MCDD

Jacobs Challenging today. Reinventing tomorrow.

Replacement of 110,000 gpm of Pumping: Design Conclusions and Lessons Learned

PNWSAWWA Conference

Agenda

Presentation

- History
- Design
- Bidding Process
- Construction
- Lessons Learned / Considerations

Q&A

Multnomah County Drainage District - Pump Station 1

History

History

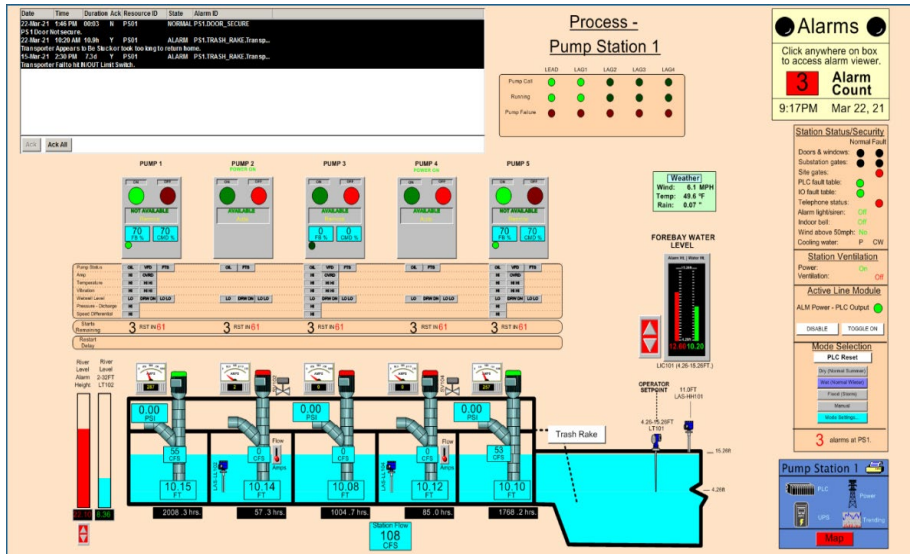
MCDD – Overview

The Multnomah County Drainage District (MCDD) helps protect lives and property from flooding by operating and maintaining flood management systems for nearly 13,000 acres of land along the Columbia Slough and the lower Columbia River. These systems include 27 miles of levee, 12 pump stations, and 45 miles of sloughs, streams, and culverts.

History

Pump Station 1 – Overview

- Constructed 1948
- 356 mgd @ 33' of Head
- All pumps on 2300V power
- 1997 overhaul – Replaced P2 / P4



Multnomah County Drainage District - Pump Station 1

DESIGN

Project Goals

- Replace Pump 1, Pump 3 and Pump 5
- Replace Pump 1, 3 and 5 Discharge Piping Inside Station
- Improve Station Efficiency and Recover Allowed Costs through ETO Incentives

