SW LINCOLN COUNTY WATER

People's Utility District

LINCOLN COUNTY, OREGON

Water System Master Plan

September 2019

Civil West
Engineering Services, Inc.

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SW Lincoln County Water

People's Utility District

LINCOLN COUNTY, OREGON

Water System Master Plan

September 2019

Prepared by:

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PUBLIC HEALTH DIVISION
Center for Health Protection, Drinking Water Services
Kate Brown, Governor

Oregon Health Authority

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November 22, 2019

Carla Young
SW Lincoln County Water PUD
P.O. Box 368
Waldport, OR 97394

Re: **Master Plan (PR#2019-139)**
SW Lincoln Co. Water PUD (PWS#00925)
Master Plan Approval

Dear Carla Young:

Thank you for the submittal to the Oregon Health Authority's Drinking Water Services (DWS) of a Water System Master Plan for the SW Lincoln County Water PUD. On October 18, 2019 our office received a copy of the SW Lincoln County Water PUD Water System Master Plan dated September 2019. A plan review fee of $4,125 was also received. The ten elements of a Master Plan required in Oregon Administrative Rule (OAR) 333-061-0060(5)(A through J) have been met and DWS concurs with these findings. DWS grants the Master Plan approval.

The Master Plan represents a 20-year planning horizon out to the year 2039. The plan includes system goals and description, future demand estimates, engineering evaluation, evaluations of options to meet future demand, financing, and a list of recommended projects and cost estimates. A seismic risk assessment and mitigation plan is included.

In addition, I have the following comments on the plan:

- Identification water quality issues are not mentioned, which may be driven by there are no issues currently with the water quality. At the very least, if there are no water quality issues then that should be mentioned.

- Please be aware that USEPA has resources to increase resiliency regarding an earthquake. These can be found at www.epa.gov/waterutilityresponce.

Please note that OAR 333-061-0060 contains plan submission and review requirements for all major water system additions or modifications. Construction plans and specifications must be submitted to and approved by DWS before construction begins. Thus, this approval letter does not apply to individual projects identified within the Master Plan. Each project, or combined projects, must go through plan review with DWS, with the exception of water main extensions or replacements when the water system meets the requirements of OAR 333-061-0060(4).

Thank you for the Master Plan submission. If you have any questions, you are welcome to contact me at (541) 726-2587 x29 or via email at rebecca.a.templin@dhsoha.state.or.us.

Sincerely,

Rebecca Templin, P.E.
Regional Engineer
Drinking Water Services

cc: Julie Wray, DWS Portland
Keven Shreeve, Civil West Engineering Services, Inc.

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1 EXECUTIVE SUMMARY

1.1 Introduction and Overview

The Southwest Lincoln County Water People's Utility District ("District") is a public water district located between the City of Waldport on the North and the City of Yachats on the South along Highway 101. The Southwest Lincoln County Water PUD is responsible for supplying water to property owners within the District boundaries. Due to seasonal fluctuation, the District can serve as few as 2000 people to as many as 6000 people.

Civil West Engineering Services, Inc was commissioned by the District to develop a new 20-year Water System Master Plan ("Plan") with the assistance of District staff. This Plan will act as a guide for the District as it prepares for the future. The Plan addresses a wide range of recommended improvements, including be not limited to system pressures, fire flows, aging pipelines, water storage, and redundancy concerns. A valuable piece of this Plan was the creation and utilization of a computer water model that evaluated the current and future distribution pipeline network.

1.2 Purpose and Need

The purpose of this Plan is to document findings regarding the District's potable water system in its current state and over the next 20-year period.

The District and Civil West reviewed and assessed fundamental planning elements such as current population, projected population growth, water supply sources, current and projected water demand, and the capability to meet current and future fire flow requirements. The assessment did result in a number of recommended improvements (capital improvements) with associated costs and priorities. Figures and supporting data for the information presented in this report have been included in the appendices for reference.

This Master Plan includes:

- A review of the fundamental planning elements (design criteria) such as population, system capacity, water supply and demand, and fire flow requirements.
- A summary of each water system component, its condition and status.
- A seismic risk assessment.
- Identification of upgrades and improvements to address potential vulnerabilities and correct deficiencies.
- A summary of recommended capital improvements with anticipated costs.
- Potential water user rate impacts due to capital improvement projects.

1.3 Existing Water System and Improvement Recommendations

1.3.1 Water Supply Sources

There are four (4) sources of water, each source from a surface water stream: Dicks Fork, Big Creek, Vingie Creek, and Starr Creek. These creeks have proven to be very reliable water sources. There are improvements that can be made to a couple of diversion structures and should be anticipated as Priority 2 or later projects. Water rights appear to be sufficient for the needs of the District for the next several years; however, the District is taking proactive steps and currently seeking to acquire additional water rights for Vingie Creek.

1.3.2 Water Quality and Treatment Plants

The District operates two water treatment plants (Blodgett Water Treatment Plant and the Dicks Fork Water Treatment Plant), that treat the water from the above-mentioned water sources. The Blodgett Water Treatment Plant provides water to approximately 75% of the District's customers. The Dicks Fork Water Treatment Plant serves the remaining 25%. At this time, both treatment plants are adequate for the near future, although routine maintenance and upkeep is always required. As shown within this Plan, some minor upgrades and improvements to the Blodgett Water Treatment Plant are recommended in Priority 1. Additional improvements to both water treatment plants are recommended in Priority 2.

1.3.3 Water Storage

The District's existing treated water storage consists of two concrete storage tanks plus three steel storage tanks. Present storage capacities and elevations are as follows:

Name	Capacity (gals)	Elevation	Type
Dicks Fork Tank	200,000	330	Concrete
Seabrook Tank	200,000	180	Concrete
Blodgett Tank	1,000,000	185	Steel
Starr Creek Tank	500,000	180	Steel
Crabapple Tank	54,000	335	Steel

From computer modeling and analysis additional storage is needed, primarily to fight a major fire in certain locations in the District. Future storage locations and capacities are as follows:

Name	Capacity (gals)	Suggested Elevation
Dicks Fork Tank No. 2	500,000	330
Wakonda Beach Road Tank	500,000	180
Seabrook Tank No. 2	250,000	180

1.3.4 Distribution System

The distribution system generally appears adequate. However, due to the overall age of the system and deteriorating pipelines, the following additional reasons are why the District should consider upgrades and improvements to their distribution pipeline system:

1. Replacement of pipelines due to insufficient system pressures (pipes are too small).
2. Replacement of asbestos cement pipelines.
3. Installation of new pipelines to eliminate dead-end lines (provide a looped network – eliminating possible water quality and quantity problems).
4. Seismic resiliency and secure infrastructure backbone

1.4 Recommended Alternative and Capital Improvement Plan (CIP)

As shown in this Plan, and as mentioned above, there are recommended water system improvements for each component of the system. Some improvements are more important than others and are denoted as Priority 1 projects. These Priority 1 projects should be considered within the next five years. Priority 2 and other improvements should be considered and anticipated to be completed within the Plan timeframe of 20-years.

Recommended system-wide improvements are summarized in Table 7.1 along with opinions of probable costs. Table 7.2 found later in the report, and shown below for convenience to the reader, shows the Priority 1 recommended improvements with opinion of probable costs.

Water CIP - Priority 1		
Description	**Item Cost**	
Blodgett WTP Phase 1	$	324,000.00
Dicks Fork Tank No. 2	$	1,532,000.00
Pump Stations	$	154,000.00
Treated Water Distribution System Upgrades - Priority 1	$	3,201,000.00
Environmental Report and Geotechnical (seismic)	$	100,000.00
Project Interim Financing	$	140,000.00
Opinion of Probable Cost Total (rounded)	**$**	**5,451,000.00**

1.5 Project Financing and Potential User Rate Impacts

The current District water rate schedule includes a base rate plus usage plus existing debt surcharge. Table 7.7, found later in the report and shown below for convenience, shows the financial impacts of Priority 1 improvements to residential users depending on the amount of grant money received.

Priority 1	**No Grant, 2.00% Loan**	**20% Grant**	**30% Grant**
Capital Cost	$5,451,000	$5,451,000	$5,451,000
Loan Needed	$5,451,000	$4,360,800	$3,815,700
Interest Rate	2.000%	2.000%	2.000%
Loan Period (yrs)	30	30	30
Annual Annuity	$243,386.73	$194,709.38	$170,370.71
Monthly Income Required	$20,282.23	$16,225.78	$14,197.56
Monthly Income Reqd' w/ 10% reserve	$22,310.45	$17,848.36	$15,617.31
Number of EDUs (Current)	1258	1258	1258
Priority 1 Subtotal - Monthly Cost per EDU	**$17.73**	**$14.19**	**$12.41**
Current Base Rate + Usage (Res.)	$43.20	$43.20	$43.20
Current Bond Surcharge (Res.)	$9.20	$9.20	$9.20
New Average Residential Water Bill - Phase I	**$70.13**	**$66.59**	**$64.81**

EDU = Equivalent Dwelling Unit (e.g. an average household customer)

1.6 Conclusion

The District should pursue funding for the implementation of the Priority 1 improvements.

2 DESIGN CRITERIA

2.1 General

This section details the various parameters and design criteria the water system is evaluated against and serves as the basis for identifying needed improvements. These criteria include an evaluation of population, present and future potable water demands, and other factors affecting the water system.

2.2 Study Area and Planning Period

The Southwest Lincoln County Water District is located within an approximate 2-mile wide by 8-mile long strip of land between the City of Waldport on the North and the City of Yachats on the South along Highway 101. The District is responsible for supplying water to property owners within the District boundaries. The Pacific Ocean coastline forms the western border of the District and U.S. Forest Service land or sparsely developed private forestlands form the eastern border of the District. U.S. Highway 101 is the primary transportation link and most District water users are within this corridor. Topography within the District is flat to gently sloping except at some eastern limits, where foothills begin. Few locations are higher than 200 feet elevation. Most water users reside below an elevation of 100 feet.

This Water Master Plan uses a 20-year planning period.

2.3 Population Projections

2.3.1 Current Population

The District's boundaries include a small portion of the City of Waldport and all of the unincorporated area between the Cities of Waldport and Yachats. The District currently has 1200 active residential and 58 other water customer service connections ranging in size from 3/4-inch to 6-inch. According to the 2010 US Census, the average number of persons per household in Lincoln County is 2.17. Based on this household density and the number of residential service connections (many connections do not represent full-time occupancy) the estimated population is 2604. Based on past District studies and observations, the population served can fluctuate from approximately 2000 people in the winter to approximately 6000 people in the summer when all campgrounds, motels, and second residences are full. These numbers are variable as there is no accurate population count for the areas of the county outside of cities, such as this District.

Table 2.1 summarizes the historical customer connection accounts the past six years.

TABLE 2.1 – DISTRICT WATER ACCOUNTS PER CUSTOMER CLASS

Acct type	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Residential	1195	1192	1189	1189	1196	1200
Commercial	46	46	46	46	46	46
Federal	5	5	5	5	5	5
State	2	2	2	2	2	2
School	2	2	2	2	2	2
2" Fire	2	2	2	2	2	2
6" Fire	1	1	1	1	1	1
	1253	1250	1247	1247	1254	1258

2.3.2 **Future Population**

To maintain consistency between District reports, information from previous studies was used in projecting future populations. Based on the historical population trends, past projection approaches were deemed sufficient for purposes of this Plan. Current information (e.g. residential connections) was used where applicable.

> "Population estimates for the Water District do not fall within a city or area specifically delineated by Portland State University's College of Urban Public Affairs Population Research Center. The population within the Water District, for this study, will be based on water service data and be projected using information from the Ten-Year Update on Lincoln County, Oregon's Economy, which was prepared for the Lincoln County Board of Commissioners, by The Research Group, LLC, August 2014. According to the 2010 US Census, the average number of persons per household in Lincoln County is 2.17. The number of residential customers was used as the number of households in calculating year-round residential population.
>
> "Population growth for nearby areas ranges from a negative growth rate to 1.2% annually. The City of Waldport has experienced no growth (0.0%) over the last fourteen years, while the City of Yachats grew by 1.2%, and Lincoln County grew by 0.4% during the same period. The population of the unincorporated areas of Lincoln County shrunk by 1.3% over the ten-year period between the years 2000 and 2010. Based on the number of residential customers from July 2010 through June 2013, the Water District's population growth was 0.3%, so for purposes of this study, a conservative growth rate of 0.5% will be used" (SWLCWD Water Management and Conservation Plan, October 2015).

There has been little change since the Water Management and Conservation Plan was completed. Therefore, a growth rate of 0.5% is used herein. Table 2.2 shows the population and water service connections projection.

TABLE 2.2 – POPULATION AND WATER ACCOUNT TYPE PROJECTIONS

	Year				
	2018	2020	2025	2030	2040
Population	2604	2630	2697	2765	2906
Residential Water Customer Accounts	1200	1212	1243	1274	1339
Commercial, Federal, Other Water Accounts	58	59	60	62	65
TOTAL Water Services	1258	1271	1303	1336	1404

2.4 Present and Future Water Demands

Actual metered historical production data were used to determine the average annual, average winter, average summer, maximum day, and peak hour demands.

2.4.1 Present Demands

Table 2.3 calculates and summarizes District-wide water system use characteristics:

1. The **Average Annual Demand (AAD) is 51,081,820 gallons**. The AAD is the average annual water demand based on meter usage. For projected AAD the baseline quantity and an annual growth rate of 0.5% will be used.

2. The **Average Daily Demand (ADD) is 139,950 gallons/day**. The ADD is the average daily water demand based on meter usage. For projected ADD the baseline quantity and an annual growth rate of 0.5% will be used.

3. Water demands fluctuate between winter and summer months. During the months of July through September water consumption increases due to high tourist use and because of lack of rainfall. Table 2.5 shows the average winter and summer demands.

4. The **Average Maximum Daily Demand (MDD) is 349,875 gallons/day**. The MDD is experienced on the highest demand day of the year, such as July 4th. The MDD is commonly used in sizing facilities to provide capacity for periods of high demand. Daily demand data is not available to explicitly calculate the MDD; therefore, Peaking Factors are used. Peaking Factors are multipliers applied to the demand parameter in question. Peaking factors between 2 and 2.5 are commonly used for MDD. To be conservative a Peaking Factor of 2.5 was applied to the ADD to approximate the MDD.

5. The **Average Peak Hour Demand (PHD) is 699,751 gallons/day**. The PHD is the highest demand experienced during any given single hour. PHD is commonly experienced during the early morning hours when many water users are bathing, cooking, and engaging in other activities that require high water use. PHD is used to size facilities for short periods of extreme demand. Peaking factors between 3 and 5 are commonly used for PHD. To be conservative a Peaking Factor of 5 was applied to the ADD to approximate the PHD.

TABLE 2.3 - METERED DISTRICT WATER USE BY MONTH

		WATER YEARS						
MONTH		12-13	13-14	14-15	15-16	16-17	17-18	Average
		TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	
JULY	CUBIC FT	1,260,711	603,142	893,188	834,406	655,779	687,528	822,459
	CUSTS:	1,252	1,251	1,248	1,247	1,253	1,256	
AUG	CUBIC FT	851,405	881,093	734,951	721,649	705,416	936,869	805,231
	CUSTS:	1,252	1,251	1,248	1,247	1,253	1,258	
SEPT	CUBIC FT	739,804	596,123	768,233	778,401	821,271	690,395	732,371
	CUSTS:	1,253	1,251	1,248	1,247	1,253	1,258	
OCT	CUBIC FT	562,165	591,797	690,762	517,685	520,612	568,497	575,253
	CUSTS:	1,253	1,251	1,248	1,247	1,253	1,258	
NOV	CUBIC FT	542,156	432,460	415,404	486,652	559,605	574,118	501,733
	CUSTS:	1,252	1,251	1,247	1,247	1,253	1,258	
DEC	CUBIC FT	388,344	447,373	391,584	479,500	419,200	441,066	427,845
	CUSTS:	1,252	1,249	1,247	1,247	1,253	1,256	
JAN	CUBIC FT	545,694	634,913	509,982	414,574	541,418	413,855	510,073
	CUSTS:	1,252	1,249	1,247	1,247	1,253	1,256	
FEB	CUBIC FT	426,704	429,157	386,999	401,457	409,949	524,996	429,877
	CUSTS:	1,252	1,249	1,247	1,247	1,253	1,258	
MAR	CUBIC FT	405,801	428,284	409,019	510,992	426,034	438,419	436,425
	CUSTS:	1,253	1,250	1,247	1,247	1,253	1,256	
APR	CUBIC FT	434,991	558,521	552,985	466,413	445,700	476,580	489,198
	CUSTS:	1,253	1,250	1,247	1,247	1,253	1,258	
MAY	CUBIC FT	678,771	490,518	436,164	463,363	449,219	610,755	521,465
	CUSTS:	1,253	1,249	1,245	1,247	1,256	1,259	
JUN	CUBIC FT	527,600	532,028	490,604	717,528	650,579	544,812	577,192
	CUSTS:	1,254	1,248	1,247	1,247	1,256	1,259	
YEAR	CUBIC FT	7,364,146	6,625,409	6,679,875	6,792,620	6,604,782	6,907,890	6,829,120
	AVG CUSTS	**1,253**	**1,250**	**1,247**	**1,247**	**1,254**	**1,258**	**1251**
	AAD (gal)	**55,083,812**	**49,558,059**	**49,965,465**	**50,808,798**	**49,403,769**	**51,671,017**	**51,081,820**
	ADD (gal/day)	**150,915**	**135,776**	**136,892**	**139,202**	**135,353**	**141,564**	**139,950**
	MDD (gal/day)	**377,286**	**339,439**	**342,229**	**348,005**	**338,382**	**353,911**	**349,875**
	PHD (gal/day)	**754,573**	**678,878**	**684,458**	**696,011**	**676,764**	**707,822**	**699,751**

AAD – Average Annual Demand (gallons)
ADD - Average Day Demand (gallons)
MDD – Maximum Day Demand (gallons/day)
PHD – Peak Hour Demand (gallons/day)

Table 2.4 shows the average water use per customer service connection.

TABLE 2.4 – AVERAGE WATER USE PER CUSTOMER SERVICE

	WATER YEARS						**Average**
	12-13	**13-14**	**14-15**	**15-16**	**16-17**	**17-18**	
AAD / Cust gallons	43,976	39,649	40,063	40,745	39,413	41,090	**40,823**
ADD / Cust gal/day	120	109	110	112	108	113	**112**
MDD / Cust gal/day	301	272	274	279	270	281	**280**
PHD / Cust gal/day	602	543	549	558	540	563	**559**

Table 2.5 shows the total amount of water consumed within the District in gallons per day, broken down by **High Demand Period** (July through September) and **Low Demand Period** (October through June) for the past six years. The amount of water used is the volume as measured by individual customer meters.

TABLE 2.5 – EXISTING DISTRICT WATER CONSUMPTION BREAKDOWN (GALLONS/DAY)

Water Year	**Average Day Demand (ADD)**	**Average Daily Use LOW Demand Period (Oct.-June)**	**Average Daily Use HIGH Demand Period (July-Sept)**	**Peak Month Daily Avg**
2012-2013	150,915	123,632	231,873	304,197
2013-2014	135,776	124,531	169,142	212,599
2014-2015	136,892	117,365	194,835	215,518
2015-2016	139,202	122,150	189,801	201,334
2016-2017	135,353	121,168	177,444	204,770
2017-2018	141,564	125,848	188,203	226,057
Average	139,950	122,449	191,883	227,413
Avg. per customer	**112**	**98**	**153**	**182**

The average demands per customer in the Table above was based on an average customer base of 1251 over the past six years.

2.4.2 **Future Demand**

The baseline demand quantities for MDD and PHD were calculated using peaking factors. The future demand quantities were projected using an annual growth rate of 0.5%. Table 2.6 shows a summary of the projected future demands for the District.

TABLE 2.6 – PROJECTED FUTURE DISTRICT WATER DEMAND (GALLONS/DAY)

Demand Parameter	Peaking Factor	2020	2025	2030	2040
Average Daily Demand - ADD (gal/day)	1	140,650	144,202	147,843	155,403
Average Max. Day Demand - MDD (gal/day)	2.5	351,625	360,504	369,607	388,509
Average Peak Hour Demand - PHD (gal/day)	5	703,250	721,008	739,214	777,017
Maximum Monthly Demand (gal/day)	1.7	239,105	245,143	251,333	264,186

2.5 Water Storage Criteria

General recommendations and definitions for various storage components are presented here. Water storage requirements include volumes for equalization, emergency conditions (interruption of water supply), and fire demands. It is recommended total storage be the sum of all three.

- **Equalization Storage (peaking storage),** is required to meet peak hour demands in excess of the supply pumping capacity. For planning purposes, equalization storage is typically set at 20-25% of the MDD for small water systems.

- **Emergency Storage** is required to protect against a total loss of water supply such as would occur with a broken transmission line between the sources and the tanks, equipment breakdown, or source contamination. Emergency storage should be an adequate volume to supply the system's ADD for the duration of a possible emergency. For most systems, emergency storage should be equal to one maximum day of demand or 2.5 to 3.0 times the ADD.

- **Fire Reserve** storage is needed to supply fire flow throughout the water system to fight a major fire. Per the 2014 Oregon Fire Code, the minimum fire-flow and duration requirements are based on the size and occupancy of the buildings. For the District a fire flow of 2,500-gpm for 3 hours is used to account for commercial buildings.

Table 2.7 shows the present and future water storage needs based on the above three water storage criteria and growth rate. Although cumulative existing tank storage volume appear adequate District-wide, this Plan recommends localized additional storage for the primary purpose of fire protection.

TABLE 2.7 – PRESENT AND FUTURE WATER STORAGE CAPACITY SUMMARY

Storage Type	Description	2019 Capacity Needs (gal)	2040 Capacity Needs (gal)
Equalization Storage	25% of MDD	87,469	97,127
Emergency Storage	3 times ADD	419,851	466,210
Fire Reserve Storage	2,500 gpm for 3 hours	450,000	450,000
Total Storage		**957,319**	**1,013,338**

2.6 Distribution Network Criteria

Planning for the distribution network involves establishing performance standards for pressures and flows throughout the system. The design flows through the system are the largest flows reasonably anticipated to occur. For the District, these flows result from a fire event during the system's maximum day demand.

In evaluating fire flow for existing commercial areas, a minimum fire flow requirement of 2,500 gpm above 20 psi for 3-hours was used. Residential areas were evaluated using 750 gpm for 2-hours.

In addition to design standards for the delivery of flow rates, standards for system pressures are necessary for the normal daily operation of the water system. The aim of standards for system pressures are to provide safe and reliable service to water users under a variety of system conditions. If pressures are too high, damage can occur within the distribution system and at points of use. If pressures are too low, a variety of issues arise, including potential for back flow contamination, and low or no water availability. The recommended distribution pressure standards for new connections are listed in Table 2.8.

TABLE 2.8 – RECOMMENDED DISTRIBUTION PRESSURE STANDARDS

System Scenario	Pressure (psi)	
Peak Hour Demand Event	40+	Minimum
Maximum Day Demand Plus Fire	20+	Minimum
Mainline Pressures	100	Maximum, w/o special pipe design
Pressure at service w/o Pressure Regulator	80	Maximum

3 EXISTING WATER SYSTEM

This section describes the existing water system and its various components taken from the "Southwest Lincoln County Water District Water System Development Plan, Revised January 25, 2014." Pertinent information from this document, used herein, was updated, additional information added, and irrelevant information not included.

3.1 Water Supply Sources and Water Rights

The District takes surface water from four separate supply sources: Dicks Fork, Big Creek, Vingie Creek and Starr Creek. The District found periods of high turbidity coincide with heavy winter rains. The District shuts off the intake structures and operates on treated water storage during times of high turbidity, thereby saving on treatment cost. The following Table highlights some of the common characteristics of each diversion:

TABLE 3.1 – SURFACE WATER DIVERSION SUMMARY

Diversion Characteristic	Dicks Fork	Big Creek	Vingie Creek	Starr Creek
Length of stream: headwaters to ocean (miles)	4.75	4.75	4.75	3.8
Elevation of Diversion (feet)	434	238	50	238
Watershed Physical Location	Timber covered and situated within the Siuslaw National Forest.	Timber covered and situated within the Siuslaw National Forest.	Timber-covered. Above the diversion point is part private ownership (5%) and part Federal ownership (95%) within the Siuslaw National Forest.	Timber covered and situated within the Siuslaw National Forest.
Access	Via Forest Service Roads behind a locked gate.	Via Forest Service Roads behind a locked gate.	Via a dedicated county road and easements on private property behind locked gates.	Via dedicated county roads, private easements and Forest Service Roads behind a locked gate.
Stream length above diversion (miles) / stream gradient	1-mile / 14%	2.25 / 8%	4.2 / 6%	2.4 / 9%
Watershed area above diversion (sq. miles)	0.96	1.65	1.65	1.23
Estimated stream flow at diversion in September in an average rain fall year (cfs)	0.9	1.6	1.6	1.2

Additional information follows about each diversion point:

3.1.1 Dicks Fork

This stream begins at three springs located at about elevation 1200 feet. There are two stream forks that come together at the diversion point. Dicks Fork flows ultimately combine into Big Creek at about elevation 80 feet. There are no recently documented sightings of salmon in this stream near the diversion. The Dicks Fork watershed above the District's diversion point was last logged in the 1930's. The current U.S. Forest Service operating plans do not show any logging or other management practices in this watershed, which would affect the water quality for at least 30 years.

3.1.2 Big Creek

This stream is the main stream of three branches, and it begins at three springs located between elevation 1200 feet and 1600 feet. Two other creeks join this stream at about elevation 80 feet and are about the same size as the main stream. There is a small estuary on this stream at about elevation 20 feet. Salmon spawn on the lower reaches of this stream but due to a natural waterfall downstream of the diversion point, the salmon are not able to reach the District's diversion point. A portion of the Big Creek watershed above the District's diversion point was logged in the late 1980's. The current U.S. Forest Service operating plans do not show any logging or other management practices in this watershed which would affect the water quality for at least 30 years.

3.1.3 Vingie Creek

This stream lies between Starr Creek and Big Creek and has a drainage area similar in size to Big Creek. This stream is fed by two springs located at elevation 1200 feet and 1400 feet. There are no recently documented sightings of salmon in this stream. The current U.S. Forest Service operating plans do not show any logging or other management practices in this watershed which would affect the water quality for at least 30 years. The portion of the watershed in private ownership could be logged within the next 10 to 15 years but is not expected to cause water quality problems except possibly higher turbidity in the winter months. The watershed area upstream from the District's diversion point has not been logged since 1930.

