 447-1990	J.N. Murrell & Assoc., Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066
4.	Air and Vacuum Valves	Val-Matic Valve & Manuf. Corp. 8448 West 45th St. Lyons, IL 60534 (312) 447-1990	J.N. Murrell & Assoc., Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066
5.	Combination Air Valves	Val-Matic Valve & Manuf. Corp. 905 Riverside Drive Elmhurst, IL 60126 (312) 941-7600	J.N. Murrell & Assoc., Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066
6.	Well Pump Control Valves	Singer Valve 12850 - 87th Ave. P.O. Box 69 Surrey, B.C. (604) 594-5404	J.N. Murrell & Assoc., Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066

7.	Engine-Generator	Kohler Co. Kohler, WI 53044 (414) 565-3381	Pacific Detroit Diesel Allison, Inc. 5061 N. Lagoon Ave. Portland, OR 97217-7694 (503) 283-0505
8.	Diesel Fuel Tank	Ace Tank & Equipment Co. 6125 NE Portland Hy. Portland, OR 97218 (503) 284-5505	Pacific Detroit Diesel Allison, Inc. 5061 N. Lagoon Ave. Portland, OR 97217-7694 (503) 283-0505
9.	Swing Check Valve	Kennedy Valve ITT Fluid Technology Corp. 1021 E. Water St. Elmire, NY 14901 (602) 734-2211	United Pipe & Supply Co., Inc. 5000 NE Columbia Blvd. Portland, OR 97218-1228 (503) 288-6271
10.	Gate Valves, Resilient Wedge	Waterous 300 John E. Carroll Ave. East South St. Paul, MN 55075 (612) 450-5000	United Pipe & Supply Co., Inc. 5000 NE Columbia Blvd Portland, OR 97218-1228 (503) 288-6271
11.	12" Buried Butterfly Valves	M & H Valve Co. 23rd & Railroad Sts. P.O. Box 2088 Anniston, AL 36202 (205) 237-3521	United Pipe & Supply Co., Inc. 5000 NE Columbia Blvd. Portland, OR 97218-1228 (503) 288-6271
12.	Backflow Preventer	Febco Sales, Inc. P.O. Box 8070 Fresno, CA 93747 (209) 252-0791	United Pipe & Supply Co., Inc. 5000 NE Columbia Blvd. Portland, OR 97218-1228 (503) 288-6271
13.	Yard Hydrants	Campbell Manufacturing, Inc. Spring & Railroad St. Bechtelsville, PA 19505 1-800-523-0224	United Pipe & Supply Co., Inc. 5000 NE Columbia Blvd. Portland, OR 97218-1228 (503) 288-6271
14.	Fire Hydrant	Sentinel	United Pipe & Supply Co., Inc. 5000 NE Columbia Blvd. Portland, OR 97218-1228 (503) 288-6271
15.	Foundation Drain Sump Pump	Hydromatic PO Box 327 Ashland, OH 44805 (419) 289-3042	United Pipe & Supply Co., Inc. 5000 NE Columbia Blvd. Portland, OR 97218-1228 (503) 288-6271
16.	PVC Ball Valves	Spears Manufacturing Co. 15853 Olden St. PO Box 4428 Sylmar, CA 91342-0428 (818) 364-1611	United Pipe & Supply Co., Inc. 5000 NE Columbia Blvd. Portland, OR 97218-1228 (503) 288-6271

17.	PVC Check Valves	Spears Manufacturing Co. 15853 Olden St. PO Box 4428 Sylmar, CA 91342-0428 (818) 364-1611	United Pipe & Supply Co., Inc. 5000 NE Columbia Blvd. Portland, OR 97218-1228 (503) 288-6271
18.	Solenoid Valves	ASCO Automatic Switch Co. 50 - 56 Hanover Road Florham Park, NJ 07932 (201) 966-2000	
19.	Butterfly Valves, Flanged	Dezurik 250 Riverside Ave. N. Sartell, MN 56377-1743 (612) 259-2000	Tourangeau Nor Wes Corp. 11040 SW Allen Blvd. Beaverton, OR 97005-4821 (503) 644-2010
20.	All Louvers, Backdraft Dampers, Control Dampers	Philips Industries, Inc. (Ruskin) PO Box 129 Grandview, MO 64030 (816) 761-7476	Smith-Trueb & Associates, Inc. PO Box 13009 929 NE 23rd Ave. Portland, OR 97232-2220 (503) 238-6900
20a.	Filter Rack	Cambridge Filter Corporation Syracuse, NY 13221	Smith-Trueb & Associates, Inc. PO Box 13009 929 NE 23rd Ave. Portland, OR 97232-2220 (503) 238-6900
20b.	Air Filters	Eco-Air 9455 Cabot Drive San Diego, CA 92126 (619) 271-8111	Smith Trueb & Associates, Inc. P.O. Box 13009 929 NE 23rd Ave. Portland, OR 97232-2220 (503) 238-6900
21.	Vertical Turbine Booster Pump & Backwash Pump	American Industrial Pump, Inc. 5727 Luce St. Houston, TX 77087 (713) 641-6818	Hydronix 2425 SE Ochoco PO Box 22046 Milwaukie, OR 97222-7321 (503) 659-6230
21a.	Pump Motors	General Electric Co.	Hydronix 2425 SE Ochoco PO Box 22046 Milwaukie, OR 97222-7321 (503) 659-6230
22.	Flow Monitor and Sensor	508-758-6390 Data Industrial Corporation 53 Portside Drive Pcasset, MA 02559 (617) 563-7196	J.N. Murrell & Assoc., Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066

23.	Hollow Metal Doors	Curries	Oregon Builders Hardware 9255 SE McBrod Milwaukie, OR 97222-7324 (503) 653-7680
24.	Door Hardware	Various Manufacturers	Oregon Builders Hardware 9255 SE McBrod Milwaukie, OR 97222-7324 (503) 653-7680
26.	Catch Basin Grates	Inland Foundry Co., Inc. 18650 - 72nd Ave. S. Kent, WA 98032 (206) 251-0494	P.I.P.E., Inc. 755 NE Columbia Blvd. Portland, OR 97211-1405 (503) 285-8391
27.	Precast Concrete Vault	P.I.P.E., Inc. 4601 South Orchard Tacoma, WA 98409 (206) 475-8888	P.I.P.E., Inc. 755 NE Columbia Blvd. Portland, OR 97211-1405 (503) 285-8391
28.	Skylights	Kalwall Corp. PO Box 237 Manchester, NH 03105 (603) 627-3861	Baxter & Flaming Industries 3717 NW St. Helens Rd. Portland, OR 97210-1426 (503) 225-0486
30.	Roof, Supply and Exhaust Fans	Acme Engr. & Mfg. Corp. PO Box 978 1820 N. York Muskogee, OK 74403 (918) 682-7791	Smith Trueb & Associates, Inc. PO Box 13009 929 NE 23rd Ave. Portland, OR 97232-2220 (503) 238-6900
31.	Radiant Heater (Chlorine Room)	Aztec International Ltd. 2417 Aztec Rd. N.E. Albuquerque, NM 87107 (505) 884-1818	Taylor Electric Supply, Inc. PO Box 14745 1709 SE Third Ave. Portland, OR 97214-4585 (503) 233-5321
32.	Unit Heater	Qmark	Taylor Electric Supply, Inc. PO Box 14745 1709 SE Third Ave. Portland, OR 97214-4585 (503) 233-5321
33.	Fluorescent Light Fixtures	Metalux PO Box 1207 Americus, GA 31709 (912) 924-8000	Taylor Electric Supply, Inc. PO Box 14745 1709 SE Third Avenue Portland, OR 97214-4585 (503) 233-5321

33.	Incandescent Reflector Downlight and High Pressure Sodium Light	Lithonia Lighting PO Box 72 Crawfordsville, IN 47933 (317) 362-1837	Taylor Electric Supply, Inc. PO Box 14745 1709 SE Third Avenue Portland, OR 97214-4585 (503) 233-5321
35.	Liquid Level Float Switch Control	Master Level Controls Co. 293 Como Avenue St. Paul, MN 55103 (612) 224-3966	J.N. Murrell & Assoc., Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066
36.	Flow Switch	Turbo-Sika	J.N. Murrell & Assoc., Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066
38.	Motor Control Center	Furnas Electric Co. 1000 McKee St. Batavia, IL60510 (708) 879-6000	United Pacific Controls, Inc. 410 NW 14th Portland, OR 97209-2631 (503) 224-6944
39.	Chlorination Equipment	Wallace & Tiernan, Inc. 25 Main St. Belleville, NJ 07109 (201) 759-8000	Pacific Service & Supply 28525 NW Fern Flat Rd. Cornelius, OR 97113 (503) 647-5869
41.	Residual Chlorine Monitor & Flow Cell Assembly	EIT 251-E Welsh Pool Rd. Exton, PA 19341 (800) 634-4046	J.N. Murrell & Assoc., Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066

APPENDIX B

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITY FOR WELLS NO. 4 AND 7

RINSING PROCEDURE FOR STRIPPING TOWERS

The following procedure should be undertaken every six to eight weeks to prevent bacterial growth in the stripping towers. Valve numbers correspond to those shown in Figure 1 - Flow Diagram. The following instructions assume that all valves are in normal operating positions shown in Figure 1.

☐ 1. Set system control switches for Wells No. 4 and 7 to "BACKWASH", stopping both wells.

☐ 2. Place tower drain valves in "SUMMER" mode.

☐ 3. Set Blower No. 4 switch to "HAND".

☐ 4. Set Sump Pump switch to "HAND". Drain the Sump to approximately 0.5 feet, where the low level alarm float will stop the Sump Pump and light the Low Level in Sump lamp.

☐ 5. Set Sump Pump switch to "OFF".

☐ 6. Set Blower No. 4 switch to "AUTO", which will stop the blower.

☐ 7. Close Valve #3. Open Valve #9.

☐ 8. Direct backwash chlorine solution to Tower No. 4 Inlet by adjusting appropriate ball valves above Backwash Chlorinators.

☐ 9. Open gas valves to Backwash Chlorinators.

☐ 10. Press "START" button for Tower No. 4 backwash. The programmable controller will start Well No. 4 and open the solenoid valves for the Backwash Chlorinators when the flow switch is tripped.

☐ 11. Adjust Backwash Chlorinators to 180 pounds per day each.

☐ 12. Allow Sump to fill to approximately 2.0 feet, then press "STOP" button for Tower No. 4 backwash. The programmable controller will stop Well No. 4 and close the solenoid valves for the Backwash Chlorinators.

☐ 13. Close gas valves to Backwash Chlorinators.

☐ 14. The Sump now contains approximately 3,400 gallons of solution with a chlorine residual of approximately 25 to 50 mg/l, which will be circulated through all towers which are to be rinsed at this time.

☐ 15. Press Alarm Reset Button twice to clear Low Level Alarm in Sump.

☐ 16. Set Sump Pump in "HAND" mode. Solution will circulate through Tower No. 4. Rinse for 60 minutes.

☐ 17. After 60 minutes, Set Sump Pump to "OFF".

☐ 18. Close Valves #2 and #7; Open Valves #8 and #11.

☐ 19. Set Sump Pump in "HAND" mode. Solution will circulate through Tower No. 7. Rinse for 60 minutes.

☐ 20. After 60 minutes, Set Sump Pump to "OFF".

☐ 21. Close Valve #11. Open Valve #2.

☐ 22. Press "START" buttons for backwash of Towers No. 4 and 7, leaving gas valves at Backwash Chlorinators closed. This step will rinse fresh water through the towers and inlet piping into the Sump.

☐ 23. Allow Sump to fill to approximately 6.0 feet, then press "STOP" button for Towers No. 4 and 7. The Sump now contains approximately 10,000 gallons of water with a chlorine concentration of approximately 10 to 20 mg/l.

☐ 24. Reset all valves to normal operating positions. Close Valves #8 and #9. Open Valves #3 and #7. Close valves above Backwash Chlorinators.

☐ 25. Set Sump Pump control to "AUTO".

☐ 26. Set both well systems to "AUTO" mode. All wells being called by reservoir controls in Wellhouse No. 2 will start.

☐ 27. Adjust Sump Pump discharge valve #12 so that flow from Sump to Tower No. 4 is approximately 50 gallons per minute (1¼ to 1½ turns from completely closed position). Solution in Sump will be pumped through Tower No. 4 as Well No. 4 is called. Excess chlorine will be stripped out of the water as it passes through the Tower.

☐ 28. Place tower drain valves in "WINTER" mode, to continue adding dilution water to Sump each time wells turn off. Leave in this mode for several days until chlorine residual in Sump is less than 1 mg/l. Valves can then be placed in "SUMMER" mode, if desired.

☐ 29. Reset Valve #12 to full open position.

APPENDIX C

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITY FOR WELLS NO. 4 AND 7

PROCEDURE FOR ADJUSTMENT OF TIMERS IN PROGRAMMABLE CONTROLLER

Review list of program timers (Appendix D) to determine timer number which is to be changed. Changes are made by entering new values through keypad mounted on programmable controller. The procedure below details how to set timer number 611 to 30 seconds. Setting another timer is done in a similar manner by inserting the desired timer number and time (in seconds) in Steps 2 and 6 of the procedure.

1. Press "CLR".
2. Press "TMR", "SHF", "611", "SCH", "NXT".
3. Display now shows timer number 611.
4. Press "NXT".
5. Display now shows current time for timer number 611.
6. Press "SHF", "30", "ENT".
7. To verify new time, Press "PRV", "PRV"
8. Display now shows timer number 611.
9. Press "NXT".
10. Display now shows new time entered for timer number 611.

APPENDIX D

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITY FOR WELLS NO. 4 AND 7

INITIAL TIMER SETTINGS FOR PROGRAMMABLE CONTROLLER

TIMER	SETTING (Seconds)	FUNCTION
610	5.0	Blower #4 Fail in Normal Start-up Mode.
611	30.0	Well #4 Fail in Normal Start-up Mode.
612	30.0	Delay for Starting V-75 Chlorinator for Well #4.
613	900.0	Delay for Automatically Resetting Alarm Loop #4.
614	30.0	Delay for Stopping V-75 Chlorinator for Well #4.
615	90.0	Delay for Stopping Blower #4 After Well #4 Stops.
616	30.0	Well #4 Fail in Backwash Start-up Mode.
617	6.0	Delay for Starting Booster Pump #1.
620	9.0	Delay for Starting Booster Pump #2.
621	40.0 ~~3.0~~	Delay for Starting Sump Pump.
622	5.0	Blower #7 Fail in Normal Start-up Mode.
623	480.0	Well #7 Fail in Normal Start-up Mode.
624	30.0	Delay for Starting V-75 Chlorinator for Well #7.
625	900.0	Delay for Automatically Resetting Alarm Loop #7.
626	30.0	Delay for Stopping V-75 Chlorinator for Well #7.
627	90.0	Delay for Stopping Blower #7 After Well #7 Stops.
630	480.0	Well #7 Fail in Backwash Start-up Mode.
631	5.0	Delay for Chlorine Residual Alarm.
632	5.0	Delay for Clearwell High Level Alarm.
633	5.0	Delay for Clearwell Low Level Alarm.

APPENDIX E

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITY FOR WELLS NO. 4 AND 7

PROCEDURE FOR RECORDING AND LOADING PROGRAM IN PROGRAMMABLE CONTROLLER

A recording of the program should be made when timers are changed. The recording is made on cassette tape, using a Tape Recorder with volume and tone controls, and jacks for microphone and earplug. (A tape footage counter is also beneficial for locating beginning of program on tape). The cord for connection between the programmable controller and the Tape Recorder has been provided with the Programmer. During recording of the program, all control functions cease to operate, and the wells are shut off.

TO RECORD PROGRAM:

1. Turn key on Programmer from "RUN" to "LOAD".
2. Plug cord into "Tape" jack on Programmer and "MIC" jack of Tape Recorder. Set Volume and Tone.
3. Prepare Tape Recorder to record by inserting tape, rewinding, if necessary, resetting counter and forwarding past leader. Note reading on counter.
4. Press "RECORD" on Tape Recorder to start recording.
5. Press "WRITE" on Programmer ("NXT" button).
6. When display on Programmer says "END", Press "STOP" on Tape Recorder. Note reading on counter.

TO VERIFY THAT RECORDING IS GOOD:

1. Rewind Tape Recorder to beginning of recording.
2. Press "CLR" on Programmer.
3. Remove cord from "MIC" jack on Tape Recorder and insert in "EARPHONE" jack.
4. Press "PLAY" on Tape Recorder.
5. Press "CHECK" on Programmer. (SCH button).
6. If "END" appears on display when counter on Tape Recorder reaches the end of the previous recording, then the tape is okay. If an "ERROR" message is displayed, the recording is no good, and must be redone.
7. Press "STOP" on Tape Recorder.

TO RETURN PROGRAMMABLE CONTROLLER TO RUN MODE:

1. Press "CLR" on Programmer.
2. Remove cord from "TAPE" jack on Programmer.
3. Turn key on Programmer from "LOAD" to "RUN".
4. Mark date and counter numbers of recording on tape and store in secure place.

CONSULT PROGRAMMABLE CONTROLLER MANUAL TO LOAD PROGRAM FROM TAPE

APPENDIX F

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITIES AT WELL NO. 4

CEMS, INC. SUBMITTAL REGISTER

1. Butterfly Valves, Wafer Style - Dezurik
2. Expansion Joints - Unaflex
3. Silent Check Valves - Val-Matic
4. Air & Vacuum Valves - Val-Matic
5. Combination Air Valves - Val-Matic
6. Pump Control Valves - Singer
7. Standby Generator - Kohler
8. Fuel Tank - 550 Gallon
9. Swing Check Valves - Kennedy
10. Gate Valves, Resilient Wedge - Waterous
11. Butterfly Valves, Underground - M & H
12. Backflow Preventer - Febco
13. Frostproof Yard Hydrant - Campbell
14. Fire Hydrant - U.S. Pipe Sentinel
15. Footing Drain Pump - Hydromatic
16. PVC Ball Valves - Spears
17. PVC Ball Check Valves - Spears
18. 2 Way Solenoid Valves - ASCO
18A. Solenoid Valves - ASCO
19. Butterfly Valves, Flanged - De Zurik
20. Louvers, Dampers & Exhaust Fans - Ruskin & Acme
21. Vertical Turbine Booster & Sump Pumps-American Industrial Pump Co.
22. Flow Monitors - Data Industrial
23. Hollow Metal Doors - Curries
24. Door Hardware - Various Manufacturers
25. Concrete Mix Design - Lone Star (736)
26. Grates and Frames - Inland Foundry, Inc.
27. Precast Concrete Vault - Pipe, Inc.
28. Skylights - Kalwall
29-A. Reinforcing Details - Sumps and Footings
29-B. Reinforcing Details - Slabs
30. Supply Fan - Acme
31. Radiant Heater - Aztec
32. Unit Heater - Qmark
33. Light Fixtures - Various Manufacturers
34. Fabricated Steel - RLC Steel Fab Co.
35. Float Switches - Master Level Controls
36. Flow Switches - Turbo-Sika
37. Air Stripping Towers - National Environmental Systems
38. Motor Control Center
39. Chlorinators
40. Painting - Evan House Co.
41. Residual Chlorine Monitor - EIT
43. Electrical Control Drawings - UNIPAC

APPENDIX G

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITIES FOR WELLS NO. 4 AND 7

MANUFACTURERS' OPERATION AND MAINTENANCE MANUALS

VOLUME I - MECHANICAL AND MONITORING EQUIPMENT
- A. Air Stripping Tower
- B. Blower
- C. Vertical Turbine Pump
- D. Vertical Induction Motor
- E. Pump Control Valve
- F. Sand Separator
- G. Footing Drain Pump
- H. Flow Monitor
- I. Free Chlorine Monitor

VOLUME II - CHLORINATION EQUIPMENT - Wallace & Tiernan
- A. Series V-75V V-Notch Chlorinator
- B. Series V-100D V-Notch Chlorinator
- C. Series 500C Vacuum Regulator
- D. Series 50-135 Chlorine Gas Detector
- E. Chlorine Manual

VOLUME III - MOTOR CONTROL CENTER
- A. Drawings
- B. Miscellaneous Materials
- C. Programmable Controller
- D. Floatmaster Level Control

VOLUME IV - SUBMITTALS

VOLUME V - STANDBY GENERATOR
- A. Detroit Diesel Engine
  - In-Line 71 Service Manual Sections 1-3
  - In-Line 71 Service Manual Sections 4-15
  - Series 53, 71, 92 Operations Guide
  - In-Line 71 Parts Catalog (5 Books)
- B. Kohler Fast Response II Generator
  - Operation Manual
  - Service Manual
  - Scheduled Maintenance
  - Preliminary Parts Listing

CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE OF THE WATER TREATMENT FACILITY FOR WELLS NO. 2, 3 AND 5

VOLUME I

JUNE 1991

CUNNINGHAM ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
MILWAUKIE, OREGON

CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE OF THE WATER TREATMENT FACILITY FOR WELLS NO. 2, 3 AND 5

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CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE
OF THE WATER TREATMENT FACILITY FOR WELLS NO. 2, 3 and 5

CHAPTER 1 - INTRODUCTION

A. PURPOSE OF PROJECT

The packed tower aeration treatment facility, located at 3806 SE Harvey St., Milwaukie, Oregon, was constructed to remove the following volatile organic chemicals recently found in the ground water pumped from Milwaukie Wells No. 2, 3 and 5:

Trichloroethylene
1,1-Dichloroethylene
1,1,1-Trichloroethane
Tetrachloroethylene

B. PROJECT DESCRIPTION

The treatment facility consists of an operations building and three towers for air stripping of volatile organic chemicals from well water. The well pumps at Wells No. 2, 3 and 5 pump well water directly to each packed tower. The well water is chlorinated by solution injection prior to entering the tower, where it falls by gravity through the tower packing media as air is blown upward through the tower. Volatile organic chemicals are evaporated from the cascading water and exhausted through the tower stack. The air stripped water drains from the bottom of each tower to a main clearwell beneath the treatment building. Chlorination by solution injection also occurs in the main drain system between the towers and the clearwell. The air stripped and chlorinated well water is then pumped from the clearwell into the City's concrete reservoir supplying Pressure Zone No. 1. The treatment building contains the chlorination equipment, tower blowers, control center, tower backwashing equipment, and distribution pumps. The system operates automatically through the City of Milwaukie's main well control panel at Wellhouse No. 2.

Tower backwashing to remove bacterial growth from the packing media as well as system configuration changes must be done manually.

C. TREATMENT OBJECTIVES AND DESIGN CRITERIA

The treatment objective of the packed tower aeration system is to reduce the well discharge concentrations of volatile organic chemicals to the levels listed in Table No. 1-1 prior to discharge into the City's distribution system.

TABLE 1-1

DESIGN CRITERIA FOR VOC REMOVAL

	CONCENTRATION IN WATER (ug/l)	
COMPOUND	INFLUENT	EFFLUENT
Trichloroethylene	20	<0.2
1,1-Dichloroethylene	5	<0.2
1,1,1-Trichloroethane	5	<0.2
Tetrachloroethylene	5	<0.2

Treatment Towers No. 2, 3 and 5 are identical and designed to achieve the volatile organic concentration reductions listed in Table 1-1 under the following conditions:

Number of treatment towers = 3
Treatment capacity = 600 GPM each tower
Minimum design water temperature = 55°F.
Packing depth = 19 feet
Minimum air/water ratio = 40:1
Tower diameter = 6 feet
Tower material = Fiber-reinforced plastic

Flow from Well No. 2 is directed to Tower No. 2, Well No. 3 to Tower No. 3 , and Well No. 5 to Tower No. 5. Flow from any well may be directed to any tower by manually reconfiguring the tower inlet valve network at the treatment plant. Inflow to a single tower should not exceed 600 GPM at any time.

D. OREGON HEALTH DIVISION REQUIREMENTS

Maximum volatile organic chemical concentrations allowed in community and municipal water systems are regulated by the Oregon Department of Human Resources, Health Division, Office of Environment and Health Systems. Oregon Administrative Rules, Chapter 333, list maximum volatile organic chemical concentrations in public water systems as follows:

TABLE 1-2

MAXIMUM CONTAMINANT LEVELS (MCL)
FOR REGULATED VOC'S

CONTAMINANT	MCL,mg/l	MCL,ug/l
Benzene	0.005	5.0
Vinyl chloride	0.002	2.0
Carbon tetrachloride	0.005	5.0
1,2-Dichloroethane	0.005	5.0
Trichloroethylene	0.005	5.0
1,1-Dichloroethylene	0.007	7.0
1,1,1-Trichloroethane	0.200	200.0
para-Dichlorobenzene	0.075	75.0

(Tetrachloroethylene Not Listed)

Comparison of the tower design criteria in Table 1-1 with the state health requirements in Table 1-2 shows a strong factor of safety, as well as future satisfactory treatment if the contaminant levels exceed the design criteria and/or lower maximum contaminant levels (MCL) are adopted by the State.

Chlorination requirements by the State Health Division require continuous disinfection to achieve a free chlorine residual of 0.2 mg/l under all flow conditions throughout the distribution system. The chlorination system at the treatment facility is designed to provide this residual in two steps. Step 1 is the chlorination of the tower influent water to prevent bacterial growth on the tower media; and Step 2 is the rechlorination of the tower treated water prior to discharge into the City's distribution system.

CITY OF MILWAUKIE,OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE
OF THE WATER TREATMENT FACILITY FOR WELLS NO. 2, 3 AND 5

CHAPTER 2 - UNIT PROCESSES

A. AIR STRIPPING TOWERS

Air stripping towers No. 2, 3, and 5 operate virtually identically. When the City's water system requires water from a particular well, the main control panel in Wellhouse No. 2 signals the start-up of the treatment process for that well. The blower is activated, the tower inlet pipe drain is closed, and the well pump is activated. When a flow switch signals that water is flowing to the tower, the inlet chlorinator is started and, after an adjustable time delay, the outlet chlorinator is started.

Water enters the top of the tower, where it is directed into a distribution weir trough. The trough distributes the inflow evenly over the tower packing. The water is broken into small droplets as it falls through the packing media, while air is blown up from the bottom of the tower. The volatile organic chemicals evaporate and are exhausted with the air through the tower stack. A demister is installed above the inlet pipe to prevent water droplets from being blown out the tower stack. The treated water is collected at the bottom of the tower and directed through a drain system into the clearwell.

Over time the tower packing may accumulate a biological film which may reduce treatment efficiency. The backwash cycle is designed to suppress this biological layer by super-chlorinating the influent water to each tower. The super-chlorinated backwash water drains from each tower through a separate drain system to the backwash sump. The backwash water is neutralized and pumped back into the tower inflow system when normal tower operation resumes.

Uniform distribution of the raw well water by the inlet weir trough is critical to attaining uniform VOC removal. The air/water ratio of 40:1 is equally important to attain optimum removal efficiency from each tower. Blower air flow rate within the tower must be sufficient to maintain the air/water ratio. Plugged tower media, plugged louver filters, or incorrectly adjusted duct control dampers will lead to poor tower performance.

Two valved drain lines from each tower direct flow to either the clearwell or backwash sump, depending on which operation mode the tower is in. In the event of drain line stoppage, a high water alarm sensor in the tower will direct the motor control center (MCC) to shut down all affected units, including well pumps, blowers, chlorinators, etc.

Three access hatches are provided on each tower to access:

1. Demister unit, inlet piping and the weir trough liquid distributor.

2. The tower packing media for replacement.

3. The tower outlets and lower packing media support grate.

These access hatches are to remain securely bolted shut during normal and backwash tower operations.

B. AIR FLOW SYSTEM

The air flow system provides the air quantity required for VOC removal in the treatment towers. The system consists of three blowers, which draw filtered air from the east side of the treatment building, and transmit this air through the duct system into each treatment tower. Blower No. 2 supplies air to Tower No. 2; Blower No. 3 supplies air to Tower No. 3; and Blower No. 5 supplies air to Tower No. 5 under normal operating conditions. Since the three towers are designed for identical treatment capacities (600 GPM), the blowers are also designed to provide identical delivery capacities. In the event of blower failure, the affected well and tower will be shut down, although the remaining well and tower systems will be unaffected.

Blowers No. 2, 3 and 5 are located in the fan room within the new treatment building. Air enters the room through acoustical louvers mounted in the east wall of the treatment building. Replaceable air filters mount in a filter rack attached to the louvers. These filters remove foreign material from the air used for VOC removal within the tower. Periodic inspection and replacement of the filters is required to maintain blower efficiency and effective VOC removal performance.

The air duct system channels the blower air to each tower. An air flow switch is mounted immediately downstream of each blower as a fail-safe check of blower start-up and operation during tower operation. Back draft dampers are located following the air flow switches. Control dampers allow air flow direction to be regulated during manual over-riding of the system. By opening and closing dampers, air flow from either blower may be directed into either tower. Adjustment of the control dampers is a manual operation, which will affect tower VOC removal efficiency if done improperly. Control dampers should be set at normal tower operation settings at all times, except during periods of special manual override operation.

Start-up and shut down of the blowers is controlled by the MCC in the new treatment building. It is a critical component of the tower start-up and shut down sequence. The blower supplying its respective tower will operate only during operation of that tower. Blower failure will cause the MCC in the treatment building to shut down the well/tower system served by the failed blower.

Each blower may be switched from "AUTO" to "MANUAL" control at the MCC. This allows the operator to control either blower during manual tower operation. A safety power shut-off switch for each blower is located in the fan room to positively deactivate power to each blower during maintenance work.

C. CHLORINATION SYSTEM

The chlorination system performs three functions at the treatment facility:

1. Injection of chlorine solution into each tower inlet pipe pre-chlorinates the raw influent well water and helps deter biological film growth on the tower media.

2. Injection of chlorine solution into the main tower drain system boosts the free chlorine residual of the treated water to the level required in the City's distribution system.

3. Injection of a concentrated chlorine solution into the inlet pipe of a tower being backwashed will kill biological film which may foul the tower media.

During the tower start-up sequence, the chlorination system normally activates immediately following well pump start-up. The MCC in the new treatment building calls for well pump start-up and confirms flow by the tower inlet flow switch. The MCC then starts Chlorine Feed Pump No. 1 and opens the solenoid valve feeding water to the corresponding Wallace & Tiernan V-100D chlorinator assigned to the operating tower's inlet pipe. Chlorine gas is drawn by the chlorinator through a Sch. 80 PVC manifold from two 150 lb. chlorine gas cylinders with vacuum regulation valves. The chlorinator proportionally mixes chlorine gas with feed water supplied through a 2" manifold. The resulting solution is delivered to the tower inlet pipe injector by a 1½" Sch. 80 solution line. The V-100D chlorinator is adjustable from 0 to 10 pounds per day of chlorine gas. Solution concentrations above 10 PPD will require modification of the chlorinator and gas injector. Chlorination feed rates into each tower inlet pipe will be field adjusted following a period of tower operation to determine the bacterial film growth rate on the weir trough liquid distributor and tower packing media.
Chlorination of the tower effluent water will begin following an adjustable time delay to allow water to flow through the tower.

Associated with each tower is a Wallace & Tiernan V-75VA2 Chlorinator with an individual solenoid valve for start/stop control. The chlorine solution from each V-75 chlorinator is fed into a single 1½" solution line which is connected to the 18" tower drain system just ahead of the clearwell. When three towers are operating, three V-75VA2 chlorinators are contributing to the single solution injector. Each chlorinator unit is capable of supplying from 0 to 10 pounds per day of chlorine gas. Each V-75VA2 chlorinator feeding the tower drain system solution injector will be set to achieve satisfactory free chlorine residual in the treated water pumped into the City's distribution system (0.2 mg/l throughout).

Tower flow shut down begins with well pump shut-off, followed by opening of tower inlet pipe drain lines, then solenoid valve shut-off of feed water to the operating V-100D chlorinators. Following an adjustable time delay to allow each tower to drain, the solenoid valve on the feed water line to each V-75VA2 chlorinator closes and Chlorine Feed Pump No. 1 is deactivated.

Backwashing either Tower No. 2, 3 or 5 requires an extra strong chlorination dose. This is provided by a V-75VA5 chlorinator with a solenoid start/stop valve on the feed water line to the chlorinator. The backwash sequence requires manual change of the tower drain direction and overriding the normal tower operation sequence at the MCC. One of the chlorine solution directing ball valves in the chlorine room must be opened to direct chlorine solution to the tower being backwashed. Following well pump start-up and tower flow switch confirmation, the backwash chlorinator feed solenoid valve is opened and Chlorine Feed Pump No. 2 is activated. The extra strong chlorine dose is delivered to the tower inlet pipe through the normal solution supply line and solution injector. Ending the backwash cycle involves stopping the well pump, opening the tower inlet pipe drain lines, then closing the solenoid valve on the feed water line to the V-75VA5 chlorinator. Chlorine Feed Pump No. 2 is deactivated and the chlorination system completely shut down. This sequence is part of the automatic shut down operation controlled by the MCC.

The V-75VA5 chlorinator is capable of supplying from 0 to 500 pounds per day of chlorine gas. Normal backwashing of a single tower will utilize a feed rate of approximately 360 PPD. At this feed rate, the chlorine residual will be approximately 50 mg/l. During backwashing, feed water is supplied to the chlorinator by Chlorine Feed Pump No. 2 exclusively.

Chlorine gas is supplied to all chlorinators through a single 3/4" Sch. 80 PVC supply manifold with draw-offs through one-half inch PVC shut-off valves and gas tubing to the control units. The source and monitoring of the chlorine gas supply is accomplished by two 150 lb. chlorine cylinders on a Wallace & Tiernan Model 50-345 tank scale with a pair of 500 C automatic switchover vacuum cylinder valves.

Check and ball valves, as well as PVC unions, on all chlorination piping allow isolation of system components for maintenance without shutting the entire system down. A strainer and backflow preventer on the chlorinator feed water supply manifold functions to prevent clogging of the chlorinators and backflow of chlorine injection water.

A chlorine leak detector is mounted on the east wall in the chlorine room with its sensor set at nearly floor level. A chlorine leak will trip the detector causing an alarm light on the MCC panel and on the detector unit. This MCC alarm condition will also be transmitted to the Milwaukie police station.

The chlorine room in the treatment building contains all chlorination equipment. Two auxiliary chlorine tank wall bumpers with safety chains allow storage of four extra chlorine gas tanks in the room.

The feed water system to the chlorinators is supplied by two vertical centrifugal pumps controlled by the MCC and located in the pump room at the treatment plant. Chlorine Feed Pump No. 1 operates during normal tower operations, while Pump No. 2 is only activated during the backwash cycle. Both pumps are 3 HP, operating at 3500 RPM to supply 40 GPM at 180 feet TDH.

D. BOOSTER PUMP SYSTEM

Three 700 GPM vertical turbine pumps, located in the treatment building above the clearwell, transfer treated water into the distribution system. Each pump is powered by a three-phase, 460 volt, 10 HP motor operating at 1,800 RPM. Each single stage pump generates 35 feet TDH at 700 GPM.

The booster pump system is controlled by the MCC in the treatment building. The pumps start and stop in response to selected water levels in the clearwell, which are transmitted to the MCC by the float control system. Emergency low water pump cutout and high water system cutout switches are also provided in the clearwell as extra safety measures. The order of pump operation is alternated after each cycle to provide even wear on all three pumps. An adjustable time delay is also provided to control the starting of each booster pump. A single tower running may only require operation of a single booster pump, but as the clearwell water level rises with two or three towers operating, the second and third booster pumps will be activated. If a booster pump fails to start and the clearwell water level reaches the high water alarm level, the towers will be shut down automatically by the MCC. If a booster pump fails to stop and the clearwell water level drops to the low water alarm level, the MCC will deactivate all booster pumps.

The booster pump system is automatically controlled and will normally not require manual overriding except during maintenance work. The butterfly and check valves on each pump discharge line facilitate rapid isolation of the pumps and pump appurtenances for such maintenance.

E. TOWER BACKWASH (RINSE) SYSTEM

The backwash or rinsing system functions to suppress the growth of bacteria and other unwanted biological films inside the stripping towers, which could plug the packing media and hinder VOC removal efficiency.

Rinsing of the media is accomplished by mixing raw well water and a high dose of chlorine, and placing the resulting solution into the backwash sump. The solution is then recirculated through each tower for an extended period of time to contact all the media with the disinfecting dose of chlorine. At the completion of the rinsing cycle, the towers are rinsed with clear water and placed back into service. The chlorine solution is diluted and fed slowly back through the towers while they are in normal operation. Excess chlorine in the water is stripped out along with the VOCs.

The backwash pump is a single stage vertical turbine pump powered by a 5HP, three-phase, 460 volt motor operating at 1,800 RPM. This pump generates 250 GPM at 39 feet TDH. When rinsing the towers, the backwash pump is run manually. The backwash pump is also used to pump water which has accumulated in the sump when the towers are placed in "WINTER" mode. See Chapter 3 for a description of the summer/winter operation modes. Low water and high water cutout switches are also found in the backwash sump to prevent pump damage from low water levels and overfilling the sump in the event of pump failure.

