Kennedy/Jenks Consultants

Stormwater Pump Station Condition and Capacity Assessment

24 June 2016

D|C|G civil structural

Prepared for

CITY OF SHORELINE

Stormwater Pump Station
Condition and Capacity Assessment

CITY OF SHORELINE

The City of Shoreline (City) owns, operates, and maintains eight stormwater pump stations. A number of these stations were originally owned, operated, and maintained by King County prior to the City assuming ownership of them after its incorporation in 1995. The City currently contracts out maintenance of these stations to a private firm. This contract operations method may change in the coming years after the City completes its assumption of the Ronald Wastewater District in 2017.

The City plans to update their Stormwater Comprehensive Plan within the next year. Because of current issues at several of the pump stations, the City decided to undertake a Condition and Capacity Assessment of all of their stations at this time. This assessment addresses both the current pressing issues at stations as well as provides baseline assessments and recommended improvements for all stations.

The upcoming Stormwater Comprehensive Plan will address stormwater in a much broader manner citywide and will address drainage basins, projected flows, system operation and maintenance, and other stormwater issues. The future pump capacity requirements for the existing stations may change based on the Comprehensive Plan findings. This Condition and Capacity Assessment is intended to provide detailed information to help facilitate the Comprehensive Plan work, especially with alternatives analysis and Capital Improvement Plans that involved the stations.

The Davido Consulting Group team (Consultant) assessed the conditions of these existing stormwater pump stations and in the following paragraphs, provides recommended operation and maintenance activities and capital improvements for the stations. The Consultant also evaluated possible SCADA systems that the City could use at these stations.

Summary of Recommended Station Improvements

Based on the assessment of each pump station in the field and on evaluation criteria noted below, a number of improvements are recommended at each station. Detailed listings of the improvements at the stations are included in each Station Fact Sheet in Appendix B. The cost estimates for the improvement tasks are provided in Appendix C.

Table 1: Summary of Recommended Station Improvements

Station	Year Constructed	Condition Summary and Upgrade Recommendation	Estimated Project Cost
Linden Ave Pump Station	2008	Upgrade electrical components, add SCADA, provide signs and bollards, purchase redundant pump, and improve wet well access.	$ 36,300
Palatine Pump Station	2009	Upgrade electrical components, add SCADA, provide signs, purchase redundant pump, and improve wet well access.	$ 32,500
Pan Terra Pump Station	2010	Add SCADA, add pressure gauges, improve hatches, and provide guardrail.	$ 40,900
Pump Station 25	2006	Upgrade/revise PLC program, improve hatches, and provide guardrail.	$ 36,800
Pump Station 26	1970	Demolish and rebuild station, reuse existing wet well.	$ 293,900
Pump Station 30	1992	Demolish and rebuilt station, reuse existing wet well. Provide site improvements around wet well and upgrade power service.	$ 290,700
Ronald Bog Pump Station	2009	Add SCADA, add pressure gauges, and provide bollards.	$ 22,700
Serpentine Pump Station	2005	Add SCADA, add pressure gauges, improve hatches, and provide site grading improvement.	$ 37,900
		Total Cost	**$ 791,700**

Evaluation Categories and Criteria

The evaluation of each station and its various comments were grouped into the following evaluation areas. Each station was evaluated for its compliance with the five categories noted below. The categories are ordered generally in degree of importance with code compliance and operator safety being the highest priority needs to be addressed.

Table 2: Evaluation Categories and Criteria

	Category	Criteria
I	Code Compliance	NFPA 820/NEC NEC Hazard Labels
II	Ergonomics/Safety	Hatches Railings/Fences Site Lighting
III	Operational Reliability	SCADA Local Alarms Aging Infrastructure Redundancy
IV	Site/Civil	Signs Access Protection Other Site Improvements
V	Data Collection	Pump Performance/Condition
VI	Other	

I. Code Compliance evaluations focused primarily on the National Electrical Code (NEC) and the National Fire Protection Association (NFPA) standards that apply to stormwater pump stations.

NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities – along with the NEC define the area classification ratings for stormwater facilities. Stormwater facilities, including pipes, wet wells, and areas directly connected to wet wells are rated Class 1, Division 2. Dry Wells are either Class 1, Division 2 or they can be “unclassified” if certain conditions are met. Table 4.2 of NFPA 820 defines these conditions and is included in the Workshop PowerPoint in Appendix A. Class 1, Division 2 require special rated electrical equipment in comparison to “unclassified” spaces.

Several City stations with electrical conduits that do not have seal-offs to isolate the wet well atmosphere from the electrical equipment fail to meet current NFPA/NEC codes. These code violations can usually be corrected without significant impacts to the station. Pump Station 26, however, has several larger openings between the wet well and the

electrical room and these cannot easily be eliminated or sealed as they provide access to valves located within the wet well.

II. Ergonomics/Safety evaluations looked at access hatches as a minimum providing safe access and operation and including safety grating for worker protection when the hatches are open. Several of the stations have hatches that lack safety grating and/or other safety features.

Other site safety considerations included adequate safe access for operation and maintenance activities at the sites. There are recommended improvements for safety consideration at Serpentine Pump and Pump Station 26.

It was noted that area lighting was not present at any of the sites. A 14-foot high architectural style LED fixture (210-watt equivalent) could be added at a raw construction cost of approximately $4,400 each. The project cost estimates for each station do not currently include adding area lighting. Area lighting is often not provided at stations since normal operations and maintenance occurs during the day, emergency response crews typically carry portable task lights, and neighbors will often object to area lighting at utility facilities.

III. Operational Reliability evaluations included, as a minimum, elements to monitor and report station status (SCADA), pump and equipment redundancy, and the overall age of equipment. All of the stations except for Pump Station 25 need to have SCADA systems installed. Several of the stations will need added alarm floats to collect data to send via SCADA.

The Palatine and Linden Pump Stations are small simplex stations. To improve operational reliability, it is recommended that the City purchase a spare pump for each of these stations so that in the event of a pump failure, the pump could be switched out in a very short period of time. The pumps for these stations are located in catch basins that also serve as area drains that collect surface runoff. Ideally, the pumps should be located in a catch basin or small manhole downstream of the area drain. The area drains should have a sump to collect sediment, rocks, and other debris before it has the chance to get into the pump and cause damage or excess wear. Having the pumps located in a basin that does not collect surface runoff will also provide improved access for maintenance during storm events and will reduce impacts to the surface runoff collection.

The equipment in Pump Stations 26 is near or past its intended useful life and should be replaced to ensure high operational reliability at that station.

IV. Site/Civil evaluation considered adequacy of protection such as bollards or guardrails around improvements, and presence of information signs and no parking signs. At the Serpentine Pump Station, the Site/Civil evaluation also identified potential grading and paving improvements at the site.

V. Data Collection evaluations considered whether equipment such as flow meters, pressure gauges, and isolation valves to provide a means to periodically check pump performance.

Pump Tests

Pumping rates for each pump were calculated based on Record Drawing data for wet well capacity, running the pumps for a set period of time, and measuring water levels before and after pumping. As noted in the table below, test results at several of the stations were affected by inflow from upstream pipes coming into the station during the pump tests. Also, at two stations there was insufficient flow to test pumps and at one of the stations, there was insufficient flow to test the second pump. For the three stations where inflow was affecting the pumping rate calculations, those stations are recommended for retesting during dry periods. Pump Stations 26 and 30 are directly connected to ponds so testing would require plugging the influent pipe and providing a source of water to feed into the wet wells. Since the pumps at both of these stations are past their useful life and both stations are recommended for major upgrades, there appears to be little benefit to testing the pumps at this time.

The test results are shown on the Station Fact Sheets along with the station's design pumping rate when known. With the exception of Pump Station 25, there are no pressure gages installed at the stations so it was not possible to calculate pump pressures at shut-off head or at the normal operation point.

Table 3: Station Pump Tests

Station	Pump(s) Tested	Test Comments
Linden Ave Pump Station	1 of 1	Inflow from upstream pipe effected pumping rate calculation – actual pumping rate is higher than calculations indicate.
Palatine Pump Station	1 of 1	Inflow from upstream pipe effected pumping rate calculation – actual pumping rate is higher than calculations indicate.
Pan Terra Pump Station	2 of 2	No issues
Pump Station 25	2 of 2	See Appendix E for detailed test data and commentary
Pump Station 26	0 of 2	No stormwater available to test pumps
Pump Station 30	0 of 1	No stormwater available to test pumps
Ronald Bog Pump Station	1 of 1	Inflow from upstream pipe effected pumping rate calculation – actual pumping rate is higher than calculations indicate.
Serpentine Pump Station	1 of 2	Insufficient stormwater to test second pump.

Equipment Ratings

The major mechanical, electrical, and instrumentation equipment along with the civil and structural elements of each station were evaluated based on observations and, in specific cases as noted, in verifying operation of the equipment.

The equipment and other elements of each station were given a qualitative rating as noted below. In some cases, equipment or other elements of the stations were not accessible so no rating was provided. A complete listing for each station is included in Appendix D.

This information was used to guide the overall evaluation for each station and to help determine whether individual equipment could be replaced or upgraded or, as in the case of Pump Stations 26 and 30, so many items were at the end of their useful life or did not meet current codes, that a near total replacement was recommended.

Table 4: Equipment Ratings

Rating	Description	Expected Remaining Life
1	New, fully functional	15-20 year life for rotating equipment (pumps, fans, generators) 15-20 year life for electrical 20-30 year life for valves and hatches 50+ year for structural concrete, ductile iron piping.
2	Used, fully functional, minor surface corrosion	80% to 100% of the life expectancies estimated to be remaining
3	Used, fully functional, significant surface corrosion, potential to impact operations	Typically 50% or more of operating life remains. At this stage, equipment should be checked and tested more frequently to ensure it still is able to meet intended functions.
4	Impacted operations, severe external or internal corrosion, no longer performs intended function	Expected life of mechanical and electrical equipment of less than 5 years. Replacement or reconstruction should be planned accordingly.
5	Failed or failure appears imminent. Does not meet current codes.	Recommend replacement.

Section 3: Cost Estimates

Preliminary cost estimates (Opinion of Probable Costs, or OPCs) were prepared for each of the recommended improvements at each of the stations. The OPCs were developed at the task level and are based primarily on Means Estimating Guides (Means). The typical crew costs and material and equipment costs in Means were adjusted to reflect the relatively small projects and tasks that would be required for improving the City's pump stations. These adjustments were based on our experience and knowledge of typical costs and assume the City would bid this work out in larger "packages" of work to attract qualified bidders and to get competitive bids for the work.

Typical mark-ups for contractor's overhead and profit along with an estimate contingency were included to arrive at an Estimated Construction Cost for each station.

In addition to the Estimated Construction Cost, ancillary project costs including design, construction management, and legal and permit fees were added using a typical percentage rate to arrive at an overall Total Project Cost estimate for each station.

In accordance American Association of Cost Engineers (AACE), the OPCs should be considered to have a range of accuracy of +50%/-30% consistent with an AACE Class 4 estimate. The improvement projects described above are conceptual in nature and layouts or design work has been completed.

Appendices

A – Workshop PowerPoint

B – Station Fact Sheets

C – Task Costs

D – Equipment Evaluation Summaries

Appendix A

Workshop PowerPoint

PUMP STATION CONDITION AND CAPACITY ASSESSMENT

Condition Assessment Findings

SCADA Alternatives

Proposed CIP

March 22, 2016

CITY OF SHORELINE

Workshop Agenda

1. Introduction
2. Overview
   - Field Data Collection
   - Evaluation Findings Database
3. Station Issues
   - Code Compliance
   - Ergonomics/Safety
   - Operational Reliability
   - Site/Civil
   - Data Collection
   - Other
4. SCADA
5. Draft CIP
6. Wrap-Up/Next Steps

Overview - Field Data Collection

1. Review Available Data from City

2. Site Visits
   - Photo Existing Station Assets
   - Verify Pump and Valve Operation (where feasible)
   - Calc. Pump Rate (measure wet well drawdown/time)
   - Note Any Issues, Group by Category

3. Data Assessment
   - Supplement Data from Pump Manuf. (if available)
   - Rate Assets (1-5)
     5. New, fully functional, meets performance requirements.
     4. Fully functional, minor surface corrosion, varying years of service.
     3. Fully functional, significant surface corrosion, condition/age has potential to impact operations.
     2. Operates, but condition impacts operation.
     1. Failed or failure appears imminent. Does not meet code.