The location of the diversion point is on private land and requires the diverted water be pumped to the treatment plant. This diversion structure is off-stream and able to divert up to 0.9 cfs from the stream. However, being off-stream with no restrictions to the stream flow much less water is actually captured. There is the potential of diverting more water from this source. This diversion was completed in April 2002.

3.1.4 Starr Creek

Three springs, two at elevation 1400 feet one at 700 feet feed this stream. There are no recently documented sightings of salmon in this stream near the diversion. A portion of the Starr Creek watershed above the District's diversion point was logged in the late 1980's. The current U.S. Forest Service operating plans do not show any logging or other management practices in this watershed, which would affect the water quality for at least 30 years.

The following Tables are a summary of the surface water rights (Table 3.2) and historical annual diversion flows (Table 3.3):

TABLE 3.2 - SURFACE WATER RIGHTS

Water Source	Permitted Use Rate (cfs / gpm)	Permit and Certificate Number	Use and Priority Date
Dicks Fork	0.4 / 180	Permit No. S 36270, Certificate No. 80664	year-round municipal use; 6/7/1971
Big Creek	0.3 / 135	Permit No. S 19165, Certificate No. 29022	year-round municipal use; 6/8/1945
	The District has another permit to remove an additional 0.3 cfs for scheduled repairs or emergencies between November 1 and April 30 when stream flows exceed 10 cfs. This permit provides no benefit to the District during times of high use in the summer months.		
Vingie Creek	0.3 / 135	Permit No. S 31979 (Certification pending)	year-round municipal use; 9/6/1966
	1.0 / 449 *(0.6 / 269)*	Permit No. S 52498 (Certification pending)	year-round municipal use; 1/13/1989 *Use rate of 1.0 cfs for eleven months and a use rate of 0.6 cfs for one month (July)*
Starr Creek	0.3 / 135	Permit No. S 16464, Certificate No. 29023	year-round municipal use; 6/8/1945
TOTAL	2.3 / 1032 *(1.9 / 853)*		

TABLE 3.3 – HISTORICAL ANNUAL DIVERSION FROM EACH SOURCE

Water Year	Dicks Fork Creek (gal)	Big Creek (gal)	Vingie Creek* (gal)	Vingie Creek* (gal)	Starr Creek (gal)	**Total Annual Diversion (gal)**
2009-10	6,011,900	23,788,500	6,704,700	6,704,700	22,695,200	65,900,000
2010-11	5,363,000	23,180,300	7,231,700	7,231,700	21,919,500	64,900,000
2011-12	5,755,000	21,699,900	7,463,900	7,463,900	20,961,000	63,300,000
2012-13	5,965,000	23,202,400	5,555,200	5,555,200	23,861,600	64,100,000
2013-14	6,848,000	23,873,800	6,721,300	6,721,300	22,988,900	67,200,000
2014-15	5,972,100	25,726,000	11,503,500	11,503,500	20,788,900	75,500,000
2015-16	6,966,900	22,772,900	6,502,700	6,502,700	16,294,200	59,000,000
2016-17	7,417,000	23,351,700	7,153,600	7,153,600	23,120,400	68,200,000
Average	**6,300,000**	**23,500,000**	**7,400,000**	**7,400,000**	**21,600,000**	**66,100,000**

*Vingie Creek has two permits, so flows are equally split between the two permits.

3.2 Source Reliability

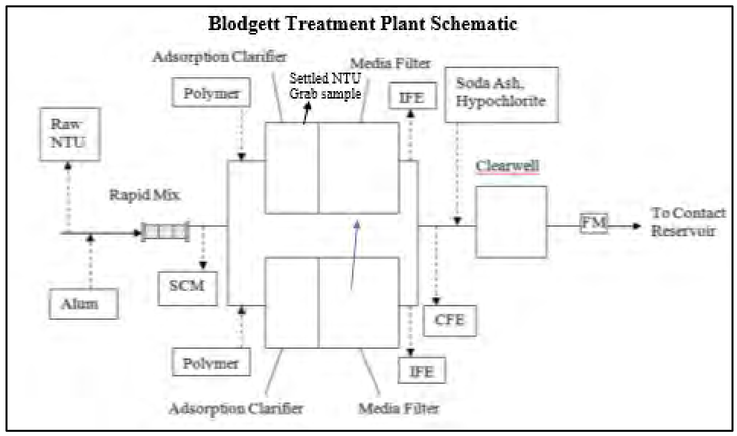
The District's four sources of water are dependent upon winter rains to restore groundwater, which then become the creeks that provide the District with water. During the months of June through October, the creeks drain the water stored in the surrounding hills. The summer time flows can get quite low if the spring rains are below normal in amounts or consistency. The only problem to date with water availability was when the Forest Service logged the headwaters of one of the watersheds in the 1980's. This caused low water flows in that creek for two or three years. There was one time in the 1970's when all of the creeks were low because of a lack of spring rains. These low flow problems lasted about one month and were relieved when the fall rains started.

The creeks that supply water to the District have proven to be very reliable water sources compared to the water supplies of other coastal communities. If one of the source creeks is damaged or not available for use during low flow conditions, the remaining three would be able to supply the District's current water needs.

3.3 Drinking Water Quality and Regulatory Standard Compliance

Oregon Health Authority stated, "water system facilities were found to be well operated and maintained by knowledgeable and competent staff. No significant deficiencies or rule violations were identified" (Water System Survey at SW Lincoln County Water PUD on 7/28/2017). The water system meets the criteria to be considered to have "outstanding performance."

FIGURE 3-1: TREATMENT PLANT SCHEMATIC



3.4 Water Treatment Plants

The District operates two water treatment plants (WTPs), Blodgett Water Treatment Plant and the Dicks Fork Water Treatment Plant, which treat the water from the above-mentioned water sources. The Blodgett Water Treatment Plant provides water to approximately 75% of the District's customers and Dicks Fork Water Treatment Plant serves the remaining 25%.

The water treatment plants went on line in July of 1997. The water treatment plants use treated water during their operation for chemical makeup water and to backWash the filter beds. This usage amounts to less than 3% of the total amount of water treated. The water treatment plants also use untreated water during the backWash process, which amounts to approximately 8% of the diverted amount of water. The actual amount depends upon number of gallons treated and the quality of the raw water. The operational treatment plant schematic shown in Figure 3-1 is typical of both treatment plants.

The WTPs use conventional treatment techniques (e.g. coagulation, sedimentation, filtration) to treat the water to a level that meets the requirements of the Safe Drinking Water Act and the Oregon Department of Human Services, Public Health Division standards for potable water (OAR 333-061-0030 and 0032). Adjacent to each WTP is a storage tank that provides the primary storage and contact time for the treated water.

3.4.1 **Blodgett Water Treatment Plant (BWTP)**

Figures 3-2 and 3-3 illustrate the water system from intake through treatment to distribution. The following is a summary of the BWTP:

FIGURE 3-2: STARR CREEK AND BIG CREEK DIVERSION

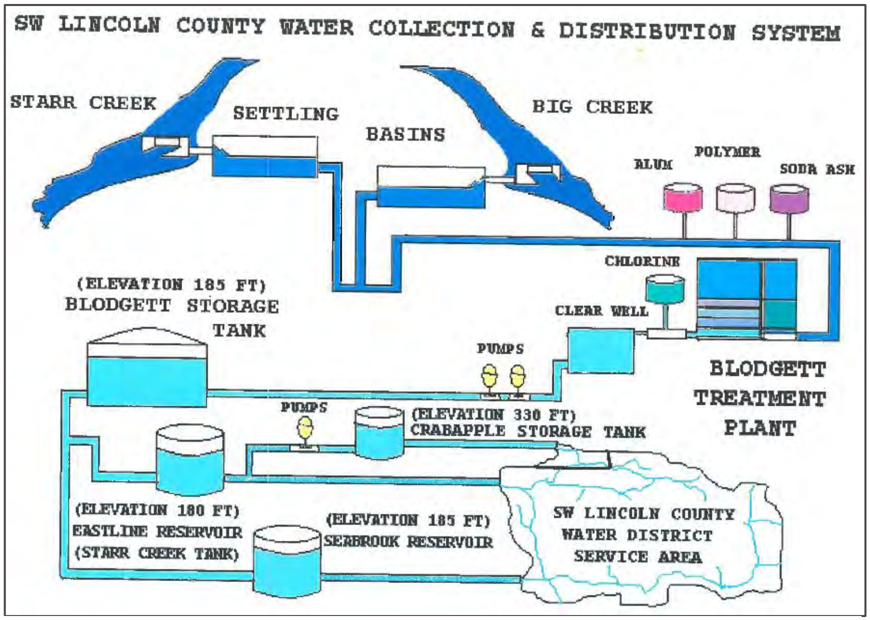
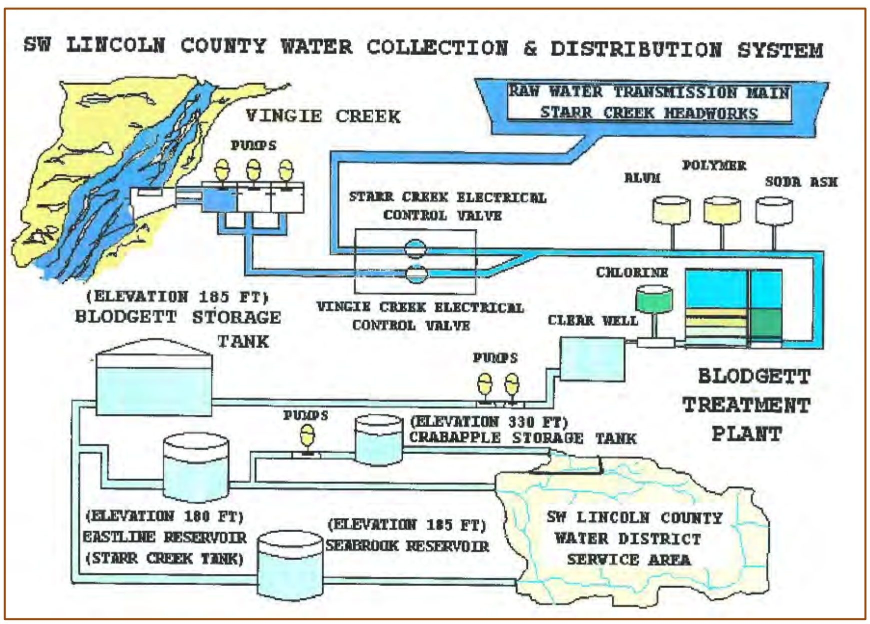


FIGURE 3-3: VINGIE CREEK DIVERSION



- The Blodgett WTP receives water from Starr Creek, Vingie Creek, and Big Creek.
- The Big Creek and Starr Creek sources are at the same elevation (238 feet). Water from these two sources is first diverted from the creeks into settling basins and then piped by gravity to the Blodgett WTP at elevation 160 feet (located at the Forest Service Blodgett Work Center).
- The Vingie Creek source water is diverted into a large manhole (there is a small settling basin between the creek and the manhole) from which the water is pumped into the raw water line from Starr Creek.
- Before Vingie Creek joins with Starr/Big Creek, both individual pipelines pass through Brubaker Vault where both flows are metered. Just downstream of the Vault the flows are joined into a single 10-inch PVC pressure pipeline which continues to Blodgett WTP. Although this pipeline can flow by gravity to the Blodgett WTP, when the Vingie pumps turn on the volume of water through the pipe increases.
- The Blodgett Water Treatment Facility has a current capacity of 350 gpm (0.7798 cfs) and is expandable to 700 gpm (1.5596 cfs). The plant can be operated at a rate of 425 gpm for short periods during the summer months. After treatment, the water is pumped to a 1,000,000 gallon tank (Blodgett Tank) near the treatment plant with a high water elevation

of 185 feet. The water is then fed, by gravity, into the distribution system below elevation 100 feet.

- A 65kW auxiliary power generator was installed at this Treatment Plant Site in 2011. This protects and can provide uninterrupted service to a major part of the District water distribution system. Because of the emergency power, it is also possible to provide water for both the City of Waldport and the City of Yachats, should they request assistance.

3.4.2 Dicks Fork Water Treatment Plant (DFWTP)

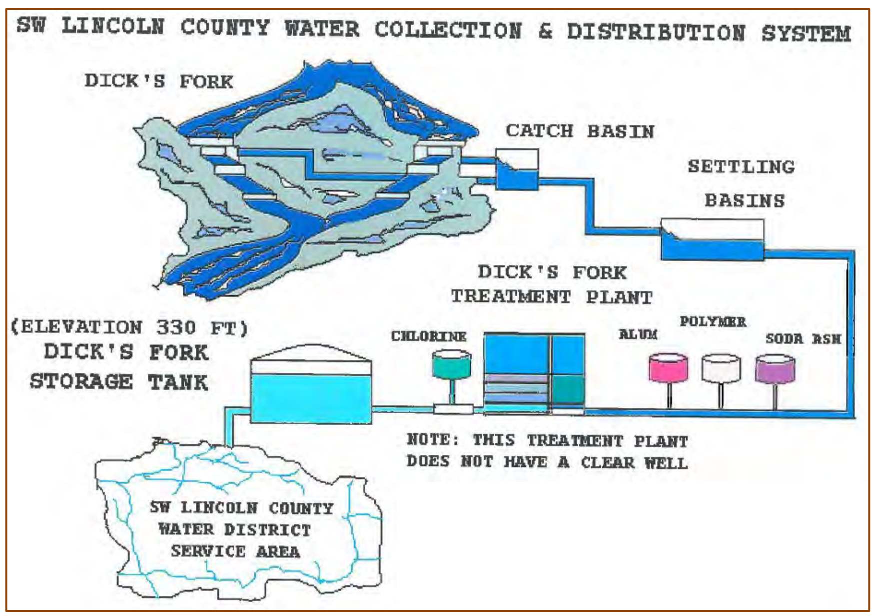
Figure 3-4 illustrates the water system from intake through treatment to distribution. The following is a summary of the DFWTP:

- Dicks Fork WTP receives water from Dicks Fork.

- Dicks Fork source is at elevation 434 feet. Water from this source flows to a settling basin at elevation 372 feet and then flows to the Dicks Fork WTP at elevation 310 feet (near the Dicks Fork Tank).

- The Dicks Fork WTP has a capacity of 200 gpm (0.4456 cfs), although only produces 180 gpm to match the maximum water right (treated water production is limited by the existing water right). After treatment, the water is pumped to the 200,000-gallon Dicks Fork Tank with a high water elevation of 330 feet. Water from the Dicks Fork Tank feeds the distribution system on the north end of the District, which is above elevation 100 feet.

FIGURE 3-4: DICKS FORK DIVERSION



- A 45kW auxiliary power generator was installed at this Treatment Plant Site in 2011. This protects and can provide uninterrupted service to the north easterly part of District water distribution system. Because of the emergency power, it is also possible to provide water for both the City of Waldport and the City of Yachats, should they request assistance.

3.5 Water Storage

The District has two types of water storage: raw water storage and treated water storage.

3.5.1 Raw Water Storage

The District's raw water storage consists of a settling basin near three of the water sources. Based on visual buildup, these basins are manually cleaned. Present storage capacities are shown in Table 3.4.

TABLE 3.4 – RAW WATER STORAGE SUMMARY

Location	Capacity (gallons)	Details	Purpose
Big Creek Settling Basin	61,000	Concrete basin, built in the 1960s. This basin has an overflow elevation of 238 feet.	These basins reduce the turbidity of the water in the winter and helps with summer flows by providing a storage buffer
Starr Creek Settling Basin	120,000	Concrete basin, built in the 1960s. This basin has an overflow elevation of 238 feet.	
Dicks Fork Settling Basin	126,000	Concrete basin, built in 1976. This basin has an overflow elevation of 372 feet.	

3.5.2 Treated Water Storage

The District's existing treated water storage consists of two concrete storage tanks plus three steel storage tanks. A total storage capacity of 1,954,000 gallons exists. The existing tanks are reported to be in good condition and visually appear adequate. Based on the condition of the tanks, no major work is anticipated on them for the next ten years. Table 3.5 provides information and capacities of the five existing storage tanks.

TABLE 3.5 – TREATED WATER STORAGE SUMMARY

Location	Capacity (gallons)	High-water Elevation	Tank Details
Dicks Fork Tank	200,000	330 feet	A concrete tank built in 1976 and located adjacent to the Dicks Fork WTP. This tank provides the required chlorine contact time needed in connection with water treatment and provides the water needed for domestic uses and fire flows in that part of the District north of Wakonda Beach Road that is above elevation 100 feet.
Seabrook Tank	200,000	180 feet	A concrete tank built in 1976 and located in the north end of the District at the East end of Seabrook Lane. This tank is fed by the Blodgett Tank and provides water needed for domestic uses and fire flows in the north end below elevation 100 feet.
Blodgett Tank	1,000,000	185 feet	A steel tank built in 1997 and located next to the Blodgett Water Treatment Plant. This tank provides the required chlorine contact time needed in connection with water treatment and since it is five feet higher than the other low-level tanks it causes the other tanks to fill before it shuts off the treatment plant. Water from this tank provides water needed for domestic uses and firefighting needs to that part of the District below elevation 100 feet.
Starr Creek Tank	500,000	180 feet	A steel tank built in 1997 and located at the South end of the District near the East end of Starr Creek Drive. This tank is fed by the Blodgett Tank and provides water needed for domestic uses and fire flows in the south end below elevation 100 feet.
Crabapple Tank	54,000	335 feet	A steel tank built in 1997 and located in the South end of the District east of the south end of Eastline Drive. The tank is filled by the Alder Street pump station and provides water needed for domestic uses and to support the fire flows in the south end above elevation 100 feet.

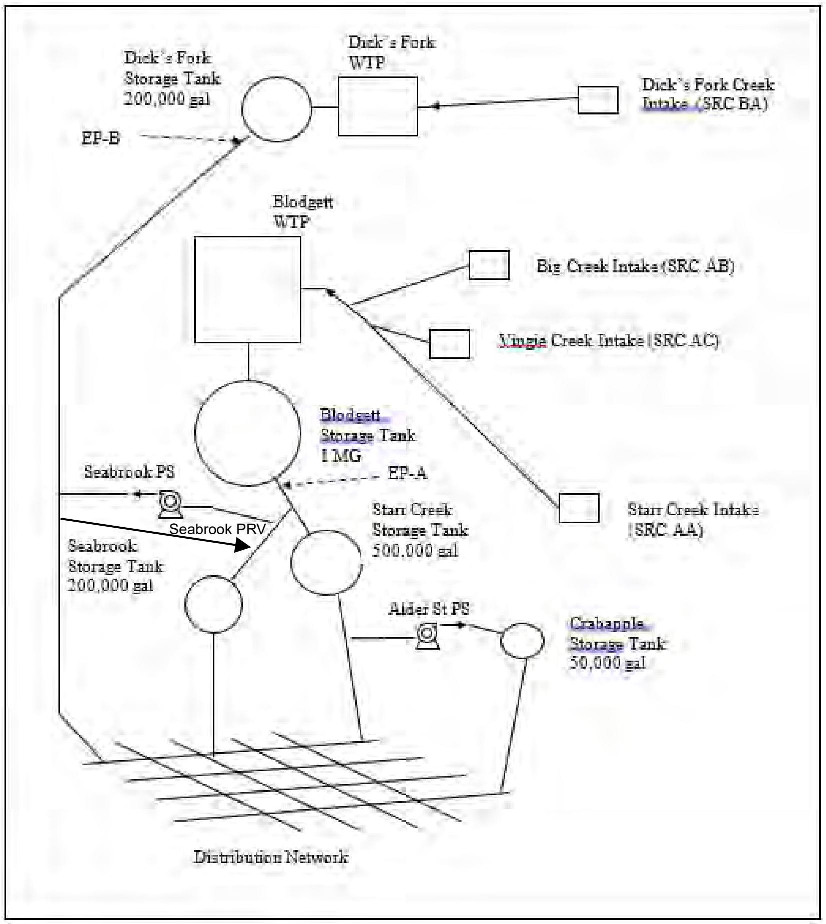
3.6 Raw Water Transmission Pipelines

These pipelines deliver raw water to the water treatment plants. At present most of these lines are new. The oldest lines are the one in Starr Creek and the one along Big Creek. The Asbestos Cement (AC) pipeline in Starr Creek has been broken numerous times by high water, windblown trees, and landslides. This pipeline is located in the streambed for about one half the distance between the headworks and the point where the line leaves Starr Creek and heads for the Blodgett Treatment Plant. A new 8-inch HDPE was installed parallel to this line but out of the creek bed in 2003. The AC line may have to be removed in the future. The other PVC transmission lines are in good condition and should not require any replacement within the next twenty years; however, a change to HDPE should be considered for seismic resiliency.

3.7 Treated Water Distribution System

Development within the District is concentrated on the coast along U.S. Highway 101. A 12-inch distribution line from the Blodgett Treatment Plant conveys the water westerly to a 10-inch line lying approximately 1300 feet east of and parallel to Highway 101 which runs from the Angell Job Corp site on the north to Starr Creek Drive on the south. This line is connected to a 6-inch north/south line along Highway 101, from the City of Yachats on the south northerly to Blodgett Road near the Angell Job Corp, approximately 4-miles. Along Highway 101 from Blodgett Road north to a point approximately ½-mile south of the Waldport City limits are two pipelines, an old 6-inch asbestos concrete (AC) pipeline and a newer 10-inch PVC pipeline. The 10-inch provides increased rate of delivery of water to the Seabrook Tank. All water services come off the 6-inch line.

FIGURE 3-5: WATER SYSTEM SCHEMATIC



The distribution system off the above-mentioned lines consist of 2-, 4-, and 6-inch lines. About 75% of these lines are looped with blowoffs on all non-looped lines. Lines that can physically be looped should be looped as funds become available. There are two different pressure zones: the north end of the District and one on the south. The pressure zones are connected by pressure reducing valves at two locations. This allows water from the Dicks Fork Tank to feed into the lower system if, and when, needed.

General water distribution system components include:

- 113 Fire Hydrants
- 2 Automatic Control Valves
- 2 Pump Stations
- 3 Pressure Zones
- 2 Pressure Reducing Stations
- 5 Water Storage Tanks

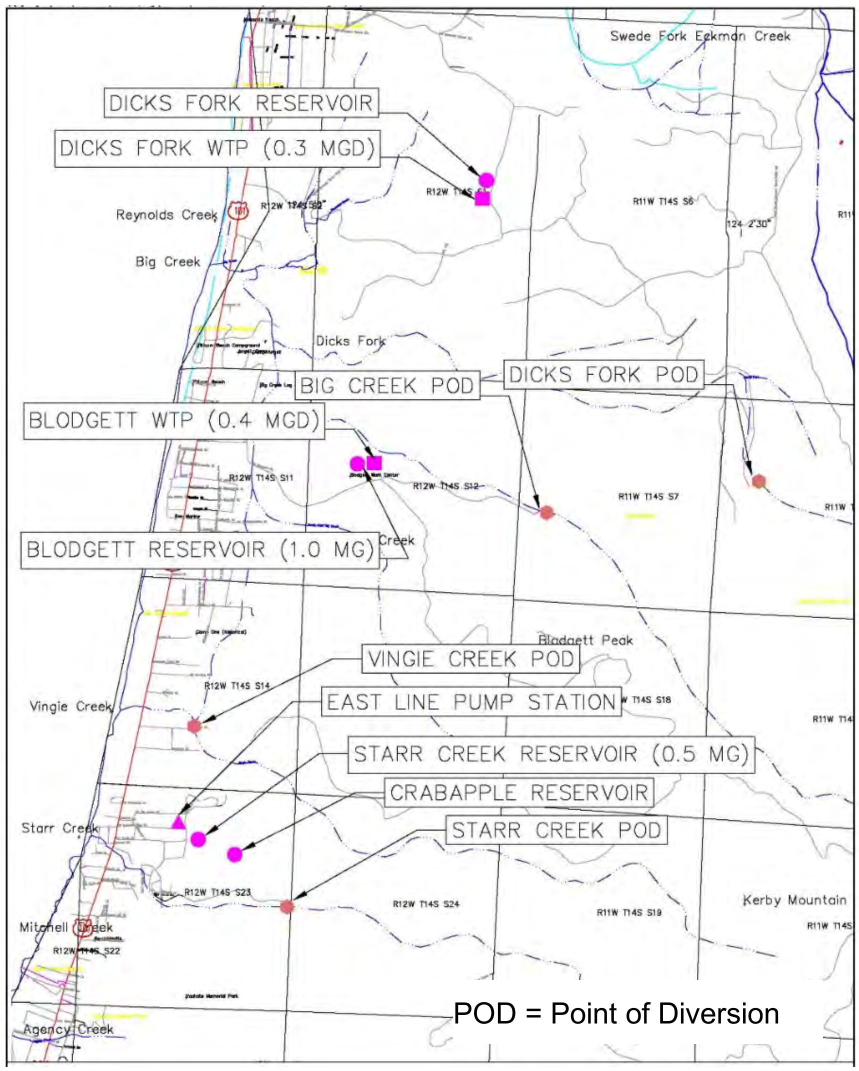
Figure 3-5 provides an operational schematic of the overall system. Figure 3-6 shows the overall system water map (Figure No. 2.1.1 in the District's Water Management and Conservation Plan, October 2015).

3.7.1 **Interconnection**

The District's water system is connected to the City of Waldport water system at Green Street on Crestline Drive. The connection consists of a closed gate valve with a metered two-inch by-pass around it. This metered by-pass is capable of delivering up to 225 gpm to the City of Waldport by gravity. Water will not flow from the City of Waldport into the District's system as presently configured.

The City of Yachats' treated water tank is higher than the District's treated water tank. The District and the City of Yachats installed a new 4-inch connection between the two water systems in the summer of 2001. This connection consists of a pump station capable of delivering approx. 300 gpm from the District water system to the City of Yachats' water system. A pressure reducer allows water to flow from the City of Yachats water system into the District water system, when needed.

FIGURE 3-6: WATER SYSTEM MAP



3.7.2 **Water Distribution Pipeline**

There is approximately 35-miles of pipeline, from 1-inch to 12-inch diameter. Materials vary and include: PVC Class 150, 160, 200, and C-900; AC; Polyethylene (PE); and Ductile Iron. The age of the pipe also varies. Much of the pipe is old and includes many original pipelines installed in 1945. There has been some pipe installed as recently as 2016. Appendix A contains maps of the water system.

Appendix A contains the water system maps showing the pipeline distribution network. Due to the size of the District, the map was broken up into three sections, South, Middle, and North.

Within the water system is a significant length of asbestos-cement (AC) pipe. Over time, AC pipe undergoes gradual degradation in the form of corrosion (i.e., internal calcium leaching due to conveyed water and/or external leaching due to groundwater). Such leaching leads to reduction in effective cross-section, which results in pipe softening and loss of mechanical strength. Accordingly, as the water distribution system ages, the number of AC pipe failures increases with time. In seismic active zones AC pipes are known to have moderate to high vulnerability for failure (Section 6.3.4).

