Working Harbor Reinvestment Strategy: Transportation Infrastructure Analysis

July 2007

CITY OF PORTLAND, OREGON
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URS

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Introduction

The purpose of the Working Harbors Transportation Infrastructure Analysis is to identify and rank transportation projects that support economic and job development within the Working Harbor industrial districts. This report summarizes transportation deficiencies noted in business interviews and describes transportation projects that have been identified in the Portland harbor area of North and Northwest Portland.

The study focused on fifteen key sites in the Working Harbor area that were identified by the City of Portland as opportunity sites for potential redevelopment for industrial and other employment uses. This report evaluates access to and from the opportunity sites and provides recommendations on transportation system improvements that could increase the potential for site redevelopment.

The Working Harbor are has been divided into four general subareas:
- Rivergate/St. John's
- Swan Island
- NW Industrial
- Linnton

The Rivergate/St. John's subarea includes port facilities along the Columbia and Willamette Rivers and rail and warehousing facilities along Marine Drive and North Lombard and in the St. John's neighborhood.

The Swan Island subarea is located on the east side of the Willamette River, south of the Rivergate/St. John's subarea. It includes the Swan Island industrial area and the Albina industrial area.

The NW Industrial subarea is located on the west side of the Willamette River, from the Fremont Bridge to the vicinity of the BNSF railroad bridge across the Willamette near Wacker Siltronics.

The Linnton subarea is located on the west side of the Willamette River, north of the St. John's Bridge.

The fifteen sites are summarized in Table 1 below and shown in Figure 1.

Table 1: Potential Redevelopment Sites & Associated Subareas

Site #	Owner	Land Available For Redevelopment	Total Land Area	Subarea
1	Time Oil	45 acres	45 acres	Rivergate/St. John’s
2	Langley St. Johns	7 acres	7 acres	Rivergate/St. John’s
3	Arkema	59 acres	59 acres	NW Industrial
4	ESCO	10 acres	10 acres	NW Industrial
5	Aventis Cropscience USA	16 acres	16 acres	NW Industrial
6	City of Portland – BES (Swan Island Lagoon)	10 acres	10 acres	Swan Island
7	City of Portland – BES (T-1 North)	19 acres	19 acres	NW Industrial
8	Linnton Plywood	25 acres	25 acres	Linnton
9	Lakea Corporation	1 acre	1 acre	NW Industrial
10	Oregonian	11 acres	11 acres	NW Industrial
11	Siltronic	15 acres	80 acres	NW Industrial
12	Stauffer Chemical	15 acres	31 acres	Rivergate/St. John’s
13	Vigor (Cascade General)	25 acres	65 acres	Swan Island
14	PGE	34 acres	74 acres	Linnton
15	Malafouris	2 acres	2 acres	Swan Island

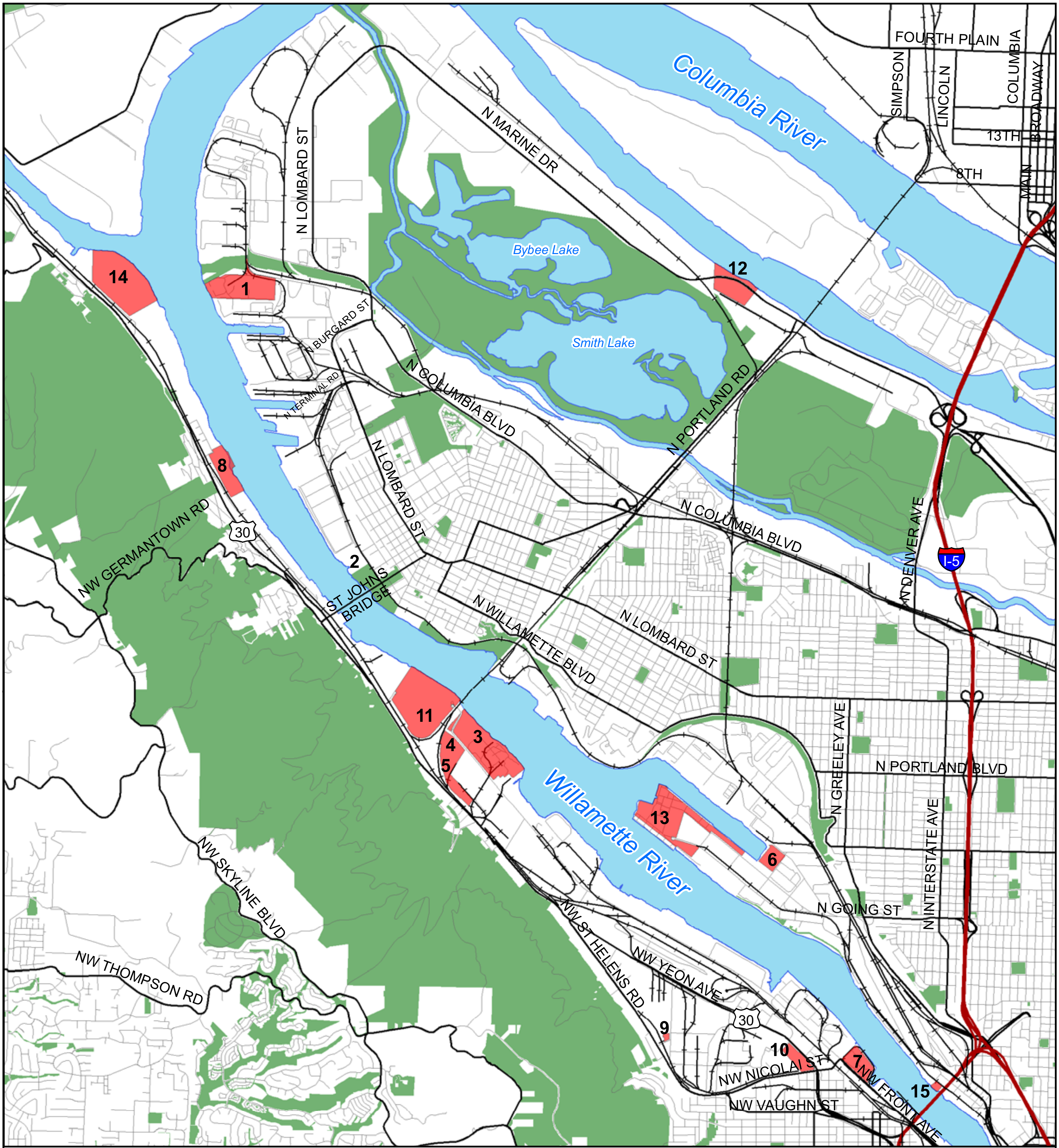

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Figure 1:
Project Study Area &
Constrained Opportunity Sites

N

0 0.5 1 2 Miles

Legend

🟥 Selected Sites
Freeway
Arterial
Street
Railroad

URS

Deficiencies and Projects

This section summarizes the results of interviews with local businesses conducted in 2006 and projects relevant to the Working Harbor study area previously identified in the following documents:

- **City of Portland Freight Master Plan adopted May 10, 2006 (FMP)** provides a road map for managing freight movement and commercial delivery of goods and services in Portland, today and into the future. Identified as a need in the Transportation System Plan (TSP), this plan ascertains freight transportation system needs and deficiencies, and develops solutions. Its goal is to foster a freight system that works for the community and its objectives center around three main themes: mobility, livability, and a healthy economy. Projects identified in the following Technical Memoranda are also included:
    - **Freight Master Plan Technical Memorandum No. 3: Existing Conditions, April 2005.**
    - **Freight Master Plan Technical Memorandum No. 4: Assessment of Freight System Needs, April 2005.**
    - **Freight Master Plan Technical Memorandum No. 5: Recommended Solutions and Strategies to Freight System Needs, June 2005.**

- **PDOT Capital Improvement Plan (CIP)** identifies capital improvements to be considered for fiscal years 2003-04 through 2007-08. These improvements are driven by City Council goals and consistent with its mission. This report reviewed the on line Capital Improvement Plan that includes major projects.

- **Regional Transportation Plan, METRO, 2004 (RTP)** is the blueprint that guides investments in the region's transportation system to reduce congestion, build new sidewalks and bicycle facilities, improve transit service and access to transit and maintain freight access. This plan includes a vision, an assessment of need based on growth and estimates costs of projects and proposes funding strategies to meet these costs. All projects that receive federal or state funds must be included in the RTP.

- **St John's Truck Strategy, PDOT, 2001 (SJTS)** is part of the Columbia Corridor Transportation Study. It identified ways in which truck circulation can be improved between the St. Johns Bridge, Rivergate and I-5 and determined how non-local truck traffic can be eliminated or reduced on residential and retail commercial streets. It listed a range of possible improvements and then recommended a subset of them.

- **Port of Portland Transportation Improvement Plan, 2006 (PTIP)** is a compilation of road, rail, waterway, transit, bike, pedestrian and transportation demand management projects that have been identified through transportation and other studies managed by or in coordination with the Port. The plan also identifies the Port's transportation project priorities. Updated annually and approved by the

Port of Portland Commission, the PTIP provides a long-range vision of transportation improvements that support the Port's mission. This report includes those projects identified in the adopted 2006 plan or included in the draft 2007 plan.

For purposes of this study, relevant projects are those that facilitate or improve the movement of freight by road, rail or ship. Pedestrian or bicycle improvements are not included. The projects are organized by subarea; Rivergate/St. Johns; Swan Island, NW Industrial area, and Linnton. Table 2 below presents information about:

- Project name
- Type of deficiency or problem
- Plan references
- Project description
- Estimated cost.
- Priority level
- Funding status

Priority level refers to the level of importance each plan gives the project. The Freight Master Plan classifies projects into four priority levels:

- Funded – Projects with full or partial funding identified, and will be implemented in the short term.
- Tier 1 – Anticipated implementation within five years.
- Tier 2 – Anticipated implementation within ten years.
- Tier 3 – Anticipated implementation within twenty years.

The Regional Transportation Plan includes the most important projects in the "Financially Constrained" portion of the plan. The Port TIP lists the most important projects as a "priority".

Table 2 combines a list of deficiencies identified in the business interviews with a list of projects identified in the plans listed above. Several of the deficiencies are addressed by projects identified in the plans, while other deficiencies are not. For deficiencies that are not addressed by an existing project, a recommendation is made regarding further action. Also, several of the projects listed do not address a deficiency that was specifically mentioned in the business interviews. These are also shown in Figure 2.

The table is divided into the four Working Harbor subareas as well as a regional level for projects or deficiencies that are relevant to the larger region. The table is further divided into types of deficiencies. The following relevant types were identified:

- Access deficiencies: Issues that make a particular site or area difficult to access.
- Bridge deficiencies: Weight restrictions or otherwise substandard bridges that limit the type or size of truck that can access a particular site or area.
- Congestion: Roadway congestion that makes it time consuming to get to and from a particular site or area.

- Marine capacity: Issues such as inadequate river channel depth or berth depth to accommodate large shipping vessels, and other on-site capacity constraints at the Port of Portland marine terminals.
- Minimizing truck impacts on neighborhood streets: A specific issue that comes up frequently in the St. Johns neighborhood is the conflict between truck traffic and pedestrians and bikes and neighborhood scale streets and land uses.
- Rail capacity: Constraints in the rail system that limit the length of trains, the ability to switch cars and store trains on sidings, and bottlenecks in the main lines.
- Safety: Issues that are related to safety, such as unprotected rail crossings or frequent unsignalized accesses on high-speed roadways.

Table 2: Deficiencies and Projects Previously Identified

Map #	Deficiency Identified in Business Interviews	Deficiency Type	Project Identified in Planning Documents	Committed Funding[1]	Priority[2]	Improvement	Cost	Plan[3]	Further Action Recommended
REGIONAL (Deficiencies and projects that relate to a variety of industrial areas or employment centers.)									
1		Access	**Denver Viaduct**	no	1	Reconstruct viaduct to improve truck access to I-5 (part of Delta Park project).	2M	FMP(B7),PTIP	
2	Turning radius at Interstate/ Lombard and Interstate/I-5 (Going St ramps) too tight for trucks.	Access	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						Work with the trucking community to establish alternative truck routes.
3		Congestion	**Marine Drive(Portland Rd to 185th)**	no	2	CCTV and changeable message signs at intersections	750K	FMP(SM11)	
4		Congestion	**I-5 Columbia Blvd improvments**	no	Priority	Construct a full interchange	34-71M	FMP(H6)	
5	I-5 through Delta Park is a bottleneck.	Congestion	**I-5 Delta Park**	yes		Widen to 6 lanes	48M	FMP(H7) PTIP	
6	I-5 Interstate Bridge is a bottleneck.	Congestion	**I-5 Columbia River Crossing**	no	1	Local share of Alternatives Analysis currently underway	200M	FMP(B11)	
7	I-5 Interstate Bridge is a bottleneck.	Congestion	**West Hayden Crossing**	no	3	Construct a new bridge to Hayden Island.	49M	FMP(B17),RTP,PTIP	
8	I-5/I-84 interchange is a bottleneck	Congestion	**I-5 Reconstruction and Widening Greeley to I-84**	no	1	Modernize freeway and ramps to improve access to the Lloyd District and Rose Quarter	106M	FMP(H8),RTP	Short-term improvements to I 5/I-84 interchange are included in Central City Freeway Loop study.
9	Willamette River needs maintenance dredging	Marine Capacity	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						This is addressed in the US Army Corps of Engineers Dredge Materials Management Plan (DMMP).
10	Portland Triangle System is inefficiently laid out, constrained by at-grade crossings, single-tracking, substandard sidings, and other bottlenecks. The existing system results in deficient rail access for some shippers.	Rail Capacity	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						Prepare a strategy that can maintain and improve access to the rail system for smaller shippers.
11		Rail Capacity	**North Portland Junction Rail Improvements**	no	2	Accommodate higher rail speeds	9.2M	FMP(R5)	
12		Rail Capacity	**Vancouver BNSF Rail Bridge Project (Columbia River)**	no	1	Replace existing swing span with lift span to create faster bridge openings, ease river navigation, and potentially add third rail track.	42M	FMP(B16)	
13		Rail Capacity	**BNSF Line at Columbia Bridge Track Improvements**	no	2	Improve rail track conditions on approaches to Columbia River rail bridge to increase track speeds.	8M	FMP(R2)	
14	Peninsula Junction is a bottleneck	Rail Capacity	**Peninsula Junction UP/BNSF Main Line**	no	2	Track realignment, double tracking, and signal upgrades to improve capacity over Columbia River Bridge.	3.5M	FMP(R6)	
15	Kenton line needs double tracking and overcrossings on its entire length.	Rail Capacity	**Kenton Rail Line Upgrade**	no	3, Priority	Upgrade to double track with new sidings.	25.4M	FMP(R3),PTIP	
16	There is no northbound to eastbound or westbound to southbound rail connection for trains at East Portland junction.	Rail Capacity	**UP Line Connection (Brooklyn Line - Graham Line)**	no	1	Add rail connection between the Brooklyn and Graham Lines to increase rail capacity.	11M	FMP(R13),PTIP	

Grey shaded box means that there is a project identified in plans, but a deficiency was not specifically mentioned in the business interviews.

[1] Projects for which partial or full funding has been identified.

[2] Priority levels for identified projects:
Tier 1 - Advancement for funding and implementation within five years.
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NW INDUSTRIAL									
17	Difficulty with safe access to Yeon, especially during shift changes.	Access	**US 30 at Lake Yard Hub: Access Improvements**	yes		Provide an access lane on US 30 and add a signal.	2M	FMP(S42)	Local circulation study in the NW Industrial District.
18		Access	**US 30 in Willbridge area**	no	1	Install center turn lane to NW Front	300K	FMP. (S38), RTP	
19	It is difficult to access the Willbridge loading racks.	Access	**US 30 at Saltzman/Balboa[4]**	no	2	Realign intersections	600K	FMP(S39)	Prepare cost benefit analysis of constructing a new grade-separated roadway crossing of the BNSF mainline and a new intersection near NW Balboa and US 30.
20	Hazmat Trucks aren't allowed on Balboa.	Access	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						
21		Access	**14/16th Connections**	no	3	Improve or create connections to route non-local traffic to 14th/16th Ave couplet	200K	FMP(S6)	
22	Bad street connectivity. There are only two roads connecting Front with Yeon that are grade separated from the railroad tracks.	Access	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						Prepare cost benefit analysis of constructing a new grade-separated roadway crossing of the BNSF mainline and a new intersection near NW Balboa and US 30.
23	The roads are in bad shape. There are a lot of potholes.	Access	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						City's Pavement Management System prioritizes maintenance needs
24	There is too much access on Yeon, which slows down traffic. Access control would speed access to I-405.	Congestion	**Yeon/US 30 (Nicolai to St. Johns Bridge) ITS**	no	1, Constrained	Interconnect signals and install CCTV and variable message signs.	222K	FMP(SM16),RTP	Local circulation study in the NW Industrial District.
25	Traffic backs up at the 61st Avenue crossing in front of the truck rack onto Front Avenue.	Congestion	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						Prepare cost benefit analysis of constructing a new grade-separated roadway crossing of the BNSF mainline and a new intersection near NW Balboa and US 30.
26	Railroad crossings on Front Avenue at Thurman and under the Steel Bridge cause traffic backups.	Congestion	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						Evaluate potential for advance warning signals to reroute traffic during train crossings. Grade separation at the Steel Bridge is not feasible. See Appendix A for additional information.
27	Rail speed on the Steel Bridge is limited to 6 mph.	Rail Capacity	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						

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[4] BNSF has applied to abandon the rail crossing at NW Balboa. ODOT is evaluating an alternative access to this area.

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LINNTON									
28	Difficulty accessing St. Helen's Road. Long delays and safety concerns.	Access	**112th ave/US30 intersection imrovements**	no	2	Add traffic signal to improve safety and access	135K	FMP(S11)	Conduct local circulation study of the Linnton area to assess feasibility of providing alternative routes to access US 30.
SWAN ISLAND									
29	There are 68 at-grade rail crossings on Swan Island.	Access	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						Internal street and rail circulation study to identify potential rail improvements or rail spurs to close.
30	Going Street gets very congested, especially during shift changes.	Bridge Strengthening	**Going Street at Swan Island**	Yes	Constrained, Priority	Replace weight restricted bridge over UPRR.	3.6M	FMP(B9),RTP,PTIP	Project currently underway to improve signal controller at Going Street/Interstate Ave intersection
31	Going Street gets very congested, especially during shift changes.	Congestion	**Going/Greeley Climbing Lane and Interchange Improvements**	no	1	Redisign Going/Greeley interchange, including constucting a climbing lane on Going.	2M	FMP(S24)	
32	Going Street gets very congested, particularly at the intersection with Interstate.	Congestion	**Going (Interstate-Swan Island)**	no	1	Interconnect signals and install CCTV cameras and variable message signs.	295K	FMP(SM8),RTP	
33	Need a secondary route to Swan Island.	Congestion	**River Ave (Port Ctr Way-River Ave) Street Extension**	no	2	Evaluate secondary access road to Swan Island	166K	FMP(S35)	
34	Albina Yard is operating at capacity and does not have room to hold more cars.	Rail Capacity	**UP Line Albina Yard upgrade**	no	2	Upgrade tracks to increase track speeds	8.8M	FMP(R14)	Investigate feasibility of developing a new rail yard to relieve congestion at Albina Yard.
35	The tracks on Swan Island are in poor condition and there is limited capacity to hold cars on-site.	Rail Capacity	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						Internal street and rail circulation study to identify potential rail improvements or rail spurs to close.

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RIVERGATE/ST. JOHNS									
37		Access	**Access Tunnel at Hyundai/Kia Facility**	no	1	Access tunnel from T-6 to Rivergate	3M	FMP(M1)	
38	Trains block trucks in at T-4.	Access	**Terminal 4 On-Site Overcrossing**	no	1	Construct overcrossing to improve truck access between lower T-4 and Lombard	2.5M	FMP(M9)	
39	Trains block trucks in at T-4.	Access	**Terminal 4 Access Improvements**	no	2	Provide terminal overpass and driveway improvements	10M	FMP(M11)	
40	Trains block trucks in at T-4.	Access	**T-4 Optional Terminal Lower Lot Access**	no	1	Regrade hill slope to provide secondary truck access route.	7M	FMP(M7),PTIP	
41		Access	**Marine Drive (at Rivergate West) Rail Crossing, Phase 2**	no	3	Construct grade-separated rail crossing at Rivergate West entrance	18M	FMP(R4),RTP,PTIP	
42		Access	**Terminal 6 - Marine Drive Overcrossing**	no	3	Construct grade-separated rail crossing between Marine Dr and T-6	18M	FMP(M17)	
43	Leadbetter Road is a dead end and has an at-grade rail crossing.	Access	**Leadbetter(Marine Drive Loop) Street Extension/Overcrossing**	Yes	Priority	Street extension and rail overcrossing	10.8M	FMP(S27),RTP,PTIP	
44	Need signalization and driveway intersection improvements at T-4/Schnitzer site.	Access	**Terminal 4 driveway consolidation**	yes	Priority	Consolidate driveways at T-4 and Schnitzer Steel to improve access.	1M (6.4)	FMP(S41),RTP,PTIP	
45	At-grade rail crossings on Columbia.	Access	**NO PROJECT IDENTIFIED IN CURRENT PLANS[4]**						Implement grade separation of Peninsula Junction, identified in the I-5 Rail Capacity Study, 2003.
46	City does not want Time Oil Road (currently a private road) because it does not meet city standards.	Access	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						Improve Time Oil Rd to city standards.
47		Bridge Strengthening	**Lombard at Columbia Slough**	yes		Strengthen bridge and add sidewalks and bike lanes.	4.9M	FMP(B13)	
48	Burgard Bridge is weight restricted.	Bridge Strengthening	**Lombard(Burgard)**	yes		Replace weight restricted bridge.	1.5M	FMP(B14)PTIP	
49		Congestion	**Widen Lombard-Purdy to Simmons**	no	Constrained, Priority	Widen N Lombard from 600 ft south of N Rivergate to Columbia Slough and add signal at Ramsey St.	4.4M	RTP,PTIP	
50		Congestion	**Columbia Blvd (I-205 - Burgard) ITS**	no	1	CCTV and changeable message signs at intersections	310K	FMP(SM6)	
51		Congestion	**Rivergate ITS**	no	1	Real time info connect to ODOT's highway ITC systems.	200K	FMP(SM14),PTIP	

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[4] Grade-separating North Portland Junction and Penn Junction (including Columbia Blvd.) identified as long term needs in the I-5 Rail Capacity Study, 2003.

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RIVERGATE/ST. JOHNS									
52		Congestion	**Lombard (MLK-Philadelphia) ITS**	no	3	CCTV and changeable message signs at intersections	210K	FMP(SM9)	
53	Traffic backups on St. John's Bridge cause safety problems. Need an additional bridge over the Willamette.	Congestion	**North Willamette Crossing Study**	no	Not included in Financially Constrained Plan	Study the need for a new bridge from US 30 to Rivergate	1.2M	RTP (not in Financially Constrained list)	Pursue increasing the priority of this project in the RTP.
54		Marine Capacity	**Terminal 6 Container Dock Extension**	no	1, Priority	Extension of dock to accommodate larger ships	19.4M	FMP(M15),PTIP	
55		Marine Capacity	**Terminal 6 Dock Structural Upgrades**	no	2	Dock Structural Upgrade	15M	FMP(M16)	
56		Marine Capacity	**Terminal 6 Computer System Upgrades**	yes		Increase efficiency of T6 terminal with improved cargo tracking systems	2M	FMP(M14)	
57		Marine Capacity	**Terminal 4 Grain Elevator Barge Conveyor Rebuild**	no	1	Rebuild conveyor connecting T4 grain elevator to Berth 405 barge unloader	1.5M	FMP(M8)	
58		Marine Capacity	**Terminal 6 Additional Post-Panamax Cranes**	no	3	Acquisition of three additional post-panamax cranes for T6	33.4M	FMP(M12)	
59	Need to finish deepening the channel.	Marine Capacity	**Columbia River Channel Deepening**	yes	Constrained, Priority	Deepen the river channel to serve larger container ships	I50.6M	FMP(M2),RTP,PTIP	
60	Docks need deeper drafts.	Marine Capacity	**Terminal 6 Berth Deepening**	yes	Priority	Deepen T6 container berths	1.25M	FMP(M13) PTIP	
61	Trucks in St. John's neighborhood: Tight turns, conflicts with bikes, noise complaints.	Minimize Truck Impacts on Neighboring Streets	**Columbia Blvd/Portland RD**	no	1	Intersection Improvements to reinforce through-truck movements on truck streets and minimize neighborhood cut-through traffic	700K	FMP(S21).PTIP SJTS	
62	Trucks in St. John's neighborhood: Tight turns, conflicts with bikes, noise complaints.	Minimize Truck Impacts on Neighboring Streets	**Ivanhoe/Philadelphia Intersection Improvements**	no	3	Redesign intersection to improve traffic and pedestrian circulation.	107K	FMP(S46),SJTS	
63	Trucks in St. John's neighborhood: Tight turns, conflicts with bikes, noise complaints.	Minimize Truck Impacts on Neighboring Streets	**Lombard/ST. Louis/Ivanhoe Multimodal Improvements**	yes		Realign intersection to reinforce truck movements on truck streets.	1.4M	FMP(S29)PTIP SJTS	

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RIVERGATE/ST. JOHNS									
64		Rail Capacity	**Barnes Rail Yard - Bonneville Rail Yard Track Expansion**	no	2	Construct additional unit train trackage to address switching bottlenecks and terminal access limitations	11.9M	FMP(R1), PTIP	
65		Rail Capacity	**So. Rivergate Rail Yard Expansion Phase 1**	no	1, Priority	Expand railroad yard	6M	FMP(R8),RTP, PTIP	
66		Rail Capacity	**Terminal 5 Unit Rail Loops #3 & #4**	no	1	Construct two additional loop tracks to Increase rail storage	2.8M	FMP(R10),PTIP	
67		Rail Capacity	**Barnes to Terminal 4 track Expansion**	no	1, Priority	Increase rail capacity from Barnes Yard to T-4	1M	FMP(R17),RTP,PTIP	
68		Rail Capacity	**Slough Rail Bridge**	no	3	Potential for future rail bridge across Columbia Slough conecting south Rivergate to T-6	4.5M	FMP(R9)	
69		Rail Capacity	**Terminal 4 Pier 2 Rail Yard Improvements**	yes	Priority	Construct new yard to increase rail capacity	54M	FMP(M10). PTIP	
70		Rail Capacity	**Honda Rail and Berth Upgrades**	yes	Priority	Berth modifications, rail loading facility expansion, and construc rail overcrossing at T-6	3.5M	FMP(M4),PTIP	
71		Rail Capacity	**Terminal 6 Intermodal Third Lead**	yes		Construct a dedicated lead for T-6 intermodal yard to remove bottleneck	4.5M	FMP(R11)	
72		Rail Capacity	**Terminal 6 A&B Yards**	no	2	Connect A & B rail yards to increase T-6 rail capacity	3M	FMP(R12)	
73	Development of Ramsey Rail Yard is a key project for getting trains off the main line for interchanging.	Rail Capacity	**Ramsey Rail Complex(south of Columbia Slough Bridge): Capacity Improvements**	no	1 Constrained, Priority	Construct six tracks and one mainline track to improve bottlenecks and storage capacity	12M	FMP(R7),RTP,PTIP	
74	Need double tracking on the Slough Bridge Lead in Rivergate.								
75		Safety	**Lombard (Rivergate T-6) Multi-Modal Improvements**	Yes		Widen N Lombard to two lanes with center turn lane, bike lanes, and sidewalks.	3.6M	FMP(S28)	
76		Safety	**Burgard-Lombard Street Improvements**	no	1	Widen to two lanes with center turn lane, bike lanes, and sidewalks	17.2M	FMP(S48), SJTP	
77	Unprotected rail crossings in St. John's in areas with recreational green space and new housing proposed.	Safety	**NO PROJECT IDENTIFIED IN CURRENT PLANS**						Pursue implementation of Whistle-Free Zone and potential crossing closures. Evaluate need for signage improvements.

Grey shaded box means that there is a project identified in plans, but a deficiency was not specifically mentioned in the business interviews.

[1] Projects for which partial or full funding has been identified.

[2] Priority levels for identified projects:

Tier 1 - Advancement for funding and implementation within five years.
Tier 2 - Advancement for funding and implementation within ten years.
Tier 3 - Advancement for funding and implementation within twenty years.
Constrained - Project is included in the Regional Transportation Plan financially constrained project list.
Priority - Project is identified as high-priority in the Port of Portland Transportation Improvement Plan.

[3] Plans in which project is identified

FMP - City of Portland Freight Master Plan, 2006. Project number listed in parentheses.
RTP - Regional Transportation Plan, Metro, 2004.
PTIP - Port of Portland Transportation Improvement Plan, 2006.
SJTS - St Johns Truck Strategy, PDOT, 2001.

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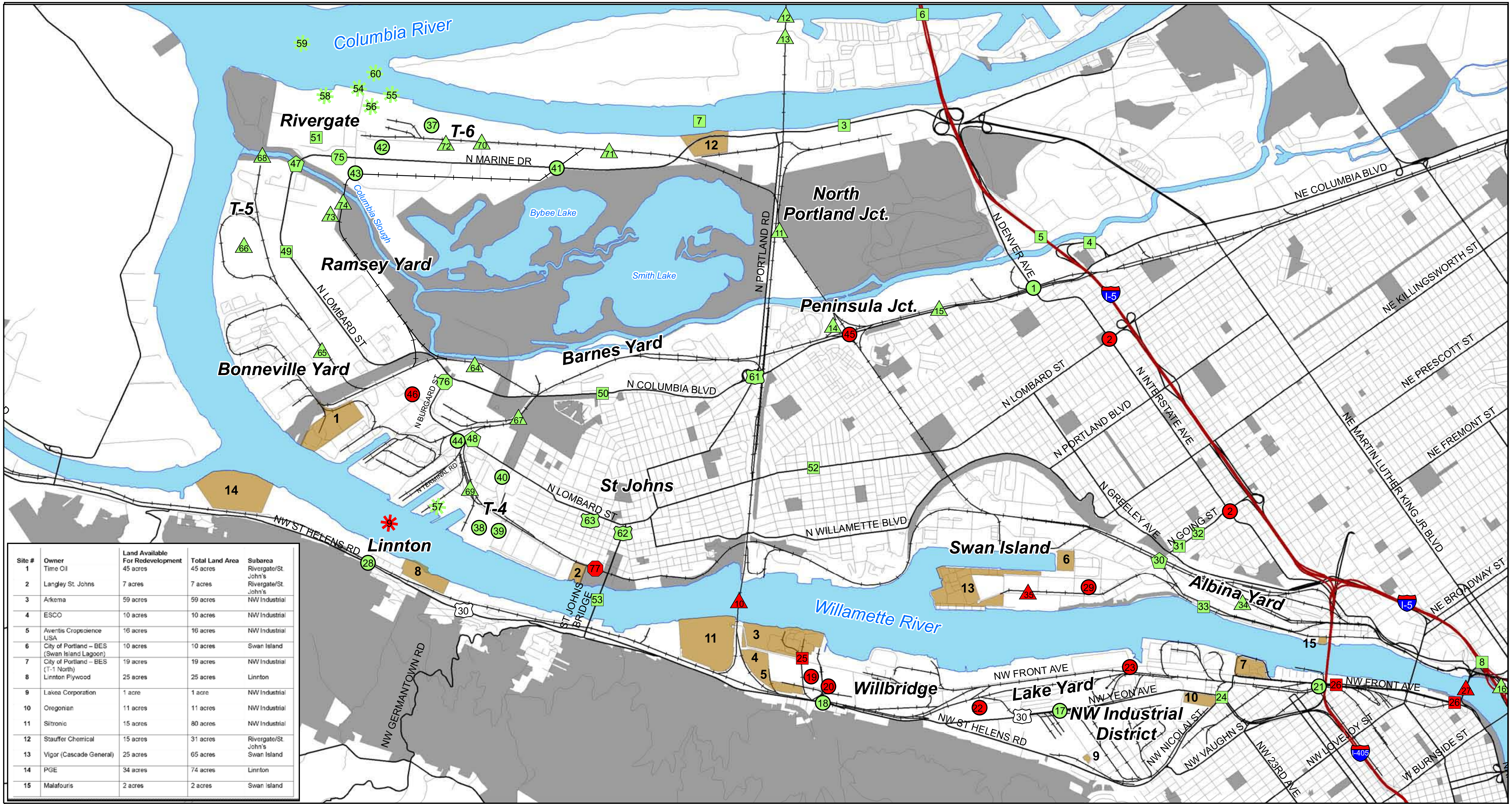
Figure 2: Identified Deficiencies and Projects



Site #	Owner	Land Available For Redevelopment	Total Land Area	Subarea
1	Time Oil	45 acres	45 acres	Rivergate/St. John's
2	Langley St. Johns	7 acres	7 acres	Rivergate/St. John's
3	Arkema	59 acres	59 acres	NW Industrial
4	ESCO	10 acres	10 acres	NW Industrial
5	Aventis Cropscience USA	16 acres	16 acres	NW Industrial
6	City of Portland – BES (Swan Island Lagoon)	10 acres	10 acres	Swan Island
7	City of Portland – BES (T-1 North)	19 acres	19 acres	NW Industrial
8	Linnton Plywood	25 acres	25 acres	Linnton
9	Lakea Corporation	1 acre	1 acre	NW Industrial
10	Oregonian	11 acres	11 acres	NW Industrial
11	Siltronic	15 acres	80 acres	NW Industrial
12	Stauffer Chemical	15 acres	31 acres	Rivergate/St. John's
13	Vigor (Cascade General)	25 acres	65 acres	Swan Island
14	PGE	34 acres	74 acres	Linnton
15	Malafouris	2 acres	2 acres	Swan Island

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Opportunity Sites – Issues and Recommendations

This section describes the local and regional access issues associated with each of the 15 opportunity sites and presents recommendations for further action. The following is a brief summary of the issues and recommended solutions along with a map showing the location of each issue for each of the key sites.

Site 1: Time Oil

Time Oil is a vacant 45-acre site located in the southwest portion of the Rivergate Industrial District. The site housed offices and storage tanks for Time Oil Company, but it is now unoccupied with a few remaining buildings and tanks (see Figure 3).

Time Oil Site Access

Truck and auto access to the Time Oil site from the north is via N Lombard Street and N Rivergate Boulevard and from the south is via N Burgard Street and N Time Oil Road.

Access to the site from the north includes three at-grade railroad spur crossings, suggesting a risk of occasional blockage. The intersection of N Rivergate Boulevard and N Lombard Street is stop controlled and subject to queues developing at peak times.

Access to the Time Oil site from the south via N Time Oil Road and N Burgard Street has no at-grade rail crossings. N Time Oil Road is privately-owned and has substandard width with no shoulders. The road also includes a series of speed bumps that limit truck mobility. The intersection of N Time Oil Road and Burgard Street is stop controlled with sight distance concerns related to curves and elevation change. The existing access to the Time Oil site via Time Oil Road has a sharp skew, making it too tight a turn for trucks to access from the north. Improved truck access could be could be accommodated via Time Oil Road by reconstructing the intersection so that it would have a less severe angle.

Speed bumps and substandard shoulders on N Time Oil Rd.

Sight distance issue at intersection of N Time Oil Rd and N Burgard St.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive uses include:

- City acquisition and improvement of Time Oil Road.
- Evaluation of traffic signal warrants at the N Rivergate Boulevard/N Lombard Street intersection.
- Reconfiguration of the N Burgard/Time Oil Road intersection.

Site transportation issues, recommendations and cost estimates are described below in Table 3.

Table 3: Time Oil (Site 1) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Blockage due to at-grade spur track rail crossings.	No action recommended – Time Oil Road offers a route with no rail crossings.	
2	Skewed intersection of existing site access with Time Oil Road.	Re-align driveway to reduce skew.	$80,000
3	Unsignalized intersection at North Rivergate Boulevard and North Lombard Street.	Perform signal warrant analysis.	$3,000
4	Speed bumps along Time Oil Road.	Consider city acquisition and improvement of Time Oil Road.	$6M to $9M[1]
5	Time Oil Road is narrow and has no shoulders.	Consider city acquisition and improvement of Time Oil Road.	
6	Unsignalized intersection at Time Oil Road and North Burgard Street.	Reconfigure intersection and Straighten curve.	$180,000
7	Sight distance issues at Time Oil Road and North Burgard Street.		

[1] Includes both acquisition of the private roadway and improvement

Time Oil Site – Regional System Access

There are three primary routes for access from the Time Oil site to the major regional transportation facilities.

- Via N Lombard Street and N Marine Drive to I-5.
- Via N Lombard Street and N Columbia Boulevard to I-5.
- Via N Lombard Street, the St Johns Bridge to US 30 and I-405.

Regional system projects that could improve accessibility to and from the Time Oil site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via N Lombard Street and N Marine Drive to I-5.
    - Widen Lombard – Purdy to Simmons (49).
    - Lombard at Columbia Slough – Strengthen bridge (47).
    - Marine Drive (at Rivergate West) Rail Crossing, Phase 2 (41).

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Figure 3:
Access Issues: Site 1 - Time Oil

Legend

🟥 Site Location
⑥ Access Issue
—+— Railroad

URS

- Via N Lombard Street and N Columbia Boulevard to I-5.
    - Burgard-Lombard Street Improvements (76).
- Via N Lombard Street, the St Johns Bridge to US 30 and I-405.
    - Lombard (Burgard) bridge replacement (48).
    - Lombard/St. Louis/Ivanhoe Multimodal Improvements (63).
    - Ivanhoe/Philadelphia Intersection Improvements (62).

Site 2: Langley St. Johns

The Langley St. Johns site is a 7-acre unoccupied site located on The Willamette River adjacent to Cathedral Park, just north of the St. Johns Bridge (see Figure 4).

Langley St. Johns Site Access

Truck and auto access to the Langley St. Johns site is via N Bradford Street and N Baltimore Avenue, which is a primarily residential street with a very steep slope. A spur line of the Union Pacific Railroad runs past the site along N Bradford Street in a shared right-of-way, suggesting a risk of occasional train blockage. The pavement and the rails are both in very poor condition.

The primary truck route through St. Johns, N Lombard Street connecting the St. Johns Bridge to N Columbia Boulevard, has an offset intersection at N St. Johns Avenue requiring trucks to cross the center line or use the parking lane in order to maneuver through the intersection. An alternative access could be provided by extending N Bradford Street northward through the T-4 property to N Terminal Road. This would avoid N Baltimore Avenue, Downtown St. Johns, and the offset intersection at N Lombard Street and N St. Johns Avenue for truck traffic destined for N Marine Drive or N Columbia Boulevard.

Rails in roadway along N Bradford Street.

Poor pavement and rail conditions along N Bradford Street.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive use include:

- Resurfacing the pavement on N Bradford Street in front of the site and at the intersection with N Baltimore Avenue.
- Repairing or replacing the railroad tracks in N Bradford Street from N Baltimore Avenue to the site.
- Increasing lane widths and turning radii on N Lombard Street at N St. Johns Avenue for northbound and southbound trips.
- A feasibility study of connecting N Bradford Street northward through T-4 to connect with N Terminal Road.

Site transportation issues, recommendations, and cost estimates are described below in Table 4.

Table 4: Langley St. Johns (Site 2) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Primary access is a residential street – N Baltimore Avenue.	Study feasibility of connecting N Bradford Street to N Terminal Road in T-4.	
2	Steep slope on primary access street – N Baltimore Avenue.		
3	Very poor pavement condition on North Bradford and North Baltimore Avenue.	Mill roadway surface and overlay with new top coat to limits of roadway with poor surface (500 linear ft.).	$175,000
4	Very poor rail condition on the Union Pacific tracks along Bradford Street.	Replace rails in conjunction with mill and overlay.	$100,000
5	Blockage and safety issues due to street and railroad sharing right-of-way along Bradford Street.	No action recommended.	
6	Poor geometry on N Lombard Street at N St Johns Avenue.	Increase lane width and turning radius for through trips on N Lombard Street.	$20,000

Langley St. Johns – Regional System Access

There are two primary routes for access from the Langley St. Johns site to the major regional transportation facilities:

- Via N Ivanhoe Street, N Lombard Street, and N Marine Drive to I-5.
- Via N Ivanhoe Street, N Lombard Street, and N Columbia Boulevard to I-5.
- Via N Ivanhoe Street and the St. Johns Bridge to US 30 and I-405.

Regional system projects that could improve accessibility to and from the Langley St. Johns site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via N Ivanhoe Street, N Lombard Street, and N Marine Drive to I-5.
  - Lombard/St. Louis/Ivanhoe Multi-Modal Improvements (63).
  - Lombard (Burgard) Bridge replacement (48).
  - Widen Lombard – Purdy to Simmons (49).
  - Lombard at Columbia Slough – Strengthen bridge (47).
  - Marine Drive (at Rivergate West) Rail Crossing, Phase 2 (41).
- Via N Ivanhoe Street, N Lombard Street, and N Columbia Boulevard to I-5.
  - Lombard/St. Louis/Ivanhoe Multi-Modal Improvements (63).
  - Lombard (Burgard) Bridge replacement (48).
  - I-5 Delta Park – Highway widening and ramp improvements, including reconstruction of the Denver Viaduct (1 and 5).
- Via N Ivanhoe Street and the St. Johns Bridge to US 30 and I-405.
  - Ivanhoe/Philadelphia Intersection Improvements (62).

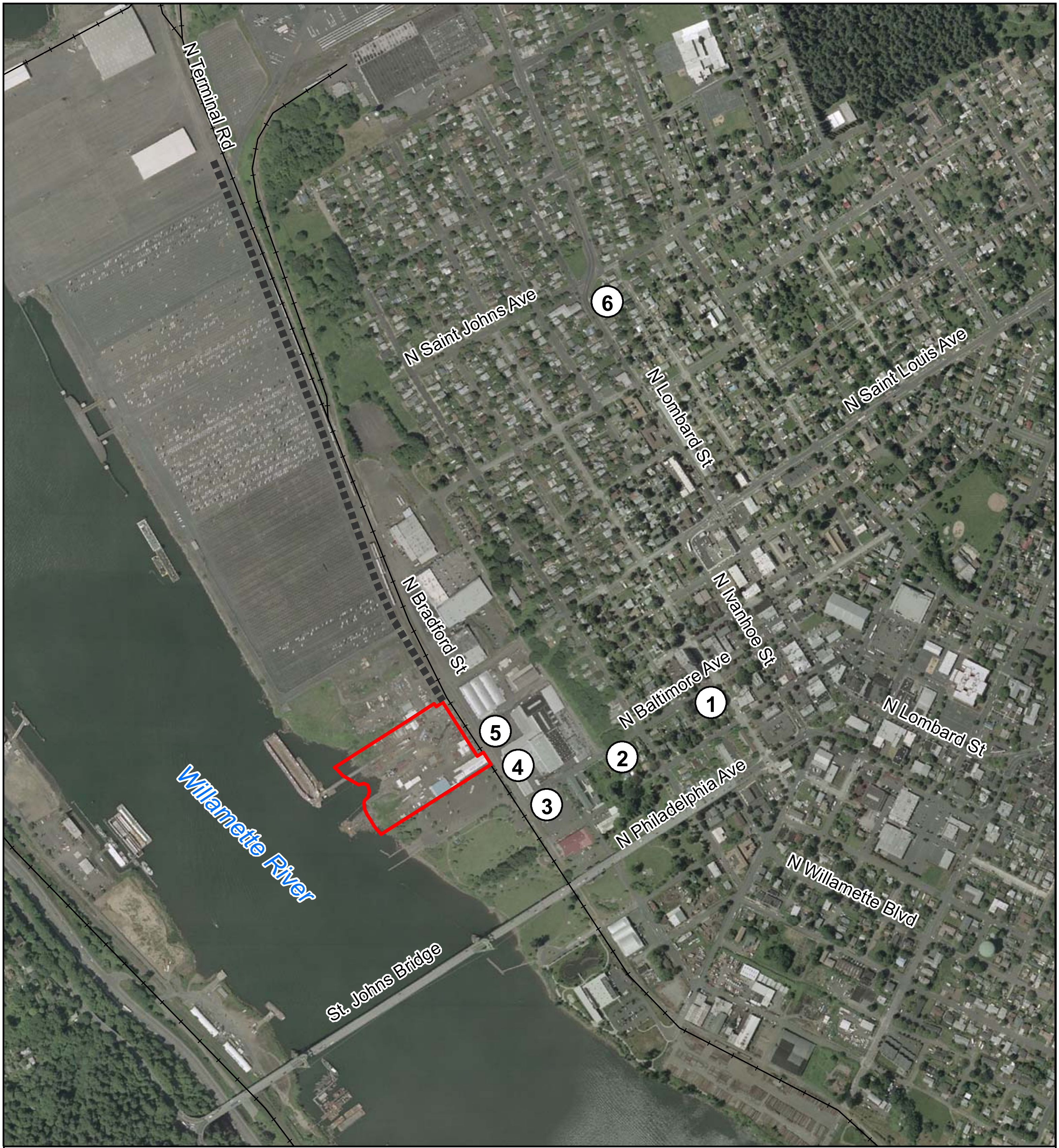

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Figure 4:
Access Issues: Site 2 - Langley St. Johns

N

0 250 500 1,000 Feet

Legend

🟥 Site Location

⑥ Access Issue

—+— Railroad

■ ■ ■ ■ Potential New Access Road

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Site 3: Arkema, Site 4: ESCO, and Site 5: Aventis Cropscience USA

Sites 3, 4, and 5 are unoccupied sites located on the west side of the Willamette River at the north end of NW Front Avenue, south of the St. Johns Bridge. Site 3 is located east of NW Front Avenue with river frontage. Sites 4 and 5 are on the west side of NW Front Avenue. There are a total of 85 unoccupied acres on the three sites. All three sites share the same access issues (see Figure 5).

Arkema, ESCO, and Aventis Site Access

Truck and auto access to the Arkema, ESCO, and Aventis sites is via NW Front Avenue and either NW 61st Avenue/NW Balboa Avenue or NW Kittridge Avenue.

Access via NW 61st Avenue/NW Balboa Avenue includes one at-grade crossing of the BNSF main line and three at-grade spur rail crossings, one of which is located within the intersection of NW 61st Avenue and NW Front Avenue. These may present blockage as well as safety issues. Movement is restricted at the intersection of NW Balboa Avenue and US 30, with only a right turn allowed onto US 30. In addition, trucks carrying hazardous materials are prohibited from using NW 61st Avenue/NW Balboa Avenue.

Rail crossing in intersection at NW 61st Ave and NW Front Ave.

Right turn channelization and railroad crossings at NW Balboa and US 30.

Access from NW Kittridge Avenue is via a grade-separated overcrossing over the BNSF main line. This route includes three at-grade crossings of spur rail lines, but no at-grade main line crossings. Kittridge Avenue provides access in both directions at US 30 at a signalized intersection and does not have any restrictions of trucks carrying hazardous materials.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive use include:

- A study of intersection geometry, signage, and striping at NW 61st Avenue and NW Front Avenue.
- A comprehensive study of the cost-benefit of constructing a new grade separated crossing of the BNSF main line with a new full directional intersection or interchange with US 30 in the vicinity of NW Balboa Avenue.

Site transportation issues, recommendations, and cost estimates are described below in Table 5.

Table 5: Arkema, ESCO, and Aventis (Sites 3, 4, and 5) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Blockage and safety issues due to at-grade spur rail crossings at the intersection of NW 61st Avenue and NW Front Avenue.	Study intersection geometry, signage, and striping for safety.	$4,000
2	Blockage due to at-grade spur rail crossings along NW 61st Avenue/NW Balboa Avenue.	Prepare a comprehensive study of the cost-benefit of constructing a new grade separated crossing of the BNSF main line with a new full directional intersection or interchange with US 30 in the vicinity of NW Balboa. The study should consider the following: • Value of a new grade separated crossing to existing or potential businesses. • Origins and destinations of freight and commuter traffic accessing businesses in the area. • Added time required to access US 30 via existing overcrossing at NW Kittridge for both northbound and southbound trips. • Impact that improved access could have on the marketability of parcels in the vicinity. • Emergency access.	$40,000
3	Blockage and safety issues due to at -grade rail crossing of BNSF main line on NW Balboa immediately east of US 30[1].		
4	Restricted turn movements from NW Balboa to US 30 (right turn only)[1].		