Overview – Evaluation Finding Database

	Serpentine Pump Station	Pump Station 26	Pump Station 25	Pump Station 30
Code Compliance				
NFPA 802/NEC		violation		violation
NEC Hazard Labels	missing	missing	missing	missing
Ergonomics/Safety				
Hatch	add safety grating		add safety grating	replace
Railings/Fence			needed	
Site Lighting	*consider*	*consider*	*consider*	*consider*
Operational Reliability				
SCADA	add SCADA	add SCADA	connect or replace	add SCADA
Local Alarms				
Aging Infrastructure		replace		replace
Redundancy				consider
Site/Civil				
Signs/Access	add info and no parking signs	add info signs	add info and no parking signs	
Protection				
Other Site Improvements	regrade for drainage			expand access around pump station
Data Collection				
Pump Field Data	add pressure gauges	add pressure gauges	connect level transducer	add pressure gauges
Other				
		Move/replace electrical	troubleshoot and repair alarm condition	Discuss with PSE upgrade to 480v Service

Overview – Evaluation Finding Database

	Ronald Bog	Linden Avenue Pump Station	Palatine Pump Station	Pan Terra Pump Station
Code Compliance				
NFPA 802/NEC		violation	violation	
NEC Hazard Labels	missing	missing	missing	missing
Ergonomics/Safety				
Hatch	add hatch	add hatch	add hatch	add lift cylinders
Railings/Fence				
Site Lighting	*consider*	*consider*	*consider*	*consider*
Operational Reliability				
SCADA	add SCADA	add SCADA	add SCADA	add SCADA
Local Alarms		add high level float	add high level float	
Aging Infrastructure				
Redundancy		spare pump	spare pump	
Site/Civil				
Signs/Access	add info and no parking signs	add info and no parking signs	add info and no parking signs	add info and no parking signs
Protection	bollards	bollards		add guardrail
Other Site Improvements				
Data Collection				
Pump Field Data	add pressure gauges			add pressure gauges
Other				
	repair CB/repair oil leak /pipe protection			

Station Issues - Code Compliance

1. NFPA 820/National Electrical Code
   - NEC Area Classification
   - Electrical Materials and Equipment

2. NEC Article 110
   - Arc Flash Labels

Station Issues - Code Compliance

Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Area	NEC-Area Classification (All Class 1, Group D)	Materials of Construction for Buildings or Structures	Fire Protection Measures
3		Storm Sewer Pipes	Possible ignition of flammable gases and floating flammable liquids	Not normally ventilated	Inside of sewer	Division 2	Non-combustible or limited-combustible or low frame spread materials	Not required
4		Storm Water Pump Station Wet Well	Possible ignition of flammable gases and floating flammable liquids	Not normally ventilated	Entire room or space	Division 2	Non-combustible or limited-combustible or low frame spread materials	Combustible gas detection system (if enclosed)
5	a	Storm Water Pump Station Dry Well	Buildup of vapors from flammable or combustible liquids	Not ventilated or less than 6 ACH	Entire dry well	Division 2 (or unclassified of pressurized per NFPA 496)	Non-combustible or limited-combustible or low frame spread materials	Portable Fire Extinguisher
	b			Continuously ventilated at min, 6 ACH		Unclassified		

(a) NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities – Table 4.2

Station Issues - Code Compliance

Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Area	NEC-Area Classification (All Class 1, Group D)	Materials of Construction for Buildings or Structures	Fire Protection Measures
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	b			Continuously ventilated at min, 6 ACH		Unclassified		

(a) NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities – Table 4.2

Station Issues - Code Compliance Pump

Station 26

Electrical Equipment not rated for Class 1, Division 2

Direct connection(s) to Wet Well

Station Issues - Code Compliance

Class 1, Division 2 – electrical separation

Pump Station 25
air-gap separation

Pan Terra
air-gap separation

Serpentine
electrical seal-offs

Station Issues - Ergonomics/Safety

1. Hatches

Serpentine
hatch 'lifting cylinder'
no 'safety grating'

Pump Station 30
very heavy hatch
no hatch 'lifting' cylinder
no hatch 'safety grating'

Pan Terra
hatch 'safety grating'
no hatch 'lifting' cylinder

Station Issues - Ergonomics/Safety

2. Site Safety

Pump Station 25
unprotected steep slope

Pump Station 30
Inadequate space around hatch

Station Issues - Operational Reliability

1. SCADA – *additional discuss later*
   - Add local alarms at Linden Avenue and Palatine

2. Redundant Pump(s)
   - Stock spare pumps for PS 30, Linden Avenue, Palatine

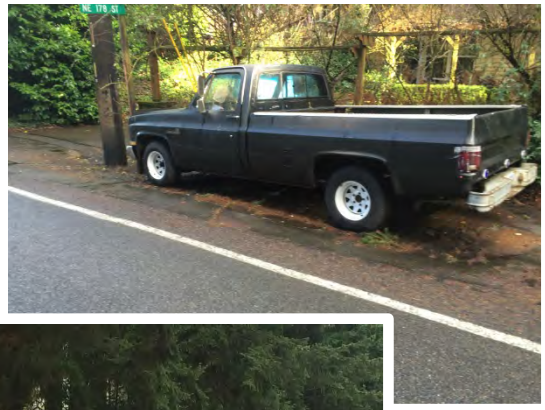
3. Aging Infrastructure
   - Major Upgrade/Replacement PS 26 and PS 30

Station Issues – Site/Civil

1. Maintenance Access
   - No Parking Zones

2. City Emergency Contact Informati

3. Facility Protection
   - Bollards



Station Issues – Site/Civil

1. Maintenance Access
   - No Parking Zones
2. City Emergency Contact Information
3. Facility Protection
   - Bollards

Station Issues – Site/Civil

1. Maintenance Access
   - No Parking Zones

2. City Emergency Contact Information

3. Facility Protection
   - Bollards

Station Issues - Data Collection

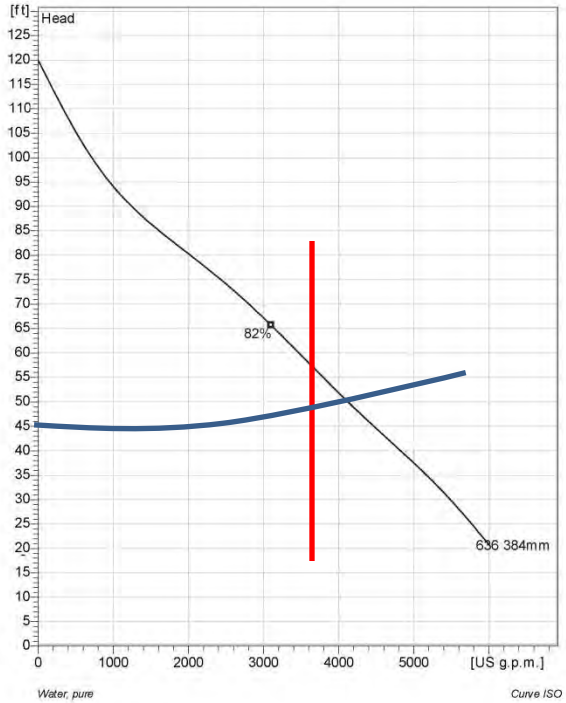
1. Pressure Gauges

2. SCADA

xylem

NP 3301 MT 3~ 636
Technical specification

FLYGT



Note: Picture might not correspond to the current configuration.

General
Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Grey cast iron
Discharge Flange Diameter	9 13/16 inch
Inlet diameter	9 13/16 inch
Impeller diameter	384 mm
Number of blades	2

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Station Issues - Data Collection

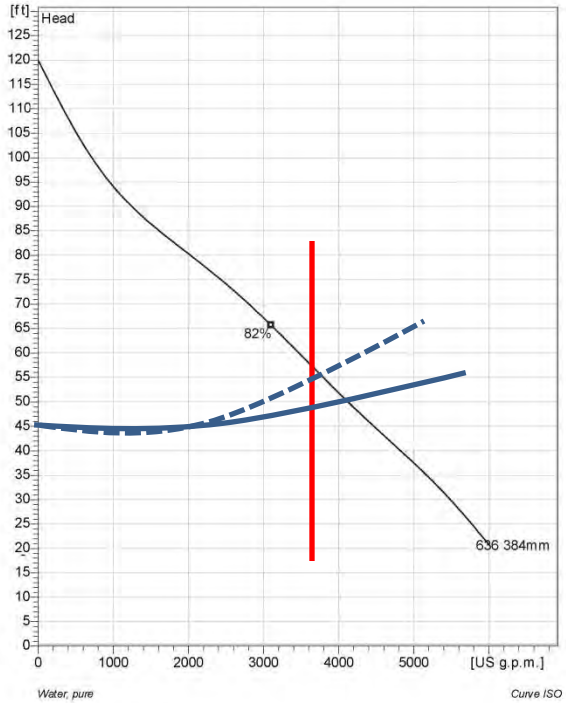
1. Pressure Gauges

2. SCADA

xylem

NP 3301 MT 3~ 636
Technical specification

FLYGT



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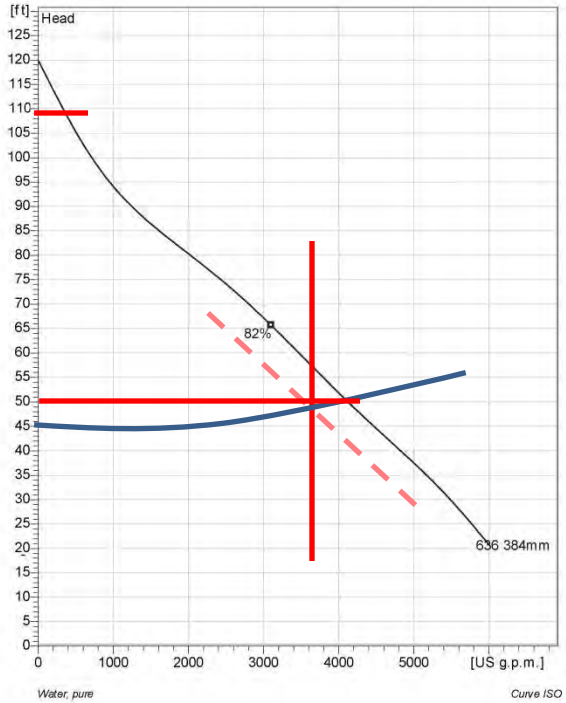

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Impeller

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Discharge Flange Diameter	9 13/16 inch
Inlet diameter	9 13/16 inch
Impeller diameter	384 mm
Number of blades	2

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Station Fact Sheets

Draft Station Fact Sheets – see hard copies

Station Issues - Data Collection

1. Pressure Gauges

2. SCADA

SCADA

1. Web Based Wireless
2. Simple to Set-Up and Operate
3. Applicability to Future Sanitary Sewer Lift Stations

SCADA

1. Typical Alarm/Monitoring Points

	REQUIRED	DESIRED	OPTIONAL
n/a	Power Fail – *built into device*		
1	High Wet Well Alarm		
2		Pump 1 Fail	
3		Pump 2 Fail	
4			Intrusion - panel
5			Intrusion - wet well
6		Low Wet Well Alarm	
7		Generator Fail	
8	Start-stop runtime		
Analog 1		Flow (sanitary)	
Analog 2			Wet Well Level
9			Pump 1 Seal Fail
10			Pump 1 Overtemp
11			Pump 1 Not in Auto
12			Pump 2 Seal Fail
13			Pump 2 Overtemp
14			Pump 2 Not in Auto
15			General Run
16			Generator Low Fuel

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SCADA

1. Mission Communications
   Wireless Monitoring
   And Alarm System

2. Raco
   AlarmAgent – web-based monitoring, reporting and configuring

3. HighTide Technologies
   HTT 1100 Pump Station Monitor
   TelemetryVIEW web based reporting

SCADA

	Mission	RACO	HighTide Technologies
	M-110 – reports every 2-hrs + events M-800 – reports every 2-minutes + events	Alarm Agent	HTT-1100
Battery Backup	24 hours	24 hours	72 hours
Power Fail [external power]	automatic alarm	automatic alarm	automatic alarm
Wireless	Yes	yes	yes
Web-Based Access	Yes	yes	yes
configuration/programming	templates	templates	templates
Digital (discrete)			
basic	8	8	8
upgradable	+8		+4 discrete, +4 analog
Analog (4-20 mA)	2	2	4
Capital Cost (per unit)	**$1,200** *M-110* **$2,000** *M-800*	**$1,300** *[chassis only]* **$1,900** *[NEMA 4X]*	**$2,000**
Yearly Maintenance/Access Fee (per unit)	**$300/yr** *M-110* **$600/yr** *M-800*	**$360/yr** *[based on 3-yr contract]*	**$xxx**
Alarm Notification Options	Web	Web	Web
	voice	Voice	Voice
	SMS (text)	SMS (text)	SMS (text)
	pager	pager	pager
	email	email	??