Table 3.6 summarizes and quantifies the amount of AC pipe in the water system. AC pipe replacement is considered a high priority and is therefore recommended as Priority 1 improvements. Section 5, Table 5.5, includes these AC pipes as part of the Priority 1 CIP.

TABLE 3.6 – ASBESTOS-CEMENT (AC) PIPE

	Asbestos Pipe (AC) Location	Size (inches)	Length (feet)
1	Wakonda Beach Rd.	8 and 6	2,450
2	E. California St. (replace 4")	8	950
3	(Big Crk. headworks), from treatment plant to basin	8	4,400
4	South side of District office running toward Blodget Rd. (Hwy 101)	8	650
5	(Seabrook Ln), Hwy 101 to Seabrook Tank	6	2,600
6	Camp 1 Rd. (replace 4")	6	1,300
7	From forest service meter on E. side Hwy 101 at Yaquina, N pt., running west, crossing Hwy 101 to hydrant at Waziyata entrance (replace 4")	6	180
8	From Tara In and Range Dr north to meter to forest service and Blue Whale Trailer Park	6	1,440
9	(From White Cap Dr.) E. side Hwy 101 running south to 2" crossing on Hwy 101 to 6" AC on west side Hwy 101 at Big Stump Beach	6	1,800
10	West side Hwy 101, at Big Stump Beach entrance running south W. side Hwy 101 to Wakeetum St.	6	2,600
11	(Storm Watch Ave.) from hydrant at intersection of Wakeetum St. south to Wakonda Beach Rd.	6	1,430
12	Tillucum St.	6	795
13	Forest Hill Ln.	6	980
14	Line between Forest Hill Ln at Starr Creek	6	1,000
		TOTAL LENGTH	**22,575**

3.7.3 **Treated Water Pump Stations**

The District has two pump stations which move water from the low-level part of the distribution system to the high-level portion. Alder Street Pump Station and the Seabrook Pump Station pumps are old and replacement should be anticipated within the next 5-years. There is also the possibility that the Seabrook Pump Station will need to be enlarged in order to provide increased fire flows to the area south of Range Drive and east of Crestline Drive.

Alder Street Pump Station. Located at the intersection of Eastline and Alder Street. Water is pumped from the low-level system into the Crabapple Tank at the South end of the District. This tank serves the area above elevation 100 feet in the Starr Creek area.

The pump station is controlled by the water level in the Crabapple Tank. There are two (2) 5 HP pumps at this location, each of which is rated at 50 gpm. The coastal tsunami and major storm concerns could restrict the Districts immediate access to the water storage tank near this location. A 25 kW emergency power generator was installed at this location to assist in providing uninterrupted operation of filling the Crabapple Tank when low levels are reached. An extended period of a power outage in this area could cause concerns for a supply of water for domestic use.

Seabrook Pump Station Located at the east end of SW Seabrook Lane. Water is taken from the low-level system (Blodgett) and delivered to the high-level system (Dick's Fork) at the North end of the District to supplement the output of the Dicks Fork Water Treatment Plant when needed for domestic and firefighting purposes. This pump station is not used often and must be exercised frequently. There are two pumps at this location. One pump delivers 160 gpm as domestic needs require. The other pump is a fire pump designed to deliver 450 gpm at 20 psi to the Waldport High/Middle School and the City of Waldport Industrial Park development on Crestline Drive.

An extended period of a power outage in this area could cause major concerns for fire protection and a water shortage for domestic needs. A coastal tsunami and major storm concerns could restrict the Districts immediate access to the water storage tank and pump station near this location. A 25 kW emergency power generator has been installed at this location to assist in providing uninterrupted fire protection as well as an alternate water supply for the Dicks Fork System.

3.7.4 Water Meters

Water meters were installed throughout the District in 1997. There are 1,258 metered service customers. Meter sizes range from 5/8-inch to 6-inch. The accuracy life of water meters is about 20 years. The meters generally seem to be operating well; however, the District has implemented a plan to begin the systematic process of replacing each meter. To date there have been 100 meters replaced, with plans to replace all.

4 WATER SUPPLY AND TREATMENT EVALUATION AND RECOMMENDATIONS

4.1 Overview and Background

This section of the SW Lincoln County Water PUD Water Master Plan provides a broad facility evaluation of the District's Surface Water Supply and Water Treatment Plants (WTPs).

The purpose of the evaluation is to identify improvements and alternatives, where such exist, for meeting the anticipated needs of the District based on existing and future demands. The information presented in this section is meant to identify and make recommendations for existing and future water supply and quantity.

4.2 Water Supply Sources Evaluation and Recommendation

The four surface water supply sources appear to be adequate and have proven to be very reliable. However, the diversions themselves need to be monitored. The following are areas of awareness that may become concerns and may need to be addressed within the next 10-years.

Dicks Fork
The fish passage system will most probably need to be upgraded within the next five to ten years.

Big Creek
Diversion structure needs to be carefully monitored for any indications that water is going under the diversion structure. The discovery of water passing under or around the diversion structure would indicate a need for immediate repair or replacement. The diversion structure may need to be reinforced.

Vingie Creek
This water source and infrastructure is in good condition. Pumps appear adequate and in good condition for the foreseeable future. The District is currently actively in the process of trying to increase water rights for Vingie Creek.

Starr Creek
Diversion structure appears to be in good condition; however, there is concern water may be going under and around the diversion structure. A constant visual should be kept for any potential undermining. When replacement is necessary, the current structure may be replaced with an out-of-stream diversion device.

Table 4.1 provides a summary and cost estimate for certain anticipated improvements of each diversion.

TABLE 4.1 – WATER SUPPLY IMPROVEMENTS

Surface Water Supply Sources						
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**	
1	**Dicks Fork Diversion Improvements**					
	Fish Ladder Improvements	LS	1	$ 15,000.00	$ 15,000.00	
	Contingency, Engineering, Bidding (40%)		0.4		$ 6,000.00	
					Total	$ 21,000.00
2	**Big Creek Diversion Improvements**					
	Diversion Structure Improvements	LS	1	$ 250,000.00	$250,000.00	
	Contingency, Engineering, Bidding (40%)		0.4		$100,000.00	
					Total	$350,000.00
3	**Vingie Creek Diversion Improvements**					
		LS			$ -	
	Contingency, Engineering, Bidding (40%)		0.4		$ -	
					Total	$ -
4	**Starr Creek Diversion Improvements**					
	Diversion Structure Improvements	LS	1	$ 250,000.00	$250,000.00	
	Contingency, Engineering, Bidding (40%)		0.4		$100,000.00	
					Total	$350,000.00
Estimated Project Total						**$721,000.00**

4.3 Water Treatment Evaluation and Recommendations

The District Water Treatment Plants were built in 1997 and have a life expectancy of 20 years. There are some components that need to be added or upgraded to maintain health regulations and meet changing operational needs. In the near future, the Blodgett Water Treatment Plant will need to be enlarged and both of the existing treatment facilities will need new filter media and some new control equipment.

4.3.1 Blodgett Water Treatment Plant (BWTP)

Of the two treatment plants, BWTP could use upgrades and improvements the soonest. Much of the infrastructure is at, or past, its useful life. The following are Priority 1 recommendations for the upkeep and operational improvement of the BWTP:

1. Renew filter units
    a. Replace filter media
    b. Inspect and repair underdrains
    c. Touch-up painting
2. Upgrade operational control panels and monitoring
3. Upgrade desktop computer and install Wonderware

Priority 2 or later priorities include: addition of another treatment train, enlarge building, upgrade chemical storage. If the District sees any unexpected growth within the 20-year planning period, there will be a need for more capacity. A new train would also allow the District the flexibility of taking a treatment train offline in the winter for maintenance. Improvements to BWTP can be prioritized as demands dictate.

Table 4.2 provides a summary and cost estimate for Priorities 1 and 2 improvements for the BWTP.

TABLE 4.2 – BWTP IMPROVEMENTS (PRIORITIES)

Blodgett Water Treatment Plant (BWTP) - Priority 1					
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**
1	Mobilization - Bonds, Insurance (5%)	LS	1	$ 9,500.00	$ 9,500.00
2	Construction Facilities and Temporary Controls (5%)	LS	1	$ 9,500.00	$ 9,500.00
3	Replace 20-year old Filter Media	LS	1	$ 45,000.00	$ 45,000.00
4	Upgrade Control Panels	LS	1	$ 115,000.00	$ 115,000.00
5	Upgrade Computer and Intall Wonderware	LS	1	$ 30,000.00	$ 30,000.00
	Estimated Construction Costs			$	209,000.00
	Administrative/Legal (5%)			$	10,450.00
	Contingency (25%)			$	52,250.00
	Engineering, Geotechnical (25%)			$	52,250.00
	Estimated Project Total (rounded)			**$**	**324,000.00**

Blodgett Water Treatment Plant (BWTP) - Priority 2					
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**
1	Mobilization - Bonds, Insurance (5%)	LS	1	$ 35,000.00	$ 35,000.00
2	Construction Facilities and Temporary Controls (5%)	LS	1	$ 35,000.00	$ 35,000.00
3	Demo and Site Prep (15%)	LS	1	$ 105,000.00	$ 105,000.00
4	Install new treatment unit, enlarge building, upgrade chemical storage	LS	1	$ 700,000.00	$ 700,000.00
	Estimated Construction Costs			$	875,000.00
	Administrative/Legal (5%)			$	43,750.00
	Contingency (25%)			$	218,750.00
	Engineering, Geotechnical (25%)			$	218,750.00
	Estimated Project Total (rounded)			**$**	**1,357,000.00**

4.3.2 Dicks Fork Water Treatment Plant (DFWTP)

The DFWTP treats water at the same capacity of the current water right feeding this plant (180 gpm). Before this plant could be enlarged an additional water source would be required. The District is currently in the process of obtaining additional water rights. The DFWTP should be refurbished and improvements should be anticipated within the next 10-years (Priority 2). Much of the infrastructure is past its useful life but is functional. The following are recommendations for the upkeep and operational improvement of the DFWTP:

1. Renew filter units
    a. Replace filter media
    b. Inspect and repair underdrains
    c. Touch-up painting
2. Upgrade operational control panels and monitoring
3. Upgrade desktop computer and install Wonderware (second priority to that of BWTP)

Table 4.3 provides a summary and cost estimate for Priorities 1 and 2 improvements for the DFWTP.

TABLE 4.3 – DFWTP IMPROVEMENTS

Dicks Fork Water Treatment Plant (DFWTP) - Priority 2					
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**
1	Mobilization - Bonds, Insurance (5%)	LS	1	$ 8,750.00	$ 8,750.00
2	Construction Facilities and Temporary Controls (5%)	LS	1	$ 8,750.00	$ 8,750.00
3	Replace 20-year old Filter Media	LS	1	$ 45,000.00	$ 45,000.00
4	Upgrade Control Panels	LS	1	$ 115,000.00	$ 115,000.00
5	Upgrade Computer and Intall Wonderware	LS	1	$ 15,000.00	$ 15,000.00
Estimated Construction Costs				$ 192,500.00	
	Administrative/Legal (5%)			$ 9,625.00	
	Contingency (25%)			$ 48,125.00	
	Engineering, Geotechnical (25%)			$ 48,125.00	
Estimated Project Total (rounded)				**$ 299,000.00**	

5 WATER STORAGE AND DISTRIBUTION SYSTEM EVALUATION AND RECOMMENDATIONS

5.1 Overview and Background

This section of the SW Lincoln County Water PUD Water Master Plan is a facility evaluation of the District's Water Storage and Water Pipeline Distribution System.

5.2 Computer Hydraulic Model – Distribution System Evaluation

Water pressure throughout the distribution system is provided by elevation head from the various tanks that have been strategically located throughout the system to provide stable pressures. In order to assess existing distribution system capacity, a distribution model using Bentley WaterCAD was developed. This water distribution system hydraulic modeling software was developed to model the movement and fate of drinking water constituents within distribution systems. A hydraulic model of the existing distribution system was created in conjunction with this Plan, using distribution system data obtained from information provided by the District and available elevation and mapping data. The computer model was calibrated with field obtained pressure readings. Appendix B provides a sample model output for Peak Hour Demand.

5.2.1 Model Evaluation of Existing System Pressures and Flows

With the calibrated model, the current distribution system was evaluated for conformance with the pressure and flow standards presented in Section 2. The following scenarios were run in the model:

a) Average Day Demand
b) Peak Hour Demand
c) Maximum Day Demand Plus Commercial Fire Demand of 2,500 gpm (North District)
d) Maximum Day Demand Plus Commercial Fire Demand (South District)
e) Maximum Day Demand Plus Commercial Fire Demand (Waldport Industrial Park)

The water system appears adequate to fight a residential fire.

a) Average Day Demand (ADD)

The distribution system is adequate for ADD and maintains appropriate pressures.

b) Peak Hour Demand (PHD)

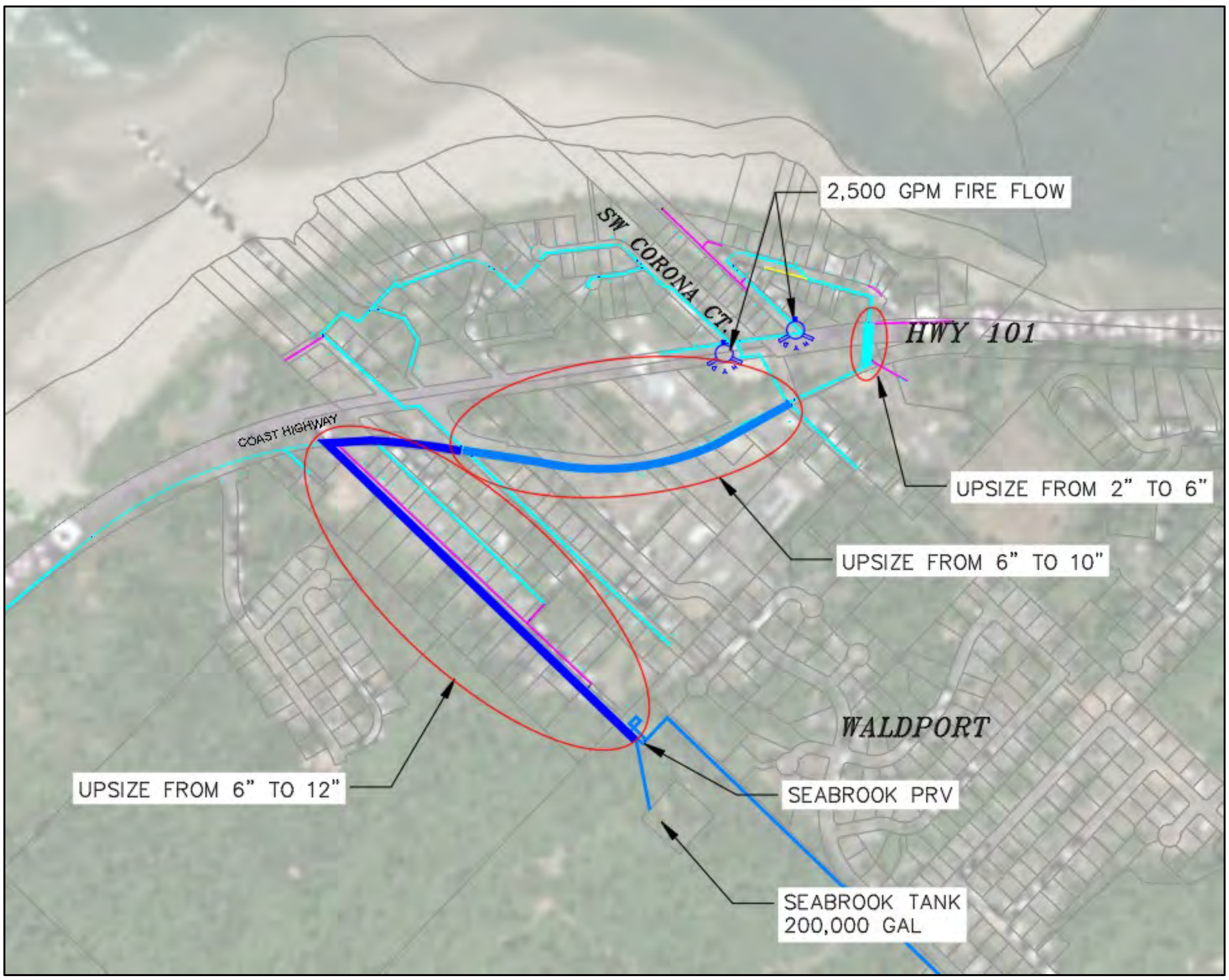
Peak hour demand (PHD) for this system was taken to be 5 times the ADD. The PHD, therefore, is 699,751 gpd, or about 0.39 gpm for each connection. The system was modeled under peak hour demands to check pressures in the system against the minimum operating pressure standards. The demand was spread evenly across all 1258 connections. Under this demand, the distribution system is adequate and pressures are within allowable standards.

c) Maximum Day Demand (MDD) Plus Fire Demand (North District)

The MDD for the system is 349,875 gpd, which corresponds to approximately 0.20 gpm for each connection. The demand was spread evenly across the system. A commercial fire flow demand of 2,500 gpm was applied at the north end of the system. The model showed the existing pipeline system incapable of delivering the required fire flow.

Figure 5-1 shows an improvement option. Fire protection primarily comes from the Seabrook Tank. With the improvements shown above, modeling indicates 2,500 gpm can be achieved with approximately 2,100 gpm coming from the Seabrook Tank and 400 gpm coming from the existing network along Hwy 101.

FIGURE 5-1: NORTH END IMPROVEMENT RECOMMENDATION



Due to the Seabrook Tank capacity being 200,000 gallons, the tank can only provide fire flow for approximately 1.6 hours with the improvements shown before being completely drained. When the tank drains and pressures drop, the Seabrook Pressure Relief Valve (PRV) opens and releases flow from the higher-pressure zone. The PRV is on a 2-inch line creating a bottleneck and preventing a continuous flow of at least 2,100 gpm (equivalent to what was coming from the Seabrook Tank). The PRV is only to supplement pressure when needed and not designed for fire flow capacity.

The recommended improvements include: Increase size of pipe from a 6-inch to 12-inch going down SW Seabrook Lane and part of Hwy 101; upsize the 6-inch to a 10-inch on SW Range Drive; and increase the 2-inch to 6-inch crossing Hwy 101 to maintain an equally sized loop for pressure distribution. An additional 250,000 gallon tank is also recommended to be installed at the Seabrook Tank location to meet the three-hour fire flow duration for the north District commercial area.

Recommendations:

1. Increase pipe sizes as shown
2. Additional 250,000 gallon storage (Seabrook Tank No. 2)

d) Maximum Day Demand (MDD) Plus Fire Demand (South District)

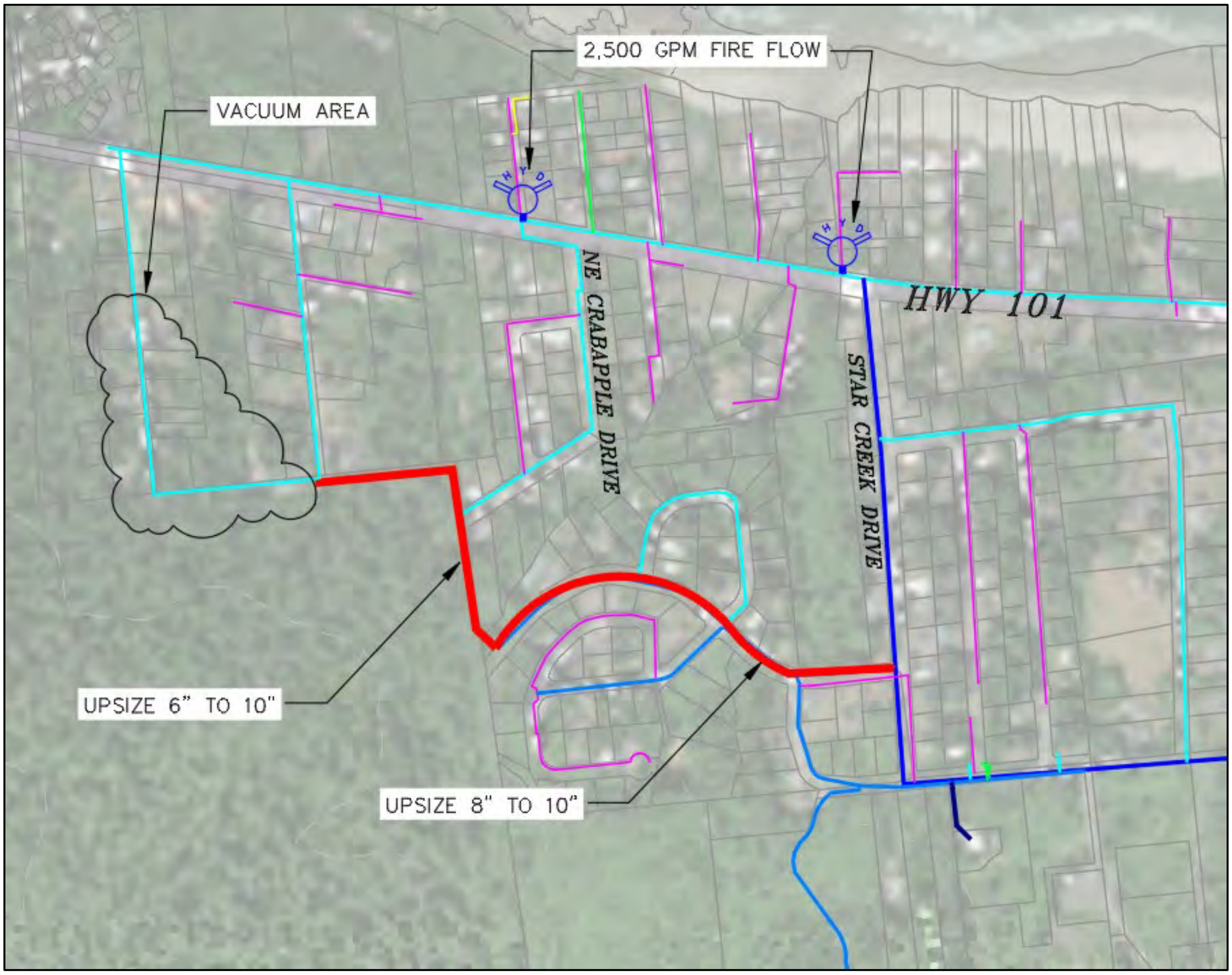
A MDD of 0.20 gpm/connection was spread out evenly across the system. A commercial fire flow demand of 2,500 gpm was applied at the south end of the system. Multiple fire flow scenarios were analyzed along Hwy 101. Existing conditions show a pressure loss/vacuum during fire flows on the southeast portion of the network.

The most prevalent improvement through all scenarios is to increase the 6-inch line shown in red to a 10-inch and the 8-inch line to a 10-inch line on NE Star Creek Road (see Figure 5-2). These improvements would equalize pressure throughout the network during a fire flow scenario and provide increased routing options and available fire flow to multiple hydrants along Hwy 101 in the southern region of the District.

Recommendations:

1. Increase pipe sizes as shown

FIGURE 5-2: SOUTH END IMPROVEMENT RECOMMENDATION



e) Maximum Day Demand (MDD) Plus Fire Demand (Waldport Industrial Park)

A MDD of 0.20 gpm/connection was spread out evenly across the system. A commercial fire flow demand of 2,500 gpm was applied at the Waldport Industrial Park. The current distribution system is not capable of delivering the required fire flow to the industrial park.

The current issues for fire flow are: (1) not enough elevation difference from Dicks Fork Tank to the industrial park sufficient to push the fire water demand through the existing pipe and maintain adequate pressures, and (2) Dicks Fork Tank can only supply enough fire flow for approximately 1.4 hours. Increased storage capacity is needed to meet the three-hour fire flow duration required.

Scenarios were analyzed to evaluate alternatives. Analysis and modeling involving the Seabrook Pump Station were performed. Further modeling and analysis are recommended when the industrial park starts to develop and fire protection becomes necessary. However, for purposes of this study, the addition of a Dick's Fork Tank appears to be a reasonable improvement along with increasing the pipe size from the tank site to the industrial park to a 12- or 16-inch pipeline.

This larger HDPE pipe would also serve as a major backbone conveyance for a seismic event. Treated water would be available above the tsunami zone.

5.3 Storage Evaluation and Recommendation

Based on the computer model, it is recommended the District consider three more tanks in order to provide the fire flows that are required at every hydrant in the District and to provide a larger treated water storage base to draw from during times of low raw water supplies. The future storage facilities should most probably be seismically rated steel storage tanks.

5.3.1 Storage Recommendations

Recommendations for the three new future tanks are as follows:

Dicks Fork Tank No. 2

This tank would be located in close proximity to the existing Dicks Fork Tank and have a minimum capacity of 500,000 gallons. The overflow elevation of this tank would match the existing tank overflow elevation.

This tank will be fed by the Dicks Fork Tank and will provide the additional water needed for domestic uses and to support the fire flows to that area of the District that is above 100 feet, including the Waldport Industrial Park. This tank will also allow the upper part of Waldport to be connected to the District's existing system.

Wakonda Beach Road Tank:

This tank should have a minimum capacity of 500,000 gallons and would be located on existing owned District property on Wakonda Beach Road at a point that is approximately one-quarter mile West of the old Easy Street Right-of-Way. This tank can be built when needed in the future. The overflow elevation would be set at 180 feet.

This tank will be fed by the Blodgett Tank and will provide water needed for domestic uses and to support the fire flows to that area of the District between Big Creek and White Cap Lane below elevation 100 feet.

Seabrook Tank No. 2:

This tank should have a minimum capacity of 250,000 gallons and would be located near the existing Seabrook Tank. This tank will be primarily filled by the Blodgett Tank.

Tables 5.1, 5.2, and 5.3 provides a cost estimate for the construction of each new tank.