F. MOTOR CONTROL CENTER

The motor control center (MCC) in the treatment building controls the tower operation sequence through a Texas Instruments programmable logic controller to produce treated water from Wells No. 2, 3 and 5 and supply this treated water into the City's low level distribution system. The MCC acts on control signals from the main control center located at ~~in~~ the Milwaukie [illegible] ~~Well No. 2 building~~. This control center monitors the water level in the concrete reservoir tank at 40th and Harvey street by use of a liquid level float control system. When the reservoir requires inflow, the control center at Well No. 2 sends a control signal to the MCC in the treatment building calling for Tower 2, 3 or 5 start-up. The MCC translates the control signal and commences start-up of the requested tower system(s). A positive tower system start-up signal is sent back to the control center at Wellhouse No. 2, which then activates the requested well pump(s). If a tower system component or well pump fails to activate, the MCC in the treatment building will send a telemetry alarm signal to the Milwaukie police station monitor. Positive tower start-up will produce run lights on both the MCC panel in the treatment building and the control panel at Wellhouse No. 2.

Manual override of the automatic tower control system is not possible, as the chlorinator solenoid valves are controlled only by the MCC. Each tower and corresponding well operate independently of the other. Therefore, it is possible to backwash one tower while the other two are contributing to the distribution system.

Failure of the blower, well pump or chlorination system causes immediate shut down of the respective well. Alarm lights are activated on the MCC in the treatment building and an alarm signal is sent to the Milwaukie police station. A reset button is provided on the MCC panel to clear the alarms. Push once to silence alarm at the police station and reactivate controls. The system will now operate in fail mode to facilitate troubleshooting. Push the reset button again to clear and reset the alarm system. If the button is not pushed again within 15 minutes (900 seconds) of the first push, the alarm system will reset itself.

G. TELEMETRY SYSTEM

The telemetry system functions solely to transmit alarms to a Milwaukie Police station receiver. The MCC, in the event of system failure, will send a telemetry signal to the Milwaukie police station. The monitor at the Milwaukie police station is a receiving unit only. Operation switches and auto controls for the treatment facility exist only in the control center at Wellhouse No. 2 and the MCC in the treatment building. The well buildings themselves contain only well pump controls. Any telemetry system adjustments should be coordinated with U.S. West Communications. Alterations of the system whether accidental or willful may result in system failure.

The MCC in the treatment building and the main control center at Wellhouse No. 2 are directly connected by buried control wires constituting a system separate from the telemetry system. A set of control wires for each tower system link the MCC to the Wellhouse No. 2 control center, and another set of wires link each well pump to the Wellhouse No. 2 control center. Tower and well pump start-up is a combined function of both the MCC (controlling the tower system) and the main control center (controlling the well pumps). The underground control wires function solely to transmit operation signals to the MCC and well pumps.

H. SENSORS AND ANALYZERS

The treatment facility for Wells No. 2, 3 and 5 monitors unit processes by use of sensors, meters, and float instruments. The instruments detect whether critical unit processes start, operate, and/or shut down correctly. Failure of a critical process component will be sensed and the system shut down to prevent distribution of untreated water. The type, location, and number of monitoring instruments is described below.

1. Tower Inlet Flow Switch

A tower inlet flow switch is tapped into each tower inlet pipe just above the chlorine injection tap. Access to the switch is from the meter box at the base of each tower. The tower inlet flow switch functions to confirm well pump start-up, inflow during tower operation, and well pump shut down. The switch contact is normally open and is closed by flow in the pipe.

During tower start-up, the MCC in the treatment building waits for the flow switch contact signal for an adjustable delay period. This delay period is required to allow for well pump start-up and filling the tower supply line. If the MCC receives a positive flow switch contact signal during the delay period, normal tower start-up operations continue. If a contact signal is not received by the MCC during the delay period, the MCC will assume well start-up failure, shut down the tower system, activate the well fail light and send an alarm signal to the Milwaukie police station. Chlorination equipment is only activated if the flow switch closes.

During normal tower operation, the inlet flow switch functions to monitor tower inflow. If inflow stops for any reason, the MCC will shut down the tower system and send an alarm signal to the police station.

When the tower system shuts down normally, the inlet flow switch functions to verify well pump shut down. After flow stops and the flow switch opens, the chlorination and blower shut down sequences are performed.

2. Air Flow Switch

An air flow switch is mounted in each blower discharge duct to monitor blower start-up, continuous operation, and shut-off. Air flow switch contact signals will be sent to the MCC continuously during tower operation. If a blower fails to start during the tower start-up sequence, the air flow switch will not send a contact signal to the MCC. The MCC will react by shutting the tower system down, activating the blower fail light, and sending an alarm signal to the Milwaukie police station.

When the tower system is operating, the air flow switch will send a continuous contact signal to the MCC. If a blower fails or air flow falls below the minimum pressure required to activate the switch, then the contact signal will stop. The MCC will react to the air flow signal loss by shutting the tower system down and sending an alarm signal to the Milwaukie police station.

During the tower shut down sequence, the blower system is the last unit process to terminate. The air flow switch is deactivated when the blower stops and the pressure in the duct system drops back to atmospheric.

Since the blower system is a critical unit process in the tower operation system, failure signals from the air flow switch should be investigated immediately. Periodic checks to confirm correct switch operation should be considered as part of the routine treatment plant inspection.

3. <u>Flow Monitors</u>

A panel mount flow monitor is located in the treatment building MCC to display quantity of flow from the treatment facility to the concrete reservoir. A brass flow sensor to measure outflow is tapped into the 12" distribution supply pipe in the vault east of the east wall of the treatment building. This flow sensor is linked to the monitor in the MCC by shielded cable in conduit. The flow monitor and sensor are not linked to the treatment plant operation sequence, and function solely to measure plant outflow.

Wall mount flow monitors with flow sensors in the pump discharge lines are installed in the Wells No. 2, 3 and 5 pump houses. These units function to measure the well discharge volumes and are not related to the treatment facility operations.

4. <u>Residual Chlorine Monitor</u>

A free chlorine residual monitor to provide accurate monitoring of the chlorine concentration in treated water being pumped into the distribution system is located in the MCC panel. A ¼" copper line, tapped into the 12" distribution main in the pump room, provides sample water to the monitor's flow cell assembly. The flow cell assembly, located on the east wall of the pump room, utilizes constant head overflow past a chlorine sensor probe. Treated discharge water continuously supplied to the overflow assembly is tested by the sensor and discharged through a 1/2" drain line back into the clearwell. The sensor signals are sent to the residual monitor in the MCC and converted to direct readout values on the panel.

The MCC monitors the free chlorine residual for high or low levels. If the chlorine residual falls outside of the pre-set operating range, the MCC signals the Well No. 2 control center to shut down the operating wells, directs tower system shut down, activates the chlorine residual alarm light, and sends an alarm signal is sent to the Milwaukie police station. Well pump shut down is controlled by the main control center at Wellhouse No. 2.

5. Tower High Water Sensor

A tower high water sensor is located in the side of each tower 2'-6" above the base. The cylindrical, side-mounted sensor functions to alert the MCC of high water build-up in the tower if the normal and backwash drain valves are inadvertently left closed or the tower outlet pipe becomes plugged. If water build-up in a tower causes the high water sensor to trip, the MCC will shut down the well/tower system, activate the tower high level alarm light and send an alarm signal to the Milwaukie police station. The high water sensor is set so that the system will shut down before the tower water level overflows into the blower duct system.

6. Liquid Level Float Controls

Liquid level float control units monitor the clearwell and backwash sump water levels. Each unit consists of a float, operating a pulley and worm gear assembly. The worm gear shaft has trip paddles to activate and deactivate mercury switches at preset water depths.

During normal clearwell operation, the first level switch will close when the water rises to a preset level. This switch initiates start-up of the lead booster pump through the MCC. If the clearwell level rises further, tripping the second level switch, the MCC will start the second booster pump. The third level switch will trip if the clearwell water level continues to rise, and the third booster pump will start. When the water level in the clearwell falls, the third level switch is tripped off first and the third booster pump is shut down. As the water level continues to fall, the second and first level switches eventually trip off and the booster pump system completely shuts down. An automatic alternator changes the lead pump after each cycle.

The backwash sump pump is directly controlled through the MCC by the float control unit assigned to the backwash sump. The level switch will initiate sump pump start-up through the MCC when the water rises to a preset level. When the water drops to a preset level due to pumping, the level switch opens and the pump stops. The backwash sump pump is automatically started/stopped by the MCC only when Well No. 2 is running in normal treatment mode.

Both float control units have a level indicator dial to provide clearwell and backwash sump liquid levels at a glance. Once set to trip at specific water levels, the float control units will operate automatically.

7. High and Low Water Alarm Floats

High water and low water float switches are provided in the clearwell and backwash sumps. The high water float switches function to alert the MCC in the treatment building of any one of the following conditions:

a. Booster or sump pump start-up circuit failure
b. Inflow exceeds pump capacity
c. Pump float control unit failure
d. Incorrect manual pump override operation

The high water float switch in the clearwell will activate if the water level rises to 12" below the bottom of the floor slab. During a clearwell high water alarm situation, all well/tower systems will be shut down. The booster pump system will remain activated to lower the water level in the clearwell. During a backwash sump high water alarm situation, all well/tower systems will be shut down. Appropriate alarm lights will be activated on the MCC panel and an alarm signal sent to the Milwaukie police station if either high water condition occurs.

The low water float switches function to shut down the booster pumps and/or backwash sump pump if any one of the following conditions occurs:

a. Pump float control unit failure
b. Pump shut-off circuit failure
c. Incorrect manual pump override operation

Activation of the low water float switch in the clearwell will occur if the water level drops to 24" above the clearwell floor. Activation of the low water float switch in the backwash sump will occur if the water level drops to 6" above the sump floor. Appropriate alarm lights will be activated on the control panel and an alarm signal will be sent to the Milwaukie police station if either low water condition occurs.

The well pump and tower systems will continue to operate normally during a low water alarm to bring the clearwell and/or backwash sump levels back to non-alarm levels.

The high and low water alarm floats are mounted on vertical pipe supports in both the clearwell and the backwash sump. Each system functions to override the auto and manual controls to prevent serious treatment plant damage from system failure. Separate alarm lights to indicate high/low water levels in either the clearwell or the backwash sump are provided on the control panel. Following an alarm condition and correction of the problem, the reset button must be pressed twice to bring the system back "on line".

I. STANDBY ENGINE-GENERATOR

A 250 KW engine-generator unit is located in the generator room at Wellhouse No. 2. This unit will power all three tower systems, Well Pumps No. 2 and 3, the main control center a Wellhouse No. 2, and all interior treatment building components, including the booster pumps. The MCC unit is designed to be manually switched over to the engine-generator as a power source in the event of utility power loss.

A 550 gallon diesel fuel tank is located in the pump room to supply the engine unit. A tank filler pipe with locking cap is accessible on the east wall of the Wellhouse No. 2. The tank is also vented to the outside by a vent tube through the east wall. Fuel lines run across the floor from the tank to the engine-generator unit.

The operation sequence to start and operate the engine-generator unit is outlined in the emergency system operation mode section. Operators should be thoroughly familiar with the engine-generator safety and operation procedures before attempting to operate the unit. Extreme care should be exercised around the engine-generator when it is operating.

J. SAND SEPARATOR

Sand separators are located on the pump discharge piping from Wells No. 2, 3 and 5. The separator functions to prevent sand carried in the well discharge from entering and depositing in the towers. The separators in Wellhouses No. 2 and 3 are mounted in 90 degree profile and bolted to the floor. In Wellhouse No. 5, the sand separator is underground just south of the well building. The operation range of the separators at Wellhouses No. 2 and 3 is from 480 GPM to 880 GPM. The sand separator at Wellhouse No. 5 is original equipment and not part of this project.

As well water passes through the separator for Wells No. 2 or 3, a vortex forms spiralling the sand particles into the separator's collection chamber. This collection chamber must be manually purged at regular intervals while the well pump is running. A ball valve on the purge line from the separator is opened and accumulated sand is blown out into a collection drum near the unit. The purged water is allowed to drain from the collection drum through a ½" line. This functions to de-water the sand, making it more manageable for disposal. Purging frequency will depend on the run times of Wells No. 2 and 3.

K. WELLHOUSE NO. 2

Wellhouse No. 2 contains the motor starter, well pump, flow meter, sand separator, and associated piping to direct Well No. 2 discharge to Tower No. 2. The Well No. 2 pump start command originates at the Wellhouse No. 2 control center in response to a reservoir level switch. The pump signal is transferred to the MCC in the treatment building where Tower No. 2 is activated. Successful tower start-up will cause the MCC to send the Well No. 2 pump start signal back to the control center which energizes the well pump. Well Pump No. 2 shut down occurs in reverse order to start up. Water and air flow monitoring switches confirm well and tower system de-activation.

Discharge from Well No. 2 is directed past a two-inch air valve and check valve before being directed upward past a flow meter probe and into the sand separator inlet. Flow straightening tubes in the vertical pipe section reduce vortexing before the flow passes the flow meter probe. Following the flow meter probe, the well discharge enters the sand separator. A second air valve is located on the highest pipe section exiting the sand separator. The 8 " line then turns downward passing through an 8" x 4" Tee with a 4" gate valve on the branch. The 8" line turns parallel to the floor, passes through an 8" butterfly valve, and exists the building. This valve arrangement provides blowoff capability for Well Pump No. 2. The butterfly valve functions to isolate the system during pump blowoff and also to regulate pump discharge during normal tower operation. Well Pump No. 2 is designed to pump into the low level concrete reservoir. No throttling of pump discharge valves is required to achieve flow into Tower No. 2.

A digital readout flow meter is located on the east wall of Wellhouse No. 2 to monitor flow from Well No. 2. The meter probe is tapped into the discharge line prior to the sand separator. The purpose of this unit is to provide individual flow reading for the well.

Auxiliary power in the event of utility power loss will be supplied by the engine-generator unit located at Wellhouse No. 2. This engine-generator will provide auxiliary power to the following components:

1. Well Pump No. 2
2. Main control center at Well No. 2
3. New treatment building and MCC controls
4. Well Pump No. 3
5. Concrete reservoir monitoring system

The engine-generator system must be manually activated and the five components listed above individually switched from utility to auxiliary power. See Chapter 3, Section C for operation instructions during utility power loss. Once switched to auxiliary power the five system components will operate automatically in response to reservoir levels.

L. WELLHOUSE No. 3

Wellhouse No 3 contains the motor starter, well pump, flow meter, sand separator and associated piping to direct Well No. 3 discharge to Tower No. 3. The Well No. 3 pump start command originates at the Wellhouse No. 2 control center in response to a reservoir level switch. The pump signal is transferred to the MCC in the treatment building where Tower No. 3 is activated. Successful tower start-up will cause the MCC to send the Well No. 3 pump start signal back to the control center which energizes the well pump. Well pump No. 3 shut down occurs in reverse order to start up. Water and air flow monitoring switches confirm well and tower system de-activation.

Discharge from Well No. 3 is directed past a two-inch air valve and check valve before being directed upward past a flow meter probe and into the sand separator inlet. Flow straightening tubes in the vertical pipe section reduce vortexing before the flow passes the flow meter probe. Following the flow meter probe, the well discharge enters the sand separator. A second air valve is located on the highest pipe section exiting the sand separator. The 8 " line then turns downward passing through an 8" x 4" Tee with a 4" gate valve on the branch. The 8" line turns parallel to the floor, passes through an 8" butterfly valve, and exists the building. This valve arrangement provides blowoff capability for Well Pump No. 3. The butterfly valve functions to isolate the system during pump blowoff and also to regulate pump discharge during normal tower operation. Well Pump No. 3 is designed to pump into the low level concrete reservoir. No throttling of pump discharge valves is required to achieve flow into Tower No. 3.

A digital readout flow meter is located on the south wall of the wellhouse to monitor flow from Well No. 3. The meter probe is tapped into the discharge line prior to the sand separator. The purpose of this unit is to provide instantaneous well discharge readings and total discharge to date.

Auxiliary power in the event of utility power loss will be provided by the engine-generator in Wellhouse No. 2 . Instructions to switch Wellhouse No. 3 from utility power to auxiliary power are outlined in Chapter 3, Section C.

M. WELLHOUSE NO. 5

Wellhouse No. 5 contains the motor starter, well pump, flow meter, sand separator (underground), and an 8" supply main to direct Well No. 5 discharge to Tower No. 5. The Well No. 5 pump start command originates at the Wellhouse No. 2 control center in response to a reservoir level switch. The pump signal is transferred to the MCC in the treatment building where Tower No. 5 is activated. Successful tower start-up will cause the MCC to send the Well No. 5 pump start signal back to the control center which energizes the well pump. Well Pump No. 5 shut down occurs in reverse order to start up. Water and air flow monitoring switches confirm well and tower system de-activation.

Well Pump No. 5 discharge is directed through a check valve and into a straight section of pipe containing flow straightening vanes and a flow meter probe. An air valve is tapped directly into the pump discharge head to provide air release during start-up. Following the meter probe the discharge piping turns 90 degrees and enters the floor. A sand separator is located underground just south to the wellhouse and provides sand removal from the well discharge flow. A 4" blowoff assembly is located along SE 40th Avenue south of Wellhouse No. 5. This assembly provides Well No. 5 pump blowoff capability before well discharge reaches treatment Tower No. 5. An 8" gate valve is located beyond the blowoff assembly to isolate the system during pump blowoff and also regulate pump discharge during normal tower operation. Well Pump No. 5 is designed to pump into the high level system. The 8" gate valve beyond the blowoff assembly is used to throttle Well No. 5 discharge to 600 GPM to prevent overloading treatment Tower No. 5.

A digital readout flow meter is located on the east wall of Wellhouse No. 5 to provide continuous flow reading from the well. The meter probe is tapped into the discharge line prior to the sand separator. Instantaneous flow readings and total flow to date are measured and displayed on the meter.

A natural gas engine unit is located in Wellhouse No. 5 to power the well pump in the event of utility power loss. All start-up, monitoring, and shutdown operations of the engine unit are manual functions. Operation of Well No. 5 during a utility power outage will require a city crew member to manually setup and control the engine unit. Wells No. 2 and 3 operate with only limited manual input during utility power outages because both wells and the treatment plant will be powered by the engine-generator located in Wellhouse No. 2. Well No. 5, on the other hand, is completely dependent on manual setup and control.

CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE
OF THE WATER TREATMENT FACILITIES FOR WELLS NO. 2, 3 AND 5

CHAPTER 3 - SYSTEM OPERATION

A. SYSTEM FLOW DIAGRAM

Figure 1 illustrates the on-site pipe flow network for operation of the treatment facility for Wells No. 2, 3, and 5. The major operational components are labeled and the valves requiring manual operation to change flow operations are numbered. Note that Figure 1 is a simplified illustration and the complete system is shown on the construction drawings.

B. NORMAL SYSTEM OPERATION

1. <u>Well and Tower No. 2 Operation</u>

a. Valve Settings

A complete description of automatic start-up of the Well and Tower No. 2 system will be discussed in this section. Figure No. 1 will be used to identify correct valve positions for normal tower operation.

For operation of Well and Tower No. 2, the following valves shown on Figure No. 1 shall be placed in the following positions:

Close valves: 10, 14, 22.

Open valves: 3, 4, 8, 15, 16, 17, 18, 19, 20, 21, 23.

The 8 " gate valve at the northeast corner of Wellhouse No. 2 must be open for pump discharge to reach Tower No. 2.

b. Automatic Start-Up

The water level in the concrete reservoir drops, closing the Well No. 2 cam switch at the main control center in Wellhouse No. 2. The main control center transmits a signal to the MCC in the treatment building calling for Tower No. 2 start-up.

The programmable controller in the MCC reacts to the control center signal with the following sequence:

Step 1) Start Blower No. 2. If the air flow switch at the blower does not trip after a 5 second delay, the system will automatically shut down and send an alarm signal to Milwaukie police station.

Step 2) Close solenoid valve on Tower No. 2 inlet pipe drain system.

Step 3) When air flow switch activates, MCC sends signal back to main control center at Well No. 2 calling for Well No. 2 start-up. Control center activates Well Pump No. 2. If water flow switch in Tower No. 2 inlet pipe does not trip following 60 second delay, the MCC will signal the main control center to stop Well Pump No. 2. The MCC will also automatically shut down the Tower No. 2 system and send a telemetry alarm signal to the Milwaukie police station.

Step 4) When water flow switch activates, open solenoid valve on solution supply line to V-100D chlorine feeder for Tower No. 2 inlet and activate Chlorine Feed Pump No. 1.

Step 5) After 30 second delay, open solenoid valve on solution supply line to V-75 chlorine feeder for Tower No. 2 outlet.

The system is now in normal operating mode. If the tower fails to drain properly and the tower high water sensor activates, the MCC in conjunction with the main control center will automatically shut the system down and send a telemetry alarm signal to the Milwaukie police station.

c. Automatic Shutdown

The Well and Tower No. 2 treatment system automatically shuts down in the following sequence:

The water level in the concrete reservoir rises, opening the Well No. 2 cam switch at the control center in Wellhouse No. 2. The control center then sends a signal to the MCC to initiate Tower No. 2 shut down. The MCC directs the Well No. 2 shut down command back to the control center. The control center then deactivates Well Pump No. 2. When the tower inlet flow switch deactivates, the MCC initiates the following sequence:

Step 6) Open solenoid valve on tower inlet pipe drain system.

Step 7) Close solenoid valve on solution supply line to V-100D chlorine solution to Tower No. 2 inlet.

Step 8) Following a 30 second delay, close solenoid valve on solution supply line to V-75 chlorinator feeding Tower No. 2 outlet. Deactivate Chlorine Feed Pump No. 1 if Wells No. 3 and 5 are not operating.

Step 9) Following an additional 90 second delay, stop Blower No. 2. System is now deactivated and ready to return to Step 1 when reservoir demand occurs.

2. <u>Well and Tower No. 3 Operation</u>

a. Valve Settings

A complete description of automatic start-up of the Well and Tower No. 3 system will be discussed in this section. Figure No. 1 will be used to identify correct valve positions for normal tower operation.

For automatic operation of Well and Tower No. 3, the following valves shown on Figure No. 1 shall be placed in the following positions:

Close valves: 11, 12, 22

Open valves: 5, 6, 7, 8, 17, 18, 19, 20, 21, 23, 24

b. Automatic Start-up BACKWASH SWITCH TO AUTO. BACK WASH IS OFF

The water level in the concrete reservoir drops, closing the Well No. 3 cam switch at the main control center in Wellhouse No. 2. The control center transmits a signal to the MCC in the treatment building calling for Tower No. 3 start-up.

The programmable controller in the MCC reacts to the control signal with the following sequence:

Step 1) Start Blower No. 3. If the air flow switch at the blower does not trip after a 5 second delay, the system will automatically shut down and send an alarm signal to the Milwaukie police station.

Step 2) Close solenoid valve on Tower No. 3 inlet pipe drain system.

Step 3) When air flow switch activates , MCC sends signal back to main control center at Well No. 2 calling for Well No. 3 start-up. Control center activates Well Pump No. 3. If water flow switch in Tower No. 3 inlet does not trip following 60 second delay, the MCC will signal the control center to stop Well Pump No. 3. The MCC will also automatically shut down the Tower No. 3 system and send a telemetry alarm signal to the Milwaukie police station.

Step 4) When water flow switch activates, open solenoid valve on solution supply line to V-100D chlorine feeder for Tower No. 3 inlet and activate Chlorine Feed Pump No. 1.

Step 5) After a 30 second delay, open solenoid valve on solution supply line to V-75 chlorine feeder for Tower No. 3 outlet.

The system is now in normal operating mode. If the tower fails to drain properly and the tower high water sensor activates, the MCC, in conjunction with the control center, will automatically shut down the system and send a telemetry alarm signal to the Milwaukie police station.

c. Automatic Shutdown

The Well and Tower No. 3 treatment system automatically shuts down in the following sequence:

The water level in the concrete reservoir rises, opening the Well No. 3 cam switch at the control center in Wellhouse No. 2. The control center then sends a signal to the MCC to initiate Tower No. 3 shut down. The MCC directs the Well No. 3 shut down command back to the control center. The control center then deactivates Well Pump No. 3. When the tower inlet flow switch deactivates, the MCC initiates the following sequence:

Step 6) Open solenoid valve on tower inlet pipe drain system.

Step 7) Close solenoid valve on solution supply line to V-100D chlorine solution to Tower No. 3 inlet.

Step 8) Following a 30 second delay, close solenoid valve on solution supply to V-75 chlorinator feeding Tower No. 3 outlet. Deactivate Chlorine Feed Pump No. 1 if Wells No. 2 and 5 are not operating.

Step 9) Following additional 90 second delay, stop Blower No. 3. System is now deactivated and ready to return to Step 1 when reservoir demand occurs.

3. <u>Well and Tower No. 5 Operation</u>

a. Valve Settings

A complete description of automatic start-up of the Well and Tower No. 5 system will be discussed in this section. Figure No. 1 will be used to identify correct valve positions for normal tower operation.

For automatic operation of Well and Tower No. 5, the following valves shown on Figure No. 1 shall be placed in the following positions:

Close valves: 10, 11, 13, 22

Open valves: 1, 2, 8, 17, 18, 19, 20, 21, 23

The 8" valve downstream of the blowoff assembly on SE 40th Avenue must be open and throttled for Well No. 5 discharge to reach Tower No. 5. Throttling is required to reduce pump discharge to 600 GPM.

b. Automatic Start-up

The water level in the concrete reservoir drops, closing the Well No. 5 cam switch at the main control center in Wellhouse No. 2. The control center transmits a signal to the MCC in the treatment building calling for Tower No. 5 start-up.

The programmable controller in the MCC reacts to the signal with the following sequence:

Step 1) Start Blower No. 5. If the air flow switch at the blower does not trip after a 5 second delay, the system will automatically shut down and send an alarm signal to the Milwaukie police station.

Step 2) Close solenoid valve on Tower No. 5 inlet pipe drain system.

Step 3) When air flow switch activates, MCC sends signal back to main control center at Well No. 2 calling for Well No. 5 start-up. Control center activates Well Pump No. 5. If water flow switch in Tower No. 5 inlet does not trip following 60 second delay, the MCC will signal the control center to stop Well Pump No. 5. The MCC will also automatically shut down the Tower No. 5 system and send a telemetry alarm signal to the Milwaukie police station.

Step 4) When water flow switch activates, open solenoid valve on solution supply line to V-100D chlorine feeder for Tower No. 5 inlet and activate Chlorine Feed Pump No. 1.

Step 5) After a 30 second delay, open solenoid valve on solution supply line to V-75 chlorine feeder for Tower No. 5 outlet.

The system is now in normal operating mode. If the tower fails to drain properly and the tower high water sensor activates, the MCC, in conjunction with the control center, will automatically shut the system down and send a telemetry alarm signal to the Milwaukie police station.

c. Automatic Shutdown

The Well and Tower No. 5 treatment system automatically shuts down in the following sequence:

The water level in the concrete reservoir rises, opening the Well No. 5 cam switch at the control center in Wellhouse No. 2. The control center then sends a signal to the MCC to initiate Tower No. 5 shut down. The MCC directs the Well No. 5 shutdown command back to the control center. The control center then deactivates Well Pump No. 5. When the tower inlet flow switch deactivates, the MCC initiates the following sequence:

Step 6) Open solenoid valve on tower inlet pipe drain system.

Step 7) Close solenoid valve on solution supply line to V-100D chlorine solution to Tower No. 5 inlet.

Step 8) Following a 30 second delay, close solenoid valve on solution supply to V-75 chlorinator feeding Tower No. 5 outlet. Deactivate Chlorine Feed Pump No. 1 if Wells No. 2 and 3 are not operating.

Step 9) Following additional 90 second delay, stop Blower No. 5. System is now deactivated and ready to return to Step 1 when reservoir demand occurs.

4. <u>Backwashing (Rinsing) Towers No. 2, 3 and 5</u>

To prevent the growth of bacteria and other unwanted organisms in the towers, they should be rinsed with a disinfecting chlorine solution every six to eight weeks. If scale buildup occurs, a mild acid solution can be rinsed through the towers in a similar manner. The rinsing procedure consists of the following steps:

a. Stop Wells No. 2, 3 and 5.

b. Drain backwash sump.

c. Place a 25 to 50 mg/l chlorine solution in the backwash sump by running Well No. 2 in the backwash mode and feeding chlorine through the backwash chlorinator.

d. Rinse the solution through Tower No. 2 for 60 minutes using the sump pump.

e. Rinse the solution through Tower No. 3 for 60 minutes using the sump pump.

f. Rinse the solution through Tower No. 5 for 60 minutes using the sump pump.

g. Rinse fresh water through Tower No. 2, 3 and 5 to remove solution and dilute it in the backwash sump to approximately 10-20 mg/l chlorine residual.

h. Return Wells No. 2, 3 and 5 to normal operating mode and feed solution through Tower No. 2 at a low flow rate to strip excess chlorine before entering the concrete reservoir.

A more detailed 29 step checklist for rinsing Towers No. 2, 3 and 5 is contained in Appendix B.

5. <u>Booster Pump Operation</u>

The three vertical turbine booster pumps located in the treatment building constitute a separate system from the well and tower systems. Water level changes in the clearwell trip pump start and stop floats. A high water alarm float serves to prevent clearwell overflow in the event of booster pump failure. This alarm situation will cause shutdown of all operating well and tower systems. A low water alarm float serves to prevent loss of impeller submergence. This low water alarm situation will not affect tower or well operation, but will stop the booster pumps.

Normal operation of the booster pumps consists of the following sequence:

a. Well and tower system in operation causes water level in clearwell to rise. Float control unit trips the first level switch sending signal to MCC.

b. MCC receives float signal and activates lead pump relay. NOTE: MCC alternates lead pump with each ON/OFF cycle.

c. After an adjustable time delay, the lead booster pump starts and begins pumping into the concrete reservoir for the low level distribution system.

d. Clearwell water level will either fall or continue to rise depending on volume of tower discharge.

e. If clearwell water level falls to pump shutoff depth, float will trip level switch sending signal to MCC.

f. MCC receives float signal and deactivates lead pump relay, stopping pump.

g. If clearwell water level continues to rise, the second float switch will trip activating the second booster pump relay through the MCC.

h. After an adjustable time delay, the second booster pump starts and begins pumping into the concrete reservoir for the low level distribution system.

i. If the clearwell water level continues to rise, the third float switch will trip activating the third booster pump relay through the MCC.

j. After an adjustable time delay, the third booster pump starts.

k. Clearwell water level will fall with three booster pumps running.

l. When clearwell water level falls to third pump shutoff depth, float will trip level switch sending signal to MCC.

m. MCC receives float signal and deactivates third pump relay, stopping pump.

n. When clearwell water level falls to second pump shutoff depth, float will trip level switch sending signal to MCC.

o. MCC receives float signal and deactivates second pump relay, stopping the pump.

p. When clearwell water level falls to first pump shutoff depth, float will trip level switch sending signal to MCC.

q. MCC receives float signal and deactivates first pump relay, stopping pump.

r. If clearwell water level continues to rise when three booster pumps are operating, high water alarm float will trip. MCC and main control center will then shut down the operating well and tower system(s). The booster pump system will remain activated to bring the clearwell liquid level to pump shutoff depth.

s. To reactivate system following alarm condition and correction of the problem, press reset button once to allow system to operate, but keeping alarm light on. Press reset button a second time to clear alarm light.

   If the lead booster pump fails to start, the clearwell water level will eventually trip the second float switch. If the second booster pump does start and pump discharge exceeds inflow, the pump will empty the clearwell. The failed booster pump run light will not activate on the MCC panel, although the second booster pump will run normally. When the clearwell level rises again, the second booster pump will start first due to pump cycle rotation. If the clearwell water level does not rise to the high water alarm level before tower system shut down, then the booster pump system will cycle again. Only by comparing pump run times, having a high water alarm condition, or observing a booster pump not running when it should, can the operator discover this cycle is occurring. Failure of any one of the three booster pumps will initiate this cycle or a variation of it.

   All well and tower systems are shut down if the chlorine residual rises above or falls below a field set operating range. The booster pump system is also shut down in this case to prevent discharge of improperly chlorinated water.

   All booster pump automatic operations are a result of the programmable controller operation program. This program can be manually overridden or changed. Alteration of the controller program should only be undertaken by knowledgeable operators or factory representatives. Manually overriding the booster pump's automatic controls is easily accomplished at the MCC panel by setting the pump selector switches to "HAND" mode.

6. Summer/Winter Tower Operation

A summer/winter selector switch is located on the MCC panel to control the tower inlet pipe drain system. A PVC drain line is tapped into each tower inlet pipe below ground to drain the inlet pipe to the backwash sump. One solenoid valve is located on each tower PVC drain line and controlled by the programmable controller in the MCC. Three solenoid valves are located in the vault at the NE corner of the tower landing slab.

When the selector switch is set to "WINTER", the solenoid valves are only closed when the well system is running. When each well stops, the respective solenoid valve opens, draining the inlet piping. When the selector switch is set to "SUMMER", the solenoid valves are held closed at all times and the tower inlet piping remains full to the top of the towers.

Winter season operation requires each tower inlet pipe to drain following well and tower shutdown. This prevents a full tower inlet pipe from freezing when flow has stopped. As a general rule, the tower inlet drain system should be set to winter mode prior to the season's first frost.

Summer season operation does not require the tower inlet pipes to drain. Thus, the solenoid valves in the tower inlet drain system will remain closed after the selector switch on the MCC is set to the summer mode. The operator should exercise caution when deciding to set the drain system to summer mode. The threat of freezing temperatures should be long past before the summer mode is activated.

C. OPERATION DURING POWER OUTAGE

In the event of electrical power failure anticipated to last more than a few hours, the standby engine-generator will be utilized to supply electrical power to run the following system components:

1. Main control center at Wellhouse No. 2
2. Treatment building systems
3. Well Pump No. 2
4. Well Pump No. 3

The engine-generator and its 550 gallon diesel fuel supply tank are located in the generator room at Wellhouse No. 2. The auxiliary power source for Well Pump No. 5 is a manually operated natural gas engine unit. Operation of Well No. 5 during utility power loss will require continuous operator control.

1. <u>Standby Power Activation</u>

The operation sequence to disconnect the entire Wellhouse No. 2 system, the treatment plant, and Wellhouse No. 3 from utility power and switch over to auxiliary power supplied by the engine-generator is given below:

a. At the Autocon control center in Wellhouse No. 2, set the following control switches to the "OFF" position:

1) Well No. 2
2) Well No. 3
3) Well No. 5
4) Transfer Pump No. 1
5) Transfer Pump No. 2

b. Set main breaker at Wellhouse No. 2 to "OFF" position.

c. Set manual transfer switch at Wellhouse No. 2 to "NEUTRAL" position.

d. Set main breaker at Wellhouse No. 3 to "OFF" position.

e. Set manual transfer switch at Wellhouse No. 3 to "NEUTRAL" position.

f. Set main breaker at treatment building to "OFF" position.

g. Set manual transfer switch at treatment building to "NEUTRAL" position.

h. At the treatment building, set the 3-way selector switch for the following components to the "OFF" position:

   1) Booster Pump No. 1
   2) Booster Pump No. 2
   3) Booster Pump No. 3
   4) Sump Pump

i. At the treatment building, set the operation switches to Well Systems No. 2, 3 and 5 to "BACKWASH" position.

j. In the generator room at Wellhouse No. 2, perform the engine-generator prestart inspection.

   1) Oil level - At or near full mark.
   2) Fuel level - sufficient fuel for anticipated run duration. Fuel line connection tight.
   3) Battery - check connections and level of electrolyte.
   4) Coolant level - within 1/2 to 1 inch below radiator cap. Use 50/50 ethylene glycol/soft water coolant solution. Recovery tank should be 1/3 full (cold) and 2/3 full (hot), if provided.
   5) Air cleaner - clean and properly installed.
   6) Drive belts - visually inspect radiator fan, water pump, and alternator belts. They should be tight and in good condition.
   7) Operating area - Check no obstructions exist around generator which may block cooling air flow. Make certain radiator fan duct is open towards door.

8) Exhaust system - check silencer and piping for tightness and condition. Exhaust outlet must be unobstructed.
9) Lamp test - check controller lamps by pressing lamp test button.

k. Manually start the engine-generator by setting the generator control switch to "RUN" position. NOTE: When the control switch is in the "OFF" position, the "NOT IN AUTO" lamp will light and the alarm horn will sound.

l. Allow the engine-generator to run with no load for 5 minutes before applying system load.

m. Set manual transfer switch at Wellhouse No. 2 to "GENERATOR" position.

n. Set main breaker at Wellhouse No. 2 to "ON" position.

o. Check Autocon control panel at Wellhouse No. 2 for status of water level in reservoirs and which Wells are being called. Set the following control switches to the "AUTO" position:

1) Well No. 2
2) Well No. 3
3) Well No. 5
4) Transfer Pump No. 1
5) Transfer Pump No. 2

p. Set manual transfer switch at Wellhouse No. 3 to "GENERATOR" position.

q. Set main breaker at Wellhouse No. 3 to "ON" position.

r. Set manual transfer switch at treatment building to "GENERATOR" position.

s. Set main breaker at treatment building to "ON" position. Clear alarms on control panel by pressing alarm reset button twice.

t. At the treatment building, set the 3-way selector switch for the following components to the "AUTO" position:

1) Booster Pump No. 1
2) Booster Pump No. 2
3) Booster Pump No. 3
4) Sump Pump

u. At the treatment building, set the Well No. 2 system switch to the "AUTO" position. After the Well and Tower No. 2 are completely activated and the "RUN" light is on, set the Well No. 3 system switch to the "AUTO" position.

v. To start and run Well No. 5, two operators are required. One operator is stationed at the MCC in the treatment building to activate the controls, while the other operator is stationed at Wellhouse No. 5 to manually operate the natural gas drive unit for Well No. 5.