Station Capacity

One of Largest in MCDD

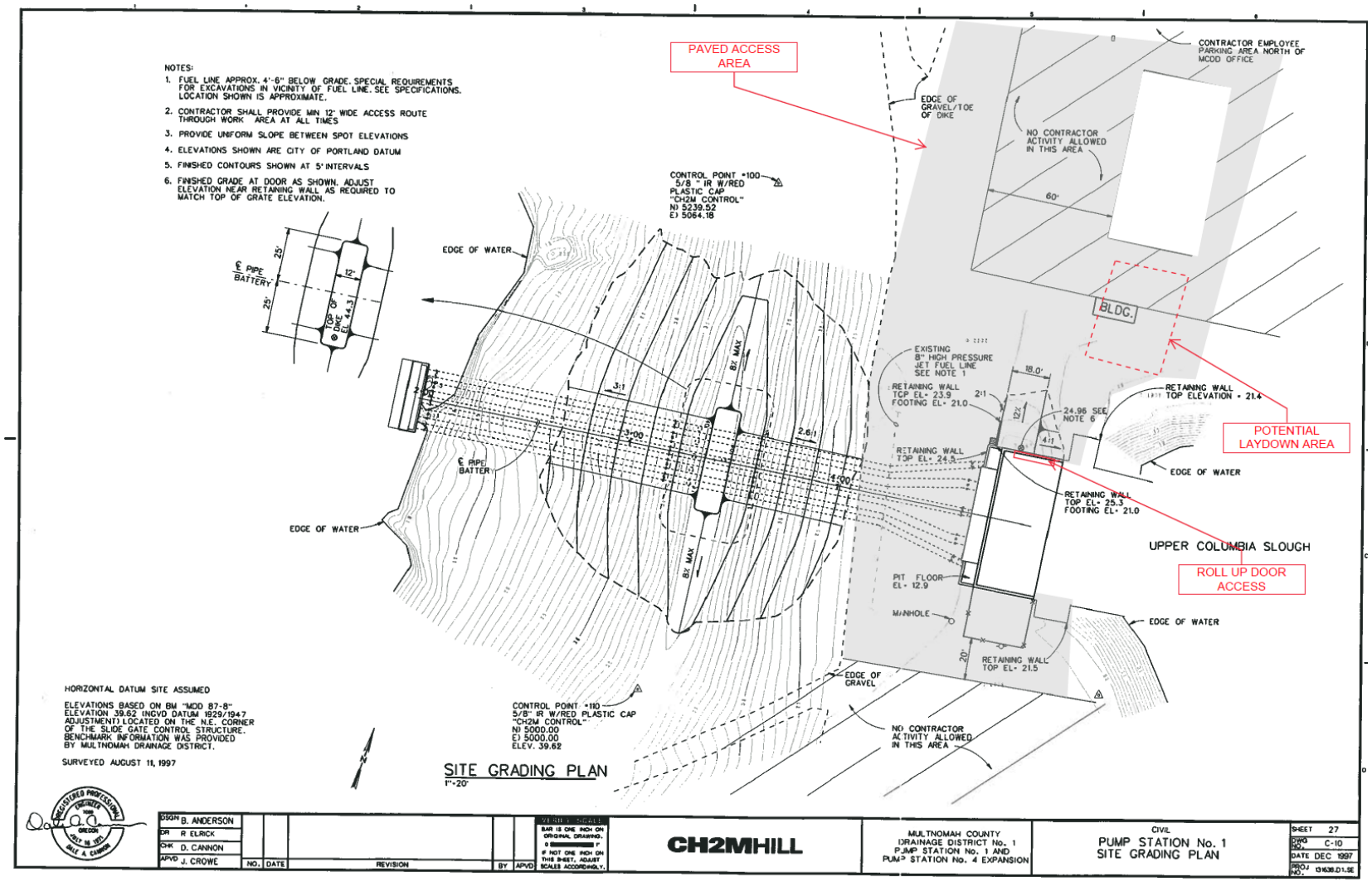
MCDD PS 1 Nominal Pump Capacities

Pump No.	Horse Power (hp)	Year Installed	Pump Capacity (gpm/mgd)
1	**250**	**1948**	**32,000 gpm / 46 mgd**
2	700	1998	68,000 gpm / 98 mgd
3	**350**	**1948**	**47,000 gpm / 68 mgd**
4	700	1998	68,000 gpm / 98 mgd
5	**250**	**1948**	**32,000 gpm / 46 mgd**

Challenges

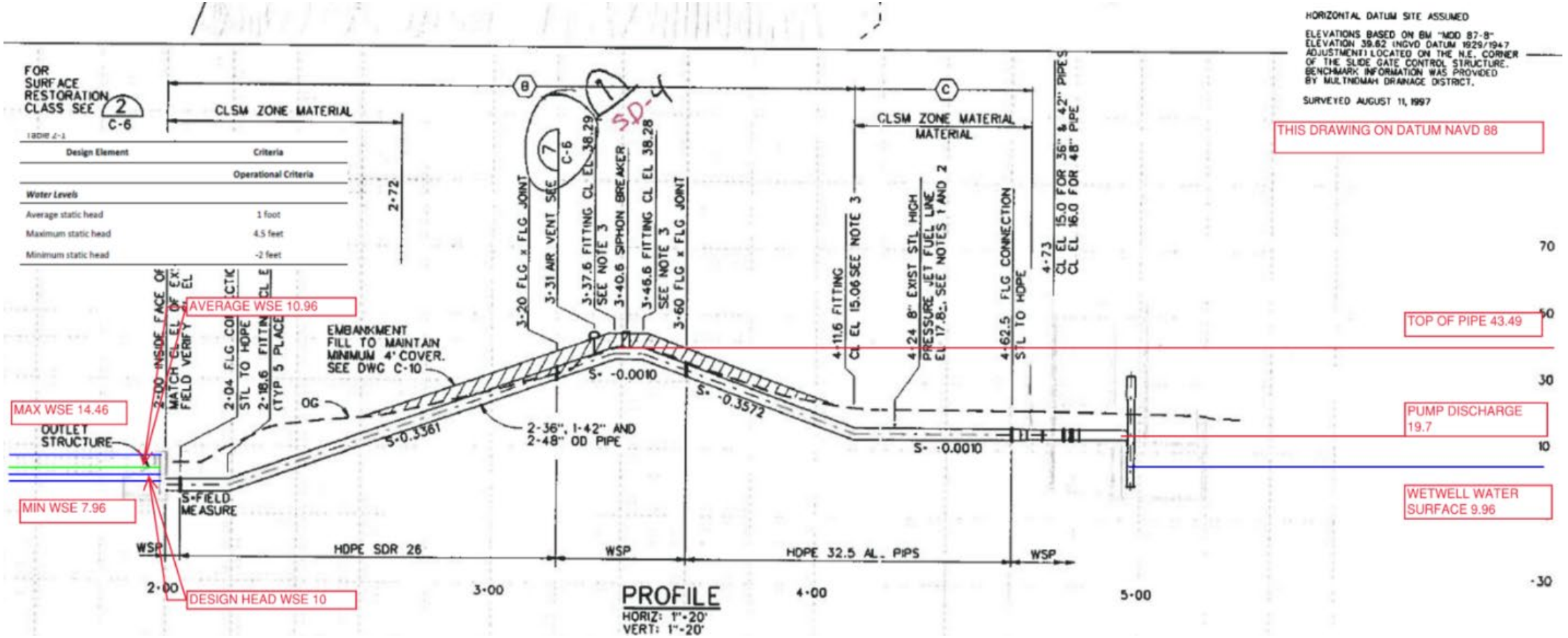
- Pumps 1, 3 and 5 Original Equipment from 1948
  - High maintenance costs
  - Reliability issues
- Operationally limited
  - Pumps off-line
  - Single-speed function
- Back-up Power Needed
- The Pumping Challenge
- The Electrical Challenge