TABLE 5.1 – DICK'S FORK TANK NO. 2 COST ESTIMATE

Dick's Fork Tank No. 2 (500,000 gallon steel tank)					
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**
1	Mobilization - Bonds, Insurance (5%)	LS	1	$ 36,000.00	$ 36,000.00
2	Construction Facilities and Temporary Controls (10%)	LS	1	$ 72,000.00	$ 72,000.00
3	Demo and Site Prep (20%)	LS	1	$ 144,000.00	$ 144,000.00
4	Glass-Fused, Bolted Steel Tank	LS	1	$ 450,000.00	$ 450,000.00
5	Reinforced Concrete Pad	LS	1	$ 75,000.00	$ 75,000.00
6	Earthwork, Grading, and Gravel Resurfacing	LS	1	$ 120,000.00	$ 120,000.00
7	Valves, Pipes and Appurtenances	LS	1	$ 75,000.00	$ 75,000.00
	Estimated Construction Costs			$	972,000.00
	Administrative/Legal (5%)			$	48,600.00
	Contingency (25%)			$	243,000.00
	Environmental Study			$	25,000.00
	Engineering, Geotechnical (25%)			$	243,000.00
	Estimated Project Total (rounded)			**$**	**1,532,000.00**

TABLE 5.2 – WAKONDA BEACH ROAD TANK COST ESTIMATE

Wakonda Beach Road Tank (500,000 gallon steel tank)					
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**
1	Mobilization - Bonds, Insurance (5%)	LS	1	$ 32,000.00	$ 32,000.00
2	Construction Facilities and Temporary Controls (5%)	LS	1	$ 32,000.00	$ 32,000.00
3	Demo and Site Prep (15%)	LS	1	$ 96,000.00	$ 96,000.00
4	Glass-Fused, Bolted Steel Tank	LS	1	$ 450,000.00	$ 450,000.00
5	Reinforced Concrete Pad	LS	1	$ 75,000.00	$ 75,000.00
6	Earthwork, Grading, and Gravel Resurfacing	LS	1	$ 40,000.00	$ 40,000.00
7	Valves, Pipes and Appurtenances	LS	1	$ 75,000.00	$ 75,000.00
	Estimated Construction Costs			$	800,000.00
	Administrative/Legal (5%)			$	40,000.00
	Contingency (25%)			$	200,000.00
	Environmental Study			$	25,000.00
	Engineering, Geotechnical (25%)			$	200,000.00
	Estimated Project Total (rounded)			**$**	**1,265,000.00**

TABLE 5.3 – SEABROOK TANK NO. 2 COST ESTIMATE

Seabrook Tank (250,000 gallon steel tank)					
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**
1	Mobilization - Bonds, Insurance (5%)	LS	1	$ 27,000.00	$ 27,000.00
2	Construction Facilities and Temporary Controls (5%)	LS	1	$ 27,000.00	$ 27,000.00
3	Demo and Site Prep (15%)	LS	1	$ 81,000.00	$ 81,000.00
4	Glass-Fused, Bolted Steel Tank	LS	1	$ 350,000.00	$ 350,000.00
5	Reinforced Concrete Pad	LS	1	$ 65,000.00	$ 65,000.00
6	Earthwork, Grading, and Gravel Resurfacing	LS	1	$ 50,000.00	$ 50,000.00
7	Valves, Pipes and Appurtenances	LS	1	$ 75,000.00	$ 75,000.00
	Estimated Construction Costs			$	675,000.00
	Administrative/Legal (5%)			$	33,750.00
	Contingency (25%)			$	168,750.00
	Environmental Study			$	25,000.00
	Engineering, Geotechnical (25%)			$	168,750.00
	Estimated Project Total (rounded)			**$**	**1,072,000.00**

5.4 Distribution System Evaluation and Recommendation

5.4.1 Raw Water Transmission Pipelines Recommendations

The water lines in the District which fall into this category are those which deliver raw water to the treatment plants from the water diversion sources. These pipelines appear to be in good condition and are currently not causing any delivery or maintenance issues.

An abandoned Asbestos Cement (AC) pipeline is located in the Starr Creek streambed. This pipe was replaced in 2003 with a new 8-inch HDPE installed parallel to this line but out of the creek bed. This is mentioned only because at some point in the future the AC pipeline may have to be removed. As such, the only potential project associated with the raw water pipelines is the potential removal of this pipe. Table 5.4 provides a cost estimate of a potential project should it ever be required. This project is not anticipated and therefore not included in the CIP found in Section 6.

TABLE 5.4 – STARR CREEK AC RAW WATER TRANSMISSION PIPELINE REMOVAL COST ESTIMATE

Raw Water Transmission Water Lines					
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**
1	Mobilization - Bonds, Insurance (5%)	LS	1	$ 37,500.00	$ 37,500.00
2	Construction Facilities and Temporary Controls (5%)	LS	1	$ 37,500.00	$ 37,500.00
3	Demo and Site Prep (8%)	LS	1	$ 60,000.00	$ 60,000.00
4	Starr Creek Raw Water Line, removal of AC pipe	LF	1	$ 750,000.00	$ 750,000.00
	Estimated Construction Costs				$ 885,000.00
	Administrative/Legal (5%)				$ 44,250.00
	Contingency (25%)				$ 221,250.00
	Engineering (18%)				$ 159,300.00
	Estimated Project Total (rounded)				**$ 1,310,000.00**

5.4.2 Treated Water Distribution Pipelines Recommendations

Upon completing the evaluation of the existing distribution system, several pipeline improvements have been identified for the following reasons:

1. Replacement of AC pipelines.
2. Replacement of pipelines due to insufficient system pressures (the pipes are too small).
3. Replacement of pipelines due to the age of the system – many pipelines are deteriorating and starting to leak and repairs are becoming more common.
4. Installation of new pipelines to eliminate dead-end lines (provide a looped network) thereby eliminating possible water quality and pressure problems.
5. Installation of HDPE pipe for seismic resiliency and secure infrastructure backbone.

Based on the five observations above, and in consultation with District staff and results from the computer water model, Table 5.5 lists recommended pipelines to be replaced or new pipe installed as part of Priority 1. Priority 1 consists of the replacement of all asbestos pipe.

TABLE 5.5 – TREATED WATER DISTRIBUTION PIPELINES REPLACEMENT RECOMMENDATIONS PRIORITY 1

AC Pipe to be Replaced				
	Road	Limits	Size	Length (ft)
1	Seabrook Tank	Seabrook Lane and Hwy 101 (replace 6") (also recommended for fire protection)	12"	2,600
			TOTAL 12"	**2,600**
1	Wakonda Beach Rd.	Sea Hawk St. to Tank site	8"	2,000
2	California	Mason - Hwy 101 (replace 4")	8"	950
3	Big Creek headworks	Treatment plant to basin	8"	4,400
4	South side of District office running toward Blodget Rd.		8"	650
			TOTAL 8"	**8,000**
1	Wakonda Beach Rd.	Sea Hawk St. to Tank site	6"	450
2	Camp One Rd	Highland - 101 (replace 4")	6"	1,300
3	Hwy 101	Waziyata - Ranger Station (replace 4")	6"	180
4	Tara Inn and Range Dr	North to meter to forest service and Blue Whale Trailer Park	6"	1,440
5	Fernwood Ln.	Fernwood Ln. to White Cap	6"	1,500
6	White Cap	Fernwood Ln. to Hwy 101	6"	300
7	West side Hwy 101, at Big Stump Beach entrance	Running south W. side Hwy 101 to Wakeetum St.	6"	2,600
8	North Field Ave	Wakonda Beach Rd - Wakeetum St.	6"	1,430
9	Tillucum St.		6"	795
10	Forest Hill Ln.		6"	980
11	Line between Forest Hill Ln at Starr Creek		6"	1,000
			TOTAL 6"	**11,975**
Fire Flow Recommended Pipe to be Replaced				
1	Seabrook Tank	SW Range Drive (replace 6")	10"	1,400
2	South end of District	NE Star Creek Road (replace 8")	10"	1,400
3	South end of District	NE Star Creek Road (replace 6")	10"	1,500
			TOTAL 10"	**4,300**
21	Seabrook Tank	Hwy 101 Crossing (replace 2")	6"	400
			TOTAL 6"	**400**

Priority 2 (Table 5.6) generally represents potential projects that may be necessary sometime in the future. For example, Priority 2 includes a 12-inch pipeline that may be needed at some point to provide adequate flows and fire protection to the Waldport Industrial Park. This 12-inch HDPE pipeline would also serve as a major backbone distribution pipeline in a seismic event.

TABLE 5.6 – TREATED WATER DISTRIBUTION PIPELINES REPLACEMENT RECOMMENDATIONS PRIORITY 2

	Road	Limits	Size	Length
1	Dicks Fork Tank	Waldport High School and Industrial Park	12"	10,000
			TOTAL 12"	**10,000**
1	Brubaker	Hwy 101	8"	1,400
2	Wyoming Ave	101 - Colfax	8"	1,450
3	Hwy 101	Seabrook - Alicia Lane	8"	510
4	Flansberg Rd	End of Existing - North	8"	2,300
5	Hwy 101	Seabrook - Alicia Lane	8"	510
			TOTAL 8"	**6,170**
1	Vingie	Hwy 101	6"	1,550
2	Alley	Southmayd - Seabrook Lane	6"	130
3	Goodwin Ave	Camp One Rd - Arizona	6"	680
4	Iris Lane	Neal Ave - Field Ave	6"	200
5	Oklahoma	Finisterre - 101	6"	360
6	Fernwood Dr.	Cross Hwy 101	6"	140
7	Hwy 101	Fernwood Dr. - South to Existing 6”	6"	260
8	Trout Street	101 - North Ave	6"	420
9	North Ave	Trout Street - Perch street	6"	240
10	Perch Street	North Ave - 101	6"	480
11	Airport Lane	Beach Side Lane - End of Existing	6"	2,250
12	Field Ave	Existing-South to Airport Lane	6"	900
13	Beach Side Lane	Hwy 101 - Airport Lane	6"	1,150
14	Nevada	Mason - Beaver - California	6"	930
15	Washington	101 - Colfax	6"	1,290
16	Oregon	101 - Colfax	6"	1,300
17	Colorado	101 - Stone Ave	6"	230
18	Stone Ave	Knoxville - Colorado	6"	260
19	Texas	Stone Ave - 101	6"	230
			TOTAL 6"	**13,000**
1	Sunset St.	Hwy 101 - East	2"	730
			TOTAL 2"	**730**

5.4.3 **Fire Hydrants**

There are 113 existing fire hydrants scattered throughout the water system which are in generally good condition. Some hydrants are no longer supported by the manufacturer and parts are not available. There is also the need for new and additional fire hydrants throughout the system:

1. A few hydrants have 4-inch barrels instead of the industry standard of 6-inches and should be replaced.
2. Hydrants are needed in locations more accessible to firefighting equipment and in areas where there has been recent housing growth.
3. Hydrants are needed in areas where current waterlines are too small to support hydrant flows (hydrants would be added when pipes are replaced and enlarged).

The Table below includes a budget for fire hydrant replacement and new installation for each Priority.

5.4.4 **Valves**

Existing valves in the system are old and deteriorating. Recently (December 2018) a 6-inch valve at Hwy 101 and Nebraska burst due to rusty bolts, spilling water and requiring emergency response. Replacement of the old pipes will provide a dual benefit of also replacing many old valves.

The following Tables include a budget for new valves as part of new pipes installed. There is also a budget for the replacement of old valves throughout the system based on the cost to repair the recent valve failure.

Based on Tables 5.5 and 5.6, Tables 5.7 and 5.8 provide a cost estimate for Priority 1 and Priority 2 recommended treated water distribution system improvements respectively.

TABLE 5.7 – TREATED WATER DISTRIBUTION SYSTEM COST ESTMATE PRIORITY 1

Treated Water Distribution System Upgrades - Priority 1					
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**
1	Mobilization - Bonds, Insurance (5%)	LS	1	$ 96,990.00	$ 96,990.00
2	Construction Facilities and Temporary Controls (5%)	LS	1	$ 96,990.00	$ 96,990.00
3	Demo and Site Prep (10%)	LS	1	$ 176,340.00	$ 176,340.00
4	12" HDPE Pipe w/ Treching and Backfill	LF	2,600	$ 65.00	$ 169,000.00
5	10" HDPE Pipe w/ Treching and Backfill	LF	4,300	$ 60.00	$ 258,000.00
6	8" HDPE Pipe w/ Treching and Backfill	LF	8,000	$ 50.00	$ 400,000.00
7	6" HDPE Pipe w/ Treching and Backfill	LF	12,375	$ 40.00	$ 495,000.00
8	12" Flanged Gate Valve	EA	6	$ 2,000.00	$ 12,000.00
9	10" Flanged Gate Valve	EA	10	$ 1,800.00	$ 18,000.00
10	8" Flanged Gate Valve	EA	8	$ 1,500.00	$ 12,000.00
11	6" Flanged Gate Valve	EA	12	$ 1,200.00	$ 14,400.00
12	Repair / Replace Old Existing Valves	EA	6	$ 3,500.00	$ 21,000.00
13	Fire Hydrant Assembly	EA	16	$ 3,500.00	$ 56,000.00
14	Blow-off Assembly	EA	4	$ 2,000.00	$ 8,000.00
15	Road / Asphalt Repair	LS	1	$ 300,000.00	$ 300,000.00
	Estimated Construction Costs			$	2,133,720.00
	Administrative/Legal (5%)			$	106,686.00
	Contingency (20%)			$	426,744.00
	Engineering (25%)			$	533,430.00
	Estimated Project Total (rounded)			**$**	**3,201,000.00**

TABLE 5.8 – TREATED WATER DISTRIBUTION SYSTEM COST ESTIMATE PRIORITY 2

Treated Water Distribution System Upgrades - Priority 2					
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**
1	Mobilization - Bonds, Insurance (5%)	LS	1	$ 110,450.00	$ 110,450.00
2	Construction Facilities and Temporary Controls (5%)	LS	1	$ 110,450.00	$ 110,450.00
3	Demo and Site Prep (10%)	LS	1	$ 200,810.00	$ 200,810.00
4	12" HDPE Pipe w/ Treching and Backfill	LF	10,000	$ 65.00	$ 650,000.00
5	8" HDPE Pipe w/ Treching and Backfill	LF	6,170	$ 50.00	$ 308,500.00
6	6" HDPE Pipe w/ Treching and Backfill	LF	13,000	$ 40.00	$ 520,000.00
7	2" Pipe w/ Treching and Backfill	LF	730	$ 20.00	$ 14,600.00
8	12" Flanged Gate Valve	EA	10	$ 2,000.00	$ 20,000.00
9	8" Flanged Gate Valve	EA	8	$ 1,500.00	$ 12,000.00
10	6" Flanged Gate Valve	EA	16	$ 1,200.00	$ 19,200.00
11	2" Valve	EA	2	$ 400.00	$ 800.00
12	Repair / Replace Old Existing Valve	EA	6	$ 3,500.00	$ 21,000.00
13	Fire Hydrant Assembly	EA	24	$ 3,500.00	$ 84,000.00
14	Blow-off Assembly	EA	4	$ 2,000.00	$ 8,000.00
15	Road / Asphalt Repair	LS	1	$ 350,000.00	$ 350,000.00
Estimated Construction Costs				$	2,429,810.00
	Administrative/Legal (5%)			$	121,491.00
	Contingency (20%)			$	485,962.00
	Engineering (25%)			$	607,453.00
Estimated Project Total (rounded)				**$**	**3,645,000.00**

5.4.5 **Pump Stations**

Alder Street Pump Station and the Seabrook Pump Station pumps are old and replacement should be anticipated within the next 5-years (Priority 1). There is also the possibility that the Seabrook Pump Station will need to be enlarged in order to provide increased fire flows to the area south of Range Drive and east of Crestline Drive. The cost of this would potentially be borne partially by new development in that area. Table 5.9 provides a cost estimate of the pump replacements for both pump stations and the potential upgrade improvements of Seabrook.

TABLE 5.9 – PUMP STATION RECOMMENDATION COST ESTIMATE

Pump Stations					
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**
1	Mobilization - Bonds, Insurance (5%)	LS	1	$ 4,500.00	$ 4,500.00
2	Construction Facilities and Temporary Controls (5%)	LS	1	$ 4,500.00	$ 4,500.00
4	Alder Street Pump Station Pump Replacement	LS	1	$ 15,000.00	$ 15,000.00
5	Seabrook Pump Station Pump Replacement	LS	1	$ 25,000.00	$ 25,000.00
6	Seabrook Pump Station Pump Upgrade	LS	1	$ 50,000.00	$ 50,000.00
Estimated Construction Costs				$	99,000.00
	Administrative/Legal (5%)			$	4,950.00
	Contingency (25%)			$	24,750.00
	Engineering (25%)			$	24,750.00
Estimated Project Total (rounded)				**$**	**154,000.00**

5.4.6 **Meters**

The District is in the systematic process of replacing all the old previously installed individual meters. Table 5.10 provides a cost estimate for the total replacement of all customer water meters if a single project were to be undertaken by a general contractor. The District currently has no interest or need to do a large capital replacement project. They will continue to replace meters on their own schedule. A significant cost savings will result by having the District do this work themselves. This cost is not included in the CIP found in Section 7.

TABLE 5.10 – METER REPLACEMENT COST ESTIMATE

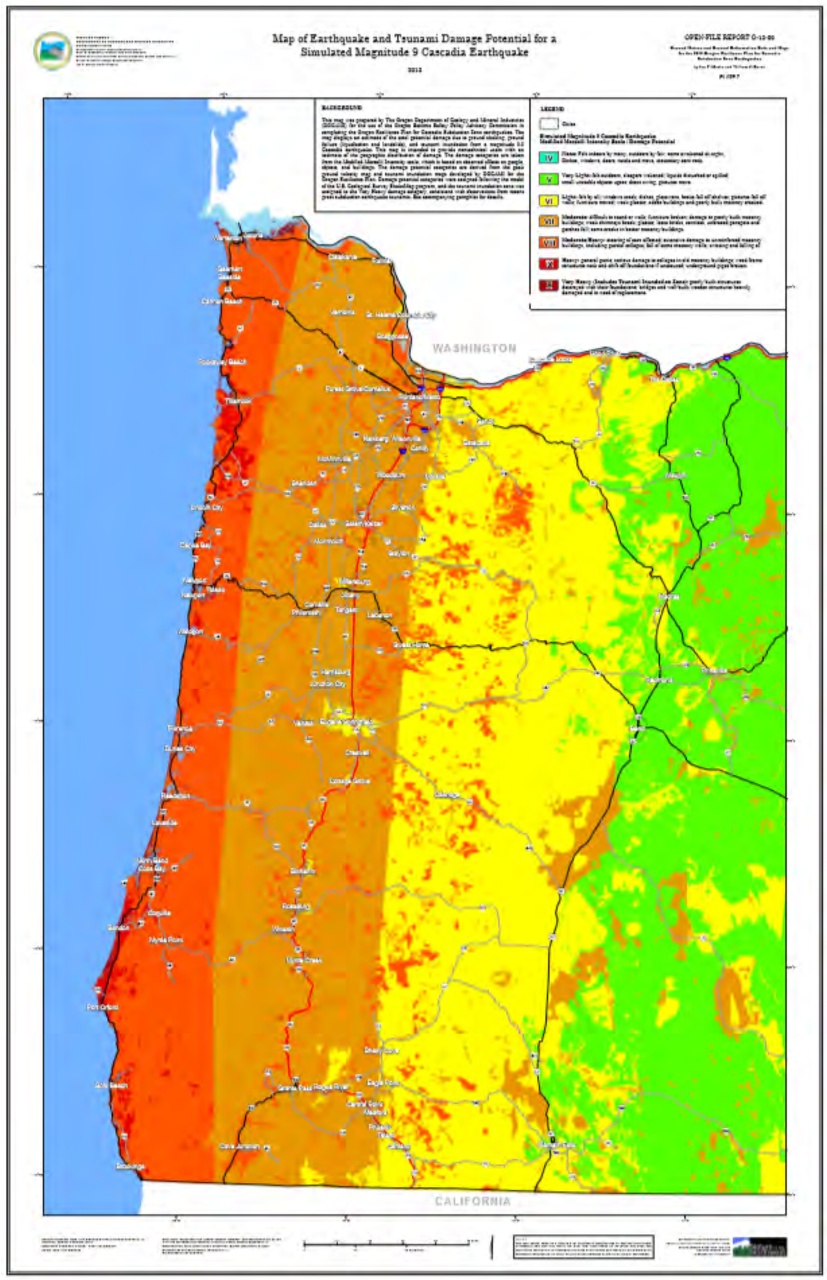
Installation of Individual Water Service Meters					
Item No.	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Item Cost**
1	Mobilization - Bonds, Insurance (5%)	LS	1	$ 104,700.00	$ 104,700.00
2	Construction Facilities and Temporary Controls (5%)	LS	1	$ 104,700.00	$ 104,700.00
3	Install New Meter, 3/4" with Meter Box and Cover	EA	1200	$ 1,600.00	$ 1,920,000.00
4	Install New Meter, 1" to 6" with Meter Box and Cover	EA	58	$ 3,000.00	$ 174,000.00
Estimated Construction Costs				$ 2,303,400.00	
	Administrative/Legal (5%)			$ 115,170.00	
	Contingency (20%)			$ 460,680.00	
	Engineering / Technical Support (5%)			$ 115,170.00	
Estimated Project Total (rounded)				**$ 2,995,000.00**	

6 SEISMIC RISK ASSESSMENT AND MITIGATION PLAN

6.1 Introduction

The SW Lincoln County PUD has been identified as a Level VIII on the Oregon Department of Geology and Mineral Industries (DOGAMI) Oregon plate number 7 for earthquake and tsunami damage as shown on Figure 6-1. Due to the District's proximity to the coast, and in the event of a large (9.0+) Cascadia Subduction Zone (CSZ) event, the lower elevation of most of the service area would be compromised if not outright destroyed by an earthquake and/or resultant tsunami.

FIGURE 6-1: DOGAMI MAP OF DAMAGE POTENTIAL



Based on the current condition and location of the existing infrastructure, the District is vulnerable to seismic events, including resultant tsunamis, subsidence, landslides and power outages. Considerable work must be done to update the District's utility infrastructure to ensure it has the most seismically resilient systems possible. Modification, replacement, and/or relocation of existing infrastructure is critical to ensure the District can continue to supply water and essential community needs after a major CSZ event.

This section of the Plan will address the likely impact a CSZ 9.0 earthquake would have on the Southwest Lincoln PUD facilities, changes that can be made to reduce the impact, and ways the District can prepare to reduce system recovery time after such an event. The intent of this section is to identify, assess, and plan to upgrade or relocate existing critical facilities and infrastructure as necessary to supply the District post-CSZ 9.0 event with:

- Clean Drinking Water
- Fire Suppression
- Health Care and Fire Aid
- Emergency Response

The 2013 Oregon Resilience Plan (ORP) has a 50-year planning goal for cities and special utility districts to attain the capability to restore critical services within a one-week period after an earthquake/tsunami event, and to be able to restore all services within three to six months. This restoration of services will be considerably more difficult for coastal communities due to the compounded effect an earthquake, subsidence, and resultant tsunami are likely to present. Currently, coastal communities are estimated to take up to 3+ years to restore drinking water services after a major seismic event. By focusing planning and capital improvement toward improving seismic resiliency, the recovery period after such an incident can be significantly reduced.

6.1.1 Guidelines

Every community water system with more than 300 connections who submits a water system master plan is required to conduct "a seismic risk assessment and mitigation plan for water systems fully or partially located in areas identified as VII to X, inclusive, for moderate to very heavy damage potential using the Map of Earthquake and Tsunami Damage Potential for a Simulated Magnitude 9 Cascadia Earthquake, Open File Report 0-13-06, Plate 7 published by the State of Oregon, Department of Geology and Mineral Industries (see Figure 6.1).

(i) The seismic risk assessment must identify critical facilities capable of supplying key community needs, including fire suppression, health and emergency response and community drinking water supply points.
(ii) The seismic risk assessment must identify and evaluate the likelihood and consequences of seismic failures for each critical facility.
(iii) The mitigation plan may encompass a 50-year planning horizon and include recommendations to minimize water loss from each critical facility, capital improvements or recommendations for further study or analysis." (OAR 333-061-0060)

The result of this District Risk Assessment is a list of infrastructure backbone components including supply, treatment, distribution, and storage elements that are needed in order to continue to supply water for essential community needs immediately after a CSZ earthquake. The assessment evaluates the likelihood and consequences of seismic failures for the District identified as critical. General information for assessing various facilities by construction date and material is found in the Oregon Resiliency Plan, which also references the American Lifelines Alliance (2001) Seismic Fragility Formulations for Water Systems, www.americanlifelinesalliance.org.

Based on the critical facilities identified to form the backbone, the District Mitigation Plan consists of projects that will be completed over the next 50-year time period to upgrade, retrofit, or rebuild these facilities so that they will continue to provide water following a CSZ earthquake. The mitigations include planned capital improvement projects, improvements to minimize water loss from each critical facility, and recommendations for further study or analysis. The Mitigation Plan includes a schedule as to when these mitigation efforts are targeted to be completed within the 50-year planning horizon.

6.1.2 Immediate Impacts of a Seismic Event

Earthquakes in the Pacific Northwest occur in response to active convergence of the Juan de Fuca oceanic plate and the North American continental plate. CSZ megathrust events generated along the boundary between the subducting Juan de Fuca plate and the overriding North American plate. Recent studies indicate that the CSZ can potentially generate large earthquakes with magnitudes ranging from 8.0 to 9.2 depending on the rupture length. The potential for a CSZ earthquake has an estimated probability of occurrence off the Oregon Coast on the order of 16 to 22 percent over the next 50 years.

The first notice of an earthquake will be severe shaking for 3 to 5 minutes. It will be very difficult to stand up. If driving, it will be difficult to maintain a position on the roadway. Non-reinforced masonry buildings will receive extensive damage and may collapse. Wooden structures will be significantly damaged. Different geographical areas will react differently; landslides will occur in the upper water shed. Roads will split, bridges will fail. In the water system, water storage tanks may shake off their footings, treatment plant structures and pump buildings may be damaged, transmission pipelines may tear apart, and distribution lines may break.

About 20 minutes after the initial shaking, a tsunami will, with high probability, hit the coast and inundate areas up to about 90 feet above sea level. This will affect about 85 percent of the water service customers in the District. It will also affect District facilities within the inundation areas including the business office on Highway 101. Fortunately, other than fire hydrants and underground pipes and valves, most of the District facilities are above the expected tsunami inundation zone.

Immediately after the tsunami, few District employees may be available as they themselves will be working to check on the status of family members or otherwise affected personally. Many telephone systems will be down. Cell phones may not be reliable, and if they are working, the service providers will be loaded with calls. Electrical power may be down for some time. Transportation will not be reliable. Portions of US Highway 101 will have been inundated with the tsunami. Sections that are structurally intact will be covered with debris. Landslides will destroy sections of Highways 20, 34, and 101, potentially isolating the District from other communities and the coastal communities from the Willamette Valley. Water leaking from broken pipes will soon empty the system tanks.

