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Bellevue's Condition Assessment Program and it's Optimization of Asset Management Procedures

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12 May 2010

pnws • awwa WATER WORKS conference 2010 • May 12-14 tacoma

Water Booster Pump Stations - Condition Assessment and Evaluation

- City of Bellevue Water System Overview
- Bellevue's Asset Management Plan Overview
- Data Collection
- Evaluation Process
- Scoring

Bellevue Water System Overview

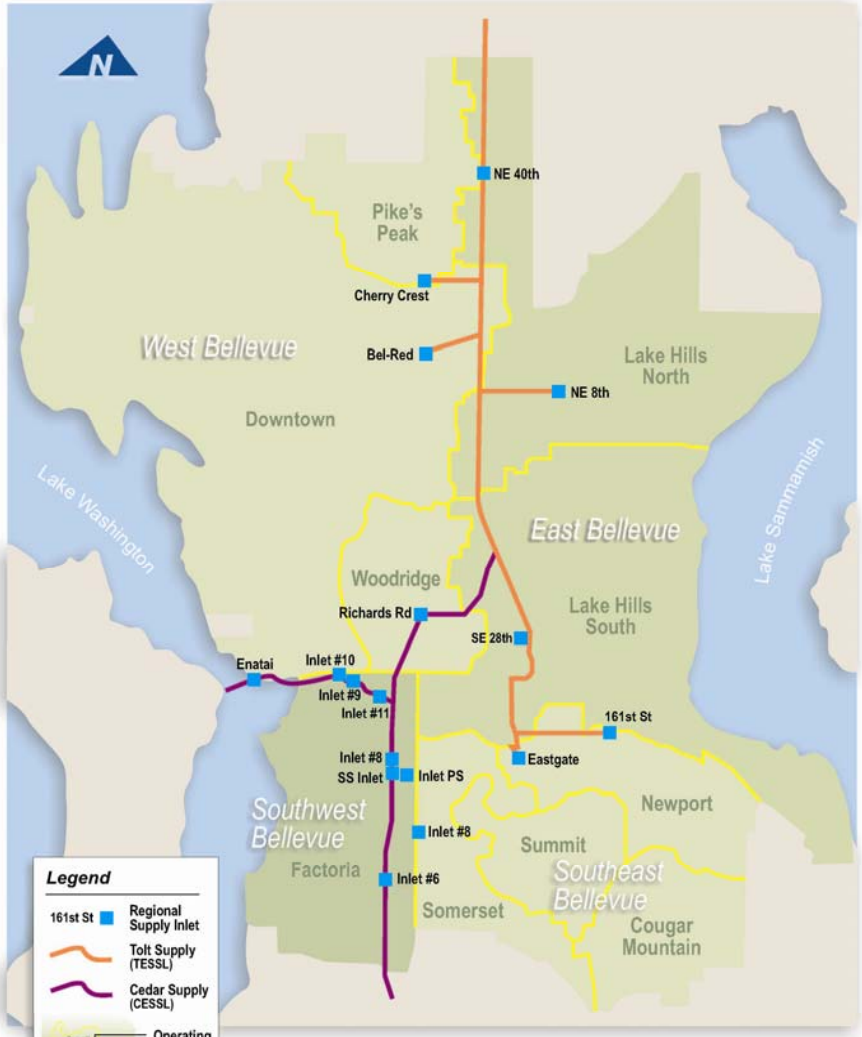


Figure 1-1
City of Bellevue
Overview of Operating Areas and Water Supply

- Serves About 134,000
- Supply from Cascade Water Alliance/Seattle
- MDD is 40mgd, 52mgd in 2040
- 10 Operating Zones
- 45 Pressure Zones
- 23 Water Booster Pump Stations
- 60% of Water is Pumped

Asset Management Plan Implementation

Start with the Water Booster Pump Stations

- Linchpins of the City Water System
- Uninterrupted operation is critical
- Complex inter-relationships
- Hard to evaluate and prioritize
- Aging facilities, some areas of poor condition

Water Booster Pump Stations – Characteristics

- No uniform standards
  - Grown by merger with old Water Districts
  - Many built by developers
- Most are old facilities
  - 9 are 40 to 50 years old,
  - Only 5 are less than 20 years old
  - Most pumps and motors 20 to 30 years old

WBPS Evaluation - Project Challenges

- Multiple pump types
- Varying levels of building quality
- Below grade vaults
- Inefficient location of emergency power
- Absence of re-chlorination facilities

WBPS Condition Evaluation – Process

- Data Collection
- Evaluation methodology
- Understand redundancy
- Determine improvements needed
- Prioritize improvements; condition and cash flow

Data Collection

- Field Condition Assessment
- Hydraulic Analysis
- Pump Curves
- Operations Data (System Demand, Reservoir Level, Pressure, Flow, Chlorine Residual)
- Maintenance Records- MAXIMO Database
  - Work Order History, Equipment No., and Cost
- Water Quality Data

Field Data Collection

- Field visit of each WBPS
  - Technical Experts
  - 5 Data Forms, for each PS
    - Pumps
    - Pipe/Meter/Valves
    - Structure (Seismic)
    - Site/Civil
    - Electrical/I&C
    - Water Quality/Storage
- Inventory of equipment
- Assessment of Condition
- On-site Interview with staff