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Wrap-Up/Next Steps

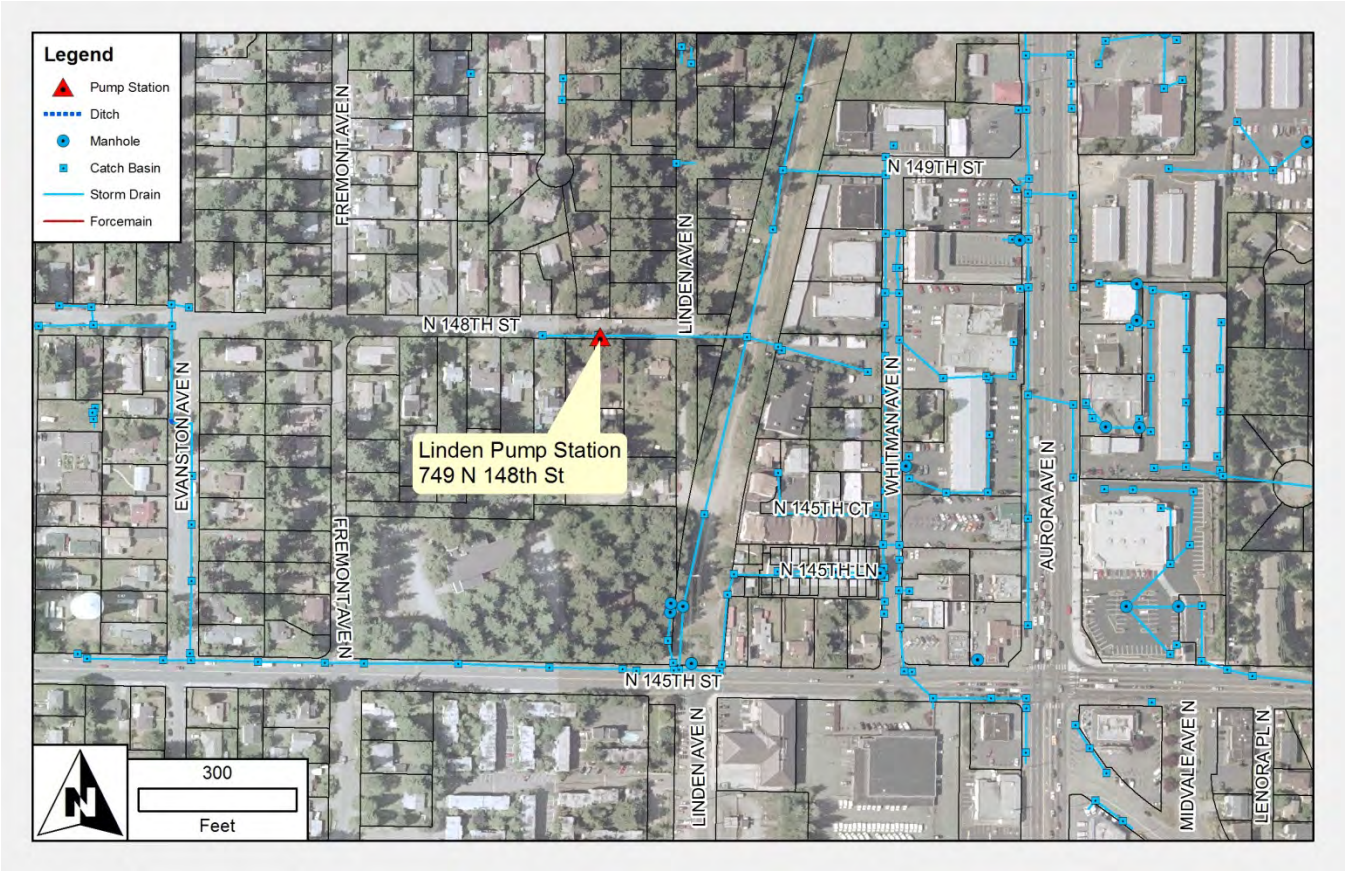
Appendix B

Station Fact Sheets

Linden Avenue Pump Station

1st Quarter 2016
most recent evaluation period

Original Construction: 2008
Station Type: simplex submersible
Pump(1): Zoeller 140, 50 gpm @ 25-ft, 1 HP
Address: 749 N 148th St
File_ID: MP-7



Kennedy/Jenks Consultants

Linden Avenue Pump Station

Capital Improvement Plan – Summary

Task Priority	Tasks to be Completed	Task Category	Raw Task Cost
1	Conduit Seal-Offs	Code Compliance	$2,200
1	Electrical Safety (Arc Flash) Signs	Code Compliance	$630
2	Add High Level Float	Data Collection	$1,330
2	SCADA	Operational Reliability	$2,470
3	Add Bollards	Site/Civil	$2,690
1	Station Information Sign(s) and No Parking sign(s)	Site/Civil	$550
4	Add Top Slab and Hatch	Operational Reliability	$2,690
4	Install New Catch Basin	Operational Reliability	$1,500
SUBTOTAL[(a)]			*$14,060*
	Division 0/1 Mark-Ups	10%	$15,470
	Contractor Overhead and Profit	15%	$17,800
	Bid Contingency	25%	$22,250
	Taxes	9.5%	$24,370
Estimated Construction Cost			**$24,370**
	Engineering/Permits/Fees/CM/Project Contingency	45%	$10,970
1	Purchase Redundant Pump (including 25% contingency plus tax)		$940
TOTAL PROJECT COST			**$36,300**

Notes:

(a) Subtotal does not include "Site Lighting – optional" raw task cost of $4,400.

Pump Design and Test Data[(a)]

Pumping Test Date	Pump #1 Flow (gpm)[(b)] @ TDH (ft)
2008 (design)	40 @ 35
	0 @ 50 (shutoff)
2/19/2016	15[(c)] @ ---[(d)]

Notes:

(a) Data collected via drawdown test using measuring tape for water levels.
(b) gpm = gallons per minute.
(c) Calculated rate does not account for inflow into CB during drawdown test.
(d) Discharge Pressure Gauge not available.

Corrective Maintenance Notes and Recommendations

Discipline	Notes	Recommendations
	- none -	

Linden Avenue Pump Station

Linden Pump Station

Control Panel and Power Meter

Linden Pump Station

Site

Linden Avenue Pump Station

Linden Pump Station

Wet Well – Pump Running

Linden Pump Station

Wet Well – Pump and Float

Palatine Pump Station

1st Quarter 2016

most recent evaluation period

Original Construction: 2009
Station Type: simplex submersible
Pump(1): Tsurumi NK-22, 140 gpm @ 35-ft, 1 HP
Address: 15532 Palatine Ave. N
File_ID: BC-14

Kennedy/Jenks Consultants

Palatine Pump Station

Capital Improvement Plan – Summary

Task Priority	Tasks to be Completed	Task Category	Raw Task Cost
1	Conduit Seal-Offs	Code Compliance	$2,200
1	Electrical Safety (Arc Flash) Signs	Code Compliance	$630
1	Station Information Sign(s) and No Parking sign(s)	Site/Civil	$550
2	Add High Level Float	Data Collection	$1,330
2	SCADA	Operational Reliability	$2,470
4	Add Top Slab and Hatch	Operational Reliability	$2,690
4	Install New Catch Basin	Operational Reliability	$1,500
SUBTOTAL[(a)]			*$11,370*
	Division 0/1 Mark-Ups	10%	$12,510
	Contractor Overhead and Profit	15%	$14,390
	Bid Contingency	25%	$17,990
	Taxes	9.5%	$19,700
Estimated Construction Cost			**$19,700**
	Engineering/Permits/Fees/CM/Project Contingency	45%	$8,870
1	Purchase Redundant Pump (including 25% contingency plus tax)		$3,900
TOTAL PROJECT COST			**$32,500**

Notes:

(a) Subtotal does not include "Site Lighting – optional" raw task cost of $4,400.

Pump Design and Test Data[(a)]

Pumping Test Date	Pump #1 Flow (gpm)[(b)] @ TDH (ft)
2009 (design)	140 @ 35
	0 @ 59 (shutoff)
2/19/2016	90[(C)] @ ---[(d)]

Notes:

(a) Data collected via drawdown test using measuring tape for water levels.
(b) gpm = gallons per minute.
(c) Calculated Rate does not account for inflow into wet well during drawdown test.
(d) Discharge Pressure Gauge not available.

Corrective Maintenance Notes and Recommendations

Discipline	Notes	Recommendations
	- none -	

Palatine Pump Station

Control Panel and Power Meter

Palatine Pump Station

Main Breaker

Palatine Pump Station

Pump Control Panel

Palatine Pump Station

Wet Well & Pump

Palatine Pump Station

Wet Well Overflow

Palatine Pump Station

Catch Basin

Pan Terra Pump Station

1st Quarter 2016
most recent evaluation period

Original Construction: 2010
Station Type: duplex submersible
Pumps(2): Flygt NP 3301, 2,400 gpm @ 75-ft, 70 HP
Address: 18500 Dayton Avenue N
File_ID: BC-8

Kennedy/Jenks Consultants

Pan Terra Pump Station

Capital Improvement Plan – Summary

Task Priority	Tasks to be Completed	Task Category	Raw Task Cost
1	Electrical Safety (Arc Flash) Signs	Code Compliance	$630
1	Station Information Sign(s) and No Parking sign(s)	Site/Civil	$550
2	SCADA	Operational Reliability	$2,470
2	Upgrade Wet Well and Valve Vault Hatches	Ergonomics/Safety	$1,940
3	Guard Rail	Site/Civil	$9,400
3	Install Pressure Gage on Pump Discharge Piping	Data Collection	$1,250
SUBTOTAL[(a)]			*$16,240*
	Division 0/1 Mark-Ups	10%	$17,870
	Contractor Overhead and Profit	15%	$20,560
	Bid Contingency	25%	$25,700
	Taxes	9.5%	$28,150
Estimated Construction Cost			**$28,150**
	Engineering/Permits/Fees/CM/Project Contingency	45%	$12,670
TOTAL PROJECT COST			**$40,900**

Notes:

(a) Subtotal does not include "Site Lighting – optional" raw task cost of $4,400.

Pump Design and Test Data[(a)]

Pumping Test Date	Pump #1 Flow (gpm)[(b)] @ TDH (ft)	Pump #2 Flow (gpm)[(b)] @ TDH (ft)
2010 (design)	2,000 @ 80	2,000 @ 80
	0 @ 119 (shutoff)	0 @ 119 (shutoff)
2/19/2016	2,270 @ ---[(c)]	2,370 @ --[(c)]

Notes:

(a) Data collected via drawdown test using Pump Control Panel level readout.
(b) gpm = gallons per minute.
(c) Discharge Pressure Gauge not available.

Corrective Maintenance Notes and Recommendations

Discipline	Notes	Recommendations
	- none -	

Pan Terra Pump Station

Pan Terra Pump Station

Street View of Station

Pan Terra Pump Station

Power, Controls, and Generator

Pan Terra Pump Station

Pump Control Panel

Kennedy/Jenks Consultants

Pan Terra Pump Station

Pan Terra Pump Station

Pump Power Cables
NEC Code Separation

Pan Terra Pump Station

Vault Access Hatch
Safety Grating
Pump Power Cable Trench

Pan Terra Pump Station

Generator

Pan Terra Pump Station

Wet Well

Pan Terra Pump Station

Wet Well

Pan Terra Pump Station

Pump Discharge Check Valves and Isolation [Plug] Valves

Pump Station 25

1st Quarter 2016

most recent evaluation period

Original Construction: 2013
Station Type: duplex submersible
Pumps(2): Myers 6VCX, 830 gpm @ 50-ft, 20 HP
Address: 17548 2nd PL NE
File_ID: TC-13

Kennedy/Jenks Consultants

Pump Station 25

Capital Improvement Plan – Summary

Task Priority	Tasks to be Completed	Task Category	Raw Task Cost
1	Station Information Sign(s) and No Parking sign(s)	Site/Civil	$550
2	SCADA	Operational Reliability	--[(a)]
2	Reprogram PLC/Level Transducer/Operations	Operational Reliability	$6,900
3	Add Safety Grating to Wet Well	Ergonomics/Safety	$2,780
3	Steep Slope Protection (wood split-rail fence)	Site/Civil	$4,380
SUBTOTAL[(b)]			*$14,610*
	Division 0/1 Mark-Ups	10%	$16,080
	Contractor Overhead and Profit	15%	$18,500
	Bid Contingency	25%	$23,130
	Taxes	9.5%	$25,330
Estimated Construction Cost			**$25,330**
	Engineering/Permits/Fees/CM/Project Contingency	45%	$11,400
TOTAL PROJECT COST			**$36,800**

Notes:

(a) Raco Alarm Agent currently installed. If another manufacturer is selected, add up to $2,470 to change to compatible equipment.
(b) Subtotal does not include "Site Lighting – optional" raw task cost of $4,400.

Pump Design and Test Data[(a)]

Pumping Test Date	Pump #1 Flow (gpm)[(b)] @ TDH (ft)	Pump #2 Flow (gpm)[(b)] @ TDH (ft)
2012 (design)	830 @ 50	830 @ 50
	0 @ 76 (shutoff)	0 @ 76 (shutoff)
5/17/2016	643 @ 49	1,128 @ 51
	496 @ 53	
	0 @ 94 (shutoff)	0 @ 76 (shutoff)

Notes:

(a) Data collected via drawdown test using measuring tape for water levels.
(b) gpm = gallons per minute.

Corrective Maintenance Notes and Recommendations

Discipline	Notes	Recommendations
Data Collection	Wet Well Level Transducer	Connect and callibrate
Operational Reliability	P1 and P2 Seal Failure Alarms	Troubleshoot and correct as indicated
Operational Reliability	UPS AC Power Fail	Troubleshoot and correct as indicated
Operational Reliability	Pump Condition	Review O&M Findings/Original Design Conditions/Review Findings with Pump Rep

Pump Station 25

Pump Station 25

Unprotected Steep Slope adjacent to Station

Pump Station 25

Pump Cable Connection Box
Code Air-Gap per Class 1/Div 2

Pump Station 25

Station Access Raod

Pump Station 25

Pump Control Panel
NEC Arc Flash Warning Labels

Pump Station 25

Pump Cable Connections
Air-Gap for Class 1/Div 2

Pump Station 25

Wet Well Level Transmitter
(not connected)

Pump Station 25

Manual Transfer Switch for Mobile Generator Connection

Pump Station 25

Wet Well

Pump Station 25

Wet Well

Pump Station 26

1st Quarter 2016

most recent evaluation period

Original Construction: 1970
Station Type: duplex vertical turbine
Pumps(2): Lane, xxx gpm @ xx-ft, 7.5 HP
Address: 18331 10th Ave NE
File_ID: TC-14

Kennedy/Jenks Consultants

Capital Improvement Plan – Summary

Task Priority	Tasks to be Completed	Task Category	Raw Task Cost
2	SCADA	Operational Reliability	$2,470
2	New Electrical/Enclosure	Operational Reliability	$114,570
	Demo Building/Top Slab/Pumps/Valves		
	New Top Slab & Hatch		
	New Submersible Pumps, Valves and Valve Vault		
SUBTOTAL[(a)]			*$117,040*
	Division 0/1 Mark-Ups	10%	$128,750
	Contractor Overhead and Profit	15%	$148,070
	Bid Contingency	25%	$185,090
	Taxes	9.5%	$202,680
Estimated Construction Cost			**$202,680**
	Engineering/Permits/Fees/CM/Project Contingency	45%	$92,200
TOTAL PROJECT COST			**$293,900**

Notes:

(a) Subtotal does not include "Site Lighting – optional" raw task cost of $4,400.