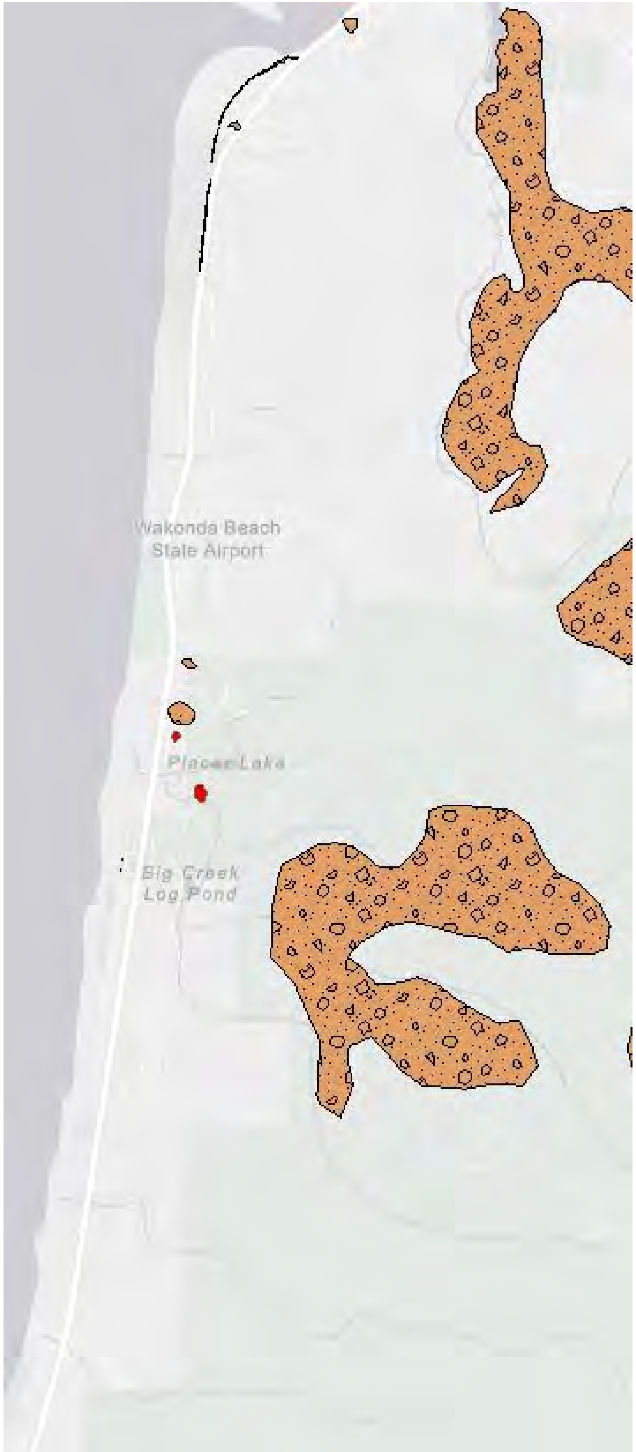
6.1.3 Geotechnical and Structural Seismic Evaluation

Although there is a general discussion here regarding seismic resilience of various components of the water system, this report does not delve into the actual geological and structural condition of the structures that make up the components. For the District to have a more accurate estimate of areas vulnerable to seismic events, it would need to commission a detailed geotechnical and structural investigation including specific recommendations as to the risks associated with various soil types and geologic features and existing structures.

6.2 Geologic and Seismic Setting

Current research indicates the region is “past due” based on historic and prehistoric recurrence intervals documented in the ocean sediments. In 2013, the State of Oregon developed the Oregon Resilience Plan (ORP, 2013) to prepare for the magnitude 9.0 CSZ event. The following are geological activities that can be triggered or intensified by ground shaking and that can damage water system infrastructure:

FIGURE 6-2: DOGAMI SLIDO



6.2.1 Ground Shaking

Ground shaking is a hazard created by earthquakes. If the vibrations are strong enough they may cause damage to buildings, roads, or other structures.

Liquefaction and landslides can be triggered by ground shaking. The rapid and extreme shaking during an earthquake can cause stress and strain in pipelines that can be damaging if the pipe material and joints are not strong enough to withstand the transient ground deformations. Damage from ground shaking occurs even when there is no peak ground displacement (PGD). The intensity of ground shaking can be quantified by measuring the peak ground velocity (PGV) at a site because of an earthquake.

Ground shaking varies depending on the soil, the topography, and the location and orientation of the rupture. Ground shaking is one hazard that causes damage to buried pipes.

6.2.2 Liquefaction

Liquefaction is a phenomenon that occurs during ground shaking in areas of loose, saturated, granular soils. The lack of soil stability may cause infrastructure to sink and collapse. The areas in the District that would be prone to liquefaction are in the floodplain near the mouth of Big Creek, Placer Lake and Reynolds Creek.

6.2.3 Landslides

Landslides generally occur on steep cliffs or slopes with saturated soils. They are frequently triggered by additional rain, uprooted trees, slope disturbance from construction, and ground shaking. Earthquake-induced landslides can occur on slopes when inertial forces from an earthquake add dynamic loading to an already unstable slope. The District experiences some of the largest amounts of rainfall statewide each year. Saturation of soils will further exacerbate the potential for landslides if the earthquake should happen during the wet season. The ground movement caused by landslides can be extremely large and damaging to pipelines, tanks, and other facilities. DOGAMI publishes maps of landslide prone areas. The Statewide Landslide Information Database for Oregon (SLIDO) shows most of the District's service area has a low propensity for landslides (Figure 6-2). However, there is a higher probability in the higher elevation areas, which include the water shed. A landslide could dislodge one of the raw water transmission pipes if it happened to occur along the path of the line.

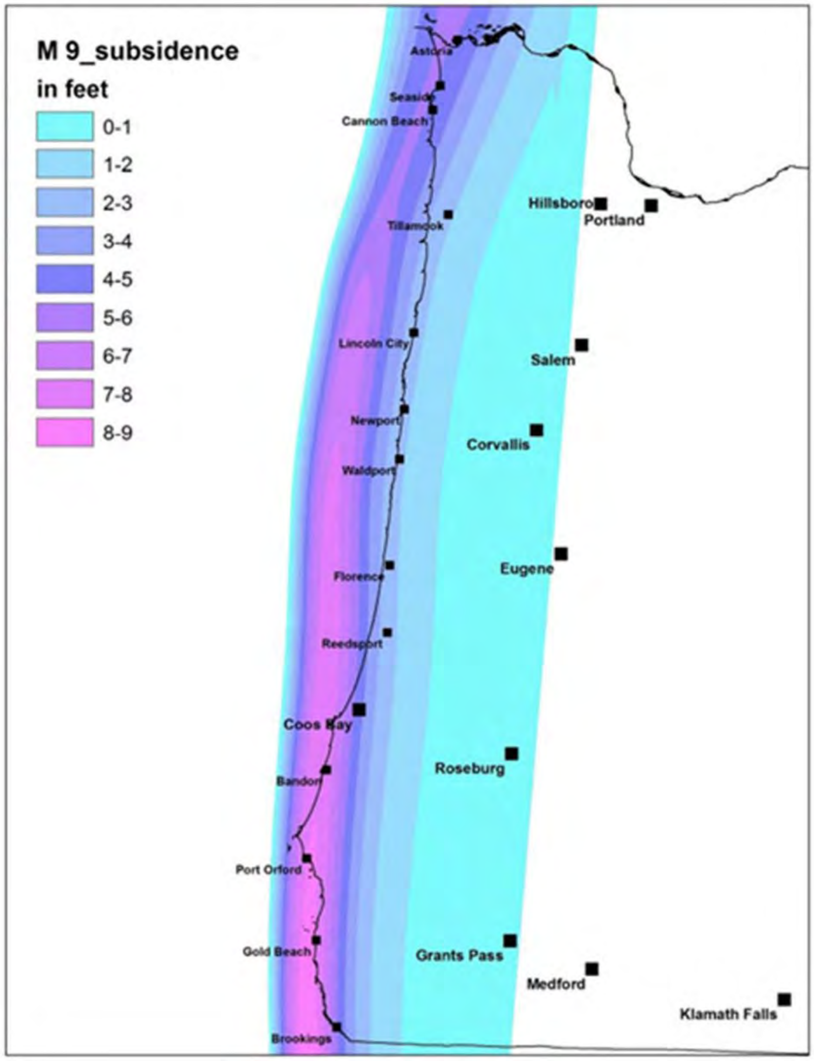
6.2.4 **Lateral Spread**

During earthquake shaking, the ground may move laterally causing blocks of land to move in the same direction. Generally, this occurs near a slope but can occur anywhere there are soils underlain with a weak foundation. Lateral spreading will crack and stretch the ground surface. The area of the District is not prone to lateral spread.

6.2.5 **Subsidence**

Subsidence causes the ground to quite literally drop in an area. Indicated on Figure 6-3 from the Oregon Resilience Plan (ORP), the District has the potential for a subsidence of 2- to 3-feet. This subsidence will further exacerbate the effect of the resultant tsunami by creating a 3-foot permanent "storm surge" prior to the tsunami arrival. Anywhere in the District that is susceptible to tsunami runup will be negatively affected by subsidence. Figure 6-3 details the potential subsidence associated with a M 9.0 seismic event along the Oregon coastline.

FIGURE 6-2: SUBSIDENCE



6.2.6 **Tsunami**

When an earthquake occurs under the ocean, the elevation of the ocean floor suddenly changes. The relative change causes a wave to propagate away from the site of the displacement. The wave, known as a tsunami, can travel thousands of miles. As it nears the shore, the wave height rises and can cause severe damage as it runs up on shore. Smaller waves will follow over a period of several hours. Appendix C contains the local Tsunami Evacuation Maps encompassing the District, showing nearly all the service area of the District below 90 feet elevation will be inundated. Most structures will not survive the impact of the debris-laden waves. As the tsunami waves withdraw, they will cause erosion of the soil. Within the tsunami zone, damage will be much worse than that from the shaking alone.

The impact on District infrastructure in the tsunami zones will vary. Some fire hydrants may be jarred loose because of the impact with debris in the waves. In some places, pipes may be exposed or broken because of erosion of the surrounding and underlying soil. Some places might have soil accumulation, making it difficult to find valves.

6.2.7 Aftermath

Due to the nature of the shaking, the unpredictable actions of landslides, and unknown weaknesses, it is impossible to predict where and to what extent damage to the system will occur. Advance preparation can reduce the chances of impact to selected areas. After the shaking and flooding stop, the District staff and officers will make an assessment to see where the damage occurred and take actions to save as much water as possible from draining through broken pipes.

Electrical power to the District is provided by the Central Lincoln People's Utility District (CLPUD). Although CLPUD has received recognition for having redundancy built into their system, there may not be any electrical power available for a time. The District will need to rely on the District-owned localized generators, which will also have a limited useful time because of unavailability of propane fuel.

The highway access for delivery of fuel, repair parts, supplies, etc. will also pose a problem for restoring service. To that end, the District should develop a list of materials that should be stockpiled in order to resume basic production and distribution of treated water.

6.3 Seismic Risk Assessment and Mitigation

The goal of the risk assessment recommendations is to create a disaster resilient water system infrastructure backbone involving each of the water system components:

- Water Supply / Sources (Watershed, Diversions, Pipelines, Pumps)
- Water Treatment
- Water Storage
- Water Distribution

The backbone system consists of key supply, treatment, transmission, storage, and distribution components that, over the 50-year timeframe, will have been upgraded, retrofitted, or rebuilt to withstand a Cascadia Subduction Zone earthquake. The backbone water system would be capable of supplying key community needs, including fire suppression, health and emergency response, and community drinking water distribution points, while damage to the larger (non-backbone) system is being addressed.

This Mitigation Plan is an effort to reduce loss of life and property by lessening the impact of a seismic disaster. To be effective, mitigation must address difficult realities, and invest in long-term goals. Taking action prior to an event will ensure the District will be safer, financially secure, and self-reliant.

The cost of complete seismic mitigation to the District's entire water infrastructure would exceed the District's resources. Therefore, as outlined in Chapter 7, a phased approach to system recovery improvements is recommended.

The next paragraphs will analyze the water system components individually for likely points of failure as a result of a CSZ -9 earthquake and subsequent tsunami. Possible actions to harden the facilities will be discussed and recommendations made to accomplish the resiliency goals.

6.3.1 Water Supply / Sources

Watershed

As noted in Section 3.1, the watersheds above the District's diversion points is about 5.5 square miles, 98.5 % of which is national forest property. The most likely disruption of water supply in the watershed from an earthquake would be a landslide triggered by the ground shaking. This would be more likely during the rainy season.

A landslide, depending on its proximity to the stream, would increase turbidity of the water for a period of time. A landslide could also cause a dam to be created that would disrupt the stream flow until it overtopped, resulting in increased stream flow of silt-laden water as the dam would wash out. This action could cause the respective settling basin to fill with sediment.

Due to the inaccessibility of the forest and the imprecise ability to predict landslides, there is not much that can be done to prevent them. Fortunately, the District has four diversions, so if one were to be out of commission for a while after a landslide, the system could still operate.

Diversions

There are four diversions on various creeks, three of which will likely need to be improved within this planning period (see Section 4.2). The main potential disruptions of the diversions due to an earthquake is a landslide. The shaking from a CSZ quake may accelerate the undermining. It is doubly important that the staff monitor these diversions. An engineering geologist should be engaged to check these sites for both water undermining as well as slide potential. A recommendation should be followed for ways to reduce the impact from any potential slide.

Settling Basins

There are three concrete settling basins; one near each of the diversions on Big Creek, Star Creek, and Dicks Fork. It is recommended a structural engineer look at these basins and give any recommendations for seismic resiliency.

Raw Water Transmission Pipelines

The District is fortunate to have one of its three raw water transmission pipelines, the Starr Creek line (a major backbone component), already replaced with HDPE pipe. However, the HDPE section is only from the diversion to the Brubaker Vault, and then PVC pipe thereafter after joining with Vingie Creek. Section 3.6 indicates that the other two transmission lines are relatively new and in good condition. However, all PVC transmission lines should be changed to HDPE pipe within the next 20-50 years, or as resources become available.

Raw Water Pump Station

All of the District's raw water pipelines are fed by gravity except for the Vingie Creek intake. The pump at Vingie Creek is located in the tsunami evacuation area and would likely be seriously damaged as a result of the effects of a CSZ-9 earthquake. Fortunately, the Vingie Creek intake supplies less than 25 percent of the Districts water and could be taken out of service while other facilities are being assessed and repaired. This pump station is not considered a key backbone element.

6.3.2 **Water Treatment Plants**

The District has two water treatment plants constructed of similar design (Section 3.4). Both treatment plants are outside of the tsunami zone and appear to be away from slide-prone areas. The most probable cause of damage to the water treatment plants during a major earthquake would be due to shaking, potentially damaging both the buildings and the machinery/equipment. The plants were built about the time the seismic standards were being upgraded in the building codes. It is recommended the District hire a structural engineer to review the construction plans and the codes that were applied at the time of construction to assure the buildings were built to the latest standards. The engineer should also look at the placement of motors, pumps, storage tanks, and other appurtenances at the plants to assure they are properly braced to prevent failure in a seismic event. If the latest codes were used, any suggested structural reinforcement would likely be minimal.

The next most probable cause of disruption of service to the plants would be lack of electricity. The plants are serviced by the CLPUD, which has redundancy in its feed lines to the area. However, in case of outage, the water treatment plants have a generator of adequate size to supply the needs to keep the plants operating for a limited period of time.

The third area of vulnerability to the treatment plants after a major earthquake will be materials and supplies, including fuel to run the generators, treatment chemicals, lab supplies, repair parts, etc. There will be major disruptions to vehicle traffic and confusion in the distribution of supplies throughout the central coast. There is not a lot the District can do to improve accessibility for these supplies, so the staff must analyze how much material and supplies they need to keep in reserve. Both of the water treatment plants are considered part of the “backbone” system.

6.3.3 **Water Storage**

The District currently has five treated water storage tanks – two concrete and three steel (see Section 3.5.2). All of the tanks are above the tsunami inundation zone. None of them appear to be in an active landslide zone. The cause of damage to these tanks will most likely be due to shaking. The inertial forces of the ground shaking and water sloshing will tend to cause a tank to either slide off its foundation or rip the walls apart. The shaking can also cause differential movement between the tank and the surrounding ground. If the pipes connecting the tank to the water system are not flexible, they can break.

The concrete tanks, Dick’s Fork and Seabrook, were both built in 1976. Both of these tanks are considered part of the “backbone” system. It is recommended both be evaluated by a structural engineer who has an emphasis on concrete water tanks. It is recommended in this report both locations receive a second, larger tank. If the existing tanks are found not to be seismically built, the recommended companion new tank will provide redundant storage since it will be built to current seismic standards.

The steel tanks, Blodgett, Starr Creek, and Crabapple were all constructed in 1997 (see Section 5.3.2). At that time of construction, they should have been built under similar current construction standards as today. Due to the critical locations of these tanks, they are also part of the "backbone" system. It is therefore recommended the structural engineer also review these tanks for resilience during an earthquake.

6.3.4 Water Distribution

Distribution System

The distribution system has hydrants, water meters, various types of valves, and several types of pipe. Pipe materials used within the District distribution system include Asbestos Cement (AC) Pipe, multiple classes and manufacturers of Polyvinyl Chloride (PVC) Pipe, Polyethylene Pipe, Ductile Iron Pipe (DIP), and High-Density Polyethylene (HDPE) Pipe. These elements of the water distribution system are most vulnerable. It is here the "backbone" system is most important.

Different types of pipe have different abilities to withstand seismic events. AC pipe is considered a "rigid" pipe and very susceptible to breaking during a seismic event. Rigid pipes are better able to handle loading without deformation, but do not have the capability to flex during ground movement. PVC, while considered a flexible pipe, is generally installed with non-restrained joints, meaning it is susceptible to pulling apart during ground movement. HDPE is the most flexible pipe material commonly used for water transmission and distribution, and is generally welded together, meaning it is fully restrained pipe. HDPE is widely recognized as the most resilient to ground movement.

As pipelines break, storage will be depleted. The principle behind a backbone is that the key pipelines will be built to be most resistant to the effects of an earthquake. Valves at key locations can be used to isolate smaller service neighborhoods until those portions of the network can be systematically repaired and restored to service. Hydrants with customer use adaptors or faucets at key locations can be part of the backbone so customers can fill water containers for their home use.

The recommendations made in Section 5.4.2, specifically the replacement of all AC pipe with HDPE pipe (Tables 5.5 and 5.6), is a great step forward towards being more resilient. As these projects are constructed, the use of HDPE pipe will make the District less susceptible to seismic activity. Through the course of this seismic assessment, it is apparent the District could struggle in a seismic event if the pipeline system isn't improved.

The hydrants are above ground and possibly subject to impact with debris in the tsunami inundation zone. As replacement or new hydrants are installed, it is recommended they be break-away hydrants to minimize water loss and damage to underlying pipes in case of such an impact.

Treated Water Pump Station

There are two treated water pump stations in the District system. The Seabrook Pump Station is associated with the Seabrook Tank and is designed to supplement the flow of water to the higher-pressure zone supplied by the Dick's Fork system. As this could be called on to supplement fire flow into the area of the schools and college as well as the Waldport Industrial Park, it is critical and should be considered part of the "backbone" system. This pump station is above the tsunami inundation zone. It is most vulnerable to shaking during a CSZ-9 earthquake. It is also vulnerable to availability of electrical power; thus, the existing on-site generator will provide power only for a limited time. Section 5.4.5 recommends replacement and possible upsizing of the Seabrook Pump Station within the next five years. At that time, attention should be given to appropriate bracing of the pumps, motors, and electrical panels. The building should also be replaced or brought up to current building codes.

The Alder Street Pump Station supplies water to a limited zone at a higher elevation, approximately 25 homes with no critical facilities. The pump is within the tsunami inundation zone and could be subject to flooding and debris damage. The electrical panels could also be submerged. The homes in this service area are above the tsunami zone and would likely survive an earthquake. There is a back-up generator with this pump station.

The Alder Street Pump Station is recommended for replacement within the next five years (Section 5.4.5). At such time, a hydrant and bypass assembly could be installed providing a means for a portable pump connection. Since an event will likely take the pump station and generator out of service, a portable pump could be brought in every few days to replenish the water in the Crabapple Tank.

6.4 Summary Recommendations

There are several improvements the District can do in phases over the next 50-years to make the water system more resistant to damage and more resilient to be returned to service in the case of an earthquake and/or tsunami. The District should actively seek to replace the ridged and brittle AC pipe with the flexible, more resilient HDPE pipe as recommended in Priority 1 improvements (Section 7.3.1). These improvements, if done, will increase the ability of the system to withstand the impacts of an earthquake.

In summary, seismic-related recommendations include:

1. Expert evaluations and analysis of specific water system components:

   a. An engineering geologist should be engaged to check the diversion and tank sites
   b. A structural engineer should evaluate the concrete settling basins and storage tanks
   c. A structural engineer should evaluate the water treatment buildings as well as look at the placement of motors, pumps, storage tanks, and other appurtenances at the plants to assure they are properly braced to prevent failure in a seismic event.

2. Have tools and equipment necessary to repair large sections of pipeline and many small breaks. It is suggested to stock approximately 3% of the total system pipeline. The pipeline stock can be coordinated with annual pipe replacement projects, so the supply pool is rotated. Pipe material should be stored out of the sun.

3. Keep a supply of various sized repair bands and fittings to facilitate repair of a minimum of 10 breaks.

4. Store vehicles, parts, materials above tsunami zone. The buildings where these items are stored should be reviewed for construction to the latest earthquake standards.

5. GPS locate all valves and meters. If such are covered with debris and dirt, GPS coordinates of valves can be used to find the valve in order to shut down a section of pipe if necessary.

6. The existing Emergency Response Plan should be periodically reviewed and updated to assure the plan is current.

7. Be a participant in ORWARN. Oregon Water/Wastewater Agency Response Network (ORWARN) is a mutual aid association for water systems. In the event of a major impact to water systems, crews can be recruited from less-damaged areas of the state, and even out of state, to help with repairs.

7 CAPITAL IMPROVEMENT PLAN AND FINANCIAL ANALYSIS

7.1 General

This Section summarizes and quantifies the recommended water system capital improvements needed to properly serve the District's needs over the next 20-years as determined by the detailed analyses in this Water System Master Plan. The Capital Improvement Plan (CIP) consists of various projects to improve water quality, maintain and protect existing water system assets, correct deficiencies, satisfy any seismic-related concerns, and provide water system capacity for projected population growth.

The water system CIP is used to help establish funding needs, user rates, system development charges (SDCs), and to plan for and prioritize various project needs. The CIP can change over time as projects are completed and/or new unforeseen needs arise. An attempt should be made to annually update the CIP and keep the list of needs current.

The CIP summarizes the recommended system improvements that are anticipated beyond routine maintenance practices. This CIP includes opinions of probable costs for the recommendations and a suggested priority phasing plan.

7.2 Capital Improvement Plan (CIP)

The various raw water supply, treatment, water storage, and water distribution system improvements recommended in this Master Plan for the 20-year planning period are summarized below in Table 7.1 with opinions of probable costs. Refer to Sections 4 and 5 for detailed breakdown and justification for the specific recommended improvements.

Anticipating the need and desire to pursue funding assistance (e.g., grants and loans), included in the cost projections is interim financing, as typically required with funding agencies. The interim financing line item below accounts for interest paid during the project design and construction portions of the projects.

TABLE 7.1 – SUMMARY OF WATER CIP PROJECTS

Summary of SW Lincoln County PUD Water System Upgrades		
Description	**Item Cost**	
Water Supply Upgrades	$	721,000.00
Blodgett WTP Priorities 1 and 2	$	1,681,000.00
Dicks Fork WTP	$	299,000.00
Dicks Fork Tank No. 2	$	1,532,000.00
Wakonda Beach Road Tank	$	1,265,000.00
Seabrook Tank	$	1,072,000.00
Pump Stations	$	154,000.00
Treated Water Distribution System Upgrades - Priority 1	$	3,201,000.00
Treated Water Distribution System Upgrades - Priority 2	$	3,645,000.00
Raw Water Starr Creek AC Pipeline Removal	Not Anticipated	
Install Distribution System Water Meters	Not Included	
Environmental Report and Geotechnical (seismic)	$	150,000.00
Project Interim Financing	$	350,000.00
Opinion of Probable Cost Total (rounded)	**$**	**14,070,000.00**

7.3 CIP Priorities

It is recommended all identified improvements be made to the existing water system. However, the cost for the water system improvements is considerable so a priority phasing plan is suggested below. Priority 1 improvements are intended to correct immediate concerns. Priority 2 improvements include less urgent facility improvements that should be anticipated within the next 20-years. Priority 2 could be further broken down into Priorities 3, 4, and so forth.

7.3.1 **Priority 1**

Priority 1 consists of minor improvements to the Blodgett WTP, addition of a new storage tank, pump station upgrades, and water distribution pipeline replacements and expansions (replace AC pipe and fire protection). Table 7.2 lists the recommended high priority improvements necessary and costs.

TABLE 7.2 – CIP PROJECTS PRIORITY 1

Water CIP - Priority 1	
Description	**Item Cost**
Blodgett WTP Phase 1	$ 324,000.00
Dicks Fork Tank No. 2	$ 1,532,000.00
Pump Stations	$ 154,000.00
Treated Water Distribution System Upgrades - Priority 1	$ 3,201,000.00
Environmental Report and Geotechnical (seismic)	$ 100,000.00
Project Interim Financing	$ 140,000.00
Opinion of Probable Cost Total (rounded)	**$ 5,451,000.00**

7.3.2 **Priority 2**

Priority 2 projects include anticipated improvements with the supply diversions, expansion and upgrades to both treatment plants, the addition of another storage tank, and a total replacement of all the system water meters. This Priority also includes replacing the AC transmission pipeline (which may not ever be required). Priority 2 does not account for inflation since the timing of these projects are unknown at this time. Table 7.3 provides anticipated costs for Priority 2.

TABLE 7.3 – CIP PROJECTS PRIORITY 2

Water CIP - Priority 2	
Description	**Item Cost**
Water Supply Upgrades	$ 721,000.00
Blodgett WTP Phase 2	$ 1,357,000.00
Dicks Fork WTP	$ 299,000.00
Wakonda Beach Road Tank	$ 1,265,000.00
Seabrook Tank	$ 1,072,000.00
Treated Water Distribution System Upgrades - Priority 2	$ 3,645,000.00
Raw Water Starr Creek AC Pipeline Removal	Not Anticipated
Install Distribution System Water Meters	Not Included
Environmental Report and Geotechnical (seismic)	$ 50,000.00
Project Interim Financing	$ 210,000.00
Opinion of Probable Cost Total (rounded)	**$ 8,619,000.00**

7.4 Current Financial Status – Debt, Rate, Structure, and SDC

There is currently no economic development in the area which could result in major expansion of the system or increased demand by the users, except for possibly the City of Waldport's Industrial Park. The District has three existing loans. The following Table highlights the current status of the loans.