[1] BNSF has applied to abandon this crossing. ODOT and the City of Portland are currently evaluating ways to provide alternative access.

Arkema, ESCO, and Aventis – Regional System Access

There are two primary routes for access from the Arkema, ESCO, and Aventis sites to the major regional transportation facilities:

- Via NW Front Avenue and NW 61st Avenue/NW Balboa Avenue to US 30 and I-405.
- Via NW Front Avenue and NW Kittridge Avenue to US 30 and I-405.

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Figure 5:
Access Issues: Site 3 - Arkema,
Site 4 - ESCO, & Site 5 Aventis

N

0 500 1,000 2,000
Feet

Legend

🟥 Site Location

⑥ Access Issue

—+— Railroad

Regional system projects that could improve accessibility to and from the Arkema, ESCO, and Aventis sites are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via NW Front Avenue and NW 61st Avenue/NW Balboa Avenue to US 30 and I-405.
    - Realign Saltzman/Balboa (19) (Would only occur if BNSF crossing is not closed).
- Via NW Front Avenue and NW Kittridge Avenue to US 30 and I-405.
    - ITS improvements on US 30 (24).

Site 6: City of Portland – BES (Swan Island Lagoon)

The BES (Swan Island Lagoon) site is a 10-acre vacant site located on Swan Island at the south end of the lagoon. The site is currently vacant (see Figure 6).

BES (Swan Island Lagoon) Site Access

Truck and auto access to the BES (Swan Island Lagoon) site is via N Basin Avenue and N Going Street. There are no significant issues with access to this site from the local arterial network. It has direct access from a signalized intersection on N Basin Avenue. There is only one route in and out of Swan Island (N Going Street), which may limit the attractiveness of the BES (Swan Island Lagoon) site.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive use include:

- Existing system level projects included in the Freight Master Plan to improve N Going Street by redesigning the Going/Greeley interchange, adding a climbing lane to N Going Street, replacing the UPRR overpass, and evaluating a potential secondary access to Swan Island by extending N River Street.
- Project currently under way to implement "smart" traffic signal system at N Going Street and N Interstate Avenue. The City should monitor the project to see if it effectively reduces congestion.

Site transportation issues, recommendations, and cost estimates are described below in Table 6.

Table 6: BES (Swan Island Lagoon) (Site 6) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Potential congestion issues on N Going Street.	Addressed by projects 31 and 32, ITS improvements on Going St. and interchange improvements at Going St. and Greeley Ave., already identified, and by current plans to improve the signal controller at N Going St. and N Interstate Ave.	NA

BES (Swan Island Lagoon) – Regional System Access

There are two primary routes for access from the BES (Swan Island Lagoon) site to the major regional transportation facilities.

- Via N Basin Avenue and N Going Street to I-5 (northbound).
- Via N Basin Avenue and N Going Street to N Greeley Avenue and I-5 (southbound).

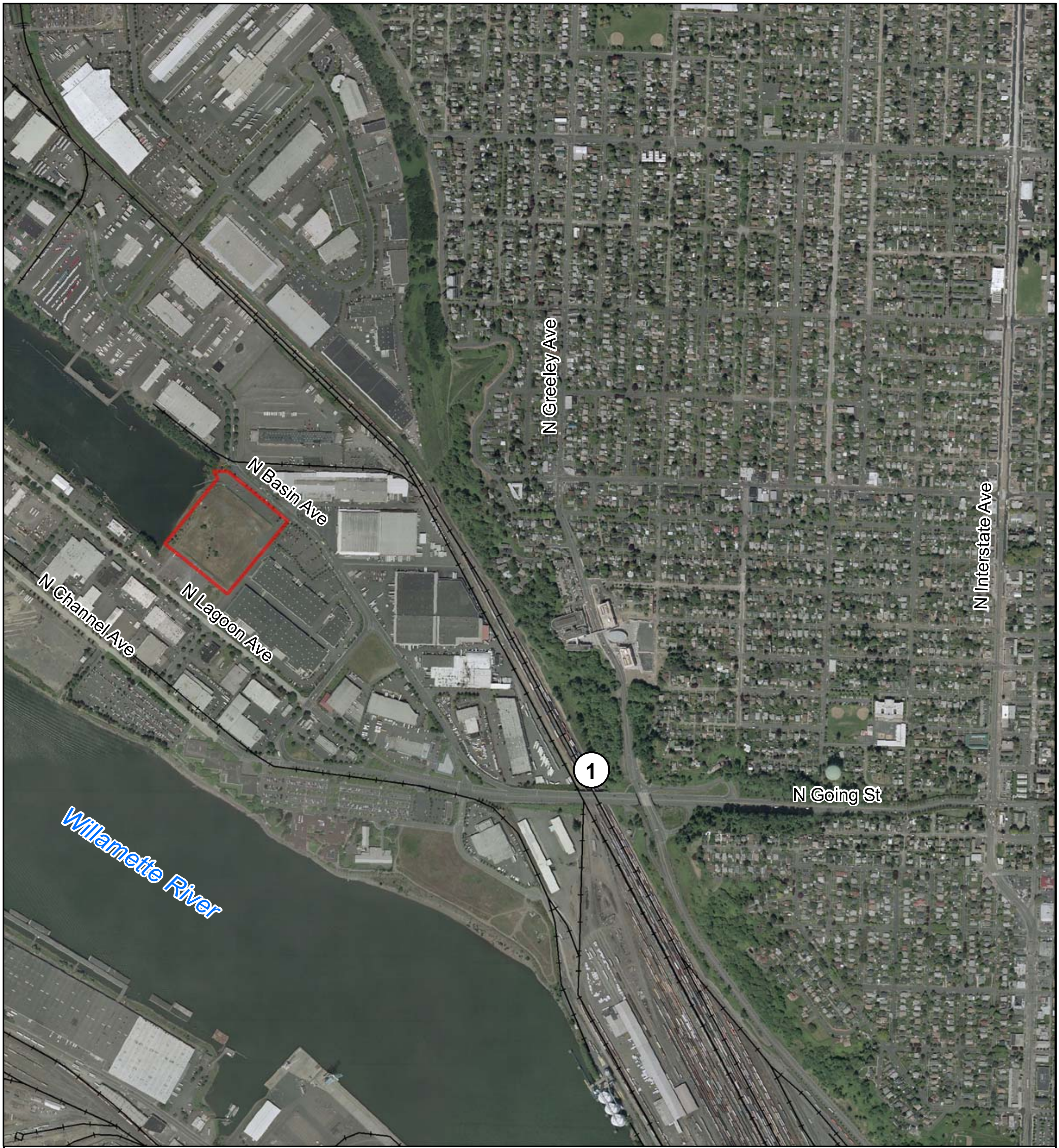

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Figure 6:
Access Issues: Site 6 - City of
Portland BES (Swan Island Lagoon Site)

Legend

🟥 Site Location
⑥ Access Issue
—+— Railroad

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Regional system projects that could improve accessibility to and from the BES (Swan Island Lagoon) site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via N Basin Avenue and N Going Street to I-5 (northbound).
    - Going Street at Swan Island – Replace bridge over UPRR (30).
    - Going/Greeley Climbing Lane and Interchange Improvements (31).
    - Going Street ITS improvements (32).
    - Evaluate secondary access road to Swan Island by extending N River Street (33).
- Via N Basin Avenue and N Going Street to N Greeley Avenue and I-5 (southbound).
    - Going Street at Swan Island – Replace bridge over UPRR (30).
    - Going/Greeley Climbing Lane and Interchange Improvements (31).
    - Going Street ITS improvements (32).
    - Evaluate secondary access road to Swan Island by extending N River Street (33).

Site 7: City of Portland – BES (T-1 North)

The BES (T-1 North) site is a 19 acre unoccupied site located on the west side of the Willamette River just north of the Fremont Bridge on NW Front Avenue at the east end of NW Nicolai Street (see Figure 7).

BES (T-1 North) Site Access

Truck and auto access to the BES (T-1 North) site is via NW Front Avenue and either NW Nicolai or NW 26th Avenue to US 30 and I-405.

Access via NW Nicolai Street includes a tight turning radius eastbound where NW Nicolai Street turns into a one-way couplet and directs eastbound traffic onto NW Sherlock Avenue and NW 21st Avenue. The Nicolai couplet crosses the BNSF main line just west of NW Front Avenue, potentially resulting in occasional delays. The intersection of NW Nicolai Street and NW Yeon Avenue (US 30) is subject to queuing during peak times. There is no left turn lane on NW Nicolai Street westbound and no protected left-turn signal.

NW Sherlock Avenue approaching tight left-turn and rail crossing at NW 21st Avenue.

The one-way couplet of NW Nicolai Street and NW 21st Avenue could potentially be removed, making NW Nicolai Street two-way across the BNSF tracks and closing the NW 21st Avenue rail crossing.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive use include:

- A local circulation study to evaluate whether NW Nicolai Street could be made two-way between NW Sherlock Avenue and NW Front Avenue, and whether the BNSF crossing at NW 21st Avenue could be closed.

Site transportation issues, recommendations, and cost estimates are described below in Table 7.

Table 7: BES (T-1 North) (Site 7) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Tight turning radius from NW Sherlock Avenue eastbound to NW 21st Avenue northbound.	The City is currently planning a study to determine local and regional system access needs and determine a circulation plan that meets the needs of area businesses. The study should evaluate whether NW Nicolai Street could be made two-way between NW Sherlock Avenue and NW Front Avenue, and whether the BNSF crossing at NW 21st Avenue could be closed.	$25,000
2	Blockage and safety issues due to at-grade rail crossings on NW Nicolai Street and NW 21st Avenue east of NW Sherlock Avenue.		
3	Queuing on NW Nicolai Street westbound at NW Yeon Avenue (US 30).	Evaluate traffic operations at the intersection of NW Nicolai Street and US 30 and determine if improvements are warranted.	$10,000
4	No protected left-turn signal for westbound NW Nicolai Street traffic turning southbound onto US 30.		

BES (T-1 North) – Regional System Access

There is one primary route for access from the BES (T-1 North) site to the major regional transportation facilities.

- Via NW Yeon Avenue (US 30) to I-405.

Regional system projects that could improve accessibility to and from the BES (T-1 North) site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via NW Yeon Avenue (US 30) to I-405.
  - ITS improvements on US 30 (24).

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Figure 7:
Access Issues: Site 7 - City of Portland BES (T-1 North)

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Site 8: Linnton Plywood

The Linnton Plywood site is a 25-acre underutilized site located on the west side of the Willamette River just south of downtown Linnton, north of the St. Johns Bridge off of US 30 (see Figure 8).

Linnton Plywood Site Access

Truck and auto access to the Linnton Plywood site is via an access road off of US 30.

The access road meets US 30 at a signalized intersection. The pavement on the access road is in poor condition. There is an at-grade rail crossing at the entrance to the property approximately 350 feet east of US 30.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive use include:

- Resurfacing the access road approaching US 30.
- Installation of new, larger signal heads at the intersection of the access road with US 30.

Site transportation issues, recommendations, and cost estimates are described below in Table 8.

Table 8: Linnton Plywood (Site 8) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Blockage due to at-grade rail crossing.	No action recommended.	
2	Access road is in poor condition.	Mill and overlay access driveway where needed.	$40,000
3	Traffic signal heads need to be updated.	Replace signal heads at intersection of site access with US 30.	$20,000

Linnton Plywood – Regional System Access

There are three primary routes for access from the Linnton Plywood site to the major regional transportation facilities.

- Via NW St. Helens Road (US 30) to I-405.
- Via NW St. Helens Road (US 30) to the St. Johns Bridge and N Columbia Boulevard to I-5.
- Via NW St. Helens Road (US 30) to the St. Johns Bridge, N Lombard Street, and N Marine Drive to I-5.

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Figure 8:
Access Issues: Site 8 - Linnton Plywood

Legend

🟥 Site Location

⑥ Access Issue

Railroad

URS

Regional system projects that could improve accessibility to and from the Linnton Plywood site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via NW St. Helens Road (US 30) to I-405.
  - ITS improvements on US 30 (24).
- Via NW St. Helens Road (US 30) to the St. Johns Bridge and N Columbia Boulevard to I-5.
  - Lombard (Burgard) Bridge replacement (48).
  - I-5 Delta Park – Highway widening and ramp improvements, including reconstruction of the Denver Viaduct (1 and 5).
- Via NW St. Helens Road (US 30) to the St. Johns Bridge, N Lombard Street, and N Marine Drive to I-5.
  - Lombard (Burgard) Bridge replacement (48).
  - Widen Lombard – Purdy to Simmons (49).
  - Lombard at Columbia Slough – Strengthen bridge (47).
  - Marine Drive (at Rivergate West) Rail Crossing, Phase 2 (41).

Site 9: Lakea Corporation

The Lakea Corporation site is a one acre unoccupied site located on NW 35th Avenue between NW Yeon Avenue (US 30) and NW St. Helens Road (see Figure 9).

Lakea Corporation Site Access

Truck and auto access to the Lakea Corporation site is primarily from the north via NW Yeon Avenue (US 30) and NW 35th Avenue. There is a secondary access from the south via St. Helens Road and NW 35th Avenue.

Access to the site from the north includes a signalized intersection at NW 35th Avenue and US 30. This intersection is subject to queues developing at peak times. There is an at-grade rail crossing immediately south of this intersection on NW 35th Avenue.

Northbound trucks on NW 35th Ave queuing at US 30.

Access to the Lakea Corporation site from the south via NW St. Helens Road and NW 35th Avenue involves an at-grade, unsignalized rail crossing at an unconventional intersection of three streets (NW St. Helens Road, NW 35th Avenue, and NW Industrial Street), requiring trucks to stop on the tracks in order to see traffic on NW St. Helens Road.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive uses include:

- Capacity analysis at the signalized intersection of NW 35th Avenue and US 30.
- Signalize the intersection of NW 35th Avenue and NW St. Helens Road and install a right-turn lane on NW St. Helens Road.

Site transportation issues, recommendations and cost estimates are described below in Table 9.

Table 9: Lakea Corporation (Site 9) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Queuing problem at NW 35th Avenue and NW Yeon Avenue (US 30)[1].	Perform intersection capacity analysis.	$8,000
2	Blockage due to at-grade rail crossing on NW 35th Avenue immediately south of NW Yeon Avenue (US 30).	No action recommended.	
3	Poor intersection geometry at NW 35th Avenue and NW St. Helens Road.	Signalize and install a right-turn lane on St. Helens Rd northbound.	$250,000
4	Blockage and safety issues due to at-grade rail crossing on NW 35th Avenue immediately north of NW St. Helens Road.		

[1] May be addressed by Lake Yard Hub access improvement which adds a fourth leg to this tee intersection (project 14).

Lakea Corporation – Regional System Access

There are two routes for access from the Lakea Corporation site to the major regional transportation facilities.

- Via NW Yeon Avenue (US 30) to I-405.
- Via NW St. Helens Road and NW Nicolai Street to I-405.

Regional system projects that could improve accessibility to and from the Lakea Corporation site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via NW Yeon Avenue (US 30) to I-405.
    - US 30 at Lake Yard Hub: Access Improvements (17).
    - ITS improvements on US 30 (24).

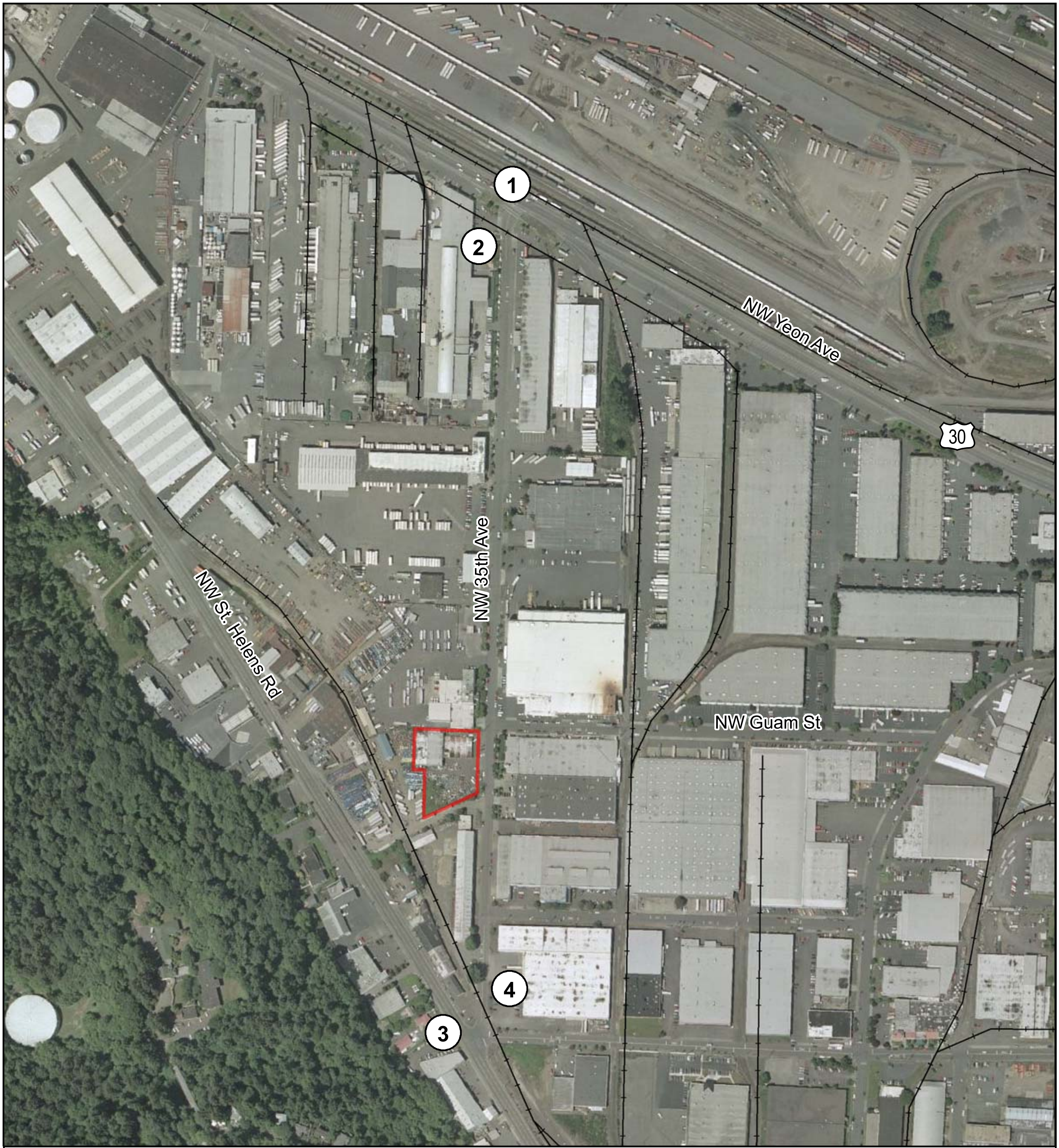

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Figure 9:
Access Issues: Site 9 - Lakea Corporation

N

0 250 500 1,000
Feet

Legend

🟥 Site Location

⑥ Access Issue

Railroad

URS

Site 10: Oregonian

The Oregonian site is an 11 acre vacant site located on the northwest corner of NW Yeon Avenue (US 30) and NW Nicolai Street. The site formerly housed the Oregonian newspaper printing facilities (see Figure 10).

Oregonian Site Access

Truck and auto access to the Oregonian site is directly off of NW Yeon Avenue (US 30) and NW Nicolai Street. There are three existing driveway cuts along NW Yeon Avenue and one along NW Nicolai Street. ODOT access spacing standards would restrict the use of the driveways on the NW Yeon Avenue side of the property to one access every 750 to 990 feet, depending on interpretation of the standards. Queuing on NW Yeon Avenue approaching NW Nicolai Street may be an issue.

Looking north on US 30 from NW Nicolai St. Oregonian site on the left.

Primary access would likely be via NW Nicolai Street. NW Nicolai has a westbound lane-drop at the location of the existing driveway, which may result in safety issues. There may be queuing problems for eastbound traffic approaching NW Yeon Avenue (US 30). Access from NW Nicolai Street could be limited to right-in right-out depending on intersection operations at NW Nicolai Street and NW Yeon Avenue (US 30).

Looking west on NW Nicolai St from US 30. Oregonian site on the right.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive uses include:

- Construct a new access road on the north side of property, connecting to the existing signalized intersection of NW 26th Avenue and US 30. This can potentially be extended further west to access additional sites or connect to NW Industrial Street.

Site transportation issues, recommendations and cost estimates are described below in Table 10.

Table 10: Oregonian (Site 10) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Access on the east side of the property directly onto US 30 may not be allowed due to ODOT access standards.	Construct new access road on north side of property, connecting to the west side of the existing signalized intersection of NW 26th Avenue and US 30.	$120,000
2	Queuing problem on NW Yeon Avenue (US 30) approaching NW Nicolai Street.	Evaluate need for improvements at intersection of NW Nicolai Street and US 30.[1]	$30,000
3	Westbound lane-drop on NW Nicolai Street in the vicinity of existing access on the south side of the property.		
4	Possible queuing problem on NW Nicolai Street approaching NW Yeon Avenue (US 30).		

[1] May be addressed by project to install ITS equipment on NW Yeon Avenue (project 24).

Oregonian – Regional System Access

There are two routes for access from the Oregonian site to the major regional transportation facilities.

- Via NW Yeon Avenue (US 30) to I-405.
- Via NW Nicolai Street to I-405.

Regional system projects that could improve accessibility to and from the Oregonian site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via NW St. Helens Road (US 30) to I-405.
  - ITS improvements on US 30 (24).
- Via NW Nicolai Street to I-405.
  - ITS improvements on US 30 (24).

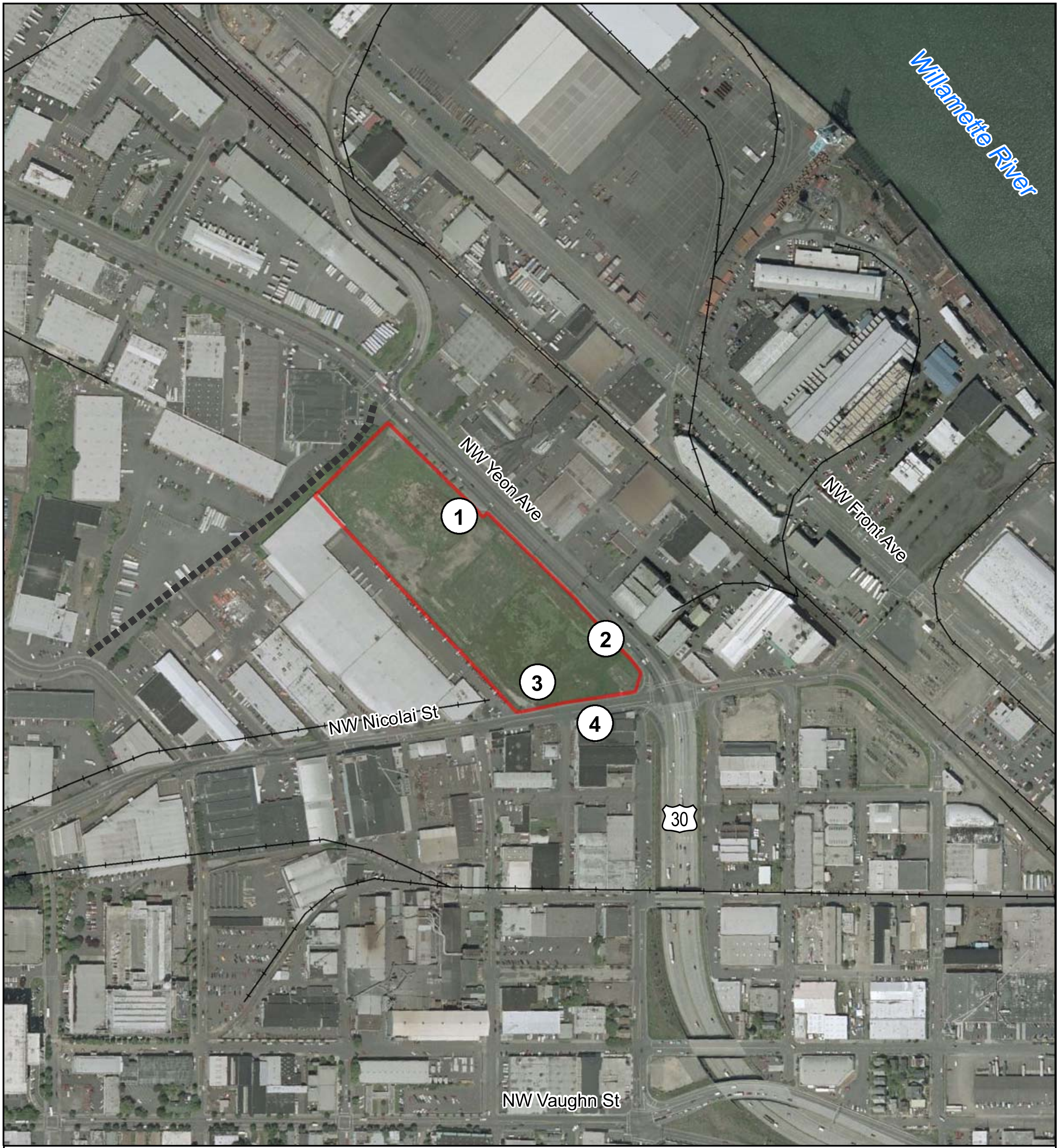

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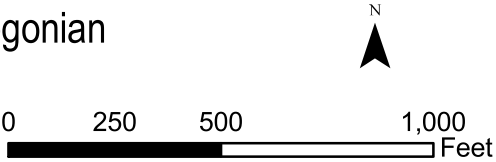
Figure 10:
Access Issues: Site 10 - Oregonian



Legend

🟥	Site Location
6	Access Issue
—+—	Railroad
■ ■ ■ ■	Potential New Access Road

URS

Site 11: Siltronic

Site 11 is an 80 acre occupied site located on the west side of the Willamette River at the north end of NW Front Avenue, south of the St. Johns Bridge. There are 15 unoccupied acres on the west side of the site, closest to US 30. The Siltronic site shares the same access issues as sites 3, 4, and 5, except that it has a secondary access on its north side off of US 30 and a cul-de-sac of NW Front Avenue (see Figure 11).

Siltronic Site Access

Truck and auto access to the Siltronic site is primarily via NW Front Avenue, south of the site, and either NW 61st Avenue/NW Balboa Avenue or NW Kittridge Avenue. The secondary access on the north side is via a dead end segment of NW Front Avenue that does not connect to the other part of NW Front Avenue on the south side of the property.

Primary access via NW 61st Avenue/NW Balboa Avenue includes one at-grade crossing of the BNSF main line and three at-grade spur rail crossings, one of which is located within the intersection of NW 61st Avenue and NW Front Avenue. These may present blockage as well as safety issues. Movement is restricted at the intersection of NW Balboa Avenue and US 30, with only a right turn allowed onto US 30. In addition, trucks carrying hazardous materials are prohibited from using NW 61st Avenue/NW Balboa Avenue.

Access from NW Kittridge Avenue is via a grade-separated overcrossing over the BNSF main line. This route includes three at-grade crossings of spur rail lines, but no at-grade main line crossings. Kittridge Avenue provides access in both directions at US 30 at a signalized intersection and does not have any restrictions of trucks carrying hazardous materials.

The dead end segment of NW Front Avenue on the north side of the site could be used as the primary route to access the vacant portion of the Siltronic site. It includes a signalized intersection with US 30, and an at-grade crossing of the BNSF main line tracks immediately east of the intersection. This crossing, however, is located on the line heading toward the coast, beyond the point where the more heavily used north-south line branches off.

NW Front Ave approaching rail crossing and US 30.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive use include:

- A study of intersection geometry, signage, and striping at NW 61st Avenue and NW Front Avenue.
- A comprehensive study of the cost-benefit of constructing a new grade-separated

crossing of the BNSF main line with a new full directional intersection or interchange with US 30 in the vicinity of NW Balboa Avenue.
- Evaluate the feasibility of using the segment of NW Front Avenue on the north side of the site as the primary access.

Site transportation issues, recommendations, and cost estimates are described below in Table 11.

Table 11: Siltronic (Site 11) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Blockage and safety issues due to at-grade spur rail crossings at the intersection of NW 61st Avenue and NW Front Avenue.	Study intersection geometry, signage, and striping for safety.	$4,000
2	Blockage due to at-grade spur rail crossings along NW 61st Avenue/NW Balboa Avenue.	Prepare a comprehensive study of the cost-benefit of constructing a new grade-separated crossing of the BNSF main line with a new full directional intersection or interchange with US 30 in the vicinity of NW Balboa. The study should consider the following: • Value of a new grade separated crossing to existing or potential businesses. • Origins and destinations of freight and commuter traffic accessing businesses in the area. • Added time required to access US 30 via existing overcrossing at NW Kittridge for both northbound and southbound trips. • Impact that improved access could have on the marketability of parcels in the vicinity. • Emergency access.	$40,000
3	Blockage and safety issues due to at-grade rail crossing of BNSF main line on NW Balboa immediately east of US 30[1].		
4	Restricted turn movements from NW Balboa to US 30 (right turn only)[1].		
		Evaluate the feasibility of using the intersection of NW Front Ave and US 30 as the primary access.	NA

[1] BNSF has applied to abandon this crossing. ODOT and the City of Portland are currently evaluating ways to provide alternative access.

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Figure 11:
Access Issues: Site 11 - Siltronic

N

0 500 1,000 2,000
Feet

Legend

🟥 Site Location

⑥ Access Issue

┼ Railroad

URS

Siltronic – Regional System Access

There are two primary routes for access from the Siltronic site to the major regional transportation facilities:

- Via NW Front Avenue and NW 61st Avenue/NW Balboa Avenue to US 30 and I-405.
- Via NW Front Avenue and NW Kittridge Avenue to US 30 and I-405.

Regional system projects that could improve accessibility to and from the Siltronic site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via NW Front Avenue and NW 61st Avenue/NW Balboa Avenue to US 30 and I-405.
    - Realign Saltzman/Balboa (19) (Would only occur if BNSF crossing is not closed).
- Via NW Front Avenue and NW Kittridge Avenue to US 30 and I-405.
    - ITS improvements on US 30 (24).

Site 12: Stauffer Chemical

The Stauffer Chemical site is made up of two tax lots that are separated by N Marine Drive. The lot on the north side of N Marine Drive is a long narrow lot with a steep slope that runs between N Marine Drive and the Columbia River. A small portion on the west end of the site could be developed. The lot on the south side of N Marine Drive is a much larger parcel. There are 15 total vacant acres on the two sites (see Figure 12).

Stauffer Chemical Site Access

It is not practical to provide access to the portion of the site north of N Marine Drive. There is a steep slope up to N Marine Drive and this section of N Marine Drive is on top of a berm, at the end of an overpass, and on a curve, presenting significant sight distance issues. N Marine Drive could be accessed from the eastern portion of the site, but a long access road to would need to be built along the shore, which is steep and narrow, in order to access the developable portion at the west end. It may not be worth building this long access road to access such a small site.

Access from the west would require a very long access road through the T-6 property on the opposite side of the rail yard from N Marine Drive. This would not be a practical means of accessing such a small site. However, the Port of Portland owns all of the property west of the Stauffer Chemical Site, suggesting that if T-6 is expanded towards the east, it would be reasonable for the Port of Portland to acquire this site.

Access to the portion of the Stauffer Chemical site south of N Marine Drive is via N Suttle Road on its southern boundary. North Suttle Road connects to N Portland Road at an unsignalized intersection, providing access to N Marine Drive and I-5. North Suttle Road includes three at-grade spur rail crossings, including one at the intersection of N Suttle Road and N Portland Road, suggesting occasional train blockage and potential safety issues.

An alternative access to N Marine Drive on the north side of the site would not be recommended. There are sight distance issues and traffic on N Marine Drive travels at high speed.

Occasional train blockage on N Suttle Road.

High speed and sight distance issues on N Marine Drive (looking east).

Transportation strategies that should be considered to improve the attractiveness for employee intensive or truck intensive uses include:

- Upgrade of traffic and railroad control at the intersection of N Suttle Road and N Portland road.

Site transportation issues, recommendations and cost estimates are described below in Table 12.

Table 12: Stauffer Chemical (Site 12) – Transportation System Issues and Recommendations

Map #	Potential Access Issue (north of N Marine Drive)	Recommended Solution	Estimated Cost
1	Sight distance issues at west end of site.	No action recommended.	
2	Potential sight distance issues at east end of site.	No action recommended.	
3	Long access road along steep slope required to access site from the east.	No action recommended.	
4	Long access road through Port of Portland T-6 property required to access site from the west.	No action recommended.	

Map #	Potential Access Issue (south of N Marine Drive)	Recommended Solution	Estimated Cost
5	Blockage due to at-grade rail spur crossings along Suttle Road.	No action recommended.	
6	Blockage and safety issues due to at-grade rail spur crossings at intersection of N Suttle Road and N Portland Road.	Upgrade geometry, striping, and other traffic control devices.	$45,000
7	Unsignalized intersection at N Suttle Road and N Portland Road.		
8	Sight distance problems accessing site directly from N Marine Drive.	Access directly to N Marine Drive does not appear to be a feasible option due to sight distance and high speeds on N Marine Drive.	

Stauffer Chemical – Regional System Access

There are three primary routes for access from the Stauffer Chemical site to the major regional transportation facilities.

- Via N Marine Drive to I-5.
- Via N Portland Road, N Columbia Boulevard, N Lombard, and the St Johns Bridge to US 30 and I-405.
- Via N Marine Drive, N Lombard, and the St Johns Bridge to US 30 and I-405.

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Figure 12:
Access Issues: Site 12 - Stauffer Chemical

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Regional system projects that could improve accessibility to and from the Stauffer Chemical site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via N Marine Drive to I-5.
    - ITS improvements on Marine Drive (3).
- Via N Portland Road, N Columbia Boulevard, N Lombard, and the St Johns Bridge to US 30 and I-405.
    - Columbia Blvd/Portland Rd intersection improvements (61).
    - Lombard (Burgard) bridge replacement (48).
- Via N Marine Drive, N Lombard, and the St Johns Bridge to US 30 and I-405.
    - Marine Drive (at Rivergate West) Rail Crossing, Phase 2 (41).
    - Lombard at Columbia Slough – Strengthen bridge (47).
    - Widen Lombard – Purdy to Simmons (49).
    - Lombard (Burgard) bridge replacement (48).

Site 13: Vigor (Cascade General)

The Vigor (Cascade General) site 13 is located at the northwestern end of Swan Island at the end of N Lagoon Avenue and N Channel Avenue. The site has 65 occupied acres with 25 acres available for redevelopment (see Figure 13).

Vigor (Cascade General) Site Access

Truck and auto access to the Vigor (Cascade General) site is via N Going Street and N Lagoon Avenue (westbound) and N Channel Avenue (eastbound).

There are approximately five at-grade spur rail crossings on N Channel Avenue, suggesting occasional blockage. There is only one route in and out of Swan Island (N Going Street), which may limit development of the Vigor (Cascade General) site if congestion is an issue.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive use include:

- Existing system level projects included in the Freight Master Plan to improve N Going Street by redesigning the Going/Greeley interchange, adding a climbing lane to N Going Street, replacing the UPRR overpass, and evaluating a potential secondary access to Swan Island by extending N River Street.
- Project currently under way to implement "smart" traffic signal system at N Going Street and N Interstate Avenue. The City should monitor the project to see if it effectively reduces congestion.

Site transportation issues, recommendations, and cost estimates are described below in Table 13.

Table 13: Vigor (Cascade General) (Site 13) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Blockage due to at-grade rail crossings on N Channel Avenue approaching the site.	No action recommended.	
2	Potential congestion issues on N Going Street.	Addressed by projects 31 and 32, ITS improvements on Going St. and interchange improvements at Going St. and Greeley Ave., already identified, and by current plans to improve the signal controller at N Going St. and N Interstate Ave .	

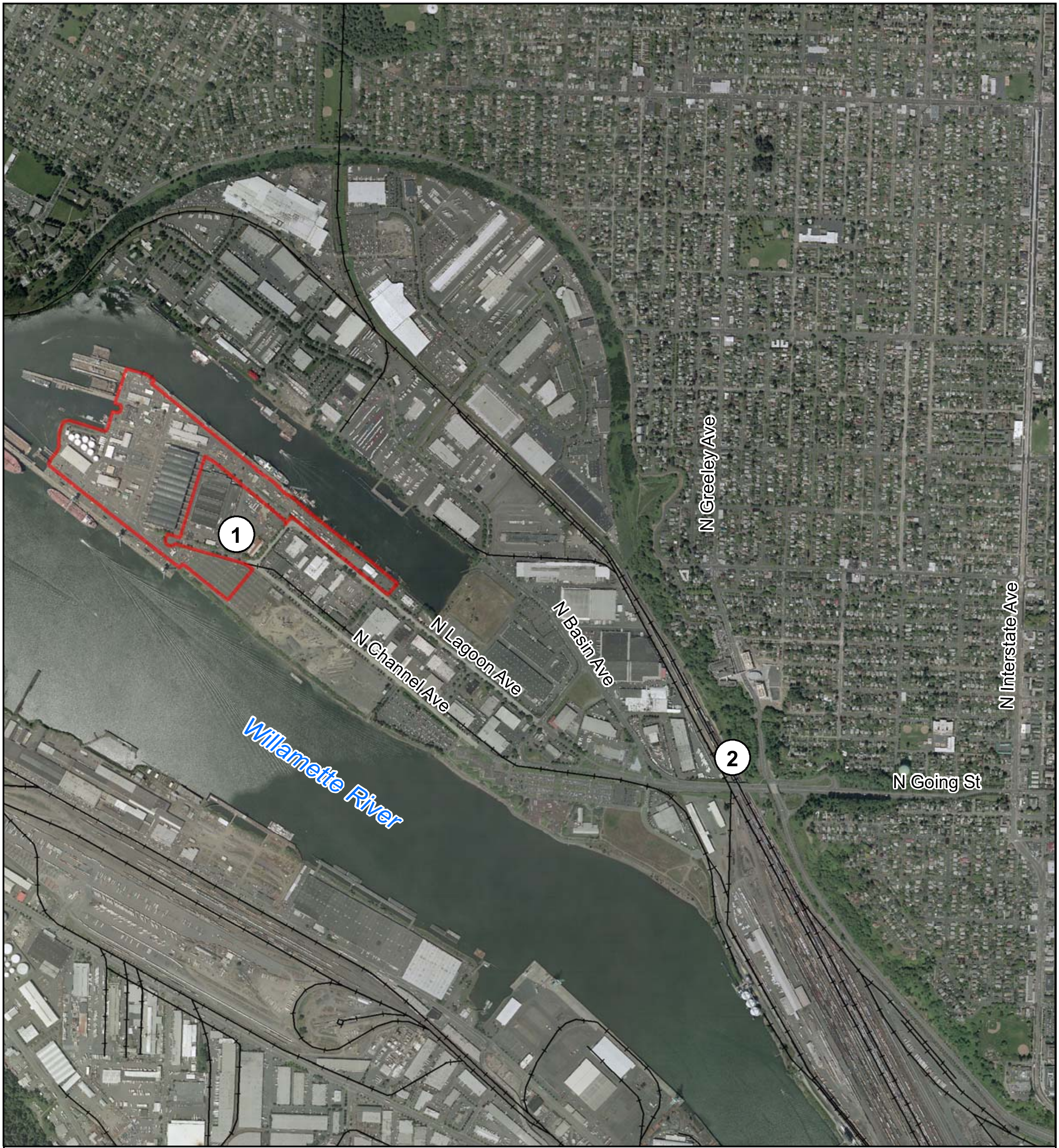

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Figure 13:
Access Issues: Site 13 - Vigor (Cascade General)

Legend

🟥 Site Location

⑥ Access Issue

—+— Railroad

Vigor (Cascade General) – Regional System Access

There are two primary routes for access from the Vigor (Cascade General) site to the major regional transportation facilities.

- Via N Lagoon Avenue/N Channel Avenue and N Going Street to I-5 (northbound).
- Via N Lagoon Avenue/N Channel Avenue and N Going Street to N Greeley Avenue and I-5 (southbound).

Regional system projects that could improve accessibility to and from the Vigor (Cascade General) site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via N Lagoon Avenue/N Channel Avenue and N Going Street to I-5 (northbound).
    - Going Street at Swan Island – Replace bridge over UPRR (30).
    - Going/Greeley Climbing Lane and Interchange Improvements (31).
    - Going Street ITS improvements (32).
    - Evaluate secondary access road to Swan Island by extending N River Street (33).
- Via N Lagoon Avenue/N Channel Avenue and N Going Street to N Greeley Avenue and I-5 (southbound).
    - Going Street at Swan Island – Replace bridge over UPRR (30).
    - Going/Greeley Climbing Lane and Interchange Improvements (31).
    - Going Street ITS improvements (32).
    - Evaluate secondary access road to Swan Island by extending N River Street (33).

Site 14: PGE

The PGE site is located north of Linnton, just south of the Sauvie Island Bridge. It is currently in use by PGE for power lines. It has 34 acres available for redevelopment (see Figure 14).

PGE Site Access

Truck and auto access to the PGE site is via NW Marina Way, which meets US 30 south of the site.

Access to the site includes a stop-controlled intersection at NW Marina Way and US 30, which has sight distance limitations. There is one at-grade railroad crossing approximately 300 feet east of US 30, suggesting a risk of occasional blockage. NW Marina Way is a dead-end street.

At-grade rail crossing on NW Marina Way.

Potential sight distance issue looking north on US 30 from NW Marina Way.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive uses include:

- Evaluation of traffic signal warrants and sight distance at the intersection of NW Marina Way and US 30.

Site transportation issues, recommendations and cost estimates are described below in Table 14.

PGE – Regional System Access

There is one primary route for access from the PGE site to the major regional transportation facilities.

- Via NW Marina Way and US 30 to I-405.
- Via NW Marina Way and US 30 to the St. Johns Bridge and N Columbia Boulevard to I-5.

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Figure 14:
Access Issues: Site 14 - PGE

Legend

🟥 Site Location

⑥ Access Issue

—+— Railroad

URS

Table 14: PGE (Site 14) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Stop-controlled access to US 30.	Perform signal warrant and sight distance analysis at intersection of NW Marina Way and US 30. Consider a more comprehensive study of safety and access to Highway 30 for adjacent land uses in the area north of the Linnton community.	$3,000
2	Blockage due to at-grade rail crossing on NW Marina Way.	No action recommended.	

- Via NW Marina Way and US 30 to the St. Johns Bridge and N Marine Drive to I-5.

Regional system projects that could improve accessibility to and from the PGE site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via NW Marina Way and US 30 to I-405.
    - ITS improvements on US 30 (24).
- Via NW Marina Way and US 30 to the St. Johns Bridge and N Columbia Boulevard to I-5.
    - Lombard (Burgard) Bridge replacement (48).
    - I-5 Delta Park – Highway widening and ramp improvements, including reconstruction of the Denver Viaduct (1 and 5).
- Via NW Marina Way and US 30 to the St. Johns Bridge and N Marine Drive to I-5.
    - Lombard (Burgard) Bridge replacement (48).
    - Widen Lombard – Purdy to Simmons (49).
    - Lombard at Columbia Slough – Strengthen bridge (47).
    - Marine Drive (at Rivergate West) Rail Crossing, Phase 2 (41).

Site 15: Malafouris

The Malafouris site is a 2 acre occupied site located on the east side of the Willamette River, at the south end of the Albina Rail Yard, just north of the Fremont Bridge. It is on the shoreline of the river and is currently in non-river dependent use (see Figure 15).

Malafouris Site Access

Truck and auto access to the Malafouris site is via N Interstate Avenue and N River Street.

Access to the site includes an overcrossing on N River Street over the Union Pacific railroad tracks, west of N Interstate Avenue. N River Street shares right-of-way with a railroad line that runs down the center of the road in places. The street is in very poor condition and has a significant amount of truck traffic. Several sites along N River Street load and unload trucks in the roadway, creating congested conditions. There is also a significant amount of employee parking along the roadway adjacent to loading areas.

Shared ROW with railroad. Looking south on N River Street.

Poor pavement conditions on N River Street in front of site.

Transportation strategies that should be considered to improve the attractiveness for employment intensive or truck intensive uses include:

- Resurface pavement along N River Street.

Site transportation issues, recommendations and cost estimates are described below in Table 15.

Table 15: Malafouris (Site 15) – Transportation System Issues and Recommendations

Map #	Potential Access Issue	Recommended Solution	Estimated Cost
1	Blockage and safety issues due to existing railroad tracks down the middle of N River Street.	No action recommended.	
2	Very poor pavement condition on N River Street.	Full depth pavement reconstruction along N River St. from approximately N Harding Avenue to N Essex Avenue (approximately 1000 feet).	$140,000
3	Congestion due to parking and truck loading on N River Street.	No action recommended.	

Malafouris – Regional System Access

There are two primary routes for access from the Malafouris site to the major regional transportation facilities.

- Via N River Street, N Interstate Avenue, and N Going Street to I-5.
- Via N River Street, N Interstate Avenue, and N Broadway Street to I-5.

Regional system projects that could improve accessibility to and from the PGE site are included in Figure 2 – System Transportation Deficiencies and Projects. Significant system-level projects include (Note: The number in parentheses is the project map number in Figure 2):

- Via N River Street, N Interstate Avenue, and N Going Street to I-5.
  - I-5 Reconstruction and Widening, Greeley to I-84 (8).
- Via N River Street, N Interstate Avenue, and N Broadway Street to I-5.
  - I-5 Reconstruction and Widening, Greeley to I-84 (8).

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Figure 15:
Access Issues: Site 15 - Malafouris

Legend

🟥 Site Location

③ Access Issue

—+— Railroad

URS

Economic Analysis – Project Ranking

This section evaluates transportation improvements for Portland's Working Harbor area based on their potential economic development benefits. The projects listed in Table 2 are examined to determine a ranking of relative benefit to the working harbor study area. Projects ranked here are specific roadway, rail and marine system improvement projects. The ranking does not include proposals for cost-benefit and feasibility studies that are identified in Table 2 or described in the report text.

The Working Harbor study area is divided into seven subareas, each consisting of one to four Transportation Analysis Zones (TAZ). A TAZ is a small, geographic area used in modeling and analyzing transportation projects. Each project from Table 2 was evaluated to assess whether it would improve access to each TAZ. The number of acres in each TAZ available for redevelopment was derived from job growth forecasts conducted by the City of Portland Bureau of Planning in August, 2006. If a project improves access to a given TAZ, the number of acres of land in that TAZ available for redevelopment is included in the total Acres Affected in Table 16. The Acres Affected is used to calculate a cost per acre for each project.

Projects are ranked based on a point system. Projects are assigned points based on the following:

- One point for projects that are below the average cost per acre for all projects.
- One point for projects that address a deficiency that was identified in business interviews as a priority for area businesses.
- One point for projects that improve access to one of the 15 opportunity sites if that site has 20 acres or more of land available for redevelopment.
- One point for projects that not only improve access to a particular subarea, but also result in inter-regional transportation improvement.

A project can score up to four points. See Table 16 for project rankings. The following is a list of projects that scored the highest (four points):

Roadway Projects:

- I-5 Delta Park (funding has been identified for this project and it is completing the environmental process).
- Yeon ITS Project.
- Going Street at Swan Island – weight restricted bridge.
- Going Street ITS Project.
- Lombard/Burgard – replace weight restricted bridge.

Rail Projects:

- Double tracking of Kenton line.

The following projects earned three points in the ranking:

Roadway Projects:
- Denver Viaduct reconstruction.
- I-5 reconstruction and widening – Greeley to I-84.
- US 30 Willbridge area – add left turn lane.
- US 30 at Salzman/Balboa intersection realignment (not recommended if Balboa/BNSF crossing is closed).
- US 30 at 112th – add traffic signal.
- Going/Greeley interchange improvements.
- River Avenue Extension – Feasibility Study
- Marine Drive at Rivergate West rail crossing – construct grade separation.
- Lombard at Columbia Slough – strengthen bridge.
- Widen Lombard – Purdy to Simmons.
- Columbia Boulevard ITS.
- Rivergate ITS.
- Columbia Boulevard/N Portland Road – intersection improvements.
- Ivanhoe/Philadelphia intersection improvements.
- Lombard/St Louis/Ivanhoe multi-modal improvements.
- Burgard/Lombard – street improvements

Rail Projects:
- North Portland Junction rail improvements.
- Vancouver BNSF - rail bridge (Columbia River).
- BNSF – Columbia Bridge track improvements.
- Peninsula Junction – track realignment/double tracking.
- Brooklyn line to Graham line rail connection.
- South Rivergate Rail Yard – expansion.
- Terminal 5 Unit Rail Loops.
- Ramsey Rail Yard – capacity improvements.

