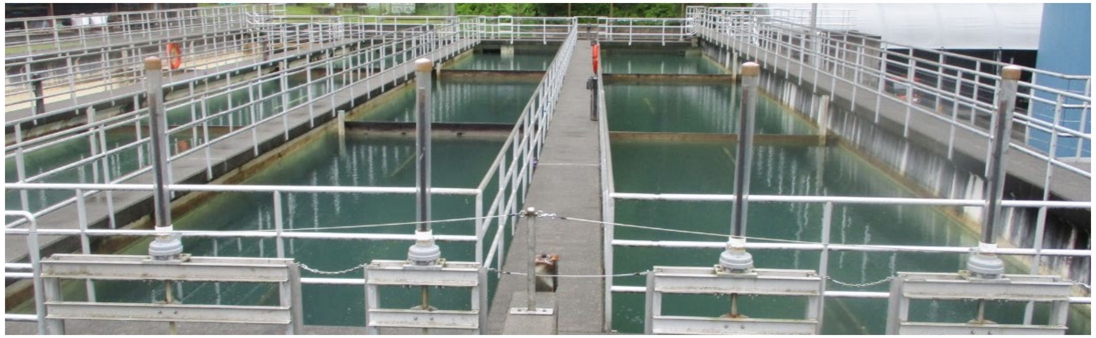
PNWS-AWWA 2022 Section Conference

April 2022

Facility Planning for More Than Capacity



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Welcome Clara Wood Weber!

Project Background

Patrick Weber

Acknowledgements

Brown and Caldwell acknowledges the valuable contributions made by City of Everett in developing the Water Filtration Plant Facility Plan. Specifically, the project recognizes the following personal for their efforts:

- John Nottingham
- Jeff Marrs
- Zach Brown
- Matt Gagner
- Chad Siedlik
- John Stokes
- Anna Thelen
- Bill Fisher

Everett Water Supply Map

Source: City of Everett 2020 Water Comprehensive Plan (HDR)

Water Filtration Plant Vicinity

Water Filtration Plant Layout

City Facility Planning Objectives

- Identify critical condition issues
- Assess 3R opportunities (resiliency, reliability, redundancy)
- Plan for long-term demand growth
- In-depth technical evaluations
- Support short and long-term Capital Improvement Program development

Existing Resources

- Previous Facility Plan (BC 2002)
- Water Supply Risk Assessment Study (Carollo 2012)
- Regional Water Supply Resiliency Project Phase 2 Summary Report (Water Supply Forum 2018)
- Water Comprehensive Plan Update (HDR 2020)

Facility Plan Assessments

Casey Gish

Brown AND Caldwell

Facility Plan Assessments

- Support short and long-term capital improvements
  - Assess plant condition
  - Enhance resiliency, redundancy, and reliability (3R)
- Plan for growth and change
  - Hydraulic profile assessment
  - Regulatory and water quality analysis
  - Unit process performance assessment

Facility Plan Assessments

- Flexible to meet immediate needs
- Unit process evaluations
  - Solids dewatering evaluation
  - Finished Water Pump Station (FWPS) assessment
  - Hypochlorite system evaluation (dosing equipment & eductor replacement)
  - Hypochlorite pipe replacement

Assess Plant Condition

- Assessment of priority WFP assets
- Multi-disciplinary team
  - Desktop review of plant records
  - Field inspections of plant assets
  - Interviews with operations and maintenance staff

Discipline	Number of Assets Inspected
Process Mechanical	49
Electrical	53
I&C	29
Structural	17
Building Mechanical	95
Total	**244**

Assess Plant Condition

- Fulcrum used for asset tracking and scoring
- Condition and performance assessment
  - 1 – 5 scale
  - Defined remaining useful service life
- Risk Assessment
  - Risk Score = Probability of failure X Impact of failure
  - Low, medium, and high scoring regions
- Plant wide valve inspection

Table 4-1. Condition and Performance Scoring Results Summary (Number of assets receiving each score)

Asset Physical Condition (decreasing condition from top to bottom)	Performance (decreasing performance from left to right)					Total Assets
	Functioning as Intended (1)	In Service, Higher-than-Expected O&M (2)	In Service, Function Impaired (3)	In Service, Function Highly Impaired (4)	Not Functioning as Intended (5)	
Excellent (1)	53	6	3	-	-	**62**
Slight visible degradation (2)	55	83	6	2	-	**146**
Visible degradation (3)	5	6	3	-	-	**14**
Integrity moderately compromised (4)	-	5	4	1	1	**11**
Integrity severely compromised (5)	-	-	-	-	-	**-**
No Score	11					**11**
Total assets	**113**	**100**	**16**	**3**	**1**	**244**

Scoring regions are: Region 1 (dark green), Region 2 (light green), Region 3 (yellow), Region 4 (orange), Region 5 (red).
"-" indicates that no assets received that scoring pair (e.g., no asset received a 5 for condition and 1 for performance).

