Brown AND Caldwell

Challenges, Opportunities, and Solutions for Terminal System Storage Reservoirs

Matthew J. Maring, P.E.

AWWA PNWS Conference | May 7, 2014

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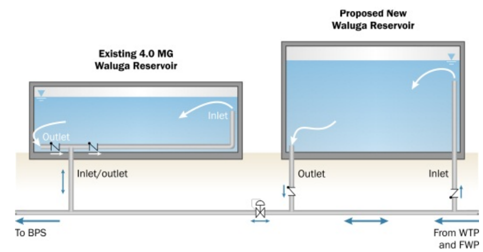
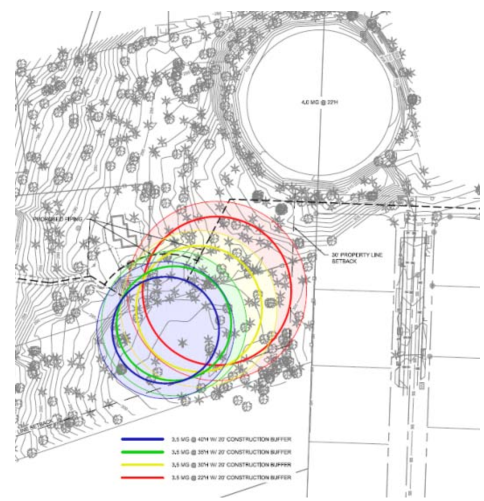
Unique Solutions to Reservoir Planning and Design Challenges

Storage Done Differently
Waluga Reservoir 2

Lake Oswego · Tigard Water Partnership
sharing water · connecting communities





General Presentation Outline

- Project and program overview
- Project planning and design development process
- Considerations and analysis
- Decisions and final design

Lake Oswego · Tigard Water Partnership
sharing water · connecting communities

WR2 – Waluga Reservoir 2

- 3.5 MG
  prestressed concrete
- AWWA D110 Type 1
- AWWA D115 bid alternate
- 131’ internal diameter
- 37.5’ sidewall
- Self supporting dome roof
- Adjacent to 4.0 MG WR1
- $7.3M construction bid

Waluga Reservoir Project Team

- Owner: Lake Oswego-Tigard Water Partnership (LOTWP)
  - City of Lake Oswego, Oregon
  - City of Tigard, Oregon
- Program Manager: Brown and Caldwell
  - Planning and modeling
  - Project definition
  - Oversight and coordination
- Designer: Black & Veatch
- Structural and Seismic: OBEC
- Landscape Architects: Greenworks

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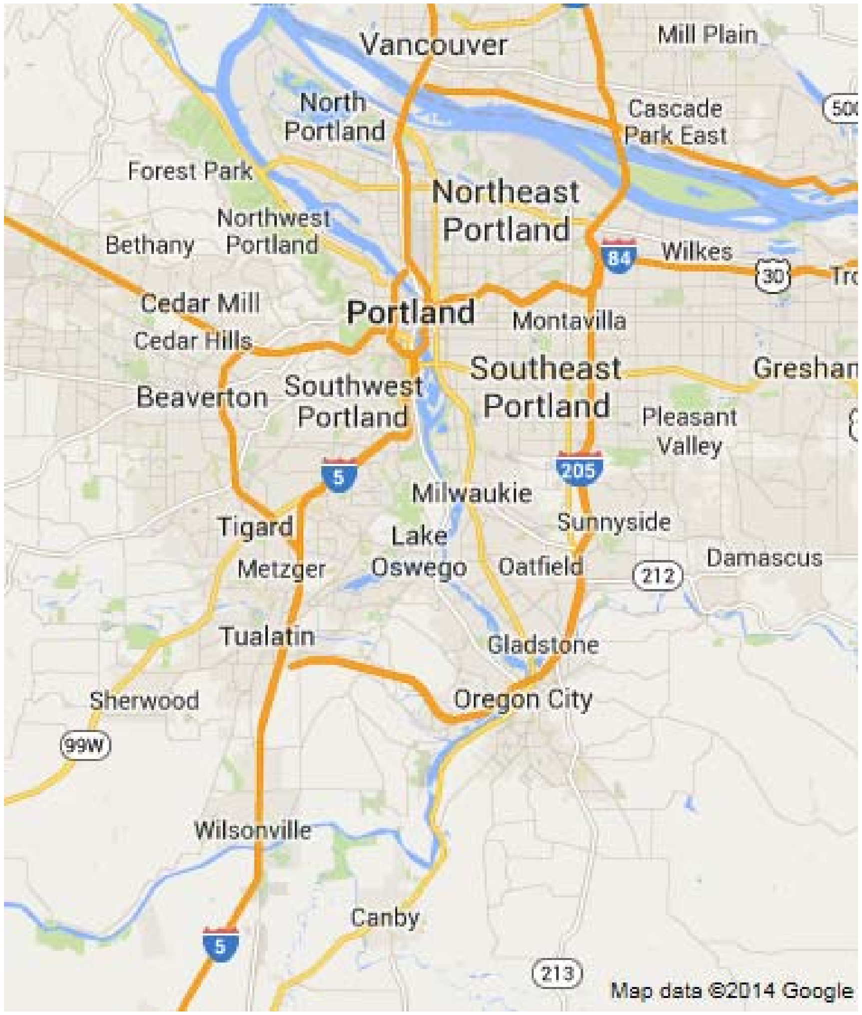
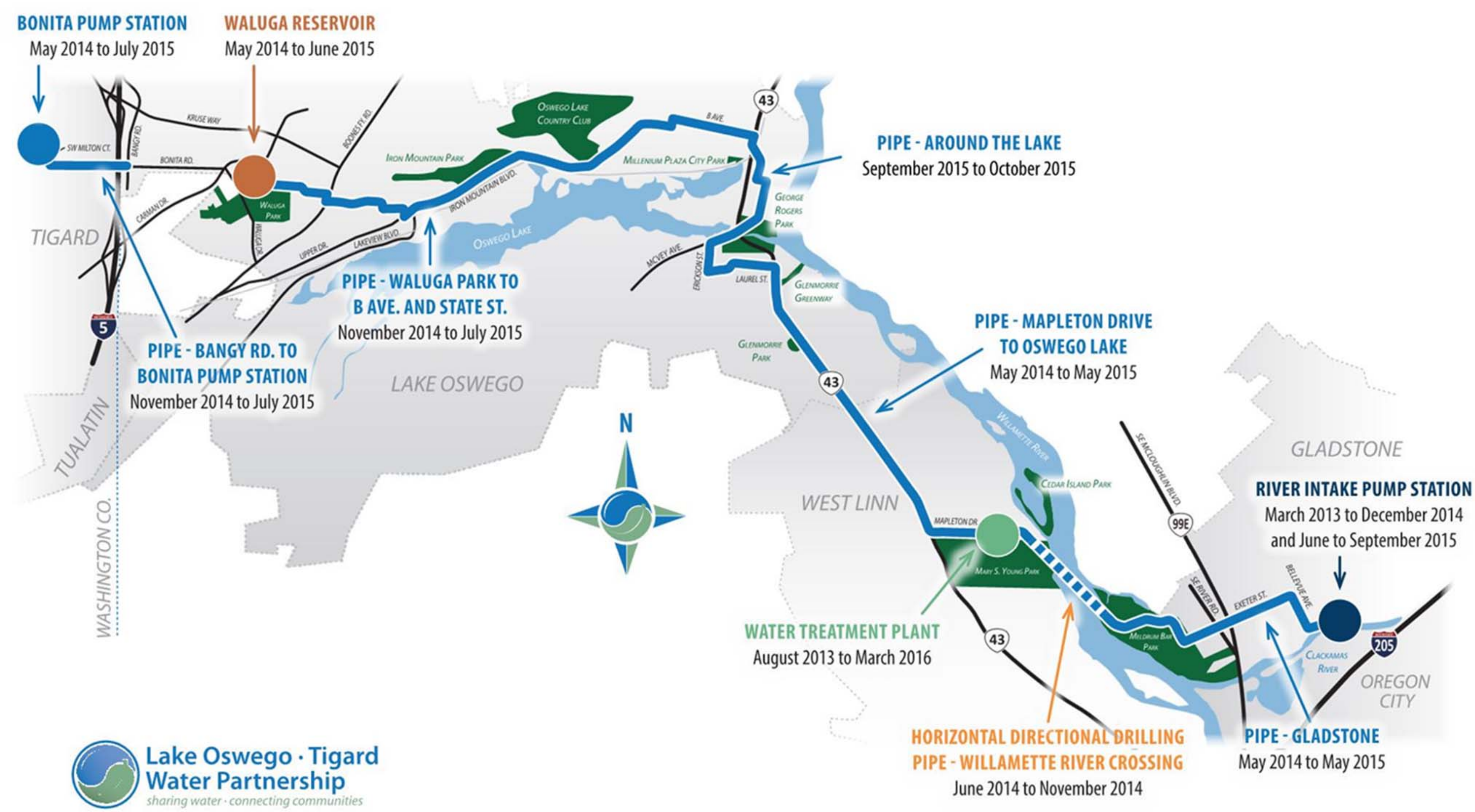
Lake Oswego-Tigard Water Partnership

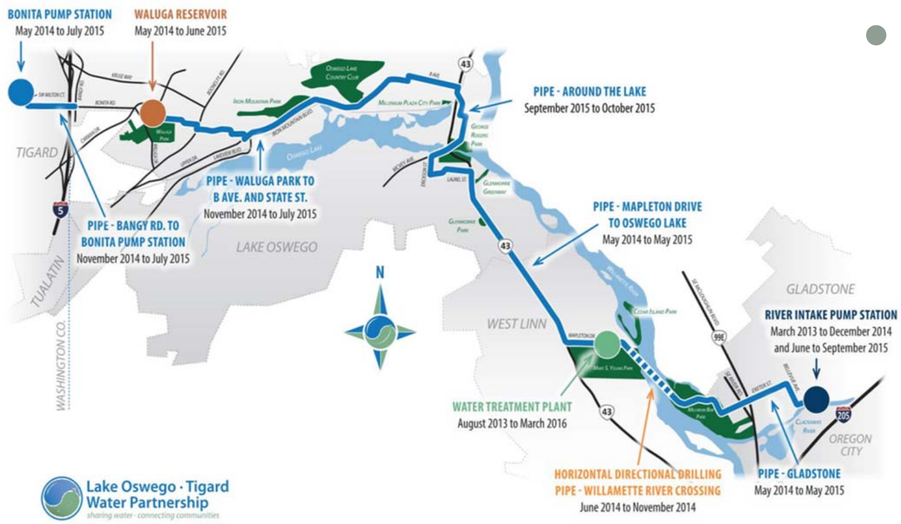


- Current Supply/Capacity
  - Lake Oswego 16 mgd from Clackamas River
  - Tigard wholesale supply from Portland system
- Future Demands
  - Lake Oswego 18–24 mgd
  - Tigard 20 mgd
- Clackamas Water Rights
  - 59 cfs = 38 mgd

LOTWP Program Overview



LOTWP Program Details



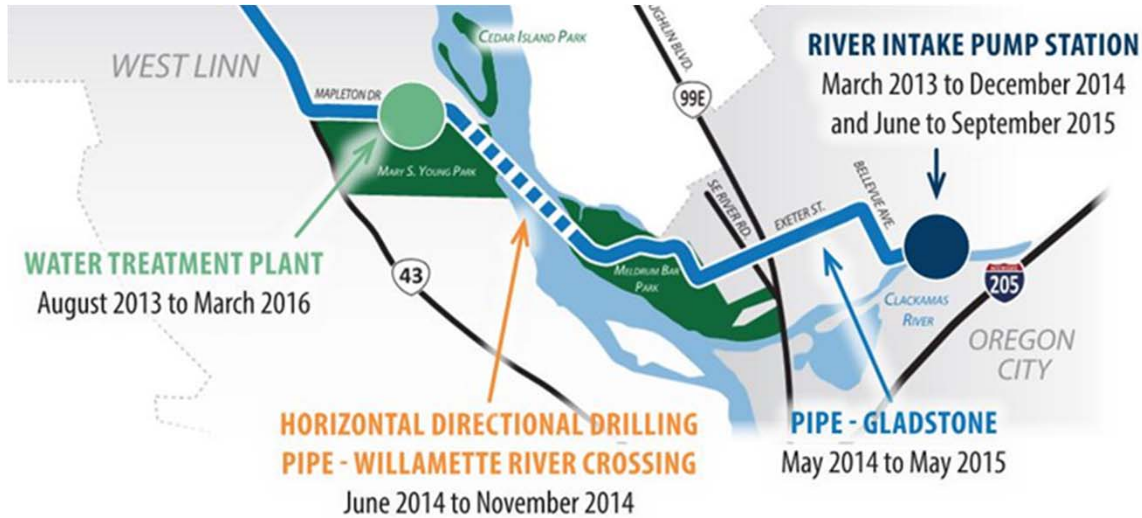
- 7 projects
  - RIPS – River Intake Pump Station
  - RWP – Raw Water Pipeline
  - WTP – Water Treatment Plant
  - FWP – Finished Water Pipeline
  - WR2 – Waluga Reservoir 2
  - BPS – Bonita Pump Station
- 3 design teams
- 10 construction contracts
- $250M program budget

RIPS – River Intake Pump Station

- 38 mgd capacity
- Hoist accessible tee intake screens
- 4+1 400 hp VTP VFD raw water pumps

RWP – Raw Water Pipeline

- 3 Schedules
  - Gladstone from RIPS and crossing HWY 99 to Meldrum Bar Park
  - Willamette River HDD crossing
  - West Linn to LOTWP WTP



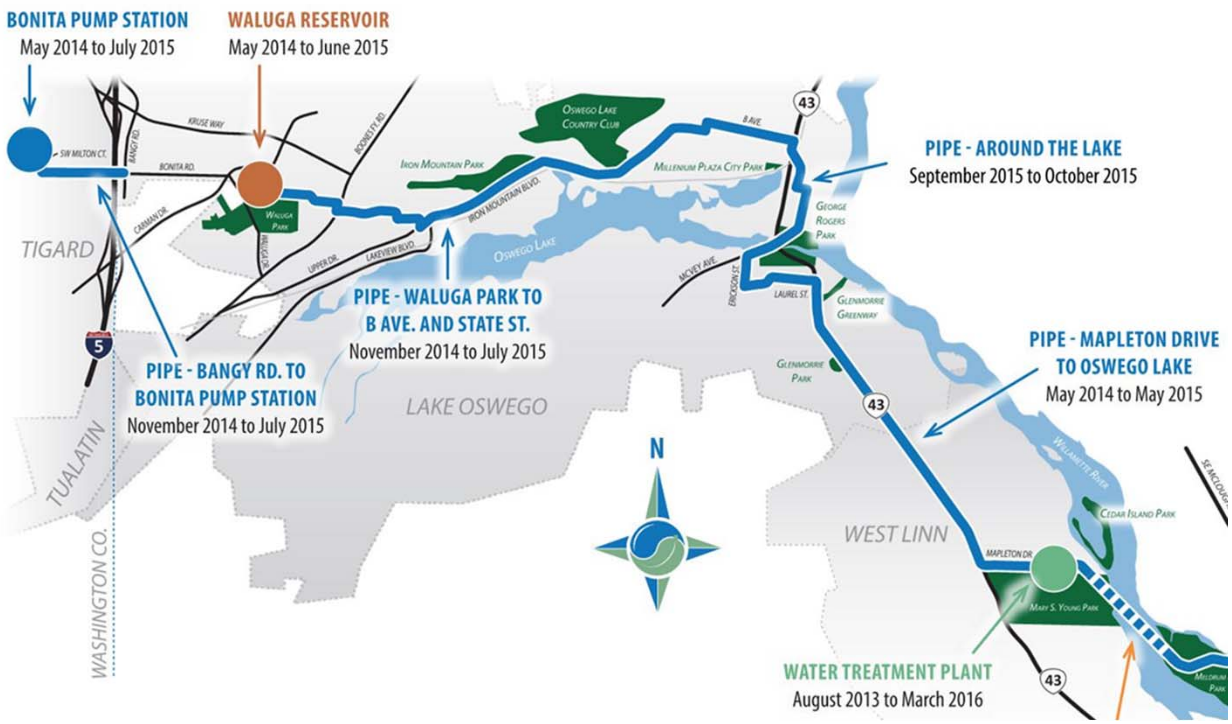
- 2.6 miles of 36” to 48” diameter steel piping
- 38 mgd capacity

WTP – Water Treatment Plant

- Ballasted sedimentation
- Ozonation
- Biologically active GAC filtration
- 2.0 MG chlorine contact clearwell
- 5+1 600 hp VTP VFD finished water pumps
- 38 mgd capacity

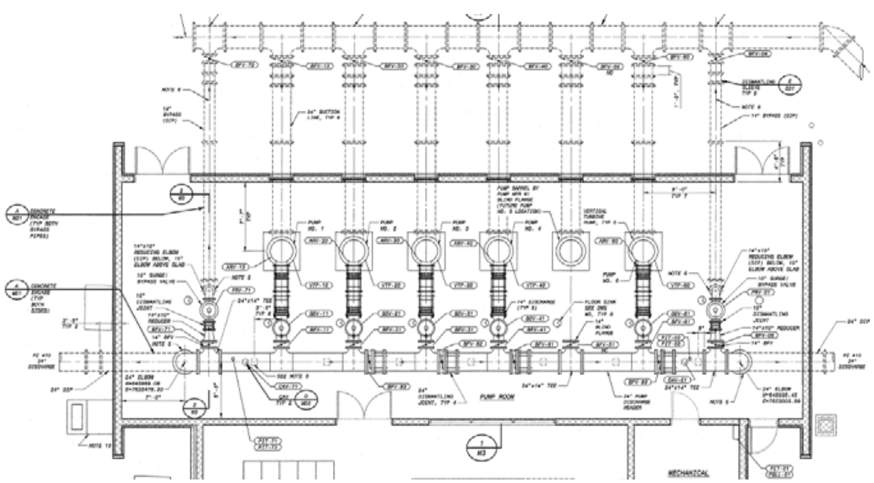
FWP – Finished Water Pipeline

- 4 Schedules
  - From WTP following HWY 43 and major arterial alignments to Waluga Reservoir site
  - Interstate 5 crossing to BPS
- 8.5 miles of 24” to 48” diameter steel piping
- 20–38 mgd capacity