Marine Projects:
- Columbia River Channel Deepening.

Table 16: Project Evaluation Matrix

		Rivergate South				Rivergate West			Rivergate North					Swan Island					NW Industrial District				Willbridge		Linnton		Acres	Cost	Cost	Cost	Business	20 +	Inter-	Total
	TAZ #	285	286	288	Subtotal	289	290	Subtotal	291	292	293	294	Subtotal	213	214	224	225	Subtotal	32	33	34	Subtotal	36	Subtotal	37	Subtotal	Affected	Estimate	per Acre	Score[1]	Priority[2]	Acres Affected[3]	Regional Access[4]	Score
	Acres Available for Redevelopment	47	45	51	143	262*	71	71	53	65	9	24	151	5	6	18	81	110	18	46	39	103	112	112	39	39								
#	Project																																	
	Road Projects																																	
1	Denver Viaduct - Reconstruct viaduct	x	x	x	143																						143	2,000,000	$13,986	x		x	x	3
3	Marine Drive(Portland Rd to 185th) - ITS improvements					x	x	333	x	x	x	x	151														484	750,000	$1,550	x			x	2
4	I-5 Columbia Blvd improvments - Interchange improvements	x	x	x	143	x	x	333																			476	71,000,000	$149,160			x	x	2
5	I-5 Delta Park - Widen highway	x	x	x	143	x	x	333	x	x	x	x	151	x	x	x	x	110	x	x	x	103	x	112	x	39	991	48,000,000	$48,436	x	x	x	x	4
7	West Hayden Crossing - Construct bridge	x	x	x	143	x	x	333	x	x	x	x	151	x	x	x	x	110	x	x	x	103	x	112	x	39	991	49,000,000	$49,445	x				1
8	I-5 Reconstruction and Widening Greeley to I-84	x	x	x	143	x	x	333	x	x	x	x	151	x	x	x	x	110	x	x	x	103	x	112	x	39	991	106,000,000	$106,963		x	x	x	3
17	US 30 at Lake Yard Hub: Access Improvements - New access at US 30/NW 35th Ave intersection																			x	x	85					85	2,000,000	$23,529	x			x	2
18	US 30 in Willbridge area - Install left-turn lane																						x	112			112	300,000	$2,679	x		x	x	3
19	US 30 at Saltzman/Balboa - Realign intersection																						x	112			112	600,000	$5,357	x		x	x	3
21	14/16th Connections																		x			18					18	200,000	$11,111	x			x	2
24	Yeon/US 30 (Nicolai to St. Johns Bridge) ITS																		x	x	x	103	x	112			215	222,000	$1,033	x	x	x	x	4
28	112th ave/US30 intersection imrovements - Add traffic signal																								x	39	39	135,000	$3,462	x	x		x	3
30	Going Street at Swan Island - Replace weight restricted bridge																x	81									81	3,600,000	$44,444	x	x	x	x	4
31	Going/Greeley Climbing Lane and Interchange Improvements																x	81									81	11,600,000	$143,210		x	x	x	3
32	Going (Interstate-Swan Island) - ITS improvements																x	81									81	295,000	$3,642	x	x	x	x	4
33	River Ave (Port Ctr Way-River Ave) Street Extension - Feasibility study of alternative access road													x		x	x	104									104	13,100,000	$125,962		x	x	x	3
36	Heineman Road - Construct new road					x	x	333																			333	570,000	$1,712	x				1
41	Marine Drive (at Rivergate West) Rail Crossing, Phase 2 - Construct grade separation					x	x	333	x	x			118														451	18,000,000	$39,911	x		x	x	3
43	Leadbetter(Marine Drive Loop) Street Extension/Overcrossing - Construct grade separation									x			65														65	10,800,000	$166,154		x			1
47	Lombard at Columbia Slough - Strengthen bridge					x	x	333	x	x	x		127														460	4,900,000	$10,652	x		x	x	3
48	Lombard(Burgard) - Replace weight restricted bridge		x	x	96																						96	1,500,000	$15,625	x	x	x	x	4
49	Widen Lombard-Purdy to Simmons					x	x	333																			333	4,400,000	$13,213	x		x	x	3
50	Columbia Blvd (I-205 - Burgard) ITS	x	x	x	143	x	x	333																			476	310,000	$651	x		x	x	3
51	Rivergate ITS					x	x	333	x	x	x		127														460	200,000	$435	x		x	x	3
52	Lombard (MLK-Philadelphia) ITS																										0	210,000	NA					0
61	Columbia Blvd/Portland RD - Intersection improvements	x	x	x	143																						143	700,000	$4,895	x	x		x	3
62	Ivanhoe/Philadelphia Intersection Improvements	x	x	x	143																						143	107,000	$748	x	x		x	3
63	Lombard/ST. Louis/Ivanhoe Multimodal Improvements	x	x	x	143																						143	1,400,000	$9,790	x	x		x	3
75	Lombard (Rivergate T-6) Multi-Modal Improvements								x	x			118														118	3,600,000	$30,508	x			x	2
76	Burgard-Lombard Street Improvements		x	x	96																						96	17,200,000	$179,167		x	x	x	3
	Rail Projects																																	
11	North Portland Junction Rail Improvements	x	x	x	143	x	x	333	x	x	x	x	151	x	x	x	x	110	x	x	x	103	x	112	x	39	991	9,200,000	$9,284	x		x	x	3
12	Vancouver BNSF Rail Bridge Project (Columbia River)	x	x	x	143	x	x	333	x	x	x	x	151	x	x	x	x	110	x	x	x	103	x	112	x	39	991	42,000,000	$42,381	x		x	x	3
13	BNSF Line at Columbia Bridge Track Improvements	x	x	x	143	x	x	333	x	x	x	x	151	x	x	x	x	110	x	x	x	103	x	112	x	39	991	8,000,000	$8,073	x		x	x	3
14	Penn Junction UP/BNSF Main Line - Track realignment, double tracking	x	x	x	143	x	x	333	x	x	x	x	151	x	x	x	x	110									737	3,500,000	$4,749	x		x	x	3
15	Kenton Rail Line Upgrade - Double tracking	x	x	x	143	x	x	333	x	x	x	x	151	x	x	x	x	110									737	25,400,000	$34,464	x	x	x	x	4
16	UP Line Connection (Brooklyn Line - Graham Line) - Construct new connection													x	x	x	x	110									110	11,000,000	$100,000		x	x	x	3
34	UP Line Albina Yard upgrade - Upgrade tracks, increase capacity													x		x	x	104									104	8,800,000	$84,615			x		1
64	Barnes Rail Yard - Bonneville Rail Yard Track Expansion	x		x	98	x	x	333																			431	11,900,000	$27,610	x		x		2
65	So. Rivergate Rail Yard Expansion Phase 1	x	x	x	143	x	x	333																			476	6,000,000	$12,605	x	x	x		3
66	Terminal 5 Unit Rail Loops #3 & #4					x	x	333																			333	2,800,000	$8,408	x	x	x		3
67	Barnes to Terminal 4 track Expansion	x	x		92																						92	1,000,000	$10,870	x				1
68	Slough Rail Bridge					x		262	x				53														315	4,500,000	$14,286	x				1
69	Terminal 4 Pier 2 Rail Yard Improvements	x	x	x	143																						143	54,000,000	$377,622					0
71	Terminal 6 Intermodal Third Lead								x				53														53	4,500,000	$84,906					0
72	Terminal 6 A&B Yards								x				53														53	3,000,000	$56,604	x				1
73/74	Ramsey Rail Complex(south of Columbia Slough Bridge): Capacity					x	x	333																			333	12,000,000	$36,036	x	x	x		3
	Marine Terminal Projects																																	
37	Access Tunnel at Hyundai/Kia Facility - Connect T-6 to Rivergate								x				53														53	3,000,000	$56,604	x				1
38	Terminal 4 On-Site Overcrossing - Connect lower T-4 and Lombard		x		45																						45	2,500,000	$55,556	x				1
39	Terminal 4 Access Improvements - Construct overcrossing		x		45																						45	10,000,000	$222,222					0
40	T-4 Optional Terminal Lower Lot Access - Provide secondary access route		x		45																						45	7,000,000	$155,556					0
42	Terminal 6 - Marine Drive Overcrossing - Construct grade separation								x				53														53	18,000,000	$339,623					0
44	Terminal 4 driveway consolidation - Intersection improvement		x		45																						45	1,000,000	$22,222	x	x			2
54	Terminal 6 Container Dock Extension								x				53														53	19,400,000	$366,038					0
55	Terminal 6 Dock Structural Upgrades								x				53														53	15,000,000	$283,019					0
56	Terminal 6 Computer System Upgrades								x				53														53	2,000,000	$37,736	x				1
57	Terminal 4 Grain Elevator Barge Conveyor Rebuild		x		45																						45	1,500,000	$33,333	x				1
58	Terminal 6 Additional Post-Panamax Cranes								x				53														53	33,400,000	$630,189					0
59	Columbia River Channel Deepening		x	x	96	x	x	333	x			x	77	x		x	x	104	x	x		64	x	112	x	39	825	150,600,000	$182,545		x	x	x	3
60	Terminal 6 Berth Deepening								x				53														53	1,250,000	$23,585	x	x			2
70	Honda Rail and Berth Upgrades								x				53														53	3,500,000	$66,038	x				1

[*] Includes 113 acre Port of Portland site on N Lombard

[1] Project cost per acre is below the average of all projects

[2] Project addresses a deficiency that was identified in business interviews as a priority

[3] Project improves access to one or more sites that have 20 acres or more available for redevelopment (based on 15 key sites identified by City of Portland)

[4] Project improves a route classified by the Freight Master Plan as a Regional Truck Way or Priority Truck Street, or improves rail or marine facilities on a regional scale

Average Cost per Acre: $77,868

Recommendations and Conclusions

Analysis of deficiencies identified by area businesses, access issues at opportunity sites, and economic development potential of transportation projects included in local plans reveals several areas where further action should be taken. These recommendations include projects and strategies included in existing plans as well as new recommendations based on the Working Harbors Transportation Infrastructure Analysis. The city should make the following recommendations a priority.

Previously Identified Projects

- Continue working on short term solutions to improve the I-5/I-84 interchange.
- City of Portland plans to implement "smart" traffic signal technology at the intersection of N Going Street and N Interstate Avenue. The smart signals will be able to allocate green time more effectively and should improve intersection function. Following implementation, PDOT should monitor intersection performance.
- Implement grade-separation of the Peninsula Junction identified in the 2003 I-5 Rail Capacity Study.
- Increase the priority of the North Willamette River Crossing study in the Regional Transportation Plan.

New Transportation Recommendations

- Prepare a strategy that can maintain and improve access to the rail system for smaller shippers.
- Conduct a local circulation study in the Northwest Industrial District to develop strategies for improving access between NW Yeon Avenue and NW Front Avenue in the vicinity of NW Nicolai Street.
- Evaluate the feasibility of extending NW 26th Avenue south of NW Yeon Avenue to improve access to properties in that area.
- Evaluate the potential for an advance warning system on NW Front Avenue to divert traffic during train crossings.
- Conduct a local circulation study in the Linnton area to evaluate the potential for combining accesses and improving safety on US 30.
- Conduct a study on Swan Island to evaluate potential rail improvements and opportunities to remove rail spurs.
- Prepare a cost-benefit analysis of constructing a grade-separated crossing over the BNSF railroad in the vicinity of NW Balboa Avenue.
- Investigate the feasibility of a new regional rail yard to relieve congestion at Albina Yard.
- Evaluate cost-benefit of city acquisition and improvement of Time Oil Road.
- Evaluate the feasibility of extending N Bradford Street through the T-4 property to connect with N Terminal Road.
- Pursue implementation of a Whistle-Free zone in the St Johns area.

Appendix A

Naito Parkway – Steel Bridge Railroad Crossing - Potential Treatments

Grade separation of the railroad crossing of NW Naito Parkway at the Steel Bridge could alleviate the periodic traffic congestion related to train crossings. Strategies to grade separate at this location, however, are limited:

- Strategies that would *elevate* the UPRR over NW Naito Parkway or elevate NW Naito Parkway over the UPRR *are not feasible* due to the upper (roadway/MAX) deck of the Steel Bridge.
- Strategies that would lower the UPRR under NW Naito Parkway or lower NW Naito Parkway under the UPRR could be feasible but would likely have significant impacts and be very expensive. Issues that would be faced with lowering either the roadway or the railroad include:
    - High water table – Any cut in this area adjacent to the river would need to provide a high level of water management (pumps, sealant, etc.) due to high water tables.
    - Retaining walls – Either a railroad cut or a roadway cut would require a significant amount of retaining walls.
    - Roadway cut – The roadway cut would require that NW Naito Parkway be lowered for approximately 700 feet on either side of the rail crossing.
    - Railroad cut – The railroad cut would require that the lower section of the Steel Bridge be rebuilt in order to allow the tracks to be lowered in order to enter the west river bank and tunnel under NW Naito Parkway with sufficient clearance. The cut into the riverbank could place portions of the track within the 100-year floodplain. The unique telescoping feature of the Steel Bridge, which allows the heavy rail tracks to be raised independent of the upper deck, could be compromised.
    - Area impacts – Potential impacts in the immediate area could include:
        - Closure of McCormick Pier driveway(s)
        - Impacts to the Willamette Greenway Trail
        - Impacts to Tom McCall Waterfront Park
        - Pedestrian and bike impacts
        - Environmental impacts
        - Endangered species impacts
        - Reconstruction of tracks at Union Station
        - Construction impacts

Appendix B

Cost methodology for site access improvements

Introduction

As part of the Working Harbor Reinvestment Strategy, the consulting team has considered the micro and macro aspect of transportation systems. Mobility and access were evaluated at each site and then the area roadway network was studied to determine the relation between sites and area access.

In general, three components of infrastructure improvements were related to cost estimating.

- Traffic Study Reports
- Signal Design/Installation/Operation
- Roadway Engineering/Construction

Cost estimates at this preliminary stage of study are intended to provide an order of magnitude sense of the potential cost and budget for the recommended actions. The Transportation Infrastructure Analysis does not provide the level of detail that would be required to prepare more accurate costs for the various elements.

Traffic Study Reports

The cost related elements of a traffic study as considered for the working harbor reinvestment strategy include but are not limited to: Data collection, analysis of raw data, site visits, modeling of intersections within a corridor and use of computer software for various types of analysis such as warrants, capacity and progression. Costs are estimated for each element in the process of developing a report.

Costs for these procedures vary at different locations in proportion to the complexity of the study, stakeholder interest and time estimated to generate a report. Estimates for traffic studies are based on assumptions related to the study approach and complexity and a rough estimate of the overall level of effort required.

Traffic Signal Design/Installation/Operation

Intersection control improvements may include a newly signalized intersection or a simple modification/upgrade. Some modifications may include small geometric changes at a single leg or multiple legs of an intersection. Included in the costs are:

- engineering fees
- cost of materials
- labor
- traffic control during construction

Depending on the circumstance, the costs could be at the expense of business owners or the jurisdictional authority. Costs vary at different locations due to the quantity of materials necessary for completing the project. Costs are based on present costs of materials and labor time.

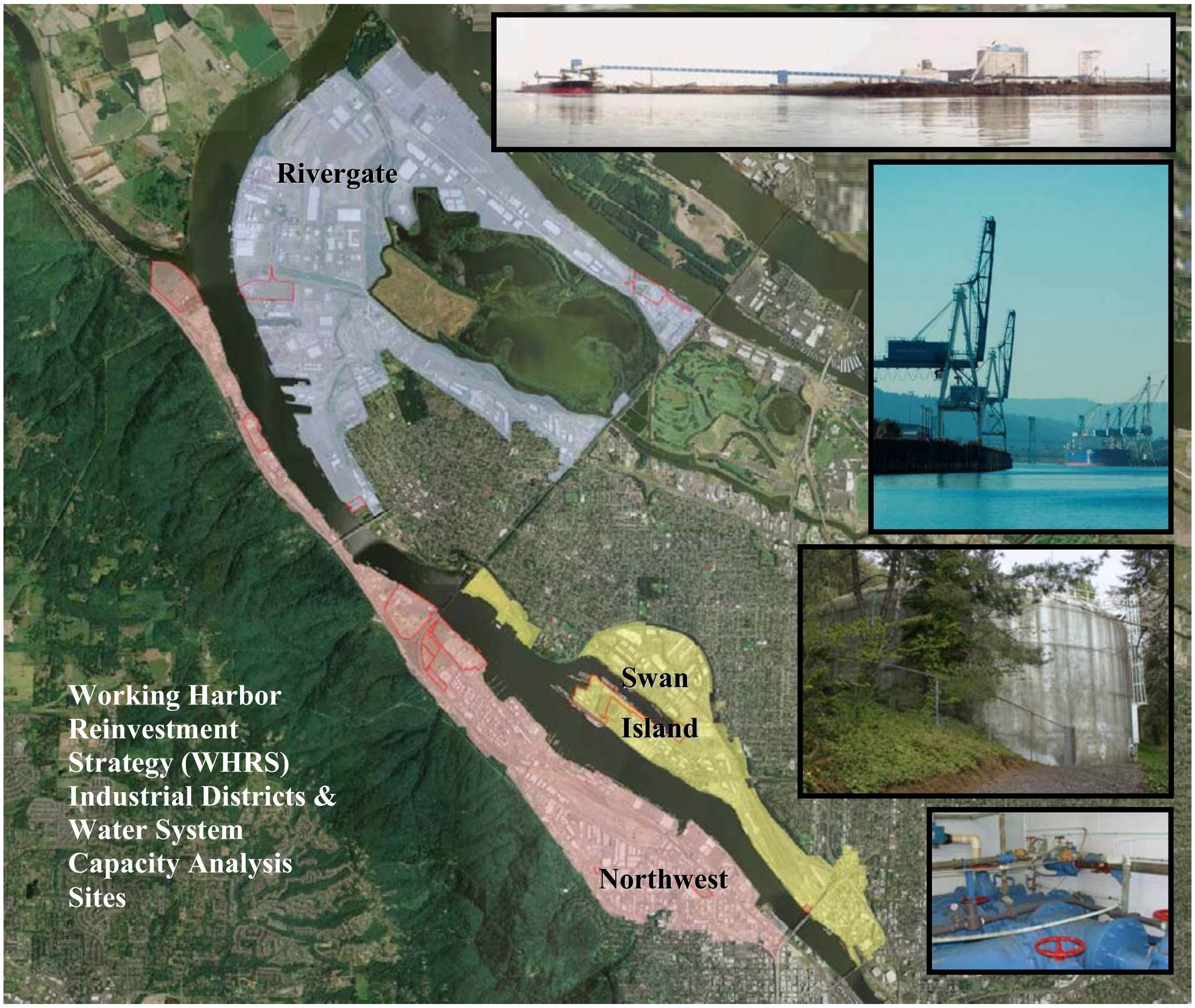
Roadway Engineering/Construction

Project types vary within this category. For example, at the Time Oil site, realignment of the driveway is recommended. At site 8, the Linnton Plywood site, a milling and overlay process is recommended.

Estimating costs on such items as overlays, road re-construction and rail replacement installations were made by comparison to existing estimates and actual costs for similar projects. In some cases where land must be acquired for road widening, an accurate estimate would require an in-depth research effort, not included in this report.

07/19/07 DRAFT **Project #1105**

Working Harbor Reinvestment Strategy
Water System Infrastructure Analysis



Portland Water Bureau
Engineering Services Group
Project Planning Section

Prepared by Evan Hofeld

July 2007

- DRAFT -

Working Harbor Reinvestment Strategy
Water System Infrastructure Analysis
Project # 1105

REGISTERED PROFESSIONAL
ENGINEER
99,999
OREGON
MONTH 33, 9999
PROENGINEER NAME

EXPIRES 99/99/9999

This report represents a preliminary analysis of the water system infrastructure within the study area and does not reflect detailed engineering analysis suitable for identified projects to be moved forward for design. Cost estimates given herein are intended to provide an order of magnitude estimate of the potential cost for the identified projects and should be refined in more detailed design analyses prior to funding.

Acknowledgments

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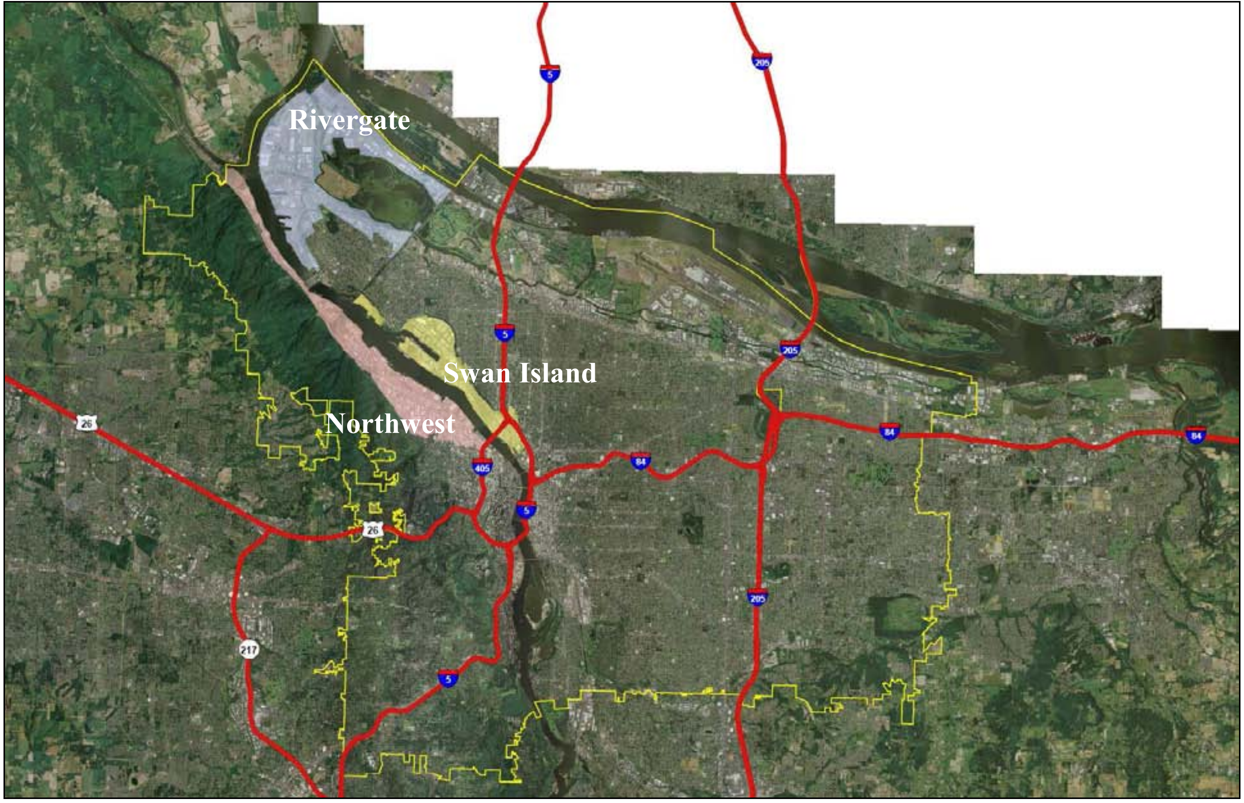
1. Executive Summary

1.1 Introduction

The Working Harbor Reinvestment Strategy (WHRS) is a 10-year program to focus on coordinating public investments in land, workforce, and infrastructure made by the City Bureaus, Portland Development Commission (PDC), and the Port of Portland in Portland's industrial centers in the Northwest, Swan Island, and Rivergate districts (see Figure 1). These investments will be made in order to stimulate and promote economic development and private investments in these industrial centers. Once finished, the WHRS will be incorporated as an economic development component of the River Plan North Reach, an update of the Willamette Greenway Plan.

The purpose of this report is to evaluate the water distribution system capacity and identify potential improvements that may be needed to support the WHRS goals. This report completes the tasks identified in an Interagency Agreement between the Bureau of Planning (BOP) and the Portland Water Bureau (PWB).

Figure 1. WHRS Districts



1.2 Background

The WHRS area is anticipated to undergo substantial job growth within the next 13 years. Metro forecasts used to prepare the 2000 Regional Transportation Plan estimate 10,460 more jobs within the Portland Harbor Area by the year 2020. Rivergate is projected to become the largest employment center within the Portland Harbor area, adding 6,590 jobs and capturing nearly 65 percent of the harbor study area's job growth. Guild's Lake and Swan Island, the study area's current largest employment centers, are forecasted to add 884 and 667 jobs, respectively. With the number of jobs estimated in 2002 being 12,155 for Guild's Lake, 8,755 for Rivergate, and 1,591 for Swan Island, the 2020 forecast represents a 36 percent increase.

The water system is an important part of meeting this growth in economic development in the WHRS area. According to a series of 80 in-depth personal interviews conducted with harbor area industry leaders

> "…nearly two-thirds of those responding indicated no change [in water usage] over the next 3-5 years. However, 38% of manufacturers report that they anticipate their water usage to increase. No major issues were noted regarding quality or quantity of service" (E.D. Hovee & Company, 2003).

Furthermore, as part of the WHRS, project staff of the BOP, PDC, and the Port of Portland conducted interviews with 25 businesses and four focus groups (approximately 60 people). The interviews were selected to reflect a cross section of industries in the harbor districts including manufacturers, warehouse and distribution, marine terminals, the three railroads, the two ports (Portland and Vancouver), and property owners and their representatives. Overall, interview respondents indicated that 14 percent of public investments should be allocated to utilities. Representatives from the manufacturing sector indicated that 27 percent of public investments be allocated to utilities, while the remaining sectors recommended anywhere from 4 to 17 percent (Bureau of Planning, 2006). The water system was not specifically addressed by any of the respondents, however, it is recognized that large water users place some importance on the affordable supply of water.

As part of the efforts in developing the WHRS and River Plan North Reach, PWB contracted with Black and Veatch in order to conduct a hydraulic analysis to identify potential deficiencies in the water distribution system given certain 10-year forecasted development scenarios. For these analyses, a fire flow of 5,000 gallons per minute (gpm) was deemed to be the most appropriate fire flow to test the system. 5,000 gpm is the zoning-based fire flow requirement for Heavy Industrial zoning (Zone IH).

1.3 Report Structure

Consistent with the tasks identified in the Interagency Agreement, the report is structured in 5 main sections:

Section 1:	Executive Summary
Section 2:	Background Information – presents background information, an overview of the WHRS, the Interagency Agreement scope of work and a general description of the WHRS area.
Section 3:	Existing Water System Condition - contains a detailed description and condition assessment of the water system infrastructure in the WHRS area. This section also describes general zoning-based fire flow requirements, identifies large water users, planned capital improvement projects and budget programs, and typical system improvements generally required for new developments.
Section 4:	Future Scenarios Analysis – presents the methodology and results of two separate analyses of the water system's ability to meet zoning-based fire flow requirements given a 10-year development forecast in the WHRS area.
Section 5:	Conclusion and Recommendations – presents conclusions derived from the existing water system infrastructure condition and the future scenarios analyses, identifies possible water system improvements, and recommends future actions to be taken to order to assess and improve the water system infrastructure in the WHRS area.

The 4 Appendices contain more detailed information on the methodologies that were used for the future scenarios analyses and the analysis reports issued by Black and Veatch.

1.4 Report Conclusions and Recommendations

The analyses demonstrated that Portland's water system in the WHRS area is:

1. In good condition with a sufficient level of reliability and redundancy;
2. Adequately sized to meet the 5,000 gpm zoning-based fire flow requirement under the forecasted development for a majority of the WHRS area; and
3. Adequately sized to meet the anticipated development of 13 of the 15 sites specified in the site-specific analysis.

Two areas (6 sites) were identified that did not meet the 5,000 gpm zoning-based fire flow:

- The first area is in the Northwest district along a 12" main running parallel to St Helens Road between the St John's Bridge and the far northern area of the Linnton Industrial Area. This early analysis indicated that the designated fire flow could be met in this location with the installation of 15,000-ft of 24" inch main running parallel to the existing 12" main along Highway 30.
- The second area is located in the Rivergate district where there is a 1,200-ft discontinuous section of 12" main along Simmons Road between Burgard and Lombard Streets. Linking this discontinuous section of main resulted in meeting the 5,000 gpm fire flow requirement.

- Three alternatives (one for Rivergate and two for Northwest) were also identified. Although the alternatives did not meet the full 5,000 gpm fire flow requirement under all demand conditions, they may prove to be a cost effective measure to provide some fire flow improvements.

Figure 2 shows the 6 sites in the two areas (one in the Northwest District and one in the Rivergate District) unable to provide the zoning-based fire flow of 5,000 gpm with the estimated demands anticipated for the forecasted development. Figure 2 also shows the two identified improvements that would meet the 5,000 gpm fire flow requirement.

Figure 2. Northwest (left side of the river) and Rivergate (right) Identified Improvements.

The two alternatives in the Northwest District include the following:

1. Installing a 16" parallel main instead of the 24" main will meet fire flows under some of the test scenarios (not all).
2. Making improvements to supply from the North Linnton tank and installing a 24" main northward would also meet fire flows in some scenarios, but would involve high costs associated with 6 rail crossings and street improvements in an unimproved right-of-way.

The alternative in the Rivergate District is a 1,700 ft, 16” main extension that would improve fire flows at the southern site only.

While completing the two identified improvements would meet the 5,000 gpm fire flow needs supporting nearly all of the types of development possible for these areas, the water system, in its current configuration, would still be able to support a great variety of future development as shown in Table 1. Fire flows shown in Table 1 would support structures as large as an average Home Depot retail store (105,000 ft^2) or could support development equivalent to Tiffany Food Service, Inc., which employing over 500 people with a total structure area of roughly 53,000 ft^2, is one of the District’s largest employers. Additionally, various on-site factors and mitigating circumstances may allow larger structures than those shown in Table 1.

It is important to note that the maximum building sizes provided are approximations only. Larger developments proposed for these sites should not be deterred without more detailed analysis using more specific information about the proposed development. Larger sites may house multiple structures of the sizes listed in Table 1, provided more than 5 hydrants are available within 300 feet of the structure. With it’s over 500 employees, Oregon Steel Mills, Inc supports roughly 1,040,000 ft^2 of buildings with 39 hydrants located on or adjacent to a single 148 acre site. At 153,000 ft^2 of structure area for every 5 hydrants, development similar to Oregon Steel Mills could potentially be located at the north end of the discontinuous 12-inch Main in the Rivergate District.

Table 1. Types of Construction Supported without Mitigation under Existing Conditions.

Site	Available Fire Flow (gpm)	Applicable Fire Flow Requirement (gpm and Duration)	Types of Construction Supported at each Site without Further Measures to Mitigate Fire Flow Requirements (Building types are based on the International Building Code)				
			IA and IB (Most Fire Resistant)	IIA and IIIA	IV and V-A	IIB and IIIB	VB (Least Fire Resistant)
			Maximum Building Area (square feet)				
South End of Discontinuous Main in Rivergate District	2,932 – 3,100	3,000 (3 hours)	83,700	47,100	30,100	21,800	13,400
North End of Discontinuous 12-inch Main in Rivergate District	4,706 - 5,554	4,750 (4 hours)	203,700	114,600	73,300	53,000	32,600
South End of Linnton Area in Northwest District	3,014 - 3,830	3,000 (3 hours)	83,700	47,100	31,100	21,800	13,400
North End of Linnton Area in Northwest District	1,343 – 2,643	1,500 (2 hours)	22,700	12,700	8,200	5,900	3,600

Another factor to consider is that increasing the system capacity in anticipation of future development introduces a host of water quality concerns. For example, if water system storage capacity increases without increases in demands, water age also increases. With increasing water age comes declining disinfectant residuals and formation of harmful disinfection byproducts such as total trihalomethanes and haloacetic acids. Adverse aesthetic effects include taste and odor issues. Industries reliant on high quality process water (e.g. high tech manufacturers such as Siltronics) may also be adversely impacted by the potential decline in water quality. In order to maintain the existing water quality, increased maintenance efforts will likely be needed at an additional cost to rate payers. For these reasons, it is recommended that the construction of the main in the Northwest District be delayed until there is a firmer commitment of development that could provide the demands necessary to keep water age low.

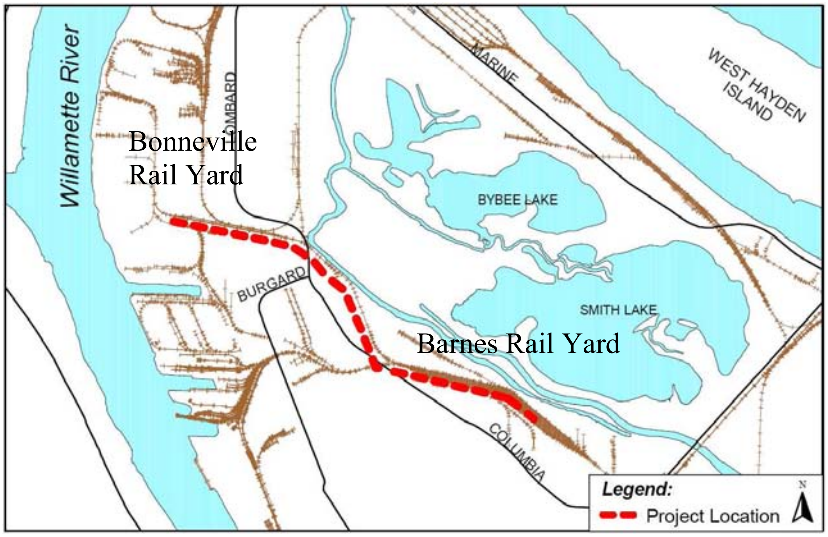
Furthermore, the improvement identified for the Linnton area of the Northwest district is estimated to cost on the order of $6.75 million, which may prove to be difficult to justify to rate payers if development either does not occur or is delayed much beyond the 10 year period. PWB infrastructure projects are approved by City Council and must be justified in order to receive funding and to be incorporated into the Capital Improvements Program.

The 12” main improvement identified for the Rivergate District could be made without significant increases in water age. However, this improvement requires installation under an active rail line, which increases the cost of the project. Lead time for railroad crossings is also considerably longer in that more time is needed to work with the rail owners and operators to ensure their approval and cooperation during construction. Figure 3 shows the Burlington Northern/ Santa Fe rail line dividing the two 12” mains in the Rivergate District.

Figure 3. Burlington Northern/Santa Fe Rail Line in the Rivergate District.

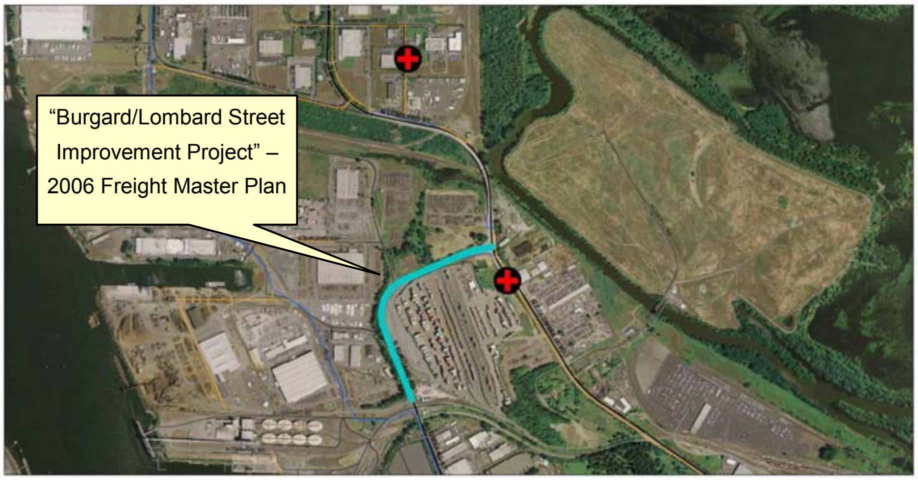
Cost savings could be realized by coordinating with the Port of Portland. The "Barnes Yard to Bonneville Yard Trackage" project (Figure 4), currently in the 2007 Port Transportation Improvement Plan, was identified by the Port as a project to be completed within the next 5 years. The Port's project calls for the construction of additional unit train trackage between the Bonneville and Barnes rail yards, which would increase the number of water main rail crossings if PWB completed the Rivergate improvement after completion of the Port's project. In order to avoid incurring additional rail crossing related expenses, PWB should pursue options to improve fire flows in this area of Rivergate. PWB should also coordinate with the Port of Portland in order to efficiently schedule improvements in this area. Access for ongoing maintenance of any mains would also have to be coordinated with the Port.

Figure 4. "Barnes Yard to Bonneville Yard Trackage" Project Location



Another alternative that would improve fire flow in the area south of the rail crossing, is to extend a 16" main roughly 1,700 feet along Burgard Road to loop into an existing dead end 8" main in an unimproved right-of-way terminating at the intersection of N. Sever Rd. and Burgard Rd. This project could be coordinated with the "N. Burgard/Lombard Street Improvement Project" (Figure 5) identified by the Portland Department of Transportation, which calls for widening the street under which the new main would be placed. This transportation project, however, is currently not funded and it is unclear at what time this project would be undertaken.

Figure 5. "N. Burgard/Lombard Street Improvement Project" Location in Rivergate



Again, the current system does support a substantial amount of development and the Port's project will likely take at least a year or more to complete, therefore it is recommended at this time to delay any immediate actions to make the identified improvement until a more detailed analysis can be completed.

Due to the afore-mentioned factors, it is recommended that PWB not proceed with immediate actions to complete the identified projects in advance of the 10-year forecasted development, but through its Capital Improvement Program and on-going analyses, investigate opportunities to improve fire flows in the identified area of the Rivergate District and continue to make improvements to the WHRS system as needs arise. Additionally, the identified improvements should be included in PWB's component of the Citywide Systems Plan, which is a citywide process of identifying infrastructure needs and projects for a 20-year planning horizon. The Citywide Systems Plan is anticipated to be completed in 2008.

2. Background Information

2.1 Overview of Working Harbor Reinvestment Strategy

The Working Harbor Reinvestment Strategy (WHRS) is a 10-year program of coordinated public investments by City Bureaus, PDC, and the Port of Portland in the harbor industrial districts. The WHRS will focus on public investments in land, workforce, and infrastructure to stimulate private industrial reinvestment as an economic development component of the River Plan North Reach, which is an update of the Willamette Greenway Plan and related design guidelines and zoning regulations. The WHRS is also related to the Willamette Industrial and Interstate Urban Renewal Areas Implementation Strategy, which is being developed concurrently with the harbor-wide reinvestment strategy. The 2003 Marine Terminals Master Plan for the Port of Portland's four marine terminals, which proposes major public investments in the harbor area, offers additional opportunities to augment and adapt to the WHRS.

Following a forecast of harbor area growth and an assessment of the infrastructure needs (Conditions, Opportunities and Constraints Analysis) and the publication of a harbor-wide portfolio of vacant and redevelopable sites, the WHRS will include a funding strategy, project selection criteria, and a 10-year capital improvements program for the harbor area. The WHRS will also recommend assistance resources and ongoing mechanisms to coordinate public investment planning that fosters economic development.

2.2 Goals and Objectives of the WHRS

- Stimulate private industrial reinvestment through public investments in land, workforce, and infrastructure.

Portland is considered a West Coast seaport and distribution hub, like Los Angeles/Long Beach, the San Francisco Bay Area, and Seattle/Tacoma. The Portland Harbor industrial districts are the heavy industrial core in the Portland metropolitan area and the hub of the state's primary rail, road, water, and pipeline infrastructure. These districts are priority locations for economic development efforts in the metro area, however, developing these areas is challenging. While industrial job creation in the Portland metro area has trended above national averages, industry managers face increasing competitive pressures in global markets and widely perceive that Portland has become a high cost region. Additionally, brownfields, aging infrastructure, and other constraints in the older harbor districts pose uncertainty and cost challenges for industrial expansion and redevelopment, even though much of the region's industrial sector relies on proximity to the harbor area transportation system and industry agglomerations. In response, public investments in land, labor, and infrastructure offer major opportunities to leverage private industrial retention and growth. Investing in these business inputs is a key factor in the area's long-term economic competitiveness.

- Coordinate capital investments by the City, PDC, and the Port of Portland that advance economic development in the harbor industrial districts.

A coordinated approach to public investments offers the potential for cost savings and a more integrated perspective among public agencies with different missions. The WHRS provides an opportunity to expand the economic development scope of three related initiatives underway in the harbor area: the City's development of the River Plan; PDC's implementation of two recently created urban renewal areas; and the Port of Portland's implementation of the 2003 Marine Terminals Master Plan. The WHRS will be developed as part of the River Plan, an area planning effort underway for the Willamette riverfront that will advance the city's River Renaissance Strategy, update the Willamette Greenway Plan (adopted by City Council in 1987) and zoning in compliance with Statewide Planning Goal 15 – Willamette River Greenway, and implement regional Goal 5 rules.

The WHRS combines the jobs and tax base advantages of harbor-wide economic development efforts with the broader public agenda of moving forward on environmental cleanup and completing other enhancements along the river as development occurs.

2.3 Water System Infrastructure Analysis Scope of Work

A key element in preparing the WHRS is a 10-year infrastructure capacity analysis, which includes the water system. As part of the Infrastructure Capacity Analysis, PWB completed a scope of work outlined in an Interagency Agreement (IA) between PWB and BOP, signed August 8, 2006. The scope of work includes the following tasks:

1) Existing Water System Condition.

    a) Describe the current water facilities, including any current deficiencies that are not related to capacity standards (e.g. pipe materials and similar). Describe the zoning based fire flow requirements and identify the location of existing large water users.

    b) Describe specific projects in the 5 year Capital Improvement Plan (CIP) (2006-2011) that affect the WHRS project area and programs that focus on service enhancements or respond to projects initiated by other agencies.

    c) Describe system improvements and general costs that are typically associated with private industrial land development proposals and generally required to be implemented at the developer's expense.

2) Future Scenarios Analyses.

    a) Define large water user for use in refining the land absorption forecast and site specific analysis.

    b) Provide a 10-yr infrastructure capacity analysis that is based on a land absorption forecast developed by BOP/PDC. The analysis will apply the assumptions stated below to 3 districts within the project area specified by BOP/PDC. It will also describe public and private system enhancements (i.e. both by PWB and developers) that are required to meet the water demand generated by those assumptions.

    c) Complete fifteen to twenty site specific "development assistance" analyses that define the water system improvements needed to develop the selected sites. The sites will be identified by BOP/PDC and will include assumptions about the specific occupancy, the building size and location on the site, and other factors necessary for the analysis.

3) Prepare Final Report.

   a) Assemble analyses. Edit and finalize report. Include cost estimates for PWB CIP projects identified in 2b if they can be estimated without incurring additional consultant costs. Identify PWB projects, if any, which could act as a catalyst for further development of the study area.

4) Support Tasks.

   a) Prepare and finalize IA between BOP and PWB

The Future Scenarios Analyses relied upon the following assumptions agreed to in the Interagency Agreement:

- The Portland water system is sized to provide sufficient water to meet fire flow requirements.

- In most cases, the zoning-based fire flow requirements are greater than the user-based water demand. This assumption holds true for most industrial users.

- To provide the 10-year infrastructure capacity analysis, the zoning-based fire flow requirements will be applied to the WHRS areas expected to develop/redevelop. This assumption will also be used to identify the deficiencies of the water transmission and distribution system, if any, from the estimated development in the WHRS area.

- The water demand for large water uses, such as silicone chip manufactures, food and beverage manufacturers or chemical manufacturers, will be estimated and used to refine the specific site analyses. Large water users (LWU) will be categorized using seven groups described as follows:

    1) General Manufacturing – Typical
    2) General Manufacturing – LWU
    3) High Tech – Typical
    4) High Tech – LWU
    5) Warehouse/Distribution – Typical
    6) Warehouse/Distribution – LWU
    7) Business Park.

- PWB will collaborate with the WHRS Team to refine the applicable assumptions in the future scenarios before any analysis is undertaken.

2.4 Operational Concerns

As identified in the IA Scope of Work, PWB is charged with identifying projects that may be needed to support future industrial development in the WHRS area. Projects identified through hydraulic analysis will be weighed with the potential for adverse impacts on water quality, which can arise when the capacity of the system exceeds user demands. Increasing the distribution system sizing to the point of exceeding existing user demands can lead to increases in water age and reduced water quality due to the added storage volume created when upsizing distribution mains. Table 2 shows the amount of storage increased due to various pipe diameters.

Table 2. Pipe Diameter Versus Pipe Volume (per mile)

	Pipe Diameter						
	2-inch	8-inch	10-inch	12-inch	16-inch	18-inch	24-inch
Gallons per mile	862	13,786	21,540	31,019	55,116	69,756	124,012

For every mile of 4-inch pipe that is replaced with 8-inch pipe, the effective volume of the distribution system increases by greater than 10,000 gallons.

Increasing the age of water in the system can lead to subsequent water quality problems (e.g. disinfection by-product formation, diminished chlorine residuals, etc.). Adverse aesthetic effects include taste and odor issues. Table 3 lists water quality problems that can be caused by increased water age. Items marked with an asterisk were identified as having direct potential health impacts (USEPA, *Effects of Water Age on Distribution System Water Quality*. 2002).

Finally, industries reliant on high quality process water (e.g. high tech manufacturers such as Siltronics) may also be adversely impacted by the potential decline in water quality. If the distribution system capacity is increased without added demand, PWB would likely need to increase maintenance efforts in order to maintain the existing water quality at an additional cost to rate payers.

Table 3. Water Quality Effects Associated with Water Age

Chemical Effects	Biological Effects	Physical Effects
*Disinfection by-product formation	*Disinfection by-product biodegradation	Temperature increases
Disinfectant decay	*Nitrification	Sediment deposition
*Corrosion control effectiveness	*Microbial regrowth/recovery/shielding	Color
Taste and odor	Taste and odor	

* Denotes water quality problem with direct potential public health impact

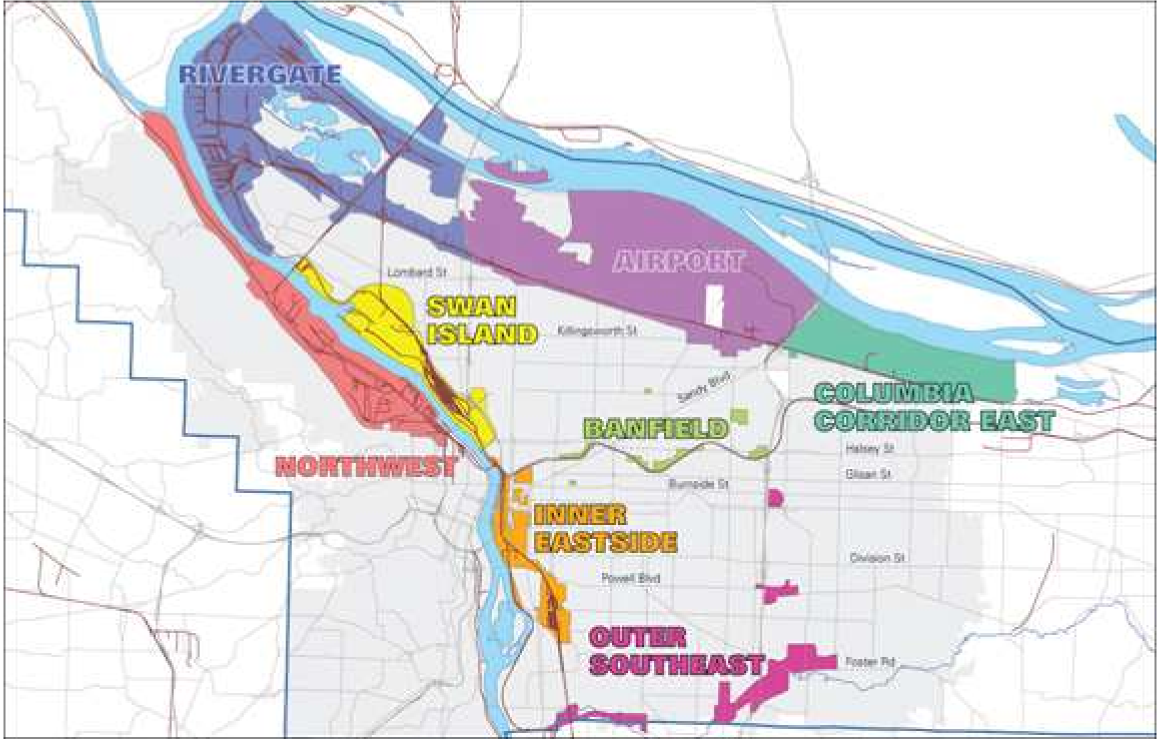
Because of the host of water quality issues associated with increased water age and the unknowns surrounding the fire flow needs of future development and the potential to increase water age if future development does not proceed as projected or requires some reduced level of fire flow, it is unclear to what capacity the system should be developed. It is also unclear to what extent capacity can be increased in advance of demands without adversely impacting water age and quality.