Design – The Pumping Challenge - Site Plan



Design – The Pumping Challenge

Pump Station 1 – Siphon Service / Large Head range for Pump



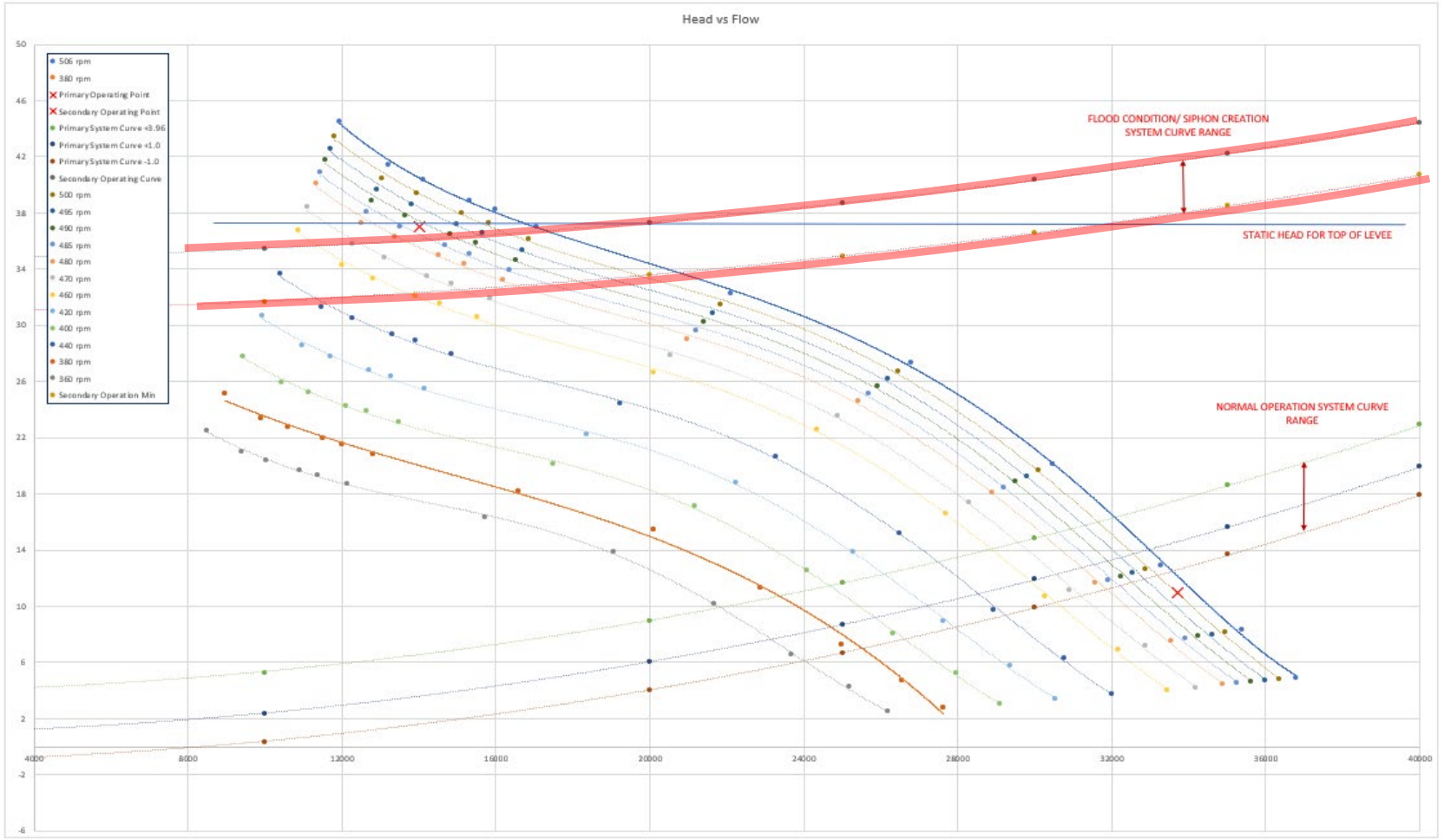
Design – The Pumping Challenge

Balancing Act

- Two Operating conditions – High Head startup, and Low Head normal operation
- Need to get a pump that has a range that just includes the High Head condition in order to get as good of a pump efficiency at Low Head operation as possible.
- Efficiency translates to pumping power, translates to dollars spent.