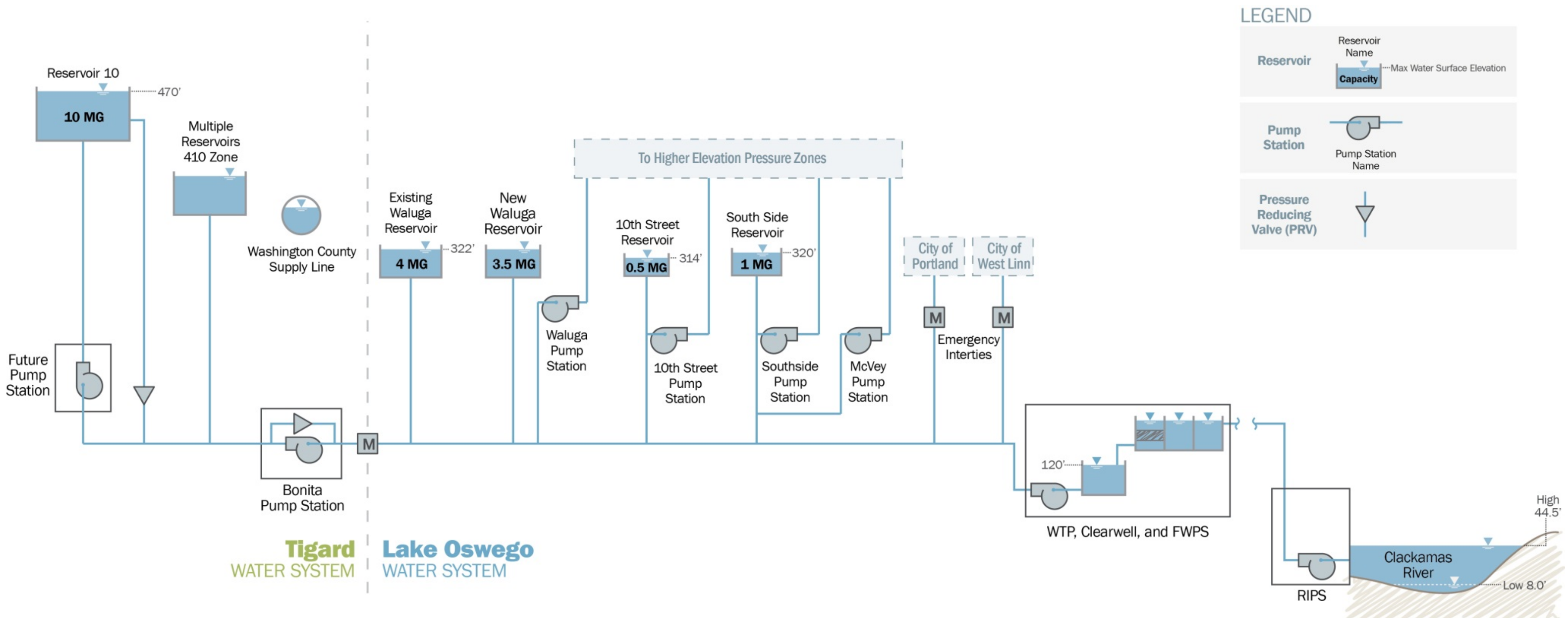


BPS – Bonita Pump Station

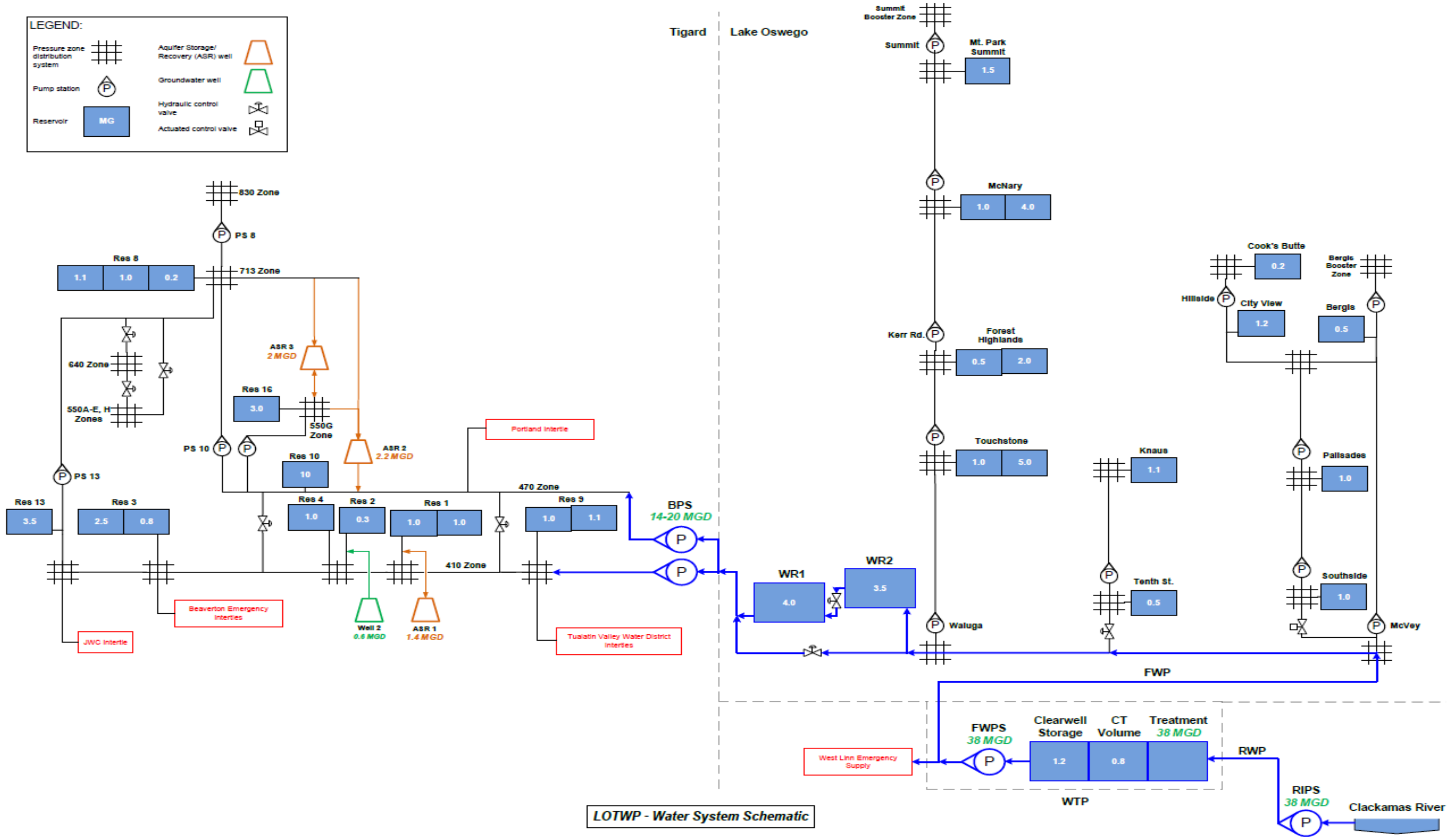
- 5+1 250 hp VTP VFD booster pumps
- Dual feed from Waluga Reservoir site to Tigard 410 and 470 zones
- 16–20 mgd capacity



LOTWP Hydraulic Overview



LOTWP Water System Schematic



LOTWP Daily Demand Summary

• Lake Oswego	3.7–24 mgd
• Tigard	4.1–20 mgd
• Combined	7.8–38+ mgd

- current minimum daily demand through future projected buildout peak day demand

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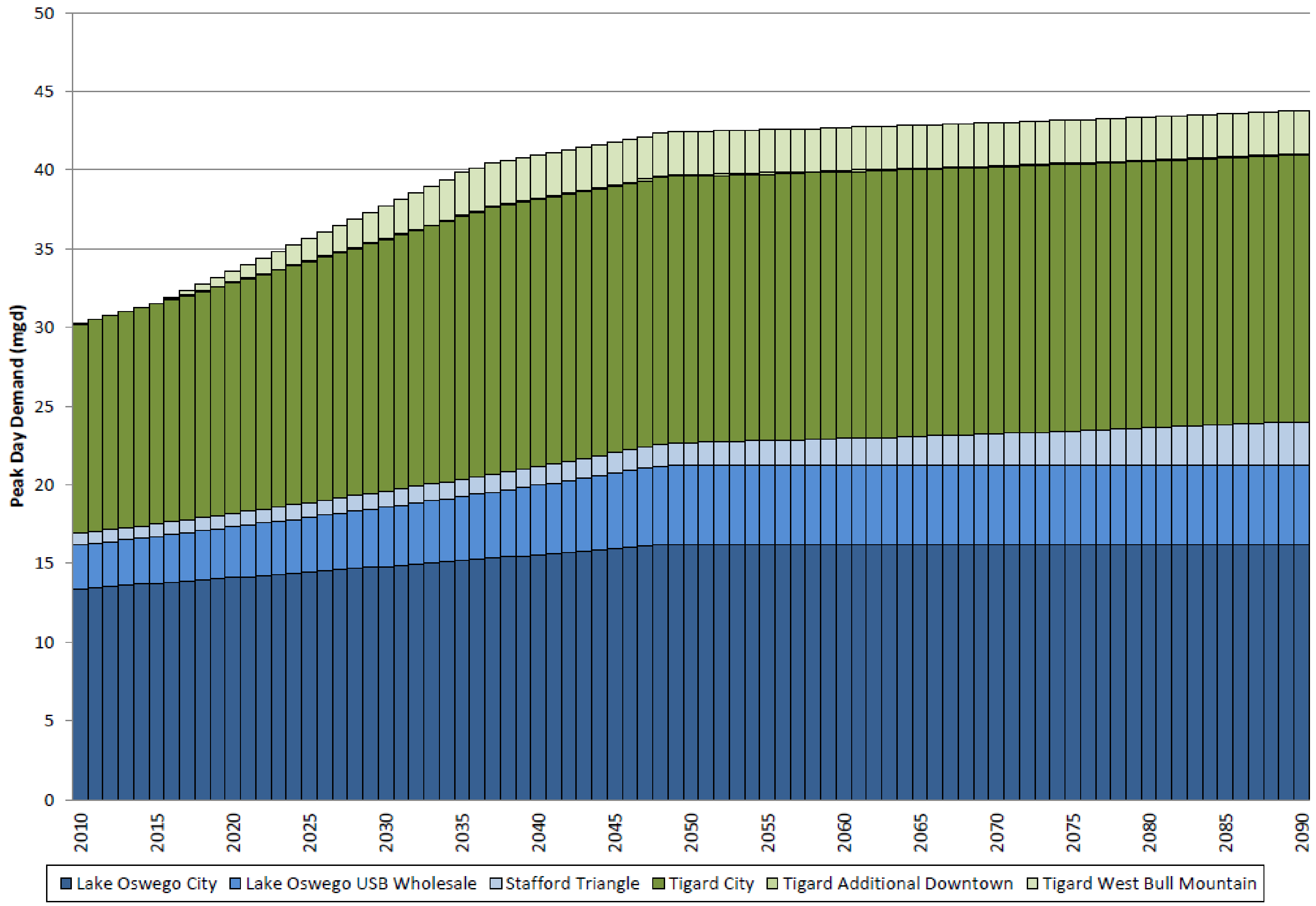
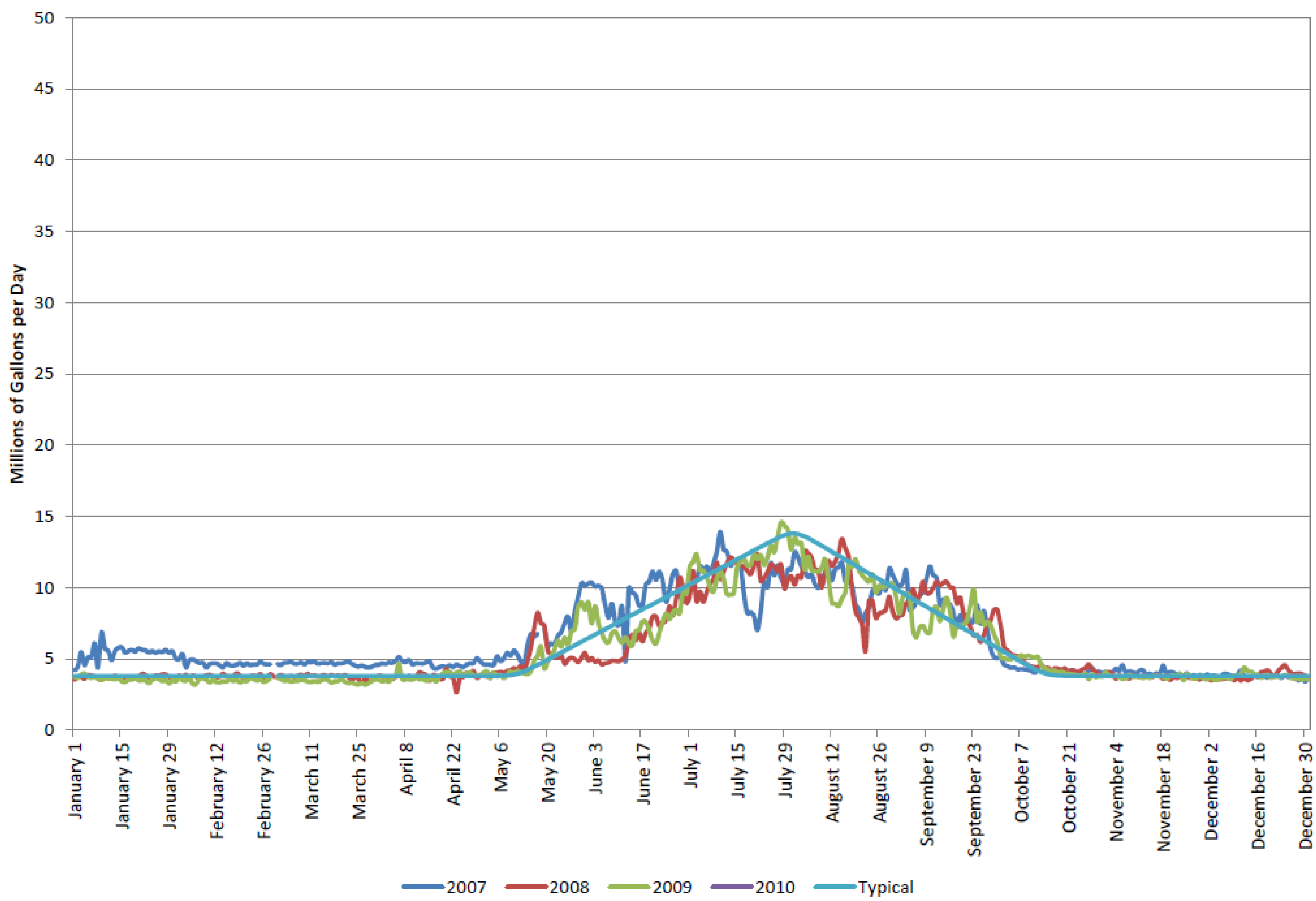
sharing water · connecting communities