2.5 Study Area

The Working Harbor area encompasses most of the land along both sides of the Willamette River downstream from the Broadway Bridge to its confluence with the Columbia River and the land along the south side of the Columbia River upstream to about the Interstate-5 Bridge to Hayden Island. The Working Harbor and other industrial areas of Portland are shown in Figure 6 and described in more detail based upon information provided in the *Industrial Districts Atlas, City of Portland, Bureau of Planning, 2004*. For the purposes of the WHRS infrastructure analysis, three districts of the area were defined, Rivergate, Northwest, and Swan Island.

The Rivergate District (Figure 8) extends along both the Willamette River and the Columbia River. The area is Oregon's primary gateway for international trade, containing about half of the marine terminals on Portland Harbor and 78 percent of their total acreage. Port of Portland Terminals 4, 5, and 6 occupy most of the district's harbor frontage. These are the Columbia Basin's primary docks for container cargo, auto imports, and mineral bulk exports. According to the *Industrial Districts Atlas*, the district has 550 acres of vacant buildable private land, 30 percent of the total supply among Portland's industrial districts, and an additional 290 acres of partly buildable vacant land that is affected by floodplain or habitat constraints.

Figure 6. Portland's Industrial Districts



Industrial Districts Atlas, Bureau of Planning 2004

The Swan Island District (Figure 9) is the southeast quarter of Portland's Working Harbor. This district is a freight hub and cluster location for the region's transportation equipment manufacturing (e.g. Freightliner, Cascade General) and freight courier (e.g. United Parcel Service, Fedex) industries. The district has 75 acres of vacant, buildable private land and another 54 acres of partly buildable vacant land affected by floodplain or habitat constraints.

The Northwest Industrial District is the west side of Portland's Working Harbor. It includes the Guilds' Lake industrial area (shown as the Northwest Industrial Area (NWINA) in Figure 9) and the Linnton industrial area (Figure 8). According to the *Industrial Districts Atlas*, the district has 140 acres of vacant, buildable private land, and another 80 acres of partly buildable vacant land which is affected by floodplain or habitat constraints.

Figures 10 and 11 show the major water facilities and distribution system flows for each of the 4 industrial areas described in this section. Flow directions are shown for a single steady-state model run and may vary throughout the day depending how pumps, tanks and valves are operated in order to meet fluctuating demands.

Services in the WHRS lie within one of four pressure zones. The Washington Park 229 pressure zone serves the Northwest District and the Vernon 270 pressure zone serves the Rivergate District. The Swan Island District is served by the Tabor 270, Denver 272 and Vernon 362 pressure zones.

Figure 7 shows these pressure zones in relation to the district boundaries.

Figure 7. Pressure Zones Serving the WHRS Districts

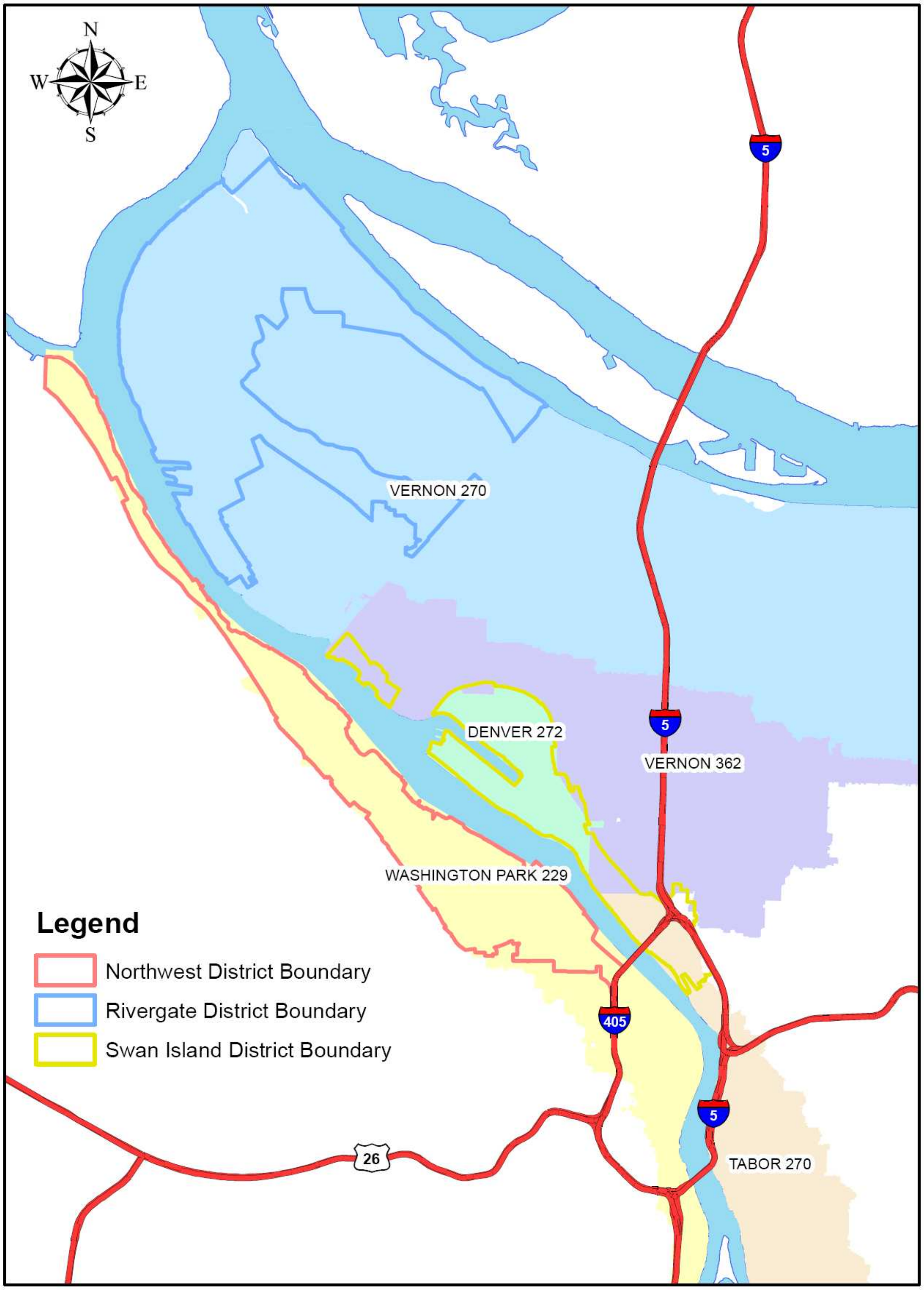


Figure 8. Rivergate & Linnton Map

Figure 9. Swan Island and Northwest Industrial Area (NWINA) Map

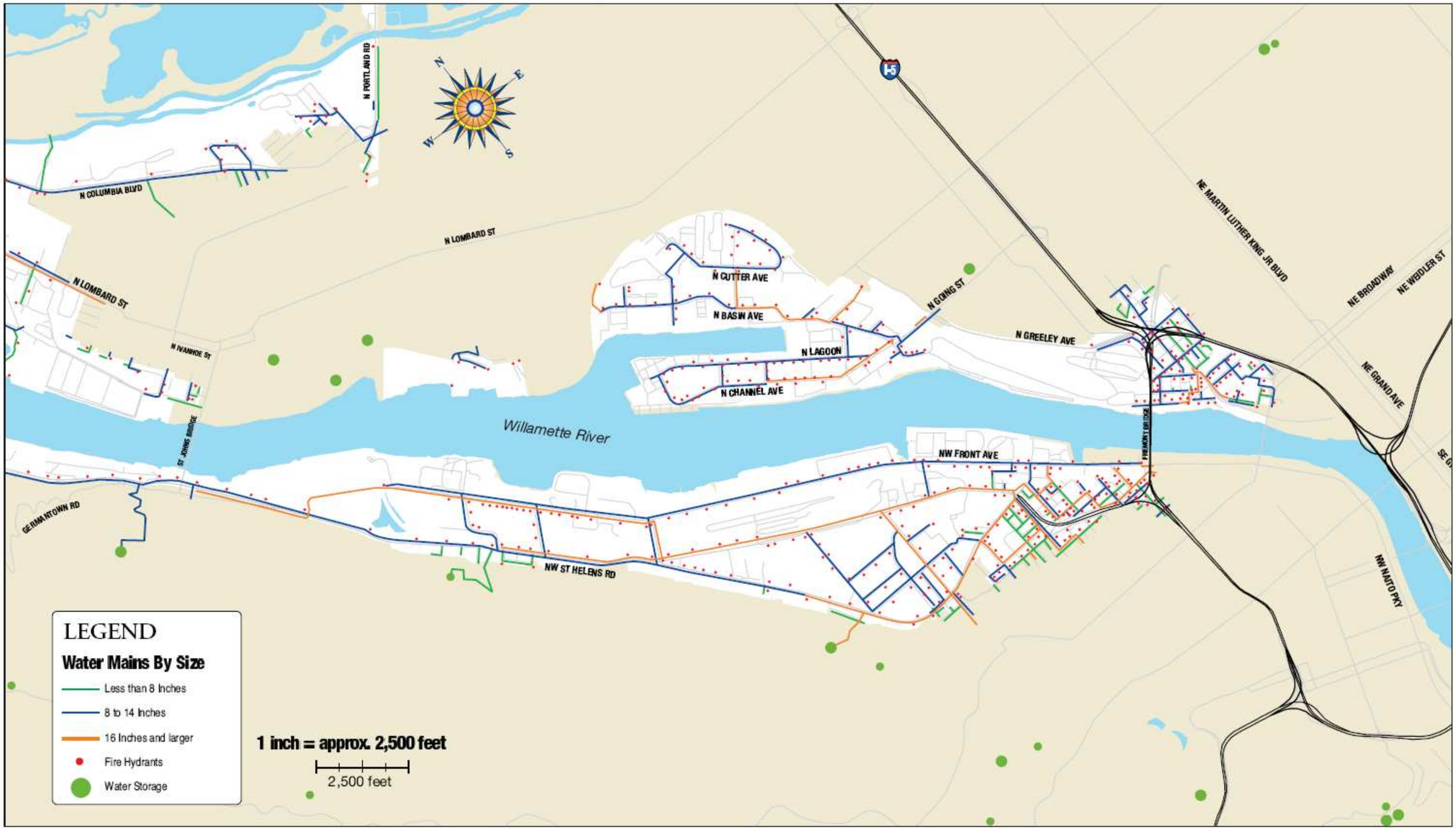


Figure 10. Swan Island and Northwest Industrial Area Major Water Facilities and General Distribution System Flows

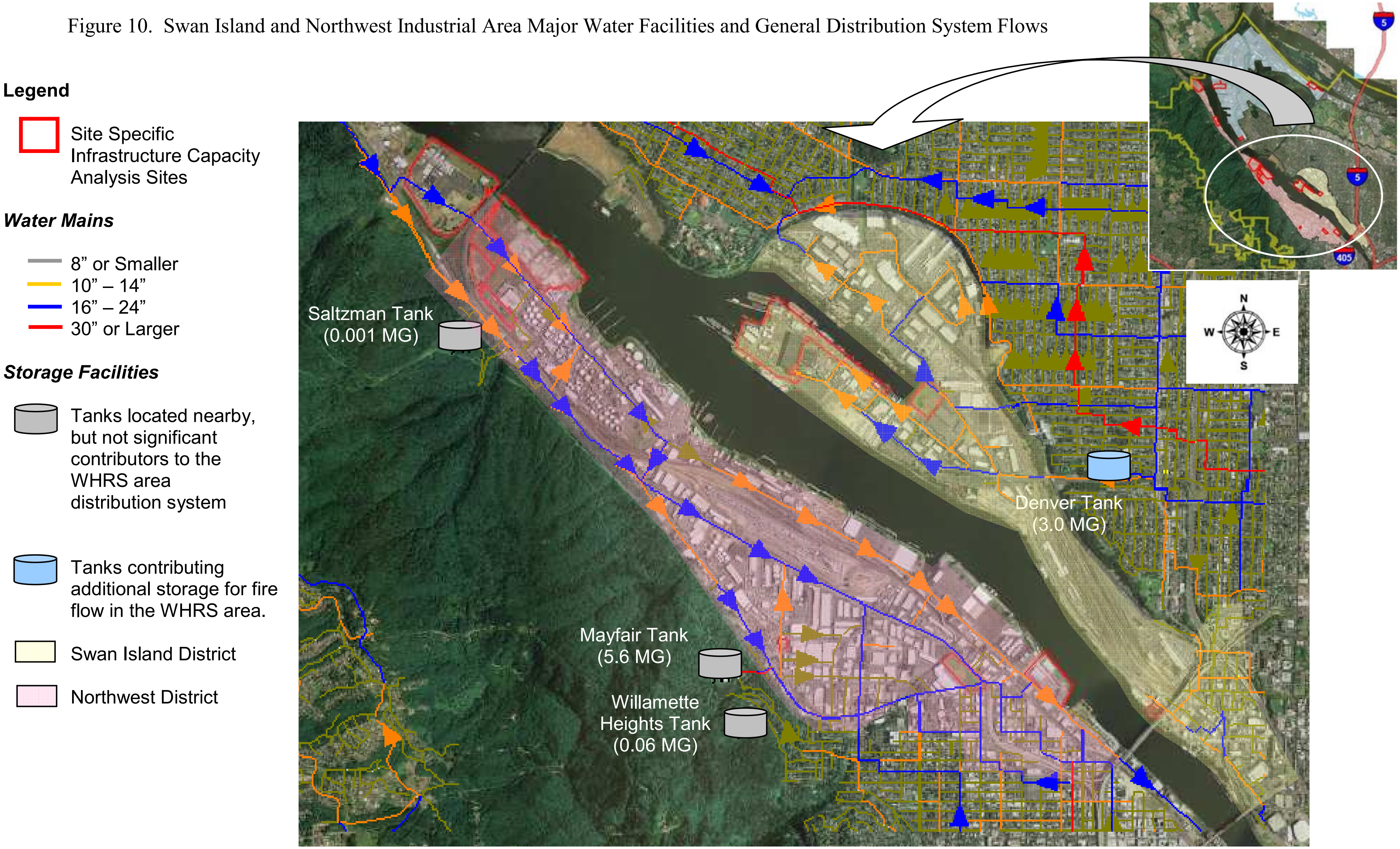
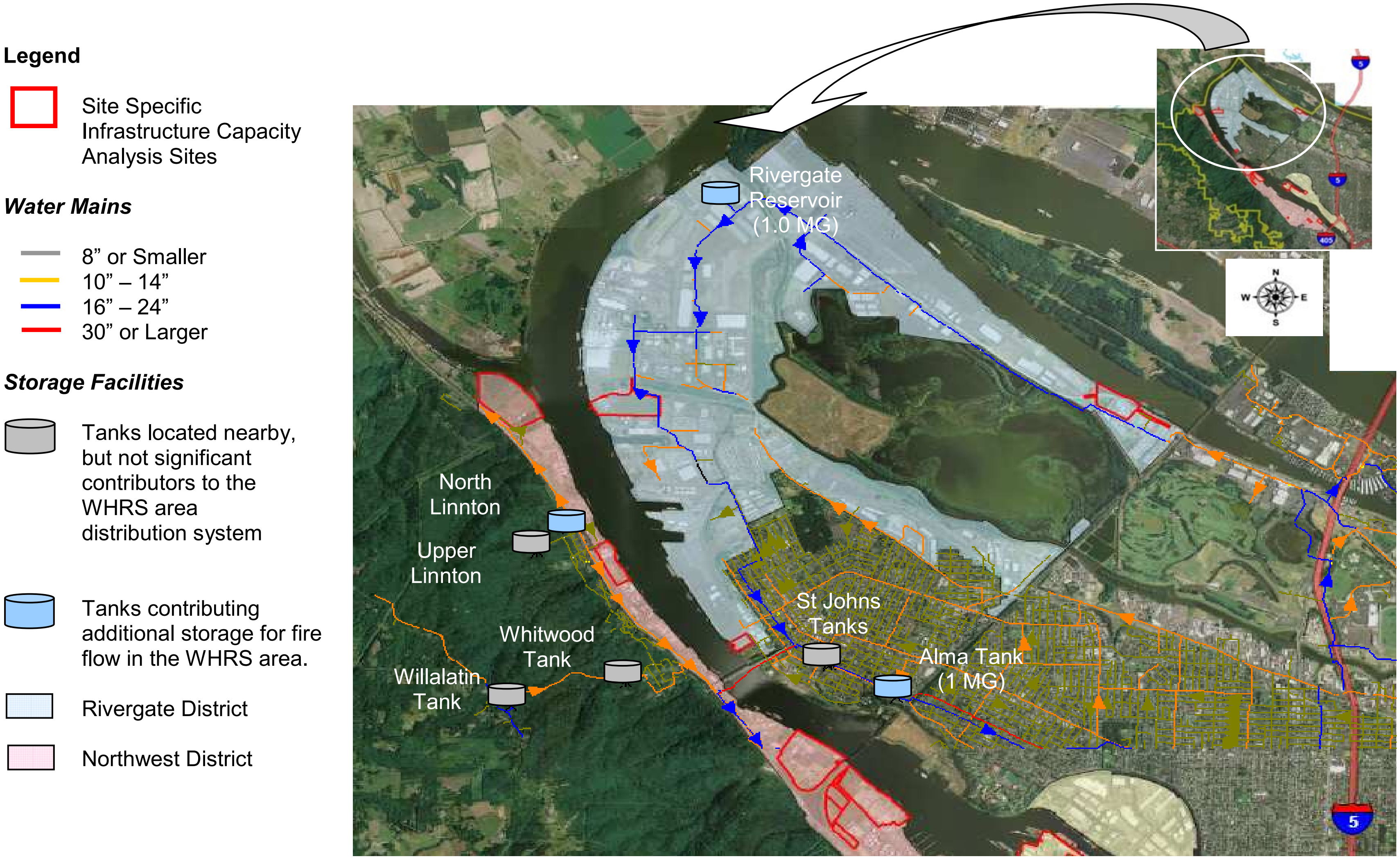


Figure 11. Rivergate and Linnton Area Major Water Facilities and Distribution System Flows



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3. Existing Water System Condition

3.1 Water System Facilities

This section addresses Task 1a of the IA by providing a description of the service area and condition assessment of the distribution system in each of the three districts (Rivergate, Swan Island, and Northwest). The study area (shown in Figure 8 and Figure 9) is described in three sections corresponding to the three districts. In general, the distribution system serving the WHRS area was found to be in good condition and capable of meeting the demands of the WHRS area.

3.1.1 Methodology

In June of 2007, PWB completed its Distribution System Master Plan (DSMP). The DSMP identified customer service goals and project plan evaluation criteria for the City's distribution system. Next, the condition of pump stations and tanks - two significant classes of the distribution system assets – were assessed through field inspections. A risk-based metric, relating the physical condition of these assets to the consequences of deterioration was used to identify the most urgent renewal needs. Then a computer based hydraulic model of the distribution system was developed to study future customer demands and identify how to improve the system and provide reliable service through year 2030 in the most cost-effective manner. The findings of the DSMP are presented here for storage and pumping facilities serving the WHRS districts.

For distribution mains, a descriptive analysis of mains in each district was conducted using GIS data (ArcGIS v. 9.0 – Data file created 11/16/06). Data available for pipe material and diameter vary by record. For example, some records contain data for material but not size, some records contain both material and size and still other records contain neither. Therefore the total number of miles for each analysis (by size, by material, and by material and size) varies because records lacking data necessary for the particular analysis were excluded. Furthermore, while some records indicate cast iron mains installed after 1965, the practice of installing cast iron mains was largely discontinued in 1965 in favor of ductile iron. Therefore, any water mains shown in the GIS data as being cast iron with a construction date of later than 1965, were deemed to be errors in the GIS data and were not counted in the analyses.

After accounting for errors and omissions in the data set, the difference in the total length of mains for all three districts (roughly 79 miles) compared to the total length of mains for which construction material data is present and deemed to be accurate (roughly 75 miles) is slightly less than 4 miles - a difference of only 5.1 percent.

Condition ratings used in this report are consistent with those used by PWB's Asset Management Group and are based upon the anticipated useful life, installation date (i.e. age), and material of the pipe (e.g. cast iron, ductile iron, etc.). A rating of "Unknown" indicates that the installation date or pipe material is absent from the GIS records. Roughly 24% of the mains in the WHRS area are lacking pipe installation dates and were therefore not represented in the condition ratings. However, it is reasonable to assume that the condition ratings determined for mains of known age within a district are reflective of the condition of mains of unknown age within the same district. For example, greater than 50% of the mains in the WHRS area are in good condition based upon known pipe age and material. 24.4% of the mains in the WHRS lack either pipe material or pipe age data necessary to directly determine the condition rating and thus, are indicated with an "Unknown" condition rating. However, it is assumed that of the 24.4% of mains with an

“Unknown” condition rating, greater than 50% are likely to be in good condition.

The condition ratings as defined by the amount of useful life remaining are shown in Table 4.

Table 4. Condition Rating Based Upon Amount of Useful Life Remaining[a]

Rating	Amount of Useful Life Remaining
Very Good	≥ 90%
Good	≥ 60% but < 90%
Fair	≥ 30% but < 60%
Poor	≥ 5% but < 30%
Very Poor	< 5%
Unknown	Age of Pipe Unknown

[a] Because useful lives vary by pipe material, pipe age is expressed as a percentage of useful life remaining. For example, a 20-year old cast iron pipe with an anticipated useful life of 100 years is expressed as having 80% of it’s useful life remaining and would receive a condition rating of “Good”.

Table 5 lists the anticipated useful life for the various pipe materials.

Table 5. Useful Lives Based Upon Pipe Material

Material	Anticipated Useful Life in Years
Ductile Iron	150
Cast Iron[a]	200 (Installed prior to 1930) 150 (Installed after 1929)
Steel	100
Galvanized	65

[a] Cast iron installed prior to 1930 was of a higher quality and higher wall thickness than cast iron installed between 1930 and 1965. Installation of cast iron mains was largely discontinued as per Water Bureau practice in 1965.

3.1.2 Distribution System Condition Assessment - General

As shown in Figure 12, the amount of mains within the WHRS area in poor to very poor condition was relatively small. For this reason, these two ratings were shown as a single composite rating of poor to very poor for mains with 30 percent remaining useful life.

Figure 12. Condition Ratings of all Distribution Mains in the WHRS area.

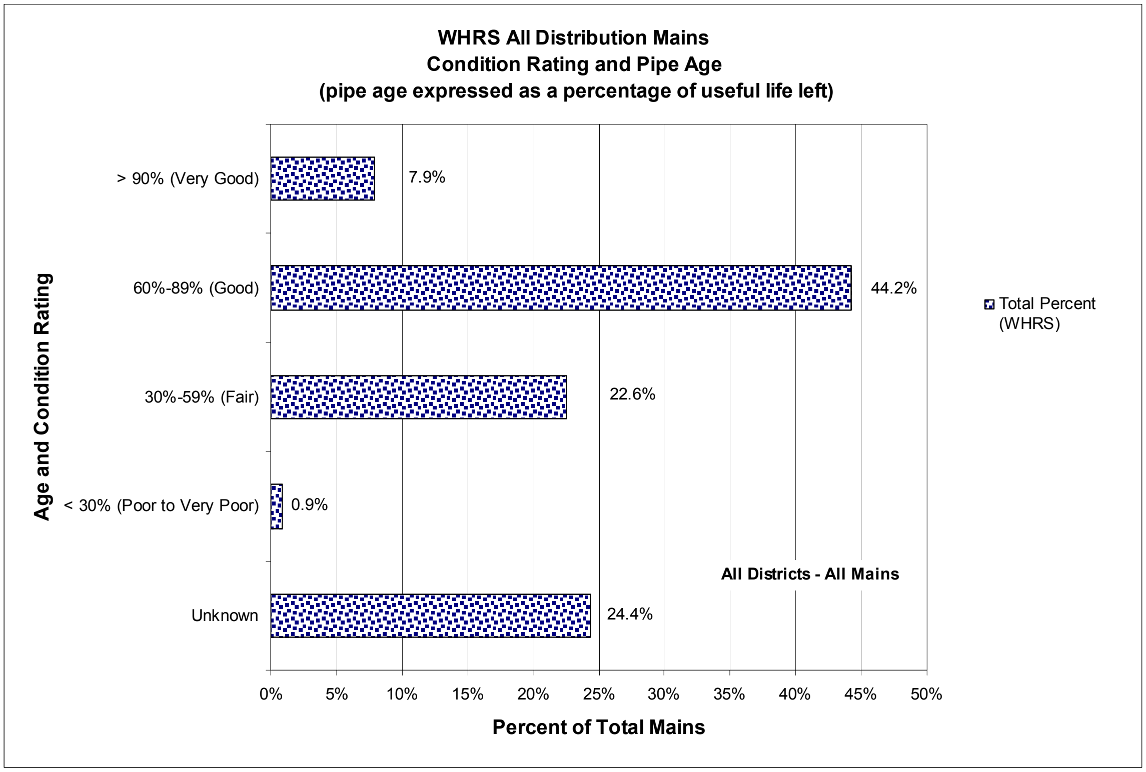


Figure 13 shows the condition rating of mains by district.

Figure 13. Condition Ratings of all Distribution Mains in the WHRS area by District.

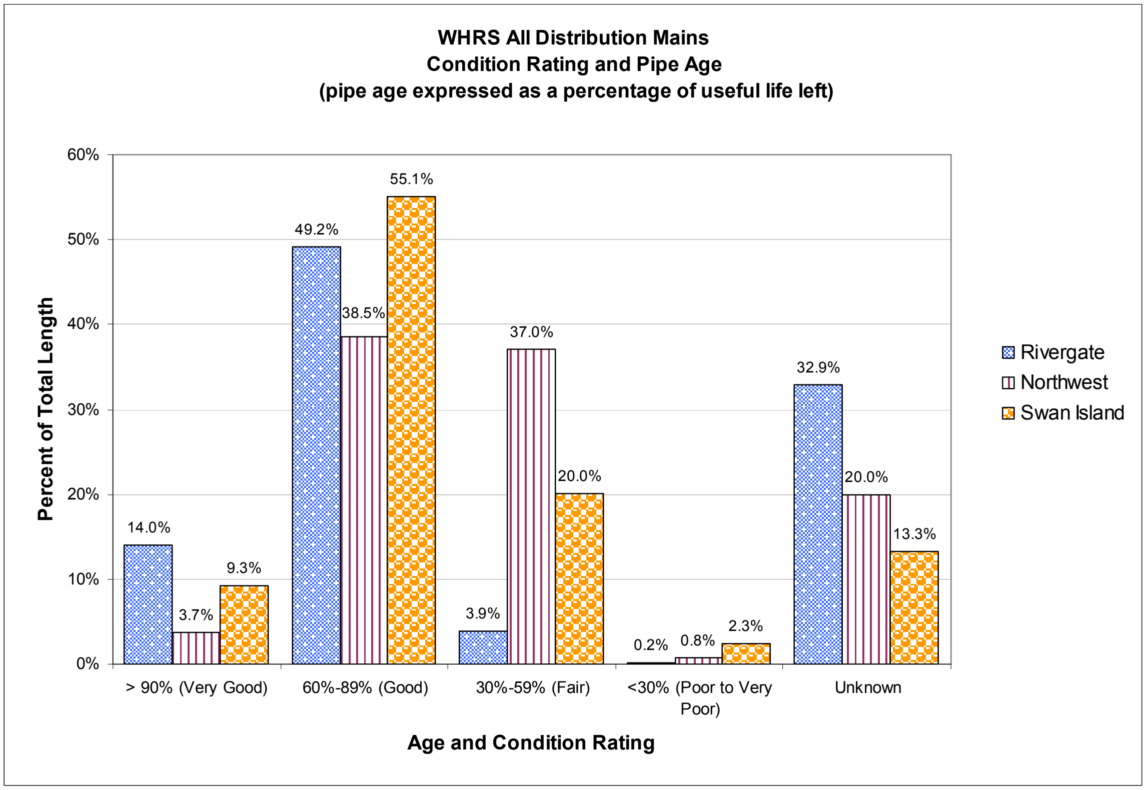


Table 6 includes condition ratings for the three districts by length of pipe and percent of the total length of pipe for each condition rating.

Table 6. Condition Rating and Percent of Useful Life Left

% of Useful Life Left & Condition Rating	District			Total Miles (WHRS)	% of Total length
	Rivergate	Northwest	Swan Island		
≥ 90% (Very Good)	3.39	1.37	1.46	6.22	7.9%
60%-89% (Good)	11.94	14.19	8.69	34.82	44.2%
30%-59% (Fair)	0.94	13.65	3.16	17.76	22.6%
< 30% (Poor to Very Poor)	0.04	0.29	0.37	0.69	0.9%
Unknown	7.98	8.54	2.67	19.20	24.4%
Total miles	24.30	38.04	16.35	78.69	
% of Total length	30.9%	48.3%	20.8%	100%	100%

As demonstrated in Table 6 above, the majority (52 percent) of mains in the WHRS area are in good or very good condition. 23 percent of the mains are in fair condition and less than 1 percent are in poor or worse condition. Even though 24.4 percent of the mains condition cannot be determined due to a lack of pipe age or material data, it is reasonable to assume that a similar breakdown of mains condition ratings applies to these "Unknown" mains. More detailed information regarding condition ratings by pipe material and size are described in the following three sections containing district-specific analysis results.

3.1.3 Distribution System Condition Assessment - Rivergate District

General Description

The Rivergate district of the Working Harbor area (see Figure 8) is defined by the peninsula formed by the confluence of the Columbia River and the Willamette River and is bisected by the Columbia River Slough and Smith and Bybee lakes and related wetlands. Zoning in the Rivergate District is predominantly Heavy Industrial with some General Industrial and a small proportion of General Employment zones. Large tenant/landowners include Time Oil Company, Langley St. John's Partnership, and Stauffer Chemical Company.

At close to 4,000 acres, Rivergate is the largest district of the area under consideration. Rivergate is served by nearly 24.3 linear miles of water mains, which is about one-third (31 percent) of the total miles of mains in the Working Harbor area.

Pressure Zones

The Rivergate district is served primarily by the Vernon 270 pressure zone with a hydraulic grade line (HGL) of 270-ft. Surface elevations range from 6 feet to 114 feet with an average elevation of 37.6 feet. The static pressure in the district ranges from 64 psi to 99 psi with an average pressure of 92 psi.

Supply, Storage, and Pumping Facilities

The Alma Tank and the St. Johns Tanks #1 and #2 serve the Vernon 270 service area. The Rivergate tank is not a terminal storage reservoir, however, it does serve as an emergency source of storage capacity. Although service pressures are maintained primarily through gravity flow, the Rivergate Pump Station is an emergency pump station that pumps directly to distribution as demands dictate. The DSMP rated the overall condition of the pump station a 7.1, which indicates that the station is generally serviceable, but in need of minor to moderate corrective maintenance. The tanks received condition ratings of between 5.6 and 7.8 indicating an average to acceptable repair history requiring minor repairs to improve performance.

Table 7 summarizes results of the DSMP assessments of storage facilities in the Rivergate District.

Table 7. Storage Facilities Serving the Rivergate District

Storage Facility	Year Constructed	Construction Type	Storage Capacity (MG)	Overflow Elevation (ft)	Condition Rating
Alma Tank	1947	Steel	1	246	7.2
Rivergate	1976	Steel	1.5	63	7.8
St Johns #1	1921	Steel	0.4	246	5.6 (Currently Off-line)
St Johns #2	1959	Steel	1.5	246	7.8 (Currently Off-line)

The DSMP recommended decommissioning the St. Johns and Alma Tanks, which have a history of water quality problems due to poor turnover, rather than making any major maintenance improvements to them. All of the current recommended maintenance improvements to the tanks listed in Table 7 include minor repairs (e.g. replace roof vent screen, clean and repaint roof, replace bad bolts, weld loose railing members, etc.). These improvements would be addressed in PWB's Storage Tank Maintenance and Repair Program.

Fire Hydrants

Of the approximately 384 fire hydrants located in the Rivergate district, 219 (57 percent) are maintained by the Water Bureau. The remaining 165 (43 percent) are privately owned.

Mains

Of the mains with marked sizes in the Rivergate district, approximately 24 percent are distribution mains smaller than 8". In general, the transmission main sizes are evenly distributed between mains 8" - 14" and mains larger than 16" (Table 8).

Table 8. Distribution of Rivergate District Mains by Size

Size	Miles	Percentage
Less than 8"	5.79	23.8
Between 8" and 14"	9.42	38.8
16" and larger	9.09	37.4
Total	*24.30*[a]	*100*

[a] Total number of miles with size data recorded.

One quarter of Rivergate's mains are cast iron and roughly three fourths of the mains in the district are ductile iron. Table 9 shows the distribution of mains in Rivergate by material.

Table 9. Distribution of Rivergate District Mains by Material

Material	Miles	Percentage
Cast iron	5.52	25.0
Ductile iron	16.05	72.6
Steel or galvanized steel	0.52	2.4
Total	*22.09*[a]	*100*

[a] Total number of miles with material data recorded.

Ductile iron transmission mains larger than 16" make up more than one-third (38.9 percent) of all of the mains in the district. Another quarter of the mains are ductile iron transmission mains between 8" and 14" (26.1 percent). Smaller mains are mostly cast iron. Table 10 shows the distribution of mains in Rivergate by size (nominal diameter) and material.

Table 10. Distribution of Rivergate District Mains by Size and Material

Main Size =>	<8"		8" - 14"		≥16"		Subtotals	
Material	Miles	%	Miles	%	Miles	%	Miles	%
Cast iron	3.33	15.1	2.02	9.2	0.16	0.7	*5.52*	*25.0*
Ductile iron	1.70	7.7	5.76	26.0	8.59	38.9	*16.05*	*72.6*
Steel or Galvanized	0.44	2.0	0.00	0	0.08	0.4	*0.52*	*2.4*
Subtotals	*5.47*	*24.8*	*7.77*	*35.2*	*8.83*	*40.0*	*22.09*	*100*

[a] Total number of miles with material and size data recorded

Mains in the Rivergate district are primarily in good to very good condition based upon the age. Figure 14 illustrates this condition.

Figure 14. Condition Ratings of all Distribution Mains in the Rivergate District.

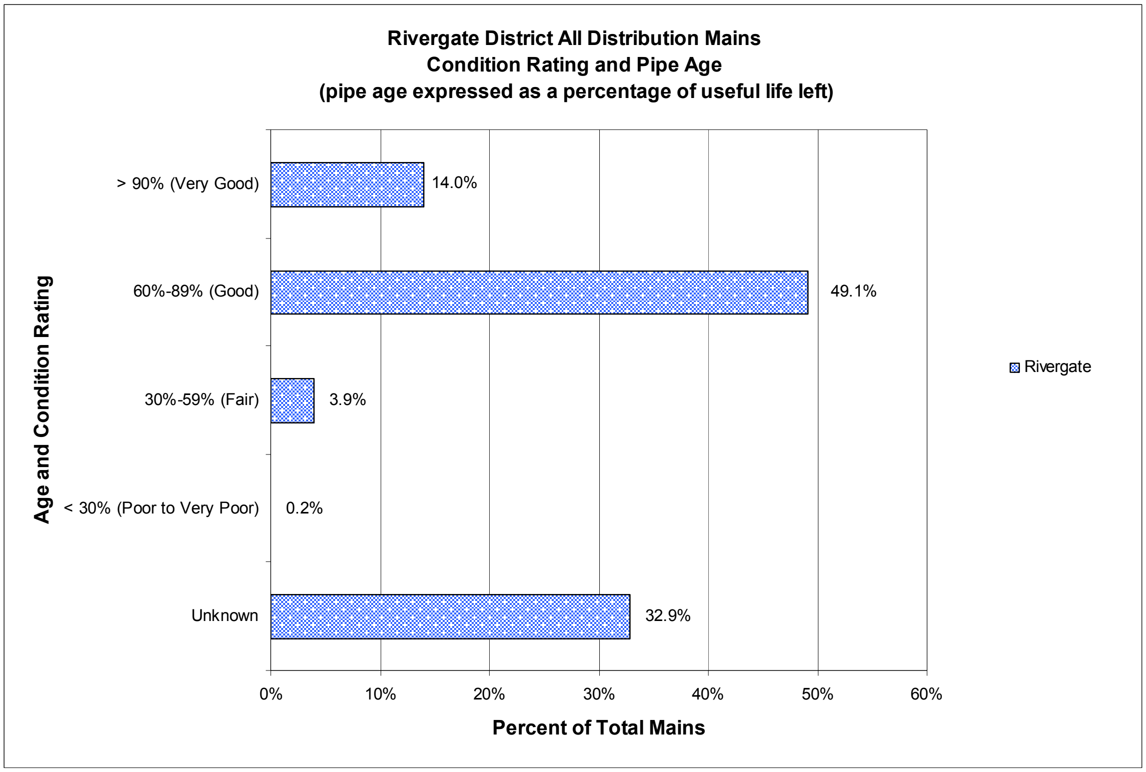


Figure 15 and Table 11 illustrate condition ratings for ductile iron mains in the Rivergate District, a majority of which are in good to very good condition. Ductile iron mains are anticipated to have a useful life of 150 years.

Figure 15. Condition Ratings of Ductile Iron Mains in the Rivergate District.

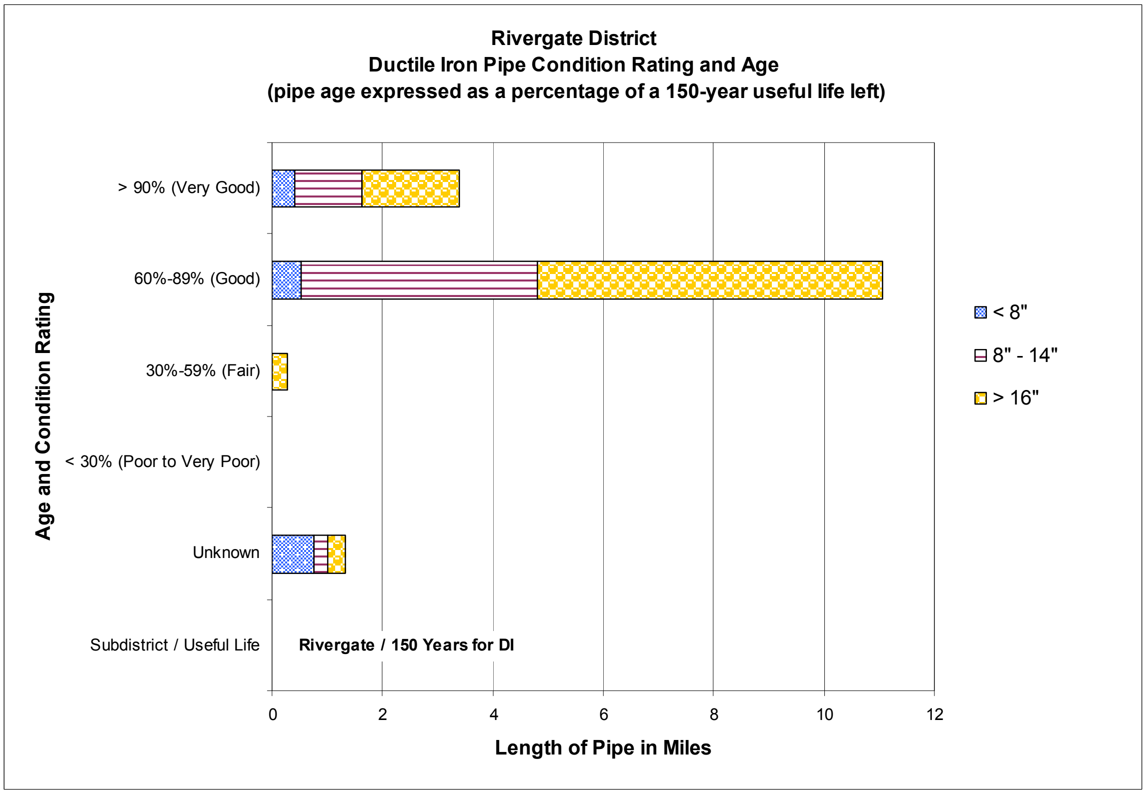


Table 11. Rivergate Ductile Iron Mains Condition Rating (150 Year Useful Life)

% of Useful Life Left & Condition Rating	Pipe Diameter < 8"	8" - 14"	> 16"	Total Miles (all sizes)	Percent of Total Length
> 90% (Very Good)	0.41	1.23	1.76	3.39	21.1%
60%-89% (Good)	0.54	4.27	6.25	11.05	68.9%
30%-59% (Fair)	0.00	0.00	0.27	0.27	1.7%
< 30% (Poor to Very Poor)	0.00	0.00	0.00	0.00	0.0%
Unknown	0.75	0.27	0.32	1.34	8.3%
Total miles	*1.70*	*5.76*	*8.59*	*16.05*	
% of Total length	*10.57%*	*35.88%*	*53.55%*	*100%*	*100%*

Figure 16 and Table 12 illustrate condition ratings for cast iron mains in the Rivergate District, a majority of which are in a condition that could not be determined based on the completeness of the construction date information in the GIS records. For those records for which construction dates are populated, the condition is fair to good. Cast iron mains have two anticipated useful lives based upon the construction date. Pipes installed prior to 1930 are anticipated to have a useful life of 200 years, while those installed in 1930 and later are anticipated to have a useful life of only 150 years. This is due to the quality of materials used during the two installation periods. Installation of cast iron mains was discontinued in 1965.

Figure 16. Condition Ratings of Cast Iron Mains in the Rivergate District

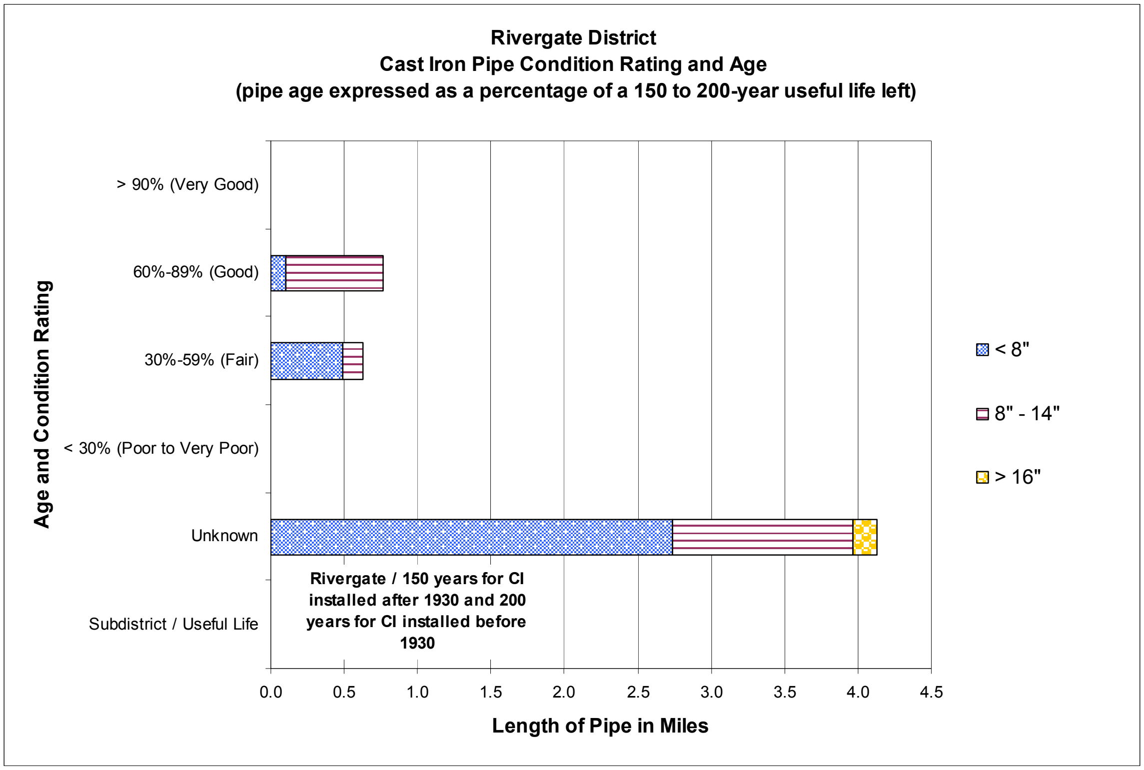


Table 12. Rivergate Cast Iron Mains Condition Rating
(150 Year Useful Life for CI installed after 1930 & 200 Years for CI Installed before 1930)

% of Useful Life Left & Condition Rating	Pipe Diameter < 8"	8" - 14"	> 16"	Total Miles (all sizes)	Percent of Total Length
> 90% (Very Good)	0.00	0.00	0.00	0.00	0.0%
60%-89% (Good)	0.10	0.66	0.00	0.76	13.8%
30%-59% (Fair)	0.49	0.13	0.00	0.62	11.3%
< 30% (Poor to Very Poor)	0.00	0.00	0.00	0.00	0.0%
Unknown	2.74	1.23	0.16	4.13	74.9%
Total miles	*3.33*	*2.02*	*0.16*	*5.52*	
% of Total length	*60.37%*	*36.68%*	*2.96%*	*100%*	*100%*

Figure 17 and Table 13 illustrate condition ratings for steel and galvanized steel mains in the Rivergate District, a majority of which are in good condition based upon age.

Figure 17. Condition Ratings of Steel and Galvanized Mains in the Rivergate District.

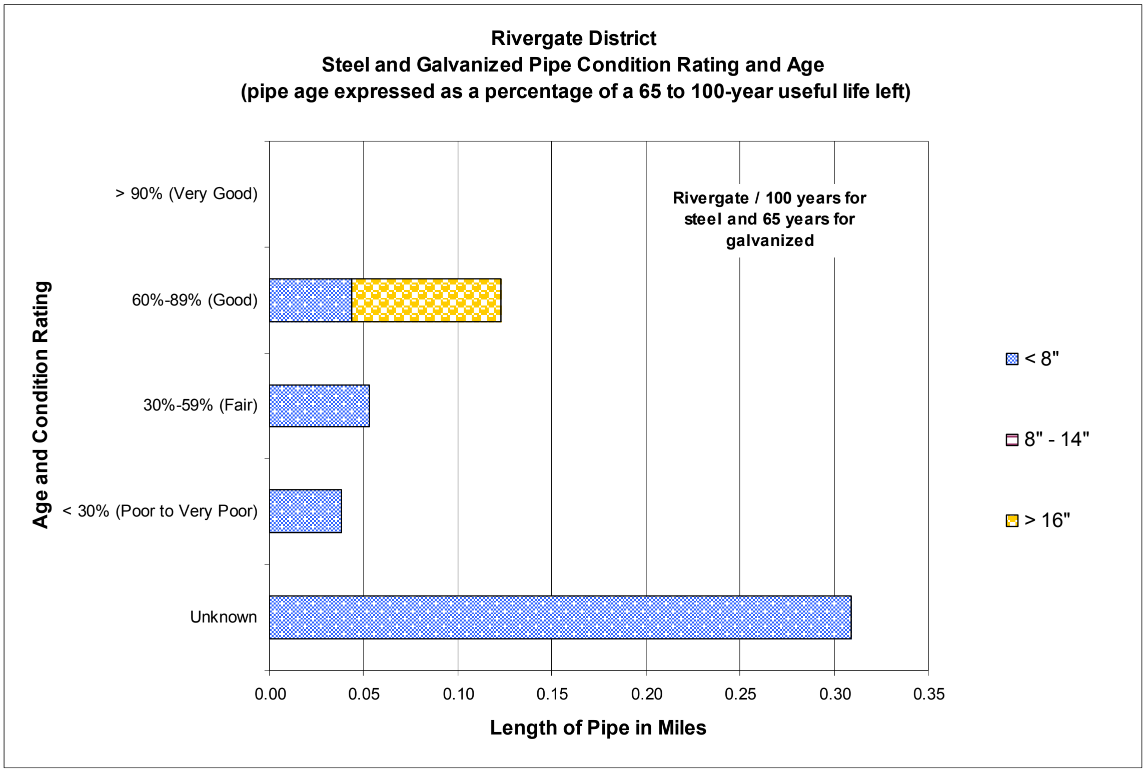


Table 13. Rivergate Steel and Galvanized Mains Condition Rating
(100 Year Useful Life for Steel and 65 Years for Galvanized)

% of Useful Life Left & Condition Rating	Pipe Diameter < 8"	8" - 14"	> 16"	Total Miles (all sizes)	Percent of Total Length
> 90% (Very Good)	0.00	0.00	0.00	0.00	0.0%
60%-89% (Good)	0.04	0.00	0.08	0.12	23.5%
30%-59% (Fair)	0.05	0.00	0.00	0.05	10.1%
< 30% (Poor to Very Poor)	0.04	0.00	0.00	0.04	7.3%
Unknown	0.31	0.00	0.00	0.31	59.1%
Total miles	*0.44*	*0.00*	*0.08*	*0.52*	
% of Total length	*84.89%*	*0.00%*	*15.11%*	*100%*	*100%*

3.1.4 Distribution System Condition Assessment - Swan Island District

General Description

The Swan Island district lies on the northeastern shore of the Willamette River (see Figure 9). Zoning in the Swan Island District is primarily in the Heavy Industrial and General Industrial zones, and serves the heavy industrial needs of tenant/landowners such as Vigor-Cascade General (the Portland Shipyard, LLC) and Gordon Malafouris. Light-industrial commercial enterprises including Federal Express and UPS are also present. The Swan Island district is roughly 1,000 acres and served by roughly 16 miles of mains, which is one-fifth (21 percent) of the mains in the Working Harbor area.