To start Well No. 5:

1) Set main circuit breaker at Wellhouse No. 5 to "OFF" position.

2) Manually couple natural gas engine drive line to Well No. 5 and disengage clutch.

3) Perform engine prestart inspection (see Step j.), then start engine and allow it to warm up for 5 minutes.

4) Radio operator at treatment building to set Well No. 5 system switch to "AUTO" position.

5) As soon as blower No. 5 starts, radio back to Wellhouse No. 5 to engage the drive line and begin pumping from Well No. 5. Upon confirmation by the flow switch that water is flowing into Tower No. 5, the chlorination equipment will automatically start and the system "RUN" light will turn on.

6) The operator at Wellhouse No. 5 should not leave the site, since he must manually disengage the drive line when the reservoir rises to the Well No. 5 shutoff level.

2. Standby Power Deactivation

When utility power become available again, the standby engine generator can be disconnected and the control center, treatment building and Wells No. 2, 3 and 5 reconnected to utility power. The operation sequence to disconnect the plant from standby power and return to utility power is given below.

a. To stop Well No. 5:

1) Set the Well No. 5 system switch at the MCC in the treatment building to "BACKWASH" position, and radio the operator at Wellhouse No. 5 to disengage the clutch on the drive line.

2) When the flow switch confirms that water is no longer flowing into Tower No. 5, the chlorination equipment and Blower No. 5 will automatically stop.

3) Allow natural gas engine to run with no load for 5 minutes to cool it down.

4) Stop engine and manually uncouple the drive line to Well No. 5.

5) Set the main breaker to Wellhouse No. 5 to "ON" position.

b. To stop Wells No. 2 and 3, set the system switches at the MCC in the treatment building to "BACKWASH". Each well system will automatically shut down. Wait for blowers to automatically stop and let booster pumps lower water level in clearwell until all pumps stop.

c. Set main breaker at treatment building to "OFF" position.

d. Set manual transfer switch at treatment building to "NEUTRAL" position.

e. Set main breaker at Wellhouse No. 3 to "OFF" position.

f. Set manual transfer switch at Wellhouse No. 3 to "NEUTRAL" position.

g. At the Autocon panel in Wellhouse No. 2, set the following control switches to the "OFF" position.

1) Well No. 2
2) Well No. 3
3) Well No. 5
4) Transfer Pump No. 1
5) Transfer Pump No. 2

h. Set main breaker at Wellhouse No. 2 to "OFF" position.

i. Set manual transfer switch at Wellhouse No. 2 to "UTILITY" position.

j. Allow engine-generator to continue running at no load condition for 5 minutes to cool the unit.

k. Set main breaker at Wellhouse No. 2 to "ON" position.

l. Check Autocon control panel in Wellhouse No. 2 for status of water level in reservoirs and which Wells are being called. Set the following control switches to the "AUTO" position:

1) Well No. 2
2) Well No. 3
3) Well No. 5
4) Transfer Pump No. 1
5) Transfer Pump No. 2

m. Set manual transfer switch at Wellhouse No. 3 to "UTILITY" position.

n. Set main breaker at Wellhouse No. 3 to "ON" position.

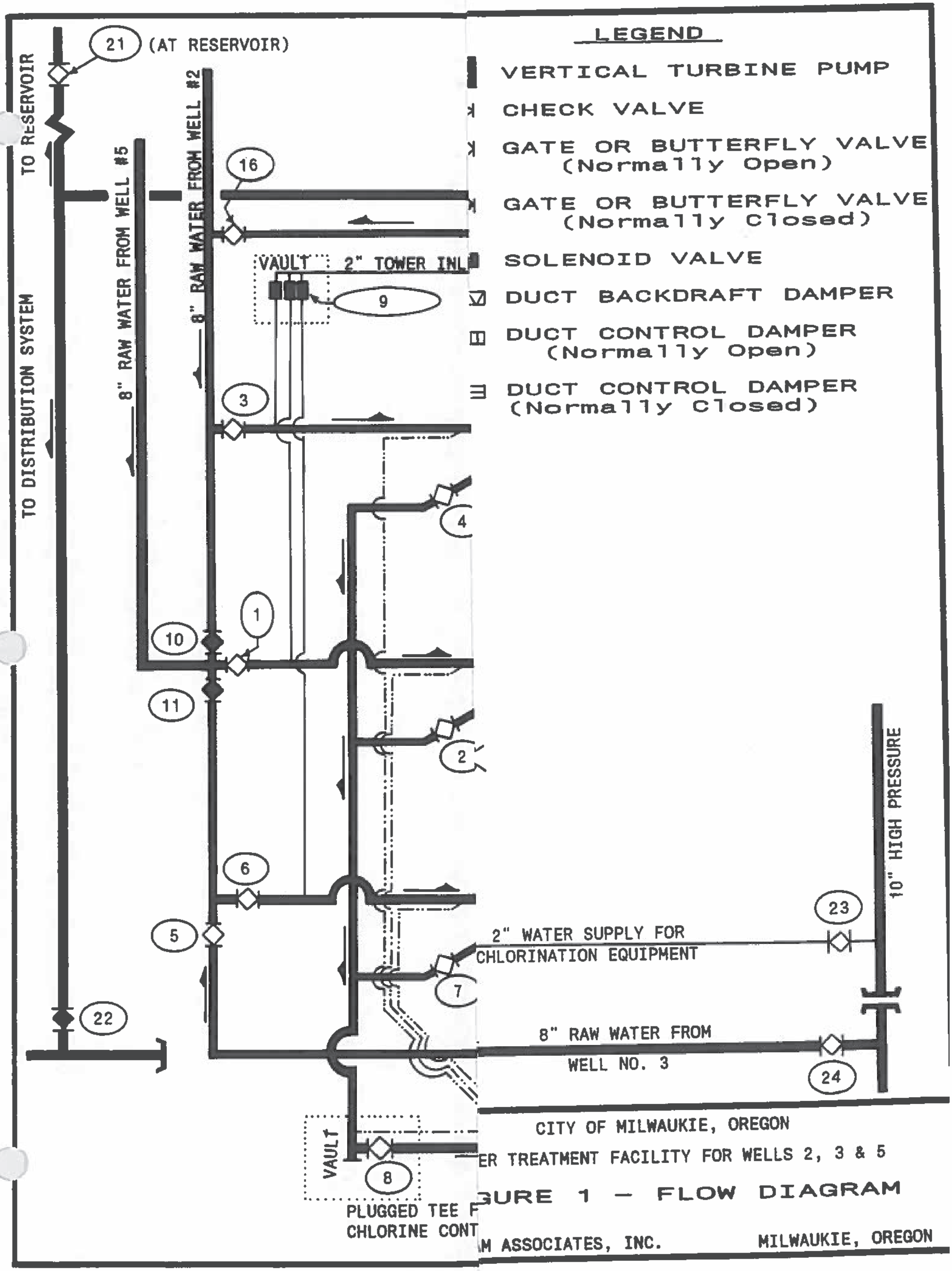
o. Set manual transfer switch at treatment building to "UTILITY" position.

p. Set main breaker at treatment building to "ON" position. Clear any alarms on control panel by pressing alarm reset button twice.

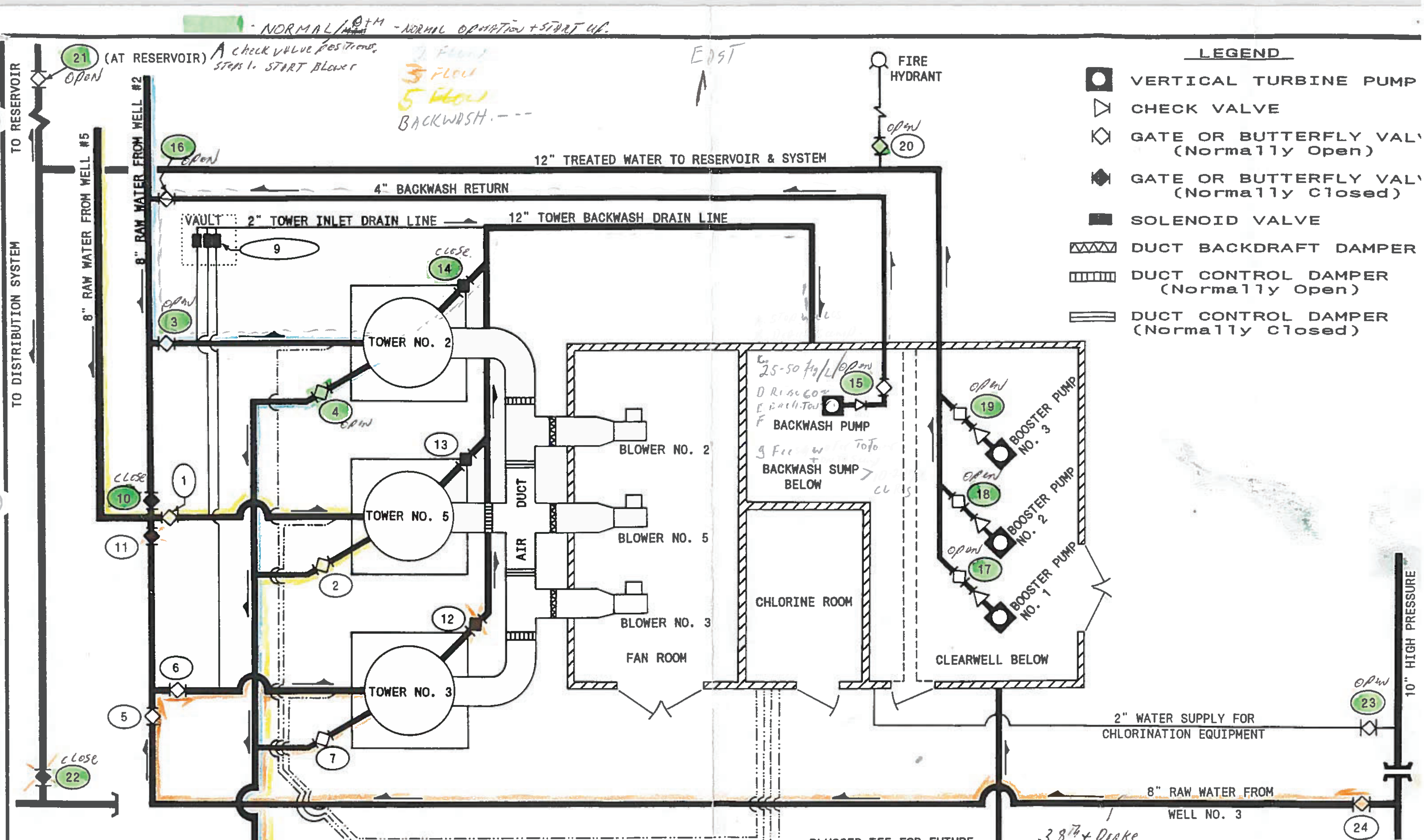
q. To operate Wells No. 2, 3 and 5, set system control switches at MCC in treatment building to "AUTO" position. Wells will automatically start when water level in concrete reservoir drops to the starting level for each well.

D. OPERATION OF WELLS NO. 2, 3 AND 5 DURING TELEPHONE OUTAGE

A telephone system outage will cause loss of the alarm signal line to the Milwaukie police station. Normal automatic reservoir, well and treatment plant operations will not be disrupted. These operating units are linked directly by control wiring separate from the telemetry system. To compensate for alarm signal loss, more frequent system inspection should occur until telephone/telemetry service is restored.



LEGEND
VERTICAL TURBINE PUMP
CHECK VALVE
GATE OR BUTTERFLY VALVE (Normally Open)
GATE OR BUTTERFLY VALVE (Normally Closed)
SOLENOID VALVE
DUCT BACKDRAFT DAMPER
DUCT CONTROL DAMPER (Normally Open)
DUCT CONTROL DAMPER (Normally Closed)
21
(AT RESERVOIR)
TO RESERVOIR
TO DISTRIBUTION SYSTEM
8" RAW WATER FROM WELL #5
8" RAW WATER FROM WELL #2
16
VAULT
2" TOWER INL
9
3
4
1
10
11
2
6
5
7
22
23
24
8
2" WATER SUPPLY FOR
CHLORINATION EQUIPMENT
10" HIGH PRESSURE
8" RAW WATER FROM
WELL NO. 3
VAULT
PLUGGED TEE F
CHLORINE CONT
CITY OF MILWAUKIE, OREGON
ER TREATMENT FACILITY FOR WELLS 2, 3 & 5
GURE 1 — FLOW DIAGRAM
M ASSOCIATES, INC.
MILWAUKIE, OREGON



CITY OF MILWAUKIE, OREGON

WATER TREATMENT FACILITY FOR WELLS 2, 3 & 5

FIGURE 1 — FLOW DIAGRAM

CUNNINGHAM ASSOCIATES, INC. MILWAUKIE, OREG

CITY OF MILWAUKIE, OREGON

INSTRUCTIONS FOR OPERATION AND MAINTENANCE
OF THE WATER TREATMENT FACILITY FOR WELLS NO. 2, 3 AND 5

CHAPTER 4 - PERFORMANCE EVALUATION AND SAMPLING

A. PROCESS CONTROL TESTS

1. Flow Meters

Comparison of well pump flow volumes with treatment plant discharge volumes will constitute a control test for the flow meters. If a discrepancy between pump discharge and treatment plant discharge is discovered, the fault may lie with one or more of the following factors:

a. Well pump discharge flow meter out of calibration. (test Wells No. 2, 3 and 5 separately)

b. Treatment plant discharge flow meter out of calibration.

c. Leak in supply pipeline from one of the wells.

d. Leak in the tower drain piping.

Comparisons of flow volumes for a specific test period is preferred rather than comparison of total to date flow volumes. The procedure to test flow meter accuracy is as follows:

a. Switch No. 2, 3 and 5 well/tower systems to "BACKWASH" mode.

b. Check clearwell liquid depth and adjust to booster pump shut-off depth.

c. Take well pump meter reading and plant output meter reading.

d. Activate well/tower system for 30 minutes.

e. Take well pump meter reading and treatment plant output meter reading after well pump and booster pumps have stopped.

f. Repeat test for other well/tower system following steps. (a. through e.)

Volume difference measured includes ± 1% deviation in flow sensor accuracy.

In the event of significant flow volume discrepancy, the flow meters tested should be recalibrated by the manufacturer's instructions. A re-test should follow recalibration of the flow meters. If continued flow discrepancy occurs, the cause may be a leak in the system.

2. Free Chlorine Residual Monitor

Recalibration of the chlorine residual analyzer should occur every time the sensor membrane is changed. Sensor membrane maintenance is recommended every 4-8 weeks depending on sample water purity. The procedure for replacing the membrane, electrolyte solution, and re-calibration of the analyzer is found in the E.I.T. Free Chlorine Monitor Operation and Maintenance Manual in the appendix. An additional sensor probe with charger has been provided to allow the operator to install the auxiliary probe containing a new membrane and charged electrolyte without shutting the treatment plant down for the electrolyte 6-8 hour stabilization period. The old probe is then available to be refitted and restabilized for future probe replacement.

Calibration of the monitor involves resetting the calibration factor to approximately 80.0, checking the zero reading, and using a preset chlorine solution as a calibration sample. The preset low/high chlorine residual alarm levels should also be checked. These checks in conjunction with the calibration procedures given in the Monitor O & M Manual will assure trouble free operation.

3. Air Flow Pressure

Air flow resistance in the tower system will increase as the tower packing media fouls with biological growth and the louver filters become plugged. Plugging of the louver filters can be determined by visual inspection. Fouling of the tower media, on the other hand, will cause increased air resistance and increased blower amperage at start-up. Field testing by coordinating blower amperage measurement with quantity of media fouling will give the operator a guide to determining when tower backwashing is required.

Calcium and mineral fouling on the tower packing media will also cause air flow resistance. The normal tower backwash operation will not remove these deposits. This type of fouling problem is anticipated to develop slowly over a long period of tower operation. Two solutions to this mineral deposition problem exist:

a. Rinse tower with mild acid solution for sufficient time to dissolve mineral deposits.

b. Replace existing packing media with new packing.

4. Engine-Generator

The engine-generator unit should be run for thirty minutes every two weeks to keep the unit in a ready state. The thirty minute run duration will allow the unit to reach operating temperature and oil pressure. Diesel fuel consumption during this 30 minute, no-load test will be roughly 2-3 gallons. The diesel fuel tank level should be maintained a minimum 3/4 full at all times.

The operator should follow all starting and safety procedures listed in the operation and service manuals provided by Kohler Power Systems. These Kohler Power System manuals may be found in the appendix of this manual. Any problems arising during a thirty minute run test should be promptly investigated.

5. Process Control Schedule

The schedule of monitoring unit control tests should follow the chart below. Unusual operating conditions may necessitate deviation from this schedule as required.

Meter/Monitor Unit	Recommended Test Frequency
Flow Meters at Wells #2, #3 and #5 and Treatment Plant	Yearly
Chlorine Residual Monitor Calibration	4-8 Weeks
Air Flow Pressure	Monthly
Engine-Generator	2 Weeks

B. SAMPLING

Municipal water supply sampling will be conducted by certified City personnel following the most current state and federal requirements. Additional sampling at the treatment plant will involve testing for free-chlorine residual in plant discharge water, and inorganic contaminant removal efficiency.

1. Sampling for Volatile Organic Chemicals

Volatile organic chemical concentration testing is required quarterly when detectable VOC levels are found. Initially, pre and post tower treatment sampling will be required bi-weekly for six months and then monthly for six months. Following this one year performance test period, the quarterly testing schedule may be resumed unless state or federal requirements indicate otherwise.

2. Sampling for Chlorine Residual

Free-chlorine residual sampling requirements call for one sample per month per 800 residences (OAR 333, Public Water Systems, 1990). A chlorine residual reading at the point of plant discharge will be taken daily. Sampling for laboratory analysis will be taken monthly or more frequently when chlorine residual analyzer calibration is required.

C. RECORD KEEPING

1. Operational Data

Operation monitoring data should be kept in the notebook in the treatment plant. Daily, weekly, and monthly operation data and notes should be recorded in this notebook. Operation data should include:

a. Treatment plant total flow quantity
b. Chlorine residual monitor readings
c. Total booster pump run times (No. 2, 3 and 5)
d. Backwash sump pump run time
e. Chlorine tank supply (scale reading)
f. Condition of blower filters

The Public Works Department should maintain a permanent file of the plant monitoring data. This information will be used to evaluate performance, maintenance costs, and staffing requirements.

2. Regulatory Requirements

Oregon Administrative Rules, Chapter 333, for Public Water Systems (1990), lists operation and testing requirements for public water systems in the State of Oregon. OAR Chapter 333 also includes requirements issued by the U. S. Environmental Protection Agency. The City of Milwaukie should continuously monitor state and federal drinking water requirements to assure compliance. This monitoring program should assess existing water quality and future quality expectations.

3. Corrective Actions

Corrective actions taken to mitigate deficiencies in plant operations and treated water quality should be recorded immediately in the plant operations notebook. A description of the action taken, dated and initialized by a certified operator, will satisfy this requirement.

4. <u>Maintenance Records</u>

Maintenance records are to be kept for every operating unit in each well/tower system. Routine as well as major overhaul work for each unit should be recorded. Manufacturer recommended maintenance schedules for each operating unit are summarized in Chapter 8. For routine and non-routine maintenance work, always consult the manufacturer's operation and maintenance manuals found in the appendix of this manual. The City of Milwaukie Public Works Department should develop a maintenance schedule for the treatment facility. This schedule should integrate into the existing maintenance program.

5. <u>Inventory and Supply Listing</u>

An inventory and supplies listing should be developed by the Milwaukie Public Works Department. This listing should include all preventative maintenance parts as well as safety equipment. Inventory and supplies required for sustained plant operation will be modified on a continuing basis.

6. <u>Operational Costs</u>

The City of Milwaukie Public Works Department should develop a cost accounting program for the operation and maintenance of the treatment facility. The cost of all materials and maintenance for the treatment facility will be totalled at the end of each operating year. Sales receipts and work order forms shall be listed and retained for annual totalling.

7. <u>Annual O & M Performance Review</u>

An annual operation and maintenance review will be conducted by the City of Milwaukie Public Works Division. The purpose of this review is to critique plant operation, review operating costs, and make recommendations for more efficient plant operation. New federal and state requirements for plant operations and MCL's should also be addressed.

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CHAPTER 5 - PERSONNEL

A. MANPOWER RECOMMENDATIONS

Manpower requirements to operate and maintain the treatment plant/wells system will be determined by the Public Works Department. A minimum suggested staffing guide is given below:

Position	Manpower
Certified Plant Operator	One designated operator making daily operations inspection and periodic performance testing. One replacement operator trained to fully operate the treatment plant as a temporary replacement.
Field Support Personnel	One part-time operator assistant with on-call status. One designated replacement assistant with similar status.
Maintenance Personnel	Two mechanical maintenance staff with chlorination system experience with on-call status. One electrician with on-call status.
Office Personnel	One part-time secretary to handle forms, filing, and administration.

B. CERTIFICATION REQUIREMENTS

The State of Oregon Administrative Rules Chapter 333 require all personnel directly involved with the operations of a public water system be certified by the state. All water department supervisory and field personnel must be certified in one of the three categories listed below:

1. Water Treatment Operator
2. Water Distribution Operator
3. Operator-In-Training (OIT)

Certification level requirements for the water treatment plant operator should be developed in consultation with the State Health

Division Drinking Water Section. Field and maintenance personnel subordinate to the designated plant operator should meet the minimum state classification of Operator-In-Training.

Education and experience requirements to meet each operator grade level for water treatment and distribution system certification is available from the Oregon State Health Division. Grade advancement requires successful completion of a written examination in addition to experience and education requirements. For complete requirements, contact the Oregon State Health Division at 1400 SW 5th Avenue, Portland, Oregon 97201, Telephone (503) 229-6309.

C. ADMINISTRATION AND SUPERVISION

Management of the water treatment facility will be integrated into the existing public works organization structure. Supervision of facility operations will be the responsibility of the water department. Compliance with State and Federal regulations will be an important ongoing management and field personnel function. Development of a management and supervisory program for the treatment facility operations should be initiated immediately.

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CHAPTER 6 - SAFETY

A. SAFETY

Safety should be a critical consideration during operation and maintenance of the water treatment facility for Wells No. 2, 3 and 5. Safety hazards are always present and take many diverse forms. All personnel assigned to operate and maintain the water treatment facility should be apprised of all safety hazards present and emergency procedures in case of accident. A safety program designating supervisory responsibilities, operator training, accident investigation, and record keeping for the treatment facility should be developed. This program will be integrated into the existing City of Milwaukie Public Works Safety Program. This program is required to incorporate all state and federal guidelines for safety and accident reporting.

This chapter outlines the potential hazards associated with the main components of the treatment plant. Its purpose is to outline safety hazards and safety procedures to help prevent accidents.

B. WATER SYSTEM

Potable water is available from four sources at the treatment plant. All other sources are to be considered untreated water unless otherwise marked. The potable water source locations are listed below:

1. Fire hydrant facing east wall of treatment plant.
2. Frost free yard hydrants at NW and SE corners of treatment building.
3. Sampling tap on east wall of pump room in treatment building.
4. Faucet on chlorine feed pump supply line in treatment building.

All faucets and prelube lines at Wellhouses No. 2, 3 and 5 are potable sources at this time. No modifications of existing piping should be undertaken without clear understanding of the system flow layout.

Sand separators at Wells No. 2 and 3 will discharge a slurry of untreated water and sand into a collection barrel when purged. The barrel contains a one-half inch poly-tubing drain system to dewater the sand and return the untreated well water back into the well casing. The drain line valve should remain open to facilitate sand dewatering and be closed only when the barrel is removed for emptying.

The backwash sump contains a mixture of untreated well water and super-chlorinated tower backwash water. Potentially high chlorine levels in the backwash sump water may cause injury if skin contact occurs. Chlorine gases may also accumulate to lethal levels in the backwash sump. Proper safety equipment and procedures for entry into a chlorine gas environment must be followed by ALL personnel entering the backwash sump at ANY time. The treatment plant must be completely shut down prior to worker entry into the backwash sump.

Complete liquid evacuation is strongly recommended prior to backwash sump entry. Full disinfection to prevent sump contamination is also required each time the backwash sump is accessed. The access cover to the backwash sump must remain closed at all times during the treatment plant operation for contamination prevention and safety.

The clearwell contains treated chlorinated water for system distribution. Lethal levels of chlorine gas may also accumulate in the clearwell. Proper safety equipment and procedures for entry into a chlorine gas environment must be followed by ALL personnel entering the clearwell at ANY time. The treatment plant must be completely shut down prior to worker entry into the clearwell. Complete liquid evacuation by submersible pump is strongly advised prior to clearwell entry. Full disinfection to prevent clearwell contamination is required each time the clearwell is accessed. The access cover to the clearwell must remain closed at all times during treatment plant operation for contamination prevention and safety.

Tower access hatches provide a means to check media condition and the inlet weir troughs. These hatches must remain securely bolted shut during tower operation for safety and contamination prevention. Full treatment plant shutdown is required prior to any access into a tower. Full disinfection procedures are to be followed to prevent contamination within the tower.

Milwaukie City Wells No. 2, 3 and 5 are linked directly to the treatment facility to avoid cross-connection contamination. Special water separation assemblies on the discharge piping from Wells No. 2, 3 and 5 direct all well discharge to the treatment plant. In well buildings No. 2, 3 and 5 each well pump prelube assembly has been tapped into the City's distribution system. Check valves or backflow preventers exist on all treatment plant piping where cross-connections could occur. Revision of, or new connections to any piping in the well/tower treatment system should be undertaken with extreme care to prevent cross connections.

C. ELECTRICAL EQUIPMENT

Proper electrical safety procedures must be followed when operating or performing maintenance on electrical equipment in the treatment plant system. Overriding or manually operating any electrical component should only be attempted by plant operator(s) thoroughly familiar with the system operating procedures. Any work on electrical equipment requires complete manual power isolation to remove all electrical shock hazard. Failure to manually isolate the electrical component being worked on may result in a lethal shock if automatic controls engage. Electrical system work should be performed by a certified electrician familiar with the plant system. Tagging all locked out breakers should be done in all instances prior to commencing any electrical work.

Primary power to the treatment plant is provided at 480 volts, three phase, from Portland General Electric. Well buildings No. 2, 3 and 5 also have primary power at 480 volts, three phase. Single phase, 120/240 volt, power is provided to run minor electrical components in the treatment building and each wellhouse.

All electrical equipment in the pump room from the booster pumps to the overhead lighting is tied to the MCC. Power isolation of any electrical component in the pump room will require tripping circuit breakers and/or main power switches in or on the MCC panel. The chlorine feed pumps, booster, and backwash sump pumps are automatically controlled by the programmable controller in the MCC. Manual overriding the automatic controls should be an integral part of the de-energizing process.

Electrical equipment in the chlorine room is wired through the main breakers or, in the case of the solenoid valves, through the automatic controller in the MCC.

Electrical equipment in the fan room is wired through the main breaker and/or the automatic controller in the MCC in the case of the blowers themselves. A power isolation switch for each blower is mounted on the south wall of the fan room. This switch isolates the blowers from the automatic controller and disconnects power to each blower. The blower controls on the MCC panel should also be switched to "OFF" to prevent surprise start-up when the room breaker is reactivated.

Electrical equipment found on the exterior of the treatment building such as lights are wired through the main breaker. Process control and monitoring equipment such as the tower inlet drain system solenoid valves or high water alarm floats found in the towers are wired to the automatic controller in the MCC. Alarm lights and reset switches for each alarm condition are found on the MCC panel. Electrical equipment found in Wellhouse No. 2 consists of the controls and wiring to operate the main Autocon control center, Well Pump No. 2, and two distribution system transfer pumps. Accessory electrical equipment including heaters, lights, and the well pump flow meter are also found in Wellhouse No. 2. Isolation of Well Pump No. 2 requires manual disengaging of the automatic controls at the main control center, then manual disengaging of the pump starter at the pump control panel. Electrical power to the well pump must be deactivated prior to any work affecting the motor assembly.

The engine-generator system is also located in Wellhouse No. 2 and will be utilized to replace utility power during periods of power loss. The engine-generator system will run the following components: 1) The treatment plant, 2) Wells No. 2 and 3, and 5) The main Autocon control center at Well No. 2. The main electrical transfer switches to cut-in the engine-generator for the Autocon system and Wells No. 2 and 3 are located in Wellhouse No. 2. The procedure to transfer electrical power sources is outlined in Chapter 3.

Electrical equipment found in Wellhouse No. 3 consists of the basic controls and wiring to operate the well pump, heater, lights, and flow meter. The pump control system is linked directly to the main control center in Wellhouse No. 2. Isolation of the No. 3 well pump requires manual disengaging at the main control center and manual disengaging of the pump starter in Wellhouse No. 3. Electrical power to the well pump must be deactivated prior to any work affecting the motor assembly.

Electrical equipment found in Wellhouse No. 5 consists of the basic controls and wiring to operate the well pump, heater, lights, and flow meter. The pump control system is linked directly to the main control center in Wellhouse No. 2. Isolation to the No. 5 well pump requires manual disengaging at the main control center and manual disengaging of the pump starter in Wellhouse No. 5. Electrical power to the well pump must be deactivated prior to any work affecting the motor assembly. In the event of utility power loss, a natural gas engine located in Wellhouse No. 5 will be used to run the well pump. The procedure to transfer power sources is outlined in Chapter 3.

D. MECHANICAL EQUIPMENT

Booster and backwash sump pumps in the treatment building may pose a safety hazard to the unaware worker. When the treatment system is in automatic mode these pumps will start and stop automatically and without pre-warning. Maintenance and pump removal should only be undertaken by experienced employees after securely disengaging the automatic controls and electrically isolating the affected pump(s). Prior to beginning work on the booster pumps or backwash pump, the discharge valves should be fully closed and tagged. Tagging will also serve as a reminder to open the valve(s) when work has been completed.

The engine-generator in Wellhouse No. 2 can only be operated manually and all safety precautions given in the manufacturer's operation manual should be followed. Care should be exercised when working on or around the engine-generator and its fuel supply system. The fuel tank should be kept full at all times. The fuel supply and return lines running from the fuel tank to the engine unit cross the floor, creating a possible tripping hazard. Care should be exercised in this area to avoid personal injury and/or damage to these lines.

Fans found in all rooms of the treatment building for exhaust or ventilation are protected by dampers or screens. The blowers supplying air to the treatment towers have safety screens and motor housings to prevent injury from fan blades or pulley drive systems. These safety features should not be altered without the consent of the manufacturer. Any maintenance work on the fans should only be undertaken after positive electrical isolation. Automatic controls to any of these units must also be positively disengaged.

E. HEALTH HAZARDS

Health hazards associated with the treatment plant and its operation are to be outlined to each employee during his/her orientation of plant operations. Safe procedures to mitigate these hazards should also be presented as well as emergency procedures in the event of injury. Health hazards associates with four components of the treatment system will be discussed in this section. This section does not attempt to address all potential health hazards.

Backwash sump water poses two health hazards:

1. Untreated well water containing volatile organic chemicals is not safe for consumption.

2. Potentially high chlorine residual from tower backwashing operations may cause injury if skin contact occurs.

Safety procedures for handling contaminated liquids should be followed when handling any equipment in contact with the backwash sump liquid. Unauthorized entry into the backwash sump should not be allowed. Any accidents and/or injuries caused by exposure to backwash sump water should be treated immediately.

The diesel fuel for the engine-generator and its battery system pose potential health hazards to the plant operator. Skin contact with diesel fuel should be avoided and affected clothing washed thoroughly. Batteries required to start the engine-generator produce dangerous fumes which will normally be exhausted from the room by open doors. These fumes are also explosive and spark sources should be kept a safe distance from the batteries. Safety procedures outlined on the O & M manual from the engine-generator manufacturer must be followed.

Untreated water is considered any water discharged from Wells No. 2, 3 and 5 prior to discharge into the City's distribution system. This water many contain volatile organic chemicals and harmful bacteria making it unfit for consumption. Cross-contamination prevention is very important when working with system components exposed to untreated water. Indiscriminate discharge of untreated water should be avoided, if possible.

Chlorine gas is used in the treatment plant for water disinfection. When released into the atmosphere it gives off an odor similar to household bleach. Physical symptoms of exposure include irritation of the respiratory tract, mucus membranes, and eyes. If skin contact occurs, flush with clean water for a minimum of 15 minutes and seek immediate medical attention if irritation persists. If eye contact occurs, flush eyes with clean water for a minimum of 15 minutes, and seek emergency medical assistance immediately. All personnel responsible for the chlorination system should be certified and trained in first aid.

F. CHLORINE HANDLING

Chlorination by solution injection is used for disinfection and backwashing operations at the treatment plant. Two 150 lb. chlorine gas cylinders actively supply the chlorination system at any one time. Two backup 150 lb. chlorine gas cylinders are also located in the chlorine room to facilitate expended cylinder replacement. Chlorine gas poses a serious health risk if handled improperly. Only certified maintenance personnel should be allowed to operate and maintain the chlorination equipment.

For the protection of the operator, the chlorine room door is hinged to open out. There is a louver in the door near floor level to allow heavy chlorine gas to escape and a ventilation fan is located near the ceiling to draw fresh air into the room. When working in the chlorine room, the operator should leave the door open and the ventilation supply fan should be on. A chlorine leak detector is positioned on the east wall of the chlorine room with a chlorine leak alarm light on the MCC panel. This alarm light should always be checked prior to entry into the chlorine room.

A serious chlorine leak will initiate a chlorine leak alarm light on the MCC panel and odor may detected outside the chlorine room. In the event of a chlorine leak, two certified personnel familiar with the chlorination system and equipped with proper respiratory protection should investigate. A Chlorine Institute Emergency Kit or equal should be available in the treatment building in the same location as the respirators.

Additional chlorine gas handling information is available in The Chlorine Manual published by the Chlorine Institute, Inc. and found in the back of each chlorinator instruction book.

G. SAFETY EQUIPMENT

Safety equipment for the treatment plant varies depending on the task to be accomplished. Storage of all safety equipment required for all tasks at the plant is not possible due to the storage constraints. Safety equipment not stored at the treatment plant should be easily accessible to personnel responsible for maintenance and operation of the plant. A preliminary listing of recommended safety equipment is included in this section as a guide only. Treatment plant operations personnel should draw up the final safety equipment list based on previous experience and current OSHA Standards.

Suggested Safety Equipment:

1. Portable fresh air blower and flex hose for clearwell and sump ventilation.
2. Portable chlorine gas detector and atmospheric testing equipment.
3. Self contained breathing apparatus for each person going into the clearwell or backwash sump and for standby rescue crew.
4. First aid kit(s)
5. Fire extinquishers.
6. Safety harnesses and life lines.
7. Safety kit for chlorine room, including gas masks or breathing apparatus.
8. Portable non-conductive ladder.
9. Protective clothing, rubber gloves, hard hats, and safety goggles at Well No. 4.

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CHAPTER 7 - EMERGENCY PLANS AND PROCEDURES

A. EMERGENCY RESPONSE

Table 7-1 lists nine emergency conditions and their effects on the treatment system. Table 7-2 lists the general response procedures which might be taken to mitigate the condition. Operations during emergencies require excellent communication and coordination of all personnel involved. The operator(s) is responsible for the safe and effective operation of the treatment plant. A rigorous maintenance and plant performance monitoring program will result in safe and trouble free plant operation.

1. Power Failure

In the event of utility power failure, the plant operator and support personnel should evaluate the need to activate the treatment system on standby power. If system demand requires treatment plant operation, the procedures to activate these standby power sources and operate the treatment plant are given in Chapter 3. Depending on the severity of the outage and the operational status of the telemetry system, personnel may be required to manually operate the major system components on a continuous basis. Mobile communications may be required to coordinate reservoir levels with well and plant operations. Communication links with police and fire agencies should be maintained to assess distribution system demands. Emergency coordination with local water districts may also be sought to solve special distribution problems.

An emergency response program to respond to a major utility power outage should be developed. Drills testing the response and performance of the personnel assigned to this program should be conducted on a regular basis. The City of Milwaukie Public Works Department should develop this program as an extension of its existing emergency response program.

2. Natural Disasters

Natural disasters including earthquake, fire, and severe cold weather will require a well coordinated response by the designated plant operator and support personnel. A system damage survey in the event of earthquake should be taken prior to restarting the treatment system. A system demand survey in the case of fire will provide the operator with a level of production expected from the treatment plant. Severe cold weather may necessitate more frequent plant inspection and system demand monitoring. Communication links with police and fire agencies should be maintained in the event of natural disaster to assess distribution system demands. Emergency coordination with local water districts may also be sought to solve special distribution problems.

An emergency response program designed to respond to specific natural disasters should be developed. Drills testing the response and performance of the personnel assigned to this program should be conducted on a regular basis. The City of Milwaukie Public Works Department should develop this program as an extension of its existing emergency response program.

3. <u>Health Hazards</u>

Accident injury or illness of the plant operator or support personnel will require substitution of alternate personnel into the plant operation team. These substitute individuals should be properly certified and have thorough knowledge of the treatment plant operations. State certification is required of the backup operator, and substitute support personnel should be thoroughly familiar with hands-on plant operations. All personnel assigned to the plant operation team should have current Red Cross first-aid training. Immediate first aid and medical assistance must always be sought in the case of accident or illness at the treatment facility.