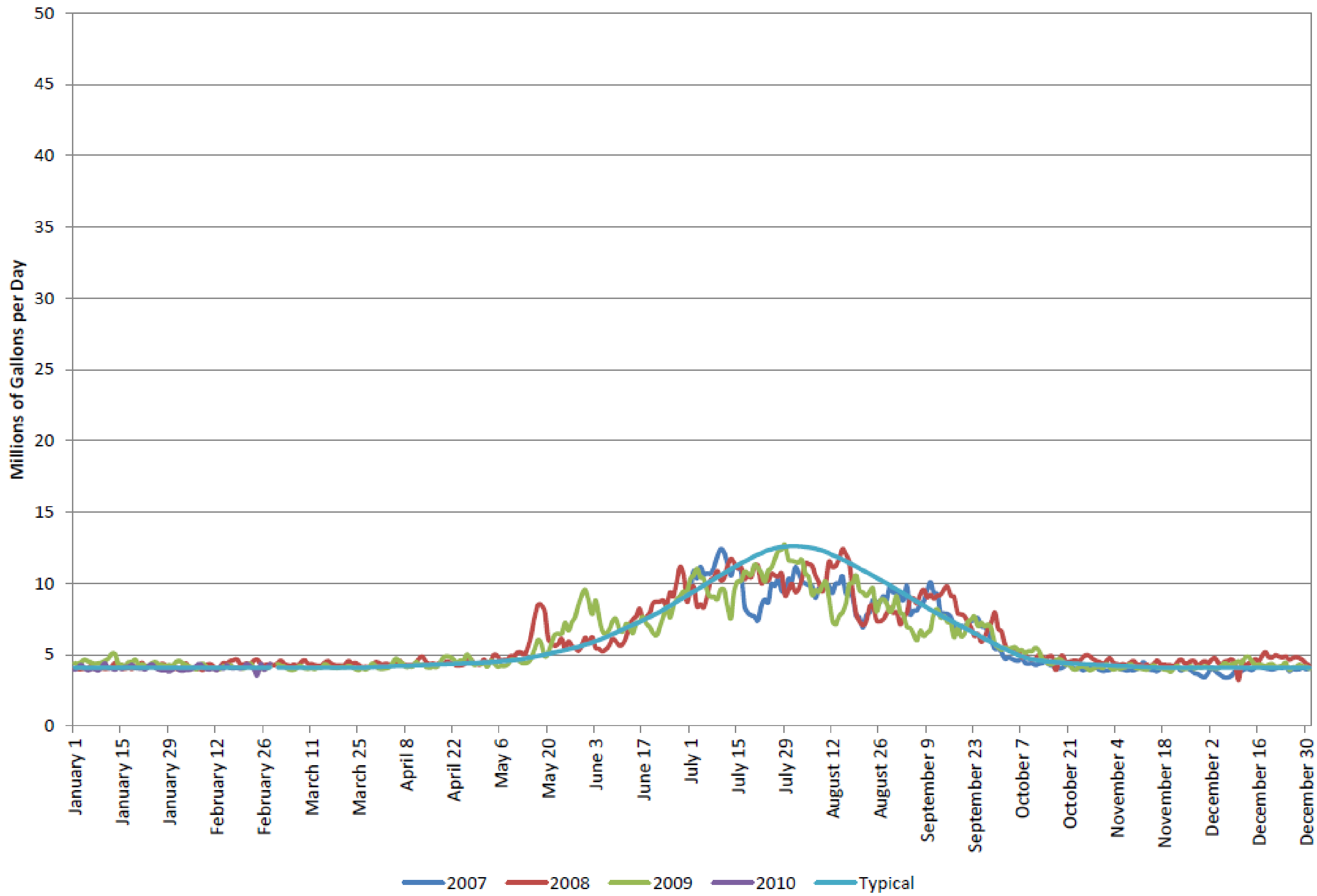
LOTWP Peak Day Demand Projections



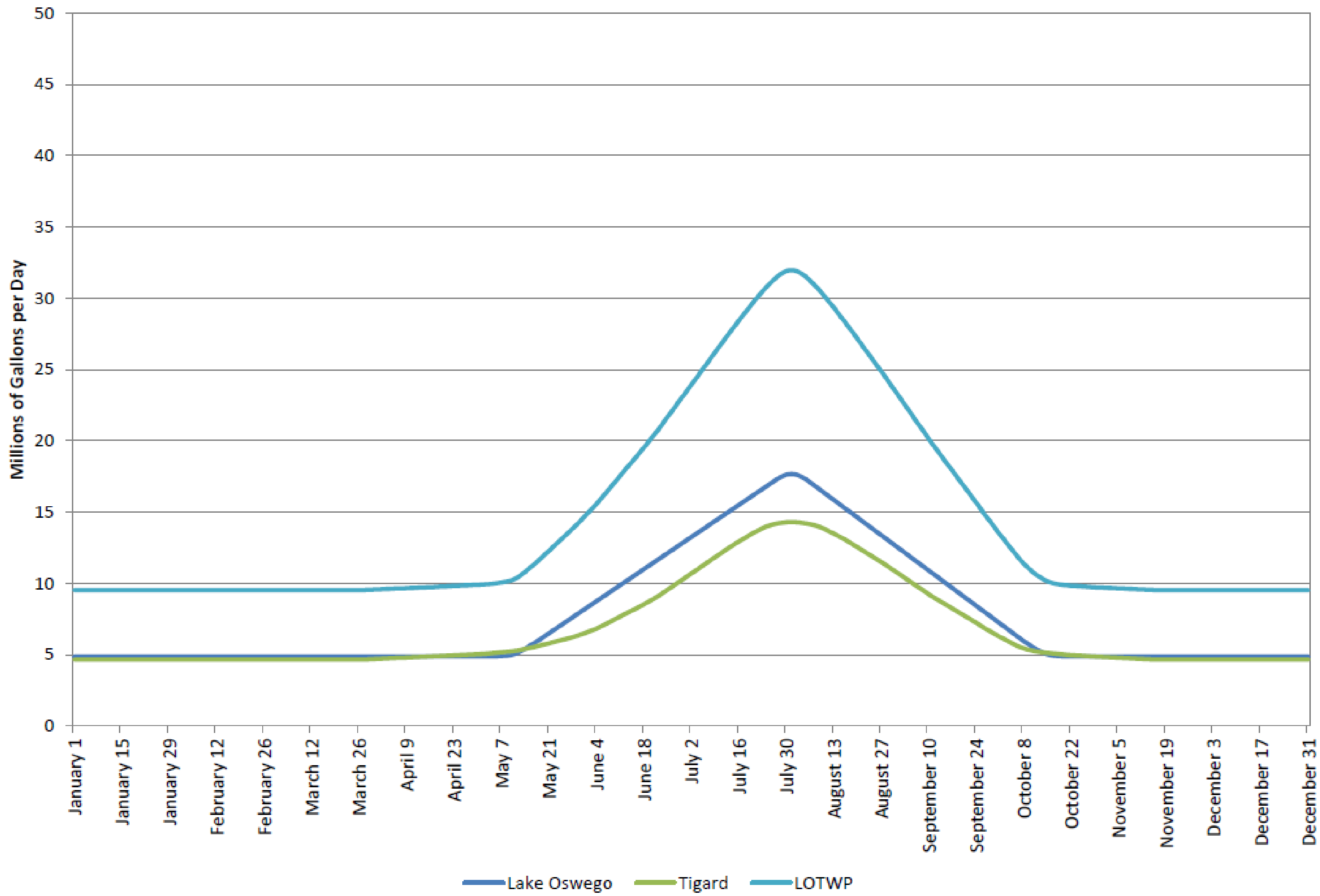
Lake Oswego Water Demand History



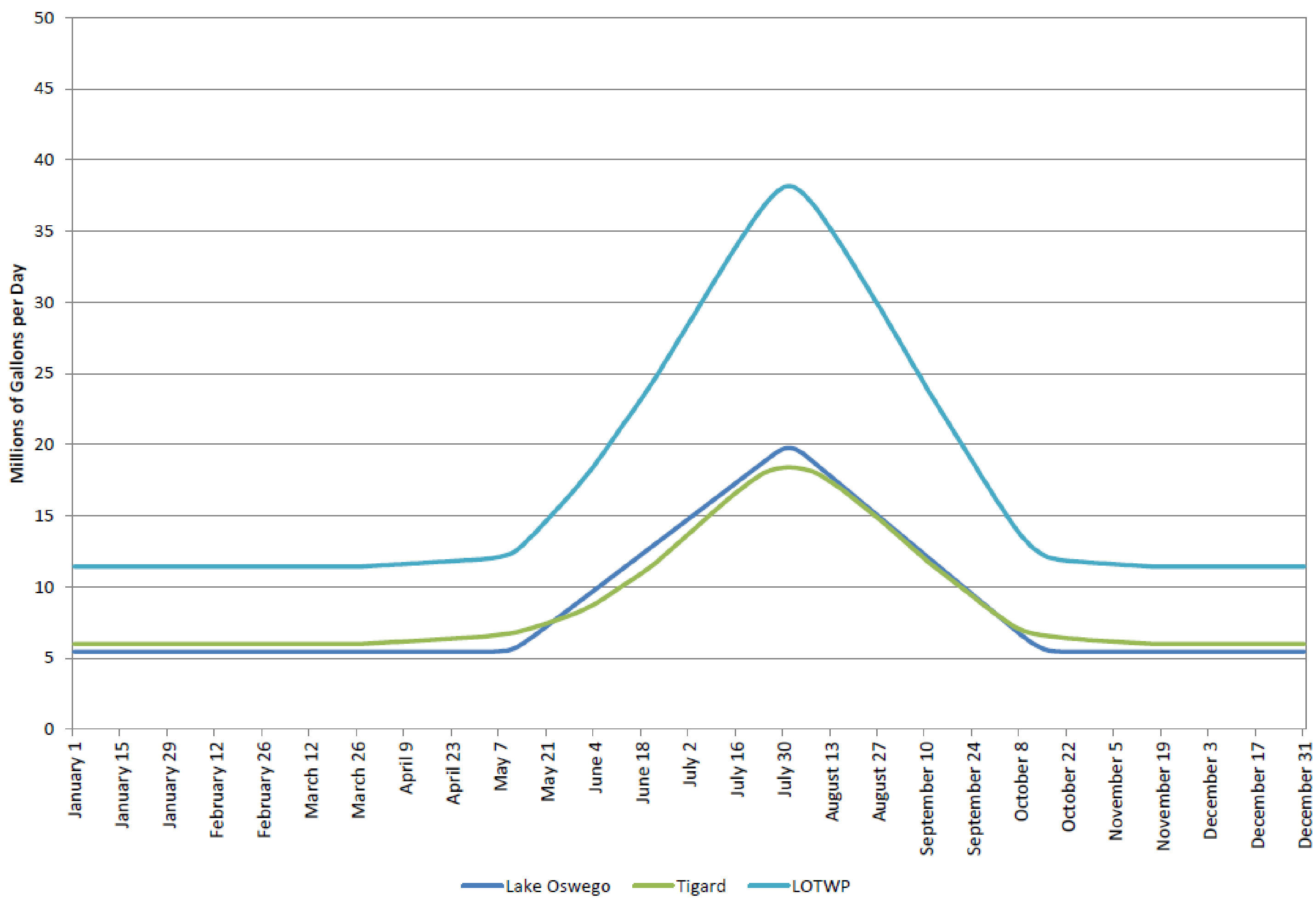
Tigard Water Demand History



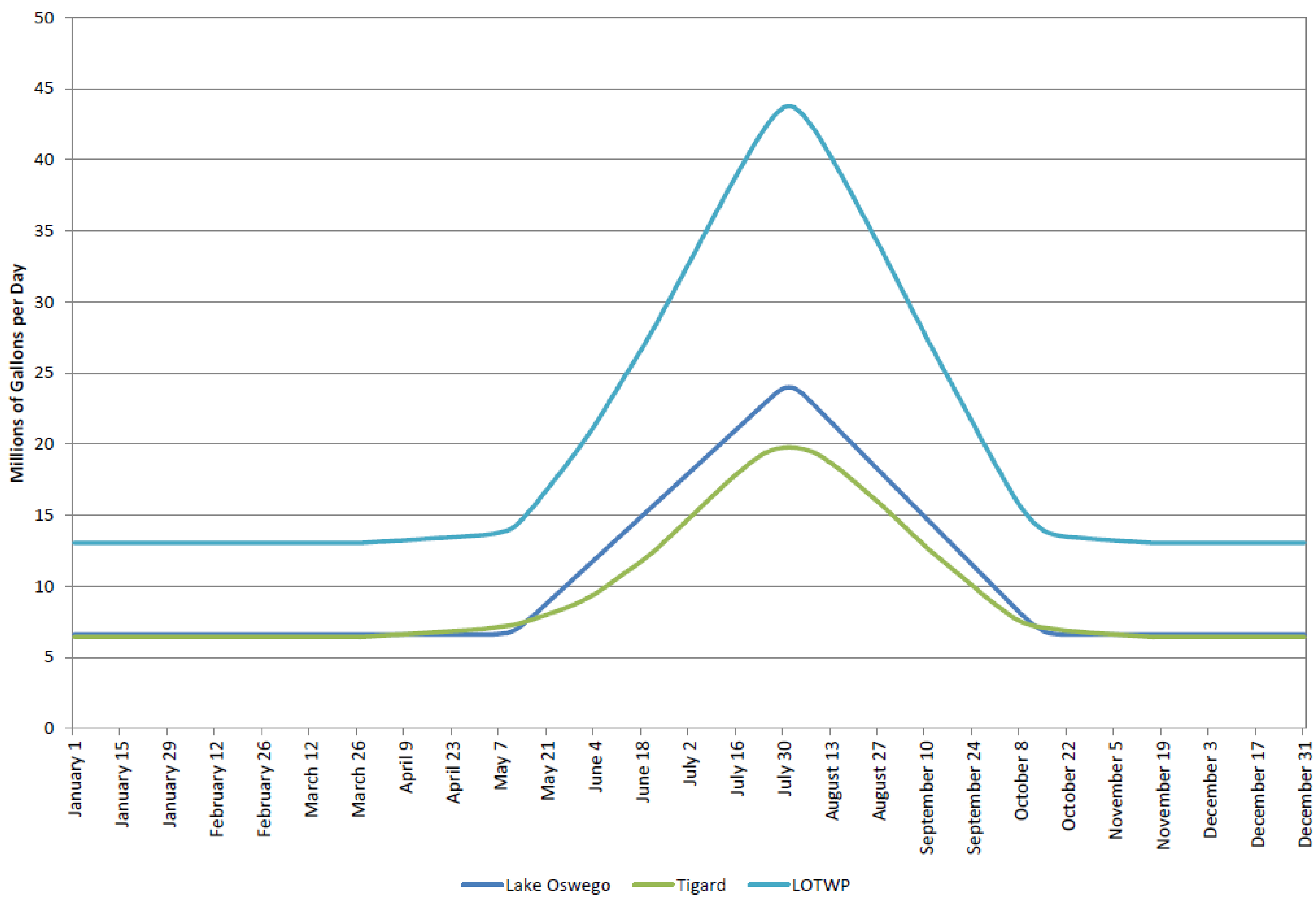
LOTWP 2016 Demand Projection



LOTWP 2031 Demand Projection



LOTWP Buildout Demand Projection



Storage Implementation Considerations

- How much storage is needed?
- Where should storage be located?
- How does new storage integrate with system facilities?
- How should storage be configured?
- How does storage affect water quality?
- How can storage promote resiliency?

Optimal Storage Solutions may Defy Conventional Wisdom

- Storage volume
  - More is better?
- Design configuration
  - Paired facilities should have matched elevations?
  - Community needs trump neighborhood values?
- Water supply paths
  - Dual facilities should operate in parallel?
- Resilience
  - A system is only as strong as its weakest link?

WR2 – Waluga Reservoir 2 Initial Concept

- 6.0 MG
  prestressed concrete
- AWWA D110 Type 1

- 226’ internal diameter
- 22’ sidewall
- Flat column supported roof
- Adjacent to 4.0 MG WR1
- $10M+ construction cost

WR2 – Waluga Reservoir 2 Refinements

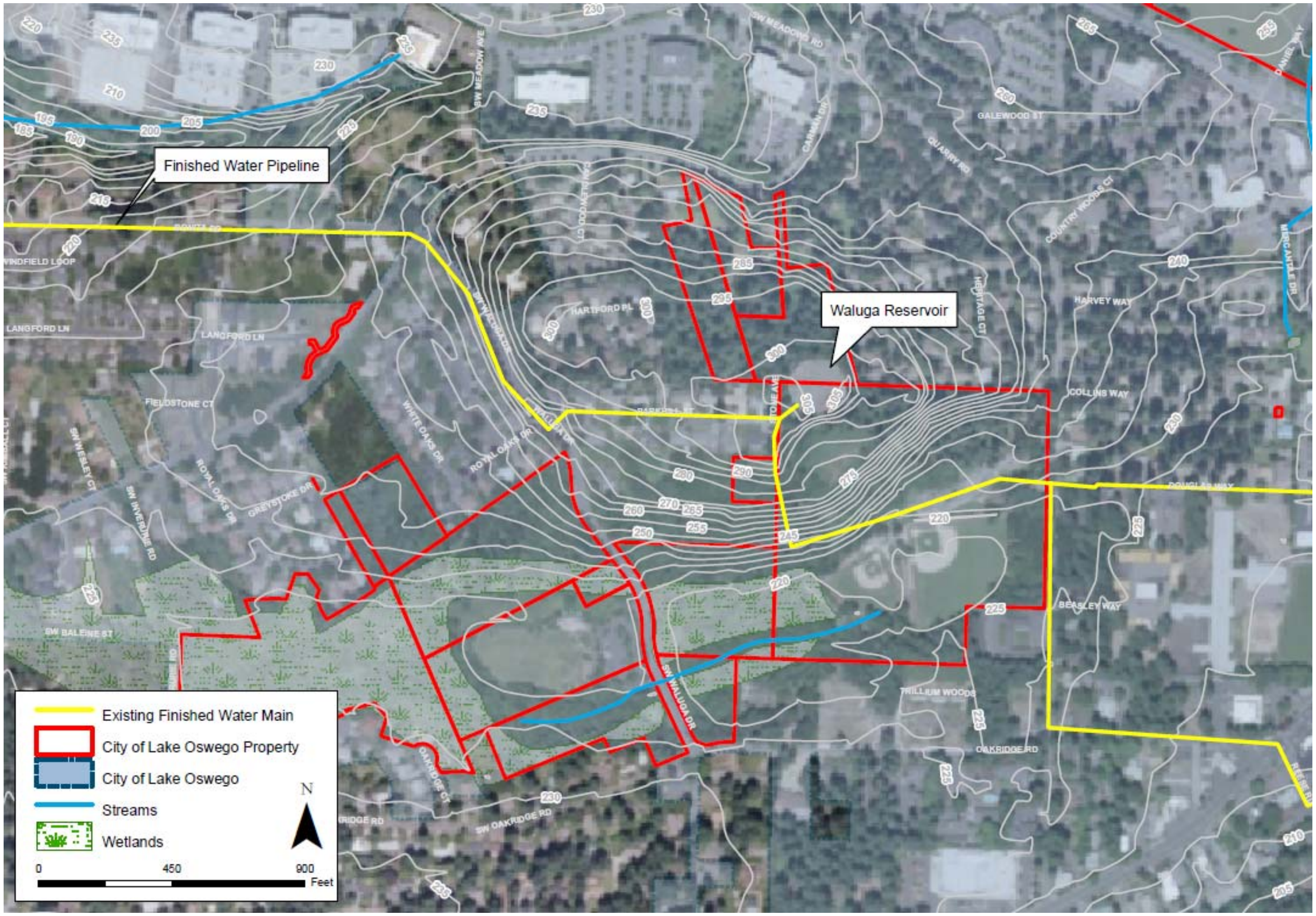
- 3.5 ~~6.0~~ MG prestressed concrete
- AWWA D110 Type 1
- AWWA D115 bid alternate
- 131’ ~~226’~~ internal diameter
- 37.5’ ~~22’~~ sidewall
- Self supporting dome roof ~~Flat column supported roof~~
- Adjacent to 4.0 MG WR1
- $7.3M construction bid ~~$10M+ construction cost~~

WR2 – Waluga Reservoir 2 Final Design

- 3.5 MG prestressed concrete
- AWWA D110 Type 1
- AWWA D115 bid alternate
- 131' internal diameter
- 37.5' sidewall
- Self supporting dome roof
- Adjacent to 4.0 MG WR1
- $7.3M construction bid

Waluga Reservoir Site

Waluga Reservoir Site



Storage Volume

Storage Myth – More storage is better; there's no such thing as too much storage.