Area	**Pumps**			
Date	**9-Nov-06**			
Pump Station	**670/NE 40th**			
Rated Performance				
Pressure Zone	**Pike's Peak 670/**			
	Lake Hills 520			
Description	**Pump**			
	No. 1	**No. 2**	**No. 3**	**No. 4**
Description	Horizontal split case booster pump	Horizontal split case booster pump	Horizontal split case booster pump	Horizontal split case booster pump
Required Performance	1000 gpm	1000 gpm	2000 gpm	
Nameplate Information				
Pump				
Pump Mfg	PACO Type KP	PACO Type KP	PACO Type KP	Goulds
Pump Model	29-20136-720-61	29-20136-7200-6100	29-60196-7500-71	
Pump Serial #	PD90A0034101	PD90A0035201	PD90A0034301	
Year	Aug-91	Aug-91	Aug-91	
Flow	200+/-	300+/-	1800+/-	
Head	110	110	110	
BHP				
Efficiency				
Seal or Packing	Mech Seal	Mech Seal	Mech Seal	Mech Seal
Motor				
Motor Mfg	US Motors	US Motors	US Motors	Marathon Electric
Motor Model	638026	638027	638054	
Motor HP	10	15	75	40
Motor Speed	1800	1775	1190	1765
Motor Serial #	K05-638026-M	E1001066791	E1201006713-100R-01	
Amps				
Voltage	460-3-60	460-3-60	460-3-60	460-3-60
Constant or Variable Speed	Variable	Variable	Variable	Constant
Year	2001	2002	2001	
Enclosure				
Efficiency				
VFD				
VFD Mfg	Siemens	Seimens	Seimens	
Ratings	10	15	75	
Year	2001	2001	2001	
Other				
Pump Curves				
Available	YES	YES	YES	
Ratings				
Operations	Serves 670 Zone	Serves 670 Zone	Serves 670 Zone	Serves 520 Zone
Primary or Standby	Primary	Primary	Primary	For backup to NE 40th reservoir site
Operating Hours				
Concerns				
Maintenance History				
Failures	Motor shorted out in 2006. Replaced with new motor.			
Overhaul	Reconditioned in 2003 (seals, bearings, balance) New bearing and mechanical seals in 2006	New motor coupling installed in 2002 Reconditioned in 2006 (new shaft seals and bearings, new mechanical seals)		
Ongoing problems				
Equipment Access				
Physical Condition				
Overall Appearance				
Corrosion	Slight corrosion of casing at split			
Leakage	No drain line on air valve. Standing water on pump base.			
Vibration	No vibration isolators on pumps. Does not appear to have caused any problems.			
Sound				
Anchorage				
Pressure Gauges	No pressure gauges on suction or discharge			
Motor				
VFD	Motors installed in 2003 along with VFDs. Appear to be in good condition.			
Space for Future Expansion				
Available	No			

Field Data Results, Observations

- Many of the WBPS needed improvements
- Improvements varied but were critical systems
- Without improvements, reliability was compromised
- Due to inter-relationships, redundancy was important
- Improvements at a WBPS, became a package

Data Collection Results

- Thorough review of existing information
- Analysis of consumption
- Rigorous assessment of each pump station condition
- Understanding of the interrelationships
- Development of 10 system schematics