An emergency response program designed to respond to accident or illness of a member of the plant operations team should be developed. Plant operation instruction seminars for the personnel assigned to this program should be conducted on a regular basis. The City of Milwaukie Public Works Department should develop this program as an extension of its emergency response program. Substitute personnel should also be included in any professional training programs given to the primary plant personnel.

4. <u>Equipment and Process Failures</u>

Equipment and process failures will result in decreased supply to the City's low level distribution system. The plant operator(s) should respond immediately in coordination with maintenance personnel to trouble shoot and repair the system. Substitute personnel should be available to assist with repairs if so required. A list facilitating immediate access to suppliers and manufacturer representatives should be available at the treatment facility. Adequate inventory of standard repair parts for equipment found in the plant should be kept on hand at all times. System supply and demand should be carefully monitored during plant down-time and public announcement of conservation measures be made promptly, if required.

An emergency response program to respond to critical equipment or process failure in the treatment system should be developed. Testing of the response and performance of the maintenance personnel assigned to this program should be conducted on a regular basis. The City of Milwaukie Public Works Department should develop this program as an extension of its existing emergency response program.

5. Emergency Notification

An emergency notification schedule listing the supervisory personnel to contact and telephone or mobile numbers in the event of an emergency should be posted in the well buildings and treatment building. This listing must be periodically updated to reflect changes in personnel location and duties. All personnel assigned to the treatment plant operation team should be aware of this notification listing. The City of Milwaukie Public Works Department should develop and maintain this listing as part of its emergency response program.

Emergency Agencies:
Police Department: 911 (Emergency), 659-2389 (Non-Emergency)
Fire Department: 911 (Emergency), 659-4042 (Non-Emergency)
Ambulance Service: 911

Hospitals:

Providence Milwaukie Hospital	652-8300
Eastmoreland General Hospital	234-0411
Portland Adventist Medical Center	257-2500

B. EMERGENCY READINESS

1. Equipment, Parts and Supply Inventory

Emergency equipment required by certified personnel responding to a chlorine leak should be stored in the treatment building separate from the chlorine room. Maintenance equipment required in response to a mechanical or electrical equipment failure should be readily available to maintenance crews dispatched from the Public Works Center on Johnson Creek Blvd. A suggested safety equipment guide is provided in Chapter 6. This list is not complete and the City's own safety program should dictate the types and location of safety equipment available to personnel assigned to the operation of the treatment plant.

Spare parts for common maintenance repairs should be part of the supply inventory kept at the Water Department Maintenance Center. Routine maintenance will dictate the types and quantities of parts required for each piece of equipment. A current listing of suppliers and manufacturer representatives should also be kept with the inventory to facilitate rapid replacement of parts not normally stocked. Personnel assigned to monitor and order inventory should tailor the inventory to match field equipment and safety requirements. An annual review of the inventory program should be conducted by the Public Works Department to assess its effectiveness and update inventory requirements.

2. <u>Personnel Training</u>

The Department of Public Works should develop a water treatment plant emergency operations program. This program should list emergency response procedures and responsible personnel for a minimum of the nine emergency conditions listed in Table 7-1. Designated primary and backup personnel should be trained to operate the treatment plant during an emergency situation.

Training drills to gage the effectiveness of the response program should be conducted on a regular basis. These drills should be incorporated into the existing emergency response program for the Water Department. Coordination with all public works departments, as well as police and fire agencies, is strongly recommended.

The Department of Public Works should conduct a yearly review of the emergency response program. This review should incorporate changes in personnel, equipment, and facilities. Emergency drill response performance should also be evaluated. The objectives of the emergency response program should be:

a. Early detection.
b. Effective response time.
c. Control of emergency situation.
d. Correction/mitigation of situation.
e. Review/improvement of program based on experience from actual emergencies.

3. <u>Alarm Conditions</u>

A series of alarm conditions may occur at the treatment plant if an equipment or process failure occurs. A major component or process failure will cause the treatment plant to shut down, while a minor system upset may only cause activation of a warning light on the MCC panel. Plant shutdown will activate an alarm light on a special monitor in the Milwaukie police station. The operational status of Wells No. 2, 3 and 5 is also available at the master control center at Wellhouse No. 2. The operational status of the major treatment facility components is continuously displayed on the MCC panel in the treatment plant. A listing of alarm conditions and recommended courses of action for responding personnel is given below:

ALARM	ACTION
Well No. 2 Fail	Notify maintenance personnel to trouble shoot well pump failure.
Well No. 3 Fail	Notify maintenance personnel to trouble shoot well pump failure.
Well No. 5 Fail	Notify maintenance personnel to trouble shoot well pump failure.
Blower No. 2 Fail	Check breaker in fan room. Notify maintenance personnel to trouble shoot blower failure.
Blower No. 3 Fail	Check breaker in fan room. Notify maintenance personnel to trouble shoot blower failure.
Blower No. 5 Fail	Check breaker in fan room. Notify maintenance personnel to trouble shoot blower failure.
Tower No. 2 High Water Alarm	Check position of Tower No. 2 drain valves. Check 18" tower drain system valve position. Contact maintenance personnel to trouble shoot system.
Tower No. 3 High Water Alarm	Check position of Tower No. 3 drain valves. Check 18" tower drain system valve position. Contact maintenance personnel to trouble shoot system.
Tower No. 5 High Water Alarm	Check position of Tower No. 5 drain valves. Check 18" tower drain system valve position. Contact maintenance personnel to trouble shoot system.
Clearwell High Water Alarm	Check operation status of booster pumps. If pumps will not start, contact maintenance personnel to trouble shoot system.
Clearwell Low Water Alarm	Activate one or more well/tower systems to raise water level. Trouble shoot float control system. Booster pumps will not start during alarm condition.

Chlorine Residual Alarm	Check residual analyzer for high or low residual. Low residual may indicate empty tanks. Contact maintenance personnel to trouble shoot system.
Chlorine Leak Alarm	Immediately notify supervisor. Certified maintenance personnel with proper safety equipment should respond immediately. Notify police and fire agencies if problem is serious.
Backwash Sump High Water Alarm	Activate Well/Tower No. 2 system. If backwash pump fails to start, contact maintenance personnel to trouble shoot system.
Backwash Sump Low Water Alarm	Switch operation mode to "WINTER", or backwash one or more towers to fill sump. Trouble shoot float control system. Backwash pump will not activate during alarm condition.

TABLE 7-1

EMERGENCY CONDITIONS AND SYSTEM EFFECTS

CONDITION	COMMUNICATION	WATER MAINS	PERSONNEL	POWER SUPPLY	WELL PUMPS AND TREATMENT PLANT	RESERVOIRS	REPAIR INVENTORY
Accident or Illness to Operator(s).	No immediate effect. May be needed in the event of an accident.	No short term effect, some maintenance may be delayed.	Immediate first aid and medical assistance required. Reduced staff may require temporary replacement(s).	No effect.	Reduced staff may delay maintenance. Primary operation in "AUTO" mode.	No effect.	No short term effect
Bomb Threat	Calm and concise communication to emergency agency required.	Unlikely target.	Operator/staff coordinate with emergency agencies.	No effect. Power may be disrupted.	Potential target.	Potential target.	Unlikely target.
Chlorine Gas Leak	Notify fire & police departments immediately.	No effect.	Extreme danger. Lethal hazard from gas inhalation.	No effect.	Complete system shutdown until problem corrected.	Supply to reservoirs reduced due to treatment plant shutdown.	Respirators and emergency repair kits will be required.
Civil Disorder	Emergency agencies may be difficult to contact due to overloaded communication lines.	No effect. (Unlikely target)	Operator duties may be disrupted.	Power loss possible.	Vandalism and/or system disruption possible.	Vandalism and/or malicious contamination possible.	No short term effect.
Earthquake	Telemetry and telephone system may be inoperative. Mobile communications may be required.	Multiple main breaks possible. Heavy flow demand expected.	Work crews isolated from headquarters by road damage. Coping with personal disaster effects.	Power loss likely. Emergency power may be required.	Damage to treatment plant, mains and wells may prevent or reduce operation.	Structural damage possible and high demand may cause rapid drawdown.	Pipe, repair fittings, and chlorine disinfectant required in large quantities.
Fire	Communicate with fire fighters to advise on the status of available pressure.	High flow demand expected.	On-call employee to monitor system.	No effect. Power may be disrupted.	Distribution system demand may require full treatment system operation.	High demand may cause drawdown.	Hydrant usage may necessitate repair.
Extensive Utility Power Outage	Telemetry circuits may or may not be operable. Plant controls under auxiliary power.	No effect.	Normal operator/staff manually monitor and operate system. Emergency staff on-call status.	Power loss requires emergency standby power sources.	Total power loss. Emergency standby power required.	Long term outage may cause drawdown.	Generator fuel, maintenance parts, & portable lights required.
Mechanical Equipment Failure	Reduced supply of water may require reduced consumption notifications.	No effect.	Normal operator/maintenance staff respond to situation. System may be down for short period.	No effect.	Treatment system partially or completely shutdown.	Lost or reduced supply will result in reservoir drawdown.	Repair parts for failed mechanical equipment required
Severe Weather (snow or ice storm)	Telemetry and telephone system may be inoperative. Mobile communications may be required.	Frozen service lines possible, routine maintenance delayed.	Operator/staff may be unable to reach plant. Emergency staff on-call status.	Power loss likely. Standby power may be required. High power demand.	Treatment system run in "WINTER" mode. Long term power loss may result in frozen pipes.	No short term effect. Broken pipes may increase demand.	Pipe repair parts may be required.

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CHAPTER 8 - MAJOR EQUIPMENT SPECIFICATIONS AND MAINTENANCE

A. AIR STRIPPING TOWERS

1. <u>Manufacturer</u> - Remedial Systems, Inc.
   56 Leonard Street
   Foxboro, MA 02035
   (508) 543-1512

2. <u>Supplier</u> - Anlar Industries
   PO Box 68095
   Milwaukie, OR 97268
   (503) 652-0481

3. <u>Operating Parameters</u>

   Tower Diameter = 6 Feet
   Water Flow Rate = 600 gpm
   Liquid Loading = 21 gpm per sq.ft.
   Air/Water Ratio = 40:1
   Min. Air Flow Rate = 3,200 cfm
   Packing Material = Lanpac (3.5")
   Packing Depth = 19 Feet
   TCE Removal = 99% Minimum
   Design Water Temperature = 55° F.

4. <u>Maintenance</u>

The air stripping Towers require minor maintenance to assure continuous trouble-free operation. Tower backwashing (rinsing) is recommended every 6-8 weeks to deter bacterial growth on the packing media. This procedure is outlined in Chapter 3 of this manual. Removal of the upper and lower access hatches for inspection of the interior tower components is recommended on an annual basis to determine effectiveness of rinsing and to assess mineral buildup on packing. The tower exterior should be painted with a gel-coat enamel paint containing an ultraviolet inhibitor to prevent deterioration of the fiberglass towers by ultraviolet radiation. Tower repainting frequency will depend on local climatic conditions and visual appearance requirements.

B. BLOWERS

1. <u>Manufacturer</u> - New York Blower Company
7660 Quincy Street
Willowbrook, IL 60521-5596
(312) 655-4881

2. <u>Supplier</u> - Part of equipment package supplied with stripping towers.

3. <u>Operating Parameters</u>

Model 183 General Purpose
Air Flow Rate = 3455 CFM
Static Pressure = 2.5" W.C.
Blower Speed = 1654 rpm
Blower HP = 1.83 BHP
Motor Speed = 1800 rpm
Motor Size = 2 HP
Belt Size = To Be Determined

4. <u>Maintenance</u>

Three New York Blower Model 183 General Purpose Blowers provide air flow to Towers No. 2, 3 and 5. Regular blower inspection and bearing lubrication is required to maintain trouble-free operation. Fan bearings should be lubricated with a high grade bearing grease while the fan is running. A slight bead of grease should appear around the bearing when proper grease volume has been injected. Fan belts should be inspected quarterly for condition and wear. Belts for the Model 183 blower should be replaced bi-annually as a preventative maintenance measure. Major overhaul maintenance will include bearing replacement, shaft replacement, and fan wheel removal. Consult New York Blower installation, maintenance, and operating instructions for additional information. If parts or further assistance is required, contact New York Blower at (312) 655-4881.

Eco-Air pleated air filters, Model C35-H-24242, are mounted behind both louvers in the fan room. These filters should be inspected monthly and replaced when clogging becomes evident. Replacement frequency will depend on local air quality, but annual replacement of all filter units should be considered mandatory. Replacement filters are available through Smith-Trueb & Associates at (503) 238-6900.

Flex expansion joints are located at each tower/duct connection. Periodic inspection of the Durolon flex fabric for tears which may cause air leakage should be part of the monthly inspection routine. Replacement of the 24 oz./SY Durolon flex fabric and silicone joint sealing should be undertaken by an air duct specialist.

C. CHLORINATION EQUIPMENT

1. <u>Manufacturer</u> - Wallace & Tiernan, Inc.
25 Main Street
Belleville, NJ 07109
(201) 759-8000

2. <u>Supplier</u> - Engineered Control Products, Inc.
2820 NW 29th Avenue
Portland, OR 97210-1704
(503) 222-7220

3. <u>Operating Parameters</u>

a. Series V75VA2 V-Notch Chlorinators

Maximum Capacity = 200 PPD
Rotameter Size = 0 to 10 PPD
Injector = 3/4" with 140 F throat and tailpiece
Injector Capacity = 20 PPD
Minimum Water Supply = 4.0 GPM at 20 psi
Chlorine Application Point = Tower Outlet

b. Series V75VA5 V-Notch Chlorinator

Maximum Capacity = 500 PPD
Rotameter Size = 0 to 500 PPD
Injector = 1" with 312L throat and tailpiece
Injector Capacity = 500 PPD
Minimum Water Supply = 23 GPM at 61 psi
Chlorine Application Point = Tower Inlet

c. Series V-100D V-Notch Chlorinators

Maximum Capacity = 100 PPD
Rotameter Size = 0 to 10 PPD
Injector = 3/4 with 140F throat and tailpiece
Injector Capacity = 20 PPD
Minimum Water Supply = 4.0 GPM at 40 psi
Chlorine Application Point = Tower Inlet

d. Series 500C Vacuum Regulators

Maximum Capacity = 500 PPD
Special Features = Automatic Switchover

e. Series 50-345 Two Cylinder Scale

Maximum Capacity = 2 - 150# Chlorine Cylinders
Features = Dual Independent Mechanical Scales
Accuracy = 1% of Full Scale

f. Series 50-135 Chlorine Gas Detector

Warning Level = 1 PPM Chlorine Gas
Alarm Level = 3 PPM Chlorine Gas

4. <u>Maintenance</u>

a. Series V75VA2 V-Notch Chlorinators

Chlorinator cleaning is recommended when deposits are visible in the rotameter tube or the float sticks. The V-notch plug should also be cleaned when rotameter maintenance is performed. The injector and tailway should be cleaned every six months (minimum). More frequent maintenance may be required if operating conditions are more adverse. At two year intervals, a preventative maintenance overhaul of each V-75V chlorinator is recommended. Preventative maintenance kits containing replacement parts and instructions for this two year overhaul are available through Wallace & Tiernan. The instructions for operating, maintaining, and testing this unit may be found in the Wallace & Tiernan Series V-75V Chlorinator instruction booklet found in the appendix of this manual.

b. Series V75VA5 V-Notch Chlorinator

Chlorinator cleaning is recommended when deposits are visible in the rotameter tube or the float sticks. The V-notch plug should also be cleaned when rotameter maintenance is performed. The injector and tailway should be cleaned every six months (minimum). More frequent maintenance may be required if operating conditions are more adverse. At two year intervals, a preventative maintenance overhaul of each V-75V chlorinator is recommended. Preventative maintenance kits containing replacement parts and instructions for this two year overhaul are available through Wallace & Tiernan. The instructions for operating, maintaining and testing this unit may be found in the Wallace & Tiernan Series V-75V Chlorinator instruction booklet found in the appendix of this manual.

c. Series V-100D V-Notch Chlorinators

Chlorinator cleaning is recommended when deposits are visible in the rotameter tube or the float sticks. The V-notch plug should also be cleaned when rotameter maintenance is performed. The injector and tailway should be cleaned every six months (minimum). More frequent maintenance may be required if operating conditions are more adverse. At two year intervals, a preventative maintenance overhaul of each V-100D Chlorinator is recommended. Preventative maintenance kits containing replacement parts and instructions for this two year overhaul are available through Wallace & Tiernan. The instructions for operating, maintaining and testing this unit may be found in the Wallace & Tiernan Series V-100D Chlorinator instruction booklet found in the appendix of this manual.

d. Series 500C Vacuum Regulators

The vacuum regulators on the chlorine cylinders should be reconditioned with a preventative maintenance kit at two year intervals. Periodic cleaning of the vacuum regulator should occur at intervals of 12,000 pounds of chlorine gas dispensed. This 12,000 pound cleaning interval involves checking the regulator stems, springs, and passageways for contaminant accumulation. Consult the Wallace & Tiernan instruction booklet for maintenance and operation instructions for the Series 500C vacuum check regulator. This operation and maintenance booklet is found in the appendix of this manual.

e. Series 50-345 Two Cylinder Scale

No regularly scheduled maintenance is required for the series 50-345 two cylinder scale.

f. Series 50-135 Chlorine Gas Detector

The Series 50-135 chlorine leak detector is positioned in the chlorine room to monitor the chlorination system for leaks. The unit requires replacement of the electrolyte capsule in the sensor on an annual basis. Two integral batteries run the detector during utility power loss periods and are automatically charged when utility power is resumed.

D. VERTICAL TURBINE PUMPS

1. <u>Manufacturer</u> - American Industrial Pump, Inc.
   5727 Luce Street
   Houston, TX 77087
   (713) 641-6818

2. <u>Supplier</u> - Hydronix, Inc.
2425 SE Ochoco Street
Milwaukie, OR 97222
(503) 659-6230

3. <u>Operating Parameters</u>

a. Booster Pumps - Model 10-H-75

Capacity = 700 GPM
Head = 35 Feet
Stages = 1
Speed = 1800 RPM
Motor = 10 HP US Electrical Motors
Column Assembly = 8" X 1"
Discharge Head = AT30-8" C.I.
Features = Water Lubricated

b. Sump Pump - Model 10-L-20

Capacity = 250 GPM
Head = 39 Feet
Stages = 1
Speed = 1800 RPM
Motor = 5 HP US Electrical Motors
Column Assembly = 4" X 1"
Discharge Head = AT 10-4" C.I.
Features = Water Lubricated

4. <u>Maintenance</u>

Check oil or grease level in motor bearings. Fill as required. Change oil at manufacturers recommended interval (minimum annually). Apply grease to stuffing box at the rate of one turn for each 24 hours of operation. Refill grease box as required. Adjust packing gland - tighten sufficiently to throttle leakage, but not to prevent all leakage. Always adjust packing gland with the pump running.

E. SAND SEPARATOR - LAKOS MODEL LTS-0509-B

1. <u>Manufacturer</u> - Claude Laval Corporation
1911 N. Helm
Fresno, CA 93703
(209) 255-1601

2. <u>Supplier</u> - Flow Components, Inc.
12004 NE 95th St., #800
Vancouver, WA 98682
(206) 256-0345

3. <u>Operating Parameters</u>

Minimum Flow = 480 GPM
Maximum Flow = 880 GPM
Minimum Inlet Pressure = 15 psi
Collection Chamber Capacity = 13 Gallons
Features = 90° Profile

4. <u>Maintenance</u>

The sand separator requires regular manual purging during well pump operation. Purging is accomplished by opening the PVC ball valve on the separator purge outlet. Always close this outlet ball valve tightly to prevent overflowing the collection drum following purging. No other regular maintenance is required.

F. FLOW MONITORS

1. <u>Manufacturer</u> - Data Industrial Corporation
53 Portside Drive
Pocasset, MA 02559
(617) 563-7196

2. <u>Supplier</u> - J. N. Murrell & Associates, Inc.
4991 SE Winworth Ct.
Milwaukie, OR 97222
(503) 654-9066

3. <u>Operating Parameters</u>

a. Panel Mount - Model 950 TAS

Sensor Location = 12" Treatment Plant Discharge Pipe
Monitor Location = MCC Control Panel
Units of Measure = Gallons per Minute
Flow Sensor = 2" Model 220B Brass
Accuracy = +/-1% of Full Scale
Special Features = Three Independent Alarm Relays
One 4-20 mA Analog Output

b. Surface Mount - Model 900 TAS

Sensor Location = Wells #2, 3 and 5 Discharge Lines
Monitor Location = Wellhouses No. 2, 3 and 5
Units of Measure = Gallons per Minute
Flow Sensor = 2" Model 220B Brass
Accuracy = +/-1% of Full Scale
Special Features = Three Independent Alarm Relays
One 4-20 mA Analog Output

4. Maintenance

Neither unit requires regular scheduled maintenance following initial installation and calibration. If a problem develops, consult the trouble shooting section of the flow sensor Owner's Manual found in the appendix of this manual.

G. CHLORINE RESIDUAL MONITOR

1. Manufacturer - EIT
251 - E Welsh Pool Road
Exton, PA 19341
(800) 634-4046

2. Supplier - J. N. Murrell & Associates, Inc.
4991 SE Winworth Ct.
Milwaukie, OR 97222
(503) 654-9066

3. Operating Parameters

Model 5150 Free Chlorine Monitor
Parameter = Free Chlorine
Sensor Location = 12" Treatment Plant Discharge Pipe
Monitor Location = MCC Control Panel
Special Features = Two Independent Alarm Relays
One 4-20mA Analog Output
Accessories = Constant Head Flow Cell
Sensor Polarizer

4. Maintenance

Periodic maintenance of the chlorine sensor is required, while the electronics are maintenance free. Every 4-8 weeks the sensor membrane and electrolyte should be replaced. A spare sensor is provided to allow immediate installation of a reconditioned unit to minimize plant downtime. The original sensor can then be reconditioned for the next replacement.

Sensor maintenance requires replacement of the membrane and electrolyte. O-rings in the sensor and flow-cell assembly should also be checked during sensor maintenance. Any nicked or damaged O-rings should be replaced immediately. Following sensor maintenance, the system should be zeroed and calibrated before being placed back on-line. Sensor membrane cleaning between maintenance overhauls is possible by immersing the tip of the sensor (disconnected from the monitor) in a 1N Nitric acid solution for about 5 minutes. The sensor should then be rinsed with distilled water and reinstalled. Allow 5-10 minutes for probe stabilization before recalibrating the cleaned sensor. For complete maintenance instructions and procedures, see the operation and maintenance manual for the EIT Free Chlorine Monitor found in the appendix of this manual.

H. MOTOR CONTROL CENTER

1. <u>Manufacturer</u> - Furnas Electric Co.
   1000 McKee Street
   Batavia, IL 60510
   (708) 879-6000

2. <u>Supplier</u> - United Pacific Controls, Inc.
   410 NW 14th Avenue
   Portland, OR 97208
   (503) 224-6944

3. <u>Operating Parameters</u>

   a. System 89 MCC

      Power = 480 volts, 3 ph, 60 Hz, 3 wire
      Enclosure Type = Nema 1
      Enclosure Model = 83BS 15" Deep
      Minimum Short Circuit Rating = 30,000 Amps Comb. Units
      18,000 Amps Feeder Units
      Main Horizontal Bus = 600 Amp
      Vertical Bus = 300 Amp

   b. Programmable Controller - TI Series 305

      Model = TI 325 PLC
      Discrete I/O = 168
      Analog I/O = 24
      Control Relays = 140
      Timers/Counters = 64

4. Maintenance

No regular maintenance required.

I. STANDBY GENERATOR

1. Manufacturer - Kohler Co.
   Kohler, Wisconsin 53044

2. Supplier - Pacific Detroit Diesel Allison, Inc.
   5061 N. Lagoon
   Portland, OR 97217
   (503) 283-0505

3. Operating Parameters

   Kohler Generator Model 250 ROZD
   Engine = Detroit Diesel V-92TA
   Type = 2-Cycle Turbocharged
   Cylinder Arrangement = V-6
   Maximum Power = 415 HP at 1800 rpm
   Generator Rating = 250 KW/313 KVA
   Electrical = 480 Volts, 3 ph, 60 Hz
   Accessories = Block Heater
   Critical Silencer
   Battery Pack and Charger
   1% Voltage Regulation
   Dec-3 Controller
   Fuel Tank Capacity = 550 Gallons
   Fuel Consumption = 21 gal/hr - at full load

4. Maintenance

The Kohler/Detroit Diesel engine-generator requires pre-start fluid and mechanical checks in addition to periodic maintenance. The schedule and narrative description of preventative maintenance required for the Detroit-Diesel V-92TA engine is described in the following manuals:

a. Detroit Diesel Series 92 Service Manual, Sections 4-15.
b. Detroit Diesel Series 53, 71, 92 Operators Guide.
c. Scheduled Maintenance Record Insert Publication No. ES-527 (387).

These manual may be found in the Detroit Diesel manuals accompanying this O & M manual.

The schedule and narrative description of preventative maintenance required for the Kohler Fast Response II Generator is described in the following manuals:

a. Kohler Fast Response II Generators Service Manual.
b. Scheduled Maintenance Record Insert Publication No. ES-527 (387).

These manuals may be found in the Kohler Power Systems manuals accompanying this O & M manual.

J. CHLORINE FEED PUMPS

1. <u>Manufacturer</u> - Paco Pumps, Inc.
PO Box 4285
Portland, OR 97208
(503) 224-6330

2. <u>Supplier</u> - Paco Pumps, Inc.
PO Box 4285
Portland, OR 97208
(503) 224-6330

3. <u>Operating Parameters</u>

Model VM40-432
Capacity = 40 GPM
Head = 180 Feet
Stages = 4
Speed = 3500 RPM
Motor = 3 HP TEFC
Discharge = 2"

4. <u>Maintenance</u>

Electric motors containing sealed bearings do not require additional lubrication during the first 15,000 hours of operation. Motors operated intermittently and which have grease fittings should be lubricated with a lithium based brease semi-annually. Each pump should be inspected periodically for smooth operation, no leakage, and proper pump control operation. Additional maintenance information and trouble shooting guides are found in the Paco Pump operation and maintenance manual in the appendix of this manual.

K. TRANSFER PUMPS

Two end suction centrifigal transfer pumps located in Wellhouse No. 2 were replaced in conjuction with the treatment tower project. The specifications and maintenance outline for the pumps is as follows:

1. <u>Manufacturer</u> - Cornell Pump Co.
   2323 SE Harvester Drive
   Milwaukie, OR 97222
   (503) 653-0330

2. <u>Supplier</u> - Cornell Pump Co.
   2323 SE Harvester Drive
   Milwauukie, OR 97222
   (503) 653-0330

3. <u>Operating Parameters</u>

   Model 4RB-20-4
   Capacity = 700 GPM
   Head = 80 Feet
   Speed = 1800 RPM
   Motor = 20 HP
   Features = Close Coupled Centrifugal

4. <u>Maintenance</u>

   Lubricate electric motor bearings on schedule given in Cornell Pump operation and maintenance manual. Lubrication frequency will vary based on run time accumulation. Motor regreasing should occur a minimum of every 1500 hours of operation. Complete maintenance and trouble shooting instructions are found in the Cornell Pump operation and maintenance manual in the appendix of this manual.

L. OTHER EQUIPMENT

For information on all other equipment, consult submittal data and manufacturer's operation and maintenance instructions provided with this manual. A detailed equipment listing with names of manufacturers and suppliers is contained in Appendix A.

APPENDIX A

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITY FOR WELLS NO. 2, 3 AND 5

SYSTEM COMPONENT MANUFACTURERS AND SUPPLIERS LISTING

SUBMITTAL NO. - COMPONENT		MANUFACTURER	SUPPLIER/REPRESENTATIVE
1.	Gate Valves, Resilient Wedge	Mueller Company 500 W. Eldorado St. PO Box 671 Decatur, IL 62525 (217) 423-4471	Consolidated Supply Co. PO Box 5788 Portland, OR 97228 (503) 620-7050
2.	Air and Vacuum Valves	Val-Matic Valve & Manuf. Corp. 905 Riverside Drive Elmhurst, IL 60126 (708) 941-7600	J. N. Murrell & Associates, Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066
3.	Swing Check Valve	Mueller Company 500 W. Eldorado St. PO Box 671 Decatur, IL 62525 (217) 423-4471	Consolidated Supply Co. PO Box 5788 Portland, OR 97228 (503) 620-7050
4.	Silent Check Valves	Val-Matic Valve & Manuf. Corp. 905 Riverside Drive Elmhurst, IL 60126 (708) 941-7600	J. N. Murrell & Associates, Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066
5.	Sand Separator	Claude Laval Corporation 1911 N. Helm PO Box 6119 Fresno, CA 93703 (209) 255-1601	Flow Components, Inc. 12004 NE 95th St. #800 Vancouver, WA 98682 (206) 256-0345
6.	Engine-Generator	Kohler Co. Kohler, WI 53044 (414) 565-3381	Pacific Detroit Diesel Allison, Inc. 5061 N. Lagoon Ave. Portland, OR 97217-7694 (503) 283-0505
7.	Flex Pipe Expansion Joints	Unaflex Rubber Corp. 2056 N. Dixie Hwy. Fort Lauderdale, FL 33305 (305) 561-0500	Tourangeau Nor Wes Corporation 11040 SW Allen Blvd. Beaverton, OR 97005-4821 (503) 644-2010

8.	Butterfly Valves, Wafer Style	Dezurik 250 Riverside Ave. N. Sartell, MN 56377-1743 (612) 259-2000	Tourangeau Nor Wes Corporation 11040 SW Allen Blvd. Beaverton, OR 97005-4821 (503) 644-2010
10.	Solenoid Valves	ASCO Automatic Switch Co. 50 - 56 Hanover Road Florham Park, NJ 07932 (201) 966-2000	
11.	Hollow Metal Doors	Curries	Oregon Builders Hardware 9255 SE McBrod Milwaukie, OR 97222-7324 (503) 653-7680
12.	Door Hardware	Various Manufacturers	Oregon Builders Hardware 9255 SE McBrod Milwaukie, OR 97222-7324 (503) 653-7680
13.	All Louvers	Philips Industries, Inc. (Ruskin) PO Box 129 Grandview, MO 64030 (816) 761-7476	Smith-Trueb & Associates, Inc. PO Box 13009 929 NE 23rd Ave. Portland, OR 97232-2220 (503) 238-6900
14.	Float Controls	Healy Ruff 2485 North Fairview Avenue St. Paul, MN 55113 (612) 633-7522	J. N. Murrell & Associates, Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066
15.	Flow Monitor and Sensor	Data Industrial Corporation 53 Portside Drive Pocasset, MA 02559 (617) 563-7196	J. N. Murrell & Associates, Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066
16.	Skylights	Kalwall Corp. PO Box 237 Manchester, NH 03105 (603) 627-3861	Baxter & Flaming Industries 3717 NW St. Helens Rd. Portland, OR 97210-1426 (503) 225-0486
17.	Transfer Pumps	Cornell Pump Co. 2323 SE Harvester Drive Milwaukie, OR 97222 (503) 653-0330	
18.	Vertical Turbine Booster Pump	American Industrial Pump Co. 5727 Luce St. Houston, TX 77087 (713) 641-6818	Hydronix 2425 SE Ochoco PO Box 22046 Milwaukie, OR 97222-7321 (503) 659-6230

19.	Vertical Turbine Sump Pump	American Industiral Pump Co. 5727 Luce St. Houston, TX 77087 (713) 641-6818	Hydronix 2425 SE Ochoco PO Box 22046 Milwaukie, OR 97222-7321 (503) 659-6230
21.	Footing Drain Pump	Zoeller Company 3280 Old Millers Lane PO Box 16347 Louisville, KY 40216 (502) 778-2731	
24.	Chlorination Equipment	Wallace & Tiernan, Inc. 25 Main St. Belleville, NJ 07109-3057 (201) 759-8000	Engineered Control Products, Inc. 2820 NW 29th Avenue Portland, OR 97210-1704 (503) 222-7220
25.	Residual Chlorine Monitor & Flow Cell Assembly	EIT 251 Welsh Pool Rd. Exton, PA 19341 (800) 634-4046 (215) 363-5450	J. N. Murrell & Associates, Inc. 4991 SE Winworth Ct. Milwaukie, OR 97222-4201 (503) 654-9066
26.	Electrical Fixtures, Wires & Accessories	Various	Marine and Industrial Electric PO Box 4529 Portland, OR 97208 (503) 284-5068
27.	Motor Control Center	Furnas Electric Co. 1000 McKee St. Batavia, IL 60510 (708) 879-6000	United Pacific Control, Inc. 410 NW 14th Portland, OR 97209-2631 (503) 224-6944
28.	Chlorine Feed Pumps	PACO Pumps, Inc. 845 92nd Avenue PO Box 12924 Oakland, CA 94604-2924 (415) 639-3200	
29.	Control Dampers	Philips Industries, Inc. (Ruskin) PO Box 129 Grandview, MO 64030 (816) 761-7476	Smith-Trueb & Associates, Inc. PO Box 13009 929 NE 23rd Ave. Portland, OR 97232-2220 (503) 238-6900
30.	Air Stripping Towers	Remedial Systems, Inc. 56 Leonard Street Foxboro, MA 02035 (508) 543-1512	Anlar Industries PO Box 68095 Milwaukie, OR 97268 (503) 652-0481

32.	Unit Heater	Qmark	Taylor Electric Supply, Inc. PO Box 14745 1709 SE Third Ave. Portland, OR 97214-4585 (503) 233-5321
33.	Electrical Control Drawings	Various	United Pacific Controls, Inc. 410 NW 14th Avenue PO Box 4423 Portland, OR 97208 (503) 224-6944

APPENDIX B

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITY FOR WELLS NO. 2, 3 AND 5

RINSING PROCEDURE FOR STRIPPING TOWERS

The following procedure should be undertaken every six to eight weeks to prevent bacterial growth in the stripping towers. Valve numbers correspond to those shown in Figure 1 - Flow Diagram. The following instructions assume that all valves are in normal operating positions shown in Figure 1.

- [x] 1. Set system control switches for Wells No. 2, 3 and 5 to "BACKWASH", stopping all wells.
- [x] 2. Place tower drain valves in "SUMMER" mode.
- [x] 3. Set Blower No. 2 switch to "HAND".
- [x] 4. Set Sump Pump switch to "HAND". Drain the Sump to approximately 0.4 feet, where the low level alarm float will stop the Sump Pump and light the Low Level in Sump lamp.
- [x] 5. Set Sump Pump switch to "OFF".
- [x] 6. Set Blower No. 2 switch to "AUTO", which will stop the blower.
- [x] 7. Close Valve #4. Open Valve #14.
- [x] 8. Direct backwash chlorine solution to Tower No. 2 Inlet by adjusting appropriate ball valves above Backwash Chlorinator.
- [x] 9. Open gas valve to Backwash Chlorinator.
- [x] 10. Set Chlorine Feed Pump No. 2 switch to "AUTO", (if OFF).
- [x] 11. Press "START" button for Tower No. 2 backwash. The programmable controller will start Well No. 2, open the Backwash Chlorinator solenoid valve and start Chlorine Feed Pump No. 2 when the flow switch is tripped.
- [x] 12. Adjust Backwash Chlorinator to 360 pounds per day.
- [x] 13. Allow Sump to fill to approximately 2.0 feet, then press "STOP" button for Tower No. 2 backwash. The programmable controller will stop Well No. 2, close the Backwash Chlorinator solenoid valve and stop Chlorine Feed Pump No. 2.
- [x] 14. Close gas valve to Backwash Chlorinator.
- [x] 15. The Sump now contains approximately 3,600 gallons of solution with a chlorine residual of approximately 25 to 50 mg/l, which will be circulated through all towers which are to be rinsed at this time.
- [x] 16. Press Alarm Reset Button twice to clear Low Level Alarm in Sump.

- [x] 17. Set Sump Pump in "HAND" mode. Solution will circulate through Tower No. 2. Rinse for 60 minutes.
- [x] 18. After 60 minutes, Set Sump Pump to "OFF".
- [x] 19. Close Valves #2 and #3; Open Valves #10 and #13.
- [x] 20. Set Sump Pump in "HAND" mode. Solution will circulate through Tower No. 5. Rinse for 60 minutes.
- [x] 21. After 60 minutes, Set Sump Pump to "OFF".
- [x] 22. Close Valves #1, #5 and #7; Open Valves #11 and #12.
- [x] 23. Set Sump Pump in "HAND" mode. Solution will circulate through Tower No. 3. Rinse for 60 minutes.
- [x] 24. After 60 minutes, Set Sump Pump to "OFF".
- [x] 25. Close Valves #10 and #11; Open Valves #1, #3 and #5.
- [x] 26. Press "START" buttons for backwash of Towers No. 2, 3 and 5, leaving gas valve at Backwash Chlorinator closed. This step will rinse fresh water through the towers and inlet piping into the Sump.
- [x] 27. Allow Sump to fill to approximately 6.0 feet, then press "STOP" button for Towers No. 2, 3 and 5. The Sump now contains approximately 10,000 gallons of water with a chlorine concentration of approximately 10 to 20 mg/l.
- [x] 28. Reset all valves to normal operating positions. Close Valves #12, #13 and #14. Open Valves #2, #4, and #7. Close valves above Backwash Chlorinator.
- [x] 29. Set Sump Pump control to "AUTO".
- [x] 30. Set all well systems to "AUTO" mode. All wells being called by reservoir controls in Wellhouse No. 2 will start.
- [x] 31. Adjust Sump Pump discharge valve #15 so that flow from Sump to Tower No. 2 is approximately 50 gallons per minute (1¼ to 1½ turns from completely closed position). Solution in Sump will be pumped through Tower No. 2 as Well No. 2 is called. Excess chlorine will be stripped out of the water as it passes through the Tower.
- [ ] 32. Place tower drain valves in "WINTER" mode, to continue adding dilution water to Sump each time wells turn off. Leave in this mode for several days until chlorine residual in Sump is less than 1 mg/l. Valves can then be placed in "SUMMER" mode, if desired.
- [ ] 33. Reset Valve #15 to full open position.