- Lifecycle cost efficiency (capital and O&M costs)
- Footprint and siting challenges
- Neighborhood and visual impacts
- Land use and permitting challenges
- Tank circulation and turnover, water age, and water quality

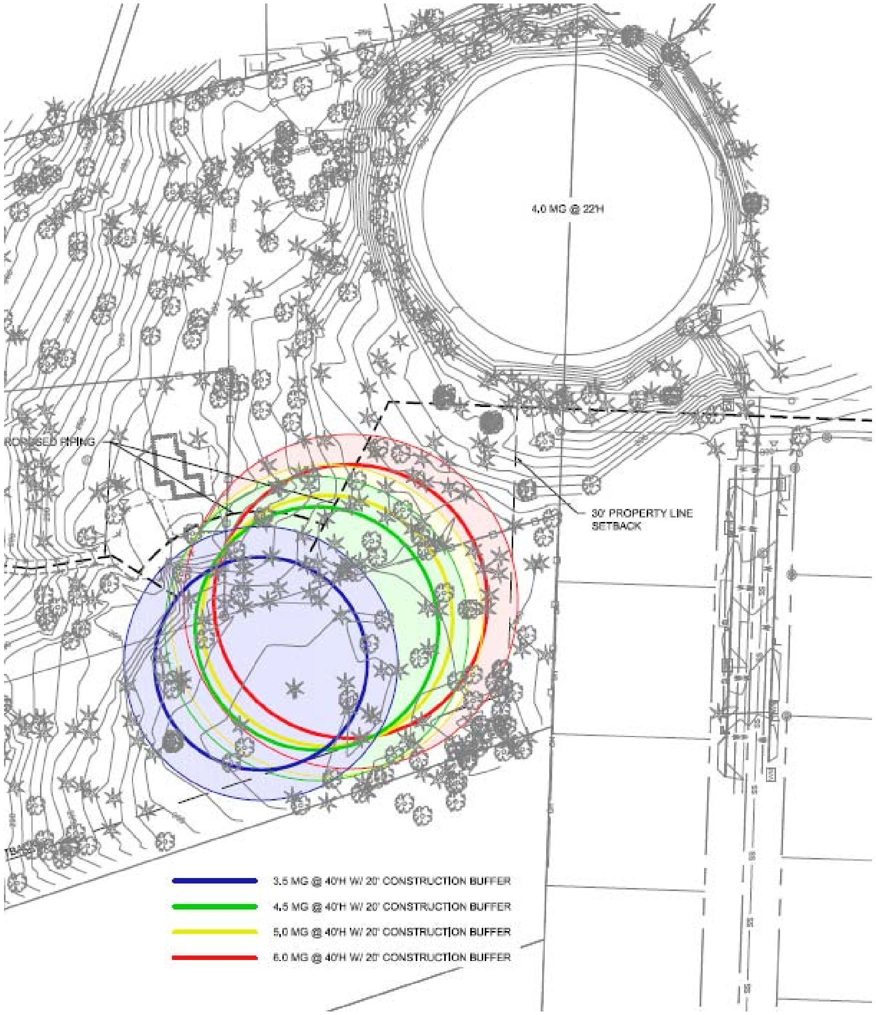
WR2 Storage Volume Criteria

• Equalizing	0.25 x Peak Day Demand
• Fire Flow	Maximum Fire Flow x Duration
• Emergency	2.0 x Average Day Demand
• Intertie Pumping	0.1 x Peak Pumping Capacity

WR2 Storage Volume Calculations

LOTWP Storage Volume Refinements	
Sizing Scenario	Storage Capacity Requirement
Initial Water Master Plan projections estimate (includes additional volume to replace aging 10th Street Tank storage tank)	6.0 MG
Fire flow storage reduced consistent with fire sprinkler system installations in Lake Oswego school buildings	5.0 MG
Emergency storage reduced consistent with likely future demand conservation	4.5 MG
1.0 MG of future Lake Oswego storage needs to be met via second future tank at existing Southside Reservoir site	3.5 MG

Benefits of Reduced WR2 Tank Volume



- Reduced cost
- Improved water circulation, turnover, age, and quality
- Reduced footprint
- Increased setbacks
- Increased tree retention and screening
- Reduced aesthetic and neighborhood impact

Storage Grade Lines and Integration

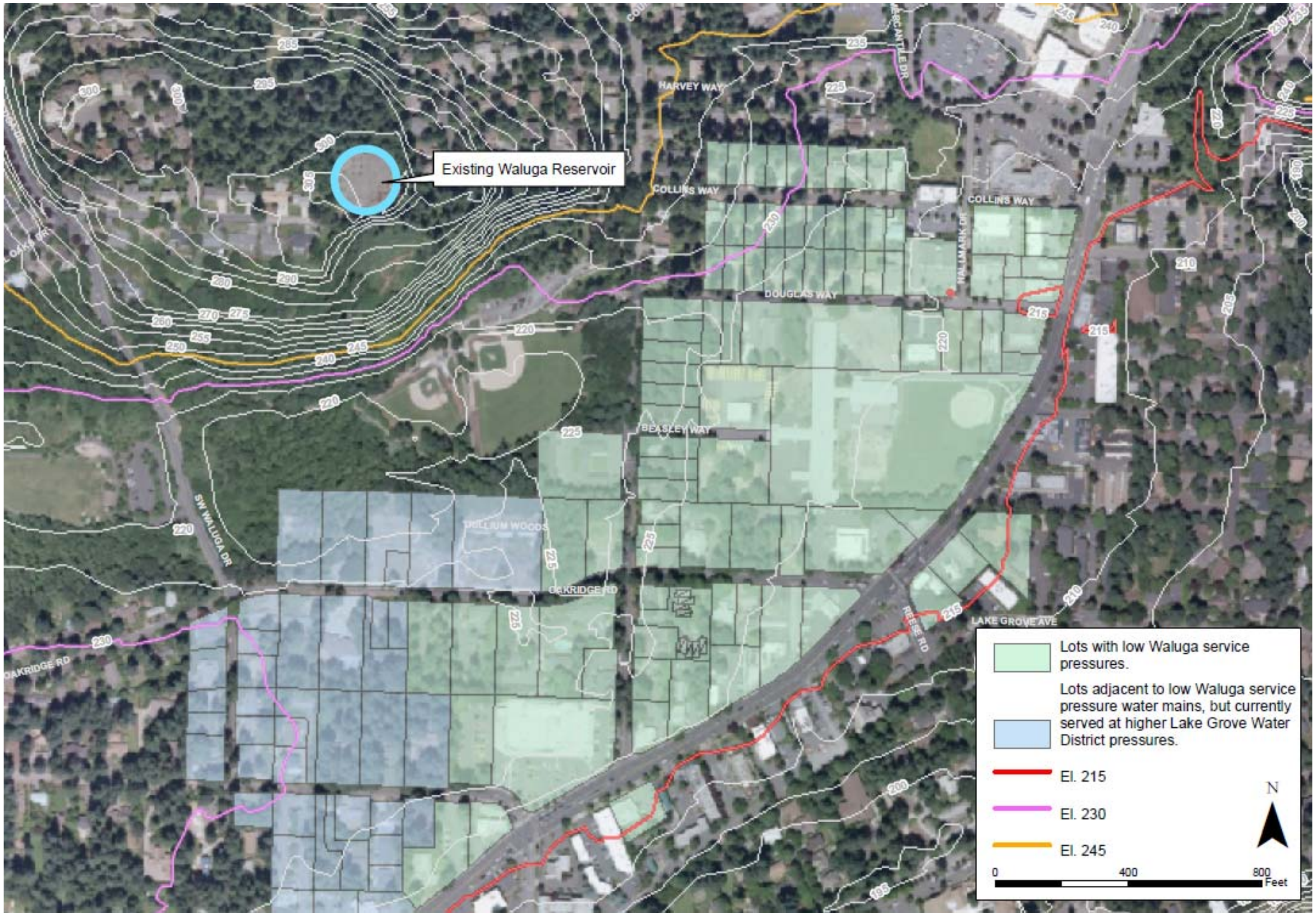
Storage Myth – Storage grade lines must be uniform.

- Overflow and water levels should be consistent
- Paired tanks should operate in parallel

WR2 Service Pressure Criteria

- Lake Oswego 40 psi minimum service pressure goal
- 322' WR1 maximum water service level
- Service elevations around WR1 range from 215' to 230'
- WR1 grade line must be at or above 322' (tank full) to maintain 40 psi pressure at upper service elevations

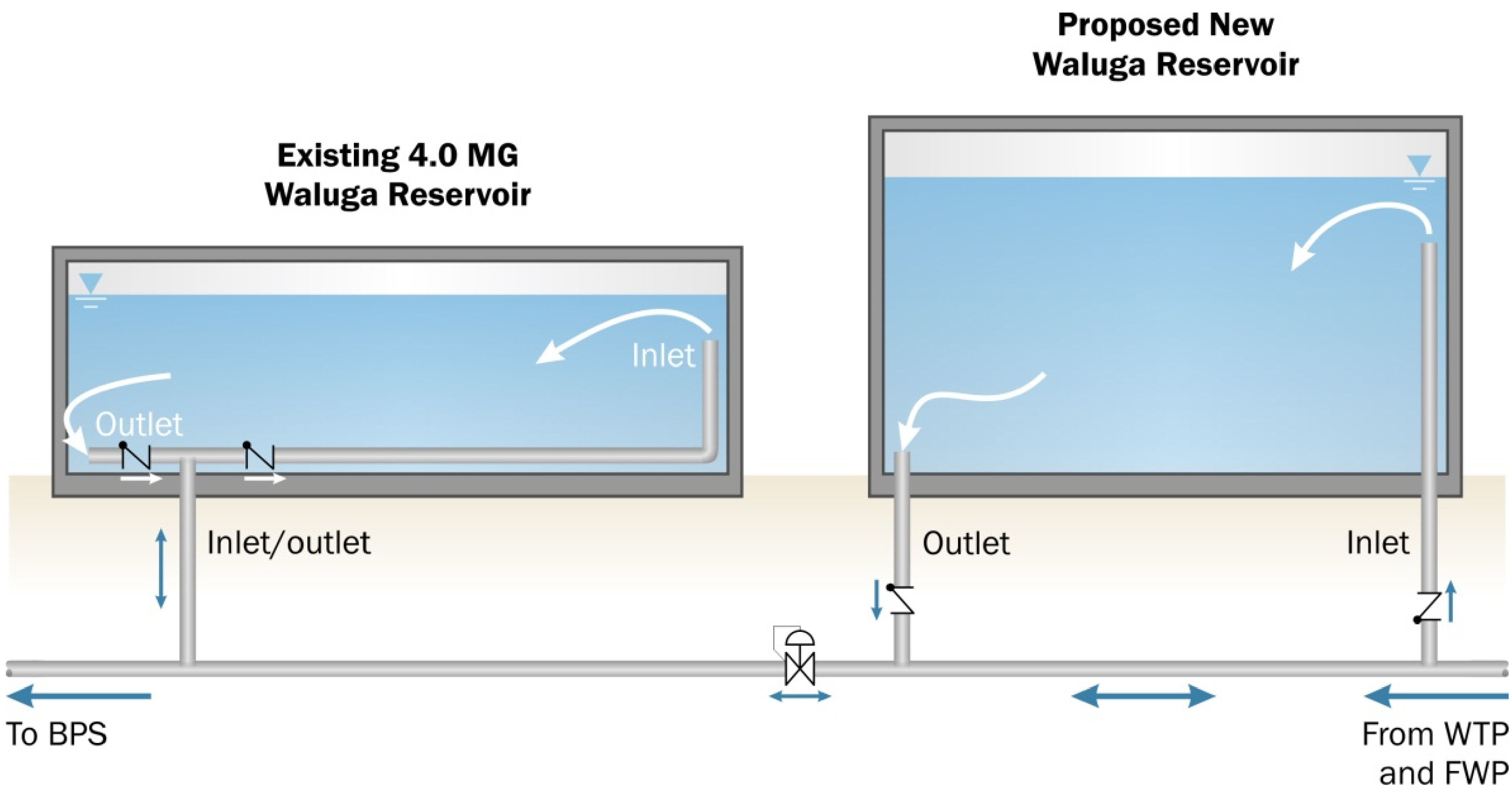
Waluga Low Pressure Areas



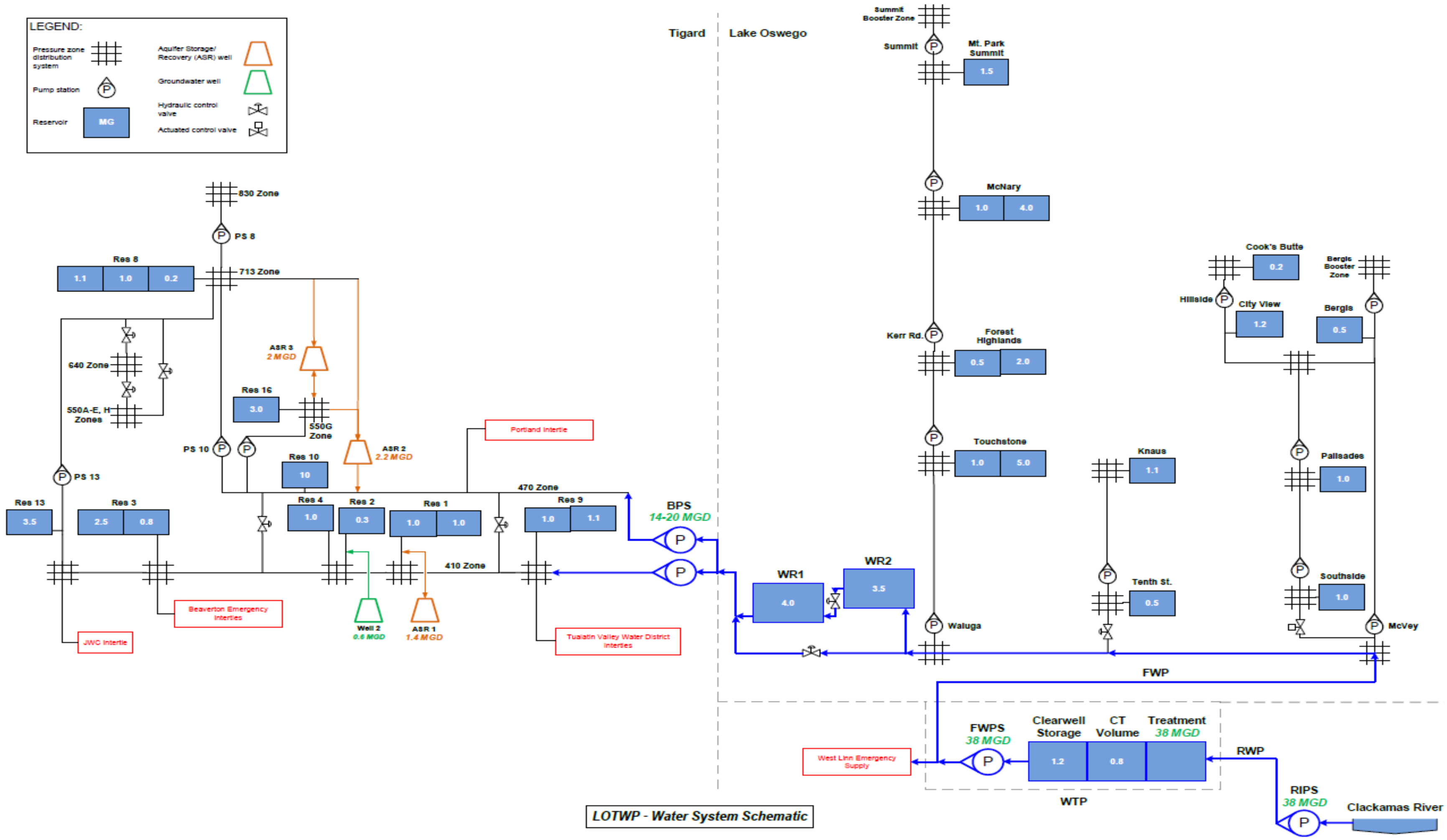
Pressure Improvement Alternatives

- Increase grade line
  - Construct taller WR2 with equalizing storage volume located above 322’ elevation
  - Flow in series from taller WR2 to lower WR1 to supply BPS and Tigard
  - Configure WR2 and WR1 to operate in parallel when WR2 water levels fall within WR1 range
- Revise pressure zone boundaries
  - Construct 0.6 miles of new 12” piping and 2 new PRV stations to shift low pressure areas into adjacent higher pressure Touchstone Regulated zone

WR2 Increased Grade Line Concept



LOTWP Water System Schematic

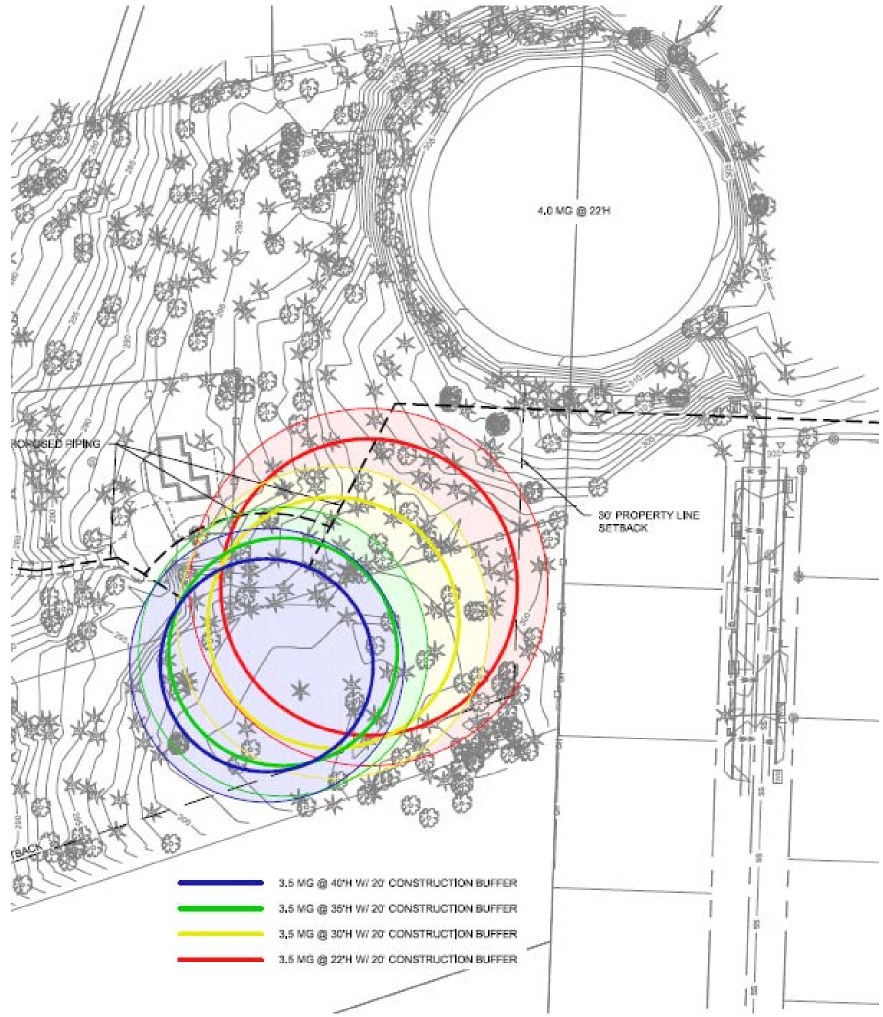


Pressure Improvement Alternative Comparison

Improve Service Pressures in Low Pressure Areas		
Relative Cost Elements	Increase Grade Line via Taller WR2	Revise Pressure Zone Boundaries
WR2 Capital Cost		$0.8M
Pressure Zone Improvements		$1.1M
Increased Pumping Costs (25 year lifecycle)	$0.9M	
Total Relative Costs	$0.9M	$1.9M