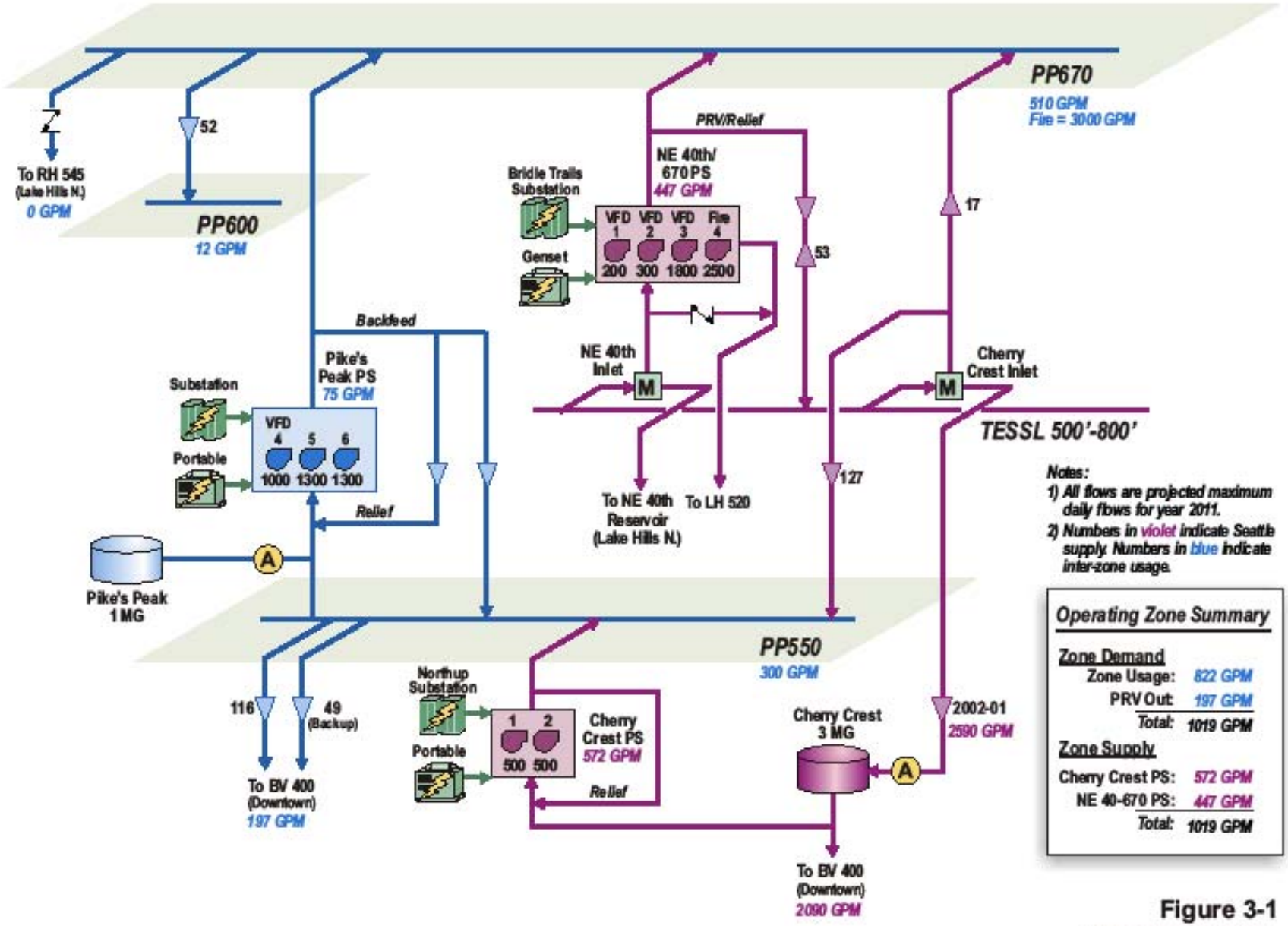


Figure 3-1
West Bellevue
Pike's Peak Operating Zone

Evaluation Criteria

Physical Condition

- Pump Condition
- Mechanical Equipment Condition
- Electrical Equipment Condition
- Condition of Structure
- Condition of Site

Operations

- Current Pumping Capacity
- Pumping Redundancy
- Power Reliability
- Expansion and Upgrade Capabilities
- Water Quality Considerations

Maintenance

- Maintenance Capability
- Safety
- Vulnerability to Damage

Evaluation Criteria

- Each criterion has 3 to 11 parameters
- Each parameter asks a “yes or no” question
  - Generally, yes is good; no is bad
  - Answers from data collection activities
- “Yes” equals 1 point; “no” takes away 1 point
- Points are added up and normalized to a 5 point scale

Evaluation Scoring Table Example

Criterion = Electrical Condition

7 scoring parameters in this criterion

Electrical Condition Evaluation

Location			Scoring							Possible		7
Operating Area	**Operating Zone**	**Pump Station**	Is electrical service and distribution more than 20 years old?	Is electrical service and distribution more than 30 years old?	Are there ongoing maintenance problems?	Does electrical installation meet current NEC requirements?	Does telemetry system meet current City standards?	Is electrical service 480 VAC?	Do pump motors above 20 hp have solid-state starters or VFD's?	Score	Scale 1 to 5	Round
West Bellevue	Pike's Peak	Pike's Peak			-1	-1				5	3.57	**4**
		NE 40th - 670								7	5.00	**5**
		Cherry Crest	-1							6	4.29	**4**
	Downtown	Meydenbauer				-1				6	4.29	**4**
		Clyde Hill	-1		-1	-1				4	2.86	**3**
	Woodridge	Woodridge								7	5.00	**5**
East Bellevue	Lake Hills North	NE 40th Reservoir				-1				6	4.29	**4**
		NE 8th	-1							6	4.2[illegible]	**4**
		Crossroads (Lake Hills)								7	[illegible]	**5**
	Lake Hills South	SE 28th	-1			[illegible]				5	[illegible]	**4**

Total score, out of 7 possible

Total score, rounded 1 to 5, lower numbers are worse

Weighting Evaluation Criteria

	Criteria	A Pump Condition	B Mechanical Equipment Condition	C Electrical Equipment Condition	D Condition of Structure	E Condition of Site	F Current Pumping Capacity	G Pumping Redundancy	H Power Reliability	I Expansion and Upgrade Capability	J Water Quality Considerations	K Maintenace Capability	L Safety	M Vulnerability to Damage
A	Pump Condition		1A	1C	1A	2A	1F	1G	1H	1A	1J	1A	1L	2A
B	Mechanical Equipment Condition			1C	1B	2B	1F	1G	1H	1B	1J	1B	1L	2B
C	Electrical Equipment Condition				1C	2C	1F	1G	1H	1C	1J	1C	1L	2C
D	Condition of Structure					1D	1F	2G	2H	1D	2J	1K	2L	1D
E	Condition of Site						2F	2G	2H	1I	2J	1K	2L	1E
F	Current Pumping Capacity							1G	1F	1F	1F	1F	1L	1F
G	Pumping Redundancy								1G	1G	1G	1G	1L	1G
H	Power Reliability									2H	1J	1H	1L	
I	Expansion and Upgrade Capability											1K		
J	Water Quality Considerations											2J		
K	Maintenace Capability													1K
L	Safety													1L
M	Vulnerability to Damage													
	Score	8	7	9	3	1	11	13	11	2	13	4	15	0