Design – The Pumping Challenge

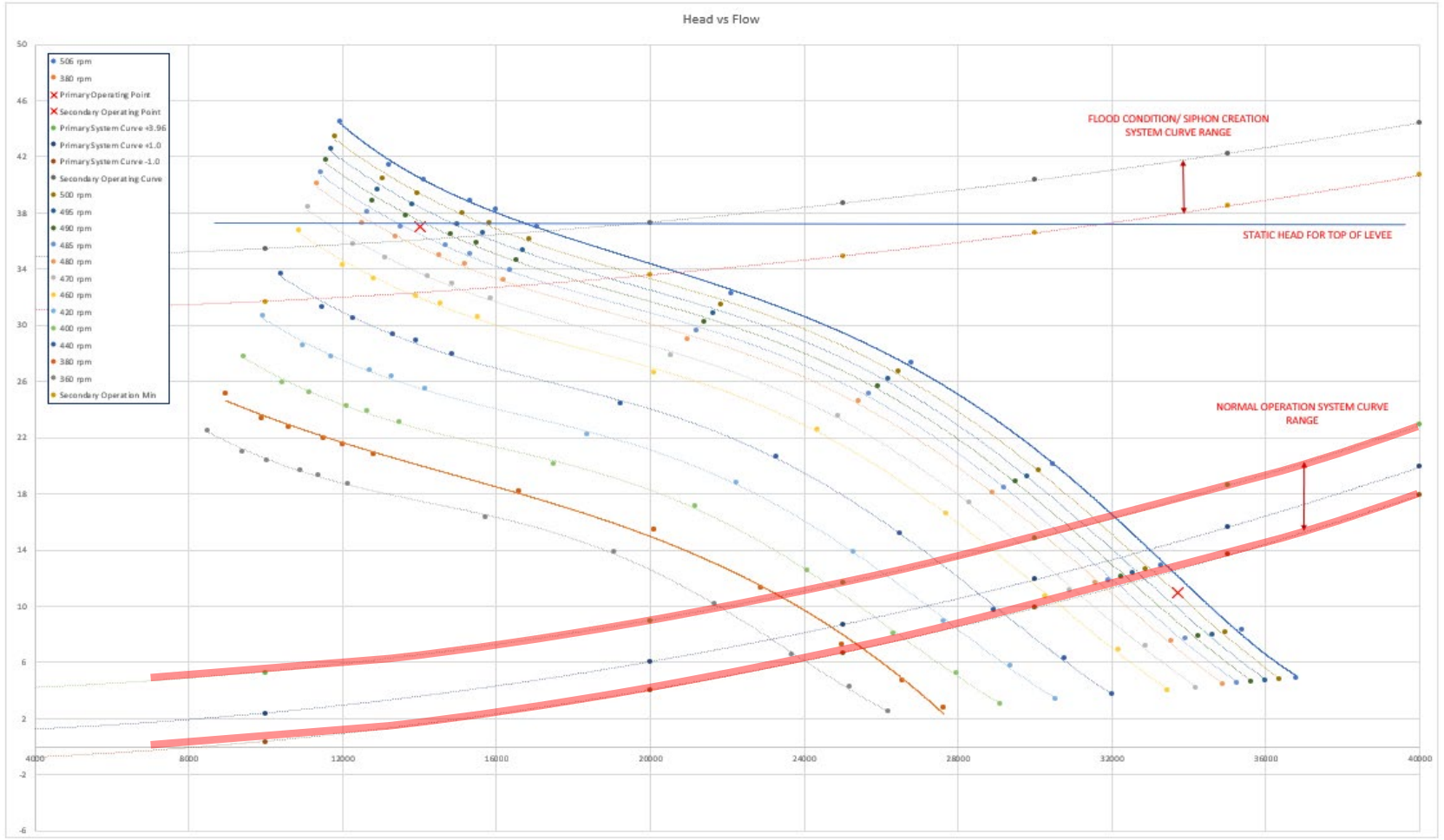
Pump Station 1 – Normal Service vs Flood Condition



FLOOD CONDITION / PRE-SIPHON SYSTEM CURVES

Design – The Pumping Challenge

Pump Station 1 – Normal Service vs Flood Condition

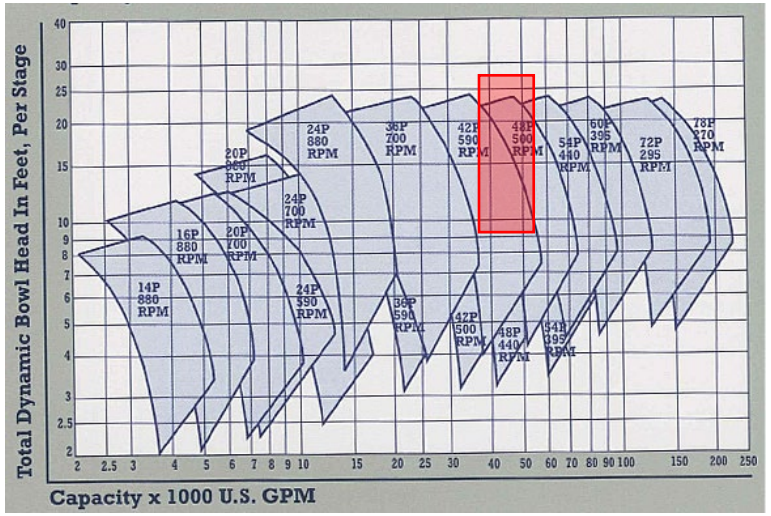


NORMAL CONDITION SYSTEM CURVES

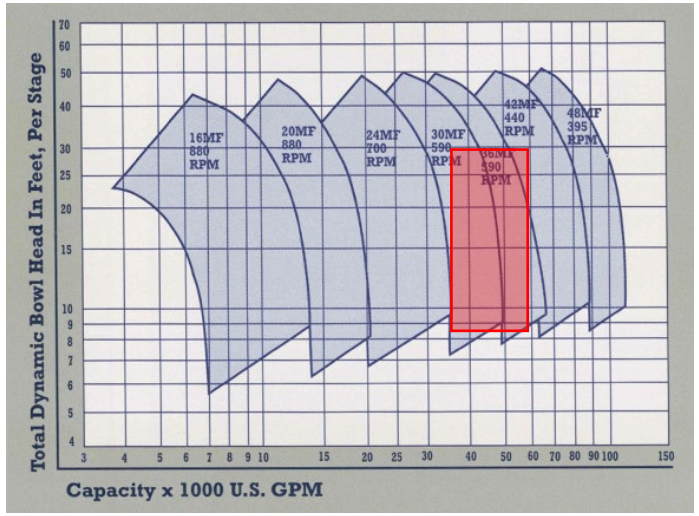
Design – The Pumping Challenge

Pump Station 1 – Siphon Service / Large Head range for Pump

- Siphon Service – Pump startup sees heads equal to the elevation of the levee pipe minus the intake water elevation (around 34 ft) – Smallest Fraction of the Overall Pump Usage
- Normal Operation – Once the siphon effect kicks in the head the pump sees ranges from 15 ft to 20 ft (incorporating friction loss) - Vast Majority of the Overall Pump Usage
- Looking around the 37,000+ gpm mark, the range of heads the pump can see ends up not quite being able to go with an Axial Flow Pump. Selected a Mixed Flow Pump