Pressure Zones

The Swan Island district is served mostly by the Denver 272 pressure zone (HGL 272-ft) and the Tabor 270 pressure zone (HGL 270-ft) with roughly 184 acres (13 percent) served by the Vernon 362 pressure zone (HGL 362-ft). Surface elevations range from 0 feet to 210 feet in elevation with an average elevation of 66.5 feet. The static pressure in the district ranges from 56 to 106 psi with an average pressure of 93 psi.

Supply, Storage, and Pumping Facilities

The Tabor 270 pressure zone is supplied primarily by regulated gravity flow from Mt. Tabor Reservoir #6. The Vernon 362 pressure zone is supplied by the Vernon Standpipe tank #2, Upper, while the Denver 272 pressure zone is supplied from the Denver Tank. The Vernon and Denver tanks both received a condition rating of 7.6 indicating that they are in average serviceable condition with minor deficiencies.

Table 14 summarizes results of the DSMP assessments of storage facilities in the Swan Island District.

Table 14. Storage Facilities Serving the Swan Island District

Storage Facility	Year Constructed	Construction Type	Storage Capacity (MG)	Overflow Elevation (ft)	Condition Rating
Mt. Tabor Reservoir #6	1911	Concrete	75	305	Not Rated in DSMP
Vernon Tank	1962	Steel	3.2	362	7.6
Denver Tank	1961	Steel	3	328	7.6

All of the recommended improvements to the tanks listed in Table 14 included maintenance repairs (e.g. clean and coat bottom of exterior wall, replace bad bolts, sandblast rusted elements and repaint, etc.). These improvements would be addressed in PWB’s Storage Tank Maintenance and Repair Program.

Fire Hydrants

Of the approximately 340 fire hydrants located in the Swan Island district, 202 (59 percent) are maintained by the Water Bureau. The remaining 138 (41 percent) are privately owned.

Mains

The majority of Swan Island (70 percent) is served by mains 8” - 14” in diameter. About 50 percent of all mains in the district are either 12” or 14” in diameter. Table 15 shows the distribution of mains in Rivergate by size (nominal diameter) and material.

Table 15. Distribution of Swan Island District Mains by Size

Size	Miles	Percentage
Less than 8”	2.34	14.3
Between 8” and 14”	11.45	70.0
16” and larger	2.57	15.7
Total	*16.36*[a]	*100*

[a] Total number of miles with size data recorded.

Slightly more than half of the mains that serve Swan Island (56 percent) are cast iron. Table 16 shows the distribution of mains by material.

Table 16. Distribution of Swan Island District Mains by Material

Material	Miles	Percentage
Cast iron	8.79	55.7
Ductile iron	6.48	41.1
Steel or galvanized steel	0.50	3.2
Total	*15.77*[a]	*100*

[a] Total number of miles with material data recorded.

Cast iron mains predominate in this district of the Working Harbor area. Cast iron transmission mains 8” - 14”make up 38 percent of all the mains, 8 percent of distribution mains smaller than 8”, and 8 percent of transmission mains larger than 14” (Table 17).

Table 17. Distribution of Swan Island District Mains by Size and Material

Main Size =>	<8”		8” - 14”		≥16”		Subtotals	
Material	Miles	%	Miles	%	Miles	%	Miles	%
Cast iron	1.51	8.0	6.03	38.2	1.25	8.0	*8.79*	*55.7*
Ductile iron	0.57	3.6	4.94	31.3	0.97	6.1	*6.48*	*41.1*
Steel or galvanized	0.11	0.7	0.05	0.3	0.34	2.2	*0.50*	*3.2*
Subtotals	*2.19*	*12.3*	*11.02*	*69.8*	*2.56*	*16.3*	*15.77*	*100*

[a] Total number of miles with material and size data recorded

Mains in the Swan Island district are primarily in good to very good condition based upon the age. Figure 18 illustrates this condition.

Figure 18. Condition Ratings of all Distribution Mains in the Swan Island District.

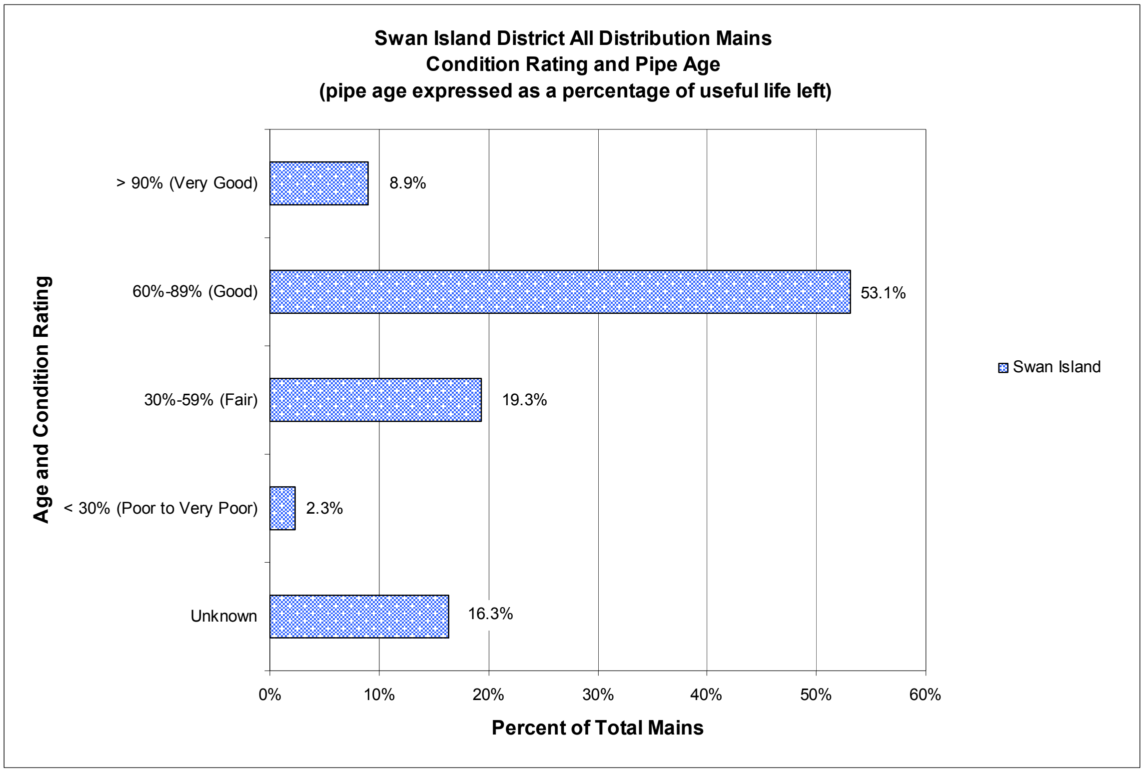


Figure 19 and Table 18 illustrate condition ratings for ductile iron mains in the Swan Island District, a majority of which are in good to very good condition.

Figure 19. Condition Ratings of Ductile Iron Mains in the Swan Island District.

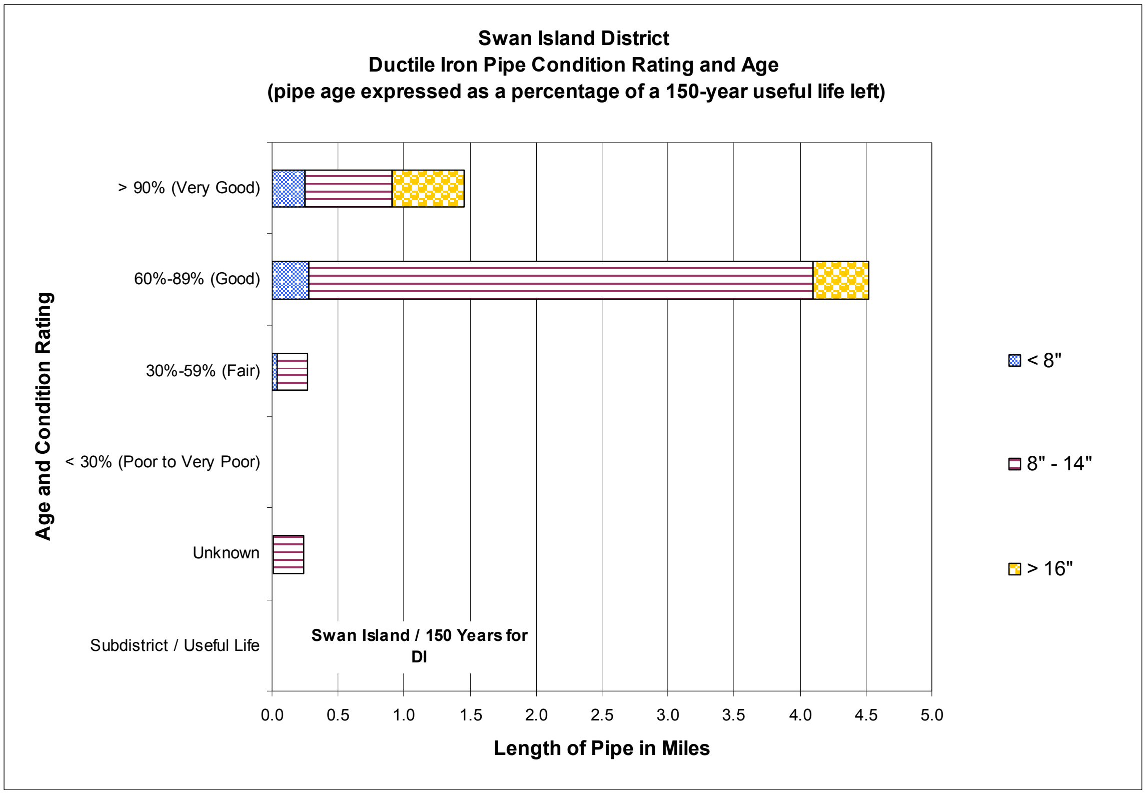


Table 18. Swan Island Ductile Iron Mains Condition Rating
(150 Year Useful Life)

% of Useful Life Left & Condition Rating	Pipe Diameter < 8"	Pipe Diameter 8" - 14"	Pipe Diameter > 16"	Total Miles (all sizes)	Percent of Total Length
> 90% (Very Good)	0.25	0.66	0.55	1.46	22.5%
60%-89% (Good)	0.28	3.82	0.42	4.52	69.7%
30%-59% (Fair)	0.04	0.23	0.00	0.27	4.1%
< 30% (Poor to Very Poor)	0.00	0.00	0.00	0.00	0.0%
Unknown	0.01	0.23	0.00	0.24	3.7%
Total miles	*0.57*	*4.94*	*0.97*	*6.48*	
% of Total length	*8.84%*	*76.20%*	*14.96%*	*100%*	*100%*

Figure 20 and Table 19 illustrate condition ratings for cast iron mains in the Swan Island District. Again, a large percentage (19.8 percent) of the cast iron mains in the Swan Island District lack construction date information in the GIS records. Those mains for which construction dates are populated are generally in fair to good condition.

Figure 20. Condition Ratings of Cast Iron Mains in the Swan Island District.

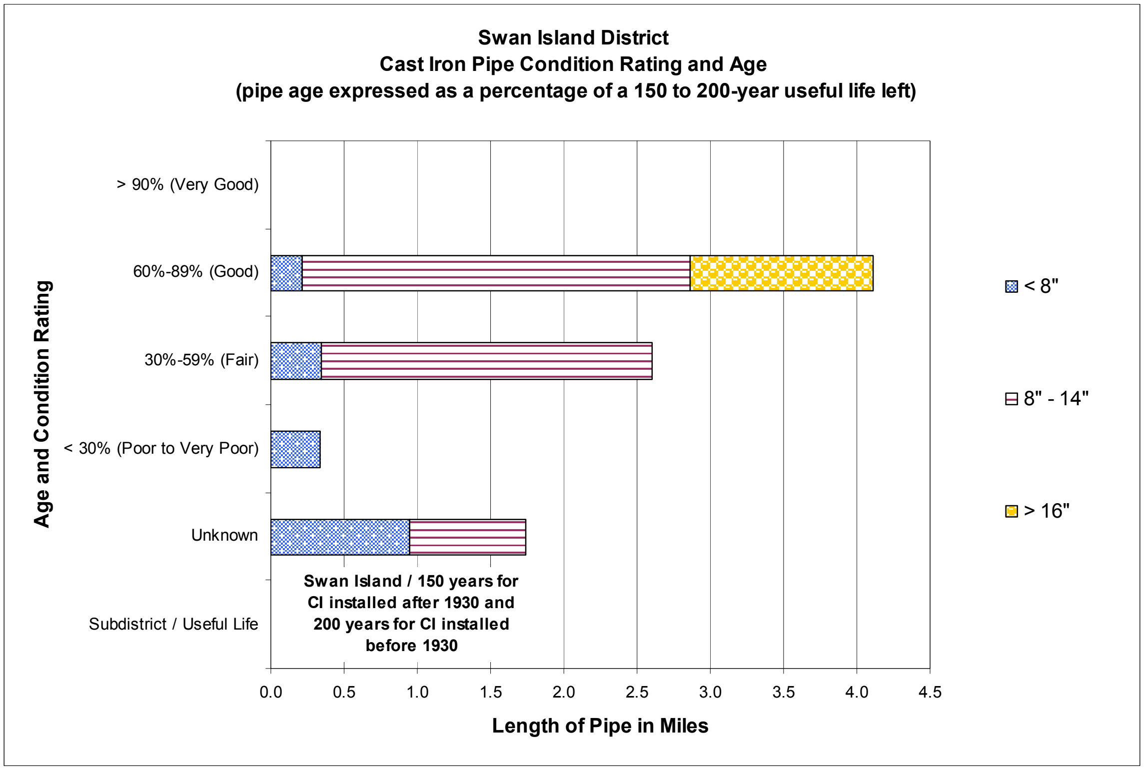


Table 19. Swan Island Cast Iron Mains Condition Rating
(150 Year Useful Life for CI installed after 1930 & 200 Years for CI Installed before 1930)

% of Useful Life Left & Condition Rating	Pipe Diameter < 8"	8" - 14"	> 16"	Total Miles (all sizes)	Percent of Total Length
> 90% (Very Good)	0.00	0.00	0.00	0.00	0.0%
60%-89% (Good)	0.21	2.65	1.25	4.11	46.8%
30%-59% (Fair)	0.35	2.26	0.00	2.60	29.6%
< 30% (Poor to Very Poor)	0.34	0.00	0.00	0.34	3.8%
Unknown	0.95	0.79	0.00	1.74	19.8%
Total miles	*1.84*	*5.70*	*1.25*	*8.79*	
% of Total length	*20.96%*	*64.79%*	*14.26%*	*100%*	*100%*

Figure 21 and Table 20 illustrate condition ratings for steel and galvanized steel mains in the Swan Island District, a majority of which are in fair condition based upon age.

Figure 21. Condition Ratings of Steel and Galvanized Mains in the Swan Island District.

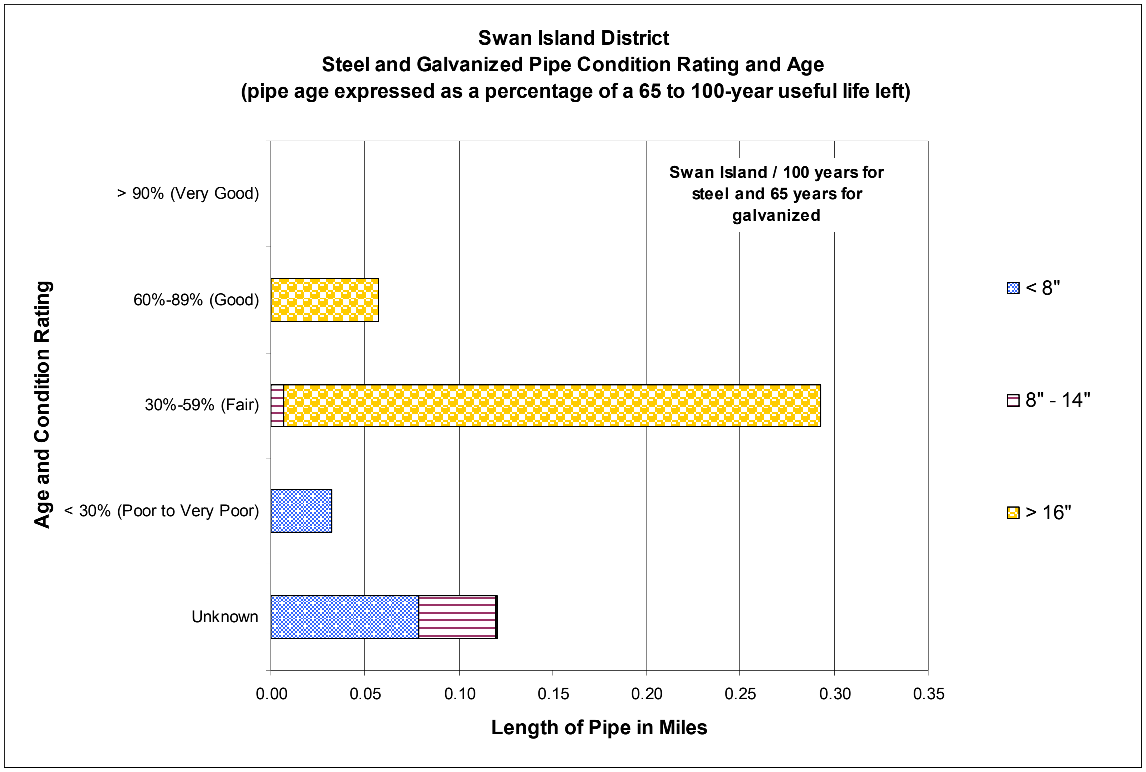


Table 20. Swan Island Steel and Galvanized Mains Condition Rating
(100 Year Useful Life for Steel and 65 Years for Galvanized)

% of Useful Life Left & Condition Rating	Pipe Diameter < 8"	Pipe Diameter 8" - 14"	Pipe Diameter > 16"	Total Miles (all sizes)	Percent of Total Length
> 90% (Very Good)	0.00	0.00	0.00	0.00	0.0%
60%-89% (Good)	0.00	0.00	0.06	0.06	11.3%
30%-59% (Fair)	0.00	0.01	0.29	0.29	58.3%
< 30% (Poor to Very Poor)	0.03	0.00	0.00	0.03	6.4%
Unknown	0.08	0.04	0.00	0.12	24.0%
Total miles	*0.11*	*0.05*	*0.34*	*0.50*	
% of Total length	*22.08%*	*9.55%*	*68.37%*	*100%*	*100%*

3.1.5 Distribution System Condition Assessment - Northwest District

General Description

The Northwest district, with roughly 38 miles of mains, is the largest district in the Working Harbor study area. The district lies on the south shore of the Willamette River, across from the Swan Island district. The Northwest District is divided into two areas for illustrative purposes. The Linnton area encompasses the area north of the Willamette River rail bridge and is shown on Figure 8. The Guild's Lake area encompasses the area south of the rail bridge and is shown on Figure 9. The Linnton area comprises 7.7 miles of mains and the Guild's Lake area comprises 30.1 miles of mains.

Zoning in the Northwest district of the Working Harbor area is almost exclusively Heavy Industrial with a very small proportion in General Industrial. Along Highway 30 there are both residential and commercial development with the City of Portland's Forest Park immediately upslope. The Burlington Northern Santa Fe Railroad occupies much of the center of the Guild's Lake area. Major tenants and landowners in the district include Gunderson, Esco, and Linnton Plywood Association.

Pressure Zones

The Northwest district is served by the Washington Park 229 pressure zone (HGL 229-ft). Surface elevations range from 0 feet to 204 feet with an average elevation of 4.6 feet. The static pressure in the district ranges from 55 psi to 99 psi with an average pressure of 78 psi.

Supply, Storage, and Pumping Facilities

Washington Park Reservoir #4 serves the Washington Park 229 pressure zone. The North Linnton tank also provides some storage capacity for the system in the Linnton area of the Northwest District. The North Linnton tank was rated an 8, meaning that the tank was in acceptable physical and operating condition, exhibiting signs of minor wear having minimal impact on performance.

Table 21 summarizes results of the DSMP assessments of storage facilities in the Northwest District.

Table 21. Storage Facilities Serving the Northwest District

Storage Facility	Year Constructed	Construction Type	Storage Capacity (MG)	Overflow Elevation (ft)	Condition Rating
Washington Park Reservoir #4	1894	Concrete	17.6	230	Not Rated in DSMP
North Linnton	1973	Steel	1.0	180	8.0

The DSMP only identified cleaning and painting the roof and walls of the North Linnton tank, which would be addressed in PWB's Storage Tank Maintenance and Repair Program.

Fire Hydrants

Of the approximately 466 fire hydrants located in the Northwest district, 283 (61 percent) are maintained by the Water Bureau. The remaining 183 (39 percent) are privately owned.

Mains

The majority of the mains in the Northwest district are transmission mains 8" and larger. Approximately half of all mains in the district are 8" - 14" mains (Table 22).

Table 22. Distribution of Northwest District Mains by Size

Size	Miles	Percentage
Less than 8"	6.35	16.7
Between 8 and 14"	20.31	53.4
16" and larger	11.39	29.9
Total	*38.05*[a]	*100*

[a] Total number of miles with size data recorded

The majority of the pipes in the Northwest district are cast iron. The Guild's Lake area has the majority of the cast and ductile iron mains. The Guild's Lake area has roughly Twenty-one miles (85 percent) of the Northwest District's cast iron mains and seven miles (65 percent) of the Northwest District's ductile iron mains.

Table 23 shows the distribution of mains by material.

Table 23. Distribution of Northwest District Mains by Material

Material	Miles	Percentage
Cast iron	24.08	65.3
Ductile iron	10.31	28.0
Steel or galvanized steel	2.35	6.7
Total	*36.84*[a]	*100*

[a] Total number of miles with material data recorded

Small cast iron transmission mains 8" - 14" in diameter predominate in the Northwest district with the majority (92 percent) located in the Guild's Lake area. The greatest proportion of ductile iron mains are those larger than 16" in diameter, with the majority (83 percent) of ductile iron pipes located in the Guild's Lake area. Nearly three-quarters (72 percent) of the ductile iron pipes larger than 16" located in the Guild's Lake area are 24" mains. Table 24 shows the distribution of mains in the Northwest District by size (nominal diameter) and material.

Table 24. Distribution of Northwest District Mains by Size and Material

Main Size =>	<8"		8" - 14"		≥16"		Subtotals	
Material	Miles	%	Miles	%	Miles	%	Miles	%
Cast iron	4.44	12.1	15.57	42.2	4.06	11.0	*24.07*	*65.3*
Ductile iron	1.30	3.5	4.20	11.4	4.81	13.1	*10.31*	*28.0*
Steel or galvanized	0.36	1.0	0.14	0.4	1.96	5.3	*2.46*	*6.7*
Subtotals	*6.10*	*16.6*	*19.91*	*54.0*	*10.83*	*29.4*	*36.84*	*100*

[a] Total number of miles with material and size data recorded

Figure 22 illustrates that mains in the Northwest district are in fair to good condition.

Figure 22. Condition Ratings of all Distribution Mains in the Northwest District.

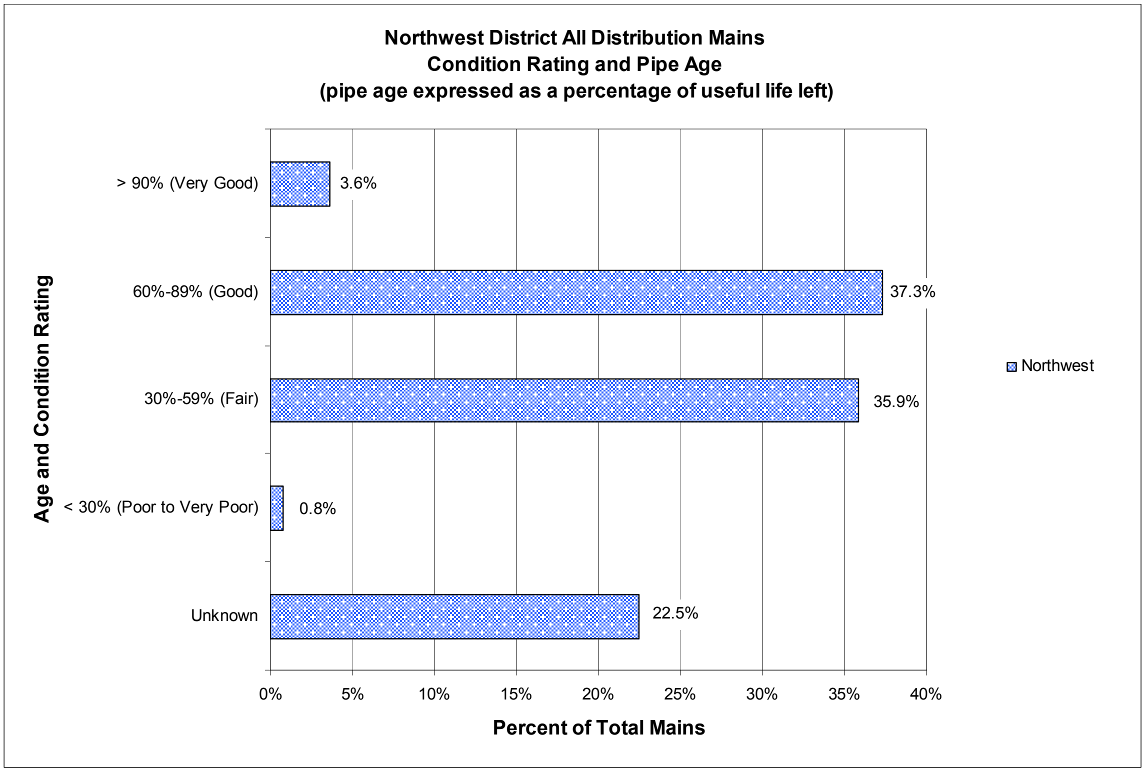


Figure 23 and Table 25 illustrate condition ratings for ductile iron mains in the Northwest District, a majority of which are in good to very good condition.

Figure 23. Condition Ratings of Ductile Iron Mains in the Northwest District.

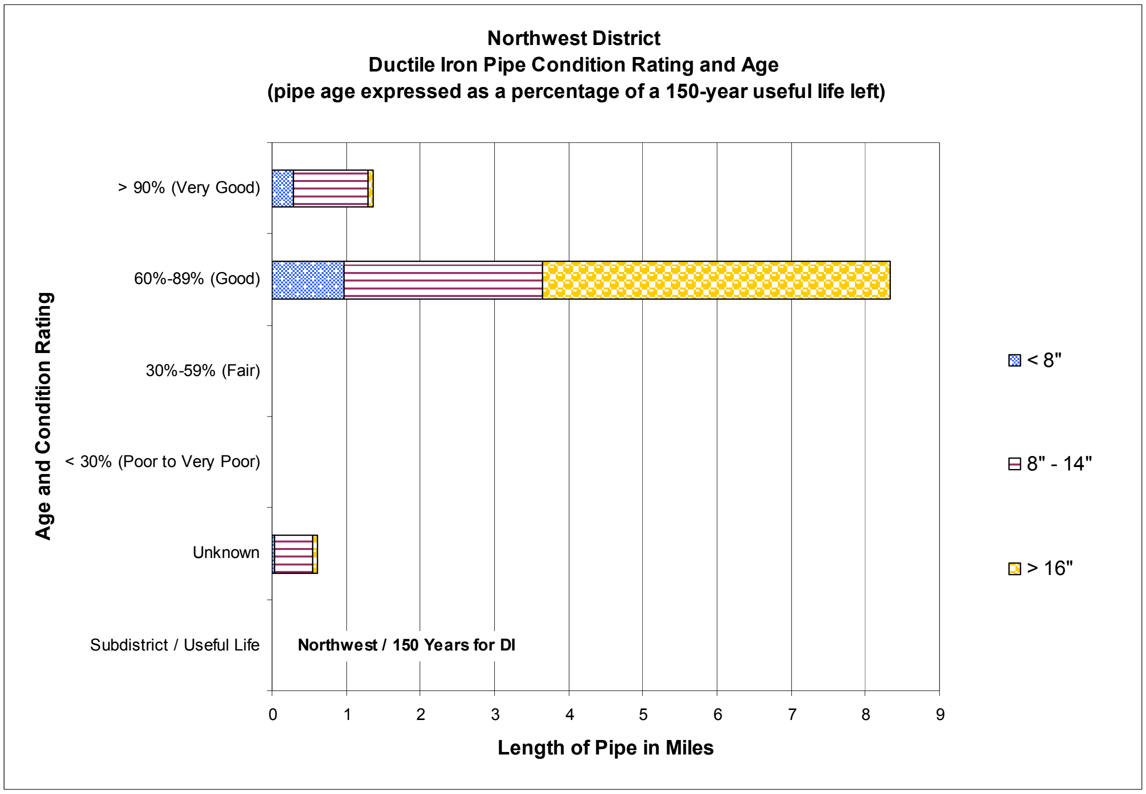


Table 25. Northwest District Ductile Iron Mains Condition Rating
(150 Year Useful Life)

% of Useful Life Left & Condition Rating	Pipe Diameter < 8"	 8" - 14"	 > 16"	Total Miles (all sizes)	Percent of Total Length
> 90% (Very Good)	0.29	1.00	0.07	1.36	13.2%
60%-89% (Good)	0.97	2.69	4.69	8.34	80.9%
30%-59% (Fair)	0.00	0.00	0.00	0.00	0.0%
< 30% (Poor to Very Poor)	0.00	0.00	0.00	0.00	0.0%
Unknown	0.04	0.51	0.06	0.61	5.9%
Total miles	*1.30*	*4.20*	*4.81*	*10.31*	
% of Total length	*12.56%*	*40.75%*	*46.69%*	*100%*	*100%*

Figure 24 and Table 26 illustrate condition ratings for cast iron mains in the Northwest District. Again, about 28 percent of the cast iron mains in the Northwest District lack construction date information in the GIS records. A majority of those mains for which construction dates are populated are in fair to good condition.

Figure 24. Condition Ratings of Cast Iron Mains in the Northwest District.

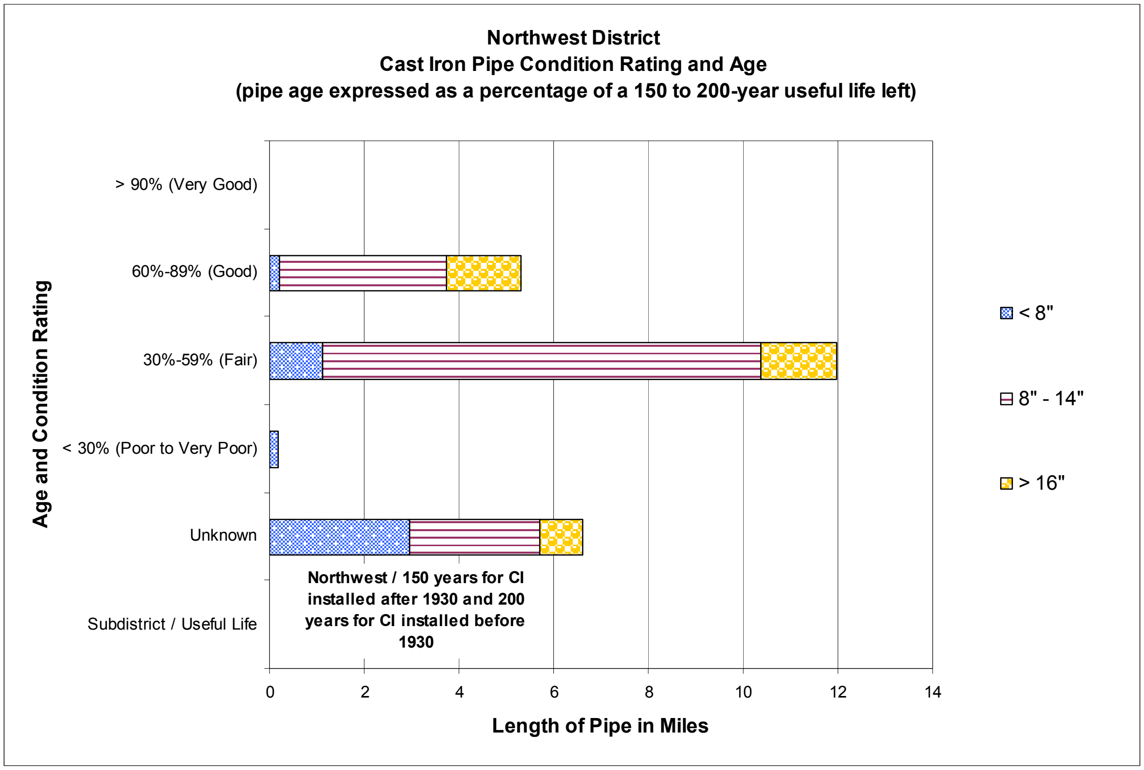


Table 26. Northwest District Cast Iron Mains Condition Rating
(150 Year Useful Life for CI installed after 1930 & 200 Years for CI Installed before 1930)

% of Useful Life Left & Condition Rating	Pipe Diameter < 8"	8" - 14"	> 16"	Total Miles (all sizes)	Percent of Total Length
> 90% (Very Good)	0.00	0.00	0.00	0.00	0.0%
60%-89% (Good)	0.21	3.53	1.57	5.31	22.0%
30%-59% (Fair)	1.11	9.27	1.59	11.97	49.7%
< 30% (Poor to Very Poor)	0.19	0.00	0.00	0.19	0.8%
Unknown	2.95	2.76	0.90	6.61	27.5%
Total miles	*4.46*	*15.57*	*4.06*	*24.08*	
% of Total length	*18.51%*	*64.64%*	*16.85%*	*100%*	*100%*

Figure 25 and Table 27 illustrate condition ratings for steel and galvanized steel mains in the Northwest District, a majority of which are in fair condition based upon age.

Figure 25. Condition Ratings of Steel and Galvanized Mains in the Northwest District.

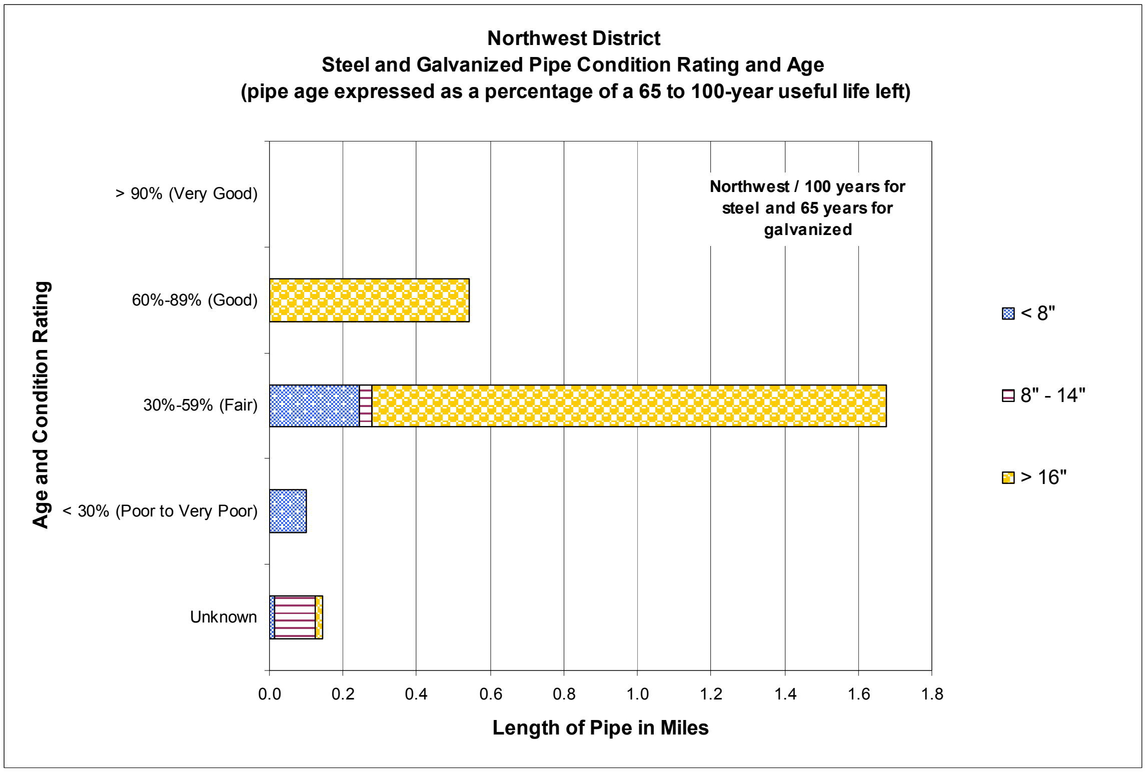


Table 27. Northwest District Steel and Galvanized Mains Condition Rating
(100 Year Useful Life for Steel and 65 Years for Galvanized)

% of Useful Life Left & Condition Rating	Pipe Diameter < 8"	8" - 14"	> 16"	Total Miles (all sizes)	Percent of Total Length
> 90% (Very Good)	0.00	0.00	0.00	0.00	0.2%
60%-89% (Good)	0.00	0.00	0.54	0.54	22.0%
30%-59% (Fair)	0.25	0.03	1.40	1.68	67.0%
< 30% (Poor to Very Poor)	0.10	0.00	0.00	0.10	4.1%
Unknown	0.01	0.11	0.02	0.14	5.8%
Total miles	*0.36*	*0.14*	*1.96*	*2.47*	
% of Total length	*14.66%*	*5.79%*	*79.55%*	*100%*	*100%*

3.2. General Zoning-Based Fire Flow Requirements

Fire flow and hydrant spacing is generally dictated by the zoning-based fire flow requirements. The requirements shown in Table 28 are based upon employment and industrial zones under Chapter 33.140 *Employment and Industrial Zones* and were developed by the Prevention Division of the Portland Fire Bureau. These requirements are deemed to be adequate for typical development that would normally occur within the industrial and employment zones in the WHRS Districts.

Table 28. Zoning-Based Fire Flow Requirements

Zone	Description	Fire Flow (gpm)	Minimum Number of Hydrants	Average spacing Between Hydrants (ft)[1,2]	Maximum Distance from any Point on Street or Road Frontage to a Hydrant (ft)[3]
EG1/EG2	General Employment	3,500	4	350	210
IG1/IG2	General Industrial	4,000	4	350	210
IH	Heavy Industrial	5,000	5	300	180

[1] Reduce by 100 feet for dead-end streets or roads.

[2] Where new water mains are extended along streets where hydrants are not needed for protection of structures or similar fire problems, fire hydrants shall be provided at no less than 1,000-foot spacing to provide for transportation hazards.

[3] Reduce by 50 feet for dead-end streets or roads.

In the event of changes to existing development (including increases in square footage to existing buildings) or changes to existing use (including changes in materials storage), fire flow requirements are made on a case-by-case basis through a plan review process administered by the Portland Fire Bureau. Fire flow requirements may change and may be made retroactive depending upon the particular situation (e.g. a site may have to accommodate increased fire flow requirements even though all prior requirements had been met). In some rare instances, fire flow requirements might rise to as high as 8,000 to 10,000 gpm. Some examples of uses that have resulted in increased fire flow requirements include large pallet storage, lumber yards, large storage sheds lacking sprinkler systems, and, in general, large, uncovered combustible materials stockpiles.

Fire flow requirements can often be reduced depending upon specific on-site factors and mitigation measures as determined during a fire flow evaluation. Examples of mitigating measures include installing fire suppression systems (properly installed sprinkling systems have typically reduced fire flow requirements by as much as 50 percent), incorporating fire resistant building materials and arranging on-site materials storage in order to reduce fire hazards. Developments located adjacent to the Willamette and Columbia Rivers also have the option of installing connections that would allow a fire boat to supply river water at a rate of up to 10,000 gpm. The degree to which these measures would reduce fire flow requirements would be determined by the Fire Marshall.

3.3. Existing Large Water Users

“Large water users” are defined differently by both PWB’s Business, Industry, and Government conservation program (BIG) and the meter shop.

In 1993, the top 100 water using customers were reviewed and selected for evaluation and inclusion in the BIG program. The top peak season users were also evaluated for inclusion in the BIG program. In recent years, however, customers seeking assistance from BIG in conserving water have not been limited based upon usage. BIG now helps all commercial, industrial and institutional customers who request assistance, regardless of overall usage. In the last 2 years, services have even been expanded to include large multifamily dwellings as well as commercial customers. In spite of expanding BIG’s inclusiveness, commercial customers have been the largest share of customers who have sought out assistance from BIG. Choosing the top 100 customers in a recent BIG data set containing total consumption data for the period from 07/01/05 to 04/06/06, lends itself to users with an average monthly demand of 4,244 CCF per month (73.5 gpm). One CCF is equal to 100 ft^3, which is roughly equivalent to 748 gallons. However, the identification of the 100 largest users is somewhat misleading, because usage data for participants using water at multiple facilities (e.g. Portland Public Schools, Bureau of Parks, etc.) is a composite of monthly data collected from several metered facilities.

PWB’s Meter Shop defines a large water user as a single connection that uses 1,000 CCF or more per month or 12,000 CCF or more per year. Choosing customers using at least 1,000 CCF per month on average (24,933 gallons per day or 17.3 gpm), provides a list of roughly 70 customers. This program also includes such customers as hotels, hospitals and universities and colleges. Figure 26 shows the locations of these large water users in the WHRS area.

Table 29 contains an abbreviated list of BIG usage data for some commercial and industrial customers that appear in the list of top one hundred BIG users and are also included in the Meter Shop’s list of large water users. All of the customers listed in Table 29 are located in the WHRS area. This list is sorted by district and then usage in descending order from largest usage to smallest usage and in some cases may represent a composite of multiple metered service connections. Figure 27 shows the relative locations of these customers in the WHRS area compared to large water users identified by the Meter Shop.

It should be noted that although these customers have been identified as large water users in the BIG program and meet the Meter Shop’s definition of a large water user, this in no way indicates an inefficient use of water. All of these customers participate in the BIG program in order to more efficiently use water. The Meter Shop has identified these customers as large water users so that it can better plan maintenance activities around meters, which would require more maintenance due to heavy use.

Table 29. BIG Program – Largest Water Users in Fiscal Year 05/06

Largest water use excludes wholesale customers, is based on billed charges, and may reflect multiple metered accounts on multiple development sites. Data for July 1, 2005 to April 6, 2006.

District	Customer	Total Usage (CCF)	Approximate GPM Equivalent[a]
Northwest	SILTRONIC CORP	592,590	1,140
	ARAMARK UNIFORM SVCS	63,364	122
	SULZER PUMPS (US) INC	57,973	112
	HERCULES INC	40,560	78
	OWENS CORNING	33,115	64
	ESCO CORPORATION	31,760	61
	PORTLAND BREWING CO	21,847	42
Rivergate	PORT OF PORTLAND	129,704	250
	BAY VALLEY FOODS	58,123	112
	AJINOMOTO FROZEN FOODS USA INC	27,015	52
	DEL MONTE FRESH PRODUCE	19,084	37
Swan Island	CASCADE GENERAL INC	96,808	186
	FREIGHTLINER CORP	43,293	83
	FRED MEYER INC	38,593	74
	WIDMER BREWING CO	33,682	65
	UNION PACIFIC RR	19,632	38
Total		Sum => 1,307,143	Average => 157

[a] Approximate GPM equivalent is based upon the total CCF converted to GPM assuming 9 months (July 1 – April 6), 30 days per month, and 24 hours per day.

Figure 26. Meter Shop Large Water Users.