Pump Design and Test Data[(a)]

Pumping Test Date	Pump #1 Flow (gpm)[(b)] @ TDH (ft)	Pump #2 Flow (gpm)[(b)] @ TDH (ft)
1970 (design)	-- @ --	--- @ --
	-- @ -- (shutoff)	-- @ -- (shutoff)
2/19/2016	-- @ ---[(c)]	-- @ --[(c)]

Notes:

(a) Data collected via drawdown test using measuring tape for water levels.
(b) gpm = gallons per minute.
(c) Insufficient water/no access to wet well level/discharge pressure gauge not available.

Corrective Maintenance Notes and Recommendations

Discipline	Notes	Recommendations
	- none -	

Pump Station 26

Pump Upstream of Pump Station Intake

Pump Station 26

Bypass Pump Discharge Connection Point

Pump Station 26

Vertical Turbine Pump Motor
Totally Enclosed Fan Cooled (TEFC)
Suitable for Class 1, Division 2

Note open termination box

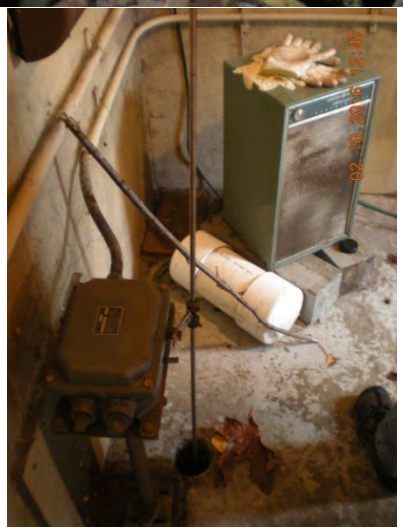
Pump Station 26

Discharge Check and Isolation (Gate) Valves
Note Open Connection to Wet Well

Wet Well NEC Classification: Class 1, Division 2

Pump Station 26

Discharge Isolation (Gate) Valve



Pump Station 26

Level Control – note open connection to Wet Well

Pump Station 26

Wood Cover Over Wet Well – Provides Access to Pump Discharge Valves

Electrical Panels – not rated for NEC Class 1 Division 2

Pump Station 26

Electrical Panels – not rated for NEC Class 1 Division 2

Pump Station 26

Heater and Dehumidifier

Pump Station 30

1st Quarter 2016

most recent evaluation period

Original Construction: 1994
Station Type: simplex submersible
Pumps(1): Myers V4WHV, 425 gpm @ 22-ft, 5 HP
Address: NE 170th and 15th Ave N
File_ID: TC-11

Kennedy/Jenks Consultants

Pump Station 30

Capital Improvement Plan – Summary

Task Priority	Tasks to be Completed	Task Category	Raw Task Cost
2	SCADA	Operational Reliability	$2,470
2	New Electrical/Enclosure	Operational Reliability	$113,280
	Demo Building/Top Slab/Pumps/Valves		
	New Top Slab & Hatch		
	Gabion Wall (to increase O&M work area around existing wet well)		
	New Submersible Pumps, Valves and Valve Vault		
SUBTOTAL[(a)]			*$115,750*
	Division 0/1 Mark-Ups	10%	$127,330
	Contractor Overhead and Profit	15%	$146,430
	Bid Contingency	25%	$183,040
	Taxes	9.5%	$200,430
Estimated Construction Cost			**$200,430**
	Engineering/Permits/Fees/CM/Project Contingency	45%	$90,200
TOTAL PROJECT COST			**$290,700**

Notes:

(a) Subtotal does not include "Site Lighting – optional" raw task cost of $4,400.

Pump Design and Test Data[(a)]

Pumping Test Date	Pump #1 Flow (gpm)[(b)] @ TDH (ft)
1994 (design)	425 @ 22
	0 @ 44 (shutoff)
2/19/2016	---[(c)] @ --[(d)]

Notes:

(a) Data collected via drawdown test using measuring tape for water levels.
(b) gpm = gallons per minute.
(c) Insufficient flow to run pump drawdown test.
(d) Discharge Pressure Gauge not available.

Corrective Maintenance Notes and Recommendations

Discipline	Notes	Recommendations
Electrical	3 phase high leg service	Unconventional power – suggest contacting PSE and getting upgraded service/transformer when station is upgraded

Pump Station 30

Main Breaker

Pump Station 30

Pump Control Panel

Pump Station 30

Panel Corrosion

Pump Station 30

Old-Style Pump Access Hatch

Pump Station 30

Wet Well
Discharge Piping and Valves
Pump

Pump Station 30

Power Terminations inside Wet Well

Pump Station 30

Pump Station – Limited Access Area

Pump Station 30

Site Pond

Pump Station 30

Bypass Pump Connection to Force Main

Ronald Bog Pump Station

1st Quarter 2016
most recent evaluation period

Original Construction: 2009
Station Type: simplex engine-driven
Pump(1): Pioneer Pump, 1,140 gpm @ 40-ft @ 1,200 RPM
Address: NE 171st St and Corliss Ave N
File_ID: ---

Kennedy/Jenks Consultants

Ronald Bog Pump Station

Capital Improvement Plan – Summary

Task Priority	Tasks to be Completed	Task Category	Raw Task Cost
1	Station Information Sign(s) and No Parking sign(s)	Site/Civil	$550
2	SCADA	Operational Reliability	$2,470
2	Add High Level Float	Data Collection	$1,330
3	Bollards	Site/Civil	$4,670
SUBTOTAL[(a)]			*$9,020*
	Division 0/1 Mark-Ups	10%	$9,930
	Contractor Overhead and Profit	15%	$11,420
	Bid Contingency	25%	$14,280
	Taxes	9.5%	$15,640
Estimated Construction Cost			**$15,640**
	Engineering/Permits/Fees/CM/Project Contingency	45%	$7,040
TOTAL PROJECT COST			**$22,700**

Notes:

(a) Subtotal does not include "Site Lighting – optional" raw task cost of $4,400.

Pump Design and Test Data[(a)]

Pumping Test Date	Pump #1 Flow (gpm)[(b)] @ TDH (ft)
2009 (design)	1,140 @ 40
	0 @ 58 (shutoff)
2/19/2016	310[(c)] @ ---[(d)]

Notes:

(a) Data collected via drawdown test using measuring tape for water levels.
(b) gpm = gallons per minute.
(c) Calculated rate does not account for inflow to Wet Well during drawdown test.
(d) Discharge Pressure Gauge not available.

Corrective Maintenance Notes and Recommendations

Discipline	Notes	Recommendations
	- none -	

Ronald Bog Pump Station

Site

Ronald Bog Pump Station
Engine-Driven Pump
Fuel Tank

Ronald Bog Pump Station

MH Cover – east of station

Ronald Bog Pump Station

Control Panel

Ronald Bog Pump Station

Leak/Staining below Engine

Ronald Bog Pump Station

Level Control Conduit

Ronald Bog Pump Station

Wet Well
Pump Suction Pipe
Pump Discharge Pipe

Ronald Bog Pump Station

Wet Well/Access Shaft

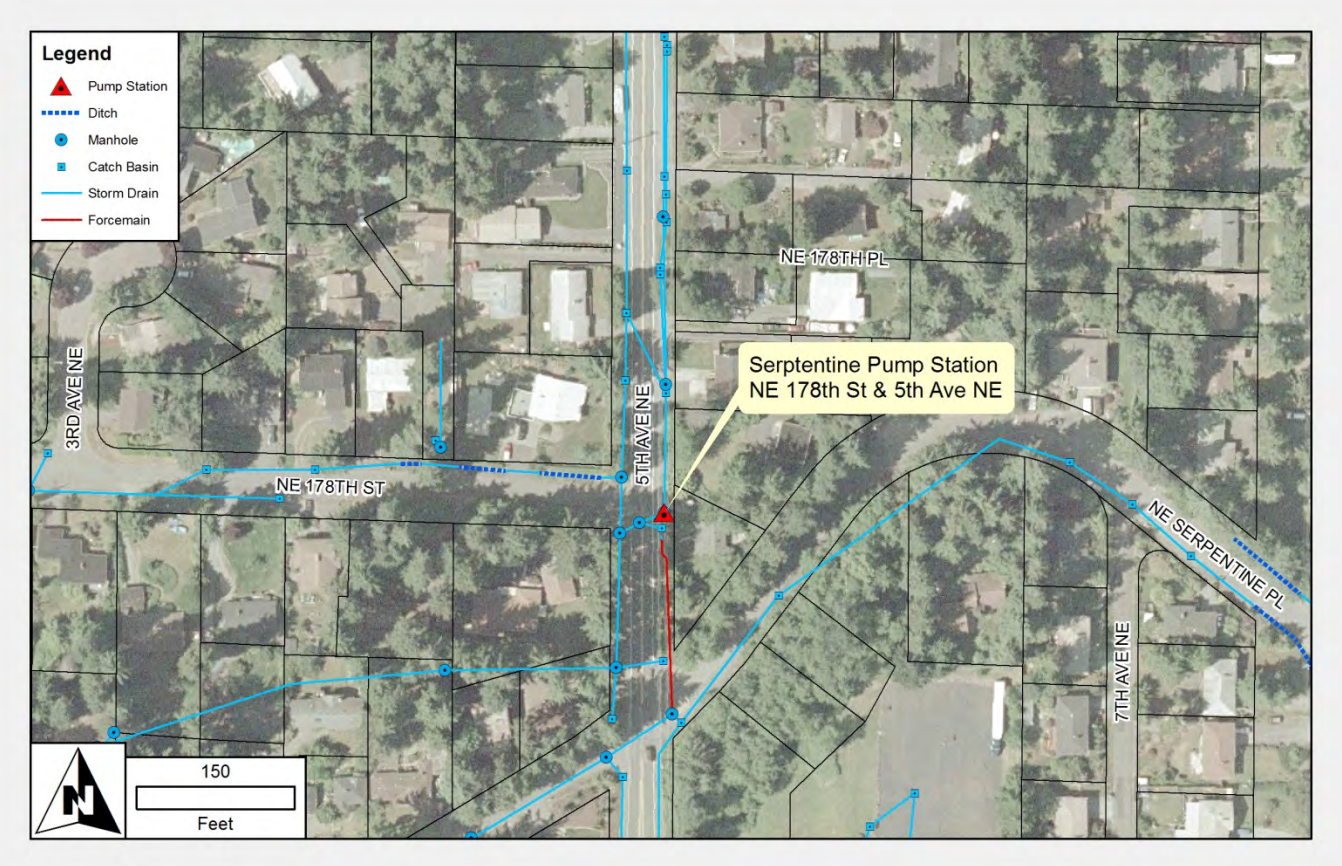
Ronald Bog Pump Station

Wet Well/Access Shaft

Serpentine Pump Station

1st Quarter 2016
most recent evaluation period

Original Construction: 2004
Station Type: duplex submersible
Pumps(2): Hydromatic, 500 gpm @ 23-ft, 5 HP
Address: NE 178th and 5th Ave NE
File_ID: TC-18



Kennedy/Jenks Consultants

Serpentine Pump Station

Capital Improvement Plan – Summary

Task Priority	Tasks to be Completed	Task Category	Raw Task Cost
1	Electrical Safety (Arc Flash) Signs	Code Compliance	$630
1	Station Information Sign(s) and No Parking sign(s)	Site/Civil	$550
2	SCADA	Operational Reliability	$2,470
3	Add Safety Grating to Hatches	Ergonomics/Safety	$3,410
3	Bollards (2)	Site/Civil	$2,690
3	Regrade area to the south (upstream) to direct storm flow around hatches and toward existing CB	Site/Civil	$4,050
4	Install Pressure Gage on Pump Discharge Piping	Data Collection	$1,250
SUBTOTAL[(a)]			*$15,050*
	Division 0/1 Mark-Ups	10%	$16,560
	Contractor Overhead and Profit	15%	$19,050
	Bid Contingency	25%	$23,820
	Taxes	9.5%	$26,090
Estimated Construction Cost			**$26,090**
	Engineering/Permits/Fees/CM/Project Contingency	45%	$11,750
TOTAL PROJECT COST			**$37,900**

Notes:

(a) Subtotal does not include "Site Lighting – optional" raw task cost of $4,400.

Pump Design and Test Data[(a)]

Pumping Test Date	Pump #1 Flow (gpm)[(b)] @ TDH (ft)	Pump #2 Flow (gpm)[(b)] @ TDH (ft)
9/21/2004 (design)	500 @ 23.6	500 @ 23.6
	0 @ 38.1 (shutoff)	0 @ 38.1 (shutoff)
2/19/2016	476 @ ---[(c)]	--[(d)] @ --[(c)]

Notes:

(a) Data collected via drawdown test using measuring tape for water levels.
(b) gpm = gallons per minute.
(c) Discharge Pressure Gauge not available.
(d) Insufficient water to test second pump.