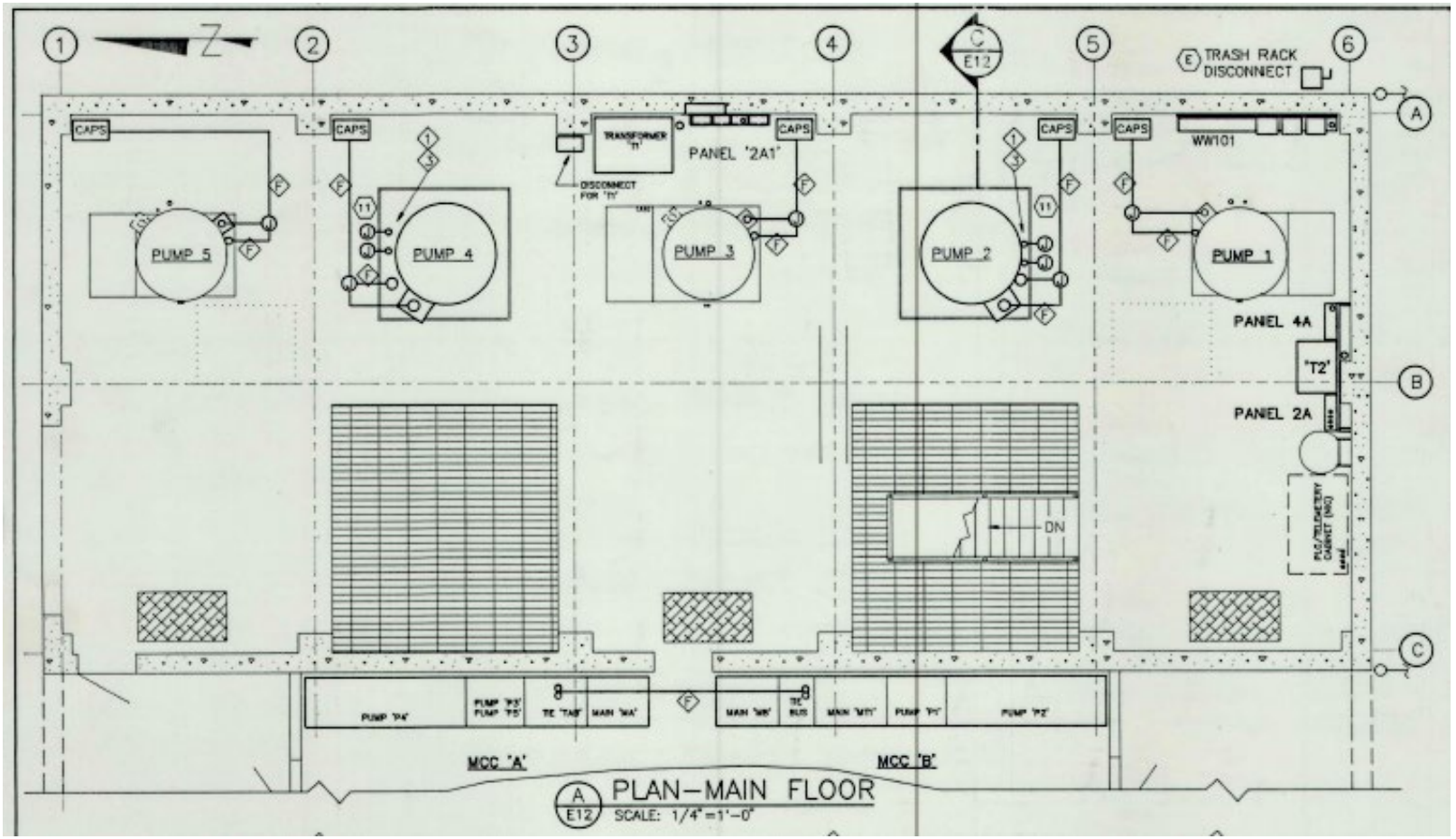
AXIAL FLOW



MIXED FLOW

Design – The Electrical Challenge

Pump Station 1 Original Layout – Electrical Level



Design – The Electrical Challenge - Electrical Service Option

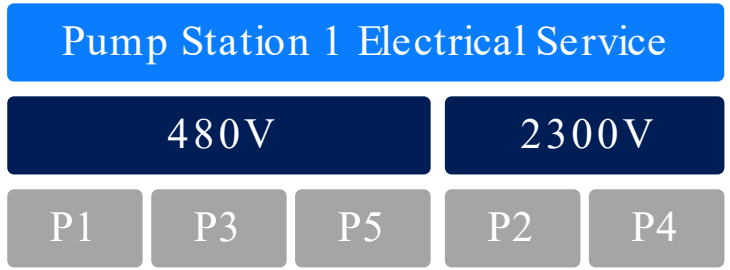
Switch one pump station power feed to 480V; remaining feed stays at 2300V

Advantages

- Standard electrical equipment available
- Much lower costs for electrical equipment
- Slightly more efficient
- Fits within electrical room
- Pump Station could be powered directly from Standby Generator
- Safer voltage

Disadvantages are mitigated:

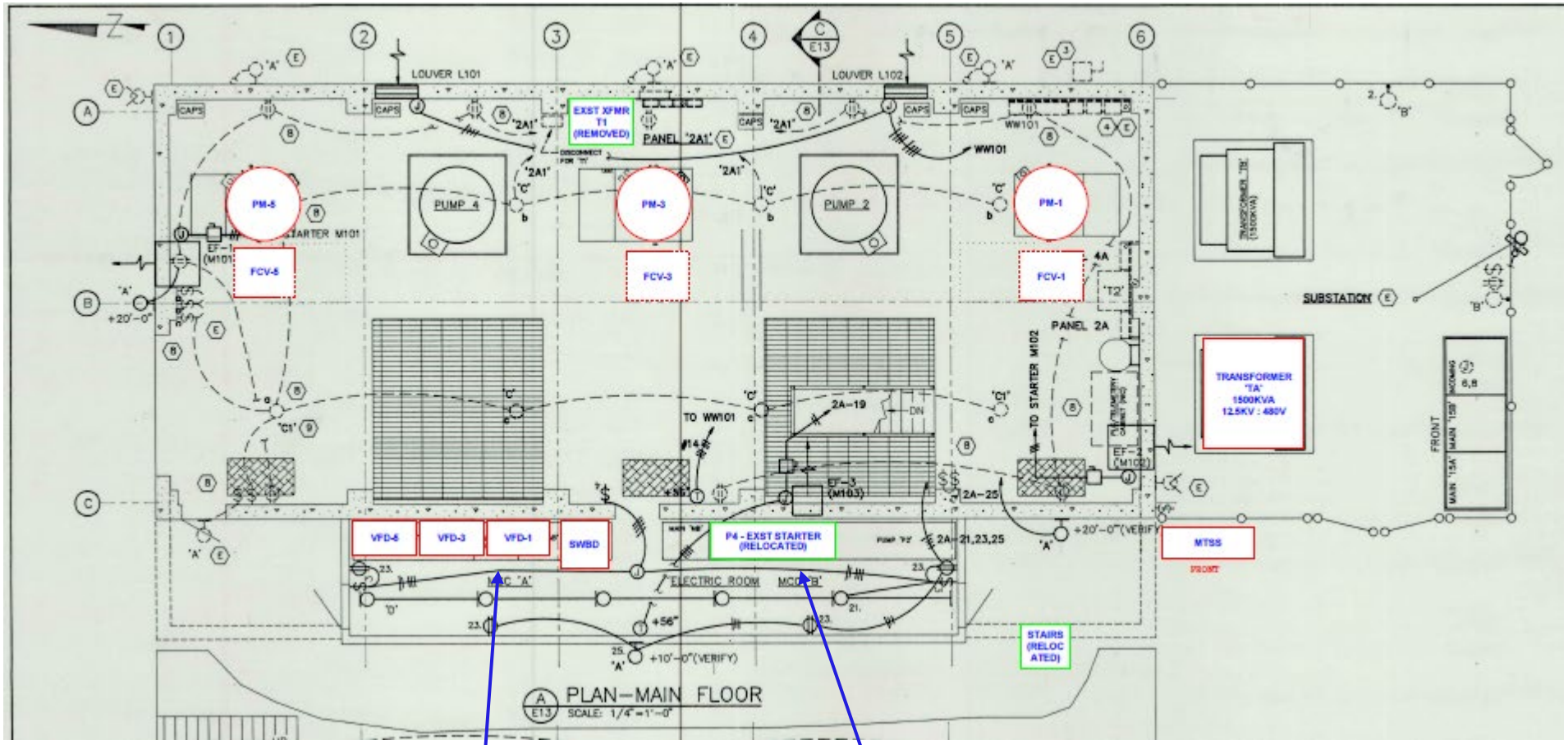
- Replace existing transformer
- Increase of heat load in electrical room
- Construction sequencing requires taking 1/2 of pumps completely offline, as electrical service of 1/2 of pump station is converted to 480V.
- Need accomodation for facility power (lighting, HVAC loads, etc…)



Pump 3:

- A 480V 350hp motor costs roughly 25% of a 2300V 350hp motor

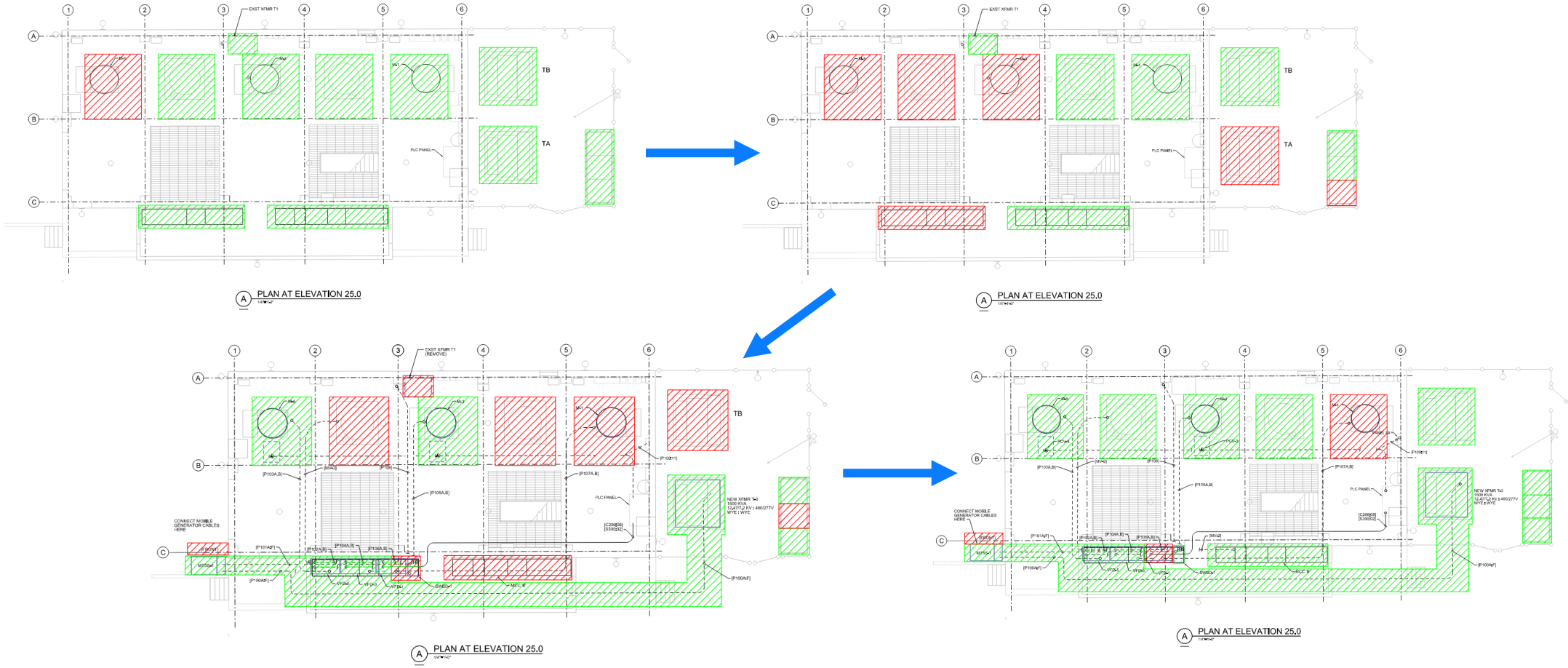
Design – The Electrical Challenge – Electrical Design Solution