Table 4-2. WFP Assets Results Summary Risk Scores

Impact of Failure	Probability of Failure					Total Assets
	Very Low (1)	Low (2)	Medium (3)	High (4)	Very High (5)	
Minor (1)	39	9	1	4	-	**53**
Significant (2)	32	55	41	22	1	**151**
Serious (3)	9	5	8	1	1	**24**
Severe (4)	-	2	-	-	-	**2**
Extreme (5)	-	-	-	2	-	**2**
No Score	-	-	-	-	-	**12**
Total assets	**80**	**71**	**50**	**29**	**2**	**244**

"-" indicates that no assets received that scoring pair (e.g., no asset received a 1 for impact and 5 for probability).

Assess Plant Condition

- Tabulated and ranked results
- Carried through to additional assessments, CIP report, and final Facility Plan
- Catalogued record of plant assets for future reference

Table 4-3. Priority Assets based on Condition and Performance Score and Risk Score								
Asset ID	Asset Description	Physical Condition Score (1-5)	Performance Score (1-5)	Condition and Performance Scoring Region	Probability of Failure	Impact of Failure	Risk Score	Comments
Siphon Intake (SI)								
Inlet siphon	Siphon pipe	2	1	1	2	1	2	Joint and insulation cracking noted. Follow-up inspection and possible repair recommended.
Alum/Polymer storage building (CSB)								
CSB	Polymer and alum storage tanks	-	-	-	-	-	-	Tank insulation damaged in places. Condition of the tanks cannot be determined from exterior inspection.
Pipe gallery (FLT)								
Panel LFB	Panelboard	4	3	3	2	2	4	Heavy corrosion and moisture may reduce the service life of the equipment.
Panel LFBG	Panelboard	3	2	2	2	3	6	Heavy corrosion and moisture may reduce the service life of the equipment.
Transformer LFB	Gallery transformer for panel LFB	3	2	2	2	3	6	Heavy corrosion and moisture may reduce the service life of the equipment.
Transformer LFBG	Pipe gallery transformer to panel LFBG	2	2	1	2	4	8	Heavy corrosion and moisture may reduce the service life of the equipment.
MCC Panel HFB	MCC	3	2	2	2	3	6	Heavy corrosion and moisture may reduce the service life of the equipment.
MCC Panel HFBG	MCC	3	2	2	2	4	8	Heavy corrosion and moisture may reduce the service life of the equipment.

Standpipe

Created	2019-10-14 14:49:47 PDT by Casey Gish
Updated	2019-10-23 17:02:56 PDT by Casey Gish
Location	47.943513, -121.833187
Area of Plant	Plant Standpipe

Structural

Structure Type	Liquid Containing
Structure Material	Steel (Pre-fab)
Visual Inspection Checklist (Struct)	Paint condition, Steel, wood, water damage
Condition Score (Struct)	3 - Moderate - Visible degradation
Performance Score (Struct)	2 - Fair - In service, but higher than expected O&M
Probability Score (Struct)	2 - Low
Impact Score (Struct)	4 - Severe
Remaining Service Life (Struct)	10

Enhance Plant Resiliency

- Resiliency, Reliability, and Redundancy (3R) Assessment
- Identify vulnerable assets, systems, and process
  - Evaluate condition assessment results through 3R lens
  - Future water quality scenarios and environmental changes
  - Integrate findings from previous risk and resiliency studies