Corrective Maintenance Notes and Recommendations

Discipline	Notes	Recommendations
	- none -	

Serpentine Pump Station

Serpentine Pump Station

Electrical Components

Serpentine Pump Station

Manual Transfer Switch and
Connection for Portable Generator

Serpentine Pump Station

Conduit Seal-Offs

Serpentine Pump Station

Serpentine Pump Station

Pump Control Panel

Serpentine Pump Station

Station Access Issue

Serpentine Pump Station

Site Drainage Issues

Serpentine Pump Station

Wet Well Hatch
Lack of Safety Grating

Serpentine Pump Station

Wet Well

Serpentine Pump Station

Valve Vault
- Lack of Safety Grating
- Lack of Discharge Pressure Gauges

Appendix C

Task Cost Estimates

City of Shoreline - Stormwater Pump Stations
RS Means

Prepared By: Keith S. Parker
Date: 5/27/2016
Project Manager:

RS Mean's Line Item Cost Estimate

CSI #		Description	Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
Code Compliance - Operational Reliability	**Area Classification (NFPA 820) and Electrical (NEC) and Aging Equipment**												
Pump Station 26 and Pump Station 30													
PS 26 and PS 30 - new meter, new main breaker, new manual transfer switch, new motor starters, new pump control panel, [7.5 HP]			Crew	Daily Output	Labor Hours	Unit	Quantity	Material	Labor	Equipment	Total	Seattle Factor	Total
26 24 19 40 0010	Pump Control Pa	Package Controls - including starters	2 Elec.	0.7	22.857	EA	1	$10,000.00	$1,250.00	$0.00	$11,250.00	1.035	$11,643.75
26 29 23 10 1120		Custom Motor Starter, NEMA 4, stainless, 7.5 HP	1 Elec.	0.47	17.021	EACH	0	$3,225.00	$940.00	$0.00	$4,165.00	1.035	$0.00
26 36 13 10 0250		Manual Transfer Switch, 200 amp, 480 v	2 Elec.	2	8	EACH	1	$3,250.00	$440.00	$0.00	$3,690.00	1.035	$3,819.15
26 24 16 30 3510		Panelboard, , 240v single phase, 100 amp	1 Elec.	2	4	EACH	1	$1,175.00	$220.00	$0.00	$1,395.00	1.035	$1,443.83
26 27 13 10 2100		Meter and Main Breaker	2 Elec.	1.6	10	EACH	1	$2,425.00	$550.00	$0.00	$2,975.00	1.035	$3,079.13
		Crew Mobe/Demobe				HR	8		$55.10		$55.10	1.035	$456.23

Ergonomics/Safety	Hatch Improvements/Guardrails/Site Lighting												
New Hatch (Linden, Palatine) Add Hatch Safety Grating (PS 25, Serpentine) Retrofit with Lifting Mechanism (Pan Terra)													
Access Doors			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
08 31 13 35 2050		Single Leaf, 36x36, Bilco J-AL, H20 Loading	2Sswk	5.5	2.909	EACH	1	$1,590.00	$155.00	$0.00	$1,745.00	1.035	$1,806.08
08 31 13 35 2550		Double Leaf, 60x60, Bilco J-AL, H20 Loading	2Sswk	4.5	3.556	EACH	1	$4,416.00	$189.00	$0.00	$4,605.00	1.035	$4,766.18
08 31 13 35		Fall Protection Grating - OSHA 29 CFR 1910.23	2Sswk			EACH	1	$500.00	$720.00	$1.28	$1,221.28	1.035	$1,264.02
08 31 13 35		Retrofit Door w/Lifting Mechanism	1Sswk			EACH	1	$150.00	$360.00	$1.28	$511.28	1.035	$529.17
		Crew Mobe/Demobe				HR	16		$90.10		$53.20	1.035	$880.99

Pump Station 25													
Wood Rail Fence			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
32 31 29 20 0700		Split Rail, 3 rail, 4-ft high	B80C	150	0.16	LF	100	$7.15	$6.30	$1.71	$15.16	1.035	$1,569.06
		Crew Mobe/Demobe				HR	24		$49.94		$49.94	1.035	$1,240.51

Pan Terra													
Vehicle Guard Rails			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
34 71 13 26 0012		Corrugated stl., galv. Stl. Posts, 6'-3" OC	B80	850	0.038	LF	250	$24.00	$1.59	$0.86	$26.45	1.035	$6,843.94
34 71 13 26 0200		End sections, galvanized, flaired	B80	50	0.056	LF	10	$34.50	$2.37	$1.28	$38.15	1.035	$394.85
		Crew Mobe/Demobe				HR	32		$64.98		$64.98	1.035	$2,152.14

optional - all stations													
Area Lighting			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle Factor	Total
34 71 13 26 0012		Concrete Base				CY	2	$150.00	$65.00	$0.86	$215.86	1.035	$446.83
26 05 39 40 0400		Buried Conduit, + allowance for trenching & cables	1 Elec	100	0.08	LF	50	$12.59	$6.41	$0.00	$19.00	1.035	$983.25
26 56 13 10 2870		Aluminum Pole, 14-ft high	1 Elec	3.4	2.535	EACH	1	$815.00	$130.00	$48.50	$993.50	1.035	$1,028.27
26 56 13 55 0130		LED Fixture, 120VAC, 210 watt equivalent	2 Elec	4.4	3.636	EACH	1	$1,175.00	$200.00	$48.50	$1,423.50	1.035	$1,473.32
		Crew Mobe/Demobe				HR	8		$55.10		$55.10	1.035	$456.23

City of Shoreline - Stormwater Pump Stations
RS Means

Prepared By: Keith S. Parker
Date: 5/27/2016
Project Manager:

RS Mean's Line Item Cost Estimate

CSI #		Description	Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
Operational Reliability	**SCADA/Local Alarms/Aging Infrastructure/Redundancy**												
all stations except Pump Station 25													
SCADA Panel			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
26 29 13		SCADA enclosure, purchase/install/connect	1 Elec			EACH	1	$1,500.00	$440.80	$0.00	$1,940.80	1.035	$2,008.73
		Crew Mobe/Demobe				HR	8		$55.10		$55.10	1.035	$456.23
Linden, Palatine, Ronald Bog													
Alarm Floats			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
		Alarm Float/Conduits/Seal-Offs/Wiring	1 Elec			EACH	1	$400.00	$440.80	$0.00	$840.80	1.035	$870.23
		Crew Mobe/Demobe				HR	8		$55.10		$55.10	1.035	$456.23
Redundant Pump			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
Palatine PS		Tsurumi NK2-22 Submersible Pump				EACH	1			$2,800.00	$2,800.00	1.035	$2,898.00
Linden Avenue PS		Zoeller N14 Submersible Pump				EACH	1			$675.00	$675.00	1.035	$698.63
Pump Station 30		replacement pump				EACH	1			$4,500.00	$4,500.00	1.035	$4,657.50
Site/Civil	**Site Improvements**												
Pump Station 30													
Gabion Wall			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
31 36 13 0700		Stone filled gabions, 36-inch deep	B13	60	0.933	SY	19	$72.50	$38.50	$12.50	$123.50	1.035	$2,428.63
31 23 23 15 5000		Granular Backfill	B12N	0.925	0.017	CY	21	$22.00	$0.78	$1.37	$24.15	1.035	$524.90
		Crew Mobe/Demobe				HR	16		$41.40	$13.37	$54.77	1.035	$906.99
all stations (PS 26 and PS 30 signs included above with major reconstruction items)													
Signs - Station Identification & No Parking			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
10 14 53 20 0600		Guide Signs, 18x24	B80x	70	0.457	EA	1	$52.50	$19.30	$10.40	$82.20	1.035	$85.08
		Crew Mobe/Demobe				HR	4		$44.53	$45.51	$90.04	1.035	$372.77
Linden, Ronald Bog, Serpentine													
Security Bollards			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
34 71 13 17 2700		Bollard, removable, concrete base, painted	B6	10	2.4	EA	1	$820.00	$100.00	$36.50	$956.50	1.035	$989.98
		Crew Mobe/Demobe				HR	12		$41.64	$15.23	$56.87	1.035	$706.33
Serpentine													
Grading and Repaving			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle	Total
02 41 13 17 5050		HMA Removal	B38	420	0.095	SY	1		$4.11	$3.01	$7.12	1.035	$7.37
31 22 16 10 0012		Finish Grading, small area	B11L	400	0.04	SF	288		$1.78	$1.79	$3.57	1.035	$1,064.15
32 12 16 14 0030		HMA, crushed, binder, topping	B25C	9000	0.005	SF	288	$2.70	$0.23	$0.27	$3.20	1.035	$953.86
		Crew Mobe/Demobe				HR	16		$45.50	$76.54	$122.04	1.035	$2,020.98
Data Collection	**Pump Field Data**												
all stations except Pump Station 25													
Tap and tee for pressure gage			Crew	Daily Output	Labor	Unit	Quantity	Material	Labor	Equipment	Total	Seattle Factor	Total
33 12 13 15 4100	Tap	tap 6-inch for 1-inch tap	Q1	3	5.333	EA	1	$0.00	$284.00	$0.00	$284.00	1.035	$293.94
23 09 53 10 2300	Pressure Gage	3-1/2-inch gage				EA	1	$18.70	$15.20	$0.00	$33.90	1.035	$35.09
23 05 23 90 1630	Valves	1/2-ich stainless valves				EA	1	$50.00	$22.00	$0.00	$72.00	1.035	$74.52
		Crew Mobe/Demobe				HR	8		$53.28		$53.28	1.035	$441.16

Appendix D

Equipment Evaluation Summaries

Site and Equipment Field Assessment Data

	MP-7 Linden	
Pump Make/Model	Zoeller 140 Series	
Design Flow, gpm	75 *est.*	
TDH @ Design flow, ft	12 *est.*	
static, ft	8 *est.*	
friction, ft	4 *est.*	
Horsepower	1	
Wet Well Diameter, inches	22x26	22x26
Wet Well - Gallons per foot	30	30
Power - voltage/single or 3 phase	230v single phase	
PUMPING RATE TESTING		**Pump 1**
Elev - Pump ON		1.92
Elev - Pump OFF		2.33
gallons ON-OFF		12
Time, seconds		10
Pumping Rate, gpm		74
Pressure at gauge, psi		n/a
Correction to CL volute, ft		n/a
TDH, ft		
CONDITION ASSESSMENTS		
Electrical Panels/Power Supply	single phase	
meter panel		4 - minor rust, exposed to elements
MCC/Main/CP		4 - minor rust, exposed to elements
Generator or Connection for Mobile		n/a
Valve Vault	n/a	
suction isolation	n/a	
discharge check valve	2-inch	4 - operation verified
discharge isolation	unknown	
force main piping	unknown	
Wet Well		
pump		4 - operation verified, exterior coating appears intact, age
power cables		4 - appear in good condition, age
seal-offs		1 - no present
access hatch		4 - some rust
lights		n/a
Pressure gauges		n/a
ladder		n/a
pump discharge lines		4 - PVC, no signs of wear or corrosion, age
guiderails		n/a
floats		4 - appear in good condition, age
Site/Civil		
lights		n/a
Site		1 - risk of public blocking access
parking		5
maintenance access		2 - risk of traffic, major maintenance work would likely to encroach into lanes
flood potential		2 - mud and debris can collect at station surface inlet. Nuisance with some risk of impeding influent flow.
protection [bollards]		None - consider adding at each end of electrical panels to protect from vehicles leaving roadway
site hazards [steep slopes, etc.]		none

Site and Equipment Field Assessment Data

	Palatine	
Pump Make/Model	Tsurumi NK-22	
Design Flow, gpm	1000	
TDH @ Design flow, ft	12	
static, ft		
friction, ft		
Horsepower	7.5	
Wet Well Diameter, inches	48	
Wet Well - Gallons per foot	94	
Power - voltage/single or 3 phase		
PUMPING RATE TESTING		**Pump 1**
Elev - Pump ON	61	1.92
Elev - Pump OFF	78	2.33
gallons ON-OFF	-133	0
Time, seconds	90	10
Pumping Rate, gpm	-88.78629531	0
Pressure at gauge, psi		n/a
Correction to CL volute, ft		n/a
TDH, ft		
CONDITION ASSESSMENTS		
Electrical Panels/Power Supply	single phase	
meter panel		4 - minor rust, exposed to elements
MCC/Main/CP		4 - minor rust, exposed to elements
Generator or Connection for Mobile		n/a
Valve Vault	n/a	
suction isolation	n/a	
discharge check valve	3-inch	4 - operation verified
discharge isolation	unknown	
force main piping	unknown	
Wet Well		
pump		4 - operation verified, exterior coating appears intact, age
power cables		4 - appear in good condition, age
seal-offs		1 - no present
access hatch		4 - some rust
lights		n/a
Pressure gauges		n/a
ladder		n/a
pump discharge lines		4 - PVC, no signs of wear or corrosion, age
guiderails		n/a
floats		4 - appear in good condition, age
Site/Civil		
lights		n/a
Site		3 - some risk of public blocking access
parking		5
maintenance access		3 - some risk of traffic, major maintenance work would likely to encroach into lanes
flood potential		5
protection [bollards]		
site hazards [steep slopes, etc.]		none