MCGA 480V

MCGB 2300V

Design – The Electrical Challenge – Construction Sequencing



Multnomah County Drainage District - Pump Station 1

Energy Trust of Oregon – Aspired Benefit

Efficiency

- Anticipated savings from Energy350 report
- Anticipated project cost cap incentive was $447,500

Estimated Energy Trust of Oregon Incentives (PRELIMINARY)**

***Energy Trust will review final project cost estimates and calculated energy savings to determine if they are able to provide an incentive for the project.*

Eligible Project Cost Cap:	50%
W/WW Electric Savings Cap:	$0.32/kWh

Alt.	Description	Measure Type	Measure Life (years)	Eligible Project Cost Cap (50%)	Electric Savings Cap ($)	Estimated Total Incentive ($)	Customer Cost After Incentive ($)	Payback with Incentive
8	Add VFDs to P1, P5; Add VFD and ctrl valve to P3	W/WW	20	$287,458	$377,700	$287,458	$287,458	4.8 years
Total for Alternative 8						**$287,458**	**$287,458**	**4.8 years**

Note: Final Incentive is the lesser of project cost cap and energy savings cap	Fraction of Project Cost Covered by Energy Trust Incentive	50%

Multnomah County Drainage District - Pump Station 1

BID PROCESS

Bid Process

- Bidding requirements to supply technical information and expertise to qualify bidders
  - Electrical installation background – Complex electrical switchover to keep plant semi-operational while changing motor voltages/ MCCs
  - Pump Curves – Two operating conditions to satisfy both flood stage pumping and normal operation pumping into a siphon over the levee
  - Vertical Pump installation background – Complex installation in existing facility with limited clearances and crane height
- Quals required:
  - 3 PS's in past 5 years, with at least vertical turbine pumps, electrical equipment, rehab
  - Pump supplier experience quals AND initial pump efficiency and motor curves
  - Electrical subcontact experience at 480V and foreman and electrician quals
- Intent was to verify that the bidders knew that they needed both industrial electrical expertise, as well as pump expertise

Bid Schedule

8	Pump 5 Replacement including Discharge Piping and Appurtenances Work	1	LS		$
9	Pressure Control Valves	1	LS		$
10	Heating, Ventilation, Air Conditioning (HVAC)	1	LS		$
11	Painting and Coating	1	LS		$
12	Modify Motor Control Centers (MCC)	1	LS		$
13	Manual Transfer Switch (MTSS)	1	LS		$
14	Pad Mount Transformer – Energy Trust of Oregon (ETO) Qualified	1	LS		$
15	Adjustable Frequency Drives (AFDs) - ETO Qualified	1	LS		$
16	Balance of Project Electrical	1	LS		$
17	Startup, Testing, and Commissioning	1	LS		$
18	Balance of Work for a Complete and Functional Installation	1	LS		$

Bid Results

- 6 total bidders responded
- 3 disqualified for pumps that didn't hit flood point, 2 didn't submit pump at all