Add the integers in front of a letter to get the weight for that criteria

Pump Station Score Card

	Criteria	Condition Evaluation (from Field Survey)	Weight	Score
A	Pump Condition	5	.08	0.40
B	Mechanical Equipment Condition	5	.07	0.35
C	Electrical Equipment Condition	4	.09	0.56
D	Condition of Structure	5	.03	0.15
E	Condition of Site	3	.01	0.03
F	Current Pumping Capacity	4	.11	0.44
G	Pumping Redundancy	2	.13	0.26
H	Power Reliability	2	.11	0.22
I	Expansion and Upgrade Capability	3	.02	0.06
J	Water Quality Considerations	3	.13	0.39
K	Maintenace Capability	5	.04	0.20
L	Safety	4	.15	0.60
M	Vulnerability to Damage	2	.00	0.00

TOTAL 3.76

Scoring and Ranking of WBPS

13 Criterion (not all shown)

Relative weight of each criterion

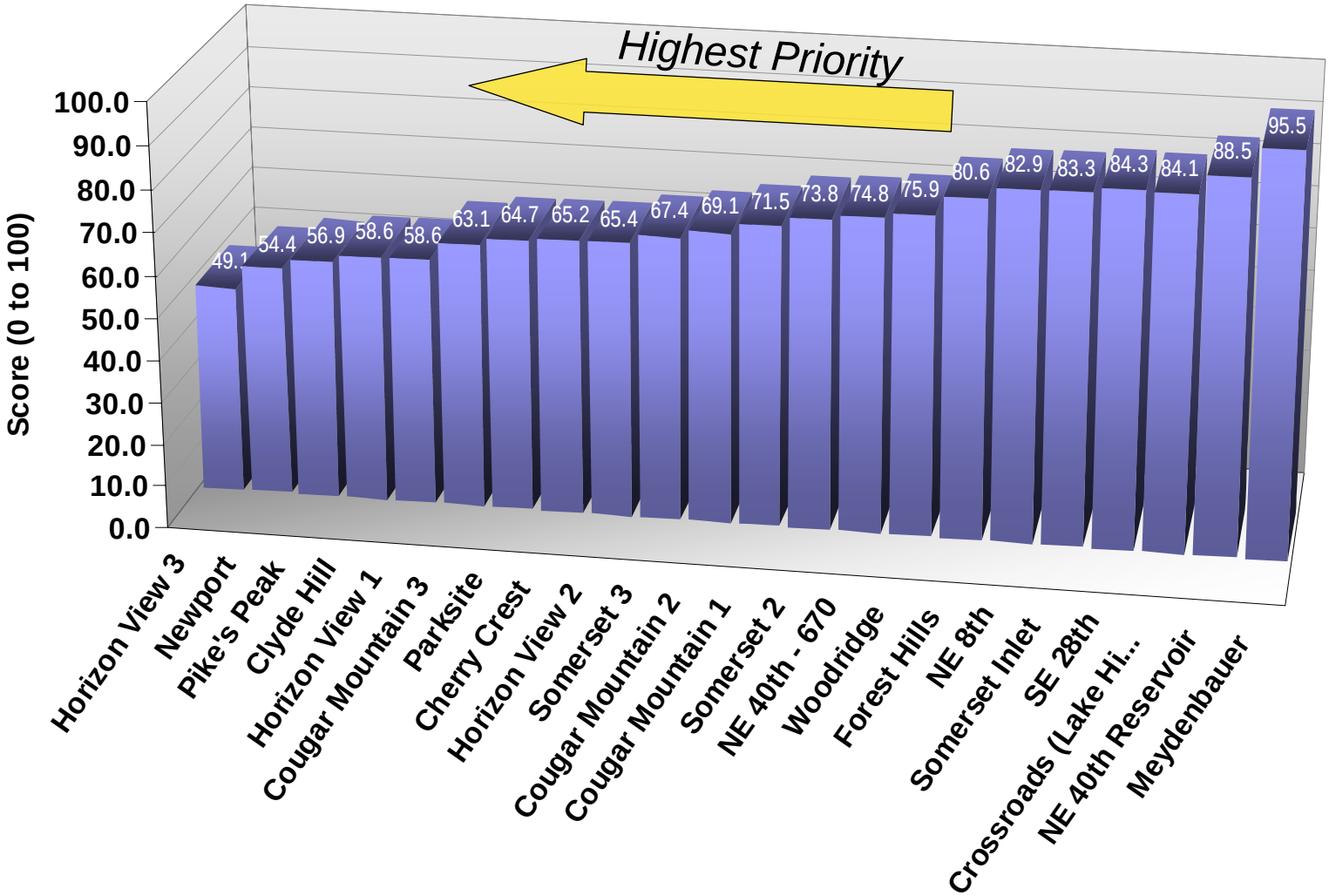
Pump Station		Physical Condition				Maintenance		Totals		
		Pump Condition (A)	Mechanical Equipment Condition (B)	Electrical Condition ©		Saftety (L)	Vulnerabiity to Damage (M)	Total (1 to 5)	Total (1 to 100)	Rank (1 to 22)
	Weight	8	7	9		15	0	**97**		
	Percent	8%	7%	9%		15%	0%	**100%**		
Pike's Peak	Raw Score	4	3	4		3	2			
	Weighted	0.33	0.22	0.37		0.46	0.00	2.85	**56.9**	**3**
NE 40th - 670	Raw Score	4	4	5		3	3			
	Weighted	0.33	0.29	0.46		0.46	0.00	3.74	**74.8**	**14**
Cherry Crest	Raw Score	3	3	4		5	2			
	Weighted	0.25	0.22	0.37		0.77	0.00	3.26	**65.2**	**7**
Meydenbauer	Raw Score	5	5	4		5	5			
	Weighted	0.41	0.36	0.37		0.77	0.00	4.77	**95.5**	[illegible]
Clyde Hill	Raw Score	2	3	3		3	[illegible]			
	Weighted	0.16	0.22	0.28		[illegible]	[illegible]	2.93	**58.6**	[illegible]
Woodridge	Raw Scor[illegible]	4	5	5		5	5			