Site and Equipment Field Assessment Data

	Pan Terra		
Pump Make/Model			
Design Flow, gpm			
TDH @ Design flow, ft			
static, ft			
friction, ft			
Horsepower	70		
Wet Well Diameter, inches	240	120	120
Wet Well - Gallons per foot	2350	588	588
Power - voltage/single or 3 phase	230/3		
PUMPING RATE TESTING			
Elev - Pump ON	377.7	6.86	4.04
Elev - Pump OFF	376.1	5	2.02
gallons ON-OFF	3760	1134	1187
Time, seconds		30	30
Pumping Rate, gpm		2268	2374
Pressure at gauge, psi		n/a	n/a
Correction to CL volute, ft		n/a	n/a
TDH, ft	5.3		
CONDITION ASSESSMENTS			
Electrical Panels/Power Supply	480v3phase		
meter panel	4 - minimal rust, exposed to elements		
MCC/Main/CP		3 - some rust, exposed to elements	
Generator or Connection for Mobile	4 - appears new and in good condition. Did not verify operation.		
Valve Vault			
suction isolation	n/a	n/a	
discharge check valve	10-inch	4 - operation verified, exterior coating appears in good condition	4 - operation verified, exterior coating appears in good condition
discharge isolation	10-inch	4 - did not verify operation, exterior coating appears in good condition	4 - did not verify operation, exterior coating appears in good condition
force main piping	20" HDPE SDR 17		
Wet Well			
pump		4 - operation verified, exterior coating appears intact	4 - operation verified, exterior coating appears intact
power cables		4 - appear in good condition, age	
seal-offs		4 - air gap pump cable connection	
access hatch		3 - good condition, but no lifting	
lights		n/a	
Pressure gauges		n/a	
ladder		n/a	
pump discharge lines		4 - coating appears intact, signs of very minor corrosion, age	
guiderails		5 - stainless, no signs of corrosion	
floats		4 - appear in good condition, age	
Site/Civil			
lights	n/a		
Site	3 - some risk of public blocking access		
parking	5		
maintenance access	2 - risk of traffic, major maintenance work would likely to encroach into lanes		
flood potential	none		
protection [bollards]	Add Guard Rail for site protection		
site hazards [steep slopes, etc.]	none		

Site and Equipment Field Assessment Data

	Pump Station 25		
Pump Make/Model	Myers 6VCX		
Design Flow, gpm	830		
TDH @ Design flow, ft	50		
static, ft			
friction, ft			
Horsepower	20		
Wet Well Diameter, inches	96		
Wet Well - Gallons per foot	376		
Power - voltage/single or 3 phase	230/3		
PUMPING RATE TESTING			
Elev - Pump ON		10.52	9.50
Elev - Pump OFF		11	10.50
gallons ON-OFF		214	376
Time, seconds		20	20
Pumping Rate, gpm		643	1128
Pressure at gauge, psi		17.5	18.0
Correction to CL volute, ft		9.0	9.0
TDH, ft		49	51
CONDITION ASSESSMENTS			
Electrical Panels/Power Supply			
meter panel		5	
MCC/Main/CP		5 - stainless enclosure	
Generator or Connection for Mobile	Manual Transfer Switch & Plug	5	
Valve Vault	none		
suction isolation	n/a		
discharge check valve	6-inch diameter	5	5
discharge isolation	gate valve, 6-inch dia.	n/a [buried] - operation verified	n/a [buried] - operation verified
force main piping	8-inch diameter	4 - very minor exterior corrosion	
Wet Well			
pump		4 - operation verified, exterior coating appears intact	4 - operation verified, exterior coating appears intact
power cables		4 - appear in good condition	4 - appear in good condition
seal-offs		4 - present	4 - present
access hatch		5	
lights		n/a	
Pressure gauges		5	
ladder		5 - no sign of corrosion	
pump discharge lines		4 - very minor corrosion	4 - very minor corrosion
guiderails		5 - stainless, no signs of corrosion	5 - stainless, no signs of corrosion
floats		4 - appear in good condition	4 - appear in good condition
Site/Civil			
lights	n/a		
Site	3 - some risk of public blocking access		
parking	4 - somewhat limited		
maintenance access	4 - some risk of access being blocked		
flood potential	5		
protection [bollards]			
site hazards [steep slopes, etc.]	Steep slope to pond risk to O&M staff		

Site and Equipment Field Assessment Data

	Pump Station 26		
Pump Make/Model	Lane		
Design Flow, gpm	unknown		
TDH @ Design flow, ft	unknown		
static, ft			
friction, ft			
Horsepower	7.5		
Wet Well Diameter, inches			
Wet Well - Gallons per foot	0		
Power - voltage/single or 3 phase	230v/3ph		
PUMPING RATE TESTING		**Pump 1[a]**	**Pump 2[a]**
Elev - Pump ON			
Elev - Pump OFF			
gallons ON-OFF			
Time, seconds			
Pumping Rate, gpm			
Pressure at gauge, psi			
Correction to CL volute, ft			
TDH, ft			
CONDITION ASSESSMENTS			
Electrical Panels/Power Supply			
meter panel	1 - age/enclosure type not rated for Cl 1, Div 2 environment		
MCC/Main/CP	1 - age/enclosure type not rated for Cl 1, Div 2 environment		
Generator or Connection for Mobile	none	n/a	
Valve Vault			
suction isolation	n/a		
discharge check valve	8-inch diameter	2 - operation not verified, exterior corrosion, age	2 - operation not verified, exterior corrosion, age
discharge isolation	gate valve, 8-inch dia.	2 - operation not verified, exterior corrosion, age	2 - operation not verified, exterior corrosion, age
force main piping	8-inch diameter	2 - exterior corrosion, age	
Wet Well			
pump		3 - operation not verified, exterior corrosion, age	3 - operation not verified, exterior corrosion, age
power cables		n/a	n/a
seal-offs		n/a	n/a
access hatch		n/a	
lights		2 - pump room lights, age	
Pressure gauges		n/a	
ladder		n/a	
pump discharge lines		3 - external corrosion, flange bolts show corrosion, age	3 - external corrosion, flange bolts show corrosion, age
guiderails		n/a	n/a
floats		2 - outdated technology	
Site/Civil			
lights	n/a		
Site	4		
parking	3 - remote from site		
maintenance access	3 - distance from road to station		
flood potential	4		
protection [bollards]	not required		
site hazards [steep slopes, etc.]	none		

a. Insufficient water/no wet well access/no pressure gauges.

Site and Equipment Field Assessment Data

	Pump Station 30	
Pump Make/Model	Myers V4WHV	
Design Flow, gpm	450	
TDH @ Design flow, ft	26	
static, ft	20.5	
friction, ft	6-inch PVC force main, 250-ft long	
Horsepower	5	
Wet Well Diameter, inches	4	
Wet Well - Gallons per foot	94 gallons per ft [wet well] + unknown from pond	
Power - voltage/single or 3 phase	230v 3 phase, Delta High Leg service	
PUMPING RATE TESTING		**Pump 1 [simplex station][a]**
Elev - Pump ON		
Elev - Pump OFF		
gallons ON-OFF		
Time, seconds		
Pumping Rate, gpm		
Pressure at gauge, psi		n/a
Correction to CL volute, ft		n/a
TDH, ft		
CONDITION ASSESSMENTS		
Electrical Panels/Power Supply		
meter panel	1 - corroded	
MCC/Main/CP		
Generator or Connection for Mobile	no permanent generator/no plug and transfer switch for mobile	
Valve Vault	none	
suction isolation	n/a	
discharge check valve	4-inch	3 - age, corrosion
discharge isolation	4-inch	3 - age, corrosion
force main piping	4-inch	unknown
Wet Well		
pump		2 - exceeded expected service life. Unable to functionally test.
power cables		2 - age beyond expected service life.
seal-offs		1
access hatch		2 - heavy, no safety grating, limited space
lights		n/a
Pressure gauges		n/a
ladder		2 - cast-in-place MH rungs. Does not meet current code.
pump discharge lines		2 - age, interferes with pump access
guiderails		n/a
floats		3
Site/Civil		
lights	n/a	
Site	5	
parking	5	
maintenance access	5	
flood potential	5	
protection [bollards]	none	
site hazards [steep slopes, etc.]	none	

a. Insufficient water/no wet well access/no pressure gauges.

Site and Equipment Field Assessment Data

	Ronald Bog	
Pump Make/Model	Pioneer Pump PP-66-S-L1	
Design Flow, gpm		
TDH @ Design flow, ft		
static, ft		
friction, ft		
Horsepower		
Wet Well Diameter, inches	72	
Wet Well - Gallons per foot	212	
Power - voltage/single or 3 phase	n/a	
PUMPING RATE TESTING		**Pump 1 [simplex engine-driven]**
Elev - Pump ON	suspicious	59
Elev - Pump OFF		72
gallons ON-OFF		229
Time, seconds		41
Pumping Rate, gpm		335
Pressure at gauge, psi		n/a
Correction to CL volute, ft		n/a
TDH, ft		
CONDITION ASSESSMENTS		
Electrical Panels/Power Supply	4 - fuel tank	
meter panel	n/a	n/a
MCC/Main/CP	4	n/a
Generator or Connection for Mobile	n/a [pump is engine drive	n/a
Valve Vault	none	
suction isolation	n/a	
discharge check valve	n/a	
discharge isolation	n/a	
force main piping	6-inch	
Wet Well		
pump		Engine-driven pump
power cables		n/a
seal-offs		n/a
access hatch		catch basin grated inlet
lights		n/a
Pressure gauges		n/a
ladder		n/a
pump discharge lines		4 - plastic. Good condition, but susceptible to vandalism and UV degradation.
guiderails		n/a
floats		n/a
Site/Civil		
lights	n/a	
Site	4 - minor risk of public blocking access	
parking	5	
maintenance access	4	
flood potential	3 - potential for area-wide flooding during large storm and pump failure.	
protection [bollards]	None - consider adding along east property line to protect catch basin and enclosure. Consider adding protection [or embankment] over suction and discharge pipes.	
site hazards [steep slopes, etc.]	none	

Site and Equipment Field Assessment Data

	Serpentine		
Pump Make/Model	Hydromatic SB4X-500		
Design Flow, gpm	500		
TDH @ Design flow, ft	23.6		
static, ft			
friction, ft			
Horsepower	5		
Wet Well Diameter, inches	72		
Wet Well - Gallons per foot	212		
Power - voltage/single or 3 phase	230v/3ph		
PUMPING RATE TESTING		**Pump 1[a]**	**Pump 2[a,b]**
Elev - Pump ON	377.7	95	
Elev - Pump OFF	376.1	104	
gallons ON-OFF	338	159	
Time, seconds		20	
Pumping Rate, gpm		476	
Pressure at gauge, psi			
Correction to CL volute, ft	5.3		
TDH, ft			
CONDITION ASSESSMENTS			
Electrical Panels/Power Supply			
meter panel		3 - some rust, exposed to elements	
MCC/Main/CP		3 - some rust, exposed to elements	
Generator or Connection for Mobile	Manual Transfer Switch & Plug	3 - some rust, exposed to elements	
Valve Vault			
suction isolation	n/a		
discharge check valve	4-inch diameter	4 - operation verified, exterior coating intact, age	4 - operation not verified
discharge isolation	plug, 4-inch diameter	4 - operation not verified, exterior coating intact, age	4 - appears good condition, age
force main piping	4-inch diameter	4 - exterior coating intact, age	
Wet Well			
pump		4 - operation verified, exterior coating appears intact, age	4 - operation not verified, exterior coating appears intact, age
power cables		4 - appear in good condition, age	4 - appear in good condition, age
seal-offs		4 - present, age	4 - present, age
access hatch		4 - some rust	
lights		n/a	
Pressure gauges		n/a	
ladder		5 - no sign of corrosion	
pump discharge lines		4 - coating appears intact, flange bolts show corrosion, age	4 - coating appears intact, flange bolts show corrosion, age
guiderails		5 - stainless, no signs of corrosion	5 - stainless, no signs of corrosion
floats		4 - appear in good condition, age	4 - appear in good condition, age
Site/Civil			
lights	n/a		
Site	1 - risk of public blocking access		
parking	5		
maintenance access	2 - risk of traffic, major maintenance work would likely to encroach into lanes		
flood potential	2 - stormwater, mud and debris can flows across station. Nuisance more than risk of damage		
protection [bollards]	None - consider adding at each end of electrical panels to protect from vehicles leaving roadway		
site hazards [steep slopes, etc.]	none		

a. No pressure gages.). Insufficient water to test second pump

Appendix E

Pump Station 25 Testing

20 July 2016

Memorandum

To: DCG, City of Shoreline

From: Keith Parker

Subject: City of Shoreline – Pump Station 25 additional pump testing
K/J 1697002*00

Attached are calc's, photos, etc. from the pump testing May 17, 2016 at Pump Station 25. DCG, Kennedy/Jenks along with City staff and Gabrial Winkler from Long Services were present.

Pumps sounded "normal", however with submersibles, it is difficult to really tell and it's not possible to get vibration tests. Nothing appeared out of the ordinary as far as noise or other issues during pump operations.

The control panel indicates a pump seal failure condition for both pumps. The City disconnected the seal probe leads in the junction box and we measures resistance across the leads per the pump O&M Manual [see page 3/6 in the attached pdf]. We have sent this info to the pump supplier to get their interpretation/recommendation.

A couple of anomalies showed up during the testing:
1) PDF Page 1/6: Pump #1 shut-off was nearly 25% higher than the pump curve data would indicate for the impeller size. This would normally mean that the installed impeller was a larger diameter than the indicated 8.875-inch on the pump curve. However, the 2 operating test points were slightly below the pump curve. We have also sent this info to the pump supplier for further discussion.

2) PDF Page 2/6: Pump #2 shut-off matched very closely with the expected shut-off head; however the operating point was "above" the pump curve. Since the pump can only operate on its curve, we would have expected either a lower flow rate at 51-ft of head or a much lower head if the pump was actually pumping 1,128 gpm.