APPENDIX C

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITY FOR WELLS NO. 2, 3 AND 5

PROCEDURE FOR ADJUSTMENT OF TIMERS IN PROGRAMMABLE CONTROLLER

Review list of program timers (Appendix D) to determine timer number which is to be changed. Changes are made by entering new values through keypad mounted on programmable controller. The procedure below details how to set timer number 611 to 30 seconds. Setting another timer is done in a similar manner by inserting the desired timer number and time (in seconds) in Steps 2 and 6 of the procedure.

1. Press "CLR".
2. Press "TMR", "SHF", "611", "SCH", "NXT".
3. Display now shows timer number 611.
4. Press "NXT".
5. Display now shows current time for timer number 611.
6. Press "SHF", "30", "ENT".
7. To verify new time, Press "PRV", "PRV"
8. Display now shows timer number 611.
9. Press "NXT".
10. Display now shows new time entered for timer number 611.

APPENDIX D

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITY FOR WELLS NO. 2, 3 AND 5

INITIAL TIMER SETTINGS FOR PROGRAMMABLE CONTROLLER

	TIMER	SETTING (Sec)	FUNCTION	
4-6-92	610	~~5.0~~ 10.0	Blower #2 Fail in Normal Start Up Mode.	
3-30-92 JLH	611	~~60.0~~ 90.0	Well #2 Fail in Normal Start Up Mode.	250.0 10/10/01 MWF
	612	30.0	Delay for Starting V-75 Chlorinator for Well #2.	
	613	900.0	Delay for Automatically Resetting Alarm Loop #2.	
	614	30.0	Delay for Stopping V-75 Chlorinator for Well #2.	
	615	90.0	Delay for Stopping Blower #2 After Well #2 Stops.	
	616	60.0	Well #2 Fail in Backwash Start Up Mode.	
	617	6.0	Delay for Starting Booster Pump #1.	
	620	9.0	Delay for Starting Booster Pump #2.	
11-4-91 JLH	621	~~9.0~~ 70.0	Delay for Starting Sump Pump.	
4-6-92	622	~~5.0~~ 10.0	Blower #3 Fail in Normal Start Up Mode.	
8/24/99	623	~~60.0~~ 120.0	Well #3 Fail in Normal Start Up Mode.	250.0 10/10/01 MWF
	624	30.0	Delay for Starting V-75 Chlorinator for Well #3.	
	625	900.0	Delay for Automatically Resetting Alarm Loop #3.	
	626	30.0	Delay for Stopping V-75 Chlorinator for Well #3.	
	627	90.0	Delay for Stopping Blower #3 After Well #3 Stops.	
	630	60.0	Well #3 Fail in Backwash Start Up Mode.	
	631	12.0	Delay for Starting Booster Pump #3.	
4-6-92	642	~~5.0~~ 10.0	Blower #5 Fail in Normal Start Up Mode.	
5-5-92 643 = 150.0 ~~4-6-92~~	643	~~60.0~~ ~~[illegible]~~	Well #5 Fail in Normal Start Up Mode.	250.0 10/10/01 MWF
	644	30.0	Delay for Starting V-75 Chlorinator for Well #5.	
	645	900.0	Delay for Automatically Resetting Alarm Loop #5.	
	646	30.0	Delay for Stopping V-75 Chlorinator for Well #5.	
	647	90.0	Delay for Stopping Blower #5 After Well #5 Stops.	
	650	60.0	Well #5 Fail in Backwash Start Up Mode.	
	651	5.0	Delay for Chlorine Residual Alarm.	

APPENDIX E

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITY FOR WELLS NO. 2, 3 AND 5

PROCEDURE FOR RECORDING AND LOADING PROGRAM IN PROGRAMMABLE CONTROLLER

A recording of the program should be made when timers are changed. The recording is made on cassette tape, using a Tape Recorder with volume and tone controls, and jacks for microphone and earplug. (A tape footage counter is also beneficial for locating beginning of program on tape). The cord for connection between the programmable controller and the Tape Recorder has been provided with the Programmer. During recording of the program, all control functions cease to operate, and the wells are shut off.

TO RECORD PROGRAM:

1. Turn key on Programmer from "RUN" to "LOAD".
2. Plug cord into "Tape" jack on Programmer and "MIC" jack of Tape Recorder. Set Volume and Tone.
3. Prepare Tape Recorder to record by inserting tape, rewinding, if necessary, resetting counter and forwarding past leader. Note reading on counter.
4. Press "RECORD" on Tape Recorder to start recording.
5. Press "WRITE" on Programmer ("NXT" button).
6. When display on Programmer says "END", Press "STOP" on Tape Recorder. Note reading on counter.

TO VERIFY THAT RECORDING IS GOOD:

1. Rewind Tape Recorder to beginning of recording.
2. Press "CLR" on Programmer.
3. Remove cord from "MIC" jack on Tape Recorder and insert in "EARPHONE" jack.
4. Press "PLAY" on Tape Recorder.
5. Press "CHECK" on Programmer. (SCH button).
6. If "END" appears on display when counter on Tape Recorder reaches the end of the previous recording, then the tape is okay. If an "ERROR" message is displayed, the recording is no good, and must be redone.
7. Press "STOP" on Tape Recorder.

TO RETURN PROGRAMMABLE CONTROLLER TO RUN MODE:

1. Press "CLR" on Programmer.
2. Remove cord from "TAPE" jack on Programmer.
3. Turn key on Programmer from "LOAD" to "RUN".
4. Mark date and counter numbers of recording on tape and store in secure place.

CONSULT PROGRAMMABLE CONTROLLER MANUAL TO LOAD PROGRAM FROM TAPE

APPENDIX F

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITIES FOR WELLS NO. 2, 3 AND 5

DaNEAL CONSTRUCTION - SUBMITTAL REGISTER

1. Resilient Wedge Gate Valve - Mueller
2. Air and Vacuum Valve - Val-Matic
3. Swing Check Valve - Mueller
4. Silent Check Valve - Val-Matic
5. Sand Separators - Lakos
6. Standby Generator - Kohler
7. Expansion Joints - Unaflex
8. Butterfly Valves - DeZurik
9. Ductile Iron Fittings - Tyler
10. 2" Solenoid Valves - ASCO
11. Hollow Metal Doors - Curries
12. Door Hardware - Various Manufacturers
13. Louvers & Fans - Ruskin & Acme
14. Float Controls - Healy Ruff
15. Flow Monitors - Data Industrial
16. Skylights - Kalwall
17. Transfer Pumps - Cornell
18. Vertical Turbine Booster Pumps - American
19. Vertical Turbine Sump Pump - American
20. Concrete Mix Design - Lone Star #736
21. Footing Drain Pump - Zoeller
22. Floor Drains - Tyler
23. Reinforcing
24. Chlorination Equipment
25. Chlorine Residual Monitor
26. Electrical Fixtures, Wires and Accessories
27. Motor Control Center - Enclosure Layout
28. Chlorine Feed Pumps - Paco
29. Control Dampers - Ruskin
30. Air Stripping Towers - Remedial Systems
31. Painting - Evan House Co.
32. Unit Heater - Qmark
33. Electrical Control Drawings - Unipac

APPENDIX G

CITY OF MILWAUKIE, OREGON
WATER TREATMENT FACILITIES FOR WELLS NO. 2, 3 AND 5

MANUFACTURERS' OPERATION AND MAINTENANCE MANUALS

VOLUME I - MECHANICAL AND MONITORING EQUIPMENT
- A. Air Stripping Tower
- B. Blower
- C. Vertical Turbine Pump
- D. Sand Separator
- E. Chlorine Feed Pump
- F. Footing Drain Pump
- G. Flow Monitor
- H. Free Chlorine Monitor
- I. Cornell Transfer Pumps (Wellhouse No. 2)

VOLUME II - CHLORINATION EQUIPMENT - Wallace & Tiernan
- A. Series V-75V V-Notch Chlorinator
- B. Series 500C Vacuum Regulator
- C. Series V-100D V-Notch Chlorinator
- D. Series 50-135 Chlorine Gas Detector
- E. Series 50-345 Scale
- F. Chlorine Manual

VOLUME III - MOTOR CONTROL CENTER
- A. Drawings
- B. Miscellaneous Materials
- C. Programmable Controller
- D. Healy-Ruff Series 2500 Float Controller

VOLUME IV - SUBMITTALS

VOLUME V - STANDBY GENERATOR
- A. Detroit Diesel Engine
  - Series 92 Service Manual Sections 1-3
  - Series 92 Service Manual Sections 4-15
  - Series 53, 71, 92 Operations Guide
  - V-92 Parts Catalog (2 Books)
- B. Kohler Fast Response II Generator
  - Operation Manual
  - Service Manual
  - Scheduled Maintenance
  - Preliminary Parts Listing

2021 Water System Master Plan

Appendix M. Water Emergency Response Plan

M. WATER EMERGENCY RESPONSE PLAN

TO BE PROVIDED WITH FINAL SUBMITTAL

2021 Water System Master Plan

Appendix N. Water Rationing Plan

CHAPTER 13.06 DROUGHT AND EMERGENCY WATER REGULATION

13.06.010 FINDINGS—DECLARATION OF A WATER EMERGENCY

Upon a finding that the municipal water supply system is or may become incapable of providing an adequate water supply for normal usage due to a prolonged drought, system failure, or any other event, the City Manager or designee may declare that water usage must be curtailed. The declaration shall include the effective date, the reason for the declaration, and the level of prohibition declared. The City Manager or designee may include an estimated time for review and revocation of the declaration. (Ord. 1727 § 1, 1992)

13.06.020 LEVELS OF PROHIBITION—RESTRICTED ACTIVITIES

A. Level 1—Critical

The following activities would be prohibited on a voluntary basis under a Level 1 restriction:

1. Watering of lawns, grass, or turf except on designated alternate days based on address number;

2. Watering landscape between 9:00 a.m. and 7:00 p.m.;

3. a. Hosing or washing sidewalks, driveways, streets, parking lots, open ground, buildings, or other hard surfaces except where necessary for public health and safety;

    b. Exceptions

        i. Power washing of buildings, homes, and roofs prior to painting, repair, remodeling, or construction, and not solely for aesthetic purposes,

        ii. Where there is demonstrable need in order to meet public safety requirements, such as to alleviate immediate fire or sanitation hazards or for dust control to meet air quality standards mandated by the Oregon Department of Environmental Quality;

4. Washing cars, boats, trailers, or other vehicles without hoses with shutoff nozzles unless done at a commercial or fleet washing facility that recycles water. Owners of vehicles are encouraged to use facilities that recycle water;

5. Serving water for drinking at a restaurant, motel, cafe, cafeteria, or other public places where food is sold and served unless specifically requested;

6. Any other voluntary restrictions deemed necessary, including but not limited to restrictions outlined under Level 2.

B. Level 2—Emergency

The following activities are expressly prohibited under a Level 2 declaration:

1. a. Watering any lawn, grass, or turf;

    b. Exceptions:

i. New lawn, grass, or turf that has been seeded or sodded after March 1st of the calendar year may be watered as necessary until established,

ii. Lawn, grass, or turf which is part of a commercial sod farm,

iii. High-use athletic fields that are used for organized play,

iv. Golf tees and greens,

v. Park and recreation areas deemed by the City Council to be of particular significance and value to the community that would allow exception to the prohibition;

2. Watering landscape plants except on alternate day watering and between 7:00 p.m. and 9:00 a.m.;

3. a. Hosing or washing sidewalks, driveways, streets, parking lots, open ground, buildings, or other hard surfaces except where necessary for public health and safety;

b. Exceptions

i. Power washing of buildings, homes, and roofs prior to painting, repair, remodeling or construction, and not solely for aesthetic purposes,

ii. Where there is demonstrable need in order to meet public safety requirements, such as to alleviate immediate fire or sanitation hazards or for dust control to meet air quality standards mandated by the Oregon Department of Environmental Quality;

4. Washing cars, boats, trailers, or other vehicles without hoses with shutoff nozzles unless done at a commercial or fleet washing facility that recycles water;

5. Serving water for drinking at a restaurant, motel, cafe, cafeteria, or other public places where food is sold and served unless specifically requested;

6. Cleaning, filling, maintaining decorative water features, natural or manmade, including but not limited to fountains, lakes, ponds, and streams, unless the water is recirculated through the decorative feature;

7. Any other restrictions deemed necessary;

8. Elimination of any exceptions deemed necessary. (Ord. 1727 § 2, 1992)

13.06.030 ENFORCEMENT

If a Level 2 prohibition is declared, violations of restrictions will be enforced as follows:

A. Warning

Each violation shall receive a warning. The letter of warning shall be in writing, shall specify the violation, may require compliance measures, and shall be served upon the resident either personally, by officer or substitute service, or by certified or registered mail, return receipt requested.

B. Citation

After the resident has received a warning letter, any subsequent violation shall be treated as a civil infraction pursuant to the Milwaukie Municipal Code. No forfeiture of this chapter shall be less than one hundred dollars ($100.00) or more than five hundred dollars ($500.00) for each violation. (Ord. 1727 § 3, 1992)

13.06.040 VIOLATION—PENALTIES

A. Penalties for violations include:

1. First violation: warning letter;
2. Second violation of the same type: Class C infraction, one hundred dollars ($100.00);
3. Third violation of the same type: Class B infraction, two hundred fifty dollars ($250.00);
4. Fourth and subsequent violations: Class A infraction, five hundred dollars ($500.00).

B. Third and subsequent violations under Level 2 may include water shutoff. (Ord. 1727 § 4, 1992)

2021 Water System Master Plan

Appendix O. Cross Connection Control Program

CITY OF MILWAUKIE
"Dogwood City of the West"

Ordinance No. 2082

An ordinance of the City Council of the City of Milwaukie, Oregon, providing for the protection of the City's water system from cross connections and replacing the existing cross connection control ordinance (MMC chapter 13.08).

WHEREAS, Pursuant to Chapter 333, Division 61, of the Oregon Administrative Rules, it is the responsibility of the City of Milwaukie to protect the public water system from pollution and contamination by instituting and enforcing a cross connection control program; and

WHEREAS, the City's existing ordinance does not provide the detail needed to implement the program effectively; and

WHEREAS, the City has completed a written plan for the cross connection program;

Now, Therefore, the City of Milwaukie does ordain as follows:

Section 1. MMC chapter 13.08 shall be replaced in its entirety.

Section 2. The attached "Chapter 13.08 Cross Connection Control" shall be adopted as the replacement language for MMC chapter 13.08.

Read the first time on **August 5, 2014**, and moved to second reading by 5:0 vote of the City Council.

Read the second time and adopted by the City Council on 8/5/14.

Signed by the Mayor on 8/5/14.

Jeremy Ferguson, Mayor

ATTEST:

APPROVED AS TO FORM:
Jordan Ramis PC

Pat DuVal

Pat DuVal, City Recorder

City Attorney

CHAPTER 13.08 CROSS CONNECTION CONTROL

CROSS CONNECTION CONTROL ORDINANCE
SECTIONS:

Pursuant to Chapter 333, Division 61, of the Oregon Administrative Rules, it is the responsibility of the City of Milwaukie to protect the public water system from pollution and contamination by instituting and enforcing a cross connection control program.

13.08.01 PURPOSE

The purpose of this Ordinance and the City's Cross Connection Control Written Program Plan is to protect the water supply and distribution system of the City of Milwaukie from contamination or pollution due to any existing or potential cross connections and to comply with the Oregon Administrative Rule Chapter 333-061-0070, 0071, 0072, 0073 and 0074 or as amended.

13.08.02 DEFINITIONS

For the purposes of this Ordinance, the following definitions shall apply unless the context clearly indicates or requires a different meaning. If a word or term used in this Ordinance is not contained in the following list, its definition, or other technical terms used, shall have the meanings or definitions listed in the Oregon Administrative Rules, Chapter 333, or the most recent edition of the Manual of Cross Connection Control published by the Foundation for Cross Connection Control and Hydraulic Research, University of Southern California ("USC").

(1) "APPROVED BACKFLOW PREVENTION ASSEMBLY" or "BACKFLOW ASSEMBLY" or "ASSEMBLY" means an assembly to counteract backpressure and/or prevent back-siphonage. This assembly must appear on the list of approved assemblies issued by the Oregon Health Authority.

(2) "AUXILIARY SUPPLY" means any water source or system other than the City of Milwaukie Water System.

(3) "BACKFLOW" means the flow in the direction opposite to the normal flow or the introduction of any foreign liquids, gases, or substances into the water system of the City of Milwaukie.

(4) "CERTIFIED BACKFLOW ASSEMBLY TESTER" shall mean a person who has successfully completed and maintains all requirements as established by the Oregon Health Authority to be a tester in the state of Oregon.

(5) "CERTIFIED CROSS CONNECTION CONTROL SPECIALIST" shall mean a person who has successfully completed and maintains all requirements as established by the Oregon Health Authority to be a Specialist in the state of Oregon.

(6) "CITY" shall mean the City of Milwaukie.

(7) "CITY WATER SYSTEM" shall refer to and mean the City of Milwaukie Water System, which shall include, wells, treatment mechanisms or processes, pumping stations, reservoirs, supply trunk or feeder lines, service lines, meters and all other appurtenances, device lines and items necessary to the operation of the system and to supply water service to individual property or premises and shall include the City of Milwaukie potable water with which the system is supplied.

(8) "CONTAMINATION" means the entry into or presence in a public water supply system of any substance which may be deleterious to health and/or quality of the water.

(9) "CROSS CONNECTION" means any physical arrangement where a potable water supply is connected, directly or indirectly, with any other non-drinkable water system or auxiliary system, sewer, drain conduit, swimming pool, storage reservoir, plumbing fixture, swamp coolers or any other device which contains, or may contain, contaminated water, sewage or other liquid of unknown or unsafe quality which may be capable of imparting contamination to the public water system as a result of backflow. Bypass arrangements, jumper connections, removable sections, swivel or changeover devices or other temporary or permanent devices through which or because of which backflow may occur, are considered to be cross connections.

(10) "DEGREE OF HAZARD" means the NON-HEALTH HAZARD or HEALTH HAZARD classification that shall be assigned to all actual or potential cross connections.

(11) "DOUBLE CHECK VALVE BACKFLOW PREVENTION ASSEMBLY", "DOUBLE CHECK ASSEMBLY", "DOUBLE CHECK" or "DCVA"means an assembly which consists of two (2) independently-operating check valves which are spring-loaded or weighted. The assembly comes complete with a resilient seated shut-off valve on each side of the checks, as well as test cocks to test the checks for tightness.

(12) "DOUBLE CHECK DETECTOR ASSEMBLY" or "DCDA" means an assembly which consists of two independently operating check valves which are spring-loaded or weighted. The assembly comes complete with a shut-off valve on each side of the checks, as well as test cocks to test the checks for tightness. It shall also be provided with a factory bypass arrangement with a meter and a minimum of an approved double check assembly.

(13) "HEALTH HAZARD" means an actual or potential threat of contamination of a physical, chemical or biological nature to the public potable water system or the consumer's potable water system that would be a danger to health.

(14) "IN-PREMISES PROTECTION" means the appropriate backflow prevention within the consumer's water system at or near the point at which the actual or potential cross connection exists.

(15) "MOBILE UNITS" shall mean units that are temporary in nature, connecting to the water system through a legally-permitted hydrant, hosebib, or other appurtenance of a permanent nature that is part of the City of Milwaukie water system or a permanent water service to a premises. Examples can include but are not limited to the following: water trucks, pesticide applicator vehicles, chemical mixing units or tanks, waste hauler's trucks or units, sewer cleaning equipment, carpet or steam cleaning equipment other than homeowner use, rock quarry or asphalt/concrete batch plants or any other mobile equipment or vessel that poses a threat of backflow in the City of Milwaukie Water System. Uses that are excluded from this definition are recreational vehicles at assigned sites or parked in accordance with other City of Milwaukie policies pertaining

to recreational vehicles and homeowner devices that are used by the property owner in accordance with other provisions of this, or other, City of Milwaukie policies pertaining to provision of water service to a premises.

(16) "NON-HEALTH HAZARD" shall mean the classification assigned to an actual or potential cross connection that could allow a substance that may be objectionable, but not hazardous to one's health, to backflow into the potable water supply.

(17) "OHA" shall mean Oregon Health Authority.

(18) "OAR" shall mean Oregon Administrative Rule.

(19) "PERSON(S)" shall mean a natural person (individual), corporation, company, city, partnership, firm, limited liability company, joint venture company or city, and other such entity.

(20) "POLLUTION HAZARD" means an actual or potential threat to the physical properties of the water system or the potability of the public or the consumer's potable water system, but which would not constitute a health or system hazard, as defined. The maximum intensity of pollution to which the potable water system could be degraded under this definition would cause minor damage to the system or its appurtenances.

(21) "PREMISES" means any piece of property to which water service is provided, including, but not limited to, all improvements, mobile structures and other structures located upon it.

(22) "PREMISES ISOLATION" means the appropriate backflow prevention at the service connection between the public water system and the premises. This location will be at or near the property line and downstream from the service connection meter.

(23) "REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTION ASSEMBLY" or "REDUCED PRESSURE PRINCIPLE ASSEMBLY" or "RP ASSEMBLY" shall mean an assembly containing two independently-acting approved check valves together with a hydraulically-operated, mechanically-independent pressure differential relief valve located between the check valves, and at the same time, below the first check valve. The assembly shall include properly located test cocks and two tightly closing shut-off valves.

(24) "REDUCED PRESSURE DETECTOR ASSEMBLY" or "RPDA" shall mean an approved assembly consisting of two approved reduced pressure backflow assemblies, set in parallel, equipped with a meter on the bypass line to detect small amounts of water leakage or use. The assembly should include properly-located test cocks and two tightly closing shut off valves.

(25) "RESIDENT" means a person or persons living within the area(s) served by the City of Milwaukie Water System.

(26) "RETROFITTING" means to furnish a service connection with parts or equipment made available after the time of construction or assembly installation.

(27) "SPECIALIST" means an Oregon Health Authority-certified Cross Connection Specialist, either employed with the City of Milwaukie or contracted by the City of Milwaukie.

(28) "SUBMERGED HEADS" means irrigation sprinkling or delivery devices that are located below the surface of the landscaped area in which they are installed.

(29) "SUPERVISOR" shall mean the Public Works Supervisor or his/her designee.

(30) "THERMAL EXPANSION" means the pressure created by the expansion of heated water.

(31) "WRITTEN PROGRAM PLAN" or "WPP" shall mean the City's current Cross Connection Control Written Program Plan.

13.08.03 APPLICATION AND RESPONSIBILITIES

This Ordinance applies throughout the City of Milwaukie Water System and to every premises and property served by the City of Milwaukie Water System. It applies to all premises, regardless of date of connection to the City of Milwaukie Water System. Every owner, occupant or person in control of any concerned premises is responsible for the terms and provisions contained in this Ordinance.

13.08.04 CROSS CONNECTIONS REGULATED

(1) No cross connections shall be created, installed, used or maintained within the area(s) served by the City of Milwaukie Water System, except in accordance with this Ordinance.

(2) The Specialist shall carry out or cause surveys to be carried out to determine if any actual or potential cross connection exists. If found necessary, an assembly commensurate with the degree of hazard will be required at the service connection.

(3) The owner, occupant or person in control of any given premises is responsible for all cross connection control within the premises.

(4) All premises found on Table 48 of the OAR shall install a Reduced Pressure Backflow Assembly at the service connection in accordance with this Ordinance.

(5) It is the responsibility of the property owner/occupant to purchase, install, test, repair and maintain all backflow assemblies.

(6) If there is a change in ownership of any and all property within the City's service area, it shall be the responsibility of the new owner to determine that all assemblies are in compliance with this Ordinance.

(7) The use of any type of chemical spray attachment connected to the premises plumbing, including garden hose fertilizers and pesticide applicators, is not allowed within the City of Milwaukie Water System without proper protection from the potential of backflow occurring.

(8) The use of any type of radiator flush kits attached to the premises plumbing is not allowed within the City of Milwaukie Water System without proper protection from backflow occurring.

13.08.05 BACKFLOW PREVENTION ASSEMBLY REQUIREMENTS

A Specialist employed by or under contract with the City of Milwaukie, shall determine the type of backflow assemblies to be installed within the City of Milwaukie Water System. All assemblies shall be installed at the service connection unless it is determined by the Specialist and approved by the Public Works Supervisor that in-premises protection would be adequate. An approved assembly shall be required in each of the following circumstances, but the Specialist is in no way limited to the following circumstances:

(1) In the case of any premises where there is any material dangerous to health which is handled in such a fashion as to permit entry into potable water system, the potable water system shall be protected by an approved air gap separation or an approved reduced pressure principle backflow prevention assembly.

(2) When the nature and extent of any activity at a premise, or the materials used in connection with any activity at premises, or materials stored at a premise, could contaminate or pollute the potable water supply.

(3) When a premises has one (1) or more cross connections, as that term is defined in Section 13.08.02.

(4) When internal cross connections are present that are not correctable.

(5) When intricate plumbing arrangements are present making it impractical to ascertain whether cross connections exist.

(6) When the premises has a repeated history of cross connections being established or re-established.

(7) When entry to the premises is restricted so that surveys for cross connections cannot be made with sufficient frequency to assure cross connections do not exist.

(8) When materials are being used such that, if backflow should occur, a health hazard could result.

(9) When an appropriate cross connection survey report form has not been filed with the City of Milwaukie Public Works Supervisor.

(10) Any and all used water return systems.

(11) If an in-premises assembly has not been tested or repaired as required by this Ordinance, the installation of a reduced pressure principle assembly will be required at the service connection.

(12) There is piping or equipment for conveying liquids other than potable City of Milwaukie water and that piping or other equipment is under pressure and installed and operated in a manner that could cause a cross connection.

(13) When installation of an approved backflow prevention assembly is deemed by a Specialist to be necessary to accomplish the purpose of this Ordinance.

(14) Wherever reclaimed water or separate irrigation water is used on premises.

(15) When there is a premises with an auxiliary water supply which is interconnected to the City of Milwaukie Water Service or supply system.

This section will be carried out in accordance with this Ordinance and the City's Written Program Plan (WPP).

13.08.06 NEW CONSTRUCTION

(1) On all new non-residential construction, an approved backflow assembly shall be installed at the service connection. The type of the assembly will be commensurate with the degree of hazard as determined by a Specialist.

(2) When a building is constructed on commercial premises, and the end use of the building is not determined or could change, a reduced pressure principle backflow prevention assembly shall be installed at the service connection to provide protection of the public water supply in the event of the most hazardous use of the building.

13.08.07 RETROFITTING

Retrofitting shall be required at all service connections where an actual or potential cross connection exists, and wherever else the City of Milwaukie deems retrofitting necessary to comply with the OAR, this Ordinance and the City's WPP.

13.08.08 IRRIGATION SYSTEMS

All irrigation systems shall be protected according to the Uniform Plumbing Code. In the event any system is equipped with an injector system, a reduced pressure principle assembly will be required at the service connection.

13.08.09 THERMAL EXPANSION

If a closed system has been created by the installation of a backflow prevention assembly, or other appurtenances, it is the responsibility of the property owner, the occupant, or person in control of the property to eliminate the possibility of damage from thermal expansion in accordance with the Plumbing Code.

13.08.10 MOBILE UNITS

Any mobile unit or apparatus, as defined in Section 13.08.02 of this Ordinance, which uses the water from any premises within the City of Milwaukie Water System, shall first obtain a permit from the City of Milwaukie and be inspected to assure an approved air gap or reduced pressure principle assembly is installed on the unit.

This section will be carried out in accordance with this Ordinance and the City's WPP.

13.08.11 INSTALLATION REQUIREMENTS

All backflow prevention assembly installations shall follow the requirements as stipulated by the City of Milwaukie and the current OAR Chapter 333, Division 061.

If the premises isolation assembly is allowed to be installed at an alternate location, the City of Milwaukie must have access to the assembly. No connections can be made between the meter and the backflow assembly.

The type of backflow prevention assembly required shall be commensurate with the degree of hazard that exists and must, at all times, meet the standards of the Oregon Health Authority. All backflow prevention assemblies required under this section shall be of a type and model approved by the OHA.

This section will be carried out in accordance with this Ordinance and the City's WPP.

13.08.12 PRESSURE LOSS

Any decrease in water pressure caused by the installation of a backflow assembly shall not be the responsibility of the City of Milwaukie.

13.08.13 FIRE SYSTEMS

An approved double check detector assembly shall be the minimum protection on all new fire sprinkler systems using piping material that is not approved for potable water use, and/or that does not provide for periodic flow-through. A reduced pressure principle detector assembly must be installed, if any solution other than potable water can be introduced into the sprinkler system.

Retrofitting on fire sprinkler systems will be required in each of the following circumstances:

(1) Where improper maintenance has occurred

(2) On all health hazard systems

(3) Wherever a Specialist deems necessary

(4) Wherever required by the OAR

In the event an assembly is installed on a designated lateral, a detector assembly commensurate with the degree of hazard will be required.

13.08.14 TEMPORARY METERS AND HYDRANT VALVES

Backflow protection will be required on all temporary meters and hydrant valves before any use. The type of assembly will be commensurate with the degree of hazard and will be determined on a case-by-case basis by a City of Milwaukie Specialist.

This section will be carried out in accordance with this Ordinance and the City's WPP.

13.08.15 PLUMBING CODE

As a condition of water service, customers shall install, maintain, and operate their piping and plumbing systems in accordance with the current Uniform Plumbing Code, or as amended. If there is a conflict between this Ordinance and the Plumbing Code, the more stringent supercedes.

13.08.16 RIGHT-OF-WAY ENCROACHMENT

All backflow assemblies must be installed in accordance with the Right-of-Way Encroachment stipulated by the City's "Right of Way" Encroachment Document.

13.08.17 ACCESS TO PREMISES

Authorized personnel of the City of Milwaukie, with proper identification and sufficient notice, shall have access during reasonable hours to all parts of a premises and within the structure to which water is supplied. However, if any owner, occupant or person in control refuses authorized personnel access to a premise, or to the interior of a structure, during these hours for inspection, a reduced pressure principle assembly must be installed at the service connection to that premise.

13.08.18 ANNUAL TESTING AND REPAIRS

All backflow prevention assemblies installed within the area(s) served by the City of Milwaukie shall be tested immediately upon installation, and at least annually thereafter by an OHA certified backflow assembly tester. All such assemblies found not functioning properly shall be promptly repaired or replaced at the expense of the owner, occupant or person in control of the premises. In the event an assembly is moved, repaired or replaced it must be retested immediately.

All repairs on backflow assemblies within the City of Milwaukie service area must be performed according to all State and County regulations.

This section will be carried out in accordance with this Ordinance and the City's WPP.

13.08.19 MAINTENANCE OF ASSEMBLIES

Backflow prevention assemblies shall be maintained, tested and repaired in accordance with the requirements set out in this Ordinance, the City's WPP, the OAR and all applicable State agencies' regulations. The assembly owner is responsible for protecting their assembly from freezing and vandalism.

In the event an assembly is not properly tested and repaired, the City of Milwaukie will have the assembly tested and repaired and apply all costs associated with this to the assembly owner's utility bill.

This section will be carried out in accordance with this Ordinance and the City's WPP.

13.08.20 RESPONSIBILITIES OF BACKFLOW PREVENTION ASSEMBLY TESTERS

(1) All backflow assembly testers operating within the City of Milwaukie Water System service area shall be certified in accordance with all applicable regulations of the OHA and must abide by the requirements of this Ordinance and the City's WPP.

(2) Persons certified as backflow assembly testers shall agree to abide by all requirements of the United States Occupational Safety and Health Administration ("OSHA") and Oregon Occupational Safety and Health Administration ("OR-OSHA").

(3) It is the responsibility of backflow assembly testers to submit records of all backflow assembly test reports to the City of Milwaukie within 10 days of completing the test.

This section will be carried out in accordance with this Ordinance and the City's WPP.

13.08.21 COSTS OF COMPLIANCE

All costs associated with purchase, installation, surveys, testing, replacement, maintenance, parts and repairs of the backflow prevention assembly, and all costs associated with enforcement of this document, are the financial responsibility of the property owner, occupant, or other person in control of the premises.

The fees for the inspection and test will be set by resolution of the City Council.

13.08.22 RECOVERY OF COSTS

Any water customer violating any of the provisions of this Ordinance and who causes damage to or impairs the City of Milwaukie Water System, including, but not limited to, allowing contamination, pollution, any other solution or used water to enter the City of Milwaukie Water System, shall be liable to the City of Milwaukie for any expense, loss or damage caused by such violation. The City of Milwaukie shall collect from the violator the cost incurred by the City of Milwaukie for any cleaning, purifying, repair or replacement work or any other expenses caused by the violation. Refusal to pay the assessed costs shall constitute a violation of this Ordinance and shall result in the termination of service.

All cost associated with any disconnect or reconnect fees resulting from the enforcement of this Ordinance are the sole responsibility of the property owner.

13.08.23 TERMINATION OF SERVICE

Failure on the part of any owner, occupant or person in control of the premises to install a required assembly, have it tested a minimum of annually and repaired if necessary, and/or to discontinue the use of all cross connections and to physically separate cross connections in accordance with this Ordinance is sufficient cause for the discontinuance of public water service to the premises pursuant to Oregon Administrative Rule chapter 333-061-0070, or as amended. In the case of an extreme emergency or where an immediate threat to life or public health is found to exist, discontinuance or termination of public water service to the premises shall be immediate.

In lieu of termination of service, the City of Milwaukie may, at the property owner's expense, install a reduced pressure assembly at the meter. Testing, maintenance and repair of the assembly will be the responsibility of the property owner.

13.08.24 FALSIFYING INFORMATION

Any person who knowingly makes any false statement, representation, record, report or other document filed or required to be maintained pursuant to this Ordinance, or who falsifies, tampers with, or knowingly renders inaccurate any backflow assembly, device or method required under this Ordinance shall be subject to civil and/or criminal penalties provided by state law.

13.08.25 CONSTITUTIONALITY AND SAVING CLAUSE

Should any provision, section, sentence, clause or phrase of this Ordinance, or the application of same to any person or set of circumstances, are for any reason held to be unconstitutional, void, invalid, or for any reason unenforceable, the validity of the remaining portions of this Ordinance, or its application to other persons or circumstances, shall not be affected; thereby, it being the intent of the City of Milwaukie Water System in adopting and approving this Ordinance that no portion hereof or provision or regulation contained herein shall become inoperative or fail by reason of any unconstitutionality or invalidity of any other portion, provision, or regulation.

2021 Water System Master Plan

Appendix P. Public Works Standards

SECTION 4—WATER DESIGN STANDARDS

TABLE OF CONTENTS

4.0000 WATER MAINS

4.0010 GENERAL DESIGN REQUIREMENTS

Performance Standards: Water distribution systems shall be designed to meet State Water Administrative Rules, AWWA Standards, and guidelines of these Design Standards.

Water system design shall provide adequate flow for fire protection and maximum water usage and consumption. Required water system demands shall be met by maintaining the minimum operating pressures required by the City. For single-family residential areas, the minimum static pressure shall be 35 PSI, and the minimum fire flow shall be 1,000 GPM. For all other developments, the required fire flow shall be as determined by the Fire Chief.

Water system design shall meet distribution needs for maximum water usage and consumption within a given pressure zone. New water systems shall allow for future extensions beyond present development. Water mains shall be looped so as to avoid dead ends.

When water systems are designed where velocities are greater than 5 FPS, special provisions shall be made to protect against displacement by erosion and shock.

All waterlines shall be located within the public right-of-way or as directed by the City Engineer. These lines are placed in the public right-of-way for ease of maintenance and access, control of the facility, operation of the facility, and to permit required replacement and/or repair. The City Engineer, under special conditions, may allow a public waterline to be located within a public water easement as referenced in Subsection 4.0024 (Easements). Waterlines shall maintain separation from public or private sewer or septic systems.

4.0011 Pipe Materials and Size

All public water distribution systems shall be constructed with ductile-iron pipe. All such pipe shall be cement mortar-lined pipe with push-on or mechanical type joints. When a corrosive potential condition is encountered, all ductile-iron pipe and fittings will be polyethylene encased with an 8-mil tubing meeting manufacturer and AWWA standards. Where an active cathodic protection system is encountered as a result of other utilities, a deviation from the normal pipe design/material/installation practice may be required by the City Engineer.

All pipe, valves, and fittings shall be pressure rated for 250 or 350 PSI. All fittings shall be factory cement lined and coated (domestic fittings only). Pipe constructed per Subsection 4.0025 (Relation to Watercourses) will require the use of restrained pipe joints or ball and socket river pipe.

Water distribution main sizes shall generally conform to the following.

4-inch: May only be used with approval of the City Engineer in residential zones on dead-end streets with a center line distance of less than 250 ft measured from the center of the intersecting street to the radius point of the cul-de-sac; with service to not more than 12 residences; and shall be connected to a looped minimum 6-inch main. Fire hydrants are not permitted on 4-inch lines. All 4-inch lines shall terminate with a standard blowoff (Oregon Standard Drawing RD262).