Enhance Plant Resiliency

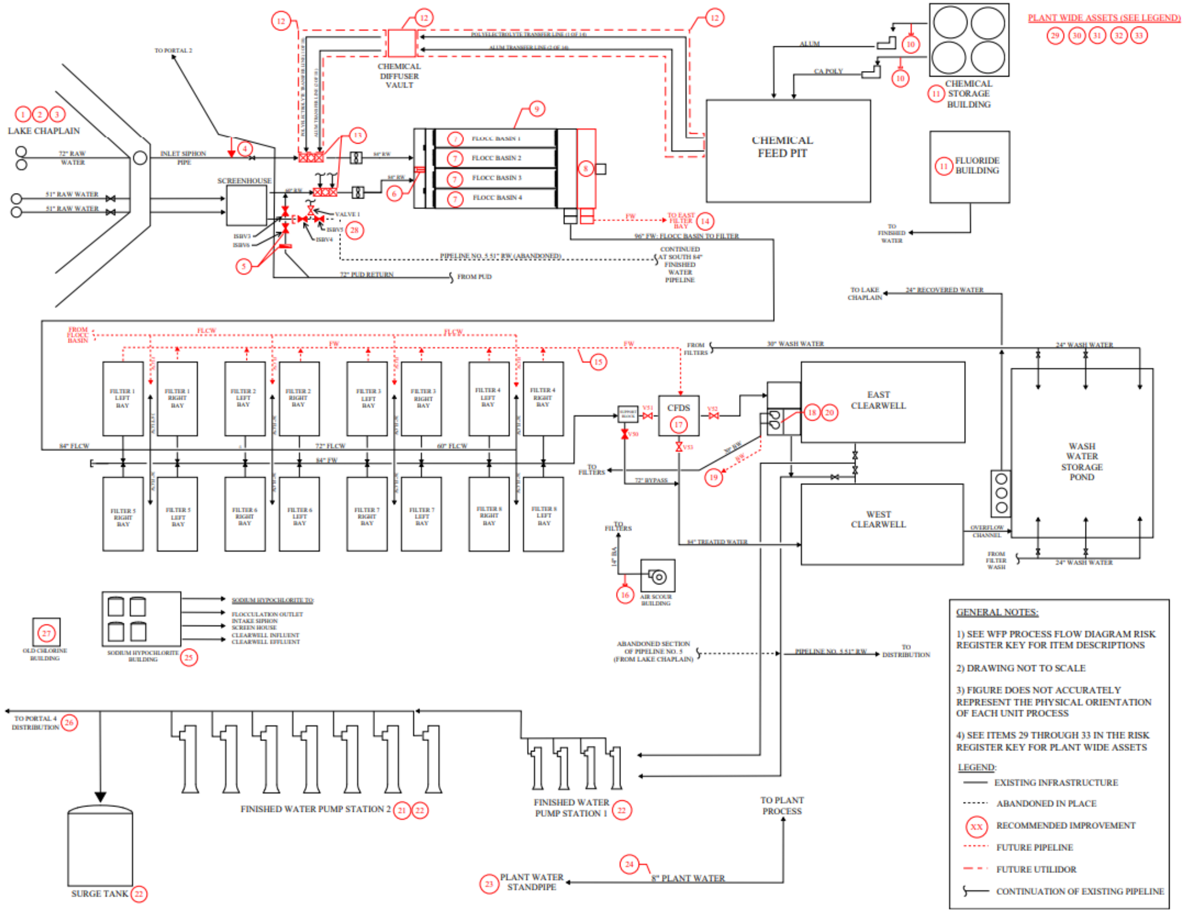
- Seismic considerations and plant resiliency
  - Incorporated findings from previous seismic studies
- Facility Plan direction
  - Implement seismic improvements with upgrades for capacity/condition

Table 5-1. Seismic Findings and Recommendations from 2012 Risk Assessment Study

Facility	Finding or recommended improvement?	Estimated corresponding earthquake[a]	Description of project or finding	Estimated cost ($)[b]
Old Chlorine Building	Improvement	Maximum	The building would be expected to sustain minor damage but remain functional in a moderate earthquake, and would sustain more significant, likely repairable damage in a major earthquake. The study recommended roof system improvements to mitigate the risk of roof failure.	$70K
Flocculation Basin	Improvement	Probable	Soil liquefaction could occur and cause large differential settlement or flotation, causing the structure to fail. The study recommended a complete rebuild of the flocculation basins using a pile supported system.	$2.4M
Filter Building	Improvement	Probable	The filter building might be prone to differential settlements due to soil liquefaction, this would damage attached pipes (addressed under the item for Large Diameter Buried Pipes), and possibly damage the building. To offset liquefaction, a soil improvement strategy (such as ground improvement by chemical injection to preclude liquefaction) could be considered.	$1M
Finished Water Pump Station 2	Improvement	Maximum	In a major earthquake, column damage could be anticipated for the building. The study recommended potential strengthening of the columns, possibly by converting part of the walls to shear walls, by replacement of some window bays; or fiber-wrap the columns.	$300K