Benefits of Increased WR2 Height

- Reduced cost
- Good water circulation, turnover, age, and quality
- Reduced footprint
- Increased setbacks
- Increased tree retention and screening
- Reduced aesthetic and neighborhood impact

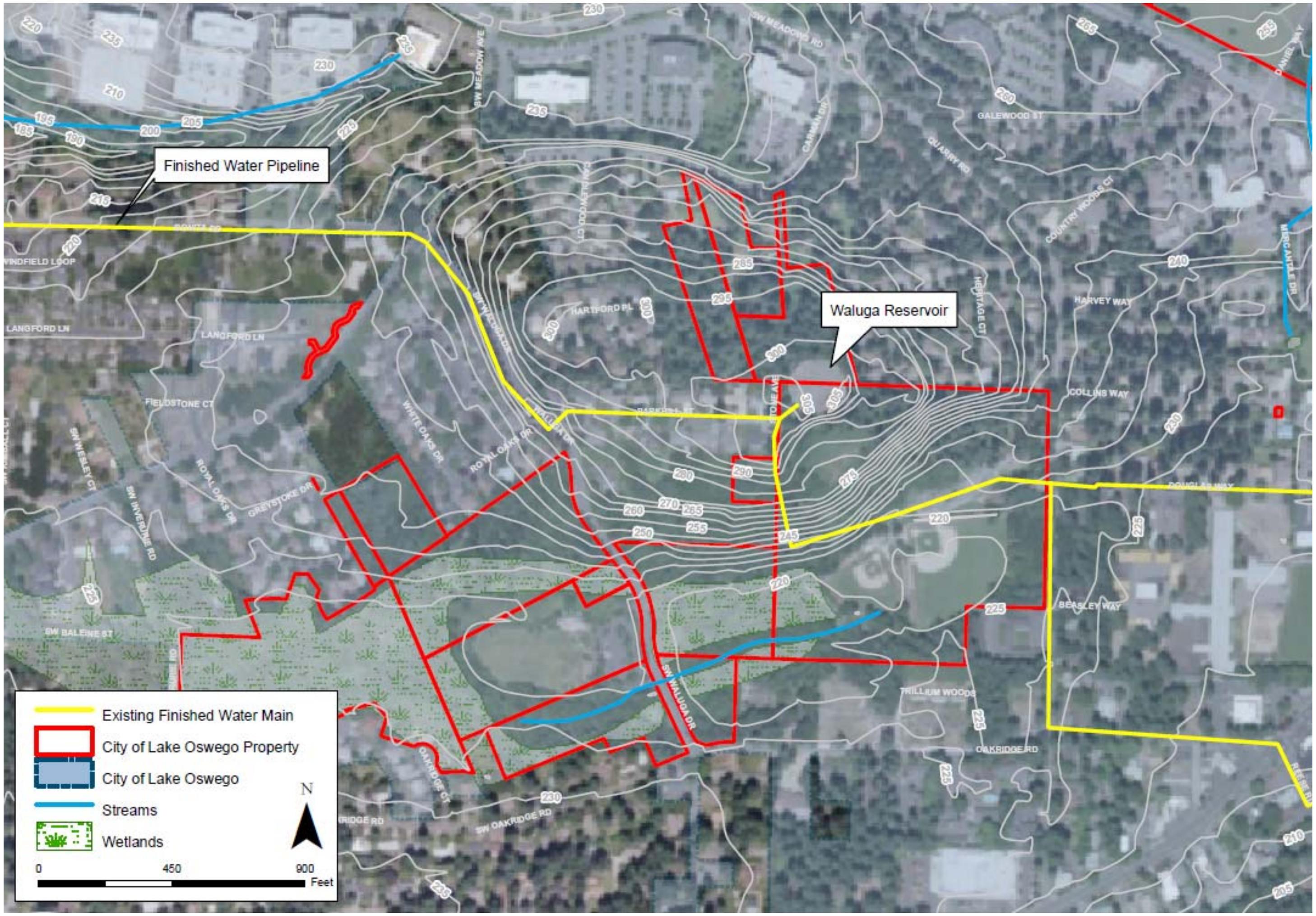


Storage Site Selection

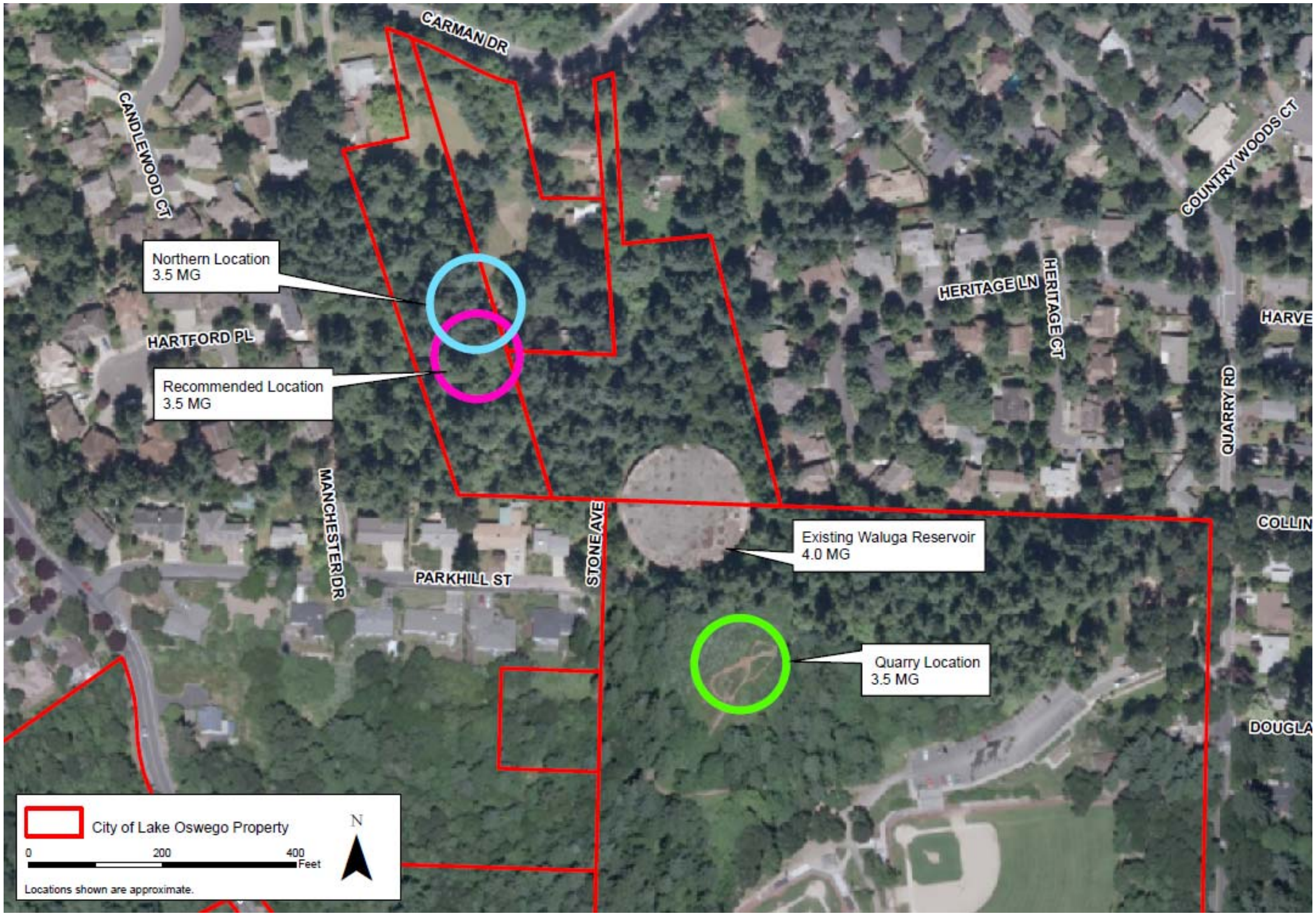
Storage Myth – Tanks are good neighbors, thus tanks make welcome neighbors.

- “Not in my backyard” attitudes
- Construction disturbance
- Aesthetic and visual impacts
- Seismic and flooding concerns
- Overflow routing
- Land use and permitting requirements

Waluga Reservoir Site

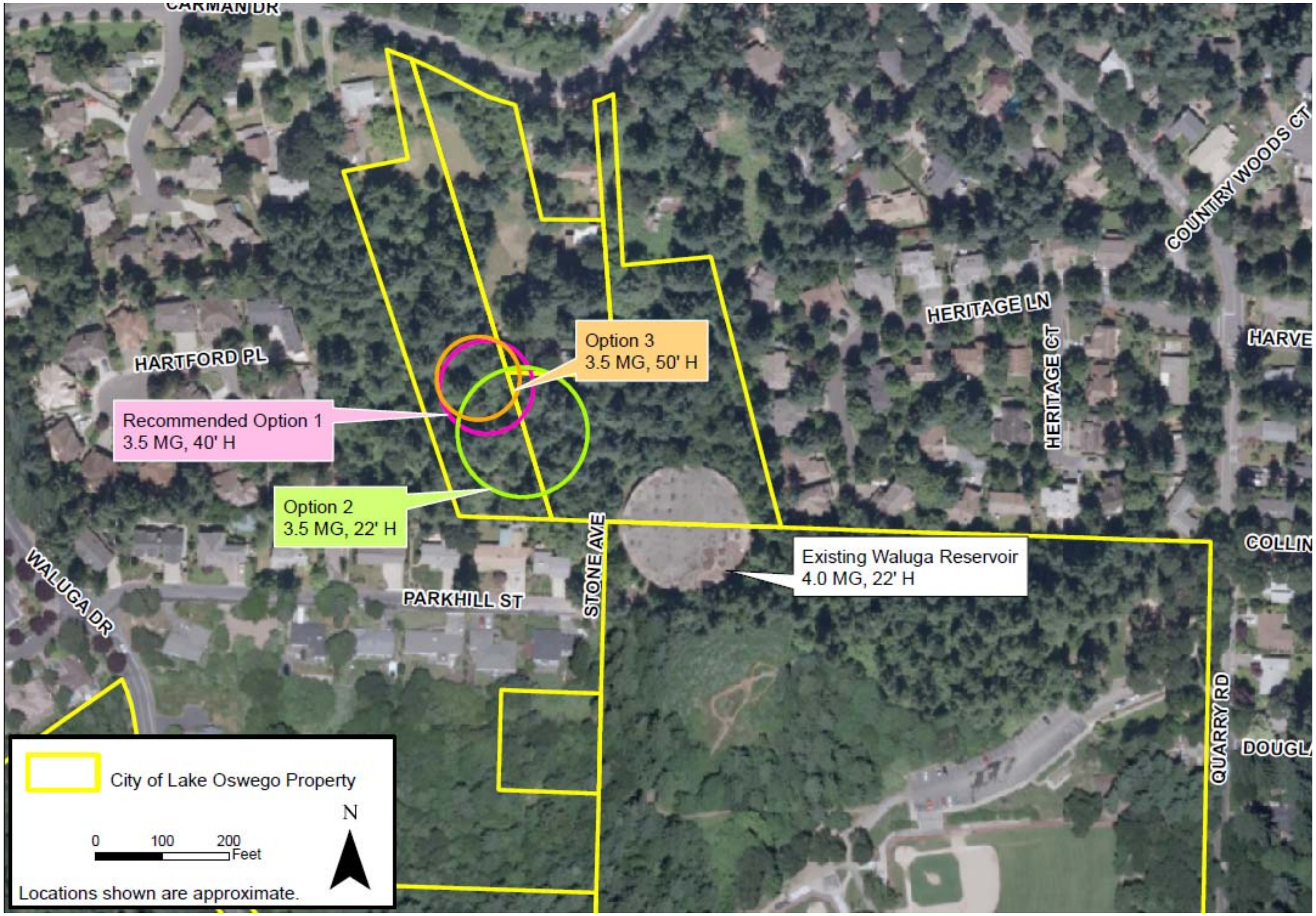


Initial Waluga Storage Siting Options



Alternate 10th Street Storage Siting Options

Refined Waluga Storage Siting Options



Storage Siting Options Analysis

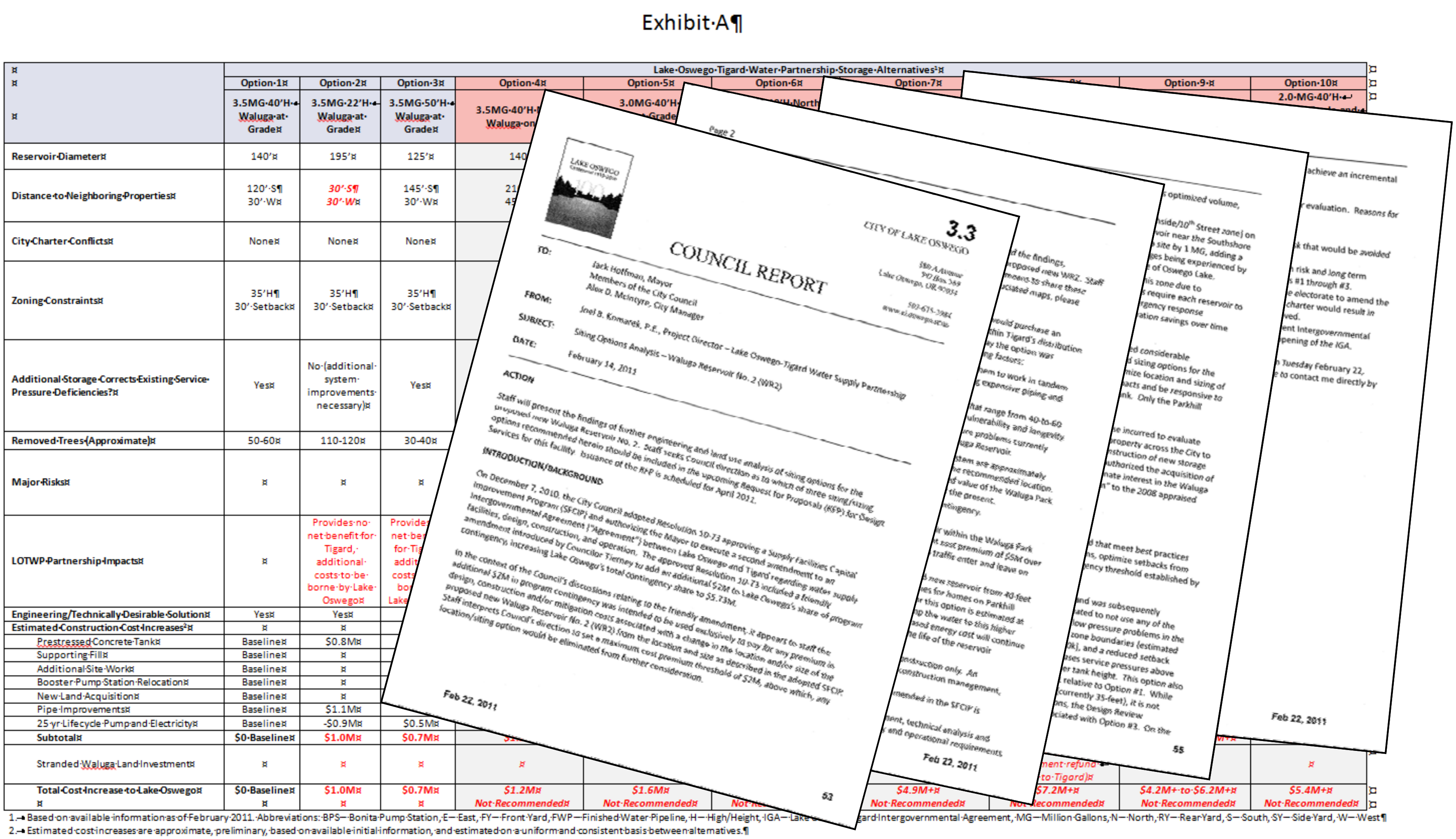


Exhibit A

Lake Oswego Tigard Water Partnership Storage Alternatives[1]

	Option 1	Option 2	Option 3
	3.5MG 40'H Waluga at Grade	3.5MG 22'H Waluga at Grade	3.5MG 50'H Waluga at Grade
Reservoir Diameter	140'	195'	125'
Distance to Neighboring Properties	120' S 30' W	*30' S* *30' W*	145' S 30' W
City Charter Conflicts	None	None	None
Zoning Constraints	35'H 30' Setback	35'H 30' Setback	35'H 30' Setback
Additional Storage Corrects Existing Service Pressure Deficiencies?	Yes	No (additional system improvements necessary)	Yes
Removed Trees (Approximate)	50-60	110-120	30-40
Major Risks			
LOTWP Partnership Impacts		Provides no net benefit for Tigard, additional costs to be borne by Lake Oswego	[illegible] net be[illegible] for Ti[illegible] addit[illegible] costs [illegible] bo[illegible] Lake [illegible]
Engineering/Technically Desirable Solution	Yes	Yes	[illegible]
Estimated Construction Cost Increases[2]			[illegible]
Prestressed Concrete Tank	Baseline	$0.8M	[illegible]
Supporting Fill	Baseline		[illegible]
Additional Site Work	Baseline		[illegible]
Booster Pump Station Relocation	Baseline		[illegible]
New Land Acquisition	Baseline		[illegible]
Pipe Improvements	Baseline	$1.1M	[illegible]
25 yr Lifecycle Pump and Electricity	Baseline	-$0.9M	$0.5M
Subtotal	**$0 Baseline**	**$1.0M**	**$0.7M**
Stranded Waluga Land Investment			
Total Cost Increase to Lake Oswego	**$0 Baseline**	**$1.0M**	**$0.7M**

	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9	Option 10
	3.5MG 40'H [illegible] Waluga on [illegible]	3.0MG 40'H [illegible] Grade [illegible]	[illegible] North [illegible]	[illegible]	[illegible]	[illegible]	2.0 MG 40'H [illegible]
Stranded Waluga Land Investment					[illegible]ment refund to Tigard)		
Total Cost Increase to Lake Oswego	*$1.2M* *Not Recommended*	*$1.6M* *Not Recommended*	[illegible] *Not Re[illegible]*	*$4.9M+* *Not Recommended*	*$7.2M+* *Not Recommended*	*$4.2M+ to $6.2M+* *Not Recommended*	*$5.4M+* *Not Recommended*

1. Based on available information as of February 2011. Abbreviations: BPS—Bonita Pump Station, E—East, FY—Front Yard, FWP—Finished Water Pipeline, H—High/Height, IGA—Lake [illegible] [illegible]gard Intergovernmental Agreement, MG—Million Gallons, N—North, RY—Rear Yard, S—South, SY—Side Yard, W—West
2. Estimated cost increases are approximate, preliminary, based on available initial information, and estimated on a uniform and consistent basis between alternatives.