6-inch: Minimum size residential subdivision distribution water main for the grid (looped) system, not to exceed an unsupported length of 600 ft and shall not be permanently dead-ended. Looping of the distribution grid shall be at least every 600 ft.

8-inch: Minimum size for permanently dead-ended mains supplying fire hydrants with a fire flow less than 1,500 GPM and for primary feeder mains in residential subdivisions.

10 inches and Up: As required for primary feeder lines in subdivisions, industrial, and commercial areas.

Velocity in distribution mains shall be designed not to exceed 5 FPS. Velocity in service lines, as defined in Subsection 4.0050 (Water Service Lines), shall not exceed 10 FPS. Standard trench patch section (Standard Drawing 510) will be utilized for all water pipe installed.

New construction and reconstruction of light rail and freight rail may require improvements to the water system at utility crossing locations. Existing pipes in the second half of their useful life within the rail zones must be replaced to current standards. Metallic or conductive pipe materials are not approved pipe materials at rail crossings.

All waterlines are to be encased through rail line crossings. Each casing pipe segment is to be positioned under rail tracks to avoid joints underneath rail lines. Metallic or conductive pipe materials are not approved at rail crossings which includes pipes used as encasement conduit.

4.0012 Grid System

The distribution system mains shall be looped at all possible locations. All developments will be required to extend mains across existing or proposed streets for future extensions of other developments within the city. All terminations shall be planned and located such that new or existing pavement will not have to be cut in the future when the main is extended. The installation of permanent dead-end mains greater than 250 ft, upon which fire protection depends and the dependence of relatively large areas on single mains, will not be permitted.

4.0013 Dead-End Mains

Dead-end mains which will be extended in the future shall be provided with a properly-sized blowoff (see Oregon Standard Drawing RD262).

Permanent dead-end mains shall terminate with a standard blowoff assembly (see Oregon Standard Drawing RD262).

4.0014 Restrained Joints

Restrained joints shall be required for transmission pipelines which cross unstable land, railroad tracks, freeways, watercourses, or other locations which could either result in unusual ground movements or could result in significant damage to property or life should a leak occur.

4.0020 ALIGNMENT AND COVER

4.0021 Right-of-Way Location

Water systems shall be located south and east from the right-of-way centerline or as directed by the City Engineer. Generally, the waterline will be located 4 ft from curbline or edge of pavement. Except as provided in Subsection 4.0024 (Easements), all waterlines shall be in the public right-of-way.

Curved alignment for waterlines or mains is permitted and shall follow the street centerline when practical. The minimum allowed radius shall be based on allowable pipe deflection for the pipe diameter and the pipe laying length, but not to exceed 3° joint deflection.

4.0022 Minimum Cover

The standard minimum cover over buried water mains within the street right-of-way shall be 36 inches from finish grade.

The minimum cover for mains in easements across private property shall be 48 inches from finish grade.

"Finish grade" shall normally mean the existing or proposed pavement elevation. Where the main is located in the cut or fill side slope or where mains are located in easements, "finish grade" shall mean final ground elevation at the water main alignment.

4.0023 Separation with Sewer Lines

Water mains shall be installed a minimum clear distance of 10 ft horizontally from sanitary sewers and shall be installed to go over the top of such sewers with a minimum of 18 inches of clearance at intersections of these pipes. When physical conditions render this spacing impossible or impractical, then cast-iron water pipe with watertight joints or concrete encasements is required for the sewer line. Wherever it is necessary for sewer and water lines to cross each other, the crossing should be at an angle of approximately 90° and the sewer shall either be located 18 inches or more below the water line or be constructed of cast-iron water pipe with watertight joints for a distance of 9 ft on both sides of the water line. Exceptions shall first be approved by the City Engineer. In all instances, the distances shall be measured edge to edge. The minimum spacing between water mains and storm drains, gas lines, and other underground utilities, except sanitary sewers, shall be 3 ft horizontally when the standard utility location cannot be maintained (Refer to OAR 333-061-0050 Figure 1).

Where water mains are being designed for installation parallel with other water mains, utility pipe, or conduit lines, the vertical separation shall be 12 inches below or in such a manner which will permit future side connections of mains, hydrants, or services, and avoid conflicts with parallel utilities without abrupt changes in vertical grade of the above mentioned main, hydrant, or service. Where crossing of utilities is required, the minimum vertical clearance shall be 6 inches.

4.0024 Easements

Mains placed in easements along a property line, shall have easements centered on the property line and shall be offset 18 inches from the property line. Mains placed in easements along a right-of-way line shall be offset a minimum 3 ft from the right-of-way line and within a minimum 10-ft-wide easement. For mains placed in easements located other than along a property or right-of-way line, the main shall be placed in the center of the easement. Easements, when required, shall be exclusive and a minimum of 15 ft in width. The conditions of the easement shall be such that the easement shall not be used for any purpose which would interfere with the unrestricted use for water main purposes. Under no circumstances shall a building or structure be placed over a water main or water main easement. This includes overhanging structures with footings located outside the easement.

Easement locations for public mains serving a PUD, apartment complex, or commercial/industrial development shall be in parking lots, private drives, or similar open areas which will permit unobstructed vehicle access for maintenance by City personnel.

Any water main placed within a water main easement shall be marked with permanent posts and metal signs at all angle points and line or sight of joints. In addition, such posts and signs shall be placed where the waterline intersects the public right-of-way at the easement location. A monument cap set in the pavement of parking lots shall be an acceptable alternative to the sign. The City shall provide wording for the sign/monument.

All easements must be furnished to the City Engineer for review and approval prior to recording. Easements shall state that the City will not in any way be responsible for replacing landscaping including any shrubs or trees, fencing, or other structures that may exist or have been placed in the easement.

4.0025 Relation to Watercourses

New water mains may cross over or under existing streams, ponds, rivers, or other bodies of water.

A. Above Water Crossings

The pipe shall be engineered to provide support, anchorage, and protection from freezing and damage, yet shall remain accessible for repair and maintenance. All above water crossings will require review and approval by the City Engineer.

B. Underwater Crossings

1. Mains crossing stream or drainage channels shall be designed to cross as nearly perpendicular to the channel as possible. Mains shall be in a carrier pipe for underwater crossings.
2. Valves shall be provided at both ends of the water crossing so that the section can be isolated for testing or repair. The valves shall be easily accessible and not subject to flooding. The valve nearest to the supply source shall be in a manhole. Permanent taps shall be made on each side of the valve within the manhole to allow insertion of a small meter for testing, to determine leakage, and for sampling.
3. The following surface water crossings will be treated on a case-by-case basis:
   a. Stream or drainage channel crossing for pipes 12 inches inside diameter and greater.
   b. River or creek crossings requiring special approval from the Division of State Lands.
4. The minimum cover from the bottom of the streambed or drainage channel to the top of pipe shall be 36 inches.
5. A scour pad centered on the waterline will be required for mains less than 12 inches inside diameter when the cover from the top of the pipe to the bottom of the streambed or drainage channel is 30 inches or less. The scour pad shall be concrete, 6-inch thick over and under the pipe and 6-ft wide; reinforced with #4 rebars with 12-inch grid spacing; and shall extend to a point where a 1:1 slope begins at the top of the bank and slopes down from the bank away from channel centerline and intersects the top of the pipe.

4.0030 APPURTENANCES

4.0031 Valves

In general, valves shall be the same size as the mains in which they are installed. Valve types and materials shall conform to the Oregon Standard Specifications for Construction.

Distribution system valves shall be located at the tee or cross fitting. There shall be a sufficient number of valves located such that not more than 4, and preferably 3 valves, must be operated to affect any one particular shutdown. The spacing of valves shall be such that the length of any one shutdown in commercial or industrial areas shall not exceed 500 ft nor 800 ft in other areas.

Valves shall be installed at each cross, tee, or any tap 2 inches or greater in diameter connected to the main line. In general, intersections shall be valved in at least 2 branches and cross-intersections shall be valved at all branches. Transmission water mains shall have valves at not more than 1,000-ft spacings. Hazardous crossings such as creeks, railroad, and freeway crossings, shall be valved on each side.

Distribution tees and crosses for future branch lines on transmission mains may be required at the direction of the City Engineer.

4.0032 Fire Hydrants

The public fire hydrant system shall be designed to provide adequate flow as required. The distribution system shall be designed in commercial/industrial areas to accommodate fire flows up to 1,500 GPM. Minimum fire flow in single-family residential areas shall be 1,000 GPM.

The distribution of hydrants shall be based upon the required average fire flow for the area served. Design coverage shall result in hydrant spacing of approximately 400 ft in residential areas, approximately 300 ft in commercial or industrial subdivisions, or as approved by the Fire

Chief and City Engineer. In addition, sufficient hydrants shall be available within 1,000 ft of a building in commercial/industrial areas to provide its required fire flow.

Residential hydrants shall be located as nearly as possible to the corner of street intersections and not more than 400 ft from any cul-de-sac radius point.

No fire hydrant shall be installed on a main of less than 8 inches inside diameter unless it is in a looped system of 6-inch mains. The hydrant lead shall be a minimum 6 inches inside diameter.

All fire hydrants will be located behind the existing or proposed sidewalk or in the planter strip. Hydrants shall be placed as to not interfere with driveways and curb ramps. If any public hydrant encroaches on private property, an easement will be provided as directed by the City Engineer.

No hydrant shall be installed within 5 ft of any existing aboveground utility and there shall not be any utility facilities installed closer than 5 ft from an existing hydrant.

Hydrant installation shall conform to Oregon Standard Drawing RD254. Full-depth hydrants will be required in all installations. Installation of hydrant extensions will not be allowed, unless approved by the City Engineer.

Each fire hydrant shall have an auxiliary valve and valve box which will permit repair of the hydrant without shutting down the main supplying to the hydrant. Such auxiliary valves shall be resilient wedge gate valves. The auxiliary valve shall have mechanical joint-flange joint ends as referenced in the Oregon Standard Drawing RD254. The valve shall be connected directly to the water main using a flange joint tee, tie rods, or megalug.

Hydrants shall not be located within 20 ft of any building, and shall not be blocked by parking. The large hydrant port should face the road or travelway.

Guard posts, a minimum of 3 ft high, shall be required for protection from vehicles when necessary. Such protection shall consist of 4-inch diameter steel pipes, 6 ft long, filled with concrete, and buried a minimum of 3 ft deep in concrete, and located at the corners of a 6-ft square with the hydrant located in the center. Use of posts other than at the four corners may be approved by the City Engineer.

4.0033 Pressure-Reducing and Air Release Valves

The City's water distribution system is divided into several pressure zones. Where water systems cross these zone lines, a pressure-reducing valve station will be required. The specific design and location for such valves will be reviewed and approved by the City Engineer.

When designated by the City Engineer, air release valves, per Oregon Standard Drawing RD270, shall be installed. Such valves will be required on large diameter lines at all high points in grade.

4.0034 Railroad or Freeway Crossings

All such crossings defined above, or as determined by the City to be of a hazardous nature, shall be valved on both sides of the crossing. Casing of railroad or freeway crossings shall be as noted in the permit from the respective agency and as approved by the City. Waterlines and casing materials shall be designed to minimize the cathodic protection required. All accessible structures shall be located a minimum of 15 ft from railroad crossing gate arms outside of the rail area, at least 25 ft from a light rail track centerline, and 50 ft from the rail track centerline for freight and higher speed trains. Pipes shall be sized per Water Master Plan and full build-out requirements at all rail crossings. Materials to be approved by City Engineer.

4.0040 BACKFLOW PREVENTION

Backflow prevention devices shall be required on all water services supplying 3-story buildings and taller.

4.0050 WATER SERVICE LINES

The sizes of water service lines which may be used are 1, 2, 4, 6, 8, 10, and 12 inches. Water service lines will be reviewed for effects on the distribution system and shall not be greater in size than the distribution main.

For services 2-inch and greater, a design drawing must be submitted showing the vault and fitting requirements with the expected flow (normal and maximum day flow) requirements and proposed usage.

Domestic service lines 1-inch through 2-inch shall normally extend from the main to behind the curb, with a meter curb stop and meter box located at the termination of the service connection (Standards 401 and 402). Meter to be provided and installed by City. Meter boxes are to be provided by the developer. In general, individual service connections shall terminate in front of the property to be served and shall be located 18 inches each side of a common side property line.

When a corrosive potential condition is encountered and the copper service passes over or under an active cathodic protection system, the service will be installed in a Schedule 40 PVC conduit for a distance of 10 ft on each side of the active system. All conduit placements will be as-built. Pex water service lines are approved to be used in areas where copper service lines fail prematurely.

4.0051 Fire Service

There are four categories of private fire services:

1. Hydrants;
2. Fire sprinkler lines;
3. Combination hydrant and fire sprinkler lines; and
4. Combination plumbing and fire sprinkler heads.

The water fire service line shall normally extend from the main to the property line and end with a vault metering device and valves. An approved backflow prevention device will be required of the property being served.

4.0052 Fire Vaults

A vault will be required when a development provides fire sprinklers. The vault drawing will be included on construction drawings submitted to the City Engineer. The vault shall contain all valves, fittings, meters, and appurtenances required for fire service to the development.

4.0060 SYSTEM TESTING

All new water systems (lines, valves, hydrants, and services) shall be individually pressure tested, chlorinated, and tested for bacteria. All testing shall be performed in accordance with Section 01140 – Potable Water Pipe and Fittings of the Oregon Standards for Construction and in the presence of a City Inspector. Sampling test charges are the responsibility of the developer.

4.0070 WATER QUALITY SAMPLING STATIONS

Water sampling stations will be required as directed by the City Engineer. Approved station is Kupferle Eclipse #88-SS with “City of Milwaukie” logo cast into the access door at no additional charge.

END OF SECTION

THE FOLLOWING LATEST VERSION OF THE OREGON STANDARD DRAWINGS PUBLISHED BY APWA/ODOT TO BE USED AS A CITY OF MILWAUKIE STANDARD WITH MILWAUKIE SPECIFIC REQUIREMENTS AS NOTED

OSSC STANDARD DRAWING NUMBER	OSSC STANDARD DRAWING NAME	MILWAUKIE EXCEPTION TO DRAWING
RD250	THRUST BLOCKING	NO EXCEPTION TAKEN
RD262	TYPICAL MAIN DEAD-END BLOWOFF ASSEMBLY	MEGALUG RESTRAINED JOINT
RD270	COMBINATION AIR RELEASE AIR VACUUM VALVE ASSEMBLY (2" AND SMALLER)	NO EXCEPTION TAKEN
RD282	WATER SAMPLING STATION	KUPFERLE ECLIPSE 88-SS WITH "CITY OF MILWAUKIE" LOGO CAST INTO ACCESS DOOR

NOTES:

1. STANDARD DRAWING PUBLISHED BY APWA/ODOT NOT LISTED MUST NOT BE USED WITHOUT PRIOR APPROVAL BY THE PUBLIC WORKS DEPARTMENT

CITY OF MILWAUKIE, OREGON – PUBLIC WORKS DEPT.

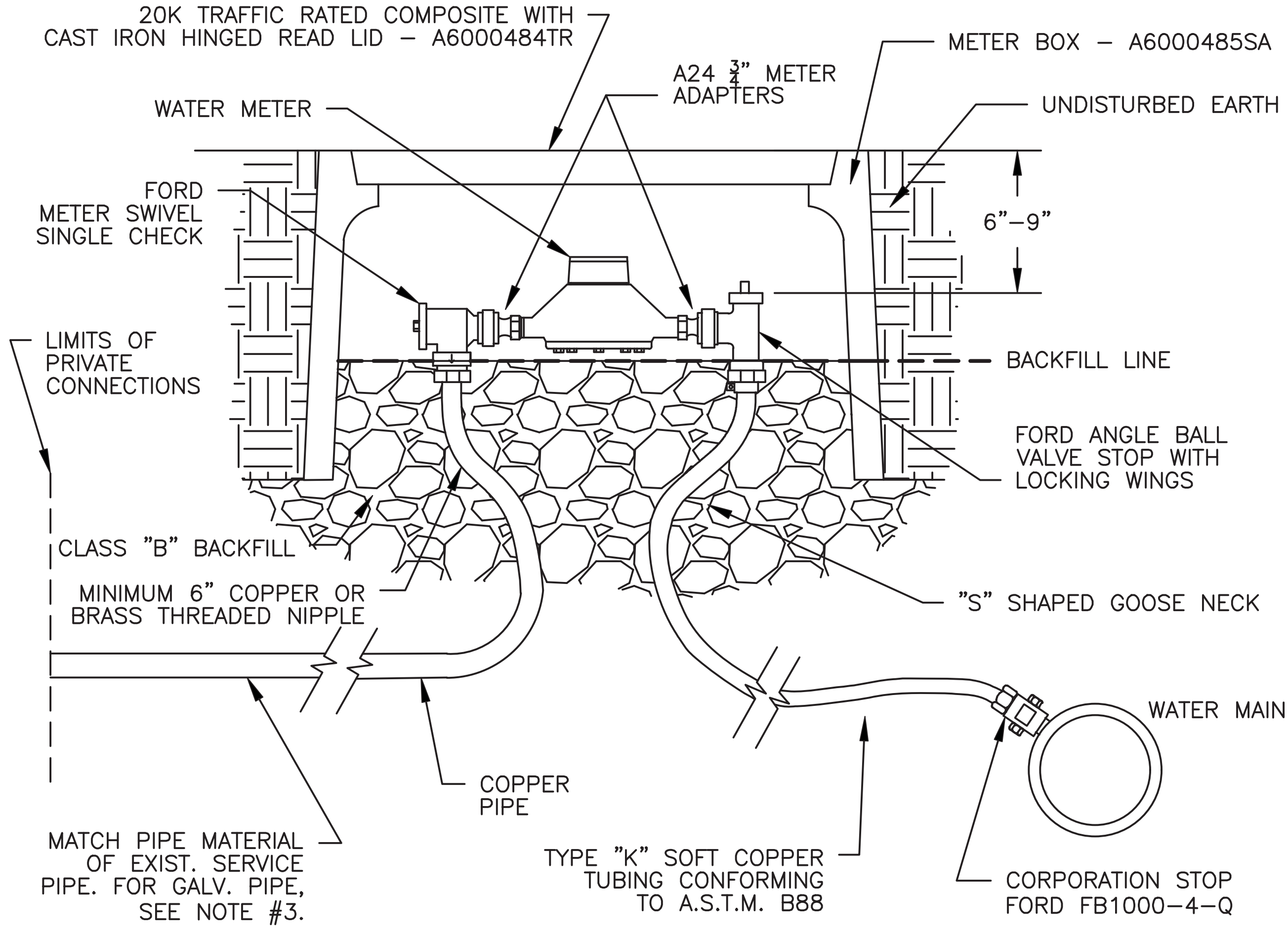
OSSC ACCEPTABLE WATER STANDARD DRAWINGS

DRAWING NO. 400

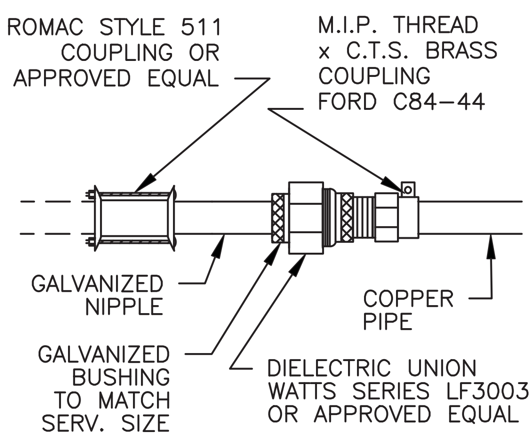
APPROVED 08/2019

CITY ENGINEER DATE

NO.	REVISIONS	DATE	BY
1	NEW DRAWING	11/18	TAP
2	NOTE CHANGED	08/19	TAP



UNTHREADED GALVANIZED PIPE CONNECTION:



NOTES:

1. IF COPPER TUBING CROSSES CATHODICALLY PROTECTED LINE, ENCASE COPPER IN POLYETHYLENE TUBING FOR 24" (CENTERED AT THE CROSSING LINE) AND FASTEN WITH 2" WIDE ADHESIVE TAPE THAT IS COMPATIBLE WITH POLYETHYLENE.

2. PLACE METER BOXES (1) LOCATED BEHIND THE SIDEWALK WHERE THERE IS SUFFICIENT RIGHT–OF–WAY, (2) WITHIN THE PLANTER STRIP, EXCLUDING WATER QUALITY FACILITIES, (3) WITHIN THE SIDEWALK WITH THE BACK OF THE METER BOX AT THE BACK EDGE OF THE SIDEWALK.

3. CONNECT GALVANIZED SERVICE PIPE; (1) AT EXISTING THREADED FITTING WITHIN 5 FEET OF WATER METER; (2) RETHREAD EXISTING GALVANIZED SERVICE PIPE; (3) IF EXISTING PIPE IS IN POOR CONDITION AND CANNOT BE RETHREADED, USE UNTHREADED GALVANIZED PIPE CONNECTION DETAIL.

4. IF METER BOX IS LOCATED IN THE SIDEWALK, DIELECTRIC UNION WILL BE INSTALLED (1) 6" FROM BACK OF METER INSIDE OF METER BOX, (2) BEHIND BACK OF SIDEWALK.

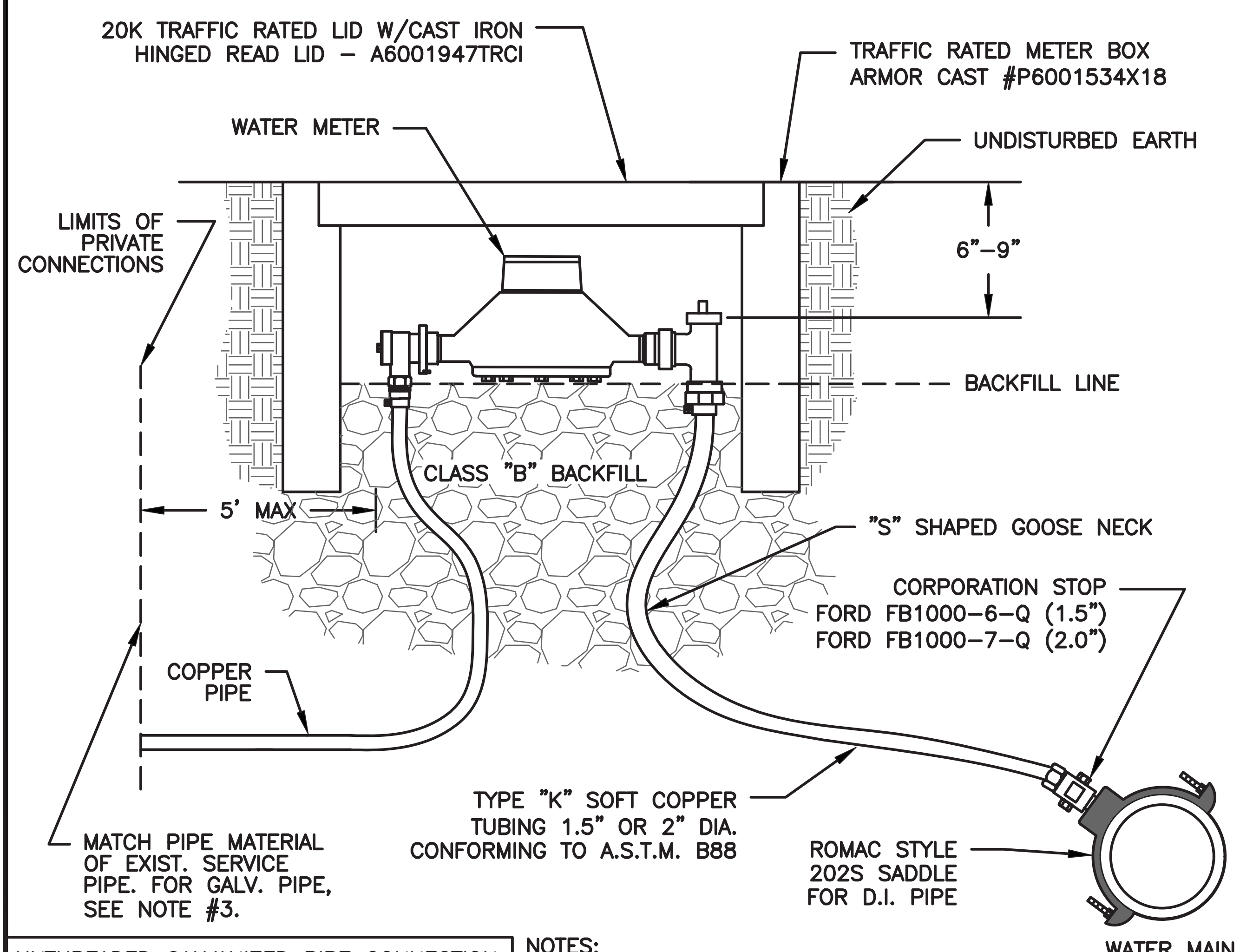
CITY OF MILWAUKIE, OREGON – PUBLIC WORKS DEPT.

3/4 to 1 Inch Water Service

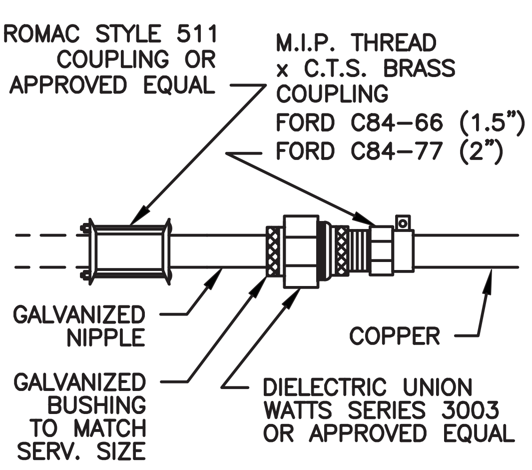
DRAWING NO. 401

APPROVED 08/2019
CITY ENGINEER DATE

NO.	REVISIONS	DATE	BY
5	ADDED DIELECTRIC UNION NOTE	12/14	AJR
6	ADDED 3/4" WATER SERVICE	11/18	TAP
7	TITLE CHANGE	08/19	TAP



UNTHREADED GALVANIZED PIPE CONNECTION:



NOTES:

1. IF COPPER TUBING CROSSES CATHODICALLY PROTECTED LINE, ENCASE COPPER IN POLYETHYLENE TUBING FOR 24" (CENTERED AT THE CROSSING LINE) AND FASTEN WITH 2" WIDE ADHESIVE TAPE THAT IS COMPATIBLE WITH POLYETHYLENE.

2. PLACE METER BOXES (1) LOCATED BEHIND THE SIDEWALK WHERE THERE IS SUFFICIENT RIGHT–OF–WAY, (2) WITHIN THE PLANTER STRIP, EXCLUDING WATER QUALITY FACILITIES, (3) WITHIN THE SIDEWALK WITH THE BACK OF THE METER BOX AT THE BACK EDGE OF THE SIDEWALK.

3. CONNECT GALVANIZED SERVICE PIPE; (1) AT EXISTING THREADED FITTING WITHIN 5 FEET OF WATER METER; (2) RETHREAD EXISTING GALVANIZED SERVICE PIPE; (3) IF EXISTING PIPE IS IN POOR CONDITION AND CANNOT BE RETHREADED, USE UNTHREADED GALVANIZED PIPE CONNECTION DETAIL.

4. IF METER BOX IS LOCATED IN THE SIDEWALK, DIELECTRIC UNION WILL BE INSTALLED (1) 6" FROM BACK OF METER INSIDE OF METER BOX, (2) BEHIND BACK OF SIDEWALK.

CITY OF MILWAUKIE, OREGON – PUBLIC WORKS DEPT.

1.5 – 2 Inch Water Service

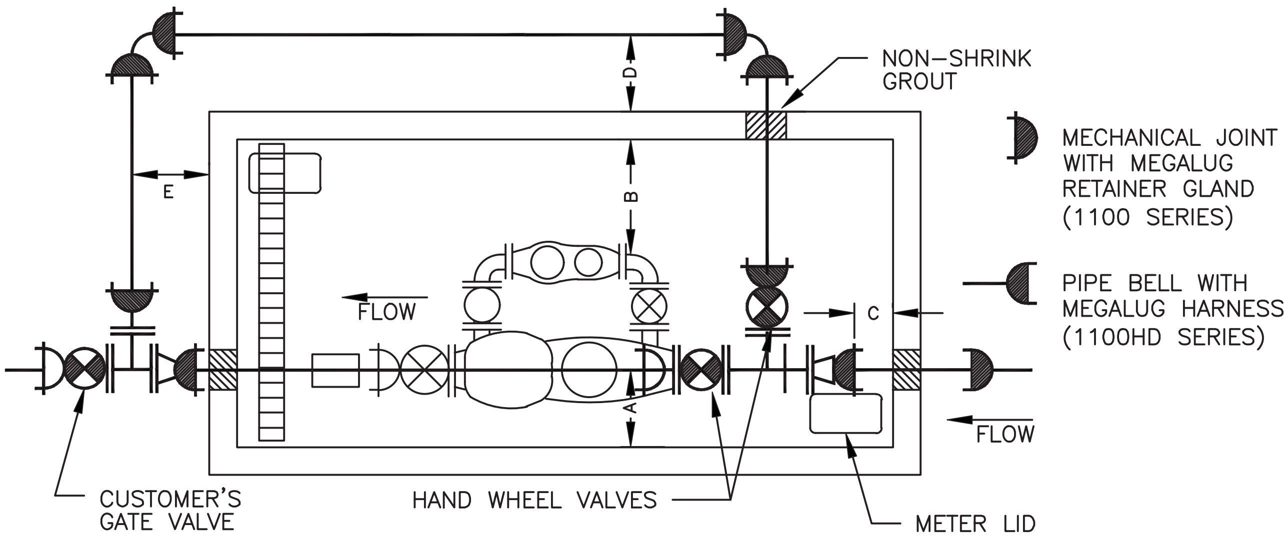
DRAWING NO. 402

APPROVED

08/2019

CITY ENGINEER — DATE

NO.	REVISIONS	DATE	BY
5	REMOVED COPPERSETTER	12/13	AJR
6	ADDED DIELECTRIC UNION NOTE	12/14	AJR
7	TITLE CHANGED	08/19	TAP



METER	INCOMING LINE SIZE	BYPASS LINE SIZE	UTILITY VAULT NUMBER	A*	B*	C*	D*	E*
4 x 2	6"	4"	810–LA	24"	36"	12"	24"	24"
6 X 3	8"	4"	712–LA	18"	36"	12"	24"	28"
8 X 4	10"	6"	816–LA	18"	36"	12"	26"	30"
3' COMPOUND	4"	2" CU	687–LA	24"	24"	12"	24"	24"

* MEASUREMENTS A–E ARE MINIMUMS AND MUST BE MET FOR APPROVAL.

NOTES:
ALL SERVICE PIPING WILL BE CHLORINATED AND TESTED TO CITY SPECIFICIATIONS. METER TO BE PROVIDED AND INSTALLED BY THE CONTRACTOR AFTER PIPING IN VAULT HAS PASSED ALL TESTS. METER TO BE COMPOUND BADGER METERS. 3" AND ABOVE MAY ALSO BE SENSUS COMPOUND AND TURBO METERS. REMOTE METERS MUST BE VISIBLE FROM LID HATCH.

1. ALL VAULT WALL OPENINGS TO BE SEALED WITH NON–SHRINK GROUT. TOP OF VAULT SHALL BE 1" ABOVE PROPOSED GRADE WITH 2% SLOPE AWAY FROM VAULT. VAULT MUST BE CLEAN AND FREE OF DEBRIS PRIOR TO METER INSTALLATION. INSTALL A MINIMUM OF 3 PIPE SUPPORTS IN VAULT, GRINNELL NO. 264 OR ELCEN NO. 50. INSTALL 4" DRAIN FROM VAULT TO DAYLIGHT OR APPROVED DRYWELL OR STORM DRAIN WITH A BACKWATER CHECK VALVE ACCESSIBLE FROM VAULT. COORDINATE DRAINAGE SYSTEM WITH BACKFLOW DEVICE VAULT INSTALLATION. ALL VAULT DOORS TO BE UTILITY VAULT NO. 3–332P WITH 2 METER LID OPENINGS. VAULT TO BE EQUIPPED WITH AN APPROVED LADDER. IF VAULT DEPTH IS GREATER THAN 6 FT., AN APPROVED EXTENSION LADDER MUST BE INSTALLED.

2. SERVICE LINE INTO VAULT MUST HAVE A MINIMUM OF 40 FEET OF RESTRAINED JOINT PIPE BETWEEN DISTRIBUTION WATERLINE AND VAULT. SERVICE LINE INTO VAULT TO BE COMPLETELY BACKFILLED WITH SELECT BACKFILL BETWEEN DISTRIBUTION LINE AND VAULT. PIPE TO BE A MINIMUM OF 12" AND A MAXIMUM OF 48" ABOVE THE FLOOR OF THE VAULT.

3. ALL MECHANICAL JOINTS WITH MEGALUG RESTRAINER GLANDS AS SHOWN. PIPE BETWEEN THE TWO TEES MUST BE ONE CONTINUOUS PIECE – NO JOINTS.

4. ONLY APPROVED RESILIENT SEAT GATE VALVES ARE ALLOWED. ALL VALVES INSIDE VAULTS MUST HAVE HAND WHEELS.

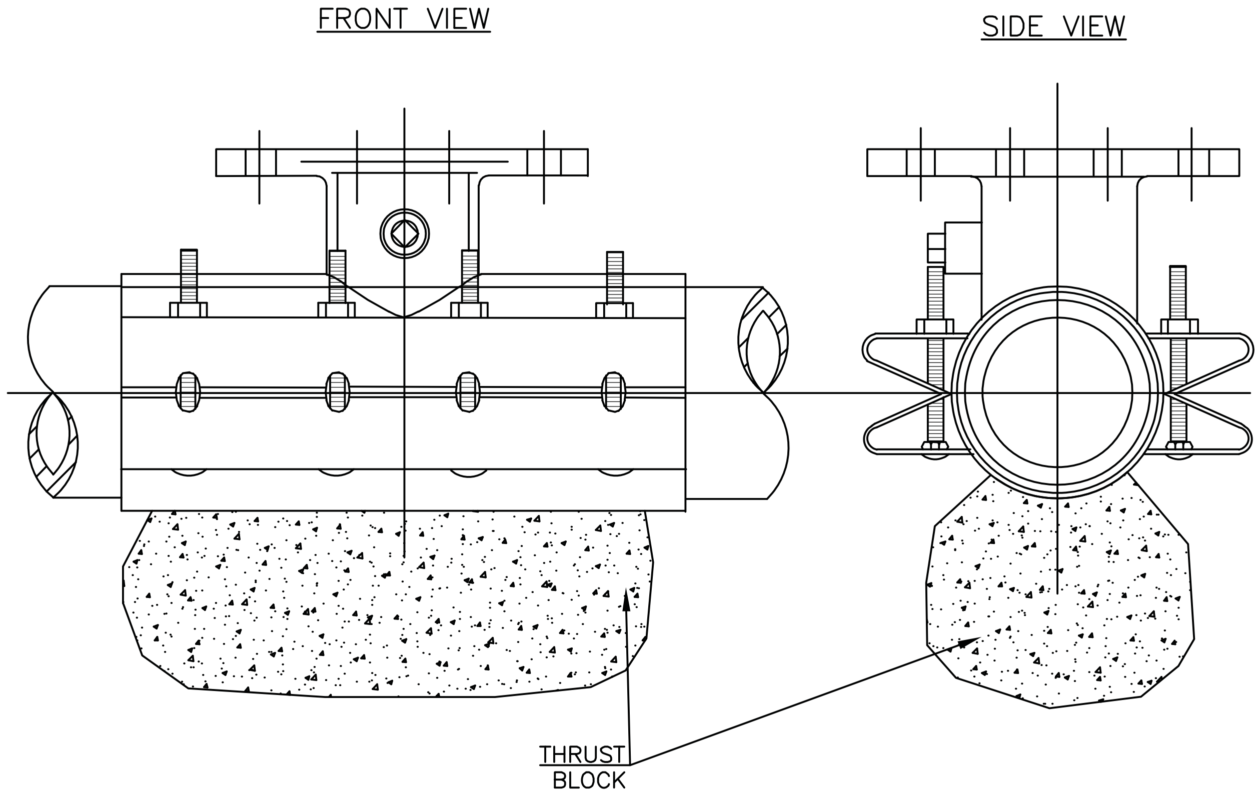
CITY OF MILWAUKIE, OREGON – PUBLIC WORKS DEPT.

Water Meter > 2"

DRAWING NO. 403

APPROVED [signature] 08/2019
CITY ENGINEER DATE

NO.	REVISIONS	DATE	BY
1	DRAWING NUMBER AND TITLE CHANGED	11/13	AJR
2	NOTES ADDED TO SHEET	11/18	TAP
3	NOTES CHANGED	08/19	TAP



NOTES:

1. WATER MAIN MUST BE CLEANED BEFORE ATTACHING SLEEVE.
2. SLEEVE AND VALVE MUST BE PRESSURE TESTED BEFORE MAKING TAP. PRESSURE TEST AND TAP TO BE MADE IN THE PRESENCE OF AN AUTHORIZED CITY REPRESENTATIVE. PROPER TAPPING MACHINE MUST BE USED TO MAKE TAP AND TAP TO BE MADE NO CLOSER THAN 18 INCHES FROM THE NEAREST JOINT.
3. THRUST BLOCKING REQUIREMENTS TO BE DETERMINED BY OSSC DRAWING RD250.
4. SLEEVE AND VALVE TO BE WRAPPED IN 8 MIL PLASTIC.
5. SLEEVES TO BE USED ARE JCM OR MUELLER STAINLESS STEEL TAPPING SLEEVES. SLEEVE TO BE AS LEVEL AS POSSIBLE.
6. ALL NUTS AND BOLTS TO BE STAINLESS STEEL. ALL BOLTS TO HAVE NEVER-SEIZE ON THREADS.
7. FOR TAPS SMALLER THAN 2.5", SEE MILWAUKIE STANDARD DETAILS 401 AND 402.