Enhance Plant Resiliency

- Prioritized plant risks
  - Estimated probability and impact of failure
  - Assigned risk scores (1 -5)
- Findings fed into CIP and Facility Plan



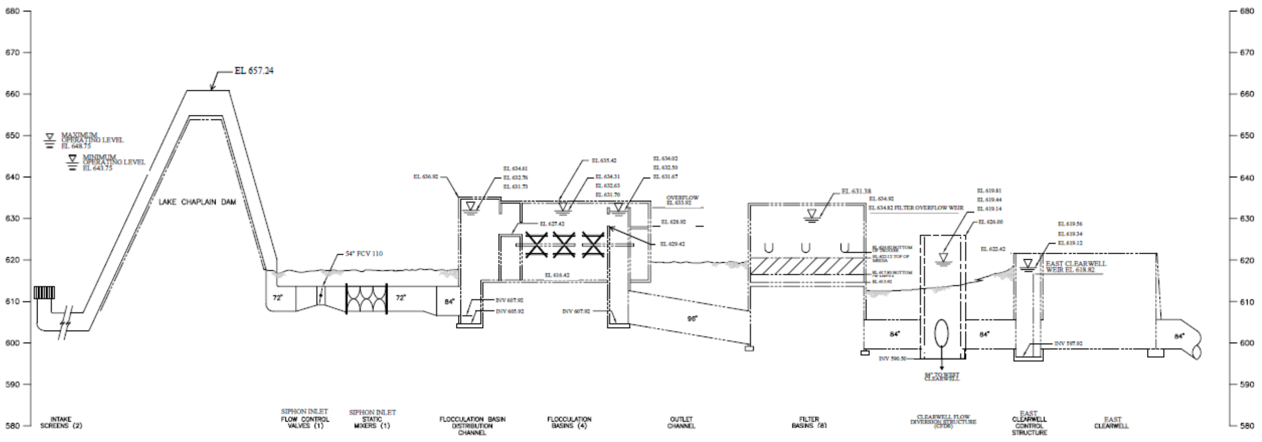
Resiliency, Redundancy, and Reliability Evaluation: Water Filtration Plant Process Flow Diagram Key		
Keynote	Item	Process Improvement
1	Raw Water	Physical threats to water quality (e.g., high turbidity) could result from disruptions such as a landslide or forest fire. These events could impact the treatment plant's process performance and/or ability to meet water demands.
2	Raw Water	Biological threats to the source water quality, such as an algal bloom, may result from increased nutrients or source water temperature. Such an event may impact the treatment plant process performance, ability to meet water quality standards, and/or impact plant capacity.
3	Raw Water	Chemical threats include manganese, iron, arsenic, or asbestos mobilization into the raw water supply potentially impacting treatment plant performance, capacity, or finished water quality.
4	PUD Return Pipeline	The 60" diameter plant intake pipeline connecting the flocculation basins to the 72" diameter PUD return line has no redundant connection. Installation of a parallel PUD raw water intake connection will provide a parallel (redundant) connection to the PUD return line and increases the PUD return line intake capacity to above 100 MGD.
5	PUD Return Pipeline ISBV6	ISBV6 cannot be isolated for repair or replacement without complete shutoff of the PUD return flow. Installation of a gate valve or isolation gate upstream of ISBV6 will allow access and maintenance for ISBV6. Additionally, ISBV6 is likely sized for on/off operation. Replacement of ISBV6 with a valve sized for throttling will increase system resiliency and reliability. If valve replacement is deemed unnecessary, replacing the existing buried gear box with an above ground gear box will improve valve reliability.