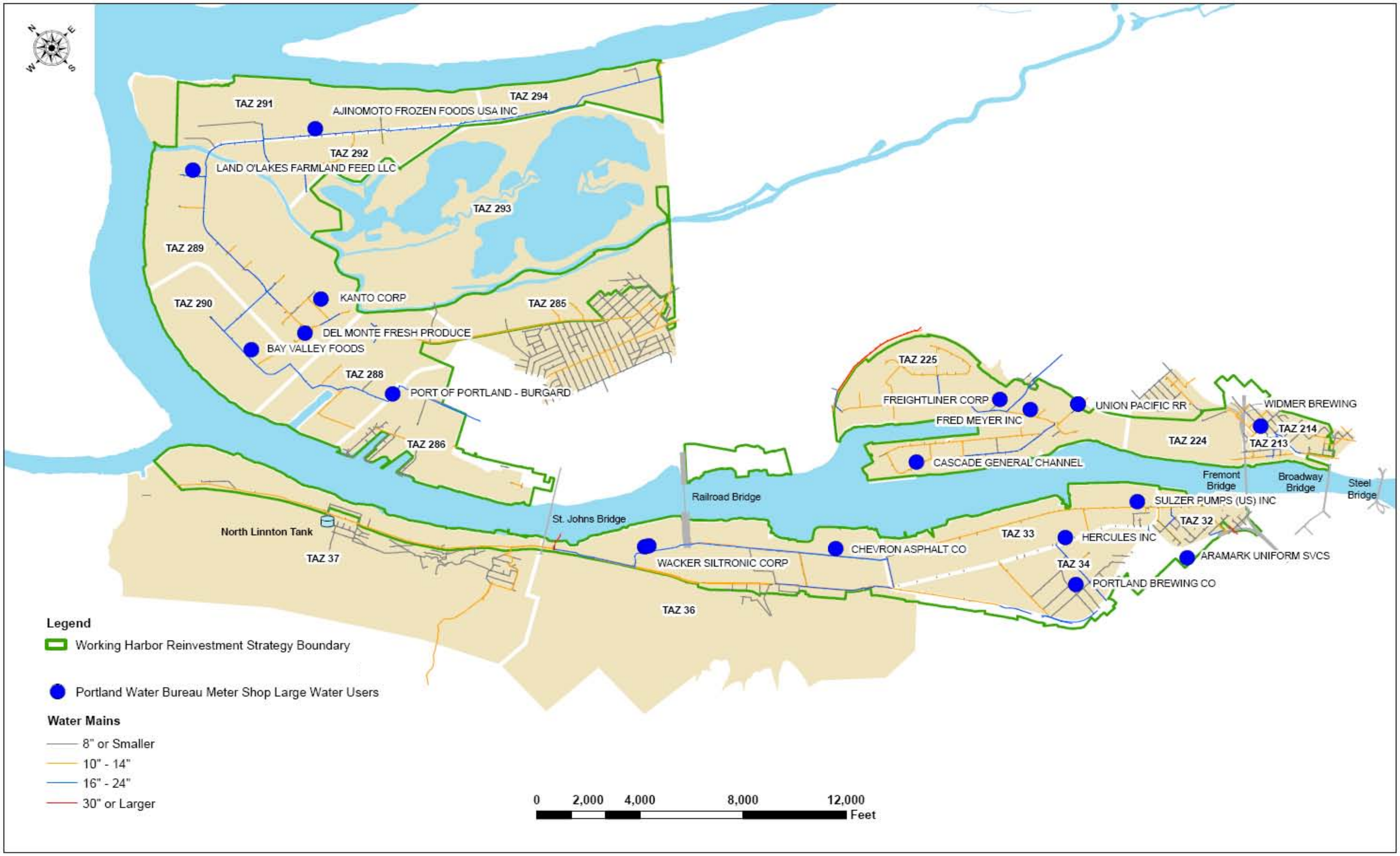
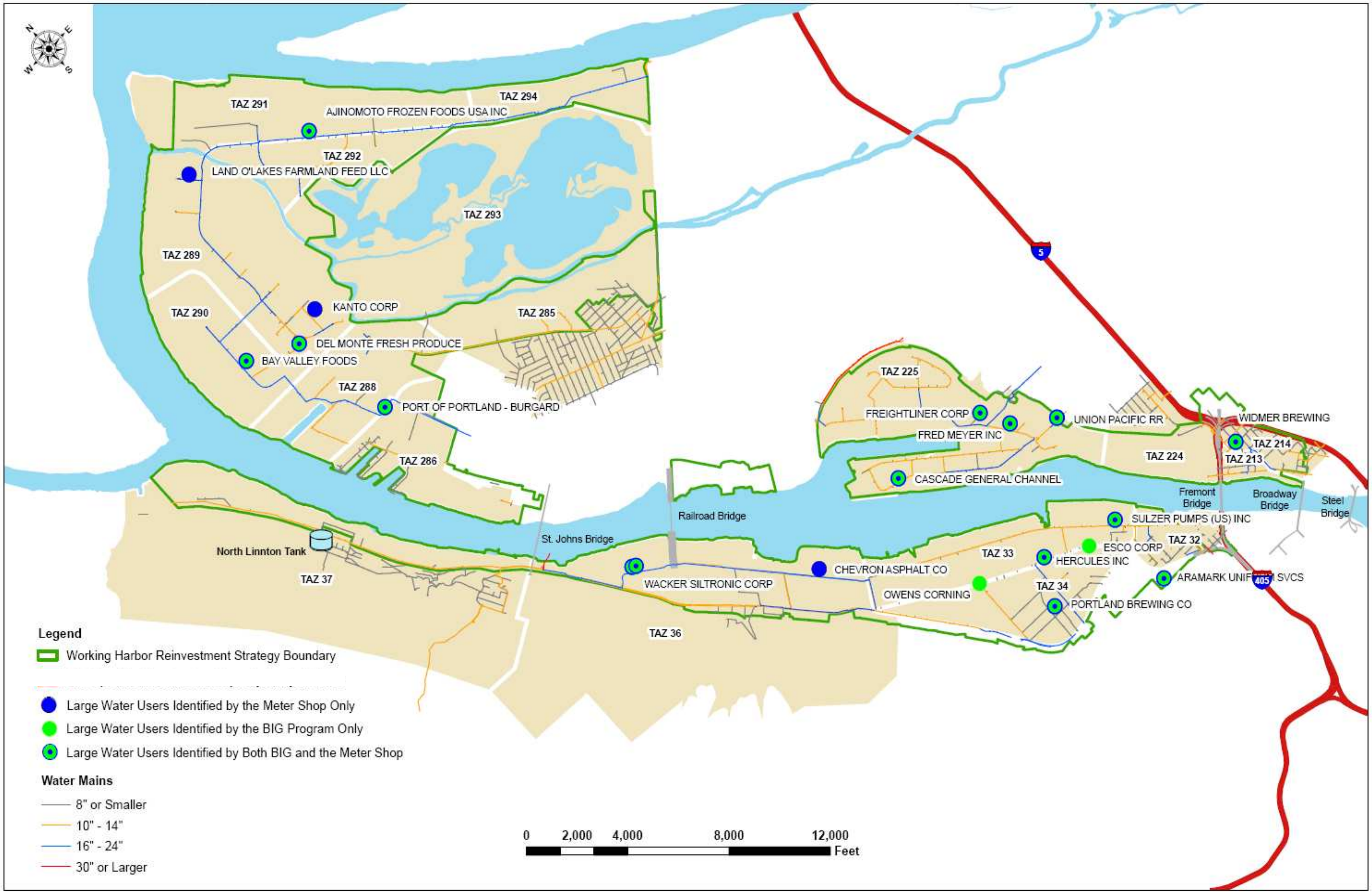


Figure 27. Large Water Users Identified by Both the BIG Program and the Meter Shop.



3.4. 5-year CIP and Budget Programs

PWB’s Capital Improvement Program (CIP) addresses water system infrastructure needs in a rolling five year plan, updated annually. For the next five fiscal years, beginning in FY 2006, the program identifies over $224.4 million in improvements. Because of past efforts in developing the WHRS area supply and distribution facilities, this area is served by a very robust and reliable network of distribution mains and redundant sources of supply. Due to these past efforts, no specific projects are identified in the current adopted CIP, however, on-going maintenance activities for the WHRS area and other areas of the City are generally included within the various programs funded under the current CIP. Any improvements to the WHRS area identified as a result of this report and other studies would likely be funded in future updates of the CIP. The following is a description of the individual programs and activities funded under the current adopted CIP.

An important element in the CIP budget is the Budget Program Framework, which provides the basic structure for the budget. The Framework consists of 6 Budget Programs and 22 Water Programs that encompass all of the Bureau's work within the descriptive areas. The six Budget Programs and 22 Water Programs are as follows:

1) SUPPLY
    - Bull Run Watershed
    - Groundwater
2) TRANSMISSION & TERMINAL STORAGE
    - Terminal Reservoirs
    - Conduits/Transmission
3) DISTRIBUTION
    - Pump Stations/Tanks
    - Distribution Mains
    - Services
    - Meters
    - Hydrants
    - Valves/Gates/Regulators
    - Field Support
4) REGULATORY COMPLIANCE
    - Regulatory Compliance
5) CUSTOMER SERVICE
    - Customer Services
    - Conservation/Sustainability
    - Security/Emergency Management
    - Fountains
    - Grounds/Parks
6) SUPPORT
    - Bureau Support
    - Employee Investment
    - Data Management
    - Planning
    - Facilities

The Distribution Budget Program is the largest budget program both in terms of budget allocation and system asset value. Over one-half of the five year total CIP ($122 million) is concentrated in improvements to the distribution system with approximately $27.0 million budgeted for FY 2006-07. Significant projects include ongoing water main replacements, efforts supporting transportation improvements in the Downtown area, and other efforts to address aging infrastructure replacement.

Each fiscal year, projects are re-evaluated and prioritized. New projects, including those identified as part of this study, would be evaluated and prioritized as part of this work effort. Not all identified projects receive funding due to budgetary constraints. Table 30 is a partial list of CIP projects currently planned for the next five years that would be re-evaluated, incorporating the results of this report and other studies.

Table 30. Distribution Budget Program Project Costs

Distribution Program Project	FY 2006-07	FY 2007-08	FY 2008-09	FY 2009-10	FY 2010-11	5-Year Total
Distribution Mains Program	4,497,000	5,900,000	6,900,000	6,900,000	6,900,000	31,097,000
Hydrant Replacement	495,000	500,000	500,000	750,000	750,000	2,995,000
Large Meter Replacement	1,298,000	1,050,000	1,050,000	1,050,000	1,050,000	5,498,000
Meter Purchases	900,000	900,000	900,000	900,000	900,000	4,500,000
New Water Services	2,142,000	2,080,000	2,080,000	2,080,000	2,080,000	10,462,000
Regulator Maintenance	69,000	150,000	150,000	150,000	150,000	669,000
Transmission Mains Program	1,621,000	2,700,000	900,000	900,000	900,000	7,021,000
Valve Replacements	877,000	802,000	802,000	1,302,000	1,302,000	5,085,000
Upper Linnton Tank	93,000	500,000	0	0	0	593,000

The following is a brief description of each of these Distribution Program Projects.

Distribution Mains Program:

Approximately 6 miles of new and replacement mains are anticipated to be installed during FY 2006-07 to support the rehabilitation and replacement of galvanized mains; expansion due to private land developments; increasing supply for fire protection, improving water quality and water system upgrades due to local infill development and street improvements. Water main replacements also include appurtenances such as fire hydrants, valves, pressure regulators, service branches and others facilities. This program insures minimal disruption to customers.

Hydrant Replacement:

PWB maintains about 16,000 fire hydrants in the water system. This program provides for the replacement of fire hydrants that are no longer repairable or that require part replacements that are no longer available. In the next year the program will replace about 130 hydrants. This program supports reliable hydrant operations and minimizes the number of hydrants out of service.

Large Meter Replacement:

This program replaces meters larger than one inch, installed prior to 1986. The replacements will occur over the next five years. Work under this program will ensure compliance with current standards for meter accuracy and water service design and reduce sources of lead from the system by physically removing older meters. In addition, PWB will install automated meter reading devices and provide non-skid access lids where applicable. PWB’s objective is to maintain metering devices to read within three percent of actual values.

Meter Purchases:

This project funds purchases of new large and small meters. The meter replacement program replaces meters when they no longer register accurately, can no longer be repaired, or are obsolete. PWB’s objective is to maintain metering devices to read within three percent of actual values.

New Water Services:

This program provides for installation of about 1,000 new water services annually and other changes to existing water services. The project provides for construction of new water services requested by customers for new development as well as redevelopment. The requesting customer reimburses PWB for the cost of new services.

Regulator Maintenance:

This program provides for maintenance or replacement needs of existing pressure regulator facilities. There are 270 regulator stations, with about 640 pressure regulators. This work also includes modifications or replacement of underground vaults to meet current safety and regulatory requirements. This program provides consistent service pressure at the customer meter.

Transmission Mains Program:

This ongoing program constructs new and replacement transmission pipelines in order to provide adequate and reliable quantities of water to distribution pressure zones and storage tanks throughout the Bureau's service area. The program maintains the backbone of the transmission pipeline network. Some of the pipelines in this program are new to supply areas that currently have insufficient supply, or have been annexed. Other pipelines will include those needed to meet growing demand or changing demographics. The program also includes maintenance to prevent corrosive deterioration and to replace key valves and related equipment. System priorities, project costs and benefits are used to assess needs and to address deficiencies. This program helps provide sufficient flow and delivery of water to customers.

Valve Replacements:

This program reduces the number of non-operational large and small valves and regulators, which helps ensure adequate and reliable service to the service to the customer. For FY 2006-07, about 15 large diameter valves are planned for replacement. It is planned to increase the annual number to between 50 and 100 through the 5 year CIP. This program reduces the areas affected during shutdowns by providing more reliable control of water when repairing leaks.

Upper Linnton Tank:

The Upper Linnton Tank, constructed in 1913 by the City of Linnton and incorporated into PWB’s distribution system, is located in Forest Park. The tank serves the residential areas along the hillside in the Linnton area of the Northwest District. This project is scheduled as a CIP project in order address leaks that have been detected. Low chlorine residuals have also been documented in the tank's service area. The capital improvement project is to create an alternative to the tank that will meet system needs for domestic water supply, fire flows, and pressure for the area. The design phase for the project is scheduled for completion by January 2008 and the construction phase is anticipated to begin on May 2008 with an estimated completion date of February 2009. The current adopted FY 2006-2011 five-year project budget is $593,000.

In addition to these activities for water system enhancements, the current 5-year CIP includes funding in order to respond to and coordinate with projects initiated by other agencies. This funding is outlined in Table 31.

Table 31. Distribution Budget Program Project Costs

Distribution Program Project	FY 2006-07	FY 2007-08	FY 2008-09	FY 2009-10	FY 2010-11	5-Year Total
ODOT Water Line Adjustment Projects	676,000	675,000	675,000	675,000	675,000	3,376,000
PDOT Water Line Adjustment Projects	7,458,000	4,000,000	500,000	500,000	500,000	12,958,000
Bureau of Environmental Services Projects	130,000	300,000	300,000	300,000	300,000	1,330,000

These Distribution Budget Program costs are described in further detail below.

ODOT Water Line Adjustment Projects:

This program provides for the relocation and adjustment of water facilities within state rights-of-way to accommodate Oregon Department of Transportation (ODOT) projects. The work includes relocation of water facilities due to roadway configuration changes, pavement overlays, and bridge improvements. Reimbursement is expected for the work performed under this program. This program can also include work done at PWB's discretion to improve the water system. Key Projects for FY 2006-2007 include:

- 926-5394 Martin Luther King Jr. Blvd/Grand Ave. Viaduct.
- 926-5512 East Columbia Blvd. to Lombard St. Connector.
- 926-5513 SW/NW Naito Parkway

PDOT Water Line Adjustment Projects:

This program provides for the relocation and adjustment of water facilities in City streets and roads to accommodate several City transportation projects managed by the Portland Department of Transportation (PDOT). These transportation projects include improvements to streets, bridges, ramps, overpasses, streetcar and light rail projects, and local improvement districts (LIDs). This program can also include work done at PWB's discretion to improve the water system. PDOT reimburses a portion of the cost to adjust the water system based on the age of the existing water facility. The Bureau's share of these relocation costs are funded through the utility relocation project. Key Projects planned for FY 2006-07 include Project #965-1012 NE 33rd Drive over Columbia Slough.

Bureau of Environmental Services Projects:

This program provides for the relocation and adjustment of water facilities to accommodate storm drainage and sewer pipelines constructed by the Bureau of Environmental Services (BES). Many FY 2006-07 projects are in response to the work associated with the Combined Sewer Overflow (CSO) program. Projects can also include work done at PWB's discretion to improve the water system in coordination with BES. BES may reimburse a portion of the cost to adjust the water system based on the age of the existing water facility. Associated projects for FY 2006-07 include Project #921-3463 Eastside Tunnel CSO: Adjustment for sewer tunnel from Oaks Bottom along the river north to Swan Island.

3.5. *Typical System Improvements Required for Development*

New development typically requires the installation of new domestic and fire services to the property. The developer is typically responsible for all costs associated with the installation of these services. Only PWB personnel may perform the work necessary to tap water mains and extend a service branch to the property line. All work after the meter is covered under the private plumbing code and is administered by the Bureau of Buildings, Plumbing Division. The following examples illustrate typical costs (2007 dollars) associated with installing new service and fire lines.

Commercial Warehouse - 2” Domestic Service & 6” Fire Line
Commercial warehouse with limited office space:

Service Installation:	$15,000
System Development Charges:	$14,300
Total Charges:	$29,300

Manufacturing Plant – 3” Domestic Service & 8” Fire Line
Examples include food processing plants or heavy machinery manufacturing facilities. These normally require fire hydrants installed on private property by the property owner. Larger water needs are anticipated for materials processing, cooling towers.

Service Installation:	$30,000
System Development Charges:	$26,812
Total Charges:	$56,812

Commercial Park – two 8” Fire Lines (to be looped) and four 1.5” Domestic Services
Examples include large commercial parks with a mix of office space, retail outlets, warehouse space and restaurants.

Service Installation:	$65,000
System Development Charges:	$35,748
Total Charges:	$100,748

These charges are estimates only and assume water is currently available to all sites through existing mains. Actual charges are calculated at the time of construction.

City Building Code requires that all property receiving water service must have dedicated frontage along a public water main. Easements are not allowed to provide water. If water is not available, applicants must pay to have a water main extended into property to be served; however, water mains may only be installed within the public right-of-way. Currently (2007), the fee is approximately $195.00 per lineal foot, which includes the installation of a 6” main under city streets and typical street restoration. The installation of larger mains, if required, would be slightly more. If PWB determines that a larger main would best serve future development, the incremental costs associated with installing a larger main, would be paid for by PWB.

City Building Code also dictates each separate parcel of land must have its own domestic and fire service. If a parcel of land with existing services is subdivided, a condition of the subdivision approval will be to provide separate services for each new parcel.

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4. Future Scenarios Analysis

The purpose of the Future Scenarios Analysis is to provide a 10-yr infrastructure capacity analysis that is based on a land absorption forecast developed by the BOP and the PDC. The land absorption forecast includes an estimate of developable land and forecasts of land absorption by new development and land affected by expansion or redevelopment in the WHRS area, projected to the year 2015. The Future Scenarios Analysis involved the following main activities.

1. Contract with Black & Veatch to conduct two hydraulic analyses and identify potential improvements using 1) a district area-wide approach and 2) a site specific approach, as described below:
    - The "Subdistrict Fire Flow Analysis" tested the system's ability to meet zoning-based fire flow using structure area-based demand estimates to model forecasted development across the WHRS study area.
        i. To characterize existing conditions, PWB staff also evaluated the existing system's capacity under current demands both before and after system improvements.
        ii. In order to test another demand scenario, PWB staff applied demands developed for the "Site Specific Capacity Improvement Analysis" to the modeling locations used in the "Subdistrict Fire Flow Analysis".
        iii. PWB staff tested a third demand scenario using the site specific demands, but this time dispersed geographically to represent employment forecasts for the WHRS area developed by BOP and PDC.
    - The "Site Specific Capacity Improvement Analysis" used employee-based water use coefficients to estimate demands from forecasted development at 15 specific sites identified by BOP and PDC.
        i. As in the "Subdistrict Fire Flow Analysis", PWB also evaluated the existing system's capacity under current demands both before and after system improvements.
        ii. Although not providing the full 5,000 gpm fire flow, a lower cost alternative was identified by PWB staff that would provide flows of roughly 4,800 gpm for roughly $1.7 million less - a 25 percent savings over the alternative capable of providing the remaining 5 percent flows to meet the 5,000 gpm zoning-based fire flow requirement.
2. Develop planning-level costs estimates to complete the improvements identified in the hydraulic analyses.

Methodologies, results, and cost estimates for both of these analyses are described in further detail in this section.

4.1 *Subdistrict Fire Flow Analysis*

The Future Scenarios Analysis was completed under contract by Black & Veatch Corporation utilizing the Bureau's peak day hydraulic model (SynerGEE version 4.1) with the specific task of identifying deficiencies in the water transmission and distribution system, if any, resulting from the forecasted development in the WHRS area. The "Subdistrict Fire Flow Analysis", used land absorption forecasts developed by the BOP and the PDC to estimate the number of square feet of new structure area and type of businesses that are likely to develop or redevelop in the WHR area. This information was used to estimate a structure area-based water demand that adequately represented the forecasted development and tested the water system for its ability to meet zoning-based fire flow requirements. In order to represent higher demand scenarios that may result from more intense development than forecasted and variations in water use patterns, development factors were applied in order to represent development (and associated water use) two- and three-times higher than forecasted.

4.1.1 Methodology

The purpose of the Subdistrict Fire Flow Analysis was to provide a 10-yr infrastructure fire flow capacity analysis. A structure area-based water demand representing future development was estimated from the land absorption forecast assuming a building coverage of 40 percent for the anticipated development and an average structure size of 125,000 ft^2. An average base water demand of 5 gpm per structure was estimated from historical billing data. The number of structures was computed from the building coverage (40 percent) and the average structure size. These structures were then modeled as service nodes with the applied base demands in PWB's hydraulic model (SynerGEE version 4.1). Service nodes were dispersed throughout the districts at unoccupied buildable vacant sites or sites containing partly buildable vacant land, partly occupied buildable land, or sites that are unoccupied brownfields. Zoning-based fire flow of 5,000 gpm was then tested at various locations in order to identify areas in which fire flow would not be met, given the forecasted development, and to identify potential water system improvements.

In order to test higher demand conditions, development factors were applied to the structure area-based water use demands in order to replicate development 2 and 3 times as much as anticipated under the forecasted development. Applying these development factors helps account for peak demands that may be experienced due to site irrigation and watering that may occur to control dust and other airborne pollutants from unpaved roads or granular materials stockpiles. Methods for estimating forecasted demands that were developed for the Site Specific Capacity Improvement Analysis covered in Section 4.2 of this report were also used to verify the results obtained in the "Subdistrict Fire Flow Analysis".

4.1.2. Required Fire Flow

The Portland water system is typically sized to provide sufficient water to meet fire flow requirements. In most cases, the zoning-based fire flow requirements are greater than the user-based water demand. This assumption holds true for most industrial users. For the 10-year infrastructure capacity analysis, the zoning-based fire flow requirements (identified to be 5,000 gpm delivered from 5 hydrants for a Heavy Industrial (IH) zone) were assumed to be adequate. Five thousand gpm is the highest fire flow typically used by the Water Bureau to test system performance.

The International Fire Code specifies fire flow requirements based upon building type and square footage. This analysis assumed that for a fire flow of 5,000 gpm, a building constructed of masonry or steel with a square footage of 55,000 ft^2 to 125,000 ft^2 would be adequate to use as a range of estimated building structure area. Fire flows for this and other building types are listed in Table B105.1 *Minimum Required Fire Flow and Flow Duration for Buildings* (2003 International Fire Code) contained in Appendix A.

4.1.3. Estimated Structure Area-Based Water Demand

In order to represent the increased daily water demand from the future development/redevelopment, an estimate of the number of buildings/square footage of developable land was determined from the total acres expected to develop/redevelop. Site building coverage in Portland's industrial districts ranges from 15 percent for heavy industrial and distribution facilities to 46 percent for non-industrial services (BOP, 2004). For the Subdistrict Fire Flow Analysis, the maximum lot coverage of 40 percent was used to estimate the square footage of development anticipated for the 10-year planning horizon.

According to the Industrial Districts Atlas, 123 identified heavy industrial facilities in Portland have an average structure area of 189,000 ft^2, Structure area as used in the Industrial Districts Atlas is defined as the footprint of buildings and other structures (e.g., tanks, silos) as identified from 1994 photogrametrics, updated by 2003 aerial photography. The 349 manufacturing sites among all the districts have an average structure area of 60,000 ft^2, while the 395 wholesale sites have an average structure area of 36,000 ft^2. Retail sites and other non-industrial service facilities located in the industrial areas have average structure area of 15,000 ft^2 to 22,000 ft^2, respectively.

Consistent with the International Fire Code specifying 5,000 gpm fire flow for steel and masonry structures ranging from 55,000 ft^2 to 125,000 ft^2, 125,000 ft^2 per structure was assumed to be an appropriate size for representing future developments, keeping in mind that larger sites with multiple buildings over 125,000 ft^2, may require more on-site hydrants in order to deliver 5,000 gpm fire flow to any one particular structure on that site. Figure 28 illustrates the use of multiple hydrants to meet fire flow for large sites with many structures. It should be noted that while average site size in the industrial districts is 4.3 acres, sites larger than 50 acres make up 41 percent of the city's industrial land and are used mostly as freight terminals (marine, rail, and air) and manufacturing facilities (BOP, 2004).

Figure 28. Multiple Fire Hydrants Utilized on Large Sites with Multiple Structures

An analysis of historical billing data collected from commercial accounts between January 2004 and April 2006 revealed that 70 percent of all commercial accounts had a peak day demand of 5 gpm or less.
A peak day demand was estimated by applying a peaking factor of 1.8 to the average monthly CCF usage. Applying a peaking factor helps account for seasonal variations in water use that may be experienced by some users (e.g. food processing facilities impacted by growing seasons, variations in landscape irrigation needs, etc.).

A summary of commercial peak day usage percentile results is included in Table 32.

Table 32. Summary of Commercial Peak Day Usage

Peak Day Demand (CCF/Month)	Peak Day Demand (gpm)	Percentile Results[a]
1,079	18.7	90%
508	8.8	80%
289	5.0	70%
179	3.1	60%
116	2.0	50%
74	1.3	40%
47	0.81	30%
24	0.42	20%
10	0.17	10%

[a]The 70th percentile indicates that 70% of the commercial services had a peak day demand of ≤ 5 gpm.

Given that historically, roughly 70 percent of commercial accounts served by PWB have had historical peak day demands of 5 gpm or less, a base demand of 5 gpm was applied for each building.

The total anticipated new building coverage and associated demand is presented in Table 33.

Table 33. Anticipated New Building Coverage and Associated Demand

District	Total Land Affected by Development (acres)[a]	Total Land Affected by Development (ft^2)[a]	Total New Building Coverage Based on 40% Coverage (ft^2)	Number of Buildings Based on 125,000 ft^2 per Building	Anticipated Additional Base Demand Based on 5 gpm/building (gpm)
Northwest	253	11,020,680	4,408,272	35	175
Swan Island	110	4,791,600	1,916,640	15	75
Rivergate	513	22,346,280	8,938,512	72	360
Total:	876	38,158,560	15,263,424	122	610

[a] 2015 Land Development Forecast for the Portland Harbor Industrial Districts (August 17, 2006). These figures include developable land, land absorption by new development and land affected by expansion or redevelopment.

4.1.4. Modeling Fire Flow and Water Demand

In order to model the new demand, 122 new service nodes would have to be added to the hydraulic model. In order to reduce the number of iterations in conducting an analysis with this number of nodes, the number of nodes was reduced by a factor of 5 (resulting in 24 service nodes) and the corresponding base demand per nodes was increased by this same factor to maintain the same overall demand value (resulting in a demand of 25 gpm per node).

In order to evaluate higher demand scenarios, development factors ranging from 1 to 3 were applied to the base demand. For example, a development factor of 3 would result in a demand of 75 gpm applied to each of the 24 service nodes. The Water Bureau requested that Black and Veatch conduct an initial analysis scenario (Scenario1) where flow at the service nodes was set at three times the estimated demand from development/redevelopment. It was estimated that the current water system capacity could supply this higher demand, in which case, modeling would be completed without further iterations. In the event that fire flow for this maximum demand factor (Scenario 1) could not be satisfied, two additional demand scenarios were to be modeled reflecting progressively smaller demand factors. To analyze the system over the requested range of potential demand conditions the daily demand flow rates were applied as follows:

- Scenario 1 assumed a development factor of 3 (75 gpm/node) applied to the 24 service nodes.
- Scenario 2 assumed the same service nodes as Scenario 1 and the development factor reduced to 2 (50 gpm/node).
- Scenario 3 assumed the same service nodes as in Scenarios 1 and 2 and the development factor reduced to 1 (25 gpm/node).

For the WHRS area, the maximum fire flow requirement for the heavy industrial (IH) zone was set at 5,000 gpm, delivered from a total of five hydrant elements spaced approximately 300 feet apart. Elements were added to the model to represent hydrants and applied to existing 8-inch or larger mains. Areas with dead-end supply lines and areas with limited pressure were tested as well as at locations near service nodes.

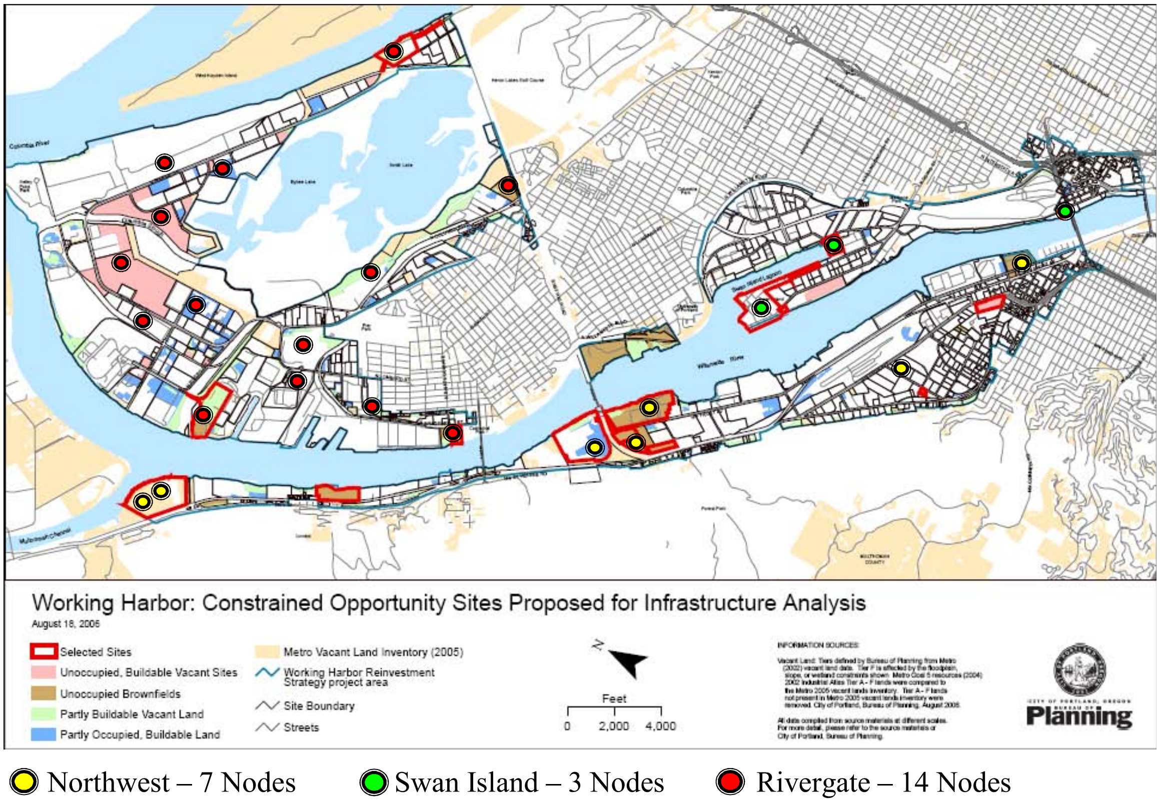
Model nodes and flows are shown in Table 34 and Figure 29.

Table 34. Modeled Service Nodes and Associated Demand

District	Number of Buildings Based on 125,000 ft^2 per Building	Anticipated Additional Demand Based on 5 gpm/building (gpm)	Service Nodes Added to the Model to Represent Buildings	Development Factor for Each of the Three Scenarios	Demand Reflecting Development Factors (gpm)
Northwest	35	175	7	1	175
				2	350
				3	525
Swan Island	15	75	3	1	75
				2	150
				3	225
Rivergate	72[a]	360	14	1	350
				2	720
				3	1,005
Total:	122	610	24		

[a] 70 replaced 72 as the number of buildings to be modeled in order to simplify the scenarios analysis. This change did not adversely affect the analysis, because any decrease in base demand for the anticipated development was made up by the application of development factors in testing higher demand conditions.

Figure 29. Subdistrict Fire Flow Analysis Model Nodes



4.1.5. Subdistrict Fire Flow Analysis Results

The results of the Subdistrict Fire Flow Analysis demonstrated that fire flow and capacity were sufficient for nearly all higher demand scenarios tested using the development factors. However, the analysis did identify two locations that were not able to meet the maximum fire flows used to test the system, even under the base demand (neglecting the application of any development factors). These areas are:

1. In the Northwest district along a 12” main running parallel to St Helens Road between the St John’s Bridge and the far northern area of the Linnton Industrial Area. The analysis determined that maximum fire flows could be met with the addition of a 16” main parallel to the existing 12” main.

2. One location in the Rivergate district where there is a discontinuous section of 12” main along Simmons Road between Burgard and Lombard Streets. The addition of a 12” main to connect the dead end mains resulted in the system meeting the required 5,000 gpm fire flow.

The findings of this analysis are discussed in further detail below.

Technical Memorandum #1 – *Subdistrict Fire Flow Analysis* (included in Appendix B) summarizes results of the analysis conducted by Black & Veatch water distribution system modelers. This analysis evaluated fire flow on a subdistrict basis for each of the Rivergate, Northwest, and Swan Island development districts.

Fire flow was analyzed at a total of ten locations representing each of the three districts as requested in the instruction document, five (5) in Rivergate, three (3) in Northwest and two (2) in Swan Island. The ten locations were selected by Black & Veatch based on professional judgment. Elevation was not a factor in selecting modeling nodes because of the low elevation of the entire area. Therefore, sites were selected to represent each of the three districts and to identify locations where dead end mains may greatly limit fire flow availability.

During the Scenario 1 analysis, which used a development factor of 3 resulting in demands of 75 gpm applied to each service node, the following fire flow conditions were observed:

1. Fire flow of 5,000 gpm was satisfied at 6 out of 10 of the test locations and where fire was less than 5,000 gpm, it was deficient under all three development scenarios.

2. A fire flow of 5,000 gpm was not met at two locations in the northwest extreme of the Northwest district in the Linnton Area (NWF001 and NWF002, Figure 30 and Table 35).

3. A fire flow of 5,000 gpm was also not met at two locations in the central area of the Rivergate district. (RGF004 and RGF005, Figure 31 and Table 35).

Figure 30. Northwest District Nodes with Fire Flow Less than 5,000 gpm.

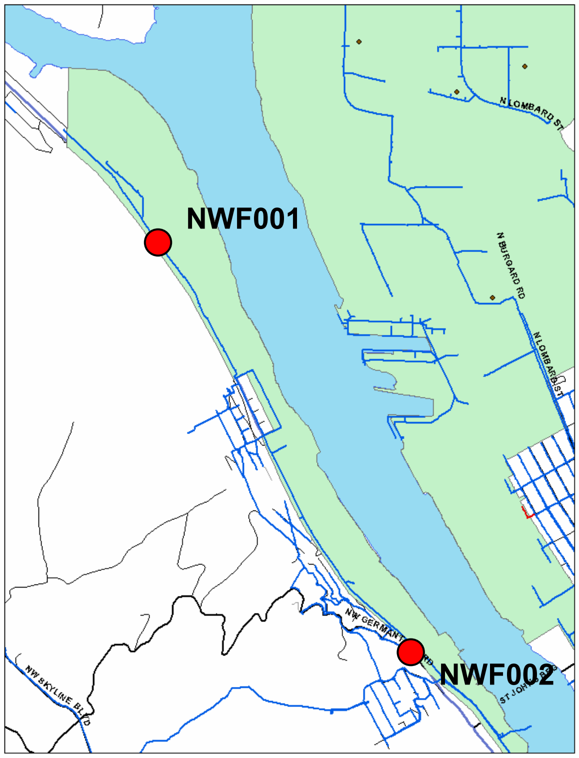


Figure 31. Rivergate District Nodes with Fire Flow Less than 5,000 gpm.

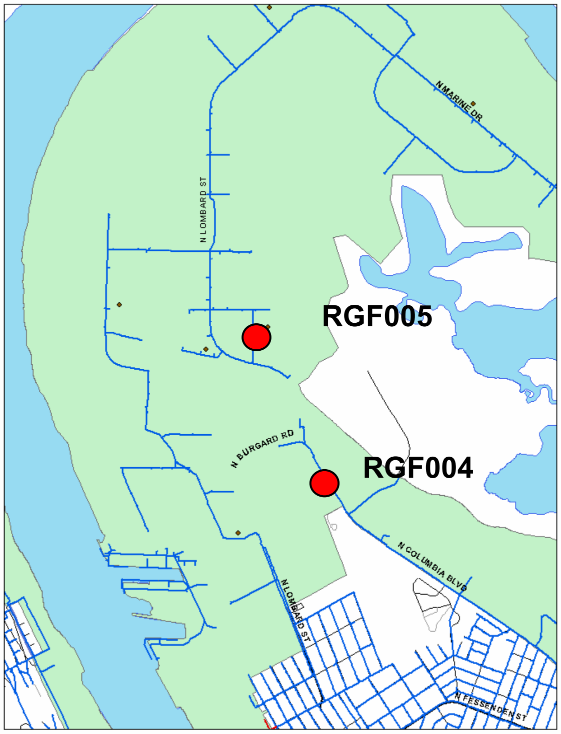


Table 35 summarizes the fire flow conditions under the Scenario 1 development factor and with the identified improvements for sites NWF001, NWF002, RGF004 and RGF005. Figure 32 shows the service nodes and fire flow analysis locations listed in Table 35.

Table 35. Scenario 1 Subdistrict Fire Flow Analysis Summary

Fire Flow Analysis Locations	Available Fire Flow for Scenario 1 (gpm)	Available FF with 12" Main Improvement (gpm)	Available FF with 16" Main Improvement (gpm)
RGF001	5,800		
RGF002	9,650		
RGF003	5,180		
RGF004	3,007	5,595	
RGF005	4,900	6,304	
NWF001	2,514		5,172
NWF002	3,014		5,174
NWF003	5,468		
SIF001	6,470		
SIF002	7,735		

Figure 32. Subdistrict Fire Flow Analysis Locations

ENERGY WATER INFORMATION GOVERNMENT

It was determined that distribution system improvements would be required if the 5,000 gpm fire flow was required in all cases.   Potential improvements that would allow the system to meet the 5,000 gpm fire flow requirement are shown in Figures 33 and 34 and identified as follows:

The addition of 15,000 feet of a 16" diameter main parallel to the existing 12" main in the Northwest district provides the required fire flow to the Northwest District locations (NWF001 and NWF002 – Figure 33) as shown in Table 35.

The addition of 1,200 feet of a 12" diameter main along Simmons Road between Burgard Street and Lombard Street would create a looped system which would provide the locations in the Rivergate district (RGF004 and RGF005 – Figure 34) with the required fire flow as shown in Table 35.

Figure 33. Northwest District Nodes Showing 16” Main Improvement.

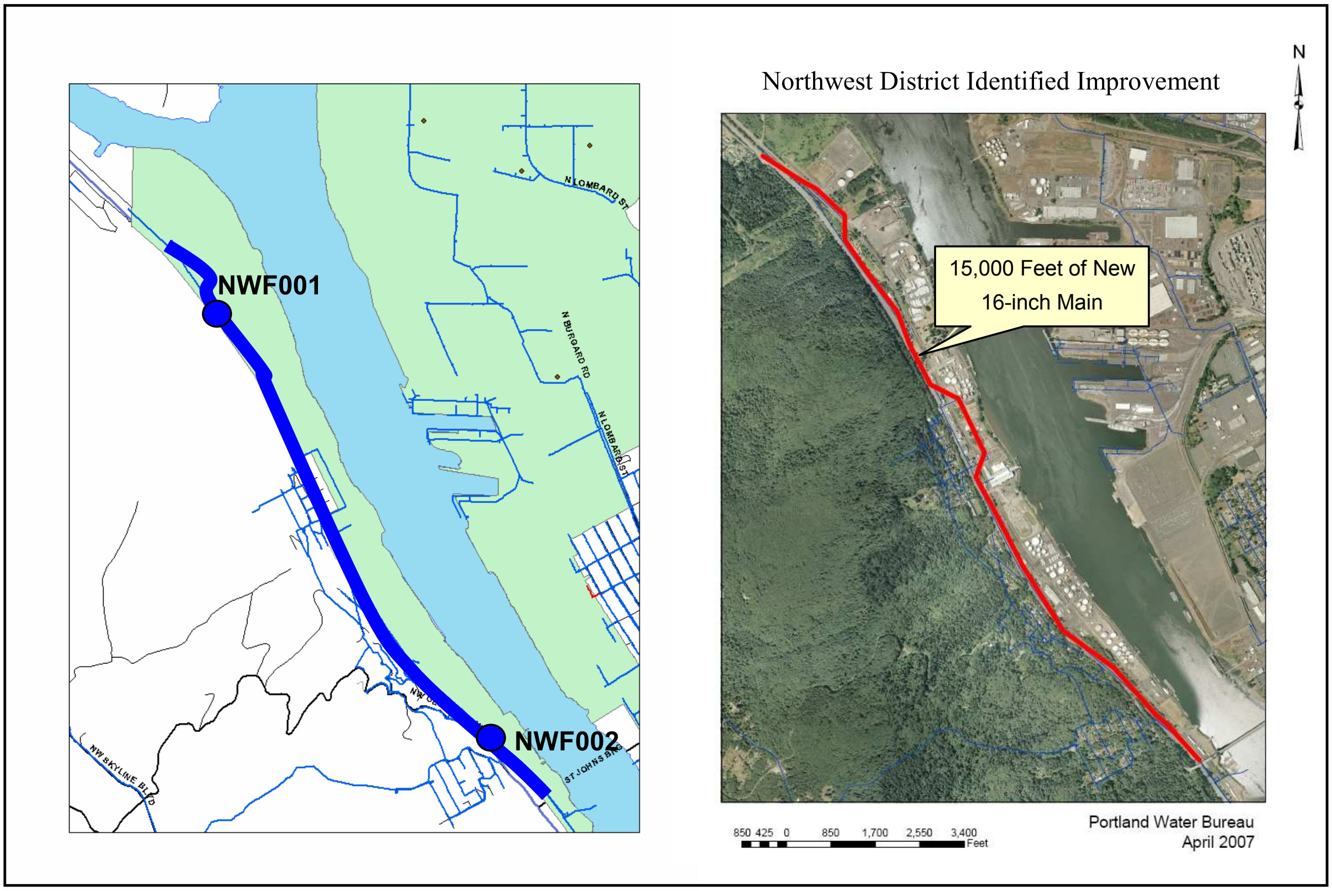
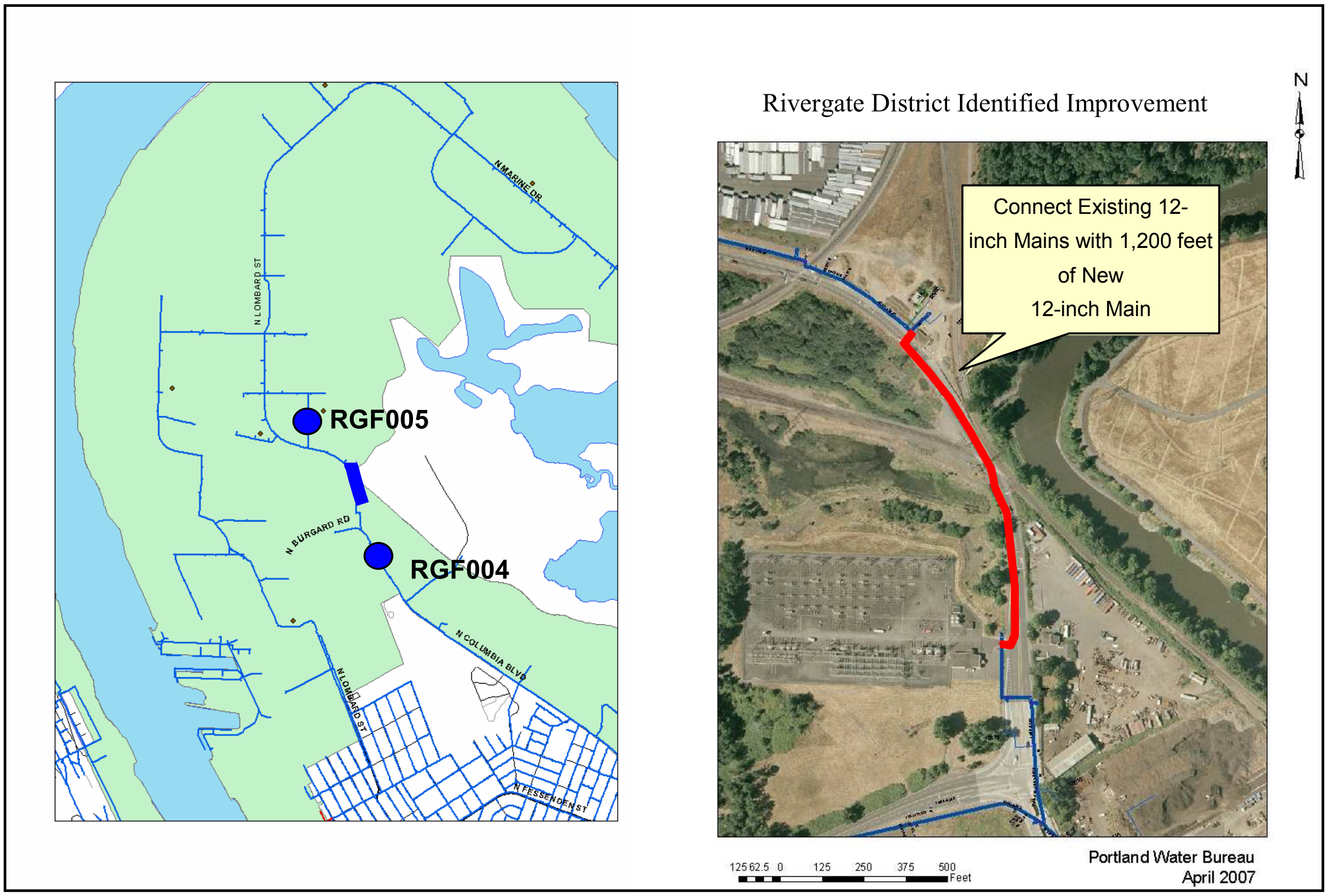
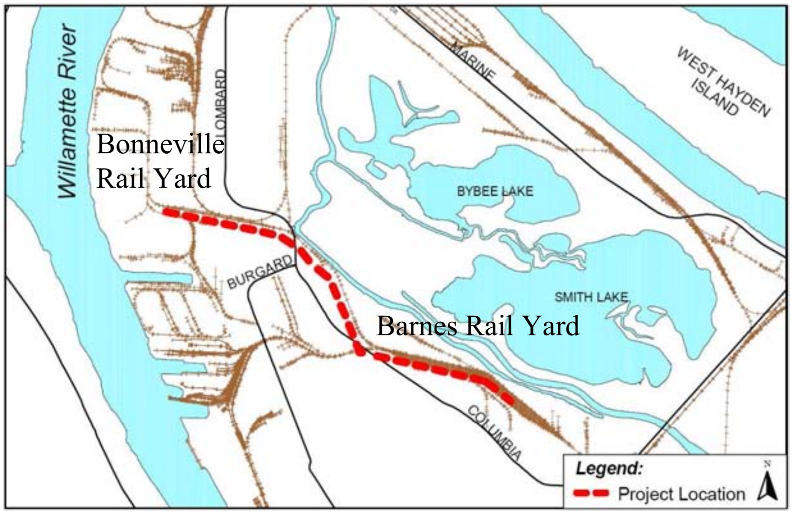


Figure 34. Rivergate District Nodes Showing 12” Main Improvement



The improvement identified for the Rivergate District is anticipated to require a crossing under a rail line. This rail crossing is anticipated to cost more and require more lead time in order to coordinate efforts with the rail line owners and operators. Figure 36 shows more detail of the improvement site.

Figure 35. Barnes Yard to Bonnevill Yard Trackage Project.



It is possible that the Rivergate improvement can be coordinated with the Port of Portland’s “Barnes Yard to Bonneville Yard Trackage” project to construct additional trackage between the Bonneville rail yard to the west and the Barnes rail yard to the east. This project is included in the 2007 Port of Portland Transportation Improvement Plan and is scheduled to be completed within the next 5 years. If this project proceeds as planned, making the identified Rivergate improvement after the Port’s project is complete, will likely increase the number of water main rail crossings.

Figure 36. 12” Main Improvement Showing Burlington Northern / Santa Fe Rail Line.