3.3

COUNCIL REPORT

CITY OF LAKE OSWEGO

TO: Jack Hoffman, Mayor; Members of the City Council; Alex D. McIntyre, City Manager

FROM: Joel B. Komarek, P.E., Project Director – Lake Oswego-Tigard Water Supply Partnership

SUBJECT: Siting Options Analysis – Waluga Reservoir No. 2 (WR2)

DATE: February 14, 2011

ACTION

Staff will present the findings of further engineering and land use analysis of siting options for the proposed new Waluga Reservoir No. 2. Staff seeks Council direction as to which of three siting/sizing options recommended herein should be included in the upcoming Request for Proposals (RFP) for Design Services for this facility. Issuance of the RFP is scheduled for April 2011.

INTRODUCTION/BACKGROUND

On December 7, 2010, the City Council adopted Resolution 10-73 approving a Supply Facilities Capital Improvement Program (SFCIP) and authorizing the Mayor to execute a second amendment to an Intergovernmental Agreement ("Agreement") between Lake Oswego and Tigard regarding water supply facilities, design, construction, and operation. The approved Resolution 10-73 included a friendly amendment introduced by Councilor Tierney to add an additional $2M to Lake Oswego's share of program contingency increasing Lake Oswego's total contingency share to $5.73M.

In the context of the Council's discussions relating to the friendly amendment, it appears to staff the additional $2M in program contingency was intended to be used exclusively to pay for any premium in design, construction and/or mitigation costs associated with a change in the location and/or size of the proposed new Waluga Reservoir No. 2 (WR2) from the location and size as described in the adopted SFCIP. Staff interprets Council's direction to set a maximum cost premium threshold of $2M, above which, any location/siting option would be eliminated from further consideration.

Feb 22, 2011

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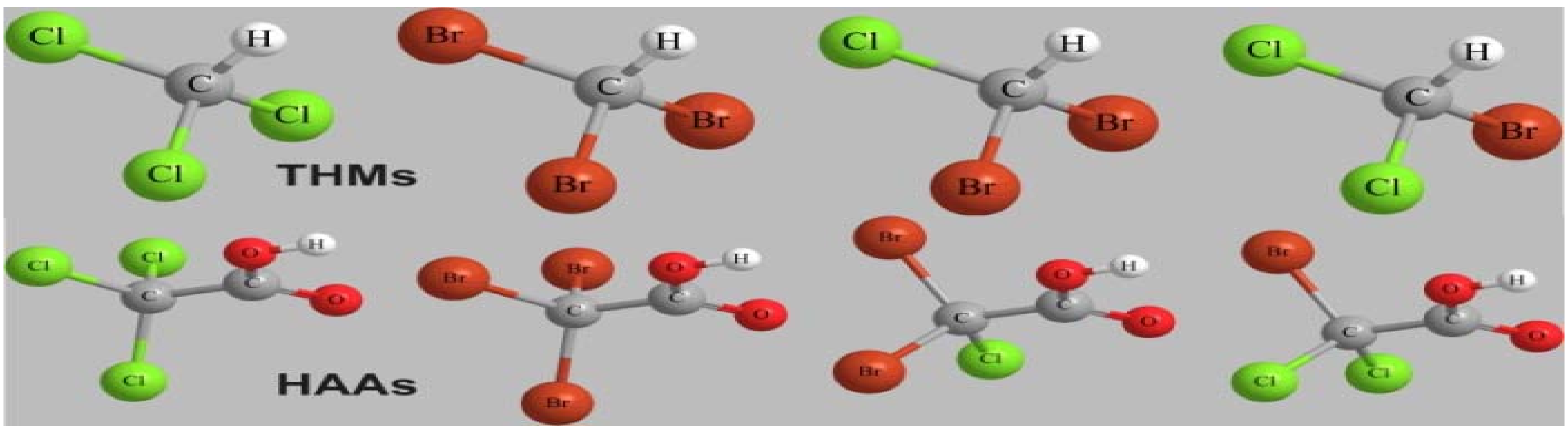
Final WR2 Site Selection

Water Quality Management

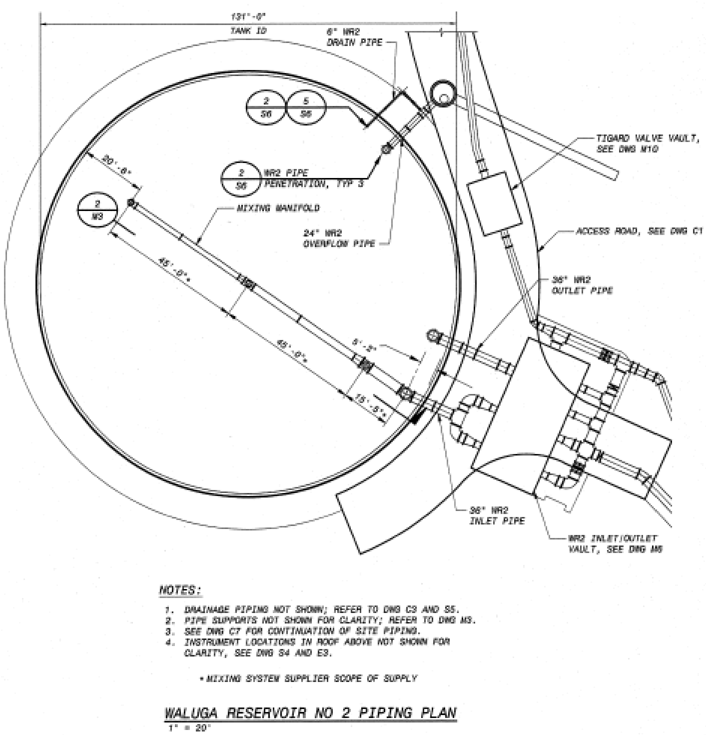
Storage Myth – Water supply and treatment drives water quality; the effect of storage on water quality is minimal.

- Flow circulation and mixing vs. water age
- Disinfection residual maintenance
- Disinfection byproduct formation

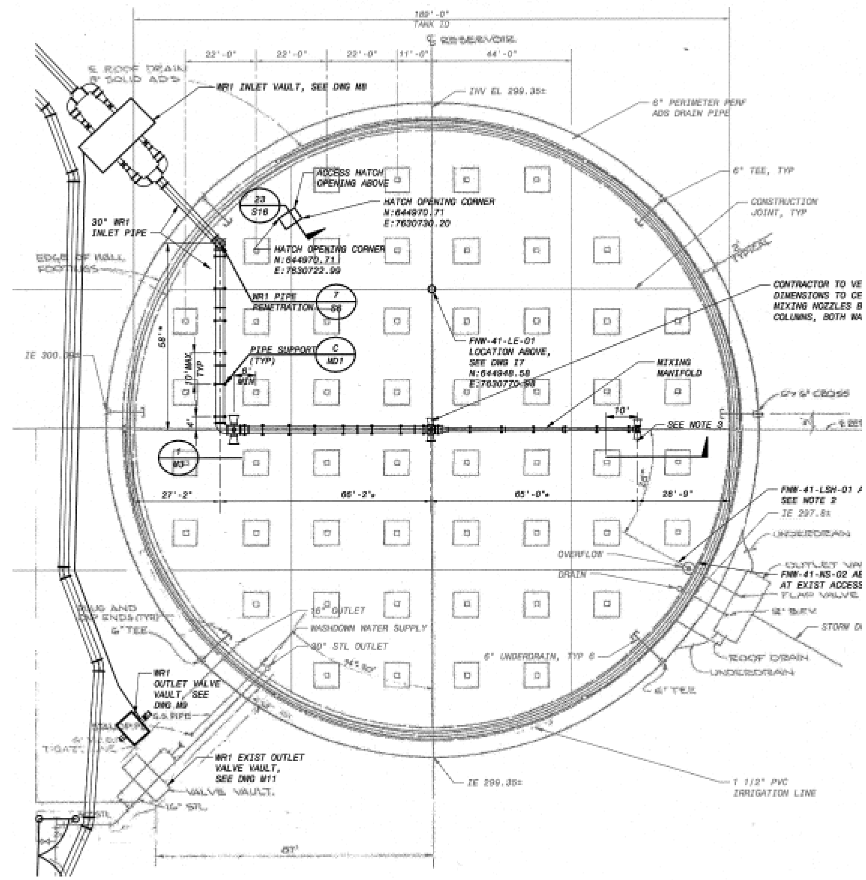


Inlet Mixing Manifold Systems Reduce Stored Water Age

WR2



WR1 Retrofit



LOTWP and WR2 Supply Solutions Improve Water Quality

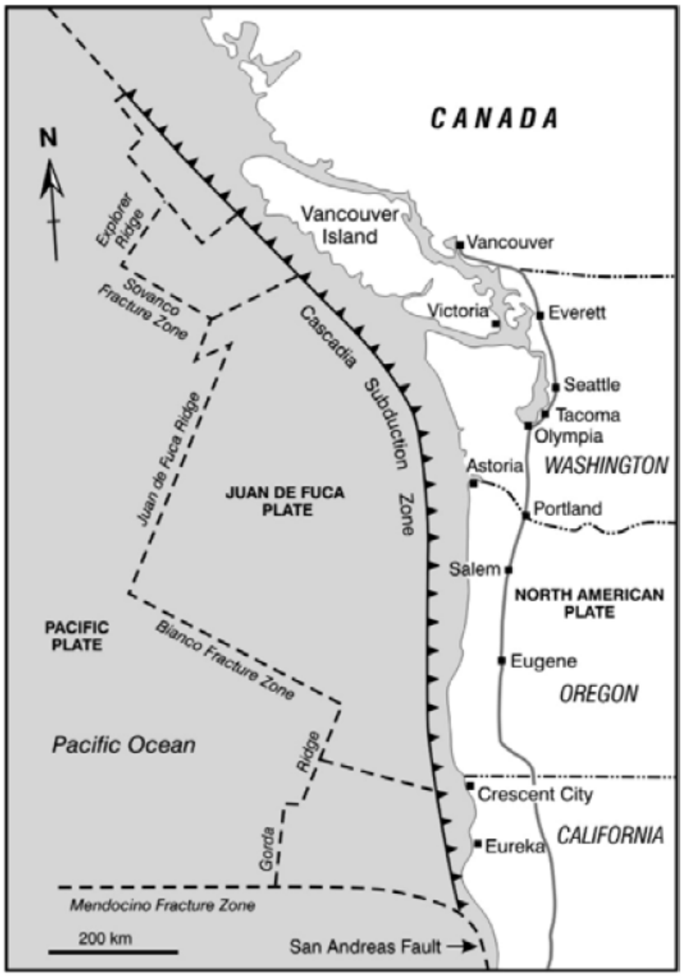
Stored Water Age Hydraulic Modeling Simulations		
Scenario	WR2 Water Age	WR1 Water Age
Peak Day Demand		
• Existing System		20+ days
• LOTWP System	Less than 2 days	Less than 4 days
Critical Water Quality Month		
• Existing System		30+ days
• LOTWP System	Less than 2 days	Less than 10 days

Storage Flexibility and Resiliency

Storage Myth – Storage tank projects are simple.

- Seismic and system resiliency
- Project cost controls and risks
- Operational flexibility
- Varied demands and operating modes

Pacific Northwest Seismic Risk

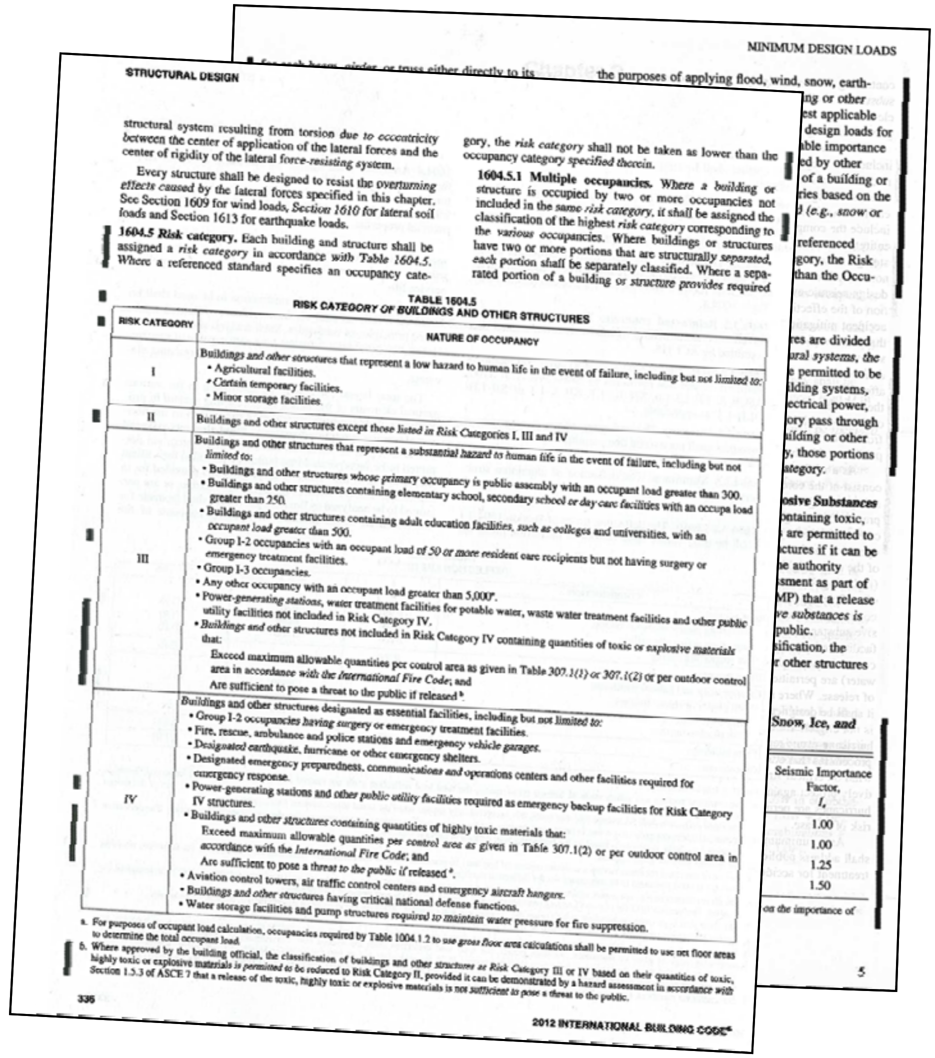


Source: Adapted from the Cascadia Region Earthquake Workgroup (2005)