Evaluate Unit Processes

- Hydraulic Profile Assessment
  - Updated and calibrated hydraulic model
  - Stepwise increase in plant flow
  - Identified hydraulic bottlenecks
- Capacity and process improvements for CIP consideration

Table 6. Plant Hydraulic Capacity Limitations

Hydraulic Capacity (mgd)	Unit Process	Notes
60	Flocculation basin outlet channel	Flocculation basin flow distribution is impacted by a high velocity in the basin outlet channel.
100	Flocculated water pipeline	Pipeline velocity reaches the maximum recommended velocity of 3 ft/s. Velocities above 3 ft/s second in the flocculated water pipeline may induce excessive mixing energy, resulting in floc shear potentially impacting filter performance.
109	Filter basins[a]	Filter control valves are required to open greater than 70% to maintain the filter WSE at 631.38 ft.
121	Filter basins[a]	Filter control valves remain fully open. Filter WSE controlled by frictional losses through the 30-inch-diameter filtered water pipeline, 84-inch-diameter filtered water pipeline, and the clearwell weir crest. Filters may be required to operate at less than 9 feet of headloss to maintain the filter WSE if plant flow is above this condition.
123	Filter basins	Firm filter capacity, 7 filters online at rated filter capacity of 8 gpm/sf.
125	Screenhouse intake	Intake control valve FCV 101 operates with a disk position greater than 70% open at low Lake Chaplain operating level, elevation 643.75 ft.
	Siphon inlet	Intake control valve FCV 110 operates with a disk position greater than 70% open at low Lake Chaplain operating level, elevation 643.75 ft.
141	Filter basins	Total filter capacity, 8 filters online at rated filter capacity of 8 gpm/sf.
145	Siphon inlet	Pipeline velocity exceeds 8 ft/s resulting in increased risk in hydraulic transients, headloss, and abrasion.
	Screenhouse intake	Pipeline velocity exceeds 8 ft/s resulting in increased risk in hydraulic transients, headloss, and abrasion.



Evaluate Unit Processes

- Regulatory and Water Quality Assessment
  - Federal and state regulatory trends
  - Water quality trends
    - 24 raw water quality parameters
    - Natural hazard impacts
- Unit Process Performance
  - Chemical use
  - Filter operation and performance
  - Disinfection
- Informed CIP considerations

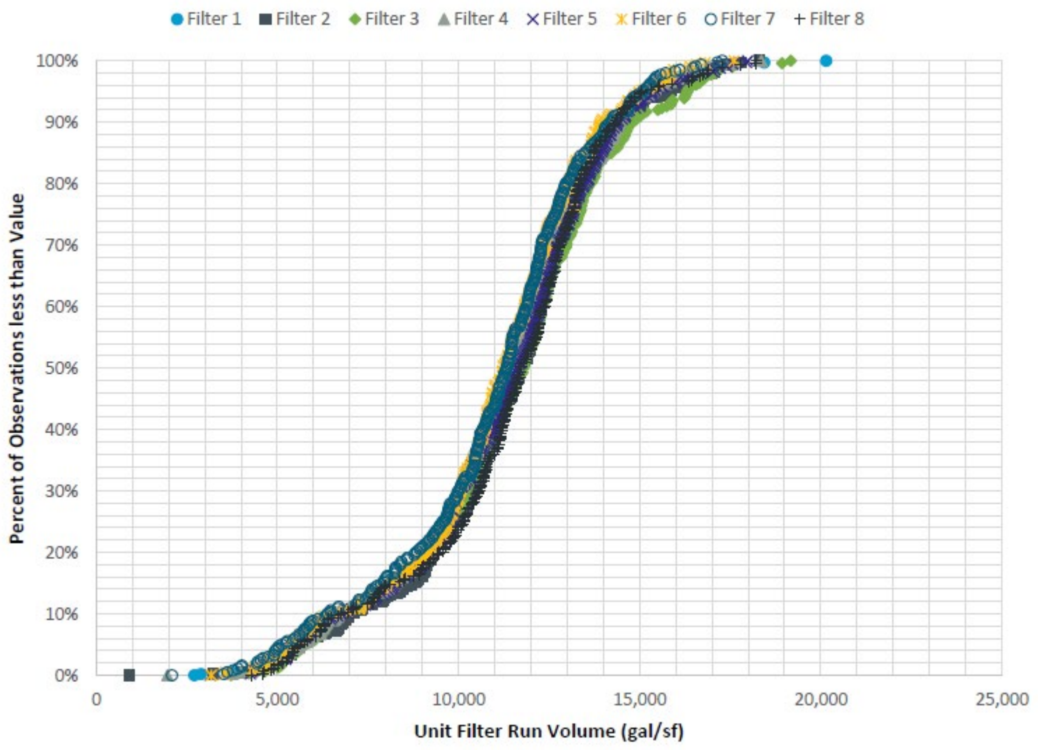


Figure 8. Percentile distribution of filter UFRVs, by filter
(May 1, 2017–September 22, 2019)