TABLE 7.4 – EXISTING DISTRICT DEBT

	WTPs, Tank, Waterlines Loan #1	Star Creek Raw Water Line Replacement Loan #2	Four Generators: (WTPs and Seabrook/Alder PS Loan #3
Original Loan Inception and Loan Term	1998 / 30-years	2004 / 30-years	2010 / 20-years
Annual Payment	$128,940	$3,419	$5,910
Remaining Time (years)	9	15	11
Remaining Balance	$936,000	$44,500	$48,000
Funding Agency	USDA - RUS	Business Oregon	Business Oregon

There are currently 1258 active services in the community. The following Table presents the current rate structure and System Development Charges (SDC).

TABLE 7.5 – DISTRICT WATER RATES EFFECTIVE AUGUST 2019

WATER BASE MONTHLY RATES (Includes up to 100 cubic feet usage) Effective 8/1/19

METER SIZE	INSIDE DISTRICT	OUTSIDE DISTRICT
5/8 or 3/4 inch	$34.45	$51.70
1 inch	$44.25	$66.40
1-1/2 inch	$56.10	$84.20
2 inch	$88.05	$132.10
3 inch	$342.70	$514.10
6 inch	$651.05	$976.60

WATER USE MONTHLY RATES

USAGE (Cubic Feet)	INSIDE DISTRICT ($ Per Cubic Feet)	OUTSIDE DISTRICT ($ Per Cubic Feet)
101 to 300	$2.60	$3.90
301 to 1000	$3.55	$5.30
1001 to 2000	$4.05	$6.10
2001 and up	$4.50	$6.75

BOND MONTHLY SURCHARGE

METER SIZE	INSIDE DISTRICT	OUTSIDE DISTRICT
5/8 or 3/4 inch	$9.20	$13.80
1 inch	$12.90	$19.35
1-1/2 inch	$16.60	$24.90
2 inch	$26.70	$40.05
3 inch	$101.20	$151.80
6 inch	$193.20	$289.80

CONNECTION AND RECONNECTION FEES

Connection and reconnection fees are as follows:

¾ Inch water service	$850
1 inch water service	$900
1-1/2 inch or larger water service	$Cost to be determined by SWLCWPUD

SYSTEM DEVELOPMENT CHARGES

A SDC applies to all new connections and Permanent Disconnect reconnections on Tax Lots where a SDC has not been previously paid. A customer paying the SDC in full is not subject to the monthly-billed Bond Surcharge. A SDC paid on a Tax Lot is not assessed a second time. The SDC charges are:

METER SIZE	INSIDE DISTRICT	OUTSIDE DISTRICT
5/8 or 3/4 inch	$2,856	$4,284
1 inch	$4,000	$6,000
1-1/2 inch	$4,930	$7,395
2 inch	$8,275	$12,415
3 inch	$31,355	$47,050
6 inch	$60,500	$90,750

Typical average water usage is 112 gal/day per customer which equates to over 400ft^3 of water per month. Therefore, this report will approximate an average residential water bill as $34.45 + ($2.60 x 2) + ($3.55) = $43.20/month per District residential customer connection.

7.5 Potential Financial Obligation and Water Rate Adjustment

Tables 7.6 and 7.7 provide an indication of the potential individual average user rate the identified improvements will have. The Tables show a range of possible funding scenarios depending on the amount of grant money awarded. Grants from Business Oregon typically have a $750,000 maximum limit, if eligible. It may be possible and advantageous to try to combine funding agencies. The project expense is spread evenly over all existing 1258 water service connections. In summary, the following criteria were assumed and used in the user rate calculations:

- Connections = 1258
- Loan Interest Rate = 2.00%
- Loan Period = 30-years
- Average residential water use assumed to be 400ft^3 per month, making the monthly charge $43.20.
- The $43.20/month rate will be retained and included to account for operation and maintenance expenses.

Table 7.6 represents the financial situation should all recommended improvements be made. From the Table, a user rate of approximately $98/month would result for an overall comprehensive improvement project if no grant funding was included. User rates of approximately $89/month or $85/month would result if 20% or 30% grants were obtained, respectively. Table 7.7 represents the financial situation if a priority approach were used. Priority 2 costs do not include likely project increases due to inflation.

TABLE 7.6 – TOTAL PROJECT PROJECTED AVERAGE WATER USER RATE

All Priorities	No Grant, 2.00% Loan	20% Grant	30% Grant
Capital Cost	$14,070,000	$14,070,000	$14,070,000
Loan Needed	$14,070,000	$11,256,000	$9,849,000
Interest Rate	2.000%	2.000%	2.000%
Loan Period (yrs)	30	30	30
Annual Annuity	$628,224.41	$502,579.53	$439,757.08
Monthly Income Required	$52,352.03	$41,881.63	$36,646.42
Monthly Income Reqd' w/ 10% reserve	$57,587.24	$46,069.79	$40,311.07
Number of EDUs (Current)	1258	1258	1258
Monthly Cost per EDU	**$45.78**	**$36.62**	**$32.04**
Current Base Rate + Usage (Res.)	$43.20	$43.20	$43.20
Current Bond Surcharge (Res.)	$9.20	$9.20	$9.20
New Average Residential Water Bill	**$98.18**	**$89.02**	**$84.44**

TABLE 7.7 – PRIORITY PROJECT PROJECTED AVERAGE WATER USER RATE

Priority 1	No Grant, 2.00% Loan	20% Grant	30% Grant
Capital Cost	$5,451,000	$5,451,000	$5,451,000
Loan Needed	$5,451,000	$4,360,800	$3,815,700
Interest Rate	2.000%	2.000%	2.000%
Loan Period (yrs)	30	30	30
Annual Annuity	$243,386.73	$194,709.38	$170,370.71
Monthly Income Required	$20,282.23	$16,225.78	$14,197.56
Monthly Income Reqd' w/ 10% reserve	$22,310.45	$17,848.36	$15,617.31
Number of EDUs (Current)	1258	1258	1258
Priority 1 Subtotal - Monthly Cost per EDU	**$17.73**	**$14.19**	**$12.41**
Current Base Rate + Usage (Res.)	$43.20	$43.20	$43.20
Current Bond Surcharge (Res.)	$9.20	$9.20	$9.20
New Average Residential Water Bill - Phase I	**$70.13**	**$66.59**	**$64.81**

Priority 2	**No Grant, 2.00% Loan**	**20% Grant**	**30% Grant**
Capital Cost	$8,619,000	$8,619,000	$8,619,000
Loan Needed	$8,619,000	$6,895,200	$6,033,300
Interest Rate	2.000%	2.000%	2.000%
Loan Period (yrs)	30	30	30
Annual Annuity	$384,837.68	$307,870.14	$269,386.38
Monthly Income Required	$32,069.81	$25,655.85	$22,448.86
Monthly Income Reqd' w/ 10% reserve	$35,276.79	$28,221.43	$24,693.75
Number of EDUs (Current)	1258	1258	1258
Priority 2 Subtotal - Monthly Cost per EDU (additional)	**$28.04**	**$22.43**	**$19.63**
Priority 1 Subtotal - Monthly Cost per EDU (incl. current rate)	**$70.13**	**$66.59**	**$64.81**
New Average Residential Water Bill (Phase 1 + Phase 2)	**$98.18**	**$89.02**	**$84.44**

7.6 Potential Grant and Loan Services

The CIP listed several improvements that add up to a substantial dollar figure. In order to make the needed and necessary improvements, assistance from a funding agency(s) will be necessary.

Funding for water system capital improvements occurs with loans, grants, principal forgiveness, bonds, or a combination thereof. Parameters such as the local and State median household income (MHI), existing debt service, water use rates, low/moderate income level percentages, financial stability, and project need are used by funding agencies to evaluate the types and levels of funding assistance that can be received by a community. Two likely sources for financial assistance are Business Oregon and USDA-Rural Development.

7.6.1 Business Oregon

Business Oregon administers resources aimed at community development activities primarily in the water and wastewater infrastructure areas. The Business Oregon Regional Coordinator for Lincoln County is Melissa Murphy (503-983-8857) and any application process will begin by contacting her. The funding programs through Business Oregon include:

1. Community Development Block Grants (CDBG)
2. Safe Drinking Water Revolving Loan Fund (SDWRLF)
3. Special Public Works Funds
4. Water/Wastewater Financing

Block Grant assistance for the District may be possible due to possibly meeting the national objectives for low and moderate-income persons.

The SDWRLF generally must be used to address a health or compliance issue and could potentially provide a loan up to $6 million per project. To receive a loan, the project must be ranked high enough on the Project Priority List in the Intended Use Plan developed by the State.

A Letter of Interest (LOI) must be submitted before a project can be listed in the Intended Use Plan. The LOIs are accepted annually. Coordinate with the regional coordinator for LOI deadlines. Loan terms are typically 3-4% interest for 20 years, however “Disadvantaged Communities” may potentially qualify for 1% loans for 30 years as well as some principal forgiveness. To be considered a Disadvantaged Community the average residential water rate must be at or above the threshold rate and the area MHI must be less that the State MHI.

All recipients of SDWRLF awards need to complete an environmental review on every project in accordance with the State Environmental Review Process (SERP), pursuant to federal and state environmental laws. The Environmental Report typically required can cost $25,000 to $75,000 depending on the specific biological, cultural, waterway, and wetland issues that arise.

Loans and grants are also available through the Special Public Works Funds and Water/Wastewater Financing depending on need and financial reviews by Business Oregon.

The Drinking Water Source Protection Fund (DWSPF) is designed for the protection of drinking water sources. Funds are available through the DWSRF local assistance and other State programs set-aside. This set-aside allows states to provide loans (up to a maximum of $100,000) for certain source water assessment (SWA) implementation activities, including source water protection (SWP) land acquisition and other types of incentive-based source water quality protection measures.

States may also provide direct assistance in the form of a grant (up to $30,000 per eligible system) or technical support in the areas of SWP area delineation and assessment, wellhead protection programs, and capacity development strategy. Examples of activities eligible through this set-aside include the development of local SWP ordinances and implementation of public education programs to highlight the importance of wellhead protection.

Currently USDA provides water system development loans at 1.875% for 30 years. 2.0% was used in this report.

7.6.2 Funding Agencies One-Stop

Business Oregon administers resources aimed at community development activities primarily in the water and wastewater infrastructure areas. The Business Oregon Regional Coordinator for Lincoln County is Melissa Murphy (503-983-8857) and any application process will begin by contacting her. The funding programs through Business Oregon include:

1. Community Development Block Grants (CDBG)
2. Safe Drinking Water Revolving Loan Fund (SDWRLF)
3. Special Public Works Funds
4. Water/Wastewater Financing

Block Grant assistance for the District may be possible due to possibly meeting the national objectives for low and moderate-income persons.

The SDWRLF generally must be used to address a health or compliance issue and could potentially provide a loan up to $6 million per project. To receive a loan, the project must be ranked high enough on the Project Priority List in the Intended Use Plan developed by the State. A Letter of Interest (LOI) must be submitted before a project can be listed in the Intended Use Plan. The LOIs are accepted annually. Coordinate with the regional coordinator for LOI deadlines. Loan terms are typically 3-4% interest for 20 years, however "Disadvantaged Communities" may potentially qualify for 1% loans for 30 years as well as some principal forgiveness. To be considered a Disadvantaged Community the average residential water rate must be at or above the threshold rate and the area MHI must be less that the State MHI.

All recipients of SDWRLF awards need to complete an environmental review on every project in accordance with the State Environmental Review Process (SERP), pursuant to federal and state environmental laws. The Environmental Report typically required can cost $25,000 to $75,000 depending on the specific biological, cultural, waterway, and wetland issues that arise.

Loans and grants are also available through the Special Public Works Funds and Water/Wastewater Financing depending on need and financial reviews by Business Oregon.

The Drinking Water Source Protection Fund (DWSPF) is designed for the protection of drinking water sources. Funds are available through the DWSRF local assistance and other State programs set-aside. This set-aside allows states to provide loans (up to a maximum of $100,000) for certain source water assessment (SWA) implementation activities, including source water protection (SWP) land acquisition and other types of incentive-based source water quality protection measures.

States may also provide direct assistance in the form of a grant (up to $30,000 per eligible system) or technical support in the areas of SWP area delineation and assessment, wellhead protection programs, and capacity development strategy. Examples of activities eligible through this set-aside include the development of local SWP ordinances and implementation of public education programs to highlight the importance of wellhead protection.

Currently USDA provides water system development loans at 1.875% for 30 years. 2.0% was used in this report.

7.7 Conclusion and Next Steps

The water project improvements, costs and investments, in this Plan is a significant undertaking. A project of this magnitude will require strong public support and financial assistance. This Plan provides sufficient technical and financial information to prospective funding agencies for their initial review and consideration.

The District should consider the projects listed in Priority 1 and move towards the implementation of these projects. Some initial next steps will include, at a minimum and not necessarily in order:

1. Public outreach regarding the overall project improvements.

2. A One-Stop meeting with Business Oregon, USDA Rural Development, and other funding agencies should be scheduled to work through options. Project funding and financing options and opportunities will be researched, and a level of comfort obtained that financial assistance is available. To make this project manageable, grants and loan-forgiveness money is important.

Appendix A

Water Distribution System Maps

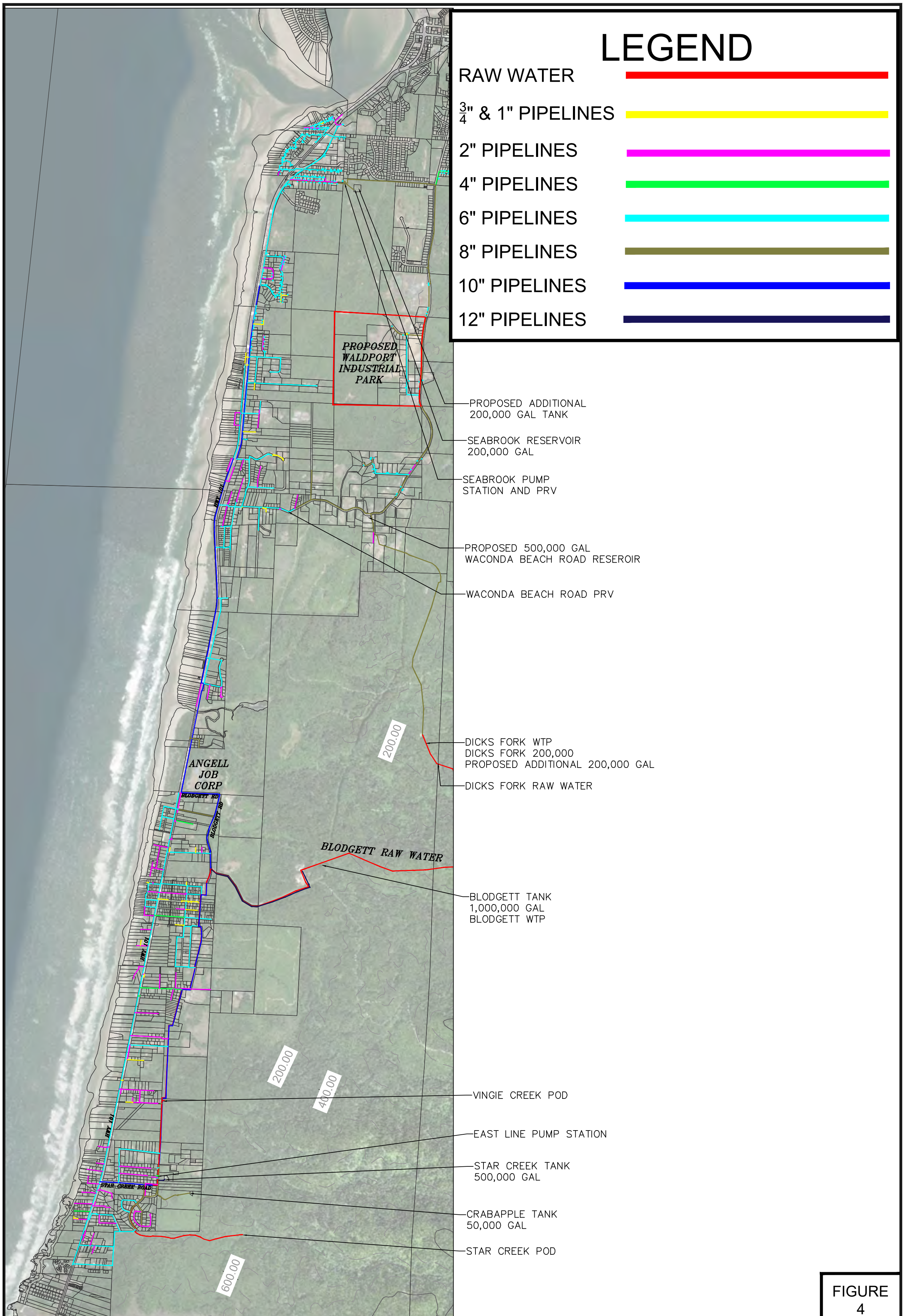


FIGURE 4

0 1"
1" = 4000'

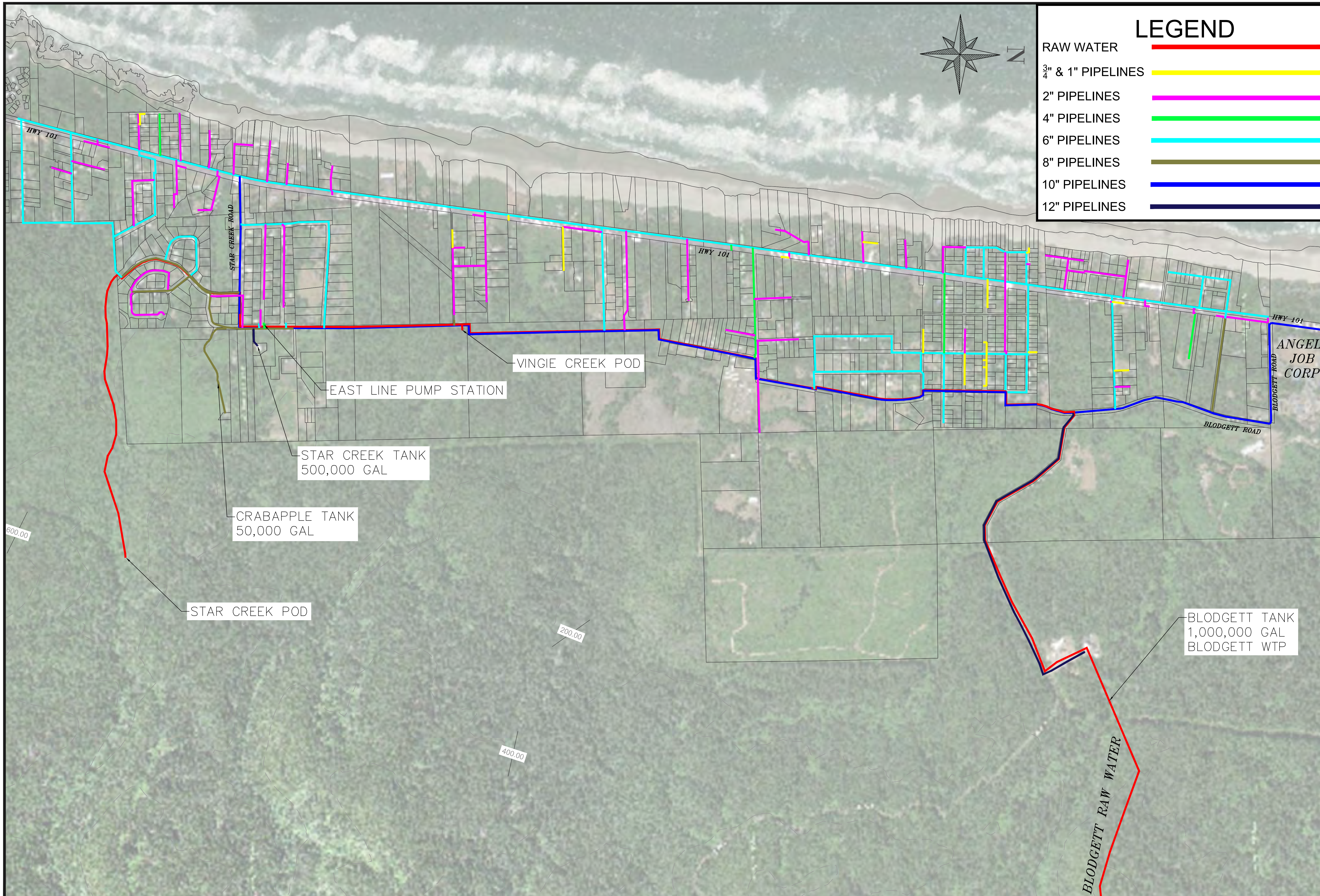
DRAWN BY: CMJ
DATE: 2/26/2019

SYSTEM PLAN

MASTER PLAN

SW LINCOLN COUNTY PUD
LINCOLN COUNTY, OREGON

Civil West Engineering Services, Inc.



Civil West Engineering Services, Inc.

MASTER PLAN
LINCOLN COUNTY, OREGON

SOUTH DISTRICT

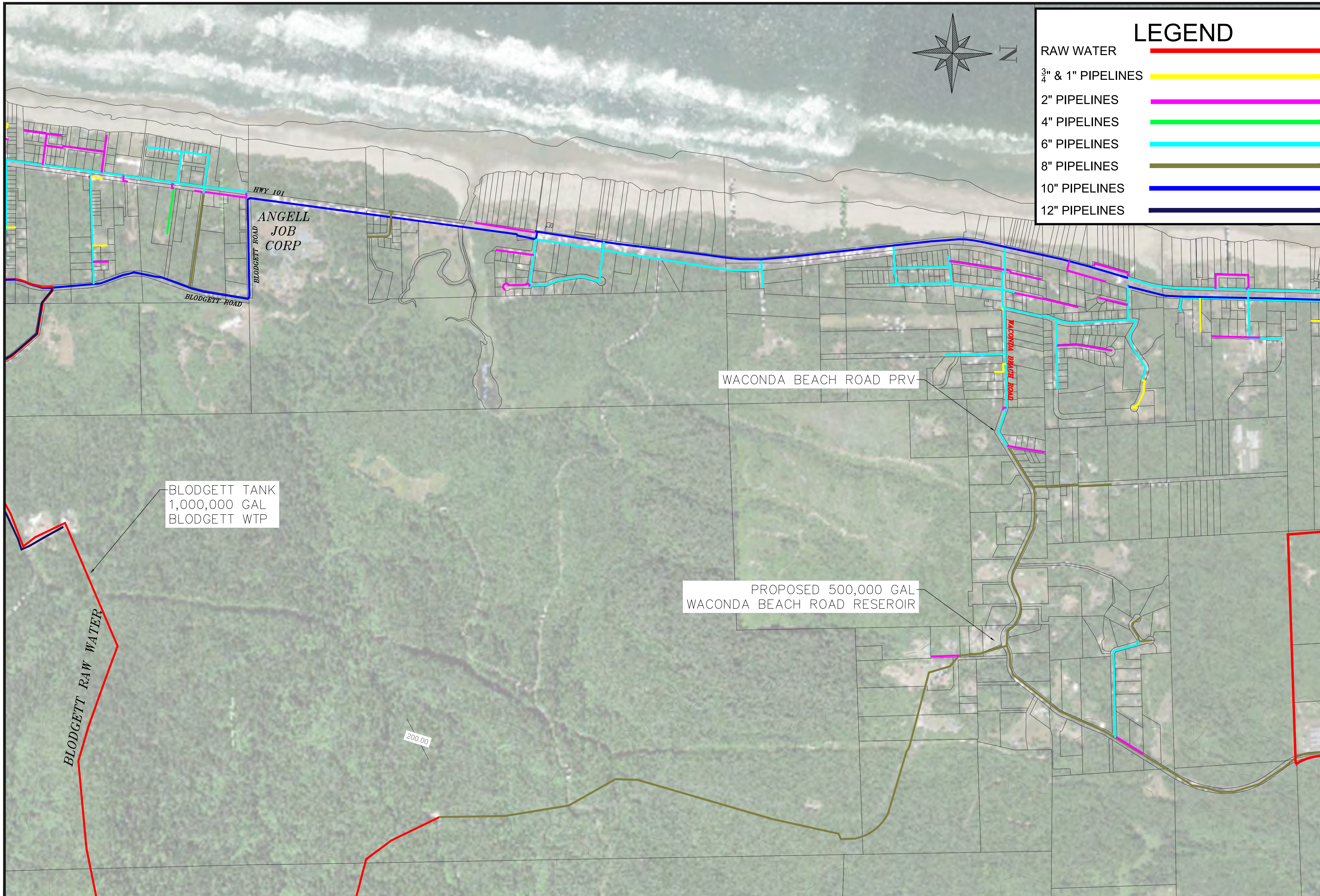
SW LINCOLN COUNTY PUD

0 1"
1" = 1000'

DRAWN BY: CMJ
DATE: 2/26/2019

FIGURE
1

DATE:2/27/19 FILE:O:\CW_Projects\2815 SW Lincoln County PUD\2815-002 Water System Master Plan\Drawings\Dwg\System map.dwg



Civil West Engineering Services, Inc.