CITY OF MILWAUKIE, OREGON – PUBLIC WORKS DEPT.

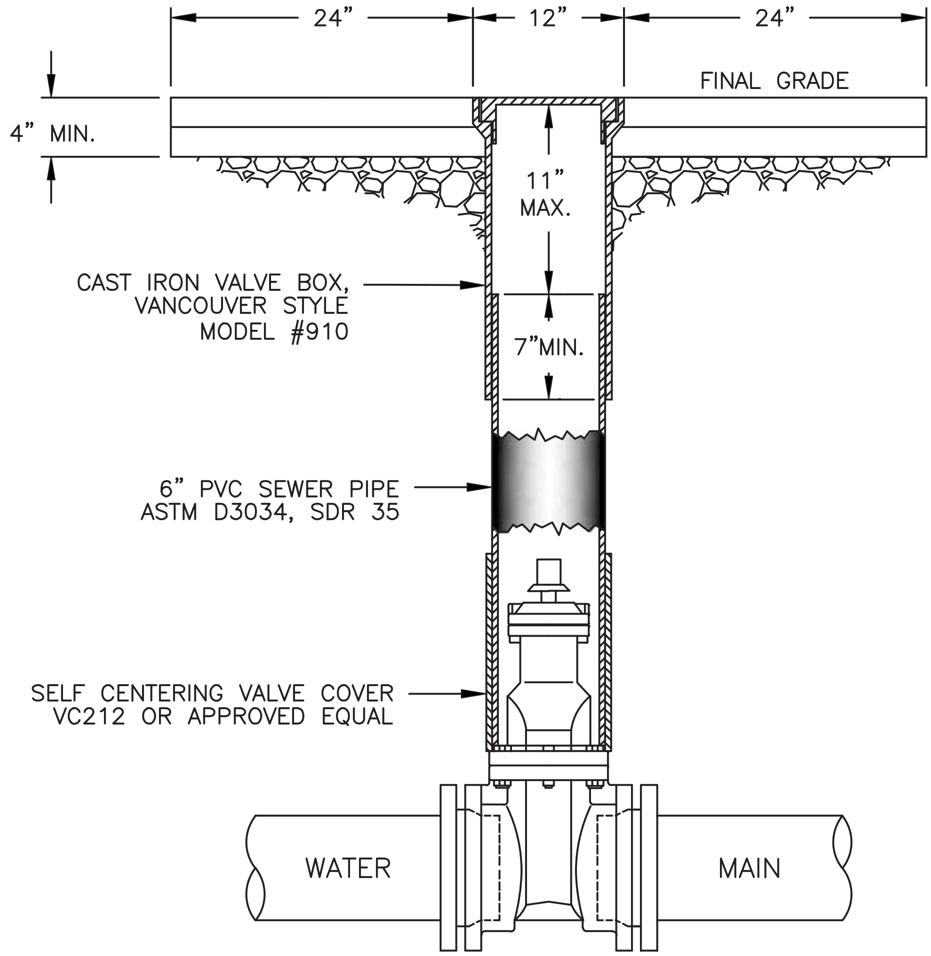
Wet Tap 2.5 Inch and Larger

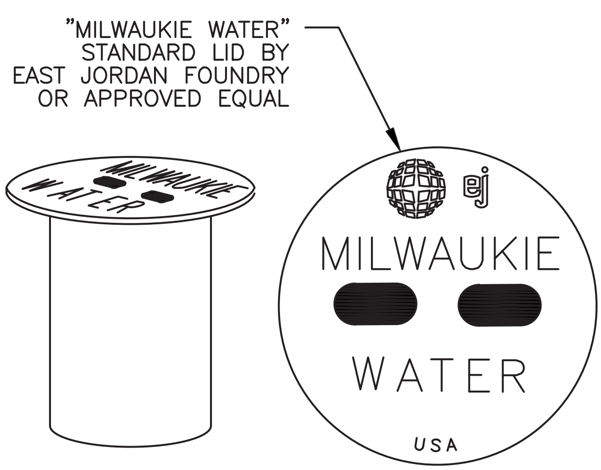
DRAWING NO. **404**

APPROVED 08/2019

CITY ENGINEER DATE

NO.	REVISIONS	DATE	BY
3	ADDED THRUST BLOCK	12/14	AJR
4	DRAWING NUMBER CHANGED, NOTES REVISED	11/18	TAP
5	TITLE AND NOTE CHANGED	08/19	TAP





18" TALL VALVE BOX

NOTES:

1. VALVE BOXES MUST BE CENTERED DIRECTLY OVER THE VALVE NUT IN A VERTICAL POSITION.
2. VALVE BOX TOP TO BE ADJUSTED TO MEET FINISHED GRADE.
3. PVC MUST BE ONE CONTINUOUS PIECE – NO BELLS OR COUPLERS.
4. VALVE NUT EXTENSIONS TO BE USED TO BRING VALVE NUT WITHIN 4 FEET OF FINAL GRADE.
5. VALVE CAN MUST BE ENCASED IN 2'x2' PAD IN UNIMPROVED AREAS. REPAIRS WITHIN PAVED STREET REQUIRE A MINIMUM 5'x5' ASPHALT PATCH.

CITY OF MILWAUKIE, OREGON – PUBLIC WORKS DEPT.

Valve Box

DRAWING NO. 405

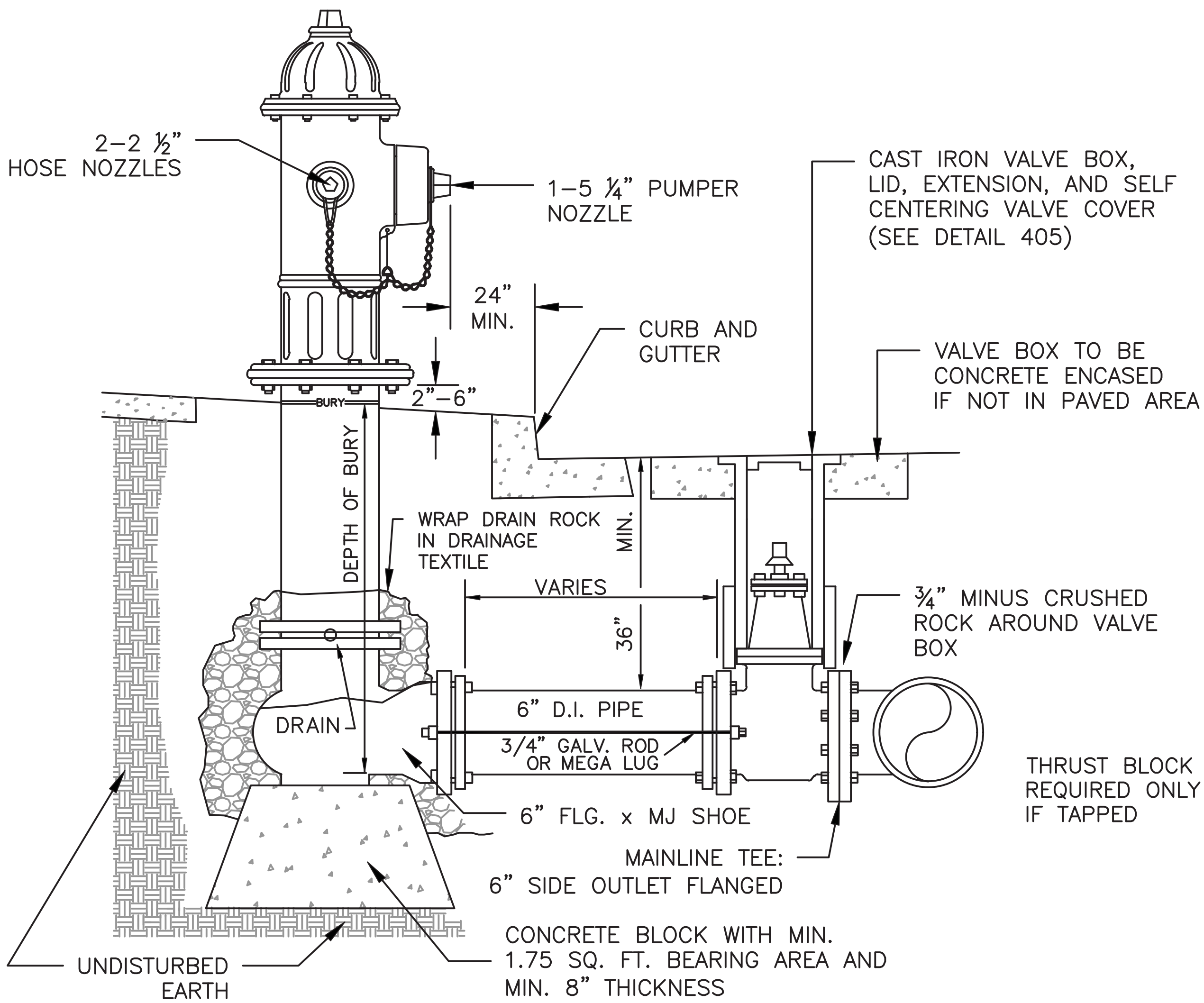
APPROVED

CITY ENGINEER 08/2019 DATE

NO.	REVISIONS	DATE	BY
3	DRAWING NUMBER CHANGED	12/13	AJR
4	DRAWING NUMBER CHANGED	11/18	TAP
5	TITLE AND NOTE CHANGED	08/19	TAP

NOTES:

1. HYDRANTS TO BE WATEROUS WB67, MUELLER CENTURION A423, M&H 929 RELIANT, OR CLOW MEDALLION F2545 WITH 1 ½" OPERATING NUTS.
2. HYDRANT COLOR TO BE MILLER EQUIP. ENAMEL OE 40 (SAFETY YELLOW).
3. JOINTS TO BE RESTRAINED BY ¾" DIA. GALVANIZED STEEL RODS <u>OR</u> MEGA LUGS.
4. ALL FITTINGS IN CONTACT W/ CONCRETE TO BE WRAPPED IN PLASTIC. HYDRANT DRAIN HOLES TO REMAIN OPEN TO DRAIN ROCK AND OPERATIONAL.
5. MIN. 4 CU. FT. OF 2"–1" CLEAN DRAIN ROCK MUST BE PLACED AROUND SHOE UP TO A MIN. OF 6" ABOVE DRAIN OUTLETS.
6. WHERE PLASTIC STRIP EXISTS, HYDRANT TO BE PLACED SO FRONT PORT IS A MINIMUM OF 24" BEHIND FACE OF CURB.
7. WHERE INTEGRAL SIDEWALK AND CURB EXISTS, HYDRANT TO BE PLACED AT BACK OF SIDEWALK, OR AS DIRECTED BY ENGINEER.
8. BURY OF HYDRANT TO BE MEASURED FROM FINISHED GRADE TO BOTTOM OF CONNECTING PIPE.
9. HYDRANT VALVE TO BE AMERICAN FLOW CONTROL SERIES 2500 OR APPROVED EQUAL.
10. WHERE NO SIDEWALK EXISTS, PLACE A 5'x5'x4" THICK CONCRETE APRON AROUND HYDRANT.
11. NO VERTICAL EXTENSIONS ALLOWED WITHOUT APPROVAL.



CITY OF MILWAUKIE, OREGON – PUBLIC WORKS DEPT.

Fire Hydrant Installation

DRAWING NO. 406

APPROVED 08/2019
CITY ENGINEER DATE

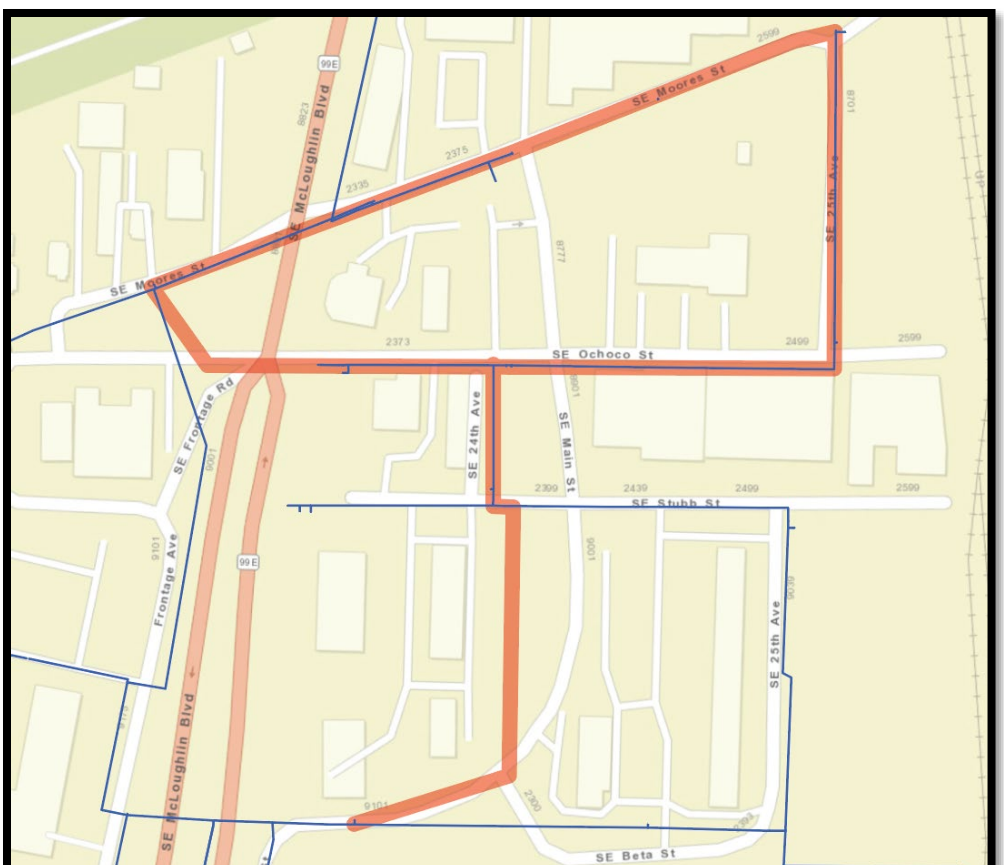
NO.	REVISIONS	DATE	BY
2	ADDED DIMENSIONS	12/12	MTC
3	REMOVED THRUST BLOCKS	12/14	AJR
4	RENUMBERED DRAWING, NOTE CHANGED	08/19	TAP

2021 Water System Master Plan

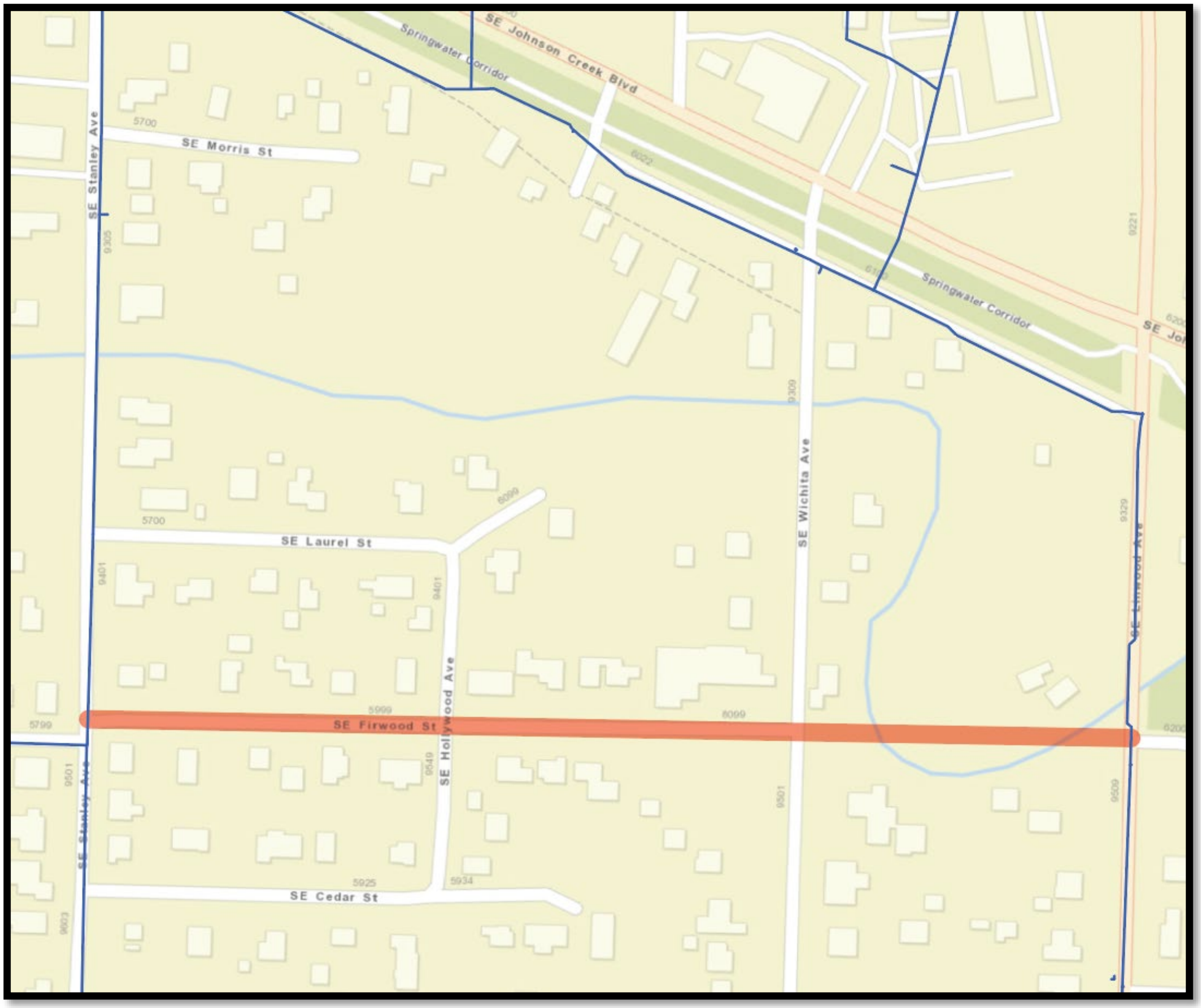
Appendix Q. CIP Distribution System Project Locations

Q. CIP DISTRIBUTION SYSTEM PROJECT LOCATIONS

Project D2—Moores Street, Ochoco Street, 25th Avenue, Main Street/24th Avenue	
Description	Replace 10-inch pipe with 650 feet of 12-inch pipe on Main St. Replace 6,10-inch pipe with 890 feet of 12-inch pipe on Ochoco St. Replace 6,10-inch pipe with 1000 feet of 12-inch pipe on Moores St. Replace 6-inch pipe with 450 feet of 12-inch pipe on 25th Ave.
Estimated Cost	$1,041,850
Recommended Schedule	2026
Purpose	Fire Flow



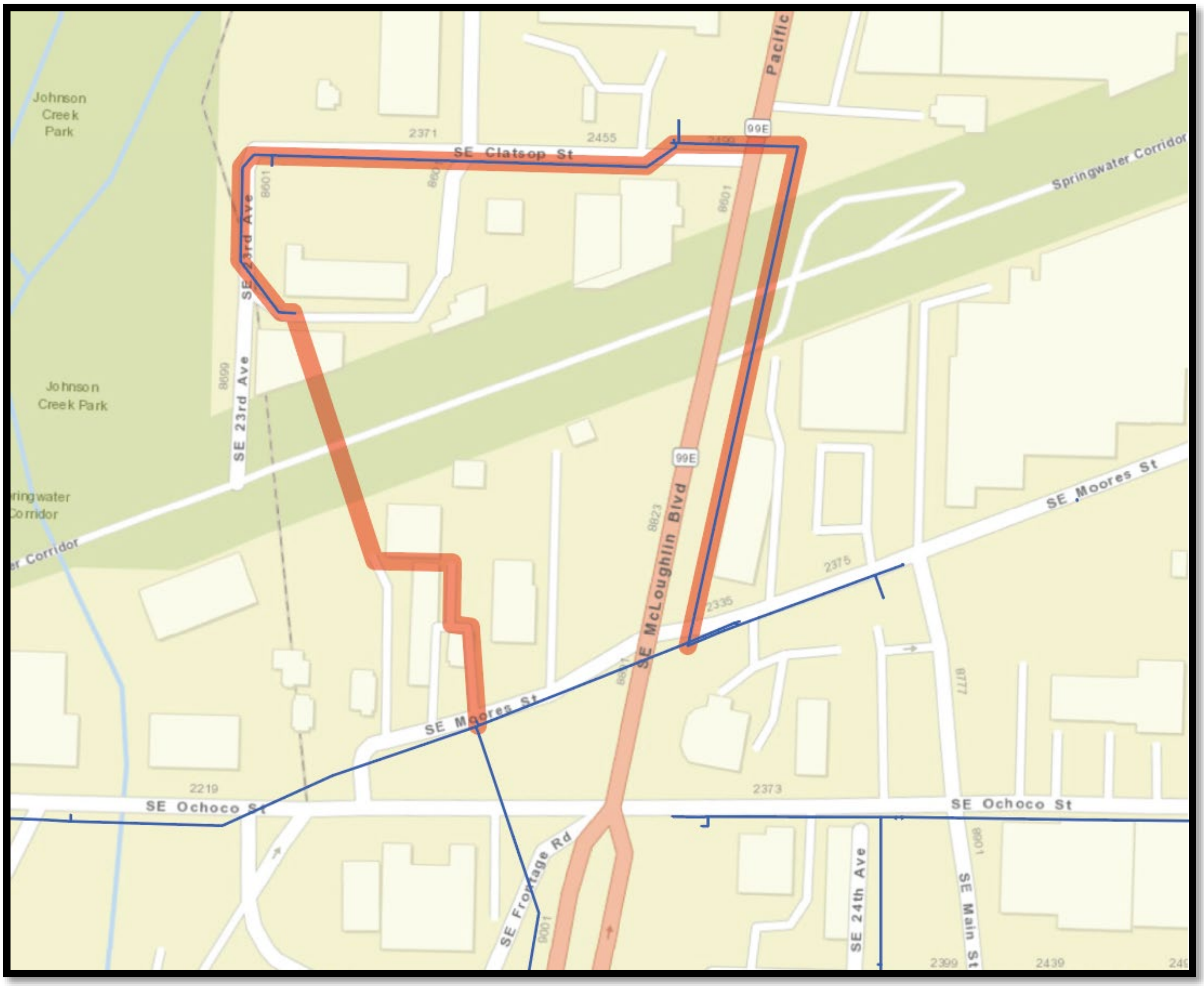
Project D3—Firwood Street	
Description	Install 1470 feet of 12-inch pipe on Firwood St.
Estimated Cost	$511,050
Recommended Schedule	2027
Purpose	Fire Flow



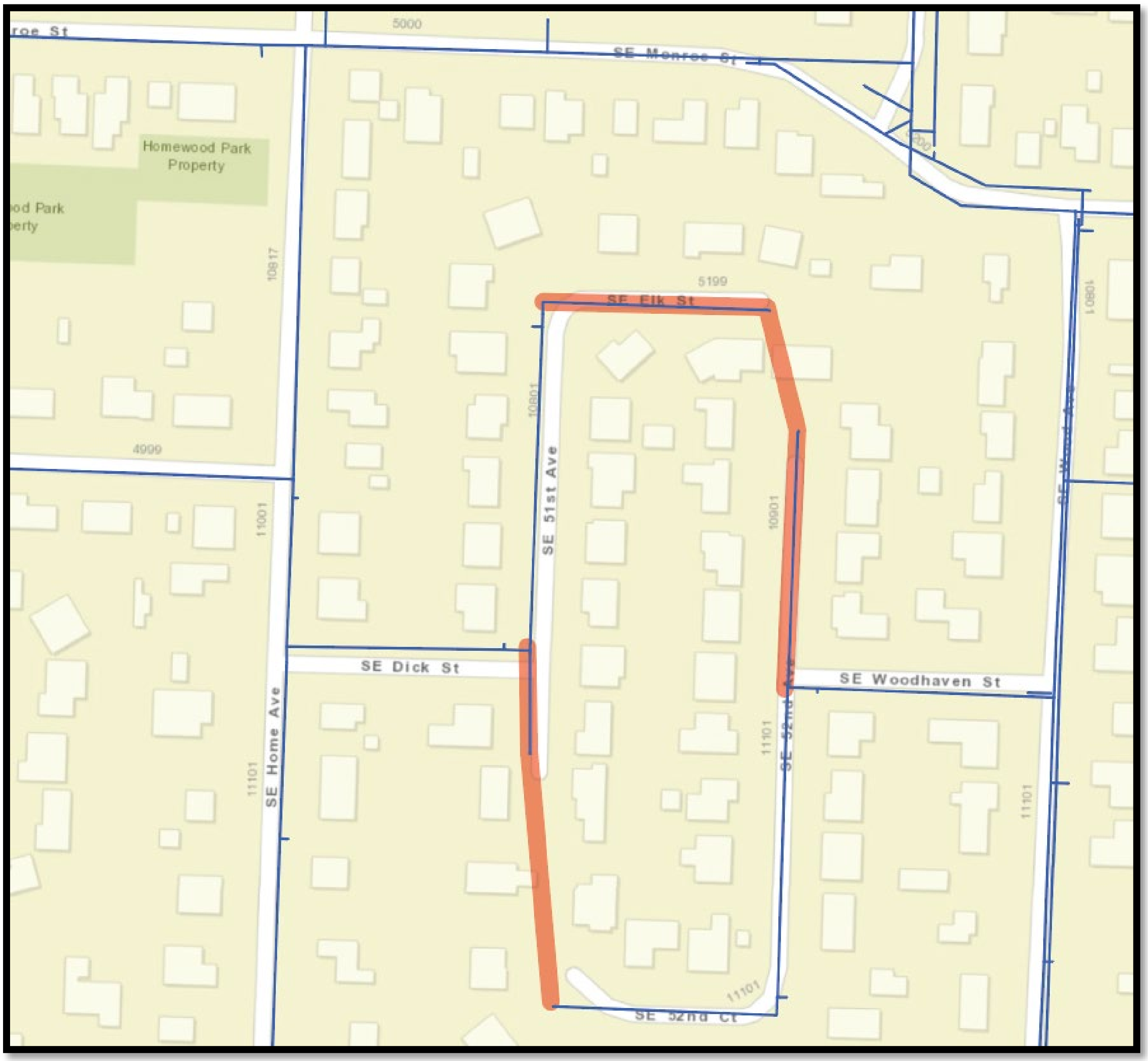
Project D4—Flavel Drive	
Description	Install 800 feet of 12-inch pipe on Flavel Dr.
Estimated Cost	$280,000
Recommended Schedule	2027
Purpose	Fire Flow

Project D5—Winworth Court	
Description	Replace 4-inch pipe with 500 feet of 8-inch pipe on Winworth Ct.
Estimated Cost	$125,500
Recommended Schedule	2028
Purpose	Fire Flow

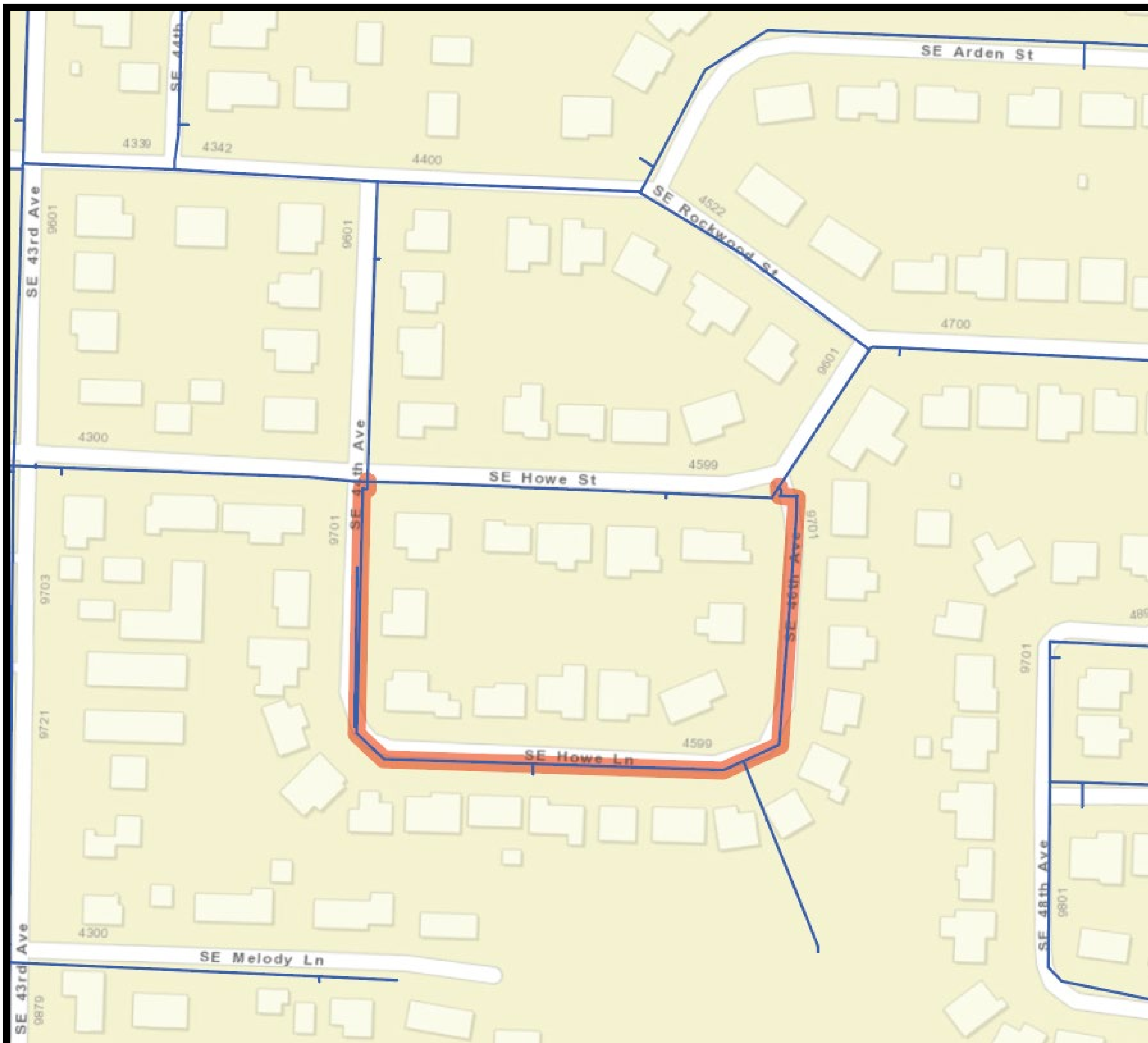
Project D6—23rd Avenue, Clatsop Street, McLoughlin Boulevard	
Description	Install 750 feet of 12-inch pipe on 23rd Ave. Replace 6-inch pipe with 600 feet of 12-inch pipe on Clatsop St. Replace 6-inch pipe with 660 feet of 12-inch pipe on McLoughlin Blvd.
Estimated Cost	$700,150
Recommended Schedule	2027
Purpose	Fire Flow



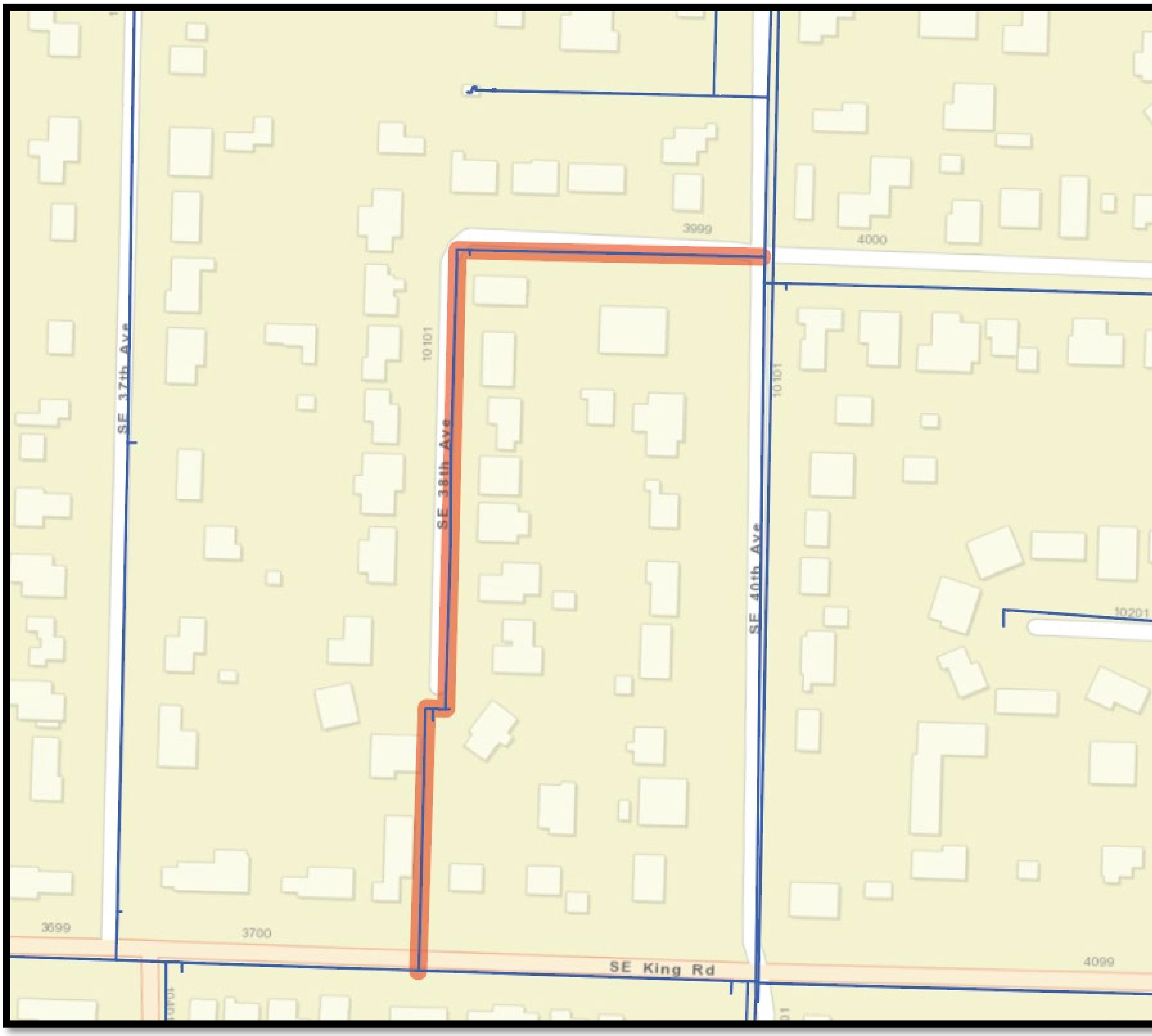
Project D7—Elk Street, 51st Avenue, 52nd Avenue	
Description	Replace 4-inch pipe with 240 feet of 8-inch pipe on Elk St. Install 380 feet of 8-inch pipe on 51st Ave. Install 380 feet of 8-inch pipe on 52nd Ave.
Estimated Cost	$252,000
Recommended Schedule	2025
Purpose	Fire Flow