Evaluate Unit Processes

- Solids Dewatering Technology Assessment
  - Reviewed plant solids production
  - Developed mechanical and non-mechanical dewatering alternatives
  - Compared alternatives to contract dewatering
- Mechanical dewatering
  - Consistency and operational flexibility

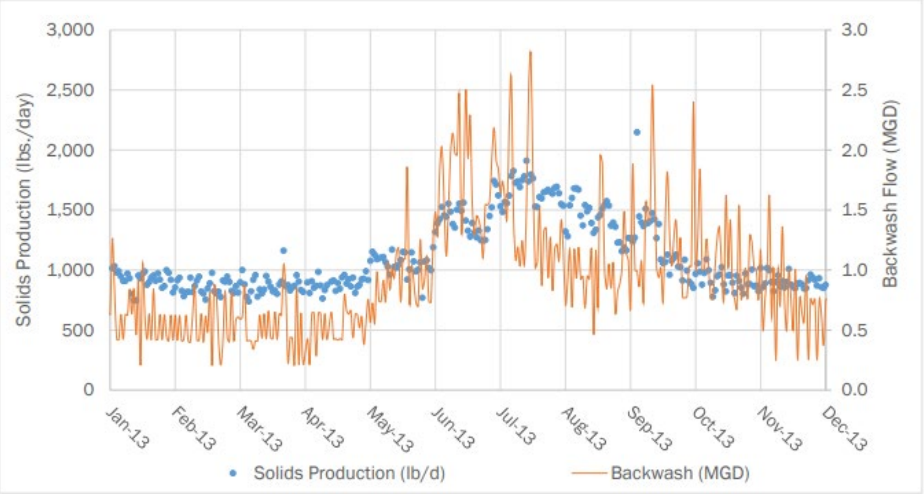


Figure 4. 2013 daily backwash water and solids production

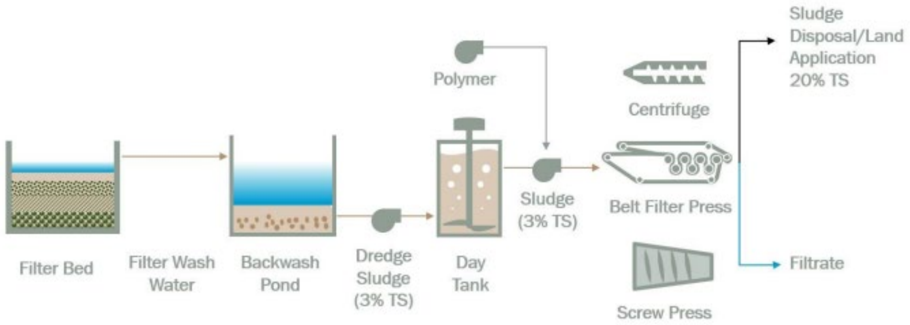


Figure 5. Mechanical dewatering Alternative 1

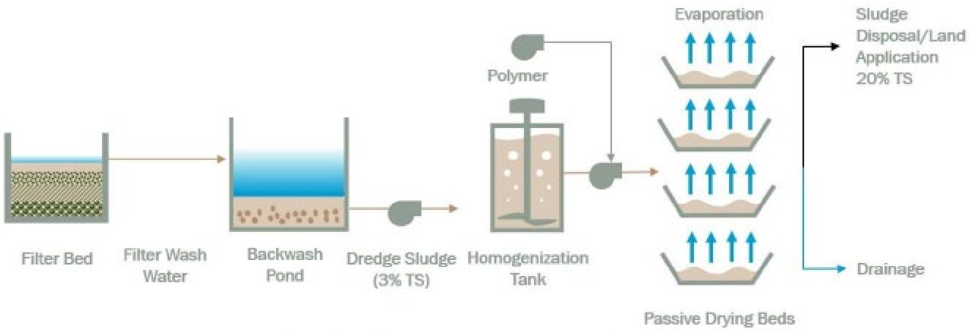


Figure 9. Alternative 3A: passive sand drying bed

Evaluate Unit Processes

- Finished Water Pump Station Evaluation
- Short-term process improvements
  - Deeper dive condition assessment
  - Desktop hydraulic analysis
- Recommendations for improved pump and system operation