MASTER PLAN
LINCOLN COUNTY, OREGON

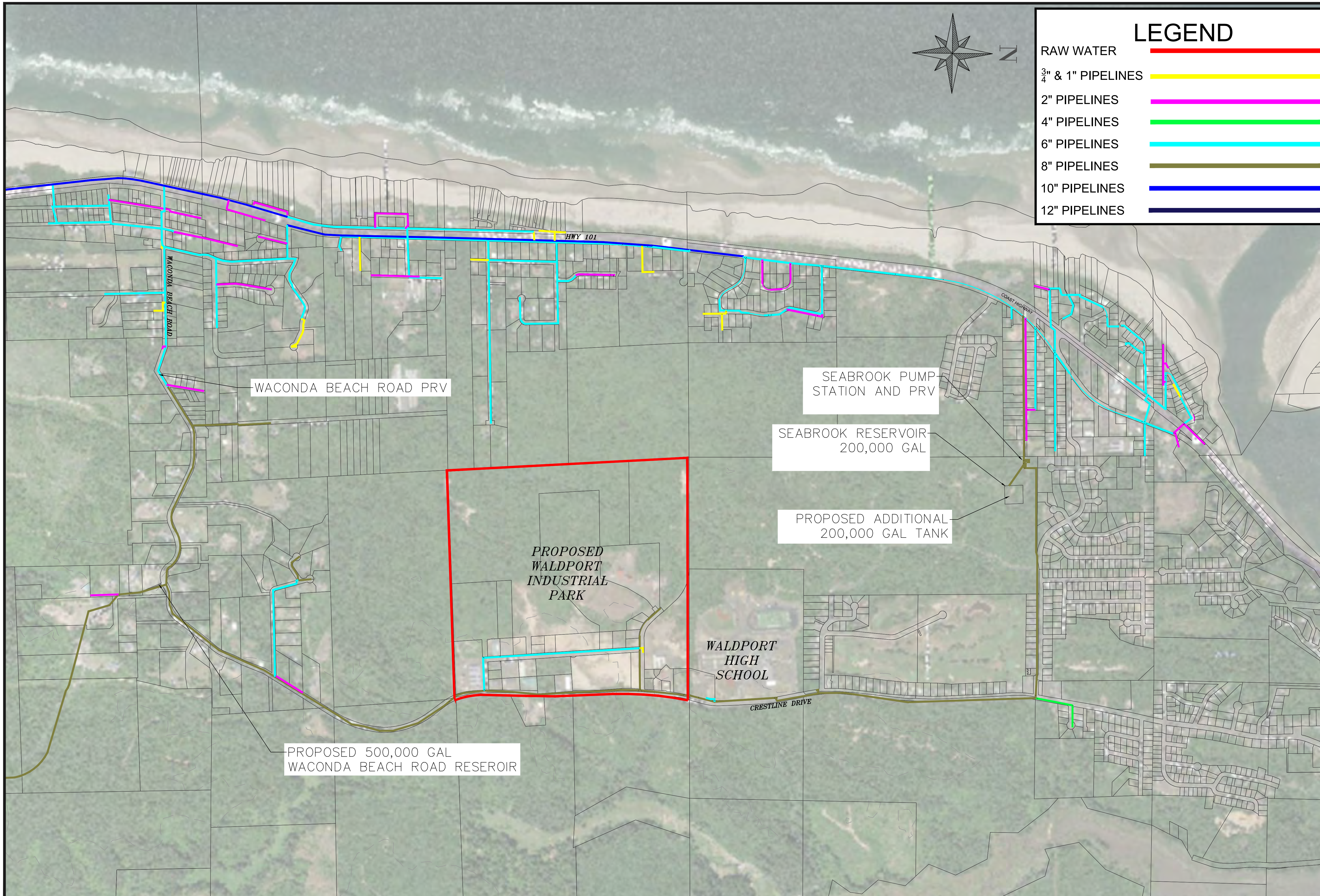
MIDDLE DISTRICT
SW LINCOLN COUNTY PUD

0 1"
1" = 1000'

DRAWN BY: CMJ
DATE: 2/26/2019

FIGURE 2

DATE:2/27/19 FILE:O:\CW_Projects\2815 SW Lincoln County PUD\2815-002 Water System Master Plan\Drawings\Dwg\System map.dwg



Civil West Engineering Services, Inc.

MASTER PLAN
LINCOLN COUNTY, OREGON

NORTH DISTRICT

SW LINCOLN COUNTY PUD

0 1"
1" = 1000'

DRAWN BY: CMJ
DATE: 2/26/2019

FIGURE 3

DATE:2/27/19 FILE:O:\CW_Projects\2815 SW Lincoln County PUD\2815-002 Water System Master Plan\Drawings\Dwg\System map.dwg

Appendix B

Water Model Computer Results

Peak Hour Demand Analysis

Appendix - Peak Hour Pipe Network Hydraulic Report

Label	Start Node	Stop Node	Diameter (in)	Length (ft)	Flow (Maximum Absolute) (gpm)	Velocity (ft/s)	Pressure (Start) (psi)	Pressure (Stop) (psi)
P-109	J-99	J-92	0.8	501	3	1.72	67	51
P-348	J-295	J-296	0.8	33	2	1.6	41	40
P-219	J-12	J-182	6	488	123	1.4	54	52
P-10	J-13	J-12	10	4,468	333	1.36	21	54
P-349	J-296	J-297	0.8	51	2	1.34	40	40
P-333	J-281	J-282	0.8	102	2	1.21	57	61
P-105	J-94	J-95	2	72	12	1.18	65	65
P-351	J-297	J-299	0.8	215	2	1.09	40	41
P-214	J-29	J-187	6	656	96	1.08	46	47
P-106	J-95	J-96	2	549	10	1.07	65	54
P-215	J-187	J-80	6	263	93	1.05	47	44
P-411	J-346	J-347	6	242	89	1.01	42	35
P-90	J-70	J-81	6	237	85	0.97	67	66
P-92	J-81	J-83	6	521	85	0.96	66	66
P-11	J-12	J-14	10	917	210	0.86	54	42
P-409	J-346	J-308	6	1,428	75	0.85	42	56
P-407	J-344	J-345	2	353	8	0.84	53	44
P-33	J-33	J-34	0.8	210	1	0.84	48	42
P-67	J-55	J-59	6	426	73	0.83	66	67
P-63	J-55	J-56	6	23	73	0.83	66	66
P-94	J-83	J-85	6	700	72	0.82	66	65
P-272	J-232	J-234	6	1,530	71	0.8	63	65
P-69	J-59	J-61	6	488	70	0.8	67	65
P-96	J-85	J-87	6	281	68	0.77	65	65
P-98	J-88	J-89	6	1,137	66	0.75	67	43
P-73	J-61	J-65	6	644	65	0.74	65	65
P-31	J-20	J-32	0.8	72	1	0.73	49	48
P-32	J-32	J-33	0.8	84	1	0.73	48	48
P-34	J-20	J-36	0.8	134	1	0.73	49	57
P-38	J-21	J-40	0.8	354	1	0.73	49	42
P-77	J-68	J-69	0.8	104	1	0.73	65	65
P-110	J-93	J-100	0.8	91	1	0.73	65	65
P-150	J-138	J-139	0.8	195	1	0.73	60	59
P-325	J-275	J-276	0.8	198	1	0.73	47	48
P-334	J-282	J-283	0.8	190	1	0.73	61	60
P-75	J-65	J-67	6	222	65	0.73	65	65
P-97	J-87	J-88	6	50	63	0.72	65	67
P-78	J-67	J-70	6	418	63	0.71	65	67
P-41	J-37	J-42	6	23	62	0.71	64	64
P-89	J-73	J-80	4	208	26	0.67	46	44
P-406	J-343	J-344	2	109	7	0.67	51	53
P-35	J-16	J-37	6	795	58	0.66	53	64
P-64	J-53	J-56	6	236	55	0.62	65	66
P-87	J-78	J-73	4	63	24	0.61	47	46
P-86	J-71	J-78	4	416	24	0.6	60	47
P-99	J-86	J-89	6	232	53	0.6	44	43
P-65	J-56	J-22	4	914	23	0.59	66	48
P-79	J-70	J-71	4	578	23	0.58	67	60
P-412	J-347	J-348	8	30	89	0.57	35	35
P-196	J-173	J-174	2	956	5	0.55	52	37

Label	Start Node	Stop Node	Diameter (in)	Length (ft)	Flow (Maximum Absolute) (gpm)	Velocity (ft/s)	Pressure (Start) (psi)	Pressure (Stop) (psi)
P-366	J-310	J-311	6	362	48	0.54	56	57
P-15	J-17	J-18	0.8	112	1	0.54	53	53
P-364	J-308	J-309	6	43	48	0.54	56	56
P-55	J-19	J-14	6	423	46	0.53	53	42
P-199	J-175	J-176	2	876	5	0.52	49	32
P-28	J-14	J-30	10	714	126	0.52	42	44
P-365	J-309	J-310	6	155	45	0.51	56	56
P-281	J-242	J-234	6	253	43	0.49	61	65
P-288	J-246	J-244	2	757	5	0.48	53	51
P-234	J-190	J-202	0.8	184	1	0.48	49	46
P-318	J-269	J-271	0.8	385	1	0.48	66	54
P-335	J-282	J-284	0.8	125	1	0.48	61	61
P-390	J-327	J-331	0.8	174	1	0.48	60	51
P-137	J-126	J-127	2	433	5	0.47	59	61
P-124	J-95	J-114	1	138	1	0.47	65	65
P-95	J-86	J-85	2	1,159	4	0.45	44	65
P-193	J-162	J-172	6	1,218	40	0.45	34	52
P-226	J-194	J-195	2	134	4	0.43	63	64
P-12	J-14	J-15	6	236	37	0.42	42	45
P-29	J-30	J-31	10	235	103	0.42	44	47
P-139	J-128	J-129	2	553	4	0.41	57	61
P-46	J-38	J-45	6	199	36	0.41	63	58
P-47	J-45	J-46	6	48	36	0.41	58	64
P-131	J-120	J-121	6	76	36	0.41	57	59
P-195	J-172	J-173	6	528	36	0.41	52	52
P-60	J-53	J-46	6	210	36	0.4	65	64
P-245	J-211	J-182	10	1,148	97	0.4	54	52
P-42	J-42	J-38	6	247	35	0.4	64	63
P-30	J-31	J-29	10	1,322	96	0.39	47	46
P-13	J-15	J-16	6	424	34	0.39	45	53
P-225	J-193	J-194	2	235	4	0.38	64	63
P-251	J-211	J-216	10	692	93	0.38	54	47
P-134	J-121	J-124	6	184	33	0.37	59	57
P-252	J-216	J-217	10	1,164	90	0.37	47	62
P-231	J-200	J-198	2	243	4	0.36	64	63
P-253	J-217	J-218	10	1,634	89	0.36	62	58
P-37	J-19	J-38	2	826	4	0.36	53	63
P-132	J-121	J-122	2	357	4	0.36	59	66
P-130	J-118	J-120	6	316	31	0.36	57	57
P-256	J-218	J-221	10	1,686	87	0.35	58	67
P-263	J-227	J-228	2	719	3	0.35	67	70
P-136	J-124	J-126	6	108	31	0.35	57	59
P-128	J-116	J-118	6	223	29	0.33	57	57
P-198	J-175	J-173	6	201	29	0.33	49	52
P-289	J-243	J-247	6	128	29	0.33	57	55
P-467	J-247	J-248	6	90	28	0.32	55	55
P-16	J-19	J-16	6	234	28	0.32	53	53
P-107	J-96	J-97	2	414	3	0.32	54	50
P-108	J-88	J-99	2	463	3	0.32	67	67
P-123	J-112	J-113	2	290	3	0.32	57	65
P-111	J-96	J-101	2	372	3	0.32	54	50
P-52	J-42	J-50	6	238	27	0.31	64	63

Label	Start Node	Stop Node	Diameter (in)	Length (ft)	Flow (Maximum Absolute) (gpm)	Velocity (ft/s)	Pressure (Start) (psi)	Pressure (Stop) (psi)
P-398	J-324	J-337	2	30	3	0.31	44	44
P-126	J-112	J-116	6	517	27	0.3	57	57
P-273	J-234	J-235	6	1,286	27	0.3	65	66
P-363	J-307	J-308	6	162	27	0.3	56	56
P-53	J-50	J-43	6	137	26	0.3	63	64
P-220	J-182	J-189	6	250	26	0.29	52	44
P-189	J-170	J-167	6	634	26	0.29	32	33
P-350	J-297	J-298	0.8	197	0	0.29	40	37
P-362	J-303	J-307	6	2,226	26	0.29	56	56
P-44	J-43	J-44	6	244	25	0.29	64	63
P-49	J-44	J-47	6	257	25	0.29	63	65
P-439	J-248	J-369	6	619	25	0.29	55	54
P-138	J-126	J-128	6	326	25	0.28	59	57
P-227	J-195	J-196	2	262	3	0.28	64	64
P-267	J-223	J-230	2	324	3	0.28	51	49
P-394	J-333	J-334	2	210	3	0.28	51	51
P-185	J-120	J-168	10	553	67	0.28	57	51
P-465	J-389	J-80	10	506	67	0.27	44	44
P-141	J-130	J-131	2	64	3	0.27	57	56
P-456	J-383	J-384	2	95	3	0.27	53	53
P-57	J-47	J-52	6	211	23	0.26	65	67
P-221	J-189	J-190	6	194	23	0.26	44	49
P-122	J-111	J-112	6	20	23	0.26	57	57
P-197	J-168	J-175	6	283	23	0.26	51	49
P-71	J-62	J-63	0.8	178	0	0.26	67	67
P-80	J-71	J-72	0.8	413	0	0.26	60	62
P-114	J-102	J-104	0.8	218	0	0.26	56	56
P-282	J-242	J-238	6	630	22	0.25	61	63
P-61	J-52	J-54	2	259	2	0.25	67	67
P-178	J-162	J-163	10	437	60	0.24	34	27
P-464	J-86	J-389	10	1,104	60	0.24	44	44
P-270	J-226	J-232	10	1,803	60	0.24	65	63
P-222	J-190	J-191	6	780	21	0.24	49	64
P-291	J-235	J-249	6	757	21	0.24	66	64
P-223	J-191	J-192	6	63	21	0.24	64	64
P-154	J-142	J-143	6	493	21	0.24	23	30
P-186	J-143	J-169	6	573	21	0.24	30	34
P-264	J-221	J-227	10	98	58	0.24	67	67
P-280	J-242	J-240	6	217	21	0.23	61	53
P-142	J-131	J-132	2	522	2	0.23	56	47
P-471	J-73	J-75	2	22	2	0.23	46	47
P-148	J-136	J-138	2	300	2	0.23	52	60
P-374	J-318	J-311	6	766	20	0.23	58	57
P-367	J-311	J-312	6	1,352	20	0.23	57	49
P-40	J-30	J-22	6	423	20	0.23	44	48
P-140	J-128	J-130	6	63	20	0.23	57	57
P-121	J-94	J-111	6	1,745	20	0.23	65	57
P-262	J-227	J-226	10	773	55	0.22	67	65
P-51	J-43	J-49	0.8	76	0	0.22	64	64
P-235	J-191	J-203	0.8	157	0	0.22	64	64
P-58	J-52	J-53	6	340	20	0.22	67	65
P-293	J-249	J-251	6	286	20	0.22	64	64

Label	Start Node	Stop Node	Diameter (in)	Length (ft)	Flow (Maximum Absolute) (gpm)	Velocity (ft/s)	Pressure (Start) (psi)	Pressure (Stop) (psi)
P-283	J-239	J-243	6	600	19	0.22	55	57
P-443	J-369	J-373	6	820	19	0.22	54	59
P-278	J-240	J-239	6	615	19	0.21	53	55
P-62	J-54	J-55	2	297	2	0.21	67	66
P-296	J-252	J-251	6	415	18	0.21	64	64
P-306	J-259	J-261	6	16	18	0.2	64	64
P-295	J-252	J-253	6	1,022	18	0.2	64	65
P-433	J-363	J-364	8	561	32	0.2	55	50
P-276	J-238	J-237	6	68	18	0.2	63	63
P-354	J-301	J-302	2	29	2	0.2	38	39
P-127	J-116	J-117	2	257	2	0.2	57	63
P-129	J-118	J-119	2	484	2	0.2	57	68
P-133	J-122	J-123	2	208	2	0.2	66	65
P-312	J-262	J-265	2	438	2	0.2	52	57
P-315	J-267	J-268	2	354	2	0.2	62	57
P-344	J-290	J-291	2	447	2	0.2	48	45
P-284	J-236	J-243	6	245	18	0.2	57	57
P-144	J-130	J-134	6	184	17	0.2	57	52
P-299	J-253	J-255	2	167	2	0.2	65	65
P-376	J-319	J-318	6	265	17	0.19	58	58
P-184	J-168	J-167	10	778	47	0.19	51	33
P-397	J-328	J-337	2	139	2	0.19	60	44
P-372	J-316	J-317	6	550	16	0.18	59	59
P-375	J-317	J-319	6	115	16	0.18	59	58
P-188	J-169	J-170	6	347	15	0.18	34	32
P-265	J-221	J-225	6	775	15	0.17	67	65
P-268	J-225	J-231	6	1,839	15	0.17	65	63
P-410	J-309	J-344	2	1,050	2	0.17	56	53
P-70	J-61	J-62	2	243	2	0.16	65	67
P-310	J-256	J-253	6	343	14	0.16	65	65
P-39	J-21	J-41	2	288	2	0.16	49	60
P-68	J-59	J-60	2	330	2	0.16	67	67
P-76	J-67	J-68	2	74	2	0.16	65	65
P-93	J-83	J-84	2	710	2	0.16	66	50
P-115	J-101	J-105	2	560	2	0.16	50	43
P-135	J-124	J-125	2	640	2	0.16	57	50
P-171	J-156	J-157	2	620	2	0.16	51	84
P-228	J-195	J-197	2	162	2	0.16	64	64
P-292	J-249	J-250	2	555	2	0.16	64	62
P-395	J-334	J-335	2	219	2	0.16	51	60
P-388	J-330	J-325	6	262	14	0.16	51	48
P-391	J-325	J-332	6	312	14	0.16	48	51
P-275	J-237	J-236	6	645	14	0.16	63	57
P-257	J-221	J-222	6	173	13	0.15	67	65
P-301	J-256	J-257	6	21	13	0.15	65	64
P-389	J-330	J-312	6	360	13	0.15	51	49
P-269	J-231	J-232	6	130	13	0.15	63	63
P-357	J-303	J-304	6	360	13	0.15	56	57
P-146	J-134	J-136	6	244	13	0.15	52	52
P-17	J-19	J-20	6	230	13	0.15	53	49
P-446	J-373	J-267	6	173	12	0.14	59	62
P-156	J-142	J-144	6	635	12	0.14	23	27

Label	Start Node	Stop Node	Diameter (in)	Length (ft)	Flow (Maximum Absolute) (gpm)	Velocity (ft/s)	Pressure (Start) (psi)	Pressure (Stop) (psi)
P-258	J-222	J-223	6	345	12	0.14	65	51
P-297	J-251	J-254	2	245	1	0.14	64	64
P-232	J-200	J-192	6	142	12	0.14	64	64
P-356	J-302	J-303	6	554	12	0.13	39	56
P-358	J-304	J-305	6	324	12	0.13	57	58
P-455	J-383	J-136	6	362	11	0.13	53	52
P-359	J-305	J-294	6	191	11	0.12	58	61
P-314	J-266	J-267	6	217	10	0.12	64	62
P-18	J-20	J-21	6	244	10	0.12	49	49
P-463	J-388	J-170	6	521	10	0.12	45	32
P-84	J-75	J-76	2	469	1	0.12	47	47
P-85	J-75	J-77	2	357	1	0.12	47	47
P-125	J-111	J-115	2	69	1	0.12	57	57
P-216	J-187	J-188	2	614	1	0.12	47	48
P-233	J-189	J-201	2	184	1	0.12	44	46
P-250	J-210	J-215	2	114	1	0.12	62	62
P-266	J-222	J-229	2	435	1	0.12	65	68
P-286	J-236	J-245	2	440	1	0.12	57	57
P-396	J-334	J-336	2	91	1	0.12	51	53
P-399	J-337	J-338	2	187	1	0.12	44	42
P-400	J-328	J-339	2	338	1	0.12	60	60
P-458	J-384	J-386	2	240	1	0.12	53	53
P-386	J-316	J-329	6	133	10	0.12	59	57
P-346	J-285	J-294	6	28	10	0.11	61	61
P-45	J-38	J-44	2	340	1	0.11	63	63
P-309	J-257	J-259	6	97	10	0.11	64	64
P-341	J-287	J-286	6	556	10	0.11	53	59
P-320	J-261	J-272	6	928	10	0.11	64	53
P-432	J-359	J-363	8	1,729	17	0.11	51	55
P-470	J-315	J-329	6	28	9	0.11	57	57
P-408	J-345	J-346	6	31	9	0.11	44	42
P-259	J-223	J-224	6	806	9	0.1	51	61
P-224	J-192	J-193	6	539	9	0.1	64	64
P-355	J-300	J-302	6	419	9	0.1	32	39
P-145	J-134	J-135	4	486	4	0.1	52	57
P-361	J-306	J-304	2	406	1	0.1	49	57
P-322	J-273	J-274	6	219	8	0.09	57	51
P-454	J-150	J-383	6	449	8	0.09	55	53
P-236	J-200	J-204	6	260	8	0.09	64	63
P-153	J-141	J-142	6	259	8	0.09	37	23
P-19	J-21	J-22	6	237	8	0.09	49	48
P-384	J-326	J-327	6	360	8	0.09	53	60
P-392	J-332	J-326	6	105	8	0.09	51	53
P-324	J-272	J-275	6	217	8	0.09	53	47
P-161	J-148	J-149	6	59	7	0.09	65	65
P-260	J-224	J-225	6	360	7	0.08	61	65
P-404	J-311	J-342	6	1,128	7	0.08	57	26
P-72	J-62	J-64	2	122	1	0.08	67	67
P-112	J-101	J-102	2	212	1	0.08	50	56
P-300	J-255	J-256	2	554	1	0.08	65	65
P-415	J-350	J-351	4	692	3	0.08	63	60
P-54	J-50	J-51	2	43	1	0.08	63	62

Label	Start Node	Stop Node	Diameter (in)	Length (ft)	Flow (Maximum Absolute) (gpm)	Velocity (ft/s)	Pressure (Start) (psi)	Pressure (Stop) (psi)
P-167	J-151	J-153	2	409	1	0.08	53	52
P-230	J-198	J-199	2	206	1	0.08	63	66
P-449	J-364	J-378	2	326	1	0.08	50	50
P-452	J-379	J-380	2	372	1	0.08	54	51
P-457	J-384	J-385	2	230	1	0.08	53	53
P-370	J-314	J-315	6	462	7	0.08	54	57
P-162	J-148	J-150	6	590	7	0.08	65	55
P-56	J-28	J-31	6	222	7	0.08	46	47
P-261	J-225	J-226	6	106	7	0.08	65	65
P-166	J-147	J-144	6	572	7	0.07	20	27
P-469	J-274	J-289	6	220	7	0.07	51	45
P-462	J-169	J-388	6	477	7	0.07	34	45
P-177	J-108	J-162	10	1,489	18	0.07	42	34
P-340	J-273	J-287	6	980	6	0.07	57	53
P-237	J-204	J-205	6	625	6	0.07	63	65
P-440	J-369	J-370	6	297	6	0.07	54	54
P-104	J-93	J-94	6	290	6	0.07	65	65
P-118	J-107	J-108	10	166	17	0.07	45	42
P-360	J-305	J-306	2	487	1	0.07	58	49
P-427	J-355	J-358	8	1,642	10	0.07	41	51
P-428	J-358	J-359	8	1,048	10	0.07	51	51
P-116	J-89	J-106	10	1,551	16	0.06	43	45
P-117	J-106	J-107	10	105	16	0.06	45	45
P-307	J-261	J-262	6	434	6	0.06	64	52
P-434	J-363	J-365	8	1,962	10	0.06	55	83
P-421	J-350	J-352	6	4,553	5	0.06	63	45
P-103	J-87	J-93	6	1,076	5	0.06	65	65
P-274	J-235	J-236	6	267	5	0.05	66	57
P-22	J-24	J-25	6	335	5	0.05	48	50
P-425	J-355	J-352	6	1,790	5	0.05	41	45
P-287	J-243	J-246	6	149	5	0.05	57	53
P-401	J-327	J-340	6	267	5	0.05	60	59
P-352	J-295	J-300	6	725	5	0.05	41	32
P-229	J-194	J-198	2	694	1	0.05	63	63
P-450	J-359	J-379	6	13	5	0.05	51	54
P-424	J-354	J-355	6	338	4	0.05	53	41
P-442	J-370	J-372	6	642	4	0.05	54	55
P-20	J-22	J-23	6	239	4	0.05	48	48
P-423	J-353	J-354	6	1,795	4	0.05	57	53
P-345	J-289	J-293	6	1,195	4	0.04	45	48
P-451	J-379	J-360	6	1,316	4	0.04	54	70
P-466	J-193	J-37	6	411	4	0.04	64	64
P-152	J-140	J-141	6	667	4	0.04	52	37
P-313	J-266	J-259	10	1,396	10	0.04	64	64
P-381	J-312	J-324	6	349	4	0.04	49	44
P-88	J-78	J-79	2	350	0	0.04	47	47
P-255	J-218	J-220	2	64	0	0.04	58	58
P-311	J-264	J-262	2	120	0	0.04	51	52
P-165	J-152	J-144	6	566	4	0.04	47	27
P-113	J-102	J-103	2	143	0	0.04	56	56
P-326	J-275	J-277	6	1,870	3	0.04	47	24
P-393	J-332	J-333	6	28	3	0.04	51	51

Label	Start Node	Stop Node	Diameter (in)	Length (ft)	Flow (Maximum Absolute) (gpm)	Velocity (ft/s)	Pressure (Start) (psi)	Pressure (Stop) (psi)
P-444	J-373	J-374	6	98	3	0.04	59	57
P-445	J-374	J-375	6	997	3	0.04	57	44
P-330	J-257	J-280	6	1,449	3	0.04	64	59
P-338	J-286	J-285	10	623	9	0.04	59	61
P-21	J-23	J-24	6	30	3	0.04	48	48
P-238	J-205	J-206	6	359	3	0.04	65	65
P-74	J-65	J-66	2	586	0	0.04	65	66
P-143	J-131	J-133	2	124	0	0.04	56	56
P-149	J-138	J-137	2	124	0	0.04	60	60
P-168	J-152	J-154	2	236	0	0.04	47	50
P-435	J-365	J-366	8	542	6	0.04	83	88
P-422	J-352	J-353	6	486	3	0.03	45	57
P-25	J-27	J-28	6	1,209	3	0.03	44	46
P-459	J-147	J-387	6	151	3	0.03	20	24
P-460	J-387	J-148	6	1,041	3	0.03	24	65
P-405	J-310	J-343	6	939	3	0.03	56	51
P-316	J-261	J-269	6	551	3	0.03	64	66
P-26	J-24	J-28	6	209	3	0.03	48	46
P-174	J-160	J-159	10	487	7	0.03	76	95
P-328	J-275	J-274	6	788	3	0.03	47	51
P-248	J-213	J-214	2	65	0	0.03	62	65
P-369	J-313	J-314	6	453	2	0.03	51	54
P-241	J-208	J-205	6	304	2	0.03	65	65
P-353	J-300	J-301	2	411	0	0.03	32	38
P-277	J-238	J-239	6	187	2	0.03	63	55
P-173	J-158	J-159	10	638	6	0.03	82	95
P-240	J-207	J-208	6	356	2	0.02	65	65
P-437	J-367	J-368	6	681	2	0.02	53	56
P-441	J-370	J-371	6	495	2	0.02	54	45
P-438	J-367	J-248	6	525	2	0.02	53	55
P-164	J-151	J-152	6	143	2	0.02	53	47
P-447	J-366	J-376	6	431	2	0.02	88	88
P-243	J-208	J-210	6	88	2	0.02	65	62
P-242	J-206	J-209	6	398	2	0.02	65	65
P-321	J-272	J-273	6	781	2	0.02	53	57
P-155	J-140	J-141	2	775	0	0.02	52	37
P-448	J-365	J-377	8	911	3	0.02	83	84
P-298	J-254	J-252	2	251	0	0.02	64	64
P-91	J-81	J-82	4	62	1	0.02	66	66
P-271	J-231	J-233	6	195	2	0.02	63	63
P-308	J-262	J-263	6	389	2	0.02	52	57
P-378	J-314	J-321	6	268	2	0.02	54	56
P-176	J-158	J-157	10	412	4	0.02	82	84
P-475	J-392	J-160	10	187	4	0.01	80	76
P-477	J-392	J-159	6	757	1	0.01	80	95
P-244	J-210	J-211	10	1,087	3	0.01	62	54
P-120	J-107	J-110	6	75	1	0.01	45	45
P-317	J-269	J-270	6	383	1	0.01	66	67
P-377	J-319	J-320	6	347	1	0.01	58	58
P-431	J-360	J-362	6	149	1	0.01	70	66
P-343	J-289	J-290	8	242	2	0.01	45	48
P-247	J-210	J-213	2	499	0	0.01	62	62