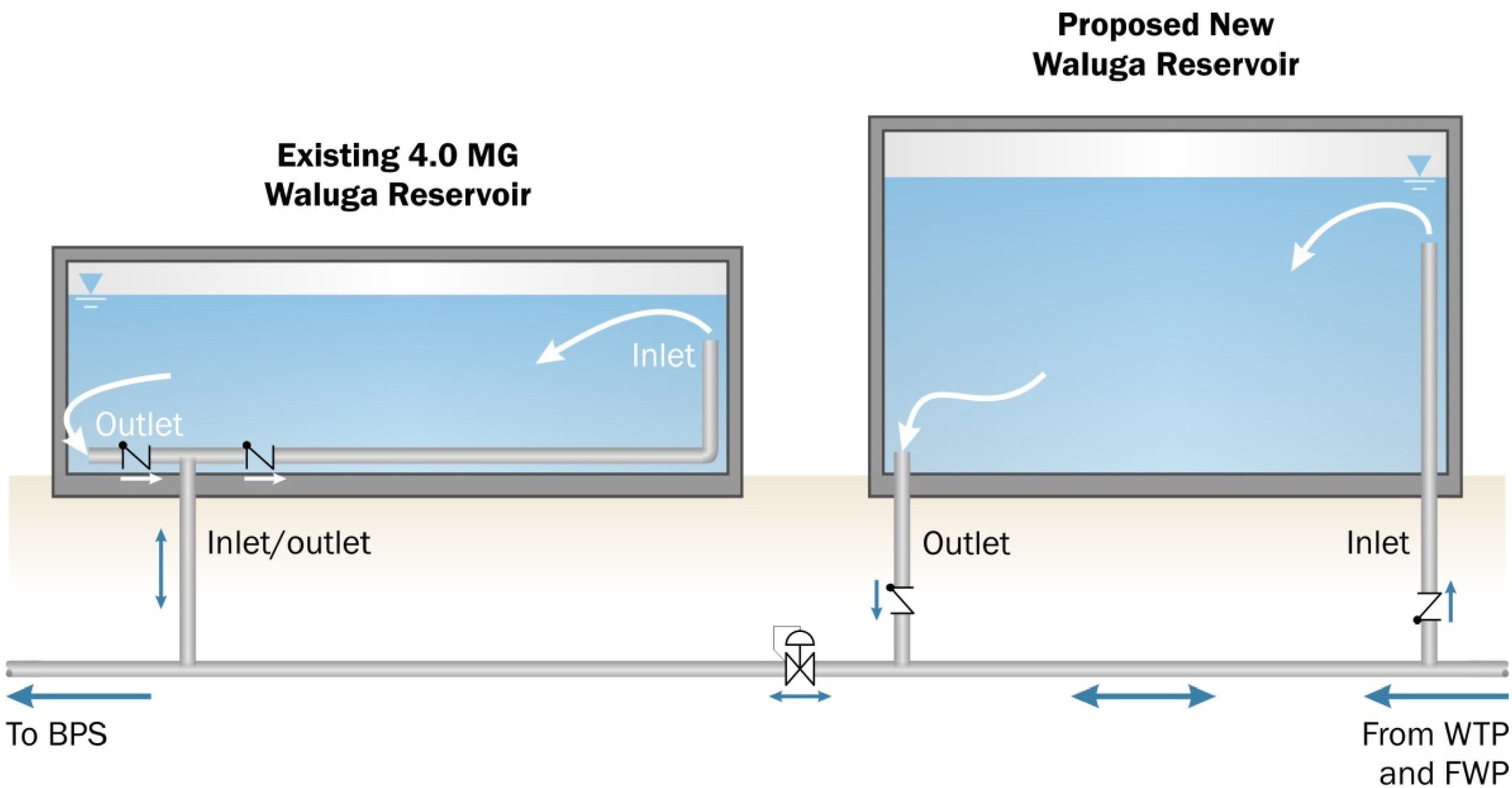
- Cascadia Subduction Zone
  - Magnitude 8.0+ earthquakes
  - 250 year recurrence interval across last 10,000 years
  - Last major event 314 years ago…
- Local Faults
  - Magnitude 6.5+ earthquakes
- Maximum Credible Earthquake (MCE)
  - Largest event expected within a 2,500 year recurrence interval
  - Magnitude 9.0 earthquakes

WR2 Seismic and System Resiliency

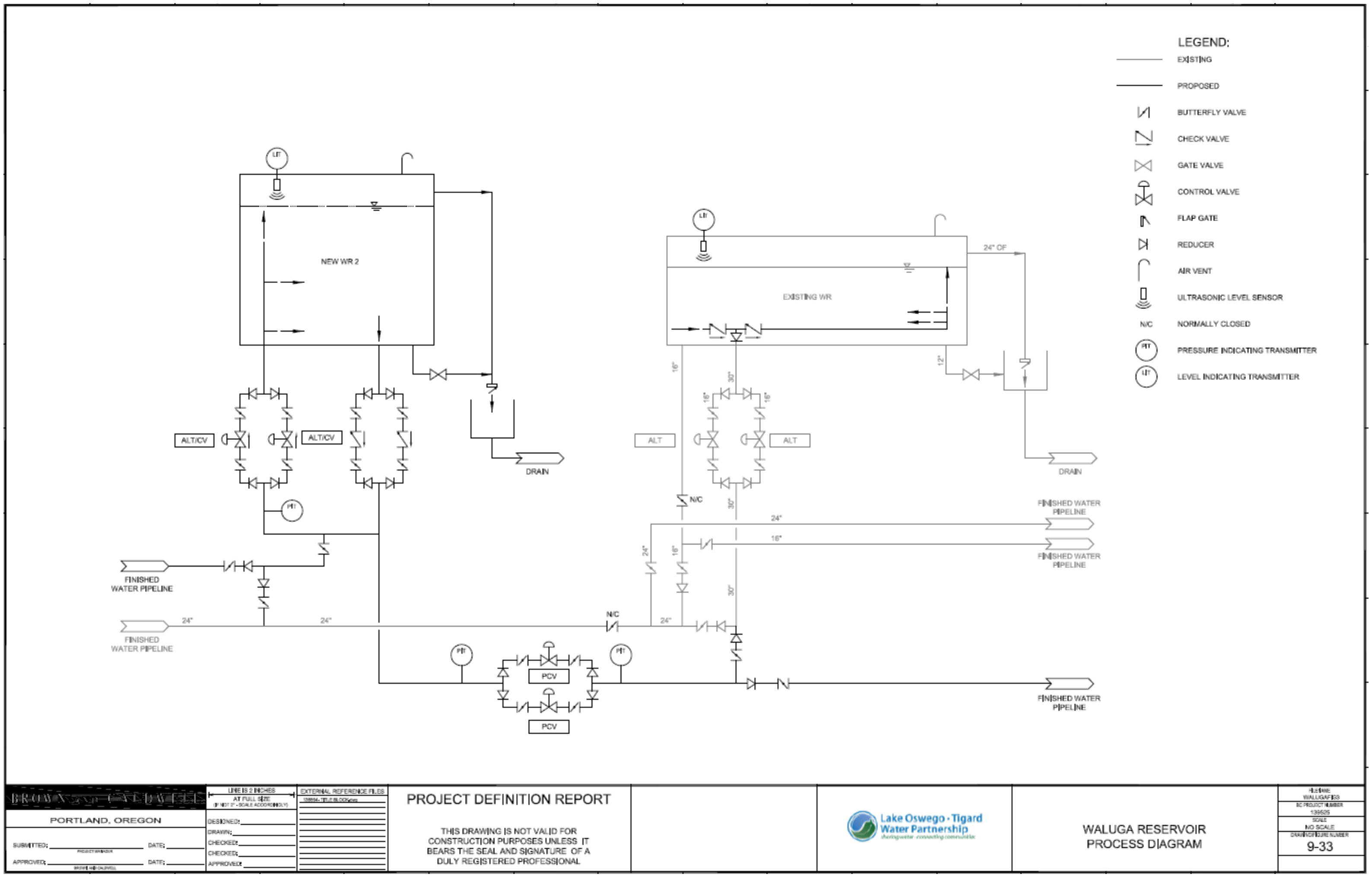
- Structural Design
  - IBC Risk Category IV
  - Seismic Importance Factor = 1.5
  - AWWA D110/D115 bid alternates
- Hydraulic Design
  - Valving and controls for multiple operating modes
  - Seismic valve and tank isolation
  - Restrained joint piping