Figure 2-15. CAD model of vaned grating basket

Short-term CIP Development

- Compiled 63 CIP improvements from technical evaluations
  - Collaborative prioritization, ranking, and schedule
  - Input from array of City staff
- 35 projects carried forward for short-term
  - 10-year planning
- Project scopes and CIP estimates
- Early-out CIP to meet City fiscal planning needs

CIP Project Number	CIP Project Title	Plant Area	Primary Driver	Priority Ranking	Preliminary Timing	Scope of Project Included in Cost Estimate	Cost Low Range (-50%)	Cost High Range (+100%)
1.1	Clearwell butterfly valve 50, 51, 52, 53 inspection and rehabilitation	Clearwell flow diversion structure	Performance	5	0-5 year CIP	Alternative 1: Excavate to valve gear box level, replace internals and replace valve operator. Install a precast vault around each new gear box.	$ 900,000	$ 3,600,000
1.2	Clearwell Valve Replacement	Clearwell flow diversion structure	Performance	5	0-5 year CIP	Alternative 2: Install bulkhead in CFDS, excavate to valve level, remove and replace valves, install new precast concrete valve vaults to maintain access to valves.	$ 1,250,000	$ 5,000,000
2	Flocculation basin mixer replacement	Flocculation basins	Condition	5	0-5 year CIP	Remove existing paddle mixers in flocculation basins. Install new vertical mixing system (e.g., Invent Brand hyperboloid mixers). Includes new walkways required for updated system.	$ 1,705,000	$ 6,820,000
3	Hydrofluorosilicic acid (fluoride) storage tanks replacement	Fluoridation building	Condition/ age	5	0-5 year CIP	Remove and replace two 6,500-gallon fluoride storage tanks. Demolish fluoride day tank and reconfigure piping to connect new storage tanks directly to pumps. New storage tanks will be cross-linked polyethylene, outfitted with ultrasonic level sensors. Estimate includes temporary removal of roof sections.	$ 280,000	$ 1,120,000
4	Portal 4 corrosion upgrades	Portal 4	Condition	5	0-5 year CIP	Cover open channel at Portal 4 with removable FRP covers, including new ventilation duct and fan for venting the covered open channel atmosphere to the building exterior. Replace/reinforce corroded steel structural joints. Replace corroded louvers, window guards, and building door. Sand blast and epoxy coat corroded gate gear boxes and steel lifting points embedded throughout Portal 4 walls.	$ 163,000	$ 652,000
5	Alum and polymer storage tank replacement	Alum/Polymer storage bldg	Condition/ age	5	0-5 year CIP	Remove the existing liquid polymer storage tanks and replace with smaller tanks sized for current conditions. Replace the existing alum bulk storage tanks. Add ultrasonic level sensors to all four new tanks. Estimate includes temporary removal of the chemical storage building wall for tank replacement.	$ 640,000	$ 2,560,000

Final CIP Development

- 11 – 20+ year capital projects
- 47 total projects
- Hydraulic capacity limitations
  - 2020 Comprehensive Water Plan demand projections
- Long-term engineering assessments
  - Seismic considerations
  - City identified projects