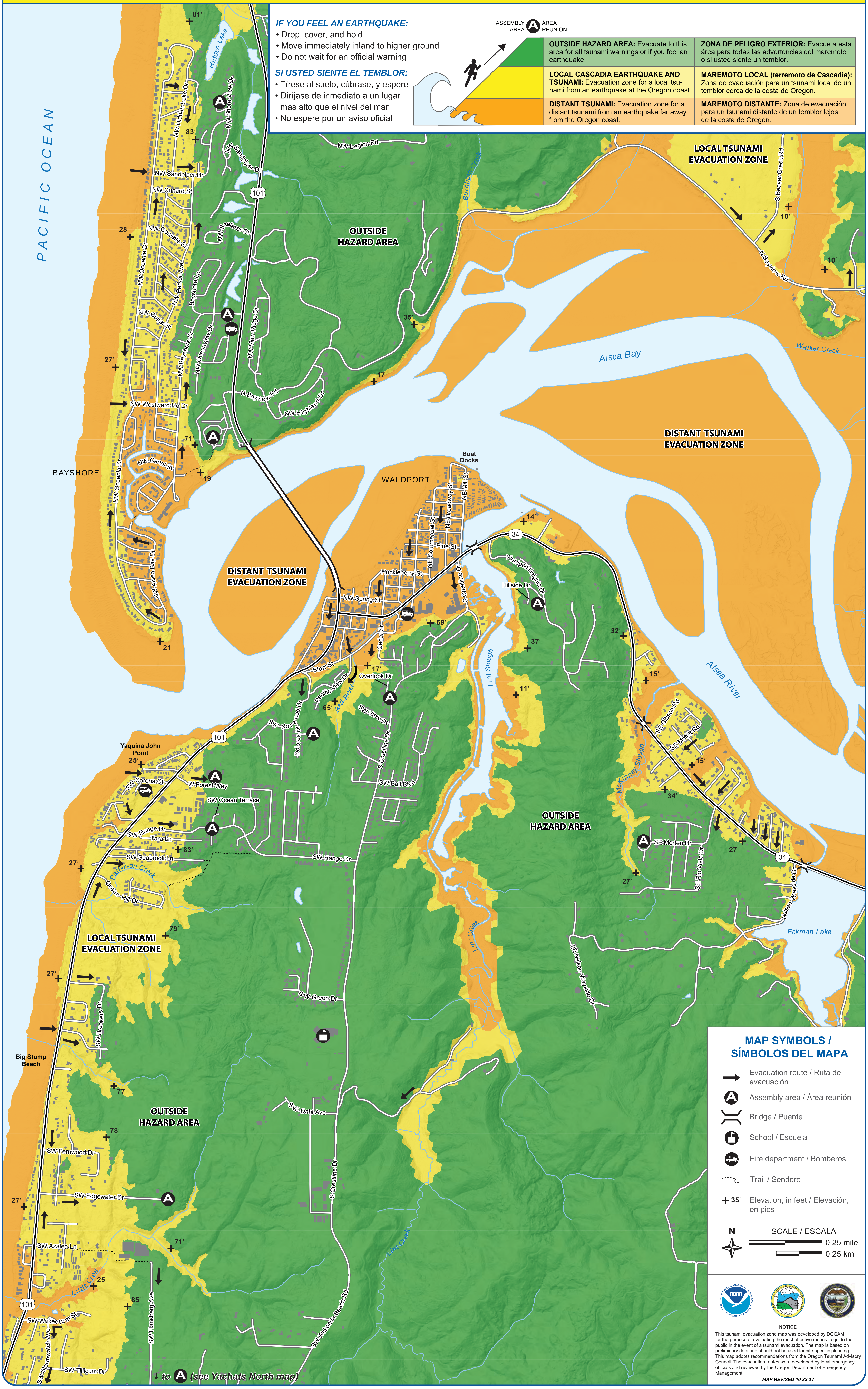
Label	Start Node	Stop Node	Diameter (in)	Length (ft)	Flow (Maximum Absolute) (gpm)	Velocity (ft/s)	Pressure (Start) (psi)	Pressure (Stop) (psi)
P-249	J-214	J-208	6	489	1	0.01	65	65
P-23	J-25	J-26	6	1,073	1	0.01	50	46
P-151	J-136	J-140	6	509	1	0.01	52	52
P-347	J-294	J-295	6	801	1	0.01	61	41
P-246	J-212	J-205	4	668	0	0.01	56	65
P-304	J-259	J-260	10	1,450	2	0.01	64	57
P-332	J-260	J-281	10	234	2	0.01	57	57
P-14	J-16	J-17	6	38	1	0.01	53	53
P-254	J-218	J-219	6	472	1	0.01	58	60
P-379	J-313	J-322	6	288	1	0.01	51	55
P-380	J-312	J-323	6	371	1	0.01	49	38
P-402	J-340	J-328	6	115	1	0.01	59	60
P-119	J-108	J-109	8	64	1	0.01	42	43
P-387	J-313	J-330	6	26	1	0.01	51	51
P-24	J-26	J-27	6	406	1	0.01	46	44
P-48	J-46	J-47	6	359	1	0.01	64	65
P-239	J-206	J-207	6	315	1	0.01	65	65
P-476	J-392	J-179	10	132	1	0	80	82
P-480	J-179	J-393	10	337	1	0	82	92
P-481	J-393	J-178	10	117	1	0	92	96
P-279	J-240	J-241	6	108	0	0	53	57
P-430	J-360	J-361	6	272	0	0	70	75
P-163	J-150	J-151	6	322	0	0	55	53
P-426	J-353	J-357	8	562	0	0	57	65
P-337	J-281	J-286	10	1,548	0	0	57	59
P-331	J-280	J-260	0.8	99	0	0	59	57
P-172	J-157	J-158	2	775	0	0	84	82
P-50	J-45	J-48	0.8	325	0	0	58	58
P-416	J-348	PRV-1	2	33	0	0	35	35
P-417	PRV-1	J-349	2	27	0	0	99	100
P-479	J-163	Alder	4	51	0	0	27	24
P-482	Alder	J-393	4	54	0	0	92	92
P-414	J-349	J-350	8	2,764	0	0	100	63
P-484	Waconda PRV-2	J-367	6	891	0	0	32	53
P-483	J-366	Waconda PRV-2	6	203	0	0	88	97
P-419	J-347	PMP-1	6	23	0	0	35	35
P-420	PMP-1	J-349	6	69	0	0	100	100

Appendix C

Tsunami Evacuation Maps

- Waldport, Oregon
- Yachats North (San Marine), Oregon
- Yachats, Oregon

TSUNAMI EVACUATION MAP WALDPORT, OREGON



IF YOU FEEL AN EARTHQUAKE:

- Drop, cover, and hold
- Move immediately inland to higher ground
- Do not wait for an official warning

SI USTED SIENTE EL TEMBLOR:

- Tírese al suelo, cúbrase, y espere
- Diríjase de inmediato a un lugar más alto que el nivel del mar
- No espere por un aviso oficial

ASSEMBLY AREA / ÁREA REUNIÓN

OUTSIDE HAZARD AREA: Evacuate to this area for all tsunami warnings or if you feel an earthquake.	**ZONA DE PELIGRO EXTERIOR:** Evacue a esta área para todas las advertencias del maremoto o si usted siente un temblor.
LOCAL CASCADIA EARTHQUAKE AND TSUNAMI: Evacuation zone for a local tsunami from an earthquake at the Oregon coast.	**MAREMOTO LOCAL (terremoto de Cascadia):** Zona de evacuación para un tsunami local de un temblor cerca de la costa de Oregon.
DISTANT TSUNAMI: Evacuation zone for a distant tsunami from an earthquake far away from the Oregon coast.	**MAREMOTO DISTANTE:** Zona de evacuación para un tsunami distante de un temblor lejos de la costa de Oregon.

MAP SYMBOLS / SÍMBOLOS DEL MAPA

- Evacuation route / Ruta de evacuación
- Assembly area / Área reunión
- Bridge / Puente
- School / Escuela
- Fire department / Bomberos
- Trail / Sendero
- 35′ Elevation, in feet / Elevación, en pies

N

SCALE / ESCALA

0.25 mile

0.25 km

NOTICE

This tsunami evacuation zone map was developed by DOGAMI for the purpose of evaluating the most effective means to guide the public in the event of a tsunami evacuation. The map is based on preliminary data and should not be used for site-specific planning. This map adopts recommendations from the Oregon Tsunami Advisory Council. The evacuation routes were developed by local emergency officials and reviewed by the Oregon Department of Emergency Management.

MAP REVISED 10-23-17

TSUNAMI EVACUATION MAP

YACHATS NORTH (SAN MARINE), OREGON

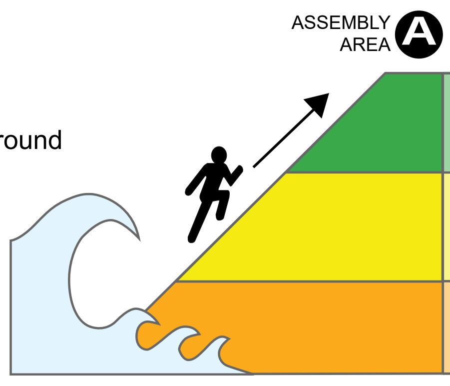
TSUNAMI EVACUATION ROUTE

IF YOU FEEL AN EARTHQUAKE:

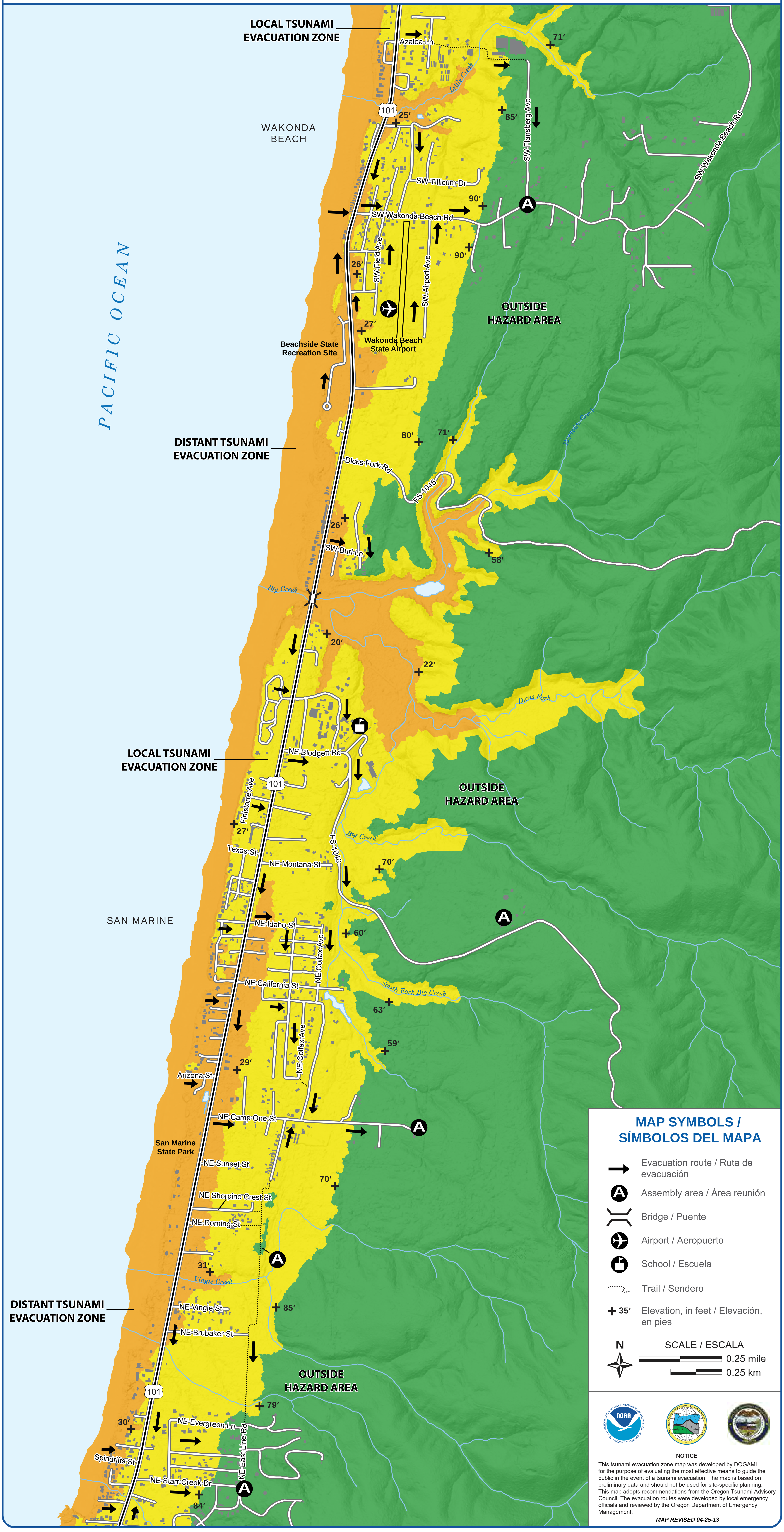
- Drop, cover, and hold
- Move immediately inland to higher ground
- Do not wait for an official warning

SI USTED SIENTE EL TEMBLOR:

- Tírese al suelo, cúbrase, y espere
- Diríjase de inmediato a un lugar más alto que el nivel del mar
- No espere por un aviso oficial



OUTSIDE HAZARD AREA: Evacuate to this area for all tsunami warnings or if you feel an earthquake.	**ZONA DE PELIGRO EXTERIOR:** Evacue a esta área para todas las advertencias del maremoto o si usted siente un temblor.
LOCAL CASCADIA EARTHQUAKE AND TSUNAMI: Evacuation zone for a local tsunami from an earthquake at the Oregon coast.	**MAREMOTO LOCAL (terremoto de Cascadia):** Zona de evacuación para un tsunami local de un temblor cerca de la costa de Oregon.
DISTANT TSUNAMI: Evacuation zone for a distant tsunami from an earthquake far away from the Oregon coast.	**MAREMOTO DISTANTE:** Zona de evacuación para un tsunami distante de un temblor lejos de la costa de Oregon.



MAP SYMBOLS / SÍMBOLOS DEL MAPA

- Evacuation route / Ruta de evacuación
- Assembly area / Área reunión
- Bridge / Puente
- Airport / Aeropuerto
- School / Escuela
- Trail / Sendero
- + 35′ Elevation, in feet / Elevación, en pies

N

SCALE / ESCALA

0.25 mile

0.25 km

NOTICE

This tsunami evacuation zone map was developed by DOGAMI for the purpose of evaluating the most effective means to guide the public in the event of a tsunami evacuation. The map is based on preliminary data and should not be used for site-specific planning. This map adopts recommendations from the Oregon Tsunami Advisory Council. The evacuation routes were developed by local emergency officials and reviewed by the Oregon Department of Emergency Management.

MAP REVISED 04-25-13

TSUNAMI EVACUATION MAP

YACHATS, OREGON

MAP LOCATION
OREGON

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- Drop, cover, and hold
- Move immediately inland to higher ground
- Do not wait for an official warning

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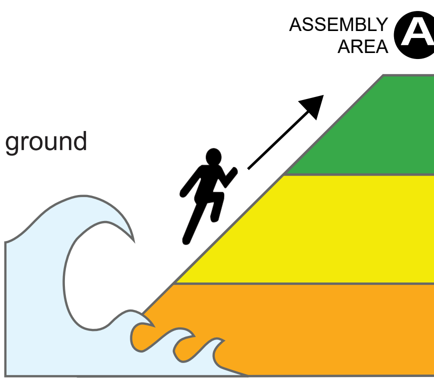

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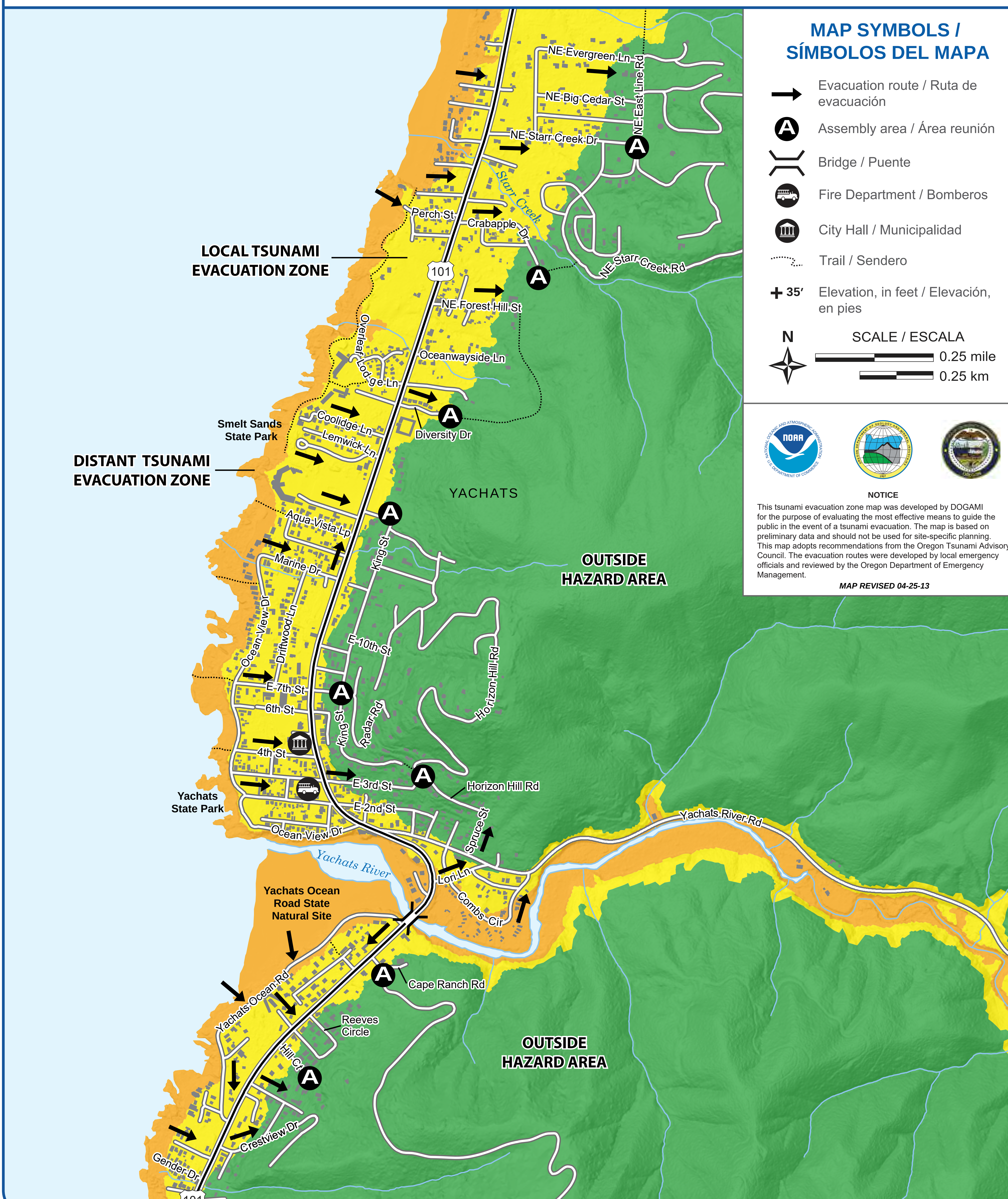

MAP SYMBOLS / SÍMBOLOS DEL MAPA

- Evacuation route / Ruta de evacuación
- Assembly area / Área reunión
- Bridge / Puente
- Fire Department / Bomberos
- City Hall / Municipalidad
- Trail / Sendero
- 35′ Elevation, in feet / Elevación, en pies

N

SCALE / ESCALA

0.25 mile

0.25 km

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MAP REVISED 04-25-13

BE PREPARED!

Assemble **emergency kits** with at least a 3-day supply for each family member:

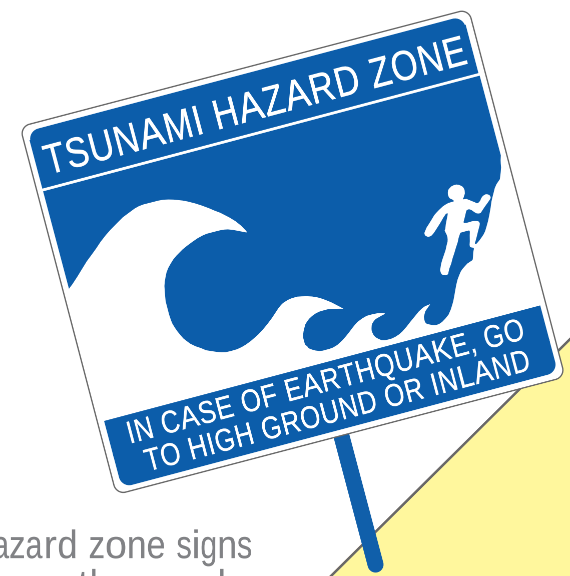
- Local map showing safe evacuation routes to high ground
- First-aid supplies, prescriptions and non-prescription medication
- Water bottle and filtration or treatment supplies capable of providing 1 gallon per person per day
- Non-perishable food (ready-to-eat meals, canned food, baby food, energy bars)
- Cooking and eating utensils, can opener, Sterno® or other heat source
- Matches in water-proof container or lighter
- Shelter (tent), sleeping bags, blankets
- Portable radio, NOAA weather radio, flashlight, and extra batteries
- Rain gear, sturdy footwear, extra clothing
- Personal hygiene items (toilet paper, soap, toothbrush)
- Tools and supplies (pocket knife, shut-off wrench, duct tape, gloves, whistles, plastic bags)
- Cash

How to help with tsunami awareness in your community

- Start a tsunami buddy system
- Make and distribute emergency packs
- Initiate or participate in a local preparedness program

Visit **OregonTsunami.org** to find more great resources!

Climb to Assembly Area



Look for these hazard zone signs and be ready to leave the area by following evacuation route signs.

WHAT TO DO for both local and distant tsunamis

1. Evacuate on foot, if at all possible. Follow evacuation signs and arrows to an Assembly Area.*
2. If you need help evacuating, tie something **white** (sheet or towel) to the front door knob. Make it large enough to be visible from the street. If the emergency is a distant tsunami, then help may arrive. In the event of a local tsunami, it is unlikely that anyone will help you, so make a plan and be prepared!
3. Stay away from potentially hazardous areas until you receive an ALL CLEAR from local officials. Tsunamis often follow river channels, and dangerous waves can persist for several hours. Local officials must inspect all flooded or earthquake-damaged structures before anyone can go back into them.
4. After evacuation, check with local emergency officials if you think you have special skills and can help, or if you need assistance locating lost family members.

*Assembly areas (A) are shown on the map. Do not confuse Assembly Areas with Evacuation Centers, which are short-term help centers set up *after* a disaster occurs.

Local tsunamis

A ***local tsunami*** can come onshore within 15 to 20 minutes after the earthquake — before there is time for an official warning from the national warning system. Ground shaking from the earthquake may be the only warning you have. Evacuate quickly!

WHAT TO KNOW about tsunamis

A ***tsunami*** is a series of sea waves, usually caused by a displacement of the ocean floor by an undersea earthquake. As tsunamis enter shallow water near land, they increase in height and can cause great loss of life and property damage.

Recent research suggests that tsunamis have struck the Oregon coast on a regular basis. They can occur any time, day or night. Typical wave heights from tsunamis occurring in the Pacific Ocean over the last 500 years have been 20–65 feet at the shoreline. However, because of local conditions a few waves may have been much higher — as much as 100 feet.

We distinguish between a tsunami caused by an undersea earthquake near the Oregon coast (a **local** tsunami) and an undersea earthquake far away from the coast (a **distant** tsunami).

Distant tsunamis

A ***distant tsunami*** will take 4 hours or more to come ashore. You will feel no earthquake, and the tsunami will generally be smaller than that from a local earthquake. Typically, there is time for an official warning and evacuation to safety.

Evacuation for a distant tsunami will generally be indicated by a **3-minute siren blast** (if your area has sirens) and an announcement over NOAA weather radio that the local area has been put into an official TSUNAMI WARNING. In isolated areas along beaches and bays you may not hear a warning siren. Here, a **sudden change of sea level** should prompt you to move immediately to high ground. If you hear the 3-minute blast or see a sudden sea level change, first evacuate away from shoreline areas, then turn on your local broadcast media or NOAA weather radio for more information.

If you feel an earthquake, a tsunami may be coming...

WHAT TO DO:

- **DROP, COVER, HOLD** until the earthquake is over; protect yourself
- **MOVE IMMEDIATELY INLAND** to high ground and away from low-lying coastal areas
- **FOLLOW EVACUATION ROUTE SIGNS**
- **DO NOT WAIT** for an official warning
- **GO ON FOOT** if at all possible
- **DO NOT PACK** or delay
- **DO NOT RETURN** to the beach – large waves may continue to come onshore for several hours
- **WAIT** for an "all clear" from local emergency officials before returning to low-lying areas

TSUNAMI EVACUATION ROUTE

www.OregonTsunami.org

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http://www.centralcoastfire.net

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Waldport, OR 97394
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http://www.waldport.org

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Emergency Management
225 West Olive Street, Room 203
Newport, OR 97365
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http://www.lincolncountysheriff.net

Oregon Emergency Management
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(503) 378-2911
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Oregon Department of Geology and Mineral Industries
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737 Bishop Street, Suite 2200
Honolulu, HI 96813
(808) 532-6422
itic.ioc-unesco.org

TSUNAMI EVACUATION ROUTE

Waldport

OREGON

This information could save your life – Please read it and share it with your family and friends.

EVACUATION MAP ON REVERSE