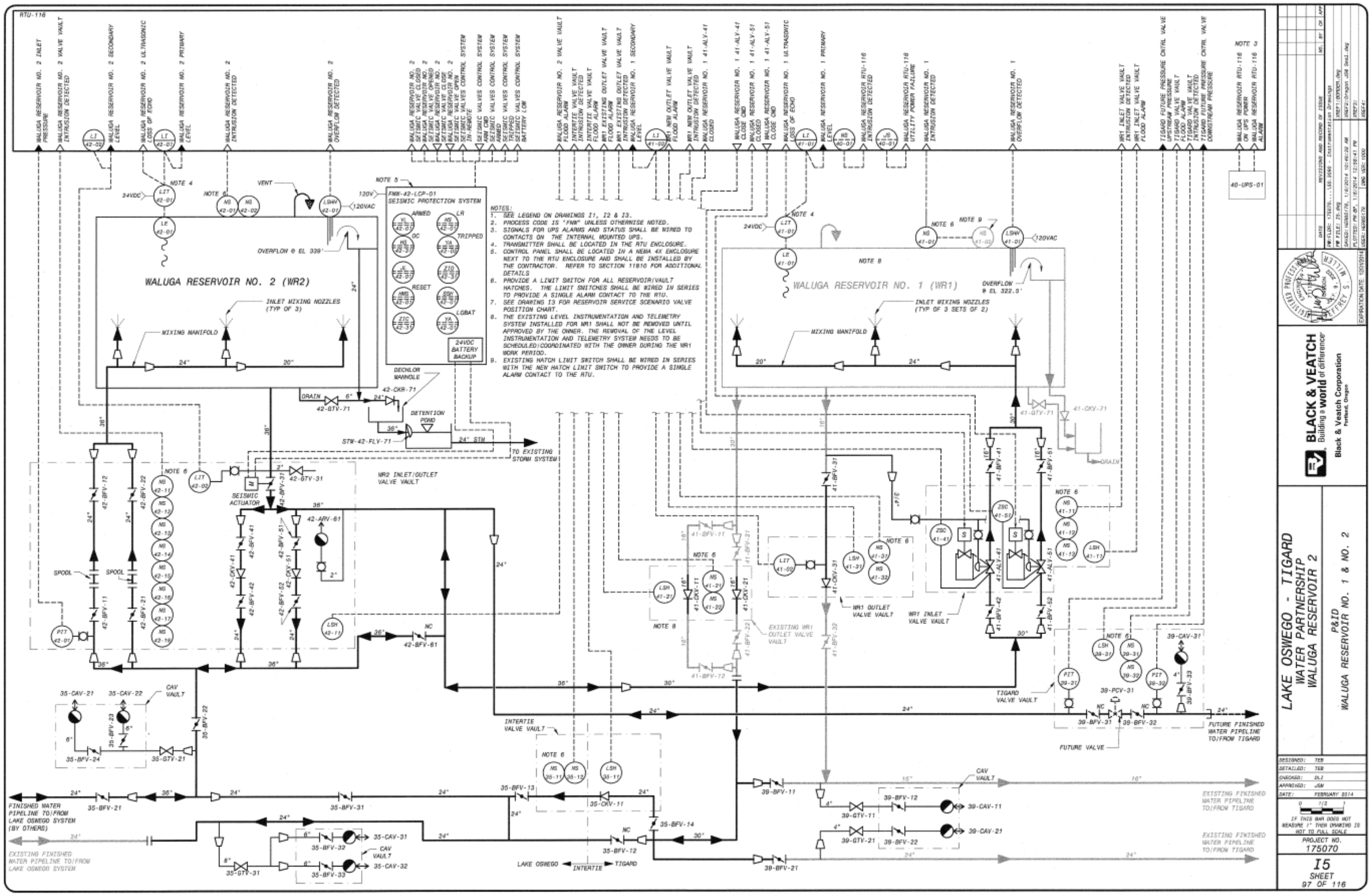
WR2 Predesign Concept



Process and Instrumentation Concept



Process and Instrumentation Design

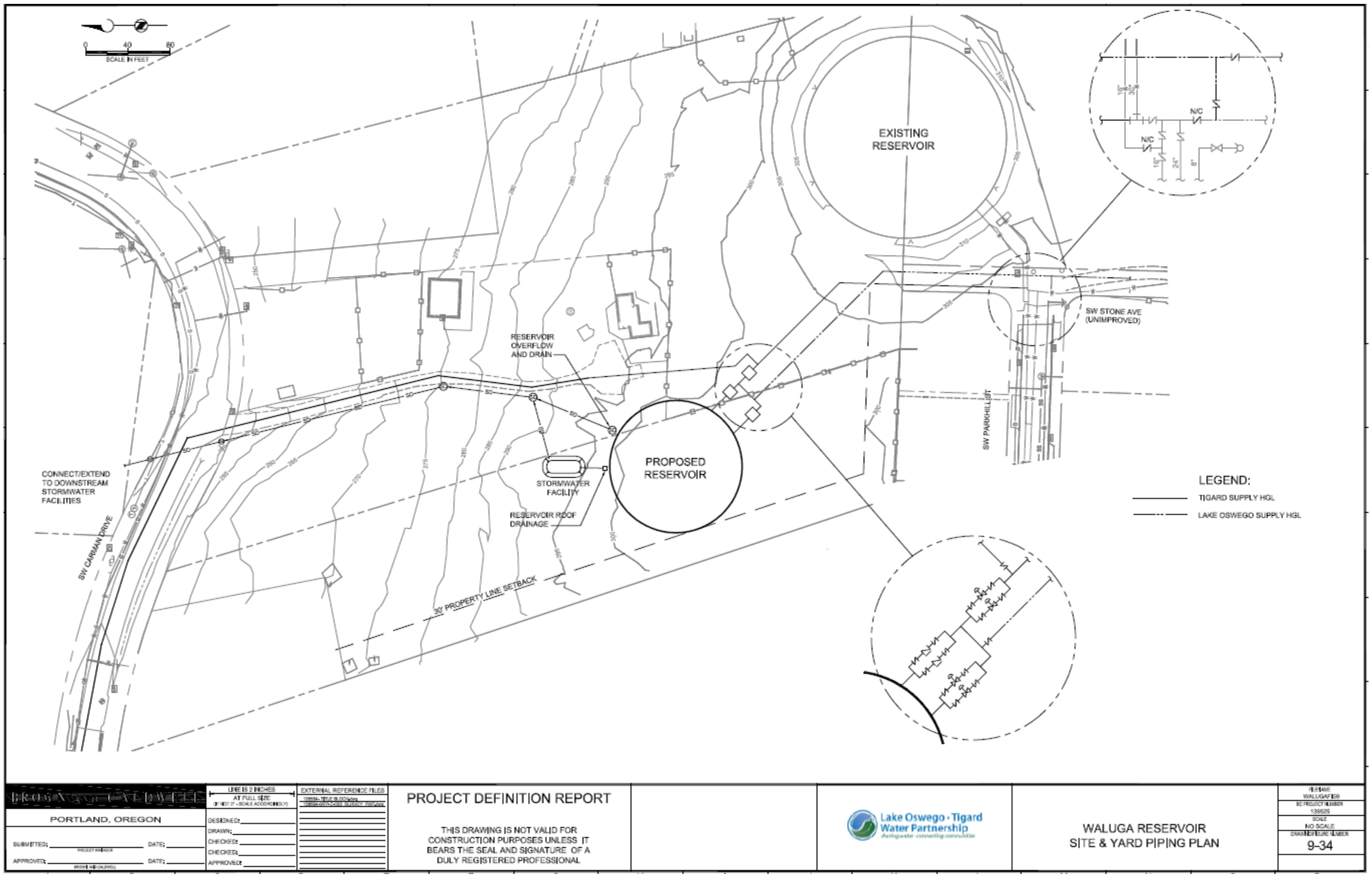


WR2 Operating Mode Flexibility

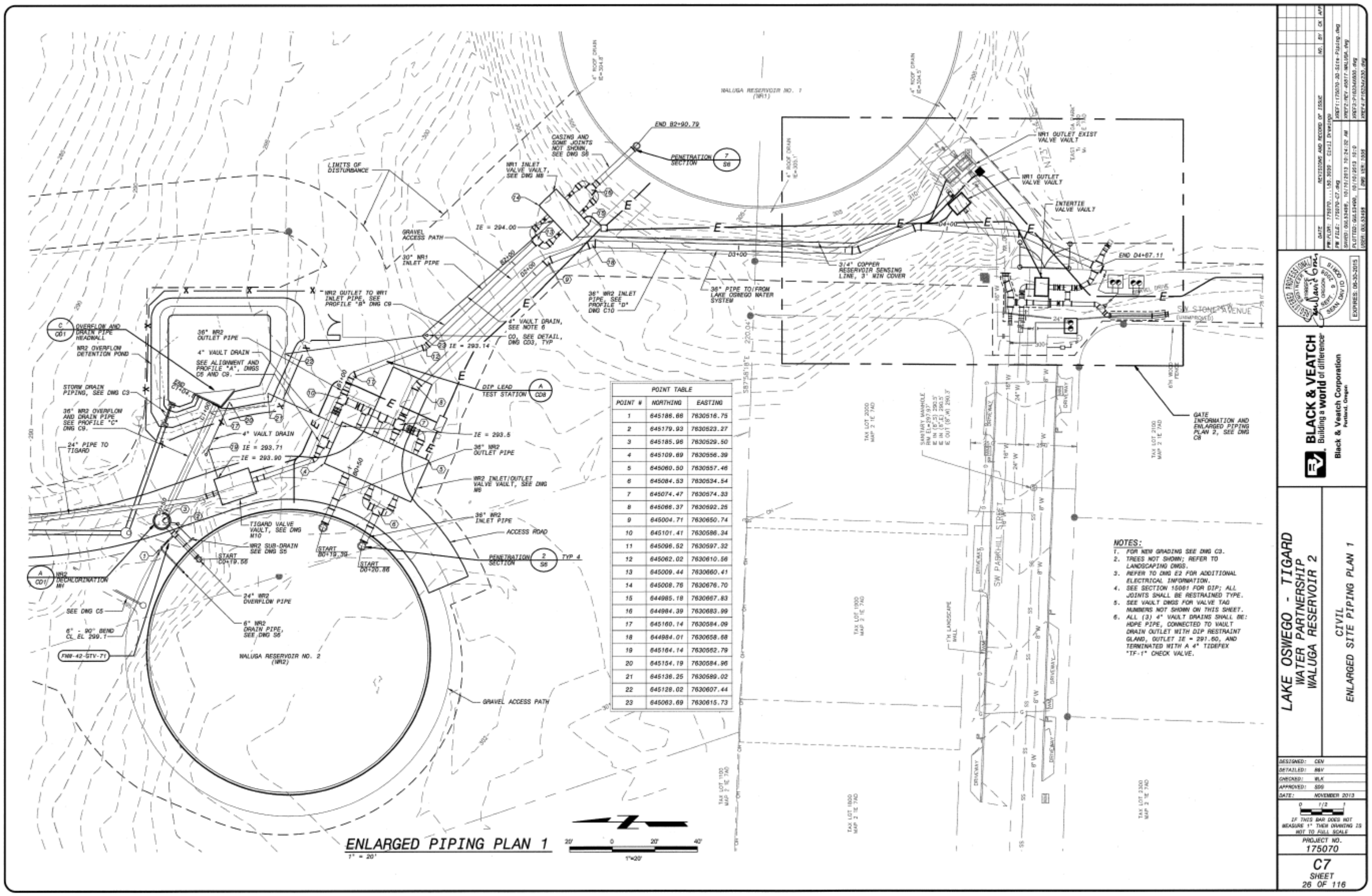
Waluga Reservoir Service Scenario Valve Position Chart (NOT INTENDED FOR CONSTRUCTION PURPOSES)							
Valve Description	Valve Tag	Reservoir No. 1 & No. 2 In-Service	Only Reservoir No. 1 In-Service	Only Reservoir No. 2 In-Service	Both Reservoirs Out-Of-Service Supply From Lake Oswego to Tigard	Both Reservoirs Out-Of-Service Supply From Tigard to Lake Oswego	Only Reservoir No. 2 In-Service Supply From Tigard to Lake Oswego
Existing supply line isolation valve	35-BFV-11	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
New supply line isolation valve	35-BFV-21	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
Cross connection between supply lines isolation valve	35-BFV-31	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
Reservoir No. 1 & No. 2 supply isolation valve	35-BFV-22	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
Reservoir No. 2 inlet spool piece 1 up isolation valve - Potentially Future	42-BFV-11	OPEN	CLOSED	OPEN	CLOSED	CLOSED	OPEN
Reservoir No. 2 inlet spool piece 1 down isolation valve - Potentially Future	42-BFV-12	OPEN	CLOSED	OPEN	CLOSED	CLOSED	OPEN
Reservoir No. 2 inlet spool piece 2 up isolation valve - Potentially Future	42-BFV-21	OPEN	CLOSED	OPEN	CLOSED	CLOSED	OPEN
Reservoir No. 2 inlet spool piece 2 down isolation valve - Potentially Future	42-BFV-22	OPEN	CLOSED	OPEN	CLOSED	CLOSED	OPEN
Reservoir No. 2 outlet isolation valve	42-BFV-31	OPEN	CLOSED	OPEN	CLOSED	CLOSED	OPEN
Reservoir No. 2 outlet check valve 1 up isolation valve	42-BFV-41	OPEN	CLOSED	OPEN	CLOSED	CLOSED	OPEN
Reservoir No. 2 outlet check valve 1 down isolation valve	42-BFV-42	OPEN	CLOSED	OPEN	CLOSED	CLOSED	OPEN
Reservoir No. 2 outlet check valve 2 up isolation valve	42-BFV-51	OPEN	CLOSED	OPEN	CLOSED	CLOSED	OPEN
Reservoir No. 2 outlet check valve 2 down isolation valve	42-BFV-52	OPEN	CLOSED	OPEN	CLOSED	CLOSED	OPEN
Reservoir No. 2 isolation valve between inlet and outlet	42-BFV-61	CLOSED	OPEN	CLOSED	CLOSED	CLOSED	OPEN
Reservoir No. 1 outlet 1 isolation 1 valve	41-BFV-11	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
Reservoir No. 1 outlet 1 isolation 2 valve	41-BFV-12	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
Reservoir No. 1 outlet 2 isolation 1 valve	41-BFV-21	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
Reservoir No. 1 outlet 2 isolation 2 valve	41-BFV-22	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
Reservoir No. 1 outlet check valve up isolation valve	42-BFV-31	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
Reservoir No. 1 outlet check valve down isolation valve	42-BFV-32	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
Reservoir No. 1 inlet altitude valve 1 up isolation valve	41-BFV-41	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
Reservoir No. 1 inlet altitude valve 1 down isolation valve	41-BFV-42	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
Reservoir No. 1 inlet altitude valve 2 up isolation valve	41-BFV-51	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
Reservoir No. 1 inlet altitude valve 2 down isolation valve	41-BFV-52	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
Lake Oswego & Tigard Intertie - isolation valve	35-BFV-12	CLOSED	CLOSED	CLOSED	OPEN	CLOSED	OPEN
Lake Oswego & Tigard Intertie - check valve up isolation valve	35-BFV-13	OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN
Lake Oswego & Tigard Intertie - check valve down isolation valve	35-BFV-14	OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN
Existing 16" supply to/from Tigard Isolation Valve	39-BFV-11	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
Existing 24" supply to/from Tigard Isolation Valve	39-BFV-21	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
New 24" supply to/from Tigard future PCV up Isolation Valve	39-BFV-31	OPEN*	OPEN*	OPEN*	CLOSED	CLOSED	OPEN*
New 24" supply to/from Tigard future PCV down Isolation Valve	39-BFV-32	OPEN*	OPEN*	OPEN*	CLOSED	CLOSED	OPEN*
Reservoir No. 1 Inlet Altitude Valve 1	41-ALV-41	HYDRAULIC CONTROL	LOCKED OPEN	N/A	N/A	N/A	N/A
Reservoir No. 1 Inlet Altitude Valve 2	41-ALV-51	HYDRAULIC CONTROL	LOCKED OPEN	N/A	N/A	N/A	N/A

* Isolation valves closed until future 24"W to Tigard is constructed in Carmen Drive and future PCV is installed.

Process Piping Concept

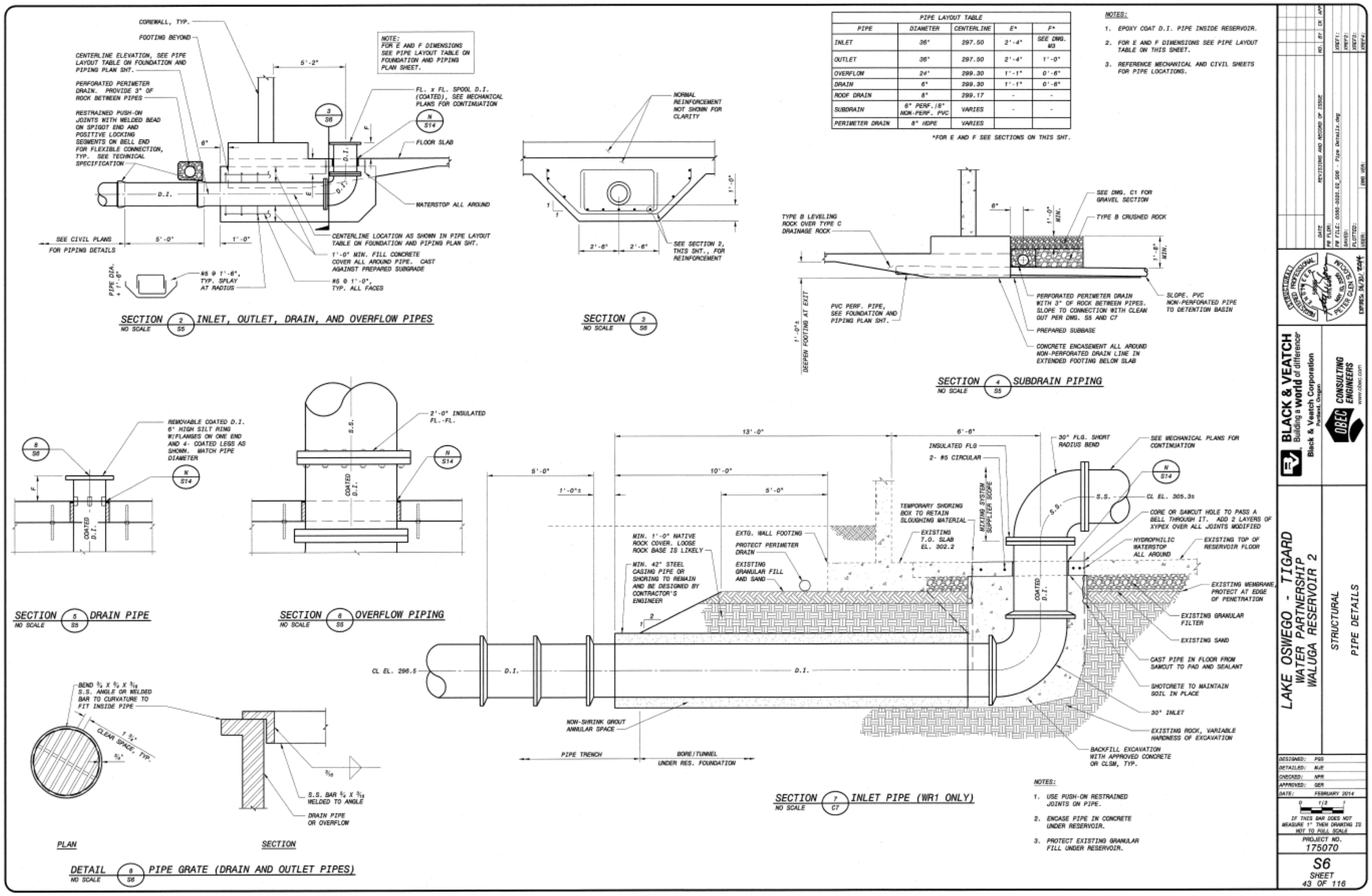


Process Piping Design

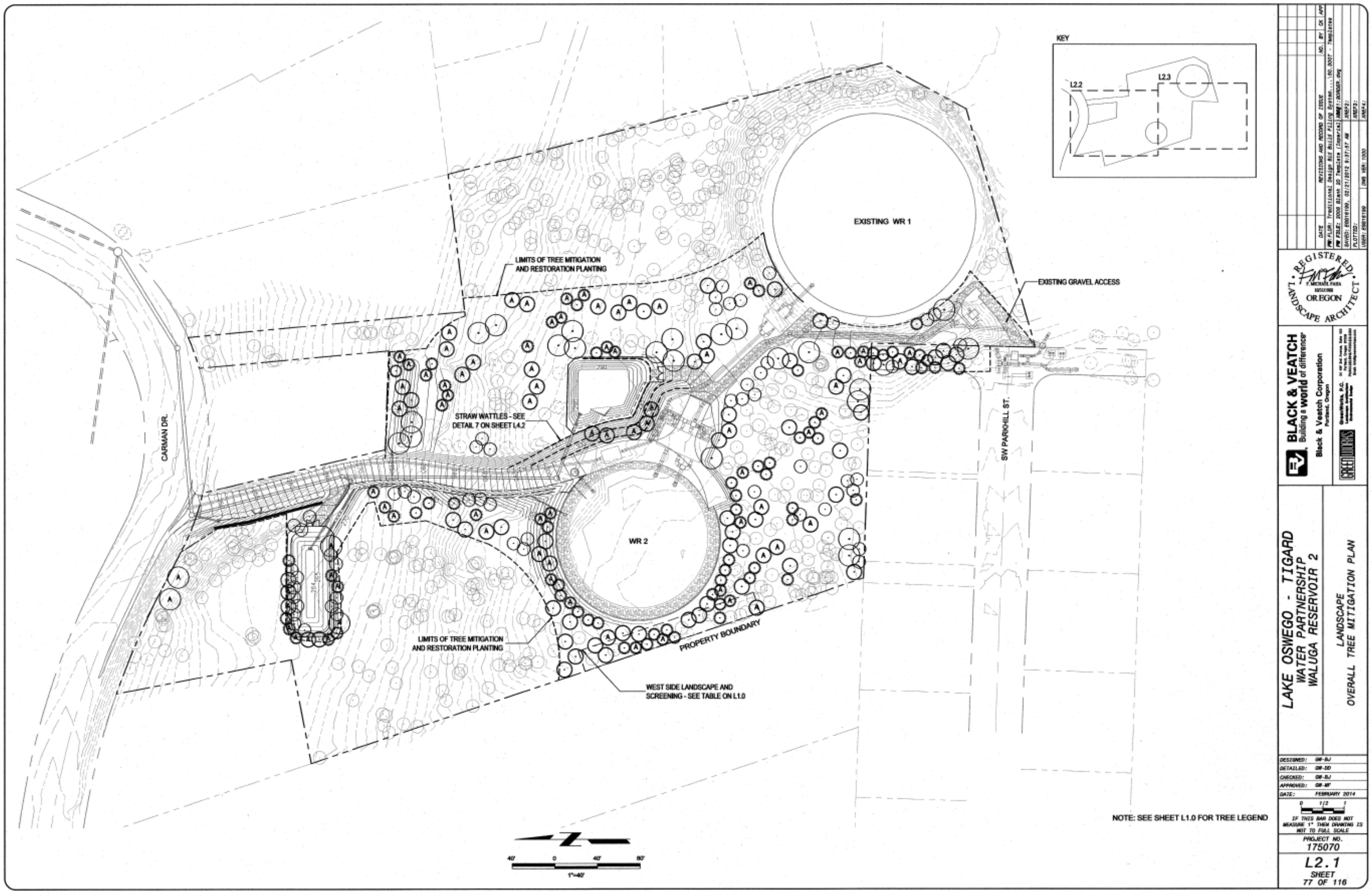


POINT #	NORTHING	EASTING
1	645186.66	7630516.75
2	645179.93	7630523.27
3	645185.96	7630529.50
4	645109.69	7630556.39
5	645060.50	7630557.46
6	645084.53	7630534.54
7	645074.47	7630574.33
8	645066.37	7630592.25
9	645004.71	7630650.74
10	645101.41	7630586.34
11	645096.52	7630597.32
12	645062.02	7630610.56
13	645009.44	7630660.41
14	645008.76	7630676.70
15	644985.18	7630667.83
16	644984.39	7630683.99
17	645160.14	7630584.09
18	644984.01	7630658.68
19	645164.14	7630562.79
20	645154.19	7630584.96
21	645136.25	7630589.02
22	645128.02	7630607.44
23	645063.69	7630615.73

Second WR1 Pipe Penetration Enables Series Flow through WR2 and WR1



WR2 Design Enables Effective Screening and Maximizes Tree Retention



WR2 Design Enables Effective Screening and Maximizes Tree Retention

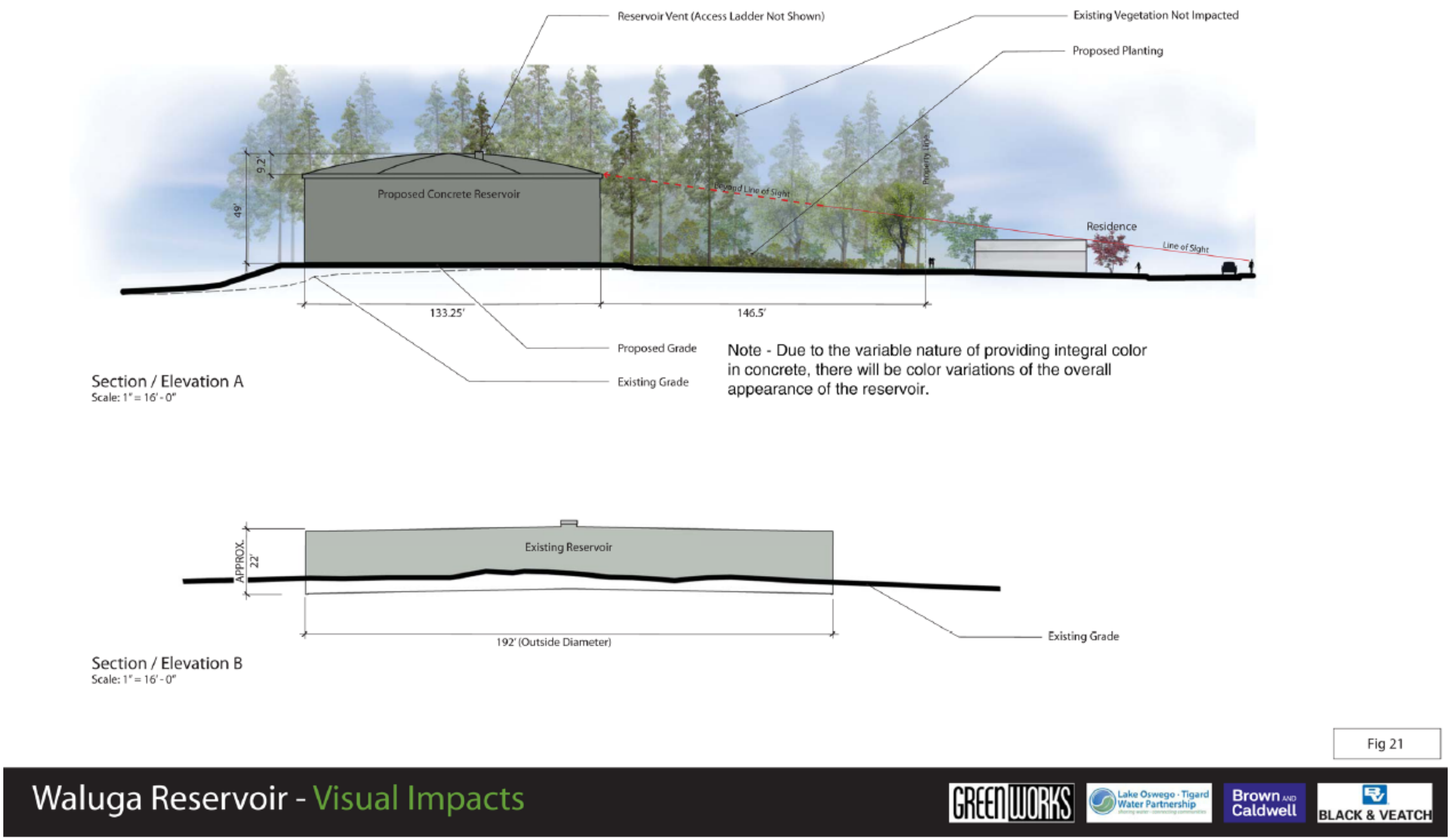
WR2 Design Enables Effective Screening and Maximizes Tree Retention

Waluga Reservoir - Construction Limits

WR2 Design Enables Effective Screening and Maximizes Tree Retention

WR2 Design Enables Effective Screening and Maximizes Tree Retention

WR2 Design Enables Effective Screening and Maximizes Tree Retention



WR2 Design Enables Effective Screening and Maximizes Tree Retention

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- Lake Oswego-Tigard Water Partnership Staff
  - City of Lake Oswego
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Questions and Discussion

Thank you!

Brown AND Caldwell