We did the shut-off tests first, then opened the discharge valves and did the operating tests. The new gauges are installed downstream of the pump check valves, so we were able to see both gauges react during pump operation and both showed very similar pressure readings.

Because of the observed high shut-off head for Pump #1, after doing the operating tests, we shut the discharge valve for Pump #1 and ran a shut-off test again and recorded the same high pressure.

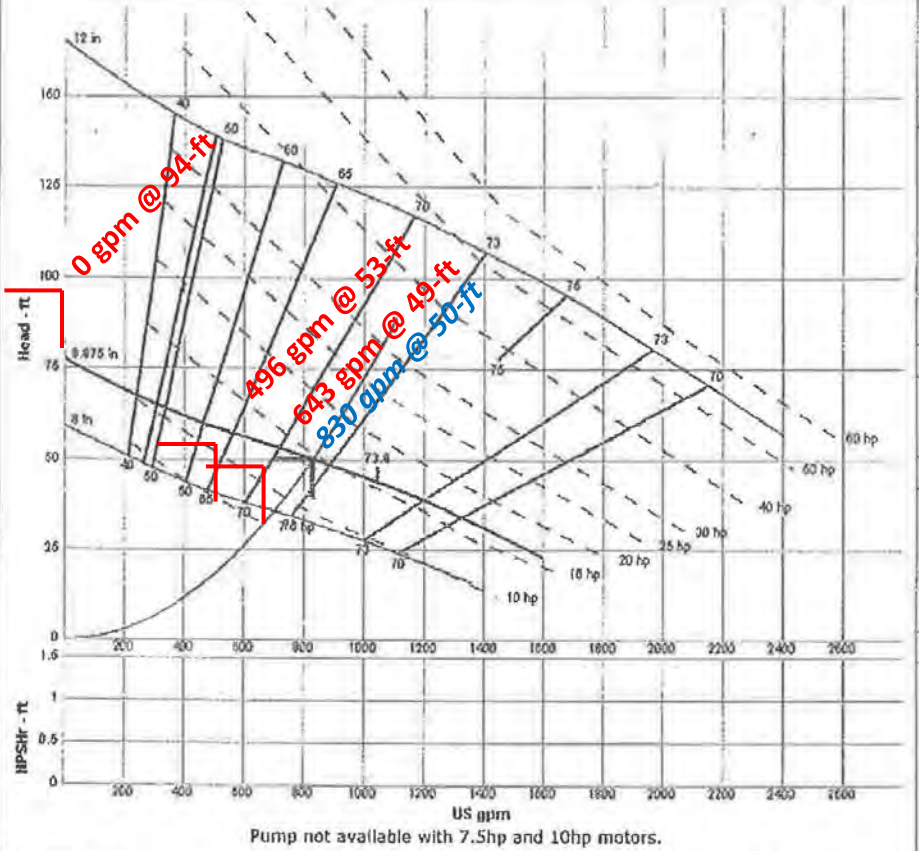
As shown on PDF Page 4/6, we didn't have the exact distance from the impeller centerline to the pressure gauge. We used an assumed distance of 9-ft for the calculations. Even if this assumed distance was incorrect by a few feet, that wouldn't materially change the anomalies we noted above.

City of Shoreline
Pump Station 25
Pump #1 [south]

Myers

My Profile | Catalogs | Manual Selection | Design Point Search | Search Results | Selected Pump

Pump Curve | Design Notes | Cost Analysis | Printed Reports | Documents



Pump not available with 7.5hp and 10hp motors.

Request for Quote

Submit your selection to Myers.

Pump

Type	Sub Solids Handling	
Size	6VC/6VCX	
Speed	1750	rpm
Diameter	8.875	in

Redraw | Reset

Display Options

Manufacturer settings
Custom

Multiple Pumps

Number of pumps 1

Parallel | Series

Redraw

Multiple Speeds (rpm)

1050 rpm - 1750 rpm

Redraw

Flow	Head	Eff	BEP	NPSHr	Power	Motor	Frame	Min flow	Sphere
830 US gpm	50 ft	72 %	73.8 %	---	14.5 hp	20 hp	256T	313 US gpm	3.19 in

Powered By PUMP-FLO

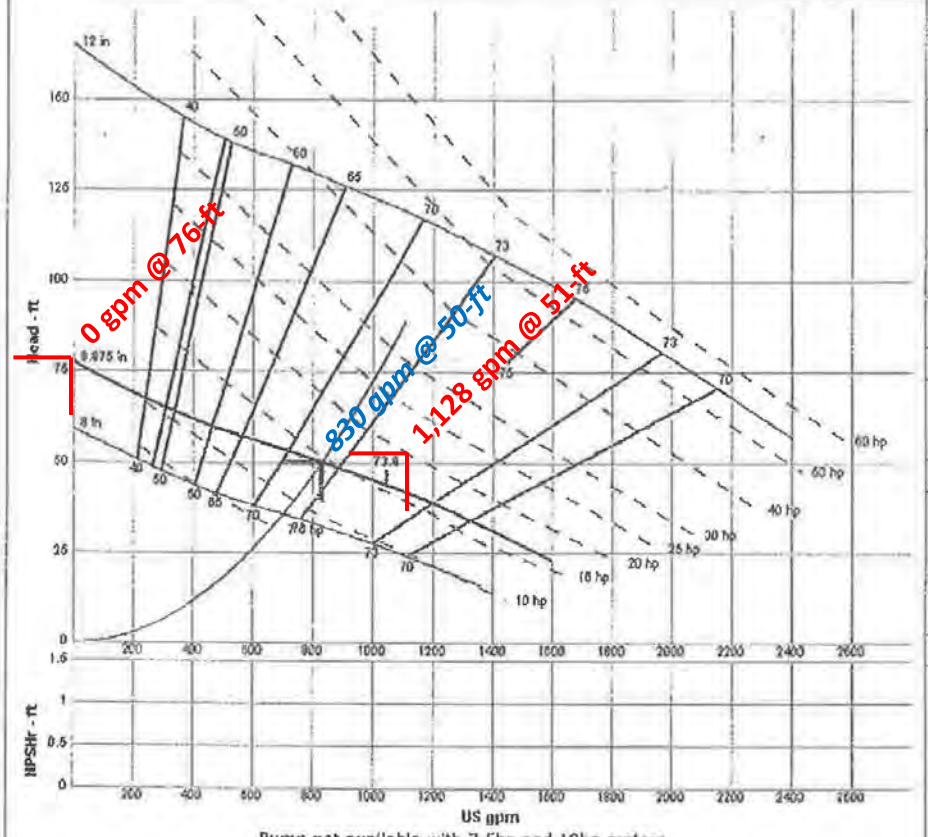
05/17/2016

City of Shoreline
Pump Station 25
Pump #2 [north]

Myers

My Profile | Catalogs | Manual Selection | Design Point Search | Search Results | Selected Pump

Pump Curve | Design Notes | Cost Analysis | Printed Reports | Documents



Pump not available with 7.5hp and 10hp motors.

Request for Quote

Submit your selection to Myers.

Pump

Type	Sub Solids Handling	
Size	6VC/6VCX	
Speed	1750	rpm
Diameter	8.875	in

Redraw | Reset

Display Options

Manufacturer settings
Custom

Multiple Pumps

Number of pumps 1

Parallel | Series

Redraw

Multiple Speeds (rpm)

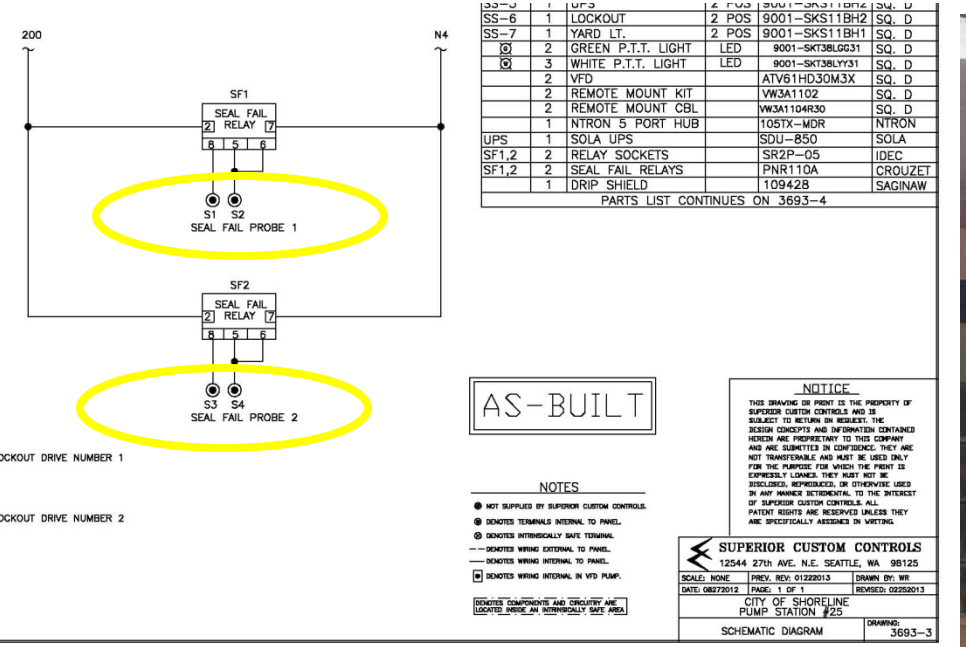
1050 rpm - 1750 rpm

Redraw

Flow	Head	Eff	BEP	NPSHr	Power	Motor	Frame	Min flow	Sphere
830 US gpm	50 ft	72 %	73.8 %	---	14.5 hp	20 hp	256T	313 US gpm	3.19 in

Powered By PUMP-FLO

05/17/2016



SS-6	1	LOCKOUT	2 POS	9001-SKS11BH2	SQ. D
SS-7	1	YARD LT.	2 POS	9001-SKS11BH1	SQ. D
⊙	2	GREEN P.T.T. LIGHT	LED	9001-SKT38LGG31	SQ. D
⊙	3	WHITE P.T.T. LIGHT	LED	9001-SKT38LYY31	SQ. D
	2	VFD		ATV61HD30M3X	SQ. D
	2	REMOTE MOUNT KIT		VW3A1102	SQ. D
	2	REMOTE MOUNT CBL		VW3A11104R30	SQ. D
	1	NTRON 5 PORT HUB		105TX-MDR	NTRON
UPS	1	SOLA UPS		SDU-850	SOLA
SF1,2	2	RELAY SOCKETS		SR2P-05	IDEC
SF1,2	2	SEAL FAIL RELAYS		PNR110A	CROUZET
	1	DRIP SHIELD		109428	SAGINAW

PARTS LIST CONTINUES ON 3693-4

AS-BUILT

NOTES

- NOT SUPPLIED BY SUPERIOR CUSTOM CONTROLS.
- DENOTES TERMINALS INTERNAL TO PANEL.
- DENOTES INTRINSICALLY SAFE TERMINAL
- DENOTES WIRING EXTERNAL TO PANEL.
- DENOTES WIRING INTERNAL TO PANEL.
- DENOTES WIRING INTERNAL IN VFD PUMP.

DENOTES COMPONENTS AND CIRCUITRY ARE LOCATED INSIDE AN INTRINSICALLY SAFE AREA

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SUPERIOR CUSTOM CONTROLS
12544 27th AVE. N.E. SEATTLE, WA 98125