Pump station score

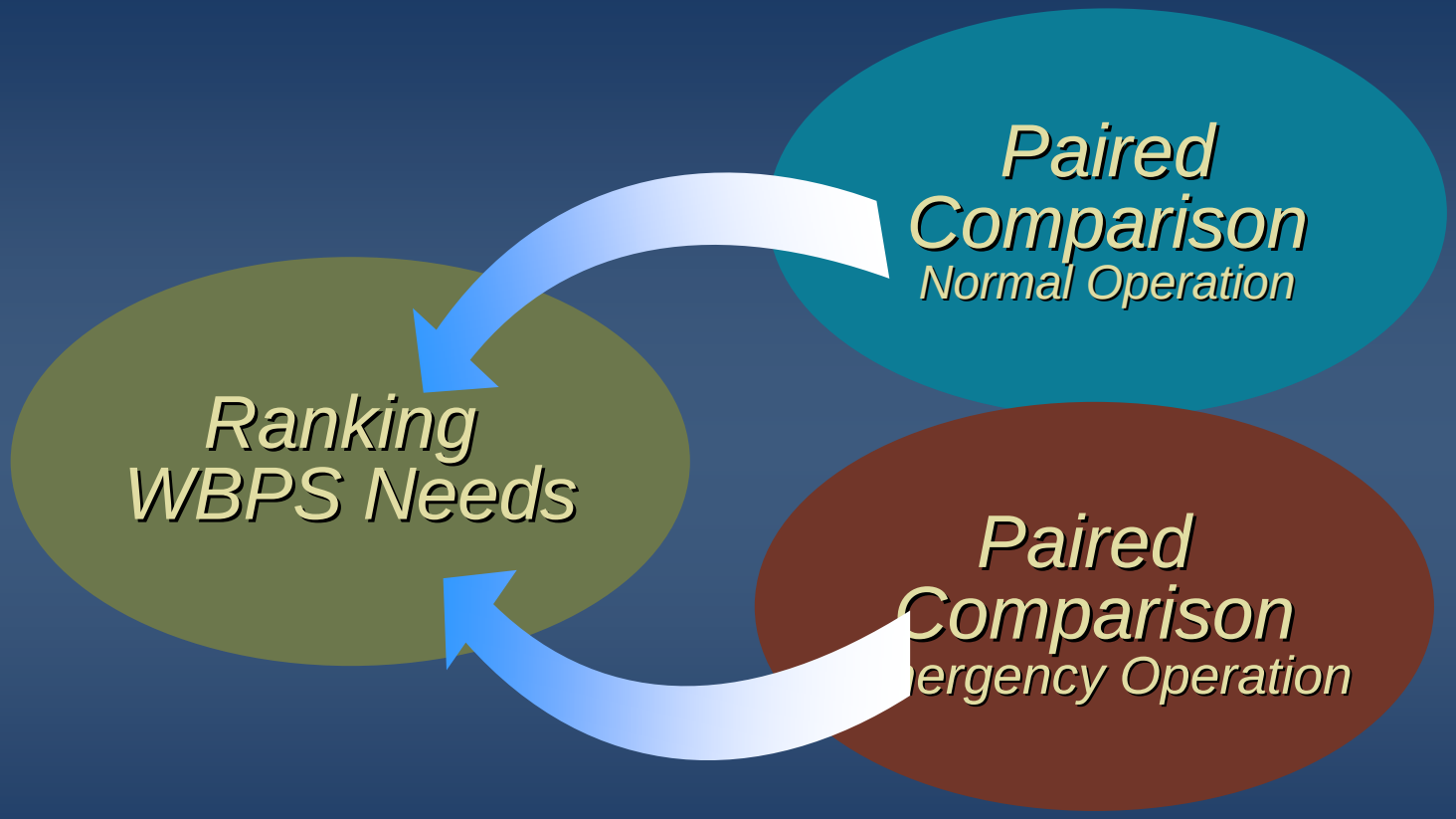
Weighted score: raw score times weight

Pump station rank

Normal Operating Ranking



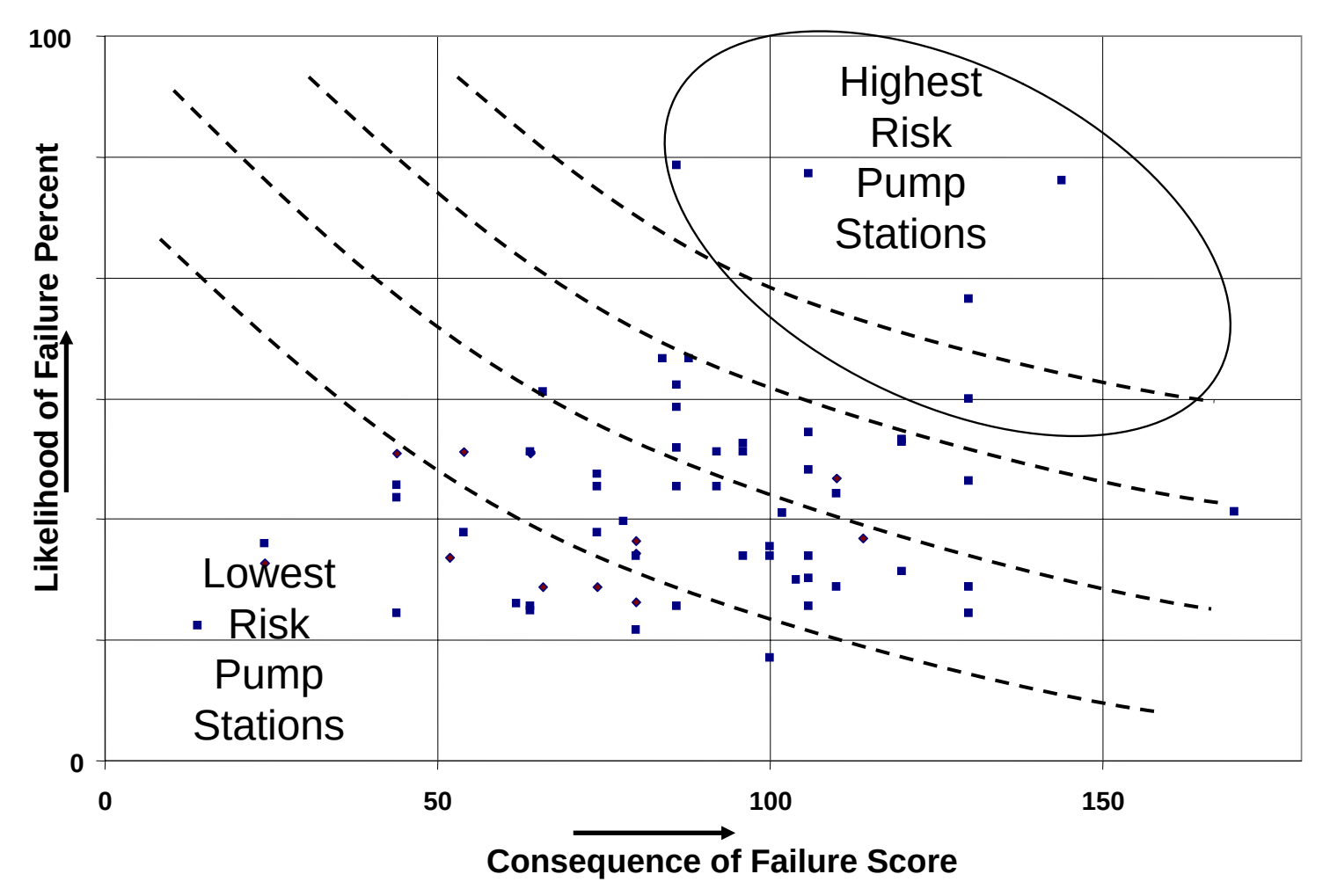
Ranking Pump Stations



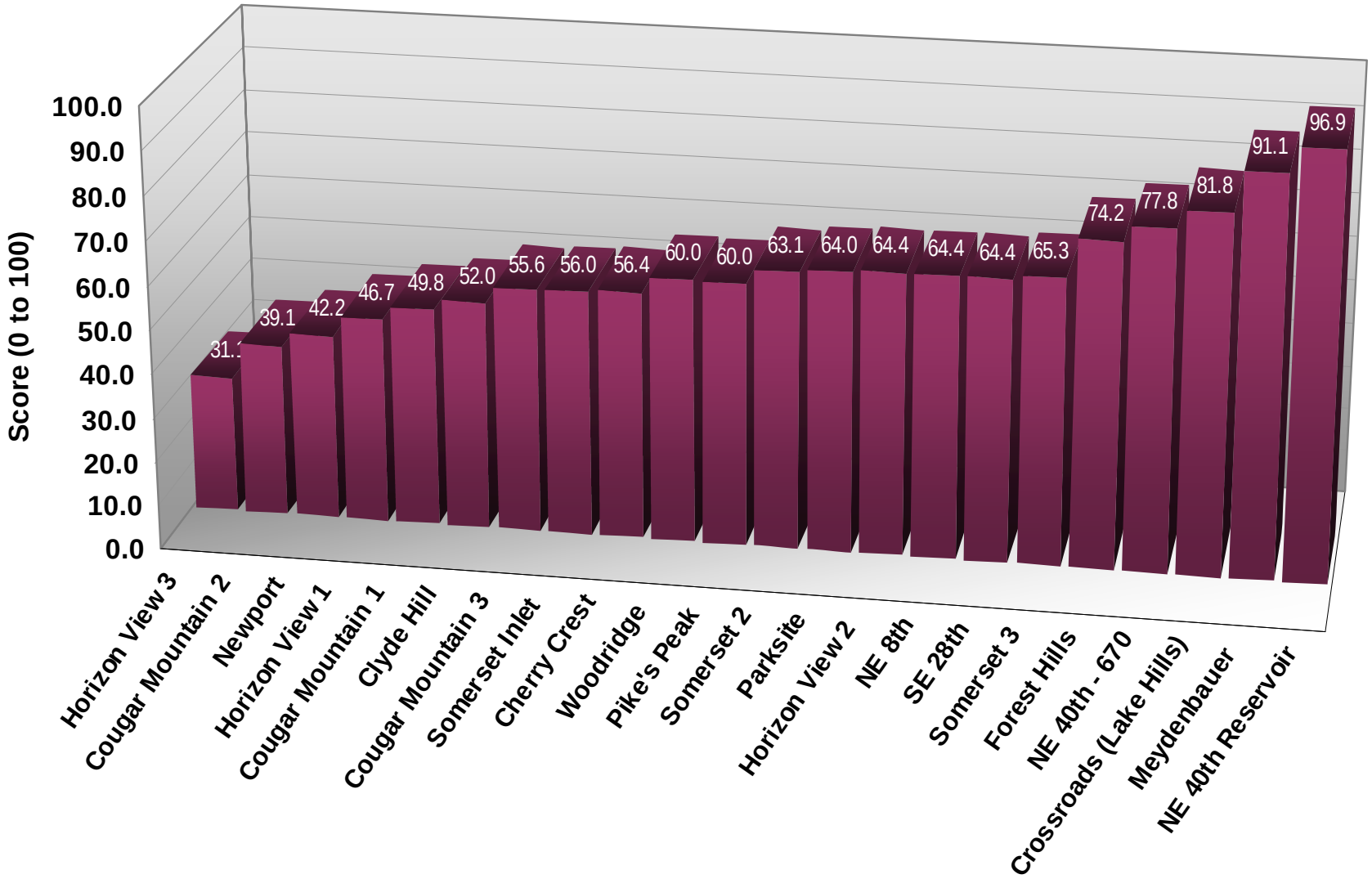
City of Bellevue WBPS Evaluation Risk Based Assessment

- Risk = Probability X Vulnerability X Consequence
- Hazards impacting multiple facilities pose the greatest risk
  - Regional power outage
  - Earthquake
  - Flooding
- Redundancy provides effective mitigation