Table 3-1. Hydraulic and Capacity Limitations by Project

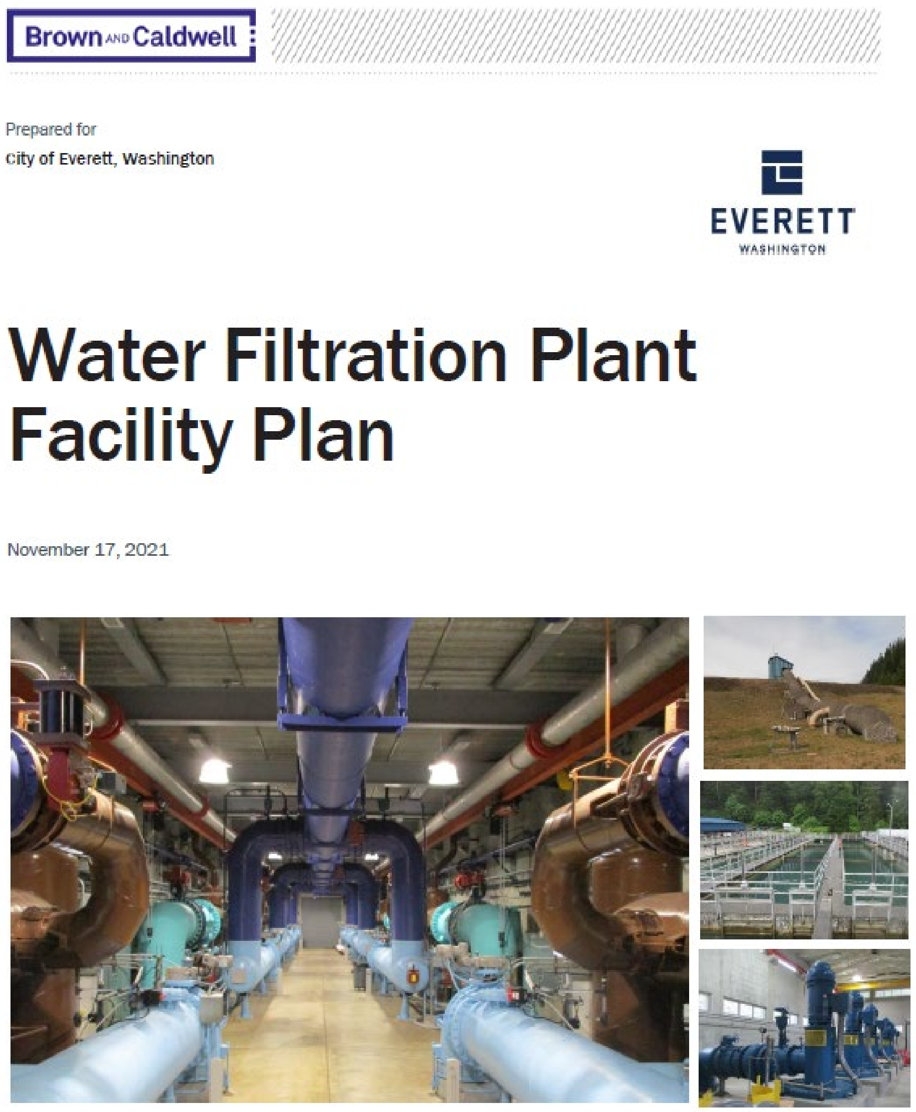
Project	Capacity Limitation Triggering Improvement (mgd)	Year Capacity Limitation Projected to Occur
Filter to waste pipe improvements	Currently limits backwash capacity to 6 gpm/sf	Complete in conjunction with construction of Filters 9 and 10
Filters 9 and 10	132[b]	2037
Parallel flocculated water pipeline [b]	150	2045
Redundant filtered water line and east filter pipe gallery [b]	150	2045
Clearwell 3	150	2045
Flocculation basin wall elevation improvements	153	2047
Filters 11 and 12	164 [a]	2051
Flocculator channels 5 and 6	170	2054

a. *Capacity limitation assumes current approved filtration rate of 8 gpm/sf.*

b. *Project also has significant redundancy benefits by addressing an existing single flow path in the WFP.*

WFP Facility Plan

- Assembly of evaluations
- Developed with CIP focus
- Projected water demands
- Plant capacity
- Regulatory constraints and water quality



Results and Lessons Learned

Zach Brown

EVERETT
WASHINGTON

Facility Plan Process Successes

- Dynamic communication between City staff and BC
  - Detailed staff interviews, workshops, on-site guided tours
  - Iterative process of recommendation development
- Collaboration amongst stakeholders
  - Different viewpoints but same overall goal
- Flexibility in project scope execution
  - Manager's reserve + collaborative execution = project success
- Multi-faceted assessment focus
  - Holistic view of water filter plant and path forward

Facility Plan Process Results

- City staff's thorough understanding of plant status, needs, and path forward
- Systematic prioritization of future projects
- 45 improvement projects recommended for future implementation
  - Maintenance and capital projects > $25,000
  - Implementation timeline = 0-20+ years
- 19 projects with 0–5-year implementation timeline
  - 4 maintenance projects
  - 3 stand-alone capital projects
  - 12 capital projects bundled together into a single PDB project

Lessons of the Facility Plan Process

- Consensus is rarely easy to achieve
  - Honest communication and an emphasis on finding common goals is key
- Coordination plays a bigger role than you may anticipate
  - Project success requires coordination of stakeholders, parallel planning efforts, and parallel projects
- Working assumptions used in planning and analysis may not be as straightforward as they initially seem

Thank you.
Questions?

Brown AND Caldwell