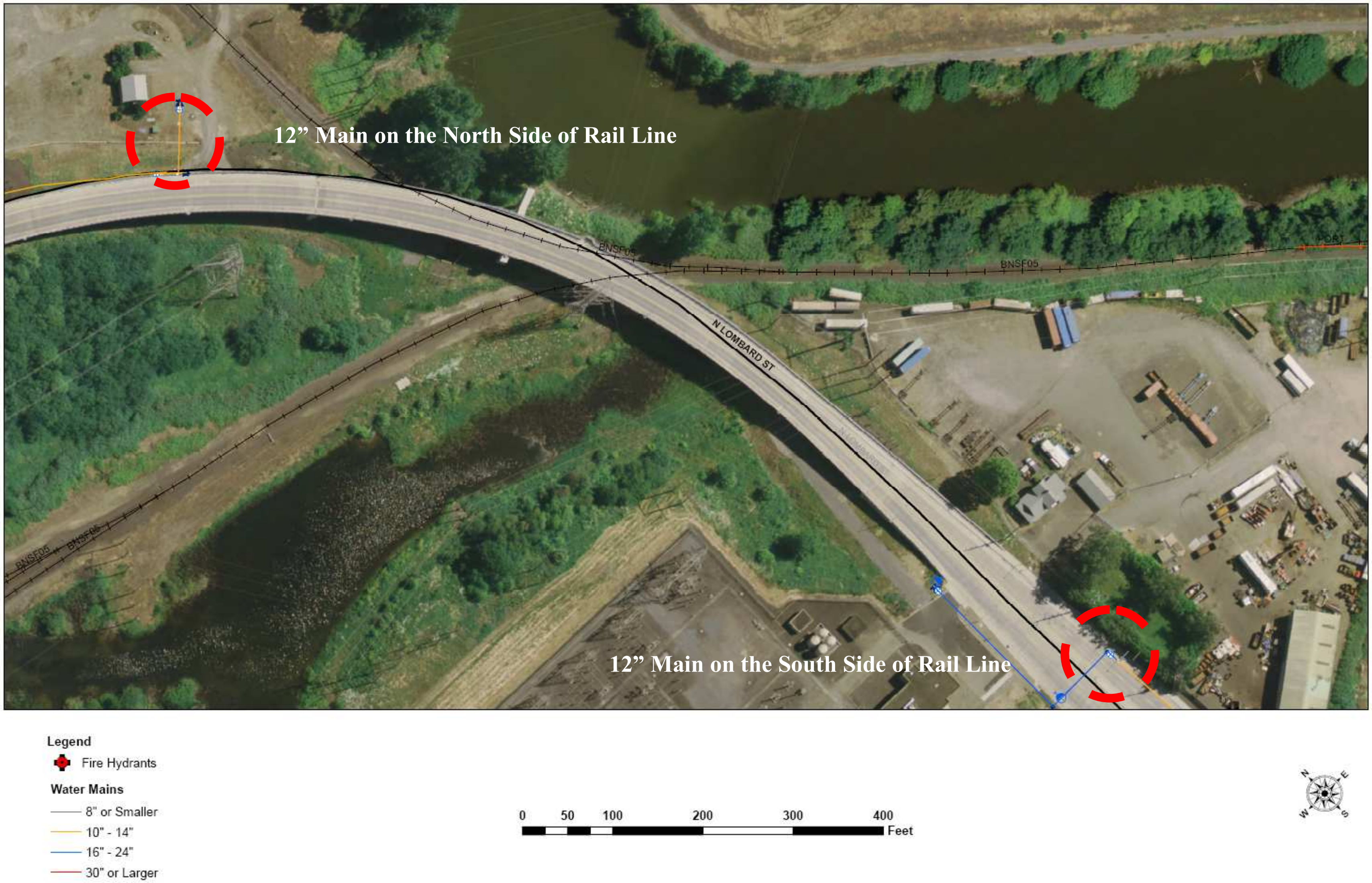
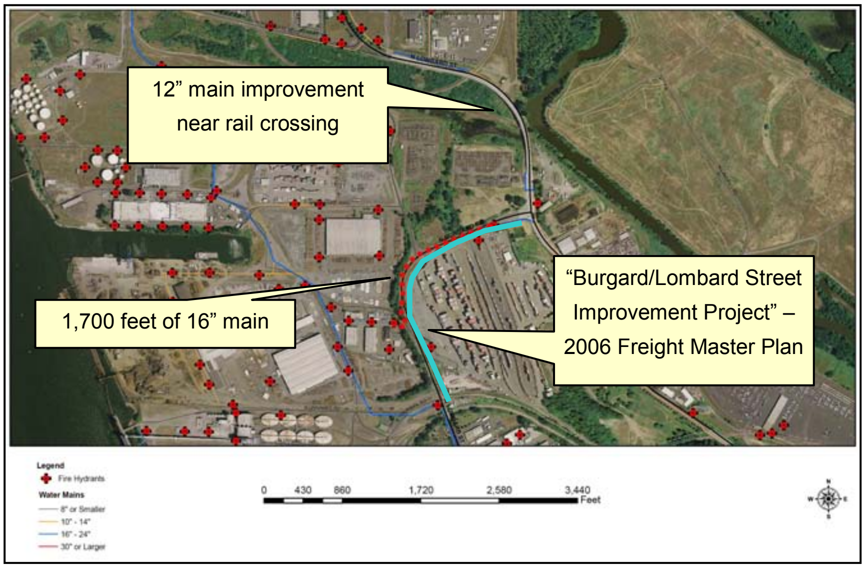
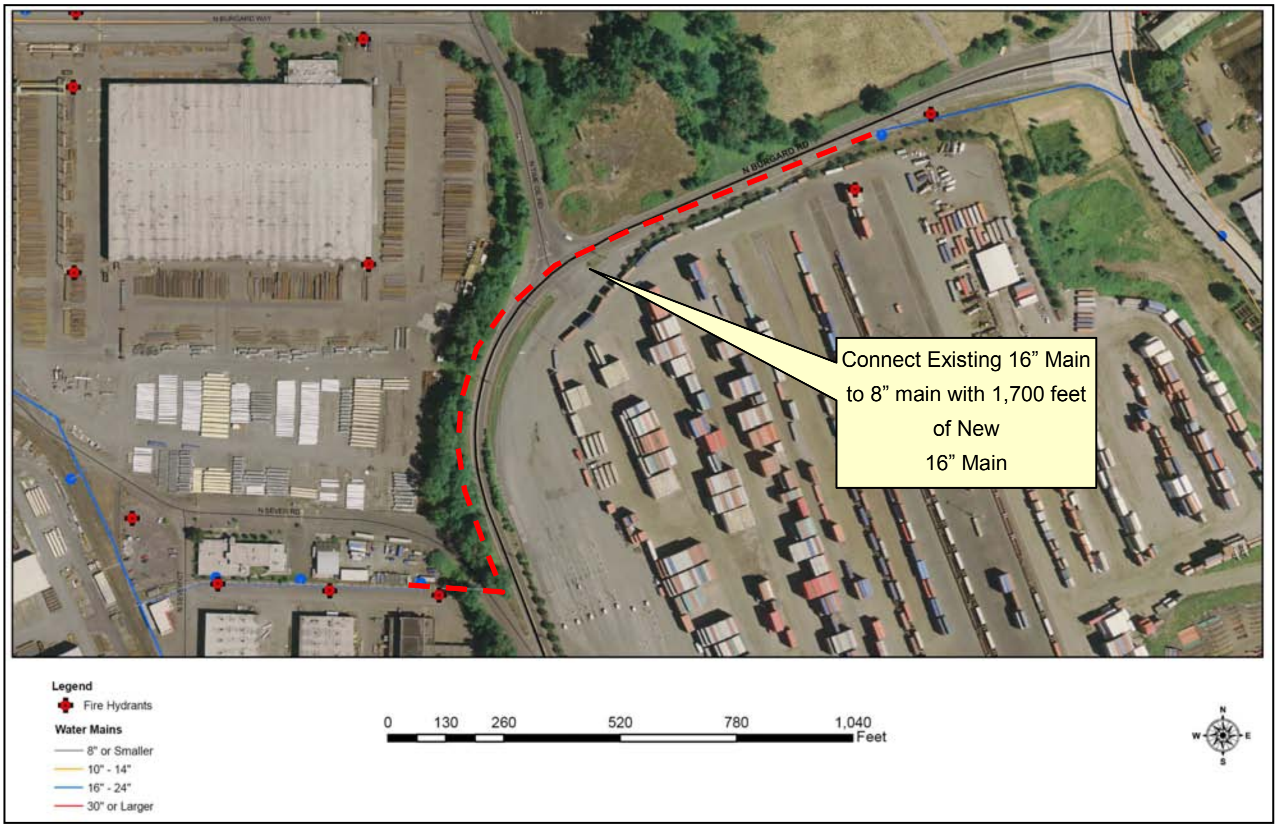


Figure 37. Alternate Rivergate Improvement



Since the available fire flow at the northern site (RGF005) of the Rivergate main improvement was found to be 4,900 gpm with the projected development, nearly meeting the 5,000 gpm fire flow requirement, an alternative would be to focus on improvements to the southern site (RGF004), which has an available fire flow of only roughly 3,000 gpm. Over time, a 16” main has been extended along North Burgard Road to the southwest of site RGF004. This main could be extended an additional 1,700 feet to loop into an existing 8” main along North Sever Court via an unimproved right-of-way. The extension is shown in Figures 37 and 38. This improvement would increase available fire flow to this area to roughly 5,385 gpm and, though costing roughly $100,000 more than the 12” identified improvement, is likely to be completed as development infills the area and demands dictate further extensions. This improvement is also unaffected by rail crossings and could be coordinated with the “N. Burgard/Lombard Street Improvement Project” (Figure 37) identified in the 2006 Freight Master Plan by the Portland Department of Transportation, which calls for widening the street under which the new main would be placed. This transportation project, however, is currently not funded and it is unclear at what time this project would be undertaken.

Figure 38. Alternate Rivergate Improvement – 1,700 feet of 16” main.



The model used by Black and Veatch was further analyzed by PWB staff to evaluate the existing system capacity. This analysis evaluated:

1. Current fire flows under existing demand (neglecting future development) and under existing demand with the improvements identified by Black and Veatch (Table 36); and
2. Fire flows with the forecasted future demands (demands estimated for forecasted development with an applied development factor 3) and fire flow with the future demands and improvements identified by Black and Veatch (Table 37).

Table 36. "Subdistrict Fire Flow Analysis" Under Existing Demand Conditions

Site ID	Fire Flow (gpm)	Improvement Added	Improved Fire Flow (gpm)
RGF004	3,100	New 12" Main	5,548
RGF005	4,824		6,227
NWF001	2,643	New 16" Main	5,253
NWF002	3,036		5,248

Table 37. "Subdistrict Fire Flow Analysis" Under Forecasted Demand (75 gpm/Node)

Site ID	Fire Flow (gpm)	Improvement Added	Improved Fire Flow (gpm)
RGF004	2,932	New 12" Main	5,392
RGF005	4,706		6,069
NWF001	2,515	New 16" Main	5,172
NWF002	3,014		5,174

With slight variations in the actual fire flow results, the conclusions drawn from this existing system conditions analysis are consistent with those found by the analysis conducted by Black and Veatch, in that the two areas in the Rivergate and Northwest District lack adequate capacity to meet a fire flow of 5,000 gpm, even under the current (2007) development, let alone under forecasted (2015) development.

As a final check, fire flow was tested using an average employee-based water use coefficient developed for the Site Specific Fire Flow Analysis covered in Section 4.2 of this report. As shown in Table 38, an employee-based water use coefficient of 517 gallons of water used per day per employee (gpdpe) was derived by omitting the highest and lowest employee-based water use coefficients and taking an average of the remaining coefficients. This 517 gpdpe (0.359 gpm per employee) coefficient was then applied to the employment forecast shown in Table 39 and grouped by district and TAZ. Employment forecasts were developed by the Bureau of Planning in August of 2006 and are for the 10 year planning horizon from 2005 to 2015.

Table 40 contains the increased demand values applied to the service nodes established by Black and Veatch. Where multiple nodes were added within a single district, the total water demand calculated for the district was divided evenly among the nodes. The results of this analysis are contained in Table 41 and demonstrate similar findings to those of the Black and Veatch Analysis.

Table 38. Employee-Based Water Use Coefficients by Water Use Category

Water Use Category		Water Use Coefficients (gpdpe)
High Tech - Large Water User	Highest =>	1,838
High Tech - Typical		246
General Manufacturing – Large Water User		1,300
General Manufacturing - Typical		255
Business Park		395
Warehouse/Distribution - Large Water User		390
Warehouse/Distribution - Typical	Lowest =>	32
Average of all Coefficients =>		*636.6*
Average of Coefficients minus the Highest and Lowest =>		*517*

Table 39. 10-Year Employment Forecast
(City of Portland, Bureau of Planning August 7, 2006)

District	TAZ	Acres	New Jobs
Rivergate	294	24	89
	293	9	33
	292	65	163
	291	53	93
	290	71	120
	289	149	371
	288	51	88
	286	45	121
	285	47	80
Rivergate District Totals =>		*514*	*1,158*
Swan Island	225	81	1,668
	224	18	59
	214	6	226
	213	5	36
Swan Island District Totals =>		*110*	*1,989*
Northwest	37	39	308
	36	112	1,115
	34	39	496
	33	46	443
	32	18	254
Northwest District Totals =>		*254*	*2,616*
Totals for all Three Districts =>		*878*	*5,763*

Table 40. Employee-Based Demands Applied to Model Nodes Established by Black and Veatch

District	Service Nodes Added to the Model to Represent Buildings	Subdistrict Fire Flow Analysis Demands (Scenario 1 – Development Factor of 3)		Demands Using Employee-Based Water Use Coefficients and Employment Forecast		
		Demand (gpm) per Node	Total District Demand (gpm)	Number of New Jobs Forecasted	Demand (gpm) per Service Node	Total District Demand (gpm)[a]
Rivergate	14	75	1,005	1,158	30	416
Swan Island	3	75	225	1,989	238	714
Northwest	7	75	525	2,616	134	939
Total:	24		1,755	5,763		2,069

[a] Total district demand is calculated by multiplying the total number of new jobs for the district by 0.359 gpmpe (517 gpdpe).

Table 41. Subdistrict Fire Flow Analysis Results Using Employee-Based Demands

Site ID	Fire Flow (gpm)	Improvement Added	Improved Fire Flow (gpm)
RGF001	6,478	New 12" Main	6,602
RGF002	18,020		
RGF003	5,649		5,698
RGF004	3,025		6,406
RGF005	5,554		7,844
NWF001	2,167	New 16" Main	5,673
NWF002	3,387		8,692
NWF003	6,317		6,327
SIF001	6,603	None Identified	6,603
SIF002	6,705		6,705

Fire flow was then tested using an employee-based water use coefficient of 517 gpdpe (0.359 gpm per employee) applied to 28 nodes distributed among the 18 TAZ using the TAZ-specific employment forecasts shown in Table 39. Twenty-four of the 28 nodes are the same service nodes used by Black and Veatch in the “Subdistrict Fire Flow Analysis”. The remaining 4 nodes were dispersed such that each of the 18 TAZs contained at least 1 service node.

Table 42 contains the increased demand values applied to these new service nodes shown in Figure 39. Where multiple nodes were added within a single TAZ, the total water demand calculated for the TAZ was divided evenly among the nodes. The results of this analysis are shown in Table 43 and also demonstrate similar findings to those of the Black and Veatch Analysis. Although flows at each of the 10 sites tested for fire flow were slightly lower, results still indicated that a majority of the system was able to deliver 5,000 gpm. Improvements would be needed for the 12” discontinuous main along Simmons Road in the Rivergate District and the far northern area of the Linnton Industrial Area in the Northwest District, as indicated in the “Subdistrict Fire Flow Analysis”, in order to deliver 5,000 gpm fire flows.

Table 42. TAZ-Specific Coefficient-Based Demands Applied to Nodes Shown in Figure 39

TAZ	Additional Water Demand Applied to TAZ (gpm)	Node Name	Existing Base Flow (gpm)	New Water Demand Applied to Node (gpm)	Total Water Demand Applied to Node (gpm)
32	91	2727.025	2.9	91	93.9
33	159	2524.005	2.9	159	161.9
34	178	2725.007	2.9	178	180.9
36	400	2422.016	2.9	133	135.9
		2422.015	2.9	133	135.9
		2321.011	2.9	133	135.9
37	111	1817.502	2.9	55	57.9
		1818.002	2.9	55	57.9
213	13	2829.012	3.0	13	16
214	81	2830.034	3.0	81	84
224	21	2729.028	3.0	21	24
225	599	2425.003	0	599	599
285	29	1925.001	2.2	29	31.2
286	43	2121.012	2.2	22	24.2
		1920.007	2.2	22	24.2
288	32	1819.001	2.2	11	13.2
		1821.004	2.2	11	13.2
		1821.003	2.2	11	13.2
289	133	1620.014	2.2	33	35.2
		1520.006	2.2	33	35.2
		1520.001	2.2	33	35.2
		1721.002	2.2	33	35.2
290	43	1619.003	0	43	43
291	33	1421.008	2.2	33	35.2
292	59	1623.001	2.2	29	31.2
		1521.003	2.2	29	31.2
293	12	1521.002	2.2	12	14.2
294	32	1725.003	2.2	32	34.2
Total	*2,067*	*28 Nodes*	65	2,067	2,132

Figure 39. Transportation Analysis Zone (TAZ) Demand Nodes

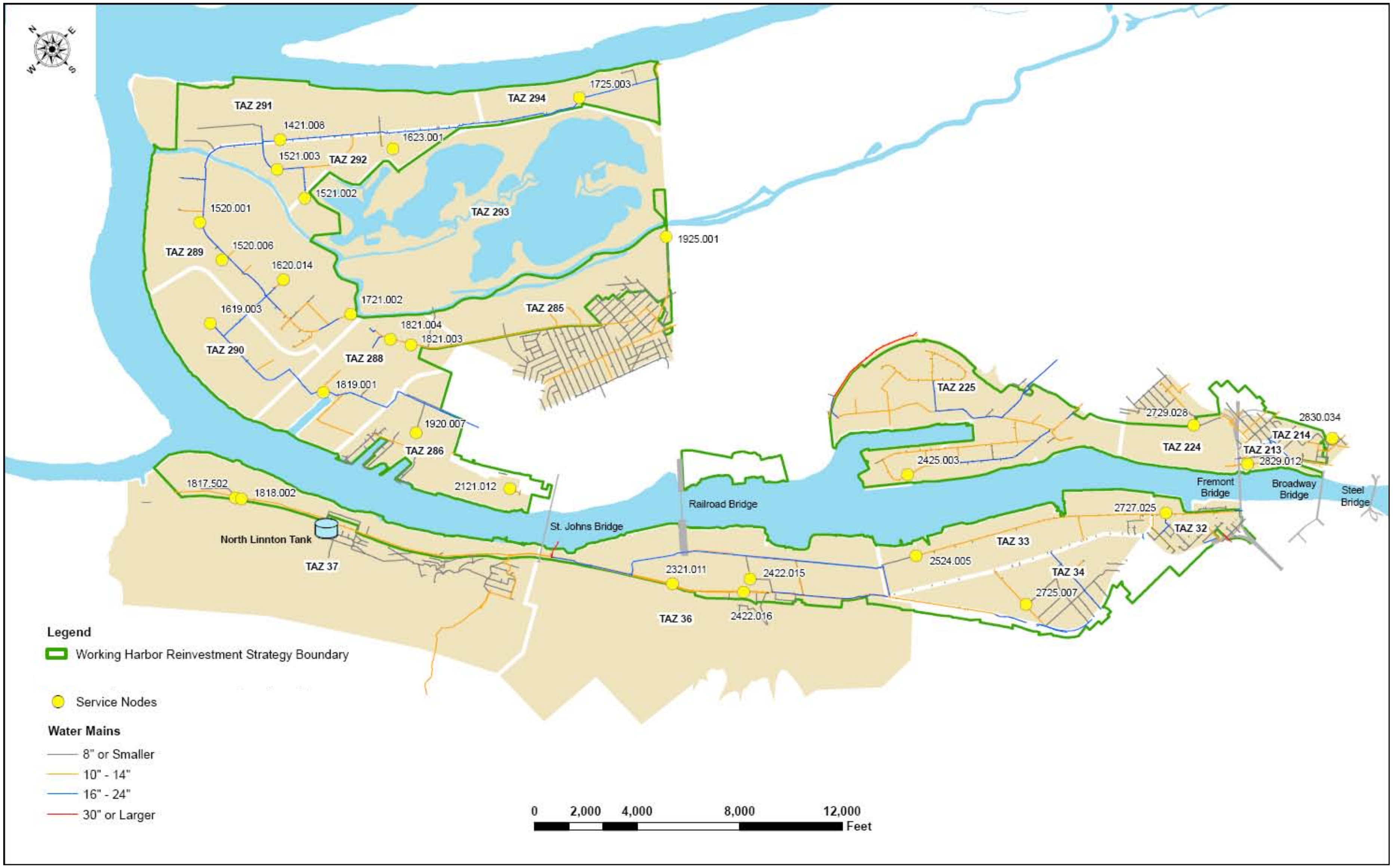


Table 43. Fire Flow Analysis Results Using TAZ-Specific Coefficient-Based Demands

Site ID	Fire Flow (gpm)	Improvement Added	Improved Fire Flow (gpm)
RGF001	6,114	New 12" Main	6,244
RGF002			
RGF003	5,545		5,591
RGF004	2,934		6,187
RGF005	5,397		7,591
NWF001	2,151	New 16" Main	5,653
NWF002	3,384		8,690
NWF003	6,238		6,249
SIF001	6,224	None Identified	6,224
SIF002	6,837		6,837

Because fire flows of 5,000 gpm could not be met in all locations, PWB used information on fire flow requirements for various building types as identified in the 2003 International Building Code (see Appendix A for more information) in order to determine the type and size of development supported by the existing water system infrastructure. Existing fire flow supports the following types of development shown in Table 44 to be constructed at the 4 locations currently unable to meet a fire flow of 5,000 gpm. Maximum building sizes provided are approximations only. Larger developments proposed for these sites should not be deterred without more detailed analysis using more specific information about the proposed development. Construction of larger buildings may be permitted depending upon site-specific conditions and mitigating factors.

Table 44. Types of Construction Supported without Mitigation Under Existing Conditions

Site ID	Available Fire Flow[a] (gpm)	Applicable Fire Flow Requirement[c] (gpm and Duration)	Types of Construction[b] Supported at each Site without Further Measures to Mitigate Fire Flow Requirements (Building types are based on the International Building Code)				
			IA and IB (Most Fire Resistant)	IIA and IIIA	IV and V-A	IIB and IIIB	VB (Least Fire Resistant)
			Maximum Building Area (square feet)				
RGF004	3,100 2,932 3,025 2,934	3,000 (3 hours)	83,700	47,100	30,100	21,800	13,400
RGF005	4,824 4,706 5,554 5,397	4,750 (4 hours)	203,700	114,600	73,300	53,000	32,600
NWF001	2,643 2,515 2,167 2,151	2,000 (2 hours)	38,700	21,800	12,900	9,800	6,200
NWF002	3,036 3,014 3,387 3,384	3,000 (3 hours)	83,700	47,100	31,100	21,800	13,400

[a] Each of 4 Possible Available Fire Flows Under the Following 4 Analysis Scenarios:

1) Existing Conditions (no added demands due to forecasted development)
2) 75 gpm per node applied to 24 service nodes dispersed throughout the 3 districts.
   (3 nodes in Swan Island, 7 nodes in Northwest, and 14 nodes in Rivergate)
3) 517 gpd per employee Applied to 24 service nodes using district job growth forecasts
4) 517 gpd per employee applied to 28 service nodes using TAZ job growth forecasts

[b] The minimum required fire flow shall be permitted to be reduced by 25 percent for residential use (Use Group R).

[c] Measured at 20 psi.

To give the reader some perspective of the types of development supported by existing fire flows, the average Home Depot retail store is 105,000 ft^2 (The Home Depot USA, Inc., 2006) and the average Safeway retail store, as of year end 2000, was approximately 44,000 ft^2 (Safeway, Inc., 2007). Table 45 lists the largest single-site employers in each district and their respective total building coverage estimated for the entire site. The approximate number of hydrants is provided and an average square footage of structure area served by 5 hydrants was computed. Figure 40 shows hydrant spacing clustered around structures at Oregon Steel Mills, Inc., illustrating the use of multiple hydrants for large sites.

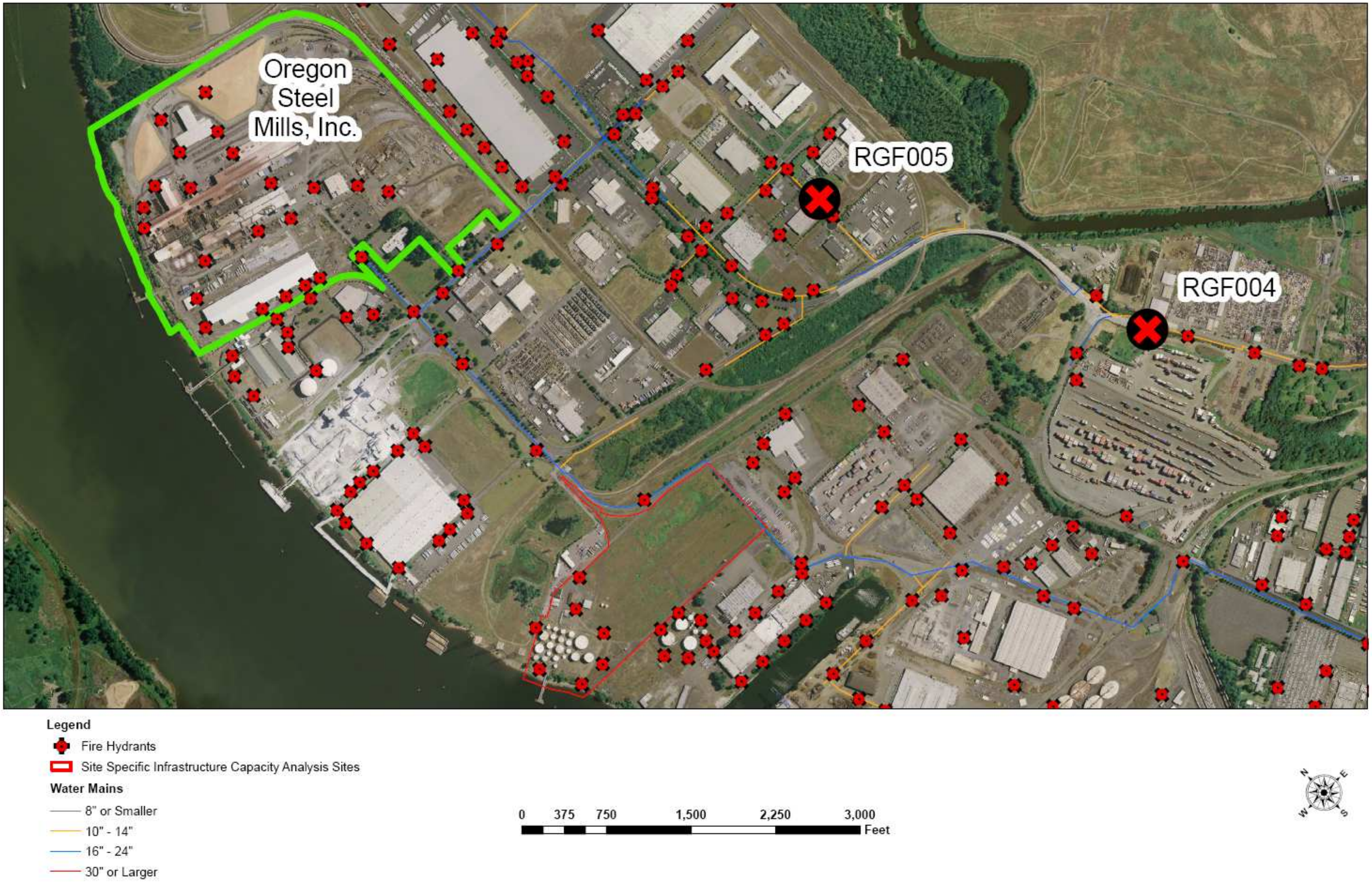
Table 45. Total Building Coverage for Some of the Largest Employers in the WHRS Area[a]

Employer	Industry	Jobs	Site Area (acres)	Approximate Total Building Coverage (ft^2)	Approximate Number of Hydrants on or within 300-ft of the Site	Building Coverage Served by 5 hydrants[b] (ft^2)
Northwest District						
Siltronic Corp	Semiconductors and Related Devices	500+	79.5	405,000	15	135,000
Gunderson, Inc.	Gray Iron Foundries (railcars and barges)	500+	57.3	844,000	21	201,000
Sulzer Pumps, Inc.	Gray Iron Foundries (pumps)	500+	24	312,000	9	173,000
Swan Island District						
United Parcel Service	Local Trucking Without Storage	500+	13.3	183,000	5	183,000
Columbia distributing Co.	Beer and Ale	500+	13.7	262,000	7	367,000
Tiffany Food Service Inc.	Merchandising Machine Operators	500+	2.6	53,000	5	53,000
Rivergate District						
Oregon Steel Mills, Inc.	Metals Service Centers and Offices	500+	148	1,040,000	39	133,000

[a] Employer information is from the Industrial Districts Atlas (BOP, 2004). Approximate building coverage and number of hydrants was obtained from City of Portland GIS spatial data (2007).

[b] Building coverage served by 5 hydrants was calculated by dividing the total building coverage by the total number of hydrants and multiplying by 5.

Figure 40. Hydrant Spacing Clustered Around Structures at Oregon Steel Mills, Inc.



4.2. Site Specific Capacity Improvement Analysis

The second part of the Future Scenarios Analysis, entitled “Site Specific Capacity Improvement Analysis”, applied employee-based water use coefficients to 15 specific sites in the WHRS area. The employee-based water use coefficients (expressed as gallons of water used per day per employee - gpdpe) were based upon the type of establishment and number of employees associated with the forecasted development at the 15 sites. Information gathered from two previous studies and site-specific information provided the basis for establishing the employee-based water use coefficients. As in the “Subdistrict Fire Flow Analysis”, a higher demand scenario was tested by applying a peaking factor of 1.8 to the estimated employee-based demands. This peaking factor was applied in order to account for seasonal variations in water use experienced by some types of development (e.g. food processing facilities impacted by growing seasons, variations in landscape irrigation needs, etc.)

4.2.1. Methodology

The purpose of the Site Specific Capacity Improvement Analysis was to identify water system improvements which may be needed to develop fifteen specific sites identified by the BOP and PDC. In order to conduct this analysis, water use categories, as specified in the IA between the BOP and PWB, were defined using Standard Industrial Classification (SIC) and National Industrial Classification System (NAICS) industry codes and employment density. Employee-based water use coefficients (defined for particular SIC/NAIC codes and expressed on a gallon per day per employee basis) were applied to the job densities and industrial classifications developed for the water use categories. The employee-based water use coefficients were derived from water use coefficients developed by the Pacific Institute for Studies in Development, Environment and Security (Pacific Institute) and the U.S. Army Corps of Engineers' Institute for Water Resources Municipal and Industrial Needs Model (IWR-MAIN model). Site-specific information provided by the BOP and PDC was then used to assign water use categories and job densities to the 15 sites. The employee-based water use coefficients were used to estimate a base demand representative of the future development. PWB contracted with Black and Veatch to conduct modeling using PWB’s hydraulic model (SynerGEE version 4.1) in order to determine if the water system could meet a 5,000 gpm fire flow requirement, given the new development. In order to test a higher demand scenario, a peaking factor of 1.8 was applied to the base demand in order to replicate demands indicative of seasonal increases in water use due to landscape irrigation and commodity fluctuations that may impact water use in production processes. As in the “Subdistrict Fire Flow Analysis”, improvements were identified for those areas not able to meet the 5,000 gpm fire flow requirement.

4.2.2. Required Fire Flow

As in the Subdistrict Fire Flow Analysis, the zoning-based fire flow requirement (identified to be 5,000 gpm delivered from 5 hydrants for a Heavy Industrial zone) was assumed to be adequate for this analysis.

4.2.3. Estimated Employee-Based Water Demand

The Site Specific Capacity Improvement Analysis involved modeling development at 15 specific sites within the WHRS area. In order to represent the increased daily water demand from the future development/redevelopment, an estimate of the square footage of building coverage was determined from the total acres expected to develop/redevelop. Estimates were also developed for the number of employees per acre expected based upon the type of development. Employee-based water use coefficients were applied to these estimates in order to derive the demand for each of the 15 specific sites.

The following water use categories provided the base development descriptors for determining the base demand:

1. General Manufacturing – Typical
2. General Manufacturing – LWU
3. High Tech – Typical
4. High Tech – LWU
5. Warehouse/Distribution – Typical
6. Warehouse/Distribution – LWU
7. Business Park.

(LWU = Large Water User)

Water Use Categories were assigned the following subsector identification codes based upon the NAICS codes. These codes were also cross-walked to SIC identification codes. Table 46 illustrates these assignments.

Table 46. Water Use Category and Associated SIC/NAICS Codes

Water Use Category	SIC/NAICS	NAICS Subsector Description
Business Park	42 / 484	Truck Transportation
	44 / 483	Water Transportation
	45 / 481	Air Transportation
	47 / 488	Support Activities for Transportation
	48 / 513	Broadcasting and Telecommunications
General Manufacturing - LWU	20 / 311	Food Manufacturing
	24 / 321	Wood Product Manufacturing
	26 / 322	Paper Manufacturing
	28 / 325	Chemical Manufacturing
	29 / 324	Petroleum and Coal Products Manufacturing
	31 / 316	Leather and Allied Product Manufacturing
	33 / 331	Primary Metal Manufacturing
General Manufacturing - Typical	22 / 313	Textile Mills
	23 / 315	Apparel Manufacturing
	25 / 337	Furniture and Related Product Manufacturing
	27 / 323	Printing and Related Support Activities
	30 / 326	Plastics and Rubber Products Manufacturing
	32 / 327	Nonmetallic Mineral Product Manufacturing
	34 / 332	Fabricated Metal Product Manufacturing
	35 / 333	Machinery Manufacturing
	37 / 336	Transportation Equipment Manufacturing
	39 / 339	Miscellaneous Manufacturing
High Tech - LWU	36 / 334	Computer and Electronic Product Manufacturing
High Tech - Typical	36 / 335	Electrical Equipment, Appliance, and Component Manufacturing
Warehouse/Distribution - LWU	51 / 424	Merchant Wholesalers, Nondurable Goods
Warehouse/Distribution - Typical	50 / 423	Merchant Wholesalers, Durable Goods

Water use categories were also paired with Facility Types as identified on page 15 of the Industrial Districts Atlas as taken from the Multnomah County Assessment & Taxation – property values, March-July 2004; Oregon Employment Department – Covered Employment 2002. Once paired, the forecasted figures for Jobs/Acre were applied to the water use categories as shown in Table 47.

Table 47. Job Density for Water Use Categories

"Site Specific Capacity Improvement Analysis"		Industrial Districts Atlas Job Density	
Water Use Category	Jobs/Acre	Facility Type(s)	Jobs/Acre
Business Park	16	Multi-Tenant[a]	16
General Manufacturing - Typical	13	Manufacturing	13
General Manufacturing - LWU	25	Construction	25
High Tech - Typical	26[b]	N/A[b]	N/A[b]
High Tech - LWU	100[c]	N/A[b]	N/A[b]
Warehouse/Distribution - Typical	6	Distribution	6
Warehouse/Distribution - LWU	10.5	Average of Transportation (10 jobs/acre) and Wholesale (11 jobs/acre)	10.5

[a] Multi-Tenant facilities include a mix of 25% manufacturing, 8% construction, 14% wholesale, 19% Rental & Transportation, 6% professional maintenance, 8% services, 5% food & retail, 4% other leisure, and 9% miscellaneous services.
[b] Taken from a typical electronic computer manufacturer (NAICS 334111) from an on-line search of the Oregon Labor Market Information System (OLMIS) for electronic computer manufacturing companies statewide – see Appendix C for more details.
[c] Figure derived from Siltronics Corp site-specific information – see Appendix C for more details.

Minimum, maximum, and average employee-based water use coefficients were developed through a comparison of coefficients developed by the Pacific Institute for Studies in Development, Environment, and Security (Pacific Institute, 2003) and the U.S. Army Corps of Engineers' IWR-MAIN model. These water use coefficients (also on a gallon per employee basis) were then converted to employee-based water use coefficients on a per square foot of development area basis. The details of these determinations are contained in Appendix C and summarized in Table 48 below.

Table 48. Water Use Coefficients for Typical and Large Water Users

Development Type	Jobs/Acre	Water Use Coeff. (gpdpe)	Water Use Coeff. (gal/day/ft^2)
Business Park	16.0	395	0.1451
General Manufacturing - Typical	13.0	255	0.0761
General Manufacturing - LWU	25.0	1,300	0.7461
High Tech - Typical	26.0	246	0.1468
High Tech - LWU	100.0	1,838	4.2195
Warehouse/Distribution - Typical	6.0	32	0.0044
Warehouse/Distribution - LWU	10.5	390	0.0940
Average =>	*28.1*	*636.6*	*0.8*

Site-specific water use was determined based upon the following two factors:

1. Number of square feet of developed floor space; and
2. Type of development (i.e. water use category).

The number of square feet of structure area was derived from site specific development forecasts resulting in a list of constrained opportunity sites proposed for infrastructure analysis (See Appendix C). Where site specific information was lacking, structure areas were developed by applying a 40% building coverage factor to the total number of acres expected to develop for each site. Based upon site specific information, an anticipated water use category was assigned for each of the 15 sites.

With the water use category and associated coefficient in gal/day/ft^2 defined and the total structure area estimated for each site, the estimated new demand represented by the development of the 15 sites was then determined. These demands are shown in Table 49, Table 50, and Table 51 for each of the three districts.

Table 49. Rivergate District Development Sites

	Development Sites =>	RGID01 Time Oil Co et al	RGID02 Langley St John’s Partnership	RGID12 Stauffer Chemical Co
	Estimated Number of Jobs	90	45	28
	Total Structure Area for Scenario Analysis (ft^2)	784,080	121,968	261,360
	% Building Coverage of Available Area (%)	40%	40%	40%
Building Coverage by Water Use Category (ft^2)	Business Park (Industrial Services)	180,300	121,968	78,408
	General Manufacturing - Typical (General Industrial)	0	0	0
	General Manufacturing - LWU (Heavy Industrial)	0	0	0
	High Tech - Typical	0	0	0
	High Tech - LWU	0	0	0
	Warehouse/Distribution - Typical	603,780	0	182,952
	Warehouse/Distribution - LWU (Remainder)	0	0	0
	Estimated Additional Water Demand (gpm)	20.0	12.3	8.5
	Estimated Additional Water Demand (CCF/month)	1,156	710	489

Table 50. Swan Island District Development Sites

Development Sites =>		SIID06 BES Swan Island	SIID13 Vigor – Cascade General	SIID15 Gordon Malafouris
Estimated Number of Jobs		25	625	11
Total Structure Area for Scenario Analysis (ft^2)		236,900	1,089,000	81,487
% Building Coverage of Available Area (%)		54%	100%	100%
Building Coverage by Water Use Category (ft^2)	Business Park (Industrial Services)	75,800	0	0
	General Manufacturing - Typical (General Industrial)	0	0	0
	General Manufacturing - LWU (Heavy Industrial)	0	1,089,000	0
	High Tech - Typical	0	0	0
	High Tech - LWU	0	0	0
	Warehouse/Distribution - Typical	161,100	0	81,487
	Warehouse/Distribution - LWU (Remainder)	0	0	0
	Estimated Additional Water Demand (gpm)	8.1	564.2	0.2
	Estimated Additional Water Demand (CCF/month)	470	32,587	14

Table 51. Northwest District Development Sites

Development Sites =>		NWID03 Arkema	NWID04 ESCO Corp.	NWID05 Aventis Cropscience	NWID07 BES T1 North	NWID08 Linnton Plywood Association	NWID09 Lakea Corp.	NWID10 Oregonian	NWID11 Siltronics Corp.	NWID14 Portland General Electric
Estimated Number of Jobs		453	52	83	99	16	10	46	600	850
Total Structure Area for Scenario Analysis (ft^2)		1,028,016	174,240	278,784	331,056	435,600	17,424	170,000	261,360	1,481,040
% Building Coverage of Available Area (%)		40%	40%	40%	40%	40%	40%	35%	40%	100%
Building Coverage by Water Use Category (ft^2)	Business Park (Industrial Services)	0	0	0	0	435,600	0	20,000	0	0
	General Manufacturing - Typical (General Industrial)	0	174,240	278,784	331,056	0	0	150,000	0	0
	General Manufacturing - LWU (Heavy Industrial)	616,810	0	0	0	0	0	0	0	1,481,040
	High Tech - Typical	0	0	0	0	0	17,424	0	0	0
	High Tech - LWU	0	0	0	0	0	0	0	261,360	0
	Warehouse/Distribution - Typical	0	0	0	0	0	0	0	0	0
	Warehouse/Distribution - LWU (Remainder)	411,206	0	0	0	0	0	0	0	0
	Estimated Additional Water Demand (gpm)	346.4	9.2	14.7	17.5	43.9	1.8	9.9	765.8	767.4
	Estimated Additional Water Demand (CCF/month)	20,008	532	851	1011	2,535	103	574	44,230	44,318

4.2.4. Modeling Fire Flow and Water Demand

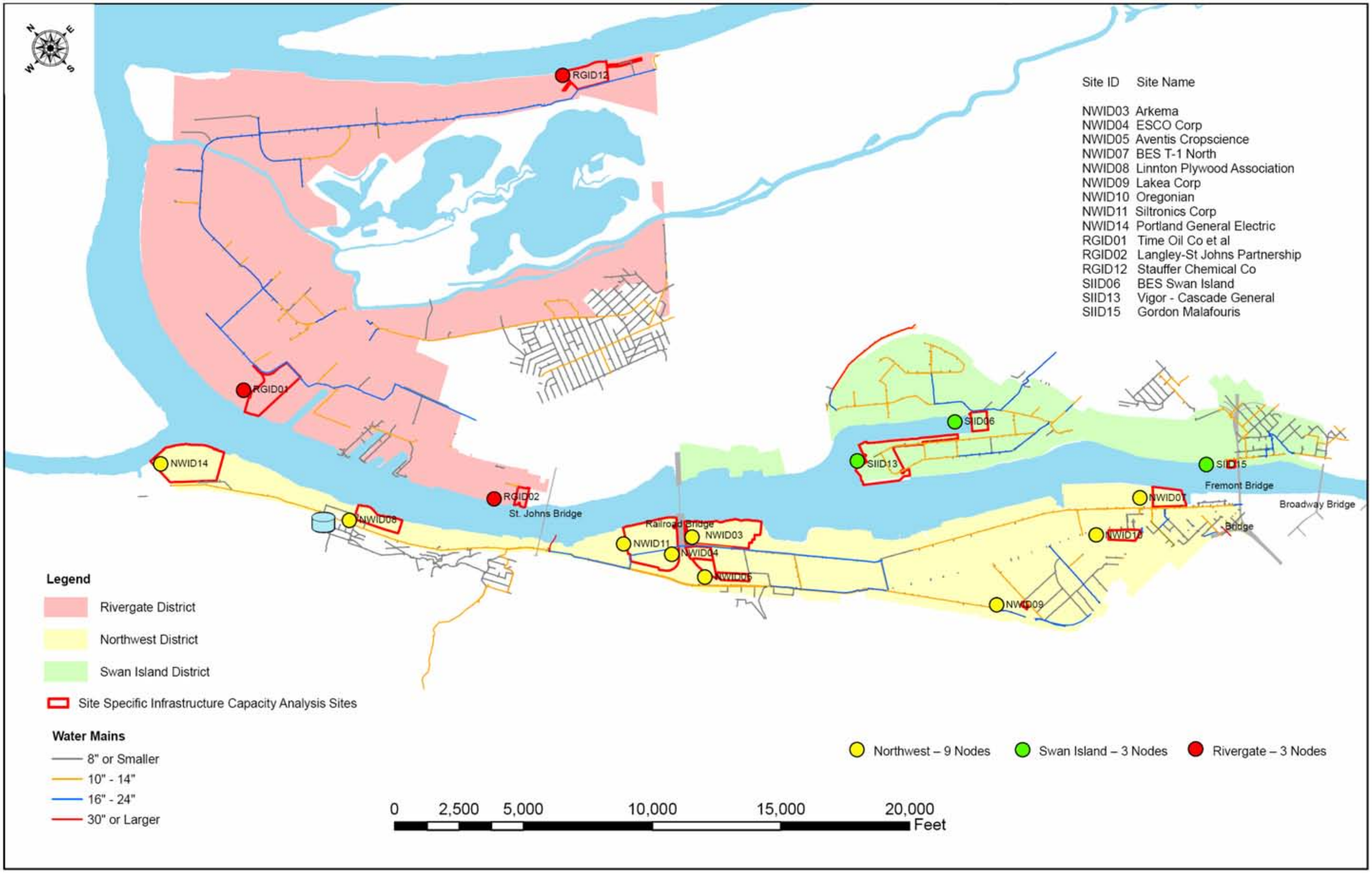
As a surrogate for demands anticipated from the 15 sites, a service node was added to the hydraulic model at each site as shown in Figure 41. The estimated demands were then applied to these 15 service nodes. A peak day demand was also estimated by applying a peaking factor of 1.8 to each site. Applying a peaking factor helps account for seasonal variations in water use that may be experienced by some users (e.g. food processing facilities impacted by growing seasons, landscape irrigation, etc.). The resultant demands are shown in Table 52.

Table 52. District Nodes and Associated Demands

District	Estimated Additional Demand (gpm)	Estimated Additional Peak Day Demand (gpm)	Number of Nodes	Demand per Node (gpm/node)	Peak Day Demand per Node (gpm/node)
Northwest	1,982	3,566	9	220	396
Swan Island	573	1,032	3	191	344
Rivergate	41	74	3	14	25
Total:	*2,596*	*4,672*	*15*	*142 (average)*	*255 (average)*

To provide the site specific fire flow, the zoning-based fire flow requirement (identified to be 5,000 gpm delivered from 5 hydrants) was applied near each of the 15 service node sites. The results from individual model runs were recorded at each service node. The same assumptions and specifications for fire flow used in the "Subdistrict Fire Flow Analysis" were used for this analysis. As in the "Subdistrict Fire Flow Analysis", areas with dead-end supply lines and areas with limited pressure were tested as well as at locations near service nodes.

Figure 41. Model Nodes for the Site Specific Capacity Analysis



Site ID	Site Name
NWID03	Arkema
NWID04	ESCO Corp
NWID05	Aventis Cropscience
NWID07	BES T-1 North
NWID08	Linnton Plywood Association
NWID09	Lakea Corp
NWID10	Oregonian
NWID11	Siltronics Corp
NWID14	Portland General Electric
RGID01	Time Oil Co et al
RGID02	Langley-St Johns Partnership
RGID12	Stauffer Chemical Co
SIID06	BES Swan Island
SIID13	Vigor - Cascade General
SIID15	Gordon Malafouris

4.2.5. Site Specific Capacity Improvement Analysis Results

The findings of the Site Specific Capacity Improvement Analysis were similar to the findings in the Subdistrict Fire Flow Analysis in that Portland's existing water system was able to meet demands and fire flow requirements for future development at nearly all of the 15 specific sites.

Unlike the "Subdistrict Fire Flow Analysis", only the north end of the Northwest District did not meet the 5,000 gpm fire flow. The analysis determined that maximum fire flows could be met with the addition of a 24" main parallel to the 12" main in the Northwest District. The findings of this analysis are discussed in further detail as follows.

Technical Memorandum #2 – *Site Specific Capacity Improvement Analysis* (included in Appendix D) summarizes the results of the analysis conducted by Black & Veatch water distribution system modelers. In this analysis, fire flow availability for specific sites within the WHRS development area was evaluated in a similar manner to the Subdistrict Fire Flow Analysis.

Black & Veatch water distribution system modelers modeled scenarios in order to evaluate available fire flow at each of fifteen development sites. Each site scenario was conducted according to the specifications provided by the Water Bureau. In order to reduce the number of redundant simulations, test locations were only simulated for peak demands at the sites if they had a demand greater than 100 gpm, which could induce a notable change after an increase by the 1.8 peaking factor. In cases where site specific base flow was relatively small (less than 100 gpm), it was determined that applying a peaking factor of 1.8 at each site would have had a negligible impact on available fire flow. In these cases another simulation was also not conducted.

Based on all modeled conditions, the following available fire flow conditions were observed:

1. Fire flow of 5,000 gpm was satisfied at 13 out of the 15 test locations.

2. All nodes which satisfied fire flow requirements under base conditions were also estimated to satisfy fire flow requirements under demand conditions with the 1.8 peaking factor applied.

3. At the two sites where available fire flow was found to be less than 5,000 gpm (NWF08, NWF14, Figure 42), a 22" parallel main improvement was added to the model, and the tests were then simulated again. With the improvement (Figure 43), NWID08 was capable of delivering a fire flow of 5,863 gpm, and NWID14 was capable of delivering 5,388 gpm under peak demand conditions. Hydraulically, a 22" main would provide the required fire flow, however, ductile iron pipes only come in 20" and 24" diameters, therefore, a 24" diameter main would be installed.