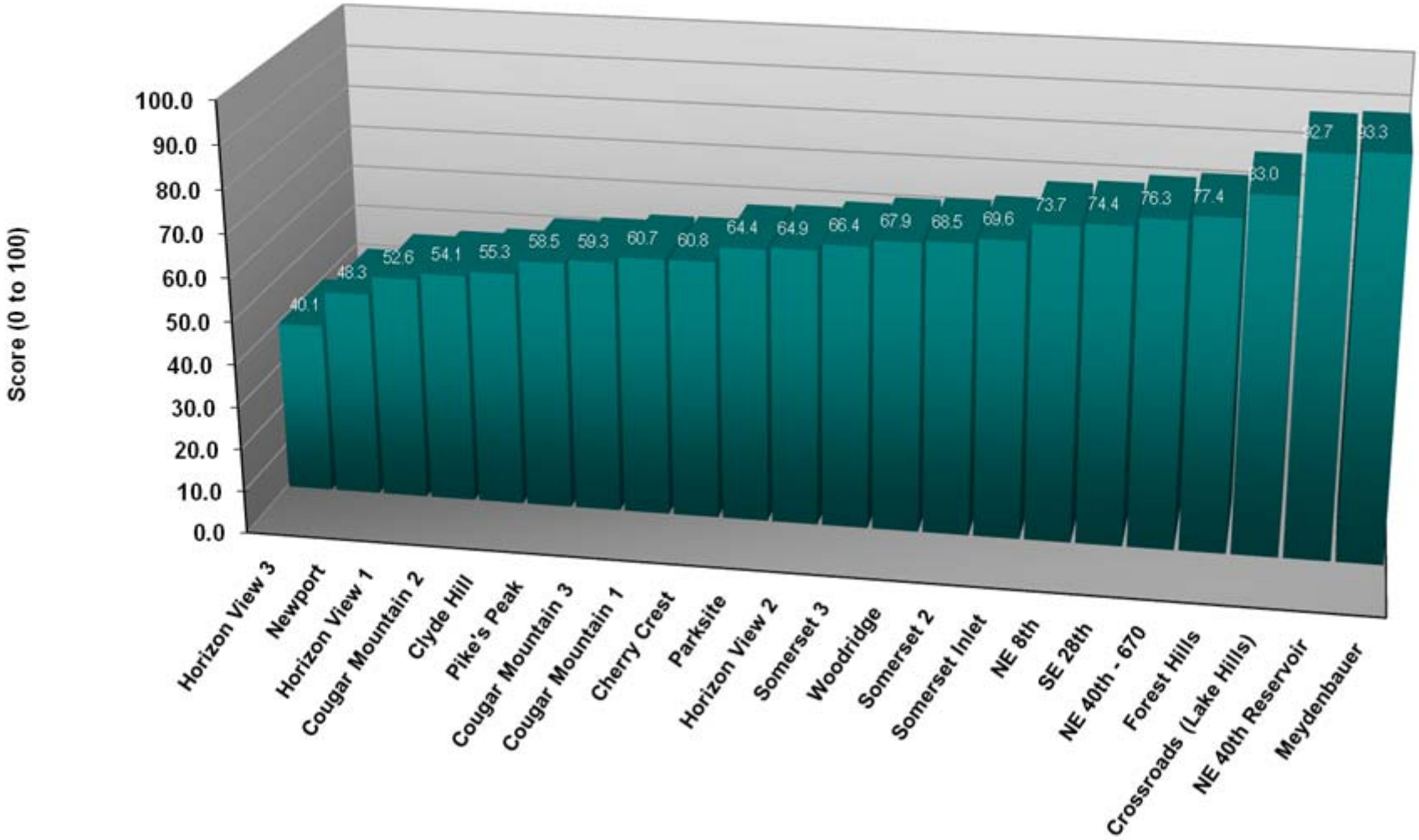
Sample Risk Ranking



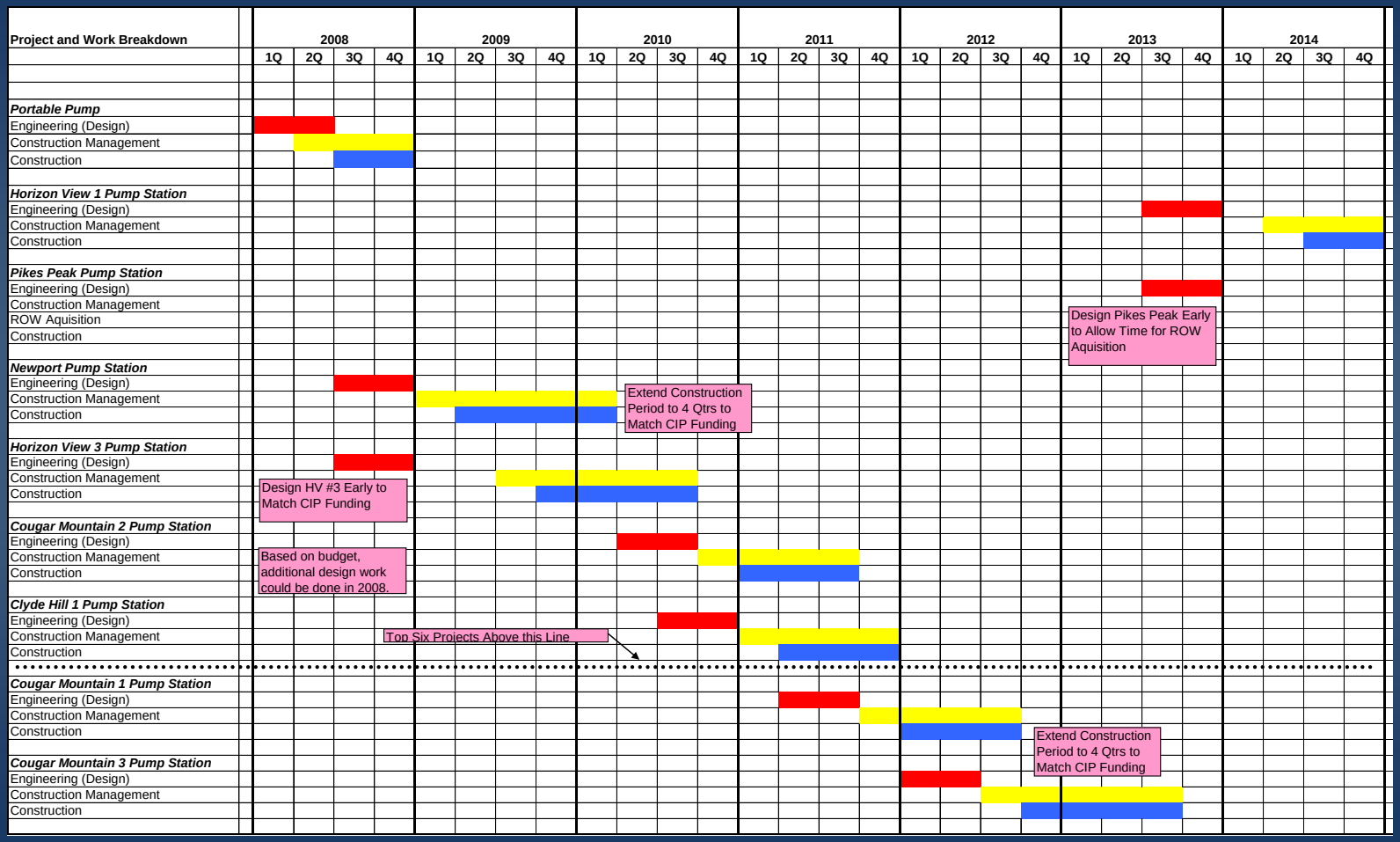
Emergency Operating Scenario



Combined Rankings



WBPS Improvements – Cash Flow



Summary

- WBPS assessed: 23
- WBPS requiring improvements: 21
- Total cost all improvements: 21.4 M
- Average cost of replacement (5): 2.9 M
- Average cost of improvements (16): 0.43 M

Questions?

City of Bellevue WBPS Evaluation Project Challenges