SCALE: NONE	PREV. REV: 01222013	DRAWN BY: WR
DATE: 08272012	PAGE: 1 OF 1	REVISED: 02252013

CITY OF SHORELINE
PUMP STATION #25

SCHEMATIC DIAGRAM — DRAWING: 3693-3

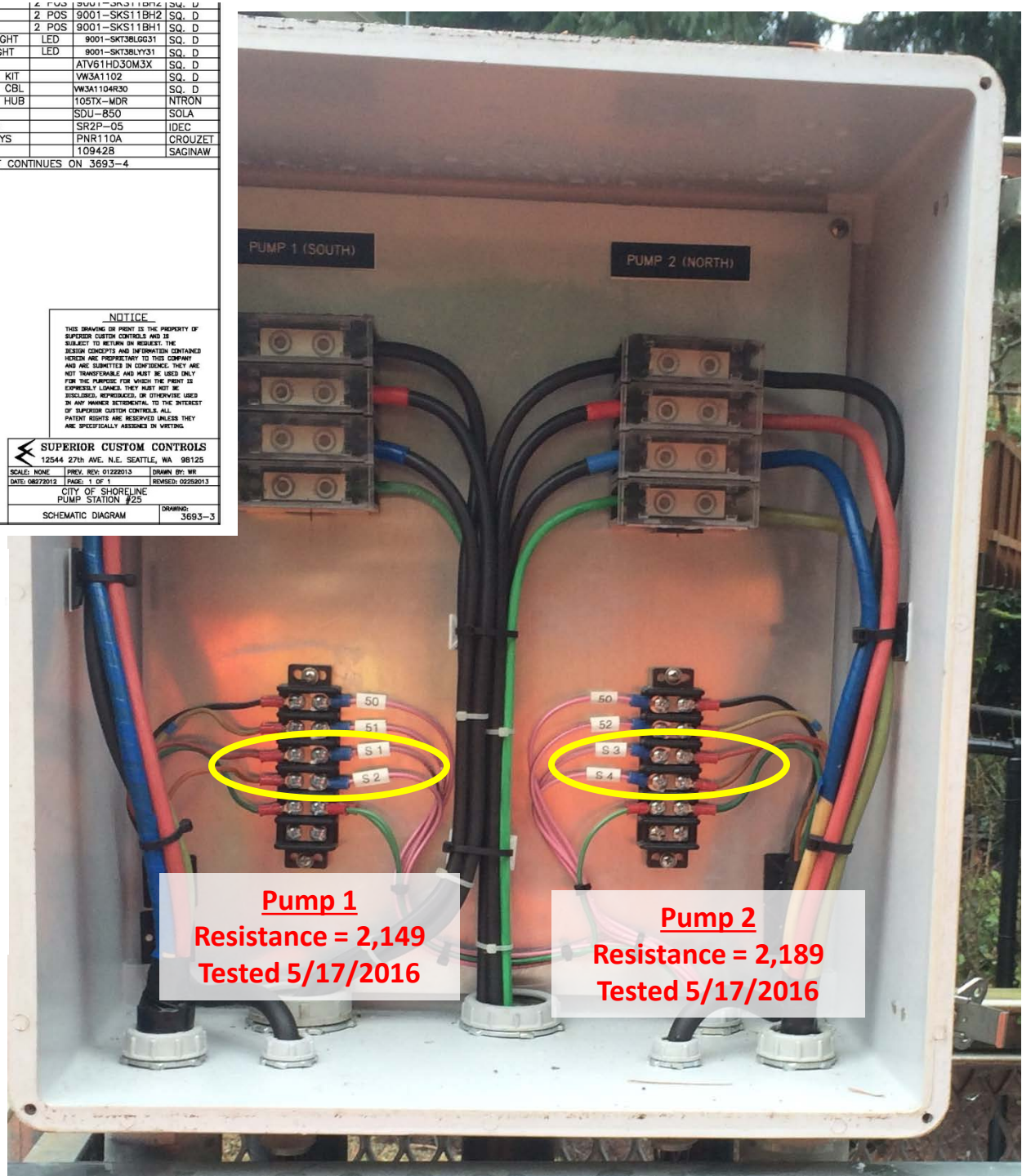
Motor Seal Failure Warning: The seal chamber is oil filled and provided with moisture sensing probes to detect water leakage through the lower shaft seal. The probes can also detect moisture present in the upper motor housing.

- The presence of water energizes a red seal leak warning light at the control panel. This is a *warning light only*, and does not stop the motor. It indicates a leak has occurred and the pump must be repaired. Normally, this indicates the outboard seal has leaked. Allowing the unit to operate after the warning could cause upper seal leakage along with motor failure.

The resistance across the moisture sensing (seal failure) probes should be checked after a seal leak warning light has lit. This can be done by disconnecting the red and orange control wires from

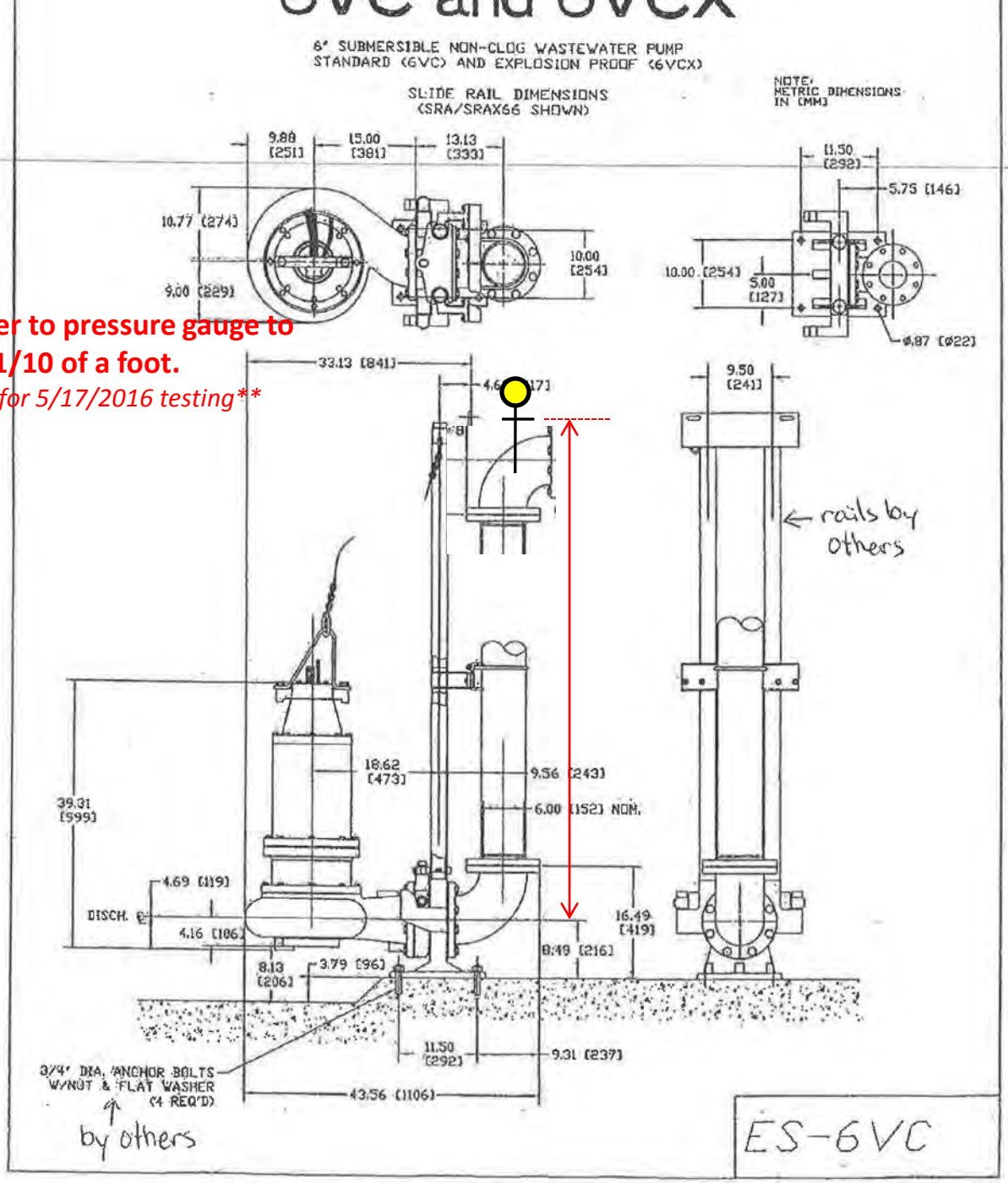
the control panel and measuring the resistance with an ohmmeter between the wires. If the measured values are below specification, the pump may have a lower seal failure and require service.

Specified value = _____



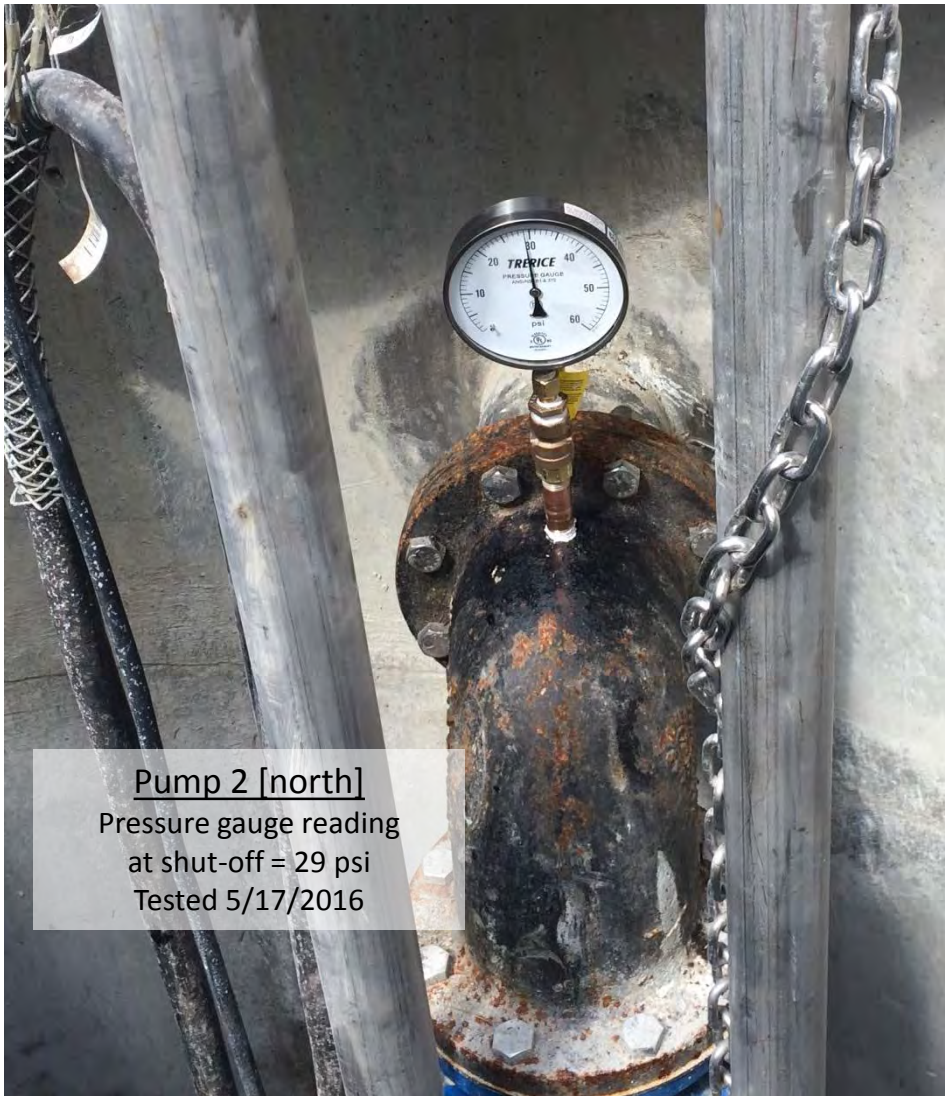
Distance from impeller to pressure gauge to the nearest 1/10 of a foot.

assume to be 9.0-ft for 5/17/2016 testing



City of Shoreline
Pump Station 25

Pump 1 [south]
Pressure gauge reading
at shut-off = 37 psi
Tested 5/17/2016



Pump 2 [north]
Pressure gauge reading
at shut-off = 29 psi
Tested 5/17/2016

City of Shoreline
Pump Station 25

Pump 1 [south]
Pressure gauge reading
at operating point = 17.5 psi
Tested 5/17/2016

City of Shoreline

Pump Station 25

Field Testing - 05/17/2016

Kennedy/Jenks Consultants

DCG Inc.

Pump Number 1 [south pump]

preliminary test #1 [with valve open] - pump at 100% speed

Pressure at Gauge	17.5	psi	pump running
distance from impeller to gauge	9	ft	
Pressure at Pump	49	ft	

shut-off test #2 [with valve closed] - pump at 100% speed

Pressure at Gauge	37.0	psi	pump running
distance from impeller to gauge	9	ft	
Shut-off Pressure at Pump	**94**	**ft**	

flow test #5 [valve fully open] - pump at 100% speed

Pressure at Gauge	17.5	psi	pump running
distance from impeller to gauge	9	ft	
Operating Pressure at Pump	49	ft	
test period	20	seconds	
Wet Well Level at time = 0	10.52	feet	
Wet Well Level at time = 20 seconds	11.09	feet	
Total Volume Pumped	214	gallons	

Pumping Rate	**643**	**gpm**
Head	**49**	**feet**

flow test #6 [valve partially closed] - pump at 100% speed

Pressure at Gauge	19.0	psi	pump running
distance from impeller to gauge	9	ft	
Operating Pressure at Pump	53	ft	
test period	20	seconds	
Wet Well Level at time = 0	11.09	feet	
Wet Well Level at time = 20 seconds	11.53	feet	
Total Volume Pumped	165	gallons	

Pumping Rate	**496**	**gpm**
Head	**53**	**feet**

wet well diameter	8	ft	
wet well volume	376	gallons/ft	
Assumed distance from impeller to gauge	9	ft	*needs to be verified*

City of Shoreline

Pump Station 25

Field Testing - 05/17/2016

Kennedy/Jenks Consultants

DCG Inc.

Pump Number 2 [north pump]

shut-off test #3 [with valve closed] - pump at 100% speed

Pressure at Gauge	29.0	psi	pump running
distance from impeller to gauge	9	ft	
Shut-off Pressure at Pump	**76**	**ft**	

flow test #4 [valve fully open] - pump at 100% speed

Pressure at Gauge	18.0	psi	pump running
distance from impeller to gauge	9	ft	
Operating Pressure at Pump	51	ft	
test period	20	seconds	
Wet Well Level at time = 0	9.50	feet	
Wet Well Level at time = 20 seconds	10.50	feet	
Total Volume Pumped	376	gallons	
Pumping Rate	**1,128**	**gpm**	
Head	**51**	**feet**	

test #7 [valve fully open] - pump at 80% speed

Pressure at Gauge	15.5	psi	pump running
distance from impeller to gauge	9	ft	
Operating Pressure at Pump	45	ft	
test period		seconds	
Wet Well Level at time = 0	11.53	feet	
Wet Well Level at time = 20 seconds		feet	
Total Volume Pumped		gallons	
Pumping Rate		**gpm**	
Head	**45**	**feet**	

affinity laws $\frac{H_1}{H_2} = \frac{N_1^2}{N_2^2}$

Pump Curve - H_1	*51*	*3062500*
		100%
predicted head- H_2	*32.3*	*1960000*
		80%