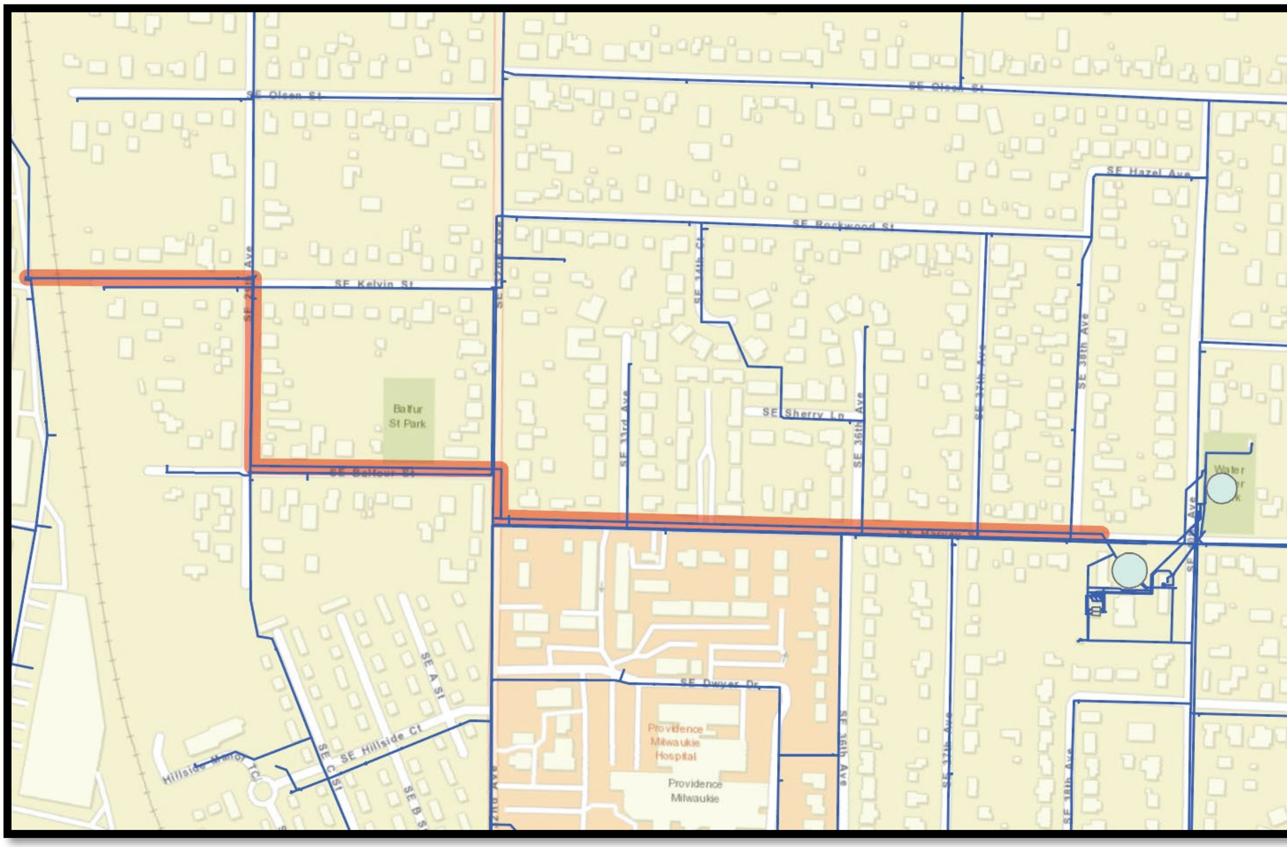
Project D8—44th Avenue, Howe Lane, 46th Avenue	
Description	Replace 4-inch pipe with 260 feet of 8-inch pipe on 44th Ave. Replace 4-inch pipe with 440 feet of 8-inch pipe on Howe Ln. Replace 4-inch pipe with 260 feet of 8-inch pipe on 46th Ave.
Estimated Cost	$239,800
Recommended Schedule	2027
Purpose	Fire Flow



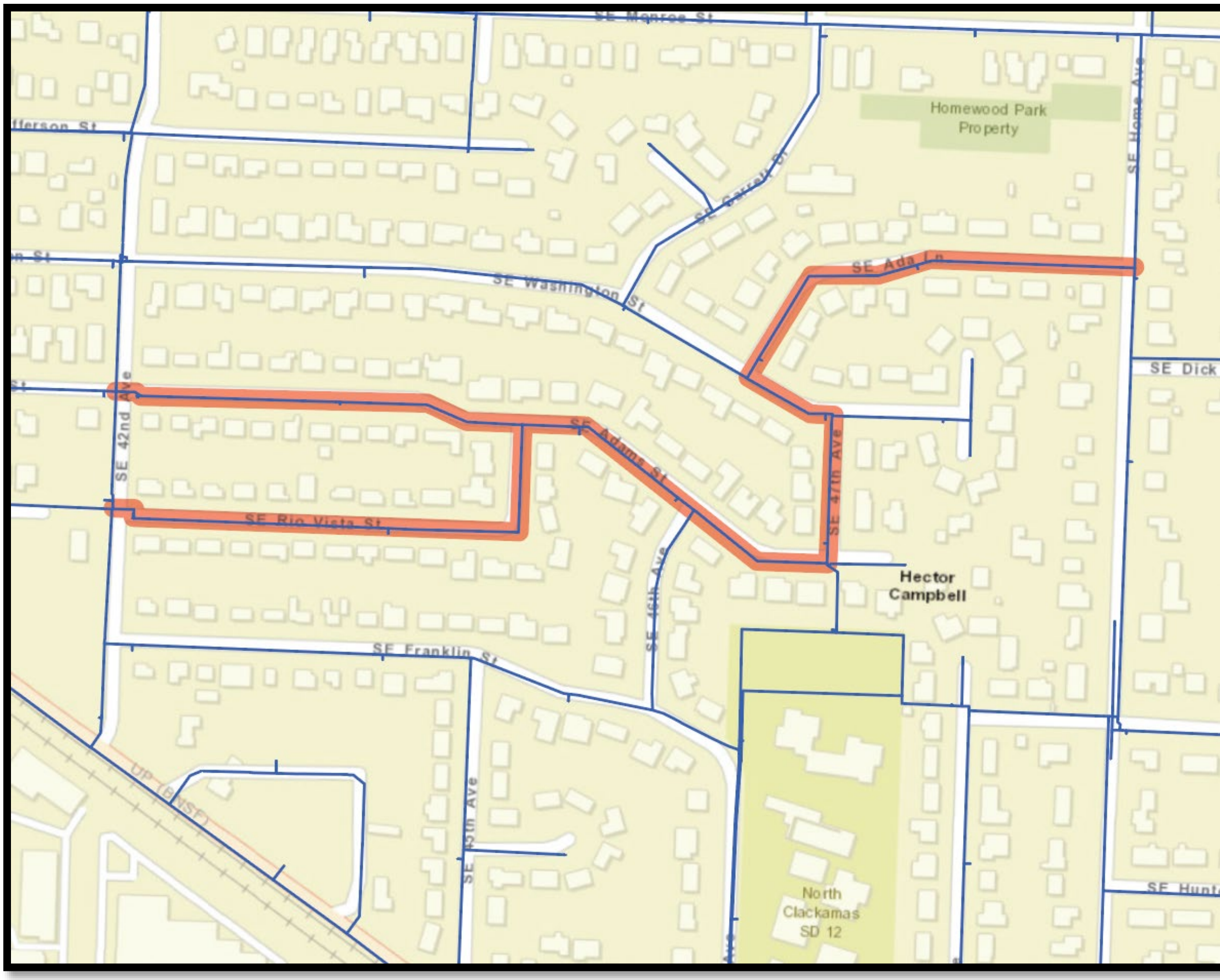
Project D9—Drake Street, 38th Avenue	
Description	Replace 6-inch pipe with 360 feet of 8-inch pipe on Drake St. Replace 4, 6-inch pipe with 780 feet of 8-inch pipe on 38th Ave.
Estimated Cost	$286,700
Recommended Schedule	2031
Purpose	Fire Flow



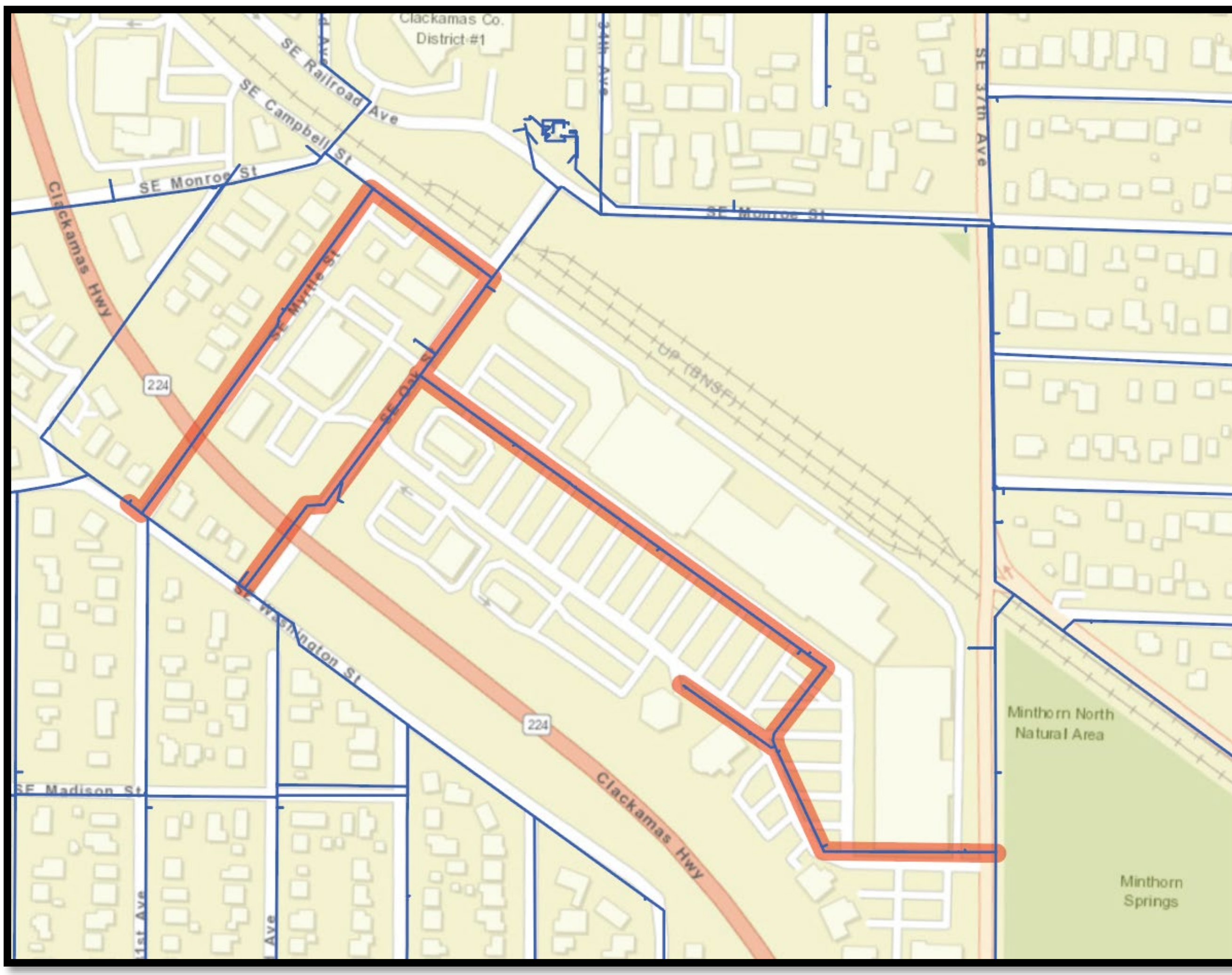
Project D10—Concrete Reservoir to Zone 2 (Harvey Street, Balfour Street, Kelvin Street)	
Description	Replace 16-inch transmission main from the Concrete Reservoir to Zone 2 with 3800 feet of 18-inch pipe.
Estimated Cost	$1,786,000
Recommended Schedule	2028
Purpose	Transmission



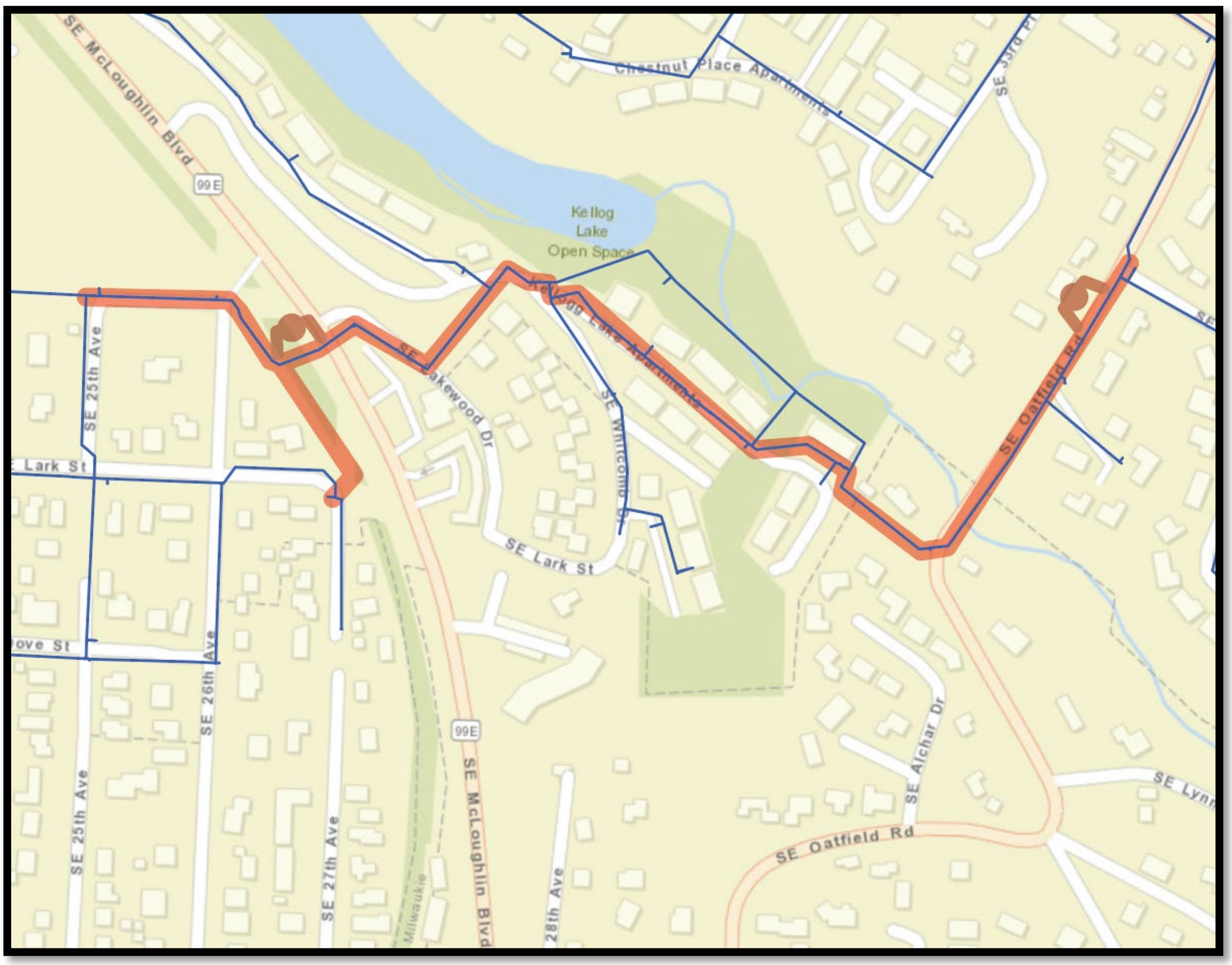
Project D11—Rio Vista Street, Adams Street, 47th Avenue, Washington Street, Ada Lane	
Description	Replace 6-inch pipe with 1550 feet of 8-inch pipe on Adams St. Replace 6-inch pipe with 300 feet of 8-inch pipe on 47th Ave. Replace 6-inch pipe with 900 feet of 8-inch pipe on Ada Ln. Replace 4, 6-inch pipe with 1,010 feet of 8-inch pipe on Rio Vista St. Replace 6-inch pipe with 190 feet of 8-inch pipe on Washington St.
Estimated Cost	$993,250
Recommended Schedule	2028
Purpose	Fire Flow



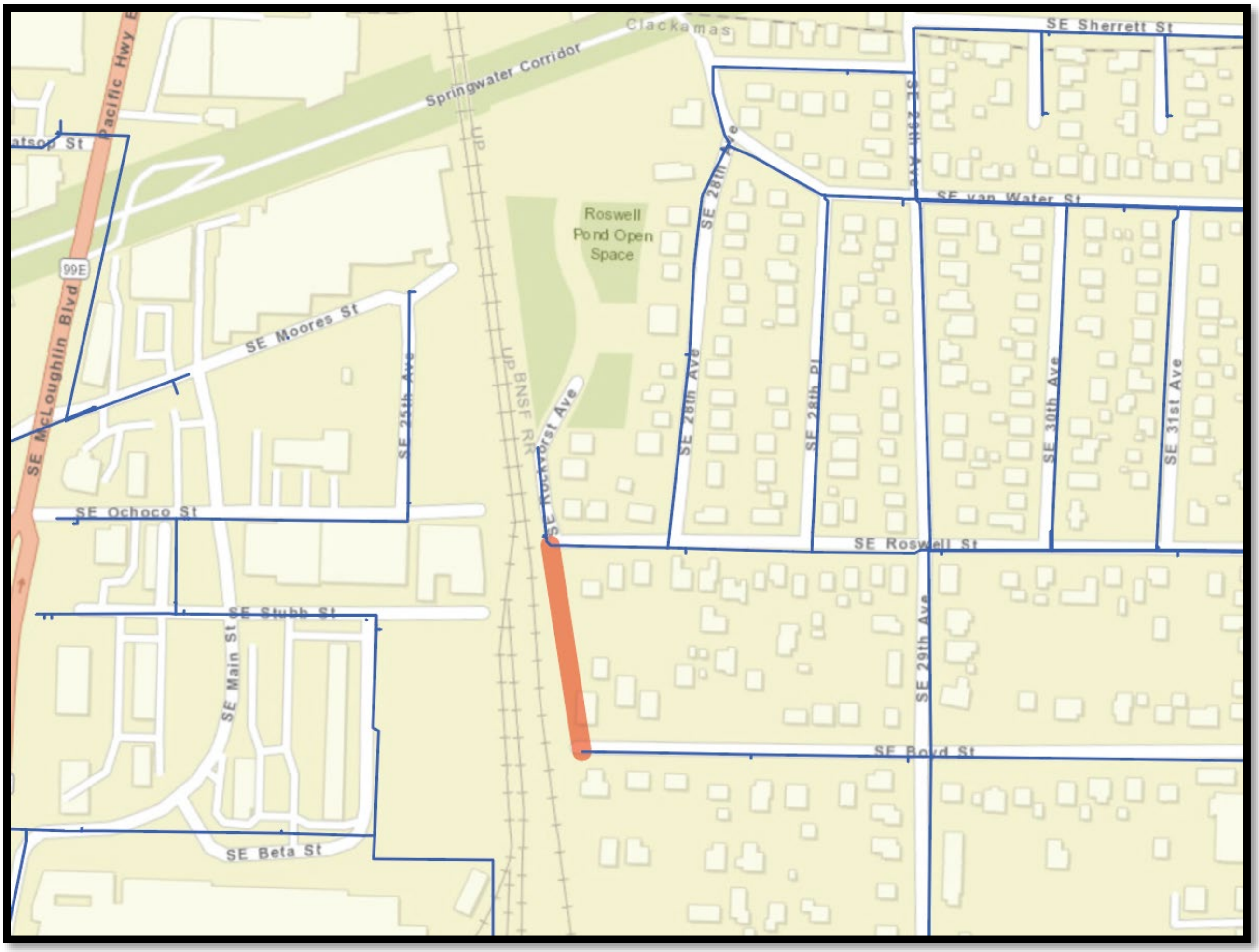
Project D12—Myrtle Street, Campbell Street, Oak Street, Retail Center	
Description	Replace 6-inch pipe with 800 feet of 16-inch pipe on Oak St. Replace 6-inch pipe with 550 feet of 16-inch pipe on Campbell St. Replace 8-inch pipe with 220 feet of 12-inch pipe in the retail center. Replace 8-inch pipe with 1820 feet of 16-inch pipe in the retail center west of 37th Ave. Replace 6-inch pipe with 240 feet of 12-inch pipe on Oak St. Replace 4-inch pipe with 800 feet of 8-inch pipe on Myrtle St.
Estimated Cost	$1,722,950
Recommended Schedule	2027
Purpose	Fire Flow



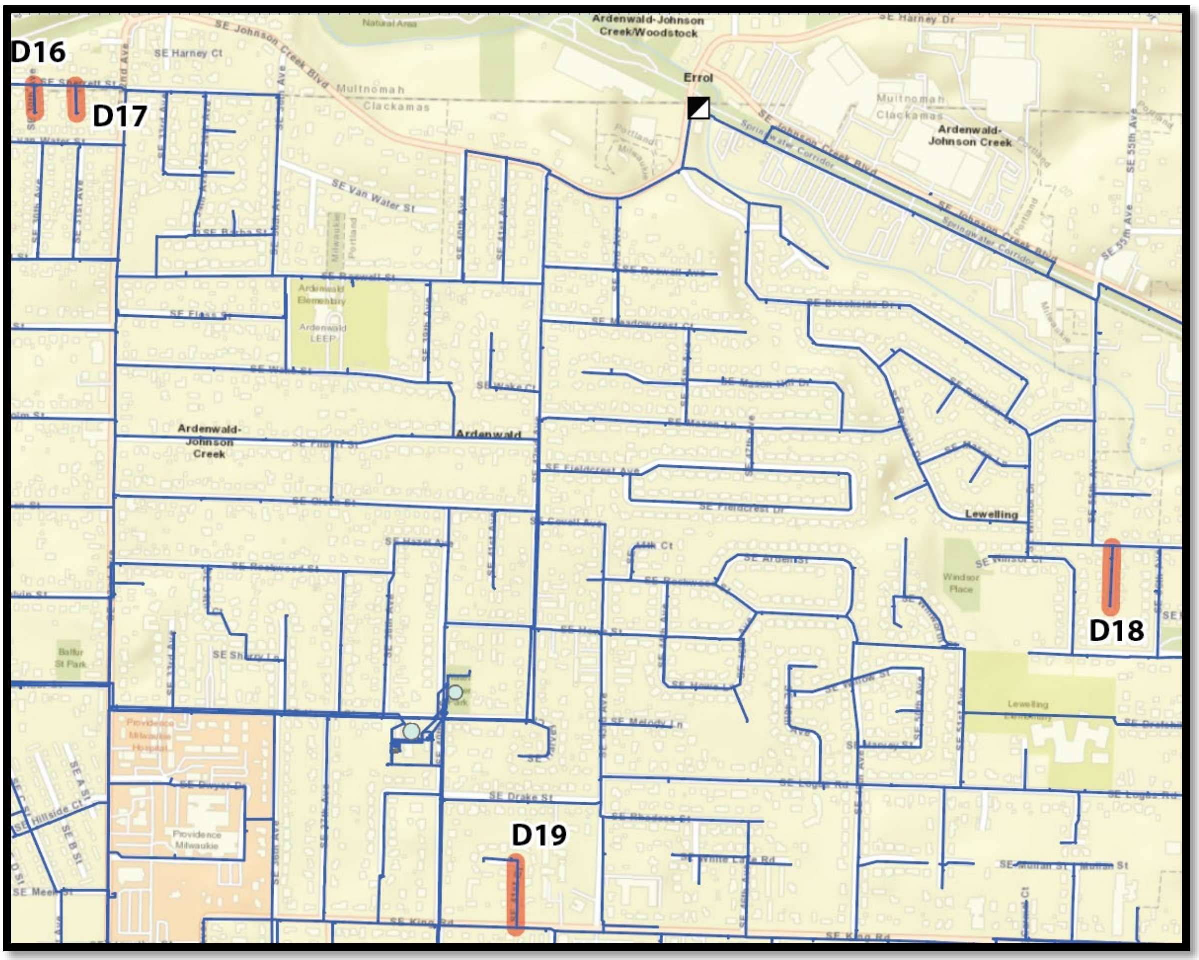
Project D13—South of Kellogg Lake	
Description	Replace 10-inch pipe with 300 feet of 16-inch pipe on Sparrow St. Replace 10-inch pipe with 250 feet of 16-inch pipe on Lakewood Dr. Replace 10-inch pipe with 850 feet of 16-inch pipe off road. Install PRV at Oatfield Rd and Guildford Ct. Replace 6-inch pipe with 330 feet of 16-inch pipe at Kellogg Lake Apartments. Replace 10-inch pipe with 380 feet of 16-inch pipe on Oatfield Rd. Install PRV at Lakewood Dr and McLoughlin Blvd.
Estimated Cost	$1,165,150
Recommended Schedule	2029
Purpose	Fire Flow



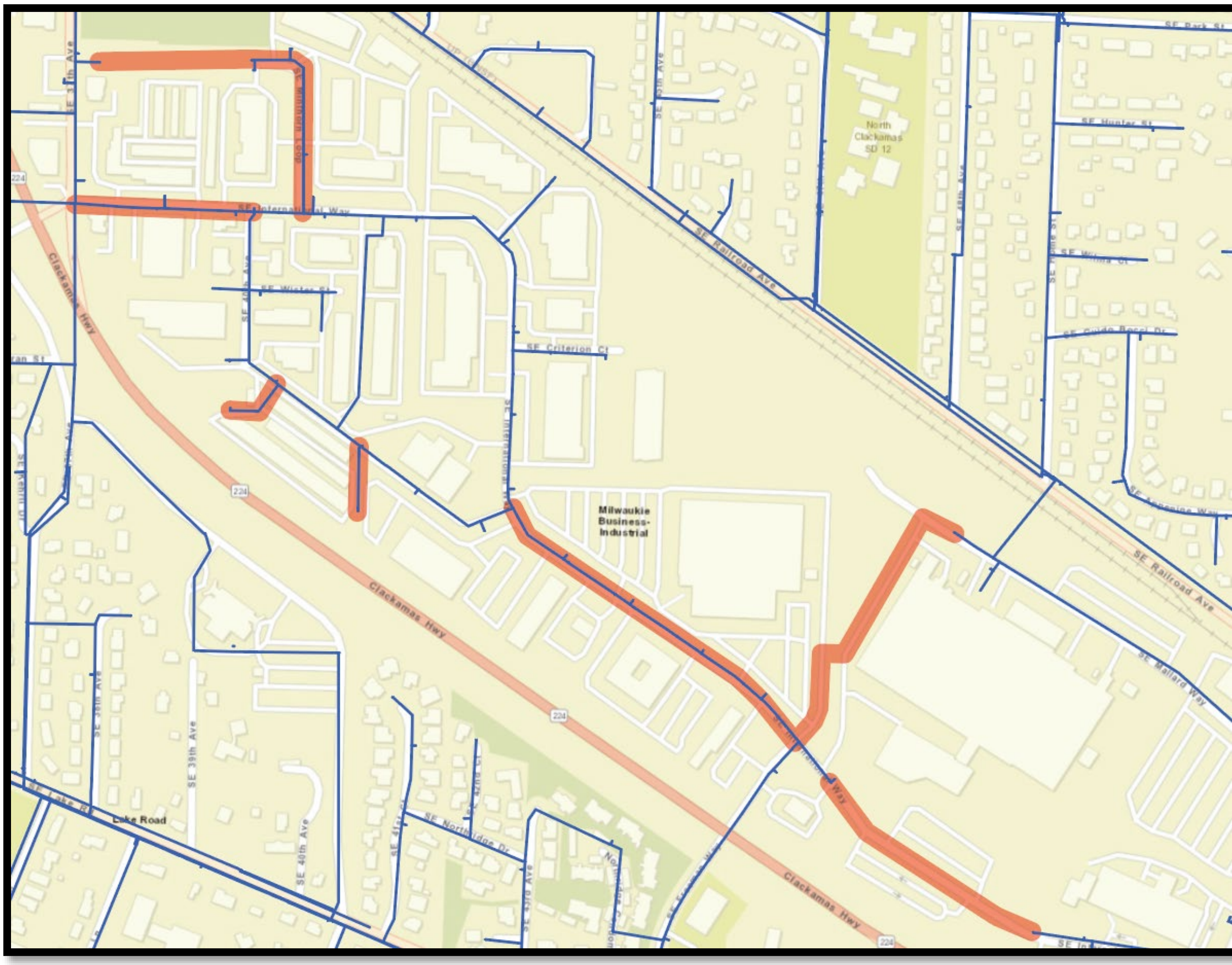
Project D14—Roswell Street/Boyd Street Connection	
Description	Install 450 feet of 8-inch pipe between Roswell St and Boyd St.
Estimated Cost	$113,750
Recommended Schedule	2024
Purpose	Fire Flow



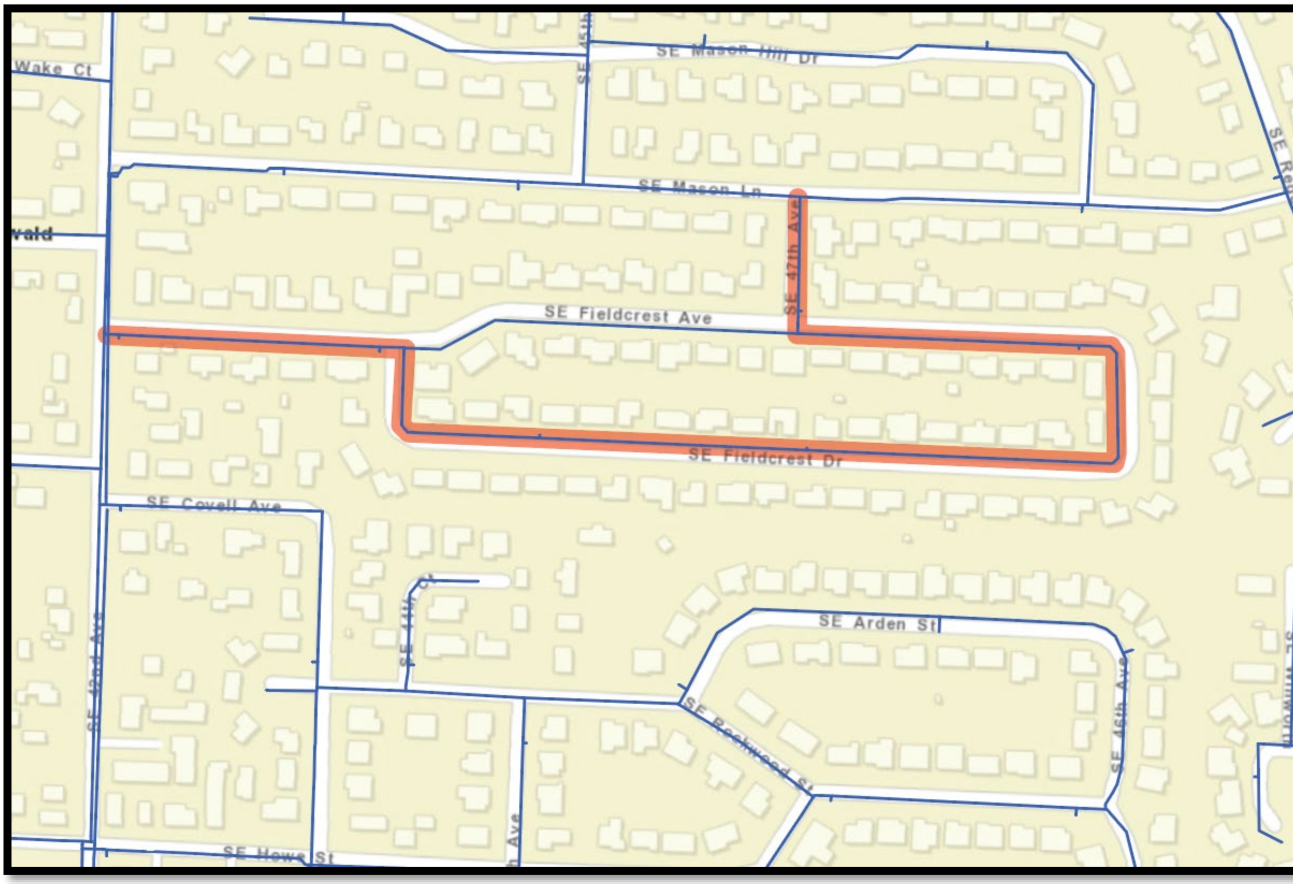
Project D16, D17, D18, D19—Upsize Dead End Mains		
Description	D16	Replace 4-inch pipe with 180 feet of 8-inch pipe on 30th Ave.
	D17	Replace 4-inch pipe with 180 feet of 8-inch pipe on 31st Ave.
	D18	Replace 4-inch pipe with 300 feet of 8-inch pipe on 55th Ave.
	D19	Replace 6-inch pipe with 470 feet of 8-inch pipe on 41st Ct.
Estimated Cost	D16	$43,900
	D17	$43,900
	D18	$76,500
	D19	$118,850
Recommended Schedule		2032
Purpose		Fire Flow



Project D20—International Way Vicinity	
Description	Install 580 feet of 16-inch pipe on Minthorn Springs. Replace 10, 12-inch pipe with 3600 feet of 16-inch pipe on International Way. Replace 8-inch pipe with 670 feet of 16-inch pipe on Minthorn Loop. Replace 6-inch pipe with 400 feet of 8-inch pipe in the industrial area east of 37th Ave.
Estimated Cost	$2,182,250
Recommended Schedule	2028
Purpose	Fire Flow

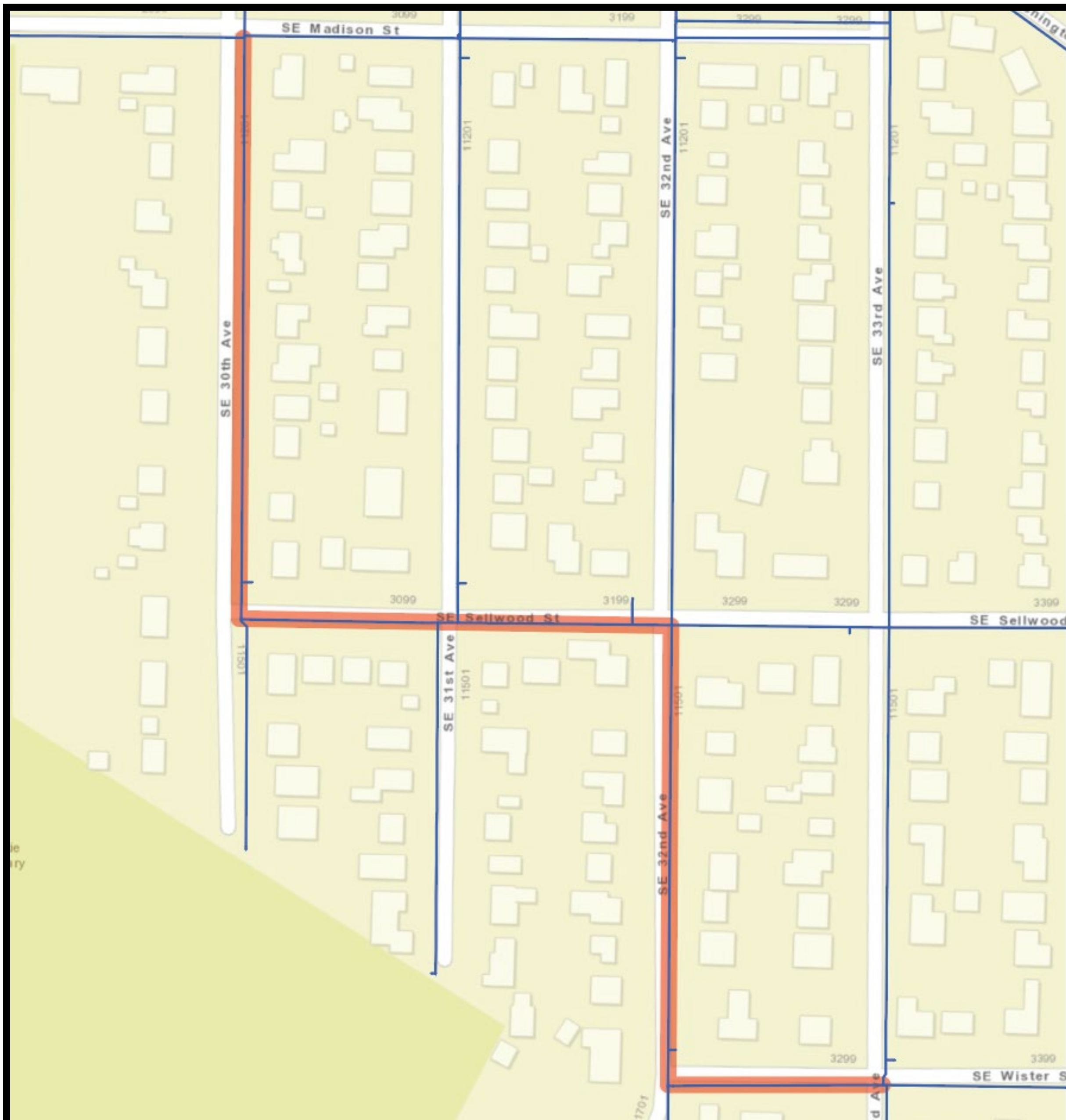


Project D21—Fieldcrest, 47th Avenue	
Description	Replace 6-inch pipe with 250 feet of 8-inch pipe on 47th Ave. Replace 4, 6-inch pipe with 1750 feet of 8-inch pipe on Fieldcrest Dr. Replace 6-inch pipe with 1120 feet of 8-inch pipe on Fieldcrest Ave.
Estimated Cost	$782,600
Recommended Schedule	2029
Purpose	Fire Flow



Project D23—King Road, Llewellyn Street, Harrison Street	
Description	Replace 6, 8-inch pipe with 1660 feet of 12-inch pipe on King Rd. Replace 8-inch pipe with 1300 feet of 12-inch pipe on Llewellyn St. Replace 8-inch pipe with 670 feet of 12-inch pipe on Harrison St. Replace 4, 10-inch pipe with 270 feet of 12-inch pipe on 42nd Ave.
Estimated Cost	$1,358,500
Recommended Schedule	2031
Purpose	Fire Flow

Project D24—30th Avenue, Sellwood Street, 32nd Avenue, Wister Street	
Description	Replace 6-inch pipe with 710 feet of 8-inch pipe on 30th Ave. Replace 6-inch pipe with 520 feet of 8-inch pipe on Sellwood St. Replace 6-inch pipe with 560 feet of 8-inch pipe on 32nd Ave. Replace 6-inch pipe with 250 feet of 8-inch pipe on Wister St.
Estimated Cost	$511,200
Recommended Schedule	2031
Purpose	Fire Flow



Project D25—King Rod Hydrants	
Description	Reconnect King Rd Hydrants to 10-inch line.
Estimated Cost	$19,400
Recommended Schedule	2031
Purpose	Fire Flow