Figure 42. NWF14 and NWF08

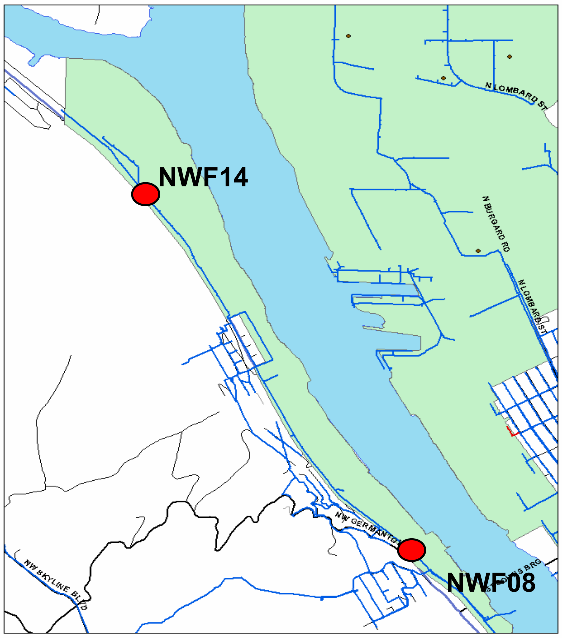


Figure 43. Northwest district after improvement

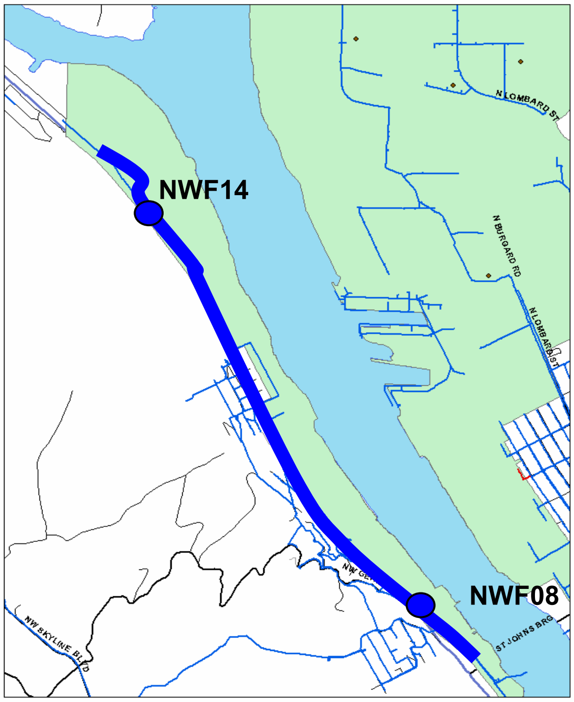


Table 53 summarizes the fire flow under existing conditions and with the identified improvement for sites NWF08 and NWF14.

Table 53. Site Specific Fire Flow Analysis Summary

Service Node ID	Fire Hydrant ID	Existing Available FF (gpm)	Existing Available FF Peak Day (gpm)	Available FF with Looped 22" Improvement (gpm)	Available FF with Looped 22" Improvement during Peak Day (gpm)
RGID01	RGF01	9,212			
RGID02	RGF02	8,637			
RGID12	RGF12	5,625	5,605		
SIID06	SIF06	8,093			
SIID13	SIF13	5,809	5,469		
NWID03	NWF03	8,437			
NWID04	NWF04	5,766	5,730		
NWID05	NWF05	7,590	7,603		
NWID07	NWF07	10,296			
NWID08	NWF08	3,830		6,036	5,863
NWID09	NWF09	9,105			
NWID10	NWF10	8,523			
NWID11	NWF11	9,575	9,523		
NWID14	NWF14	1,343		5,756	5,388

The model used by Black and Veatch was further analyzed by Portland Water Bureau staff in order to evaluate:

1. Current fire flows under existing demand and under existing demand with the improvement identified by Black and Veatch (Table 54);
2. Fire flows with the forecasted future demands and fire flow with the future demands and improvements identified by Black and Veatch (Table 55); and
3. Fire flows with the forecasted future demands and fire flow with the future demands and an alternative improvement identified by water bureau planning staff utilizing available storage in the North Linnton tank (Table 56).

Although the North Linnton tank mains improvement may result in a viable alternative, it did not meet the 5,000 gpm fire flow requirement for both sites in the Northwest District. Additionally, the North Linnton tank improvements would involve higher costs associated with six rail crossings and improvements to the existing unimproved right of way. Although, hydraulically, it is an alternative that would improve fire flows to the area without having to install the full length of 24” main beginning at the St. Johns Bridge, the number of rail crossings and associated ownership issues may make the North Linnton tank mains improvement infeasible.

Results with the Linnton Tank mains improvement and the analyses listed in 1 through 3 above are included in Tables 54 through 56

Figure 44. Northwest District 24-inch Main Improvement

Table 54. Northwest District Site Specific Existing Demand

Site ID	Fire Flow (gpm)	Improvement Added	Improved Fire Flow (gpm)
NWID08	3,830	New 24" Main	6,039
NWID14	1,343		5,757

Table 55. Northwest District Site Specific Peak Demand

Site ID	Fire Flow (gpm)	Improvement Added	Improved Fire Flow (gpm)
NWID08	3,756	New 24" Main	5,948
NWID14	742		5,948

Figure 45. Northwest District North Linnton Tank Main Improvements

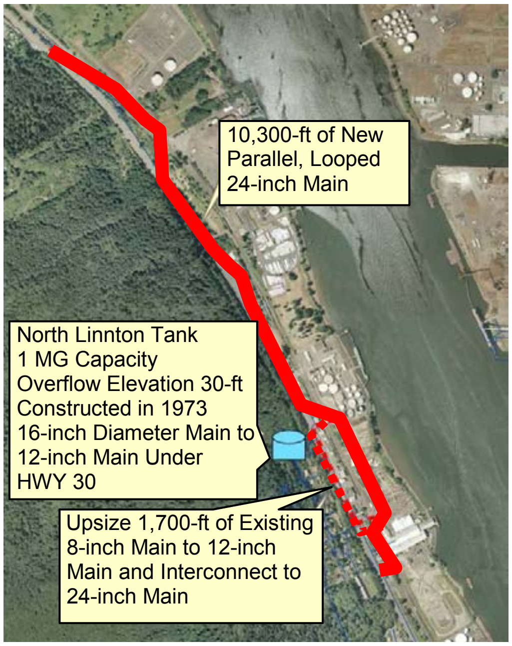


Table 56. Northwest District Site Specific Peak Demand – North Linnton Tank Mains Improvements

Site ID	Fire Flow (gpm)	Improvement Added	Improved Fire Flow (gpm)
NWID08	3,756	24" and 12" Mains	4,795
NWID14	742		5,236

Existing fire flow supports the following types of development shown in Table 57 to be constructed at the two locations currently unable to meet a fire flow of 5,000 gpm. Again, maximum building sizes are approximations only. Larger developments proposed for these sites should not be deterred without more detailed analysis using more specific information about the proposed development.

Table 57. Types of Construction Supported Under Existing Conditions Without Mitigation

Site ID	Available Fire Flow (gpm)	Applicable Fire Flow Requirement[b] (gpm and Duration)	Types of Construction[a] Supported at each Site without Further Measures to Mitigate Fire Flow Requirements (Building types are based on the International Building Code)				
			IA and IB (Most Fire Resistant)	IIA and IIIA	IV and V-A	IIB and IIIB	VB (Least Fire Resistant)
			Maximum Building Area (square feet)				
NWID08	3,830	3,750 (3 hours)	128,700	72,400	46,400	33,500	20,600
NWID14	1,343	1,500 (2 hours)	22,700	12,700	8,200	5,900	3,600

[a] The minimum required fire flow shall be permitted to be reduced by 25 percent for residential use (Use Group R).
[b] Measured at 20 psi.

4.3. Cost Estimates for Identified Improvements

General planning-level costs for the improvements identified by Black and Veatch and PWB staff are summarized in Table 58. Costs include construction plus 35 percent for design, administration, and contingencies. These project costs are for general planning purposes only and do not account for additional expenses incurred by unusual site specific complications and costs associated with the acquisition of land or easements. However, due to construction and associated street restoration of State HWY 30 for the Northwest improvements and a railroad crossing for the Rivergate improvement, these costs are higher than typically experienced for installation of mains of similar size under normal city streets.

Table 58. Total Improvement Project Cost Estimates (ENR CCI = 8640.58)

District	Rivergate		Northwest			Swan Island
Improvement	12” Main Along Simmons Rd (1,200 ft)	16” Main Along North Burgard Road[a] (1,700 ft)	Looped/Parallel 16" Main[b] (15,000 ft)	24" Parallel Main (15,000 ft)	North Linnton Tank Distribution Mains[c] (1,700 feet of 12” main and 10,300 feet of 24” main)	None
Associated Figure	 Figure 34 Page 66	 Figure 38 Page 68	 Figure 33 Page 65	 Figure 44 Page 89	 Figure 45 Page 89	N/A
Estimated Project Cost	$450,000 ($375/Lineal Foot)	$550,000 ($325/Lineal Foot)	$6,300,000 ($420/Lineal Foot)	$6,750,000 ($450/Lineal Foot)	$5,610,000 ($425/Lineal Foot – average)	N/A

[a] This option does not change the 4,900 gpm available fire flow in the northern part of the Rivergate improvement site, however, it does increase fire flow in the southern part of the Rivergate improvement site to 5,285 gpm.

[b] The 16” main was sufficient to meet fire flows in the “Subdistrict Fire Flow Analysis”, but was not adequate under the demands modeled in the “Site Specific Capacity Analysis”.

[c] This option delivers 4,795 gpm fire flow to the area just north of the St. Johns Bridge in the Northwest District (NWID08) and 5,236 gpm to the northern part of the Northwest District (NWID14).

Generally, costs associated with meeting fire flow requirements due to new developments are incurred by the developer, however, the requirements and associated costs depend on a number of factors including building size and material, property usage, and on-site fire mitigation measures. Each new development would be evaluated for fire flow availability at that site and if fire flow was not adequate, the developer would be responsible for costs associated with improvements to the water distribution system, but only to the extent that fire flow meets minimum flow requirements at the site and not for the total costs for the identified improvements shown in the table above.

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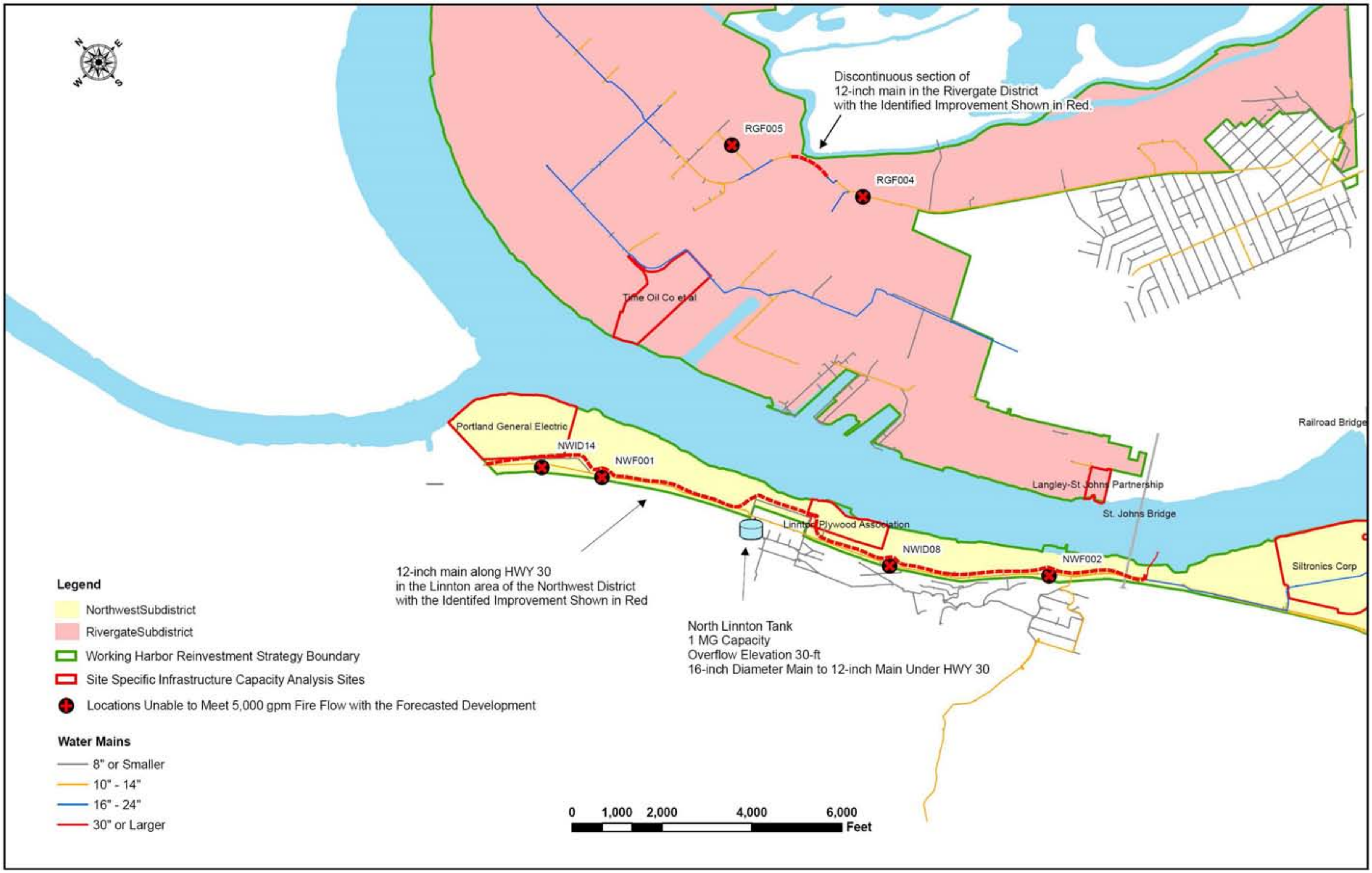
5. Conclusion and Recommendations

5.1. Conclusion

PWB used two methods of modeling new demands from development forecasted by the BOP and PDC to occur by the year 2015. The "Subdistrict Fire Flow Analysis" used a structure area-based demand in order to model demands resulting from the forecasted development. The "Site Specific Capacity Improvement Analysis" used an employee-based demand and site specific development information in order to replicate and model future demands. In both of these analyses, the water system in the WHRS area was tested using PWB's hydraulic model (SynerGEE 4.1) in order to determine if the system could supply 5,000 gpm fire flows, while maintaining system pressures above 20 psi, given the forecasted development. Higher than anticipated demands were also tested using various peaking and development factors in order to account for peak usage that may be experienced as a result of the new development (e.g. new food processing facilities whose production is impacted by growing seasons or sites with extensive landscape irrigation needs).

In general, these analyses demonstrate that adequate fire flow is available for most future development. Improvements to the water system and their potential financial impact on developers will depend upon many factors specific to each site and may be mitigated by a variety of measures, as determined by both the Portland Fire Bureau and the Portland Water Bureau on a case-by-case basis. The 6 sites identified by the two future scenarios analyses that do not meet a fire flow of 5,000 gpm are shown in Figure 46. Two of the 6 sites unable to meet the 5,000 gpm fire flow are near a discontinuous 12-inch section of main in the Rivergate District, for which an identified improvement included installing a section of 12-inch main to make that section continuous. The remaining four sites are centered around a 12-inch main along HWY 30 in the Linnton area of the Northwest District. There were several similar improvements identified for the Northwest District, but all included installing a parallel section of main in order to improve the delivery of fire flows to this area.

Figure 46. Location of Areas Unable to Meet 5,000 GPM Fire Flow Requirements



Existing fire flow to these six sites currently supports the types of development shown in Table 59. Given that even very large developments generally have individual structures smaller than those listed in Table 59 and that multiple hydrants (numbering more than 5 on or adjacent to a single site) may be installed to support multiple large structures, the ability to meet the fire flow requirements of future developments is likely. Since maximum building sizes are approximations only, larger developments proposed for these sites should not be deterred without more detailed analysis using more specific information about the proposed development. Various other on-site factors and mitigating circumstances (fire suppression systems, materials storage that limits fire hazards, etc.) may also allow larger structures than those shown in Table 59.

Table 59. Types of Construction Supported Under Existing Conditions without Mitigation

Site ID	Available Fire Flow (gpm)	Applicable Fire Flow Requirement[b] (gpm and Duration)	Types of Construction[a] Supported at each Site without Further Measures to Mitigate Fire Flow Requirements (Building types are based on the International Building Code)				
			IA and IB (Most Fire Resistant)	IIA and IIIA	IV and V-A	IIB and IIIB	VB (Least Fire Resistant)
			Maximum Building Area (square feet)				
RGF004	2,932 – 3,100	3,000 (3 hours)	83,700	47,100	30,100	21,800	13,400
RGF005	4,706 - 5,554	4,750 (4 hours)	203,700	114,600	73,300	53,000	32,600
NWID08	3,830	3,750 (3 hours)	128,700	72,400	46,400	33,500	20,600
NWF002	3,014 - 3,387	3,000 (3 hours)	83,700	47,100	31,100	21,800	13,400
NWID14	1,343	1,500 (2 hours)	22,700	12,700	8,200	5,900	3,600
NWF001	2,151 - 2,643	2,000 (2 hours)	38,700	21,800	12,900	9,800	6,200

[a] The minimum required fire flow shall be permitted to be reduced by 25 percent for residential use (Use Group R).

[b] Measured at 20 psi.

It is also important to note that increasing the distribution system sizing to the point of exceeding existing user demands can lead to increases in water age and reduced water quality due to the added storage. For the identified 12-inch main improvement in the Rivergate District, the volume increases by roughly 7,000 gallons. The 24-inch improvement in the Northwest District increases the system volume by an amount equivalent to installing a 350,000 gallon storage tank in the area. Increasing the age of water in the system can lead to subsequent water quality problems (e.g. disinfection by-product formation, diminished chlorine residuals, taste and odor, etc.) and may adversely impact large water users reliant upon consistent water quality.

Because of the host of water quality issues associated with increased water age and the unknowns surrounding the fire flow needs of future development and the potential to increase water age if future development does not proceed as projected or requires some reduced level of fire flow, it is unclear to what capacity the system should be developed. It is also unclear to what extent capacity can be increased in advance of demands without adversely impacting water age and quality. However, if the condition of the existing water system infrastructure deteriorates to the point of needing replacement or significant repairs, projects would take into account existing and near-term developments and seek to meet anticipated water supply and fire flow needs.

Furthermore, PWB would consider completing improvements in advance of development if an opportunity arises in which PWB could take advantage of cost savings by partnering work with another agency. However, careful consideration would be given to water age and water quality concerns, which may impact decisions to move forward with completing such projects. Because the existing system meets the current fire flow requirements for existing development and can support future development specified in Table 59, even with the anticipated future demands in place, PWB does not anticipate the need to move forward with immediate actions to complete the identified projects in advance of known development.

5.2. Recommendations

Based on the condition of the existing water distribution system and the conclusions of the Future Scenarios Analysis, it is recommended that PWB not proceed with immediate actions to complete the identified projects at this time. PWB should continue to carry out its functions in maintaining and improving the performance and reliability of the distribution system as funded in the current 5-year Capital Improvement Program beginning in Fiscal Year 2006. PWB should continue to provide fire flow availability information to potential developers in response to specific development requests and to evaluate opportunities to complete projects in partnership with other agencies as they arise. PWB's Development Services Branch should also continue to provide assistance for land use applications, commercial building plans, and in providing assistance to developers in all phases of development concerning water issues.

If it is deemed that investing in the identified project in the Northwest District is a key factor in the area's long-term economic competitiveness and the investment can be completed without adversely impacting water quality, PWB should make every effort to initiate efforts to meet these needs. Investigating options to improve fire flows in the identified area of the Rivergate District along Simmons Road between Burgard and Lombard Streets should also be undertaken by PWB. Efforts should be coordinated with the "Barnes Yard to Bonneville Yard Trackage" project identified in the Port of Portland's 2007 Port Transportation Improvement Plan. Options to improve fire flows in Rivergate should also be coordinated with the "N. Burgard/Lombard Street Improvement Project" identified by the Portland Department of Transportation. By coordinating these efforts, cost savings may be realized. Additionally, PWB should include both identified projects in PWB's component of the Citywide Systems Plan, which is a citywide process of identifying infrastructure needs and projects for a 20-year planning horizon. The Citywide Systems Plan is anticipated to be completed in 2008. In all of these efforts, PWB should coordinate planning with other City Bureaus in order to take advantage of cost sharing opportunities, whenever possible.

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Appendix A

Fire Flow and Flow Duration for Buildings

All buildings in the United States can be associated with one of five basic types of construction, identified by Roman numerals in building codes and by engineering schools throughout the nation: fire-resistive (type I), non-combustible (type II), ordinary (type III), heavy-timber (type IV) and wood-frame (type V). The five basic construction types are arranged in a scale based on the amount of combustible material used in their construction. For example, a type I fire-resistive building has the least amount of combustible material in its structure; a type V wood-frame building has the most.

Fire-resistance ratings reflect the period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by testing (Chapter 7, Section 702 - State of Oregon 2004 Structural Specialty Code Amendments). Table A-1 provides examples of the five building types associated with fire resistance ratings in order of decreasing fire resistance. Table A-2 contains some general fire-resistance ratings, expressed in terms of the number of hours that a building element is able to confine a fire, continues to perform its given structural function in a fire, or both. Required fire flow based upon the building types and fire ratings is provided in Table A-3. From this table, a 5,000 gpm fire flow requirement corresponds to masonry or steel structures with a square footage per building of 55,000 ft^2 to 125,000 ft^2.

Table A-1. Building Type[a] Descriptions Listed in Order of Decreasing Fire Resistance.

Building Type[a]	Description	Fire-Resistance Rating[b]	Examples
I	Type I are the most fire resistance structures in which noncombustible materials are used in the construction of the structural frame, exterior and interior bearing and nonbearing walls, floor and roof	A or B	Reinforced concrete or steel with fire protection for walls, roof and floor
II or III	Construction in which the exterior walls are of noncombustible materials and the interior building elements are of any material permitted by building code.	A or B	Structures with a fire-resistance rating of A are the same as building type I but with lesser fire resistance (typically steel or masonry buildings with fire resistive roof assemblies). Type II or III structures with a fire-resistance rating of B include steel or masonry structures without fire resistive protection.
IV (HT) or V-A	Type IV construction (Heavy Timber, HT) is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid or laminated wood without concealed spaces.	A (V only)	Heavy timber (wood elements greater than 4" nominal size) or wood protected with fire rated assemblies such as fire rated sheetrock.
V	Wood-frame (type V) construction is the most combustible of the five building types	A or B	Wood structures without fire resistive protection

[a] Types of construction are based on the 2003 International Building Code as incorporated into Section 602 of Chapter 6 of the State of Oregon 2004 Structural Specialty Code Amendments.

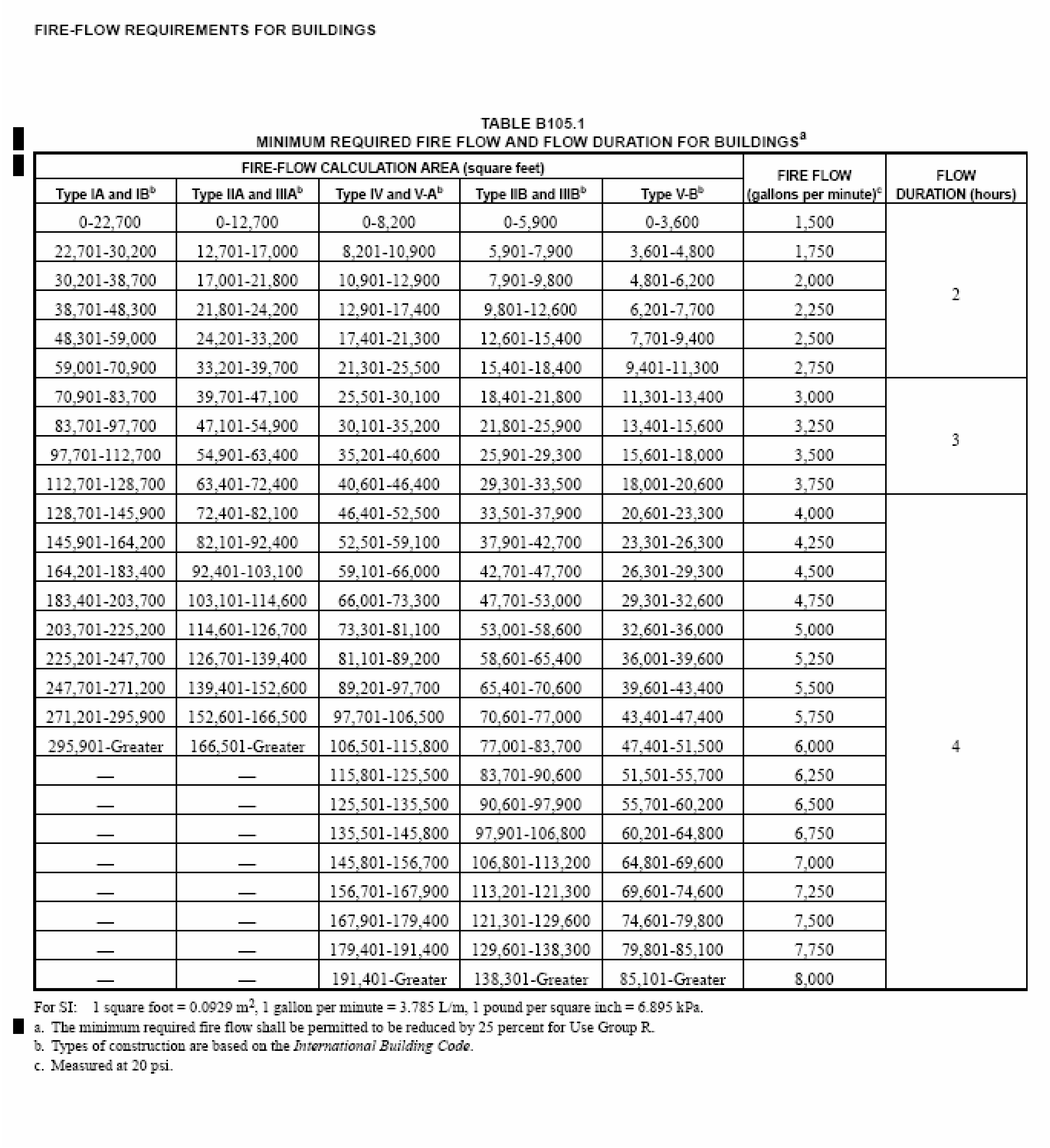
[b] Fire-resistance rating reflects the period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by testing (Chapter 7, Section 702 - State of Oregon 2004 Structural Specialty Code Amendments)

Table A-2. General Fire-Resistance Rating Requirements for Building Elements[a] (hours)

Building Element	Type I		Type II		Type III		Type IV	Type V	
	A	B	A	B	A	B	HT[b]	A	B
Structural Frame	3	2	1	0	1	0	HT	1	0
Bearing Walls									
Exterior	3	2	1	0	2	2	2	1	0
Interior	3	2	1	0	1	0	1/HT	1	0
Floor Construction	2	2	1	0	1	0	HT	1	0
Roof Construction	1.5	1	1	0	1	0	HT	1	0

[a] This table is not intended to be used for design purposes, for a complete table of fire-resistance rating requirements for building elements (includes non-load bearing walls and partitions, more complete building element descriptions, etc.), see Table 601 of Chapter 6 - State of Oregon 2004 Structural Specialty Code Amendments.

[b] HT means Heavy Timber. Under certain circumstances, fire-retardant-treated wood framing may be permitted within exterior wall assemblies with a 2-hour fire-resistance rating or less.



FIRE-FLOW REQUIREMENTS FOR BUILDINGS

TABLE B105.1
MINIMUM REQUIRED FIRE FLOW AND FLOW DURATION FOR BUILDINGS[a]

FIRE-FLOW CALCULATION AREA (square feet)					FIRE FLOW (gallons per minute)[c]	FLOW DURATION (hours)
Type IA and IB[b]	Type IIA and IIIA[b]	Type IV and V-A[b]	Type IIB and IIIB[b]	Type V-B[b]		
0-22,700	0-12,700	0-8,200	0-5,900	0-3,600	1,500	2
22,701-30,200	12,701-17,000	8,201-10,900	5,901-7,900	3,601-4,800	1,750	
30,201-38,700	17,001-21,800	10,901-12,900	7,901-9,800	4,801-6,200	2,000	
38,701-48,300	21,801-24,200	12,901-17,400	9,801-12,600	6,201-7,700	2,250	
48,301-59,000	24,201-33,200	17,401-21,300	12,601-15,400	7,701-9,400	2,500	
59,001-70,900	33,201-39,700	21,301-25,500	15,401-18,400	9,401-11,300	2,750	
70,901-83,700	39,701-47,100	25,501-30,100	18,401-21,800	11,301-13,400	3,000	3
83,701-97,700	47,101-54,900	30,101-35,200	21,801-25,900	13,401-15,600	3,250	
97,701-112,700	54,901-63,400	35,201-40,600	25,901-29,300	15,601-18,000	3,500	
112,701-128,700	63,401-72,400	40,601-46,400	29,301-33,500	18,001-20,600	3,750	
128,701-145,900	72,401-82,100	46,401-52,500	33,501-37,900	20,601-23,300	4,000	4
145,901-164,200	82,101-92,400	52,501-59,100	37,901-42,700	23,301-26,300	4,250	
164,201-183,400	92,401-103,100	59,101-66,000	42,701-47,700	26,301-29,300	4,500	
183,401-203,700	103,101-114,600	66,001-73,300	47,701-53,000	29,301-32,600	4,750	
203,701-225,200	114,601-126,700	73,301-81,100	53,001-58,600	32,601-36,000	5,000	
225,201-247,700	126,701-139,400	81,101-89,200	58,601-65,400	36,001-39,600	5,250	
247,701-271,200	139,401-152,600	89,201-97,700	65,401-70,600	39,601-43,400	5,500	
271,201-295,900	152,601-166,500	97,701-106,500	70,601-77,000	43,401-47,400	5,750	
295,901-Greater	166,501-Greater	106,501-115,800	77,001-83,700	47,401-51,500	6,000	
—	—	115,801-125,500	83,701-90,600	51,501-55,700	6,250	
—	—	125,501-135,500	90,601-97,900	55,701-60,200	6,500	
—	—	135,501-145,800	97,901-106,800	60,201-64,800	6,750	
—	—	145,801-156,700	106,801-113,200	64,801-69,600	7,000	
—	—	156,701-167,900	113,201-121,300	69,601-74,600	7,250	
—	—	167,901-179,400	121,301-129,600	74,601-79,800	7,500	
—	—	179,401-191,400	129,601-138,300	79,801-85,100	7,750	
—	—	191,401-Greater	138,301-Greater	85,101-Greater	8,000	

For SI: 1 square foot = 0.0929 m^2, 1 gallon per minute = 3.785 L/m, 1 pound per square inch = 6.895 kPa.

a. The minimum required fire flow shall be permitted to be reduced by 25 percent for Use Group R.

b. Types of construction are based on the *International Building Code*.

c. Measured at 20 psi.

Appendix B

Technical Memorandum #1
Subdistrict Fire Flow Analysis

Appendix C

Employee-Based Water Use Coefficients

The total land affected by development was estimated to have an average building coverage of 40% unless otherwise identified in the list of constrained opportunity sites (Table C-1) developed from previous studies (Group Mackenzie or Parsons Brinkerhoff analyses) or indicated by specific site characteristics (current development, open space zoning, etc.). Table C-2 shows the anticipated structure area for each site.

Table C-1. Constrained Opportunity Sites Proposed for Infrastructure Analysis.

District	Site ID#	Site Owner	Location	Assumed Developable Acres	Group Mackenzie (GM) or Parsons Brinkerhoff (PB) Analysis	GM or PB Infrastructure Needs Identified	Special Issues to Consider and Notes
Northwest	NWID03	Arkema	N end of NW Front Avenue	59 ac. Unoccupied Site			
	NWID04	ESCO	N end of NW Front Avenue	10 ac. Unoccupied site	GM: 450,000 sq ft mfg., site combined with Aventis	GM: $24,000 for half street, site combined with Gould/RP	Reclaimed Landfill Site
	NWID05	Aventis	N end of NW Front Avenue	16 ac. Unoccupied site	GM: 450,000 sq ft mfg., site combined with ESCO	GM: $24,000 for half street, site combined with ESCO	Burlington Northern – Santa Fe proposes closing Balboa RR crossing
	NWID07	BES T1 North	2400 NW Front Avenue	19 ac. Unoccupied site			Temporary use for BES Combined Sewer Overflow Project
	NWID08	Linnton Plywood	10504 NW St Helens Road	25 ac. Unoccupied site	PB: Six flex space parcels	PB: $3.1 million street, $1.1 million rail crossing, $1.9 million sewer/water/stormwater, $2.9 million pump station replacement	Consider large single user, dead end water line, RR crossing
	NWID09	Lakea Corp.	3003 NW 35th Avenue	1 ac. Unoccupied site			Cost of improvements on small site
	NWID10	Oregonian	NW Yeon Ave at Nicolai St	11 ac. Vacant site	GM: 150,000 sq ft of general industrial, 20,000 sq ft office	GM: $40,000 improvements to Yeon Ave. frontage, 5 foot R/W dedication, may benefit from traffic signal	Long-term vacancy
	NWID11	Siltronics	7200 NW Front Avenue	15 vacant ac. On 80 ac. Site			Consider Front Ave extension to cul-de-sac. DEQ active investigation
	NWID14	PGE	12500 NW Marina Way	18 redevelopment ac. + 16 vacant ac. On 74 ac. Site			Dead end water line, RR crossing. 24 ac. Greenway Natural Zone, 38 ac. Mapped wetland
Swan Island	SIID06	BES Swan Is	Basin Ave at Swan Island Lagoon	10 ac. Vacant (unimproved) site	GM: 225,000 sq ft distribution, 106,000 sq ft flex space	GM: $50,000 improvements to Basin Ave., $50,000 to Lagoon Ave. Frontage	Floodplain. Temporary use for BES Combined Sewer Overflow project.
	SIID13	Vigor (Cascade General)	555 N channel Ave.	25 redevelopment ac. On 65 ac. Site			
	SIID15	Malafouris	1300 N River St.	2 ac. Site			Substandard street with RR, cost of improvements on small site. Riverfront site not in river-dependent use
Rivergate	RGID01	Time Oil	N Time Oil Rd	45 ac. Unoccupied site	GM: 465,000 sq ft distribution, 137,500 sq ft flex space	GM: $510,000 street upgrade, CIP includes $260,000 drainage and $405,000 sewer improvements on Time Oil Rd.	Owner requests taking public street
	RGID02	Langley St. Johns	N Bradford St, St Johns	7 ac. Unoccupied site			Substandard street with RR, possible access from T-4
	RGID12	Stauffer Chemical	4429 N Suttle Rd	15 vacant acres on 31 ac. Site			DEQ active cleanup, floodplain

Table C-2. Developable Land and Anticipated Structure Area.

District	Site ID#	Site Name	Developable Site Area (acres)	Anticipated Structure Area (ft^2)	% Building Coverage
Northwest	NWID03	Arkema	59.3	1,028,016	39.8%
	NWID04	ESCO[1]	10.3	174,240	38.8%
	NWID05	Aventis[1]	16.2	278,784	39.5%
	NWID07	BES T1 North	19.1	331,056	39.8%
	NWID08	Linnton[2]	22.1	435,600	45.2%
	NWID09	Lakea	1.2	17,424	33.3%
	NWID10	Oregonian[1]	10.6	170,000	36.8%
	NWID11	Siltronics[3]	79.5	261,360	7.5%
	NWID14	PGE[4]	73.8	1,481,040	67.0%
Swan Island	SIID06	BES Swan Is	10.5	236,900	51.8%
	SIID13	Vigor[5]	65.2	1,089,000	38.0%
	SIID15	Malafouris[6]	1.9	81,487	98.5%
Rivergate	RGID01	Time Oil[1]	45.5	784,080	39.6%
	RGID02	Langley	7.2	121,968	38.9%
	RGID12	Stauffer Chemical[7]	31.2	261,360	19.2%
Total:	*15 Sites*		*453.6*	*6,752,315*	*42.3% (average)*

[1] Group Mackenzie estimates.
[2] Parsons Brinkerhoff estimates.
[3] 15 vacant acres on a 79.5 acre site.
[4] 18 redevelopment acres and 16 vacant acres on a 73.8 acre site (51 acres zoned IH and 23 acres zoned OS)
[5] 25 redevelopment acres on a 65.2 acre site.
[6] Malafouris is currently fully developed and is expected to remain so for this analysis.
[7] 15 vacant acres on a 31.2 acre site.

The anticipated building coverage for each district is summarized in Table C-3.

Table C-3. District Building Coverage

District	Total Developable Site Area (acres)	Total Developable Site Area (ft^2)	Total New Building Coverage (acres)	Total New Building Coverage (ft^2)	Percent Building Coverage
Northwest	292.2	12,723,876	95.9	4,177,520	32.8%
Swan Island	77.6	3,380,256	32.3	1,407,387	41.6%
Rivergate	83.9	3,654,684	26.8	1,167,408	31.9%
Total:	*453.6*	*19,758,816*	*155*	*6,752,315*	*35.5% (average)*

Water use coefficients and employment densities defined for the seven water use categories are contained in Table C-4 and are described in further detail in the remaining sections of this Appendix.

Table C-4. Water Use Coefficients and Job Densities by Water Use Category

Water Use Category	Jobs/Acre	Water Use Coefficients (gpdpe)
High Tech - Large Water User	100.0	1,838
High Tech - Typical	26.0	246
General Manufacturing – Large Water User	25.0	1,300
General Manufacturing - Typical	13.0	255
Business Park	16.0	395
Warehouse/Distribution - Large Water User	10.5	390
Warehouse/Distribution - Typical	6.0	32
Average =>	*28.1*	*636.6*

The number of employees-per-acre and associated water use coefficient for the High Tech – Large Water User was derived from site-specific information shown in Table C-5.

Table C-5. High Tech – Large Water User

SIC/NAICS	High Tech - LWU	Parameter	Value
36 / 334	Siltronics Semiconductors & Related Devices Manufacturer SIC = 3674 NAICS = 334413 7200 NW Front Ave Portland, OR 97210 3676	CCF/Month	67,816
		gpd	1,690,879
		employees	920
		gpdpe	1,838
		sq ft of building area	405,124
		acres	9.3
		employees/acre	99

An on-line search on the Oregon Labor Market Information System (OLMIS) for Electronic Computer Manufacturing (NAICS 334111) companies statewide produced the results shown in Table C-6. Computer Technology Link Corp was chosen as a High Tech Typical Water User.

Table C-6. Oregon Labor Market Information System Search Results for Electronic Computer Manufacturers (NAICS 334111)

Employer Name	Location	City	Number of Employees	Annual Sales
Auto Time	SW Macadam Ave	Portland	5 - 9	5 Million - 10 Million
C-Cor	NW 167th Pl	Beaverton	20 - 49	20 Million - 50 Million
Computer Technology Link Corp	NW Front Ave	Portland	20 - 49	20 Million - 50 Million
Corvallis Microtechnology	SW Jefferson Ave	Corvallis	20 - 49	2.5 Million - 5 Million
IBM	Centerpointe Dr	Lake Oswego	Not Available	Not Available
Internet Technology Inc	SW Cirrus Dr	Beaverton	5 - 9	5 Million - 10 Million
Lewis Control Inc	N 26th Ave	Cornelius	10 - 19	20 Million - 50 Million
Mentor Graphics Corp	SW Boeckman Rd	Wilsonville	1000 or more	Not Available
QSI Intl	SW Sandburg St # 320	Portland	1 - 4	1 Million - 2.5 Million
ULC Electronics	Cline Falls Rd	Bend	1 - 4	2.5 Million - 5 Million

Employees-per-acre and water use coefficient for the High Tech – Typical Water User was derived from the following site-specific information contained in Table C-7.

Table C-7. High Tech – Typical User

SIC/NAICS	High Tech - Typical	Parameter	Value
35 / 334	Computer Technology Link Corp Computers-Electronic-Manufacturer SIC = 3571 NAICS = 334111 2181 NW Front Ave Portland, OR 97209 1833	CCF/Month	162
		gpd	4,039
		employees	20
		gpdpe	202
		sq ft of building area	33,566
		acres	0.8
		employees/acre	26

Other water use coefficients for general manufacturing, warehouse/distribution, and business parks were derived from the following two sources, which are deemed to be adequate for the purpose of this analysis.

Appendix 1, National Handbook of Recommended Methods for Water Data Acquisition - USGS Institute of Water Resources, Municipal and Industrial Needs (IWR-MAIN) employee-based water-use coefficients (USGS 1982). This is a table of coefficients developed by U.S. Army Corps of Engineers' Institute for Water Resources Municipal and Industrial Needs Model (IWR-MAIN model) (Davis et.al., 1991). These IWR-MAIN water use coefficients, expressed in gallons per day per employee (gpdpe), are broken down by industry groups as defined by the Standard Industrial Classification (SIC) and represent an average water usage rates for the specified SIC codes.

Water use coefficients were also obtained from the November 2003 Pacific Institute for Studies in Development, Environment and Security (Pacific Institute) document entitled “Waste Not, Want Not: The Potential for Urban Water Conservation in California”. These coefficients are summarized in Appendix C of the document in Table C-1 – *Water Use Coefficients by SIC Code, Industrial Sector* and Table C-2 – *Water Use Coefficients by SIC Code or Establishment Type in the Commercial Sector*.

According to the U.S. Bureau of Census (1986) there are four major industry groups that account for 84% of the water used by manufacturing establishments. These groups are shown in Table C-8 and form the basis for defining the general manufacturing large water user.

Table C-8. Industry Groups Accounting for 84% of Water Used by Manufacturing Establishments

Industry Group	SIC	NAICS
Paper and Allied Products	26	322
Chemicals and Allied Products	28	325
Petroleum Refining and Related Industries	29	325
Primary Metals Industries	33	331

General IWR-MAIN water use coefficients for general manufacturing groups is contained in Table C-9.

Table C-9. IWR-MAIN Water Use Coefficients in Gallons Per Day Per Employee (gpdpe).

Water Use Category	SIC/ NAICS	General Manufacturing Groups - IWR MAIN	Average Water Use Coefficient gpdpe	Maximum Water Use Coefficient gpdpe	Minimum Water Use Coefficient gpdpe
General Manufacturing – Large Water User	26 / 322	Paper	3413.4	8304	216
	29 / 324	Petroleum	1499.0	3780	439
	28 / 325	Chemicals	926.8	1861	403
	20 / 311	Food	887.9	2681	140
	24 / 321	Lumber and wood	664.2	2385	88
	31 / 316	Leather	627.0	627	627
	33 / 331	Primary metal	588.6	1078	260
General Manufacturing – Typical Water User	22 / 313	Textiles	524.9	1076	246
	32 / 327	Stone, clay, glass, and concrete	412.4	652	211
	34 / 332	Fabricated metals	377.5	1019	136
	30 / 326	Rubber and plastic	308.3	625	78
	37 / 336	Transportation	247.4	457	141
	35 / 333	Machinery	243.3	1282	100
	39 / 339	Miscellaneous manufacturing	213.2	241	204
	25 / 337	Furniture	159.0	298	78
	27 / 323	Printing	38.0	38	38
	23 / 315	Apparel	24.0	24	24

Water use coefficients derived from the Pacific Institute (2003) for general manufacturing groups is presented in Table C-10.

Table C-10. Pacific Institute Water Use Coefficients in Gallons Per Day Per Employee (gpdpe).

Water Use Category	SIC/NAICS	General Manufacturing Groups - Pacific Institute	Water Use Coefficient gpdpe
General Manufacturing – Large Water User	24 / 321	Lumber and wood	2144
	20 / 311	Food	1967
	22 / 313	Textiles	1530
	29 / 324	Petroleum	1399
	33 / 331	Primary metal	1318
	32 / 327	Stone, clay, glass and concrete	1304
	26 / 322	Paper	1000
General Manufacturing - Typical Water User	28 / 325	Chemicals	833
	34 / 332	Fabricated Metals	738
	37 / 336	Transportation	228
	30 / 326	Rubber and plastic	120
	35 / 333	Machinery	110
	27 / 323	Printing	98
	39 / 339	Miscellaneous manufacturing	86
	25 / 337	Furniture	53
	23 / 315	Apparel	37
	31 / 316	Leather	32

The average water use coefficient for the two general manufacturing water use categories is summarized in Tables C-11 and C-12 for the IWR-MAIN and Pacific Institute water use coefficients, respectively.

Table C-11. IWR-MAIN Water Use Coefficients in Gallons Per Day Per Employee (gpdpe).

Water Use Category	SIC/ NAICS	General Manufacturing Groups - IWR MAIN	Average Water use Category Water Use Coefficient gpdpe
General Manufacturing – Large Water User	26 / 322	Paper	1230
	29 / 324	Petroleum	
	28 / 325	Chemicals	
	20 / 311	Food	
	24 / 321	Lumber and wood	
	31 / 316	Leather	
	33 / 331	Primary metal	
General Manufacturing – Typical Water User	22 / 313	Textiles	255
	32 / 327	Stone, clay, glass, and concrete	
	34 / 332	Fabricated metals	
	30 / 326	Rubber and plastic	
	37 / 336	Transportation	
	35 / 333	Machinery	
	39 / 339	Miscellaneous manufacturing	
	25 / 337	Furniture	
	27 / 323	Printing	
	23 / 315	Apparel	

Table C-12. Pacific Institute Water Use Coefficients in Gallons Per Day Per Employee (gpdpe).

Water Use Category	SIC/NAICS	General Manufacturing Groups - Pacific Institute	Average Water Use Category Water Use Coefficient gpdpe
General Manufacturing – Large Water User	24 / 321	Lumber and wood	1523
	20 / 311	Food	
	22 / 313	Textiles	
	29 / 324	Petroleum	
	33 / 331	Primary metal	
	32 / 327	Stone, clay, glass and concrete	
	26 / 322	Paper	
General Manufacturing - Typical Water User	28 / 325	Chemicals	234
	34 / 332	Fabricated Metals	
	37 / 336	Transportation	
	30 / 326	Rubber and plastic	
	35 / 333	Machinery	
	27 / 323	Printing	
	39 / 339	Miscellaneous manufacturing	
	25 / 337	Furniture	
	23 / 315	Apparel	
	31 / 316	Leather	

Table C-13. General Manufacturing - Typical and Large Water User Water Use Coefficients

Water Use Category	SIC/ NAICS	General Manufacturing Groups	Water Use Category Water Use Coefficient gpdpe
General Manufacturing – Large Water User	26 / 322	Paper	1,300[a]
	29 / 324	Petroleum	
	28 / 325	Chemicals	
	20 / 311	Food	
	24 / 321	Lumber and wood	
	31 / 316	Leather	
	33 / 331	Primary metal	
General Manufacturing – Typical Water User	22 / 313	Textiles	255[b]
	32 / 327	Stone, clay, glass, and concrete	
	34 / 332	Fabricated metals	
	30 / 326	Rubber and plastic	
	37 / 336	Transportation	
	35 / 333	Machinery	
	39 / 339	Miscellaneous manufacturing	
	25 / 337	Furniture	
	27 / 323	Printing	
	23 / 315	Apparel	

[a] 1,300 gpdpe was chosen for General Manufacturing – Large Water User as it was the average of the IWR-MAIN and 2003 Pacific Institute average water use category coefficients from Tables C-11 and C-12. 1,300 gpdpe is also the average of the Pacific Institute Water Use Category average if the chemicals group (SIC 28, NAICS 325) were included within the Large Water Users Group in Table C-10.

[b] 255 was chosen as it was the higher of the typical average water use category water use coefficient from Table C-11.

The water use coefficient for Business Parks was chosen from the following Pacific Institute water use coefficients for the SIC/NAICS industry groups shown in Table C-14.

Table C-14. Business Park Water Use Coefficient

SIC/NAICS	Business Park Industry Groups	Pacific Institute Water Use Coefficient gpdpe	Average Water Use Coefficient gpdpe
44 / 483	Water Transportation	993.6	395.1
42 / 484	Motor Freight Transportation and Warehousing	470.9	
45 / 481	Transportation by Air	326.7	
47 / 488	Transportation Services	105.0	
48 / 513	Communications	79.3	

The water use coefficients for Distribution/Warehouse were chosen from the following Pacific Institute water use coefficients for the SIC/NAICS industry groups shown in Table C-15.

Table C-15. Typical and Large Water Warehouse/Distribution Water Use Coefficients.

Warehouse/Distribution Water Use Category	SIC/NAICS	Business Park Industry Groups	Pacific Institute Water Use Coefficient gpdpe
Large Water User	51 / 424	Wholesale Trade - Nondurable Goods	389.5
Typical Water User	50 / 423	Wholesale Trade - Durable Goods	32.3

Appendix D

Technical Memorandum #2
Site Specific Capacity Improvement Analysis