Condition to be met by contractor:	BIDDER 1	BIDDER 2	BIDDER 3	BIDDER 4	BIDDER 5	BIDDER 6
General Contractor:						
The General Contractor shall have successfully managed/completed, during the past five (5) years, at least three (3) water conveyance pump station or related multi discipline plant projects of $500,000 or larger bid price. Each project listed shall have included one or more the following (all must be included at some point in five -year history):	Listed 9 projects over $500k	Listed 6 projects over $500k	Listed 3 projects over $500k	Listed 10 projects over $500k	Listed 3 projects over $500k, 1 under	Listed 3 projects over $500k
Rehabilitation of existing facility or construction of new facility with replacement or installation of pumping equipment and steel process piping,	7 pump stations / 1 hydroelectric facility / 1 wastewater	1 pump station piping replacement, 1 pump station with vertical pump install, 1 fish ladder with vertical pump install, 1 pump station overhaul, 1 sewer overhaul, 1 pump station overhaul with sump pumps	Mix of wastewater treatment and pump stations	5 projects included pump stations, the rest were wastewater that had some pumps	4 projects including 1 Fuel Storage, 1 shipyard, 1 pump station, 1 potable water demolition project	1 water conveyance project, 1 groundwell pump rehab, 1 groundwell pump station install
Vertical pump procurement and installation,	3 projects specifically called out vertical pumps	2 projects specifically called out veritcal pumps	The three full project references did not include vertical turbine pumps	2 projects specifically called out vertical pumps. 1 called out well pumps	1 vertical pump repair, 1 vertical pump install	2 projects listed vertical submersible pumps
Electrical/instrumentation systems for pumping or other water processes.	9 projects specifically called out electrical/instrumentation	3 projects specifically called out electrical/instrumentation	2 projects specifically called out electrical/instrumentation	3 projects specifically called out electrical/instrumentation. 2 called out pump stations, which may have included electrical	2 projects with pump control systems	2 projects specifically called out electrical/instrumentation. 1 cable replacement
Pump Supplier:	SUPPLIER A	SUPPLIER A	SUPPLIER A	SUPPLIER B	SUPPLIER B	SUPPLIER C
The Pump Subcontractor shall have fabricated and delivered at least ten vertical turbine axial flow or mixed flow pumps in the last five (5) years.	15 lineshaft pumps from 14,000 gpm through 115,000 gpm	15 lineshaft pumps from 14,000 gpm through 115,000 gpm	15 lineshaft pumps from 14,000 gpm through 115,000 gpm	Listed more the 100+	Listed more the 100+	Listed 10 projects
Must have provided custom built pumps to fit specific installation dimensions for vertical turbine axial or mixed flow pumps.	Unclear from proposal	Unclear from proposal	Unclear from proposal	Unclear from proposal	Unclear from proposal	Unclear from proposal
Must have provided at least 5 vertical turbine axial flow or mixed flow pump projects in coordination with a variable frequency drive for use at multiple speeds in the past 5 years.	All 15 pumps went with VFDs	All 15 pumps went with VFDs	All 15 pumps went with VFDs	Unclear from proposal	Unclear from proposal	Included 7 with VFD
The Pump Subcontractor to submit with the Qualifications form, initial pump efficiency curves and motor curves for the proposed pumps and motors for this application.	Included but does not meet secondary operating points	Included but does not meet secondary operating points	Included but does not meet secondary operating points	Included	Included	No curve submitted
Pump Information:						
P1/P5 curve	Curve ends at 21 ft. needs to get up to 37	Curve ends at 21 ft. needs to get up to 37	Curve ends at 21 ft. needs to get up to 37	Curve acceptable	No curve submitted	No curve submitted
P3 Curve	Curve ends at 22.5 ft. needs to get up to 35	Curve ends at 22.5 ft. needs to get up to 35	Curve ends at 22.5 ft. needs to get up to 35	Curve acceptable	No curve submitted	No curve submitted
Motor Information:	Included	Included	Included	Pump base speed and torque requirement included. Motor and VFD excluded from pump submittal.	no data submitted	no data submitted

Bid Process- Afterthoughts

- Pre-Bid meeting needs to be required
- Must hit **ALL** of the project aspects – At the Pre-Bid hit the high points
- Didn't end up using the Pump that did pre-qualified, ended up using Cascade instead. Pre-qualified supplier pulled out of project.

Multnomah County Drainage District - Pump Station 1

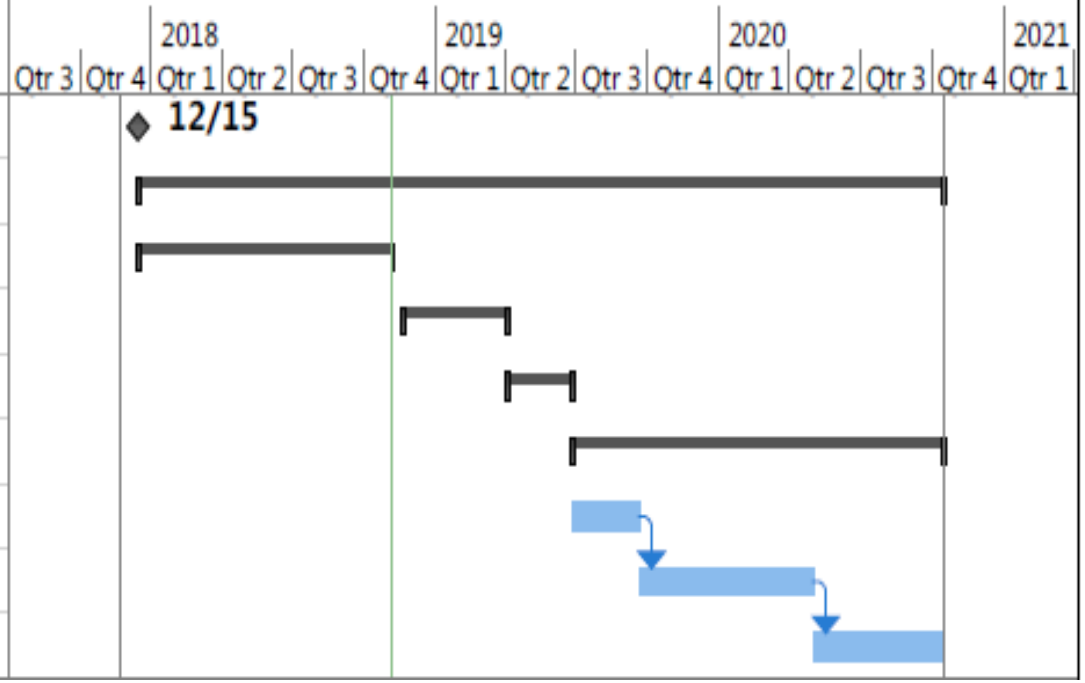
CONSTRUCTION

Schedule

- Design completed April 2019
- Construction completed November 2020

MCDD PS 1 Pump Replacement Project - Schedule

ID	Task Name	Duration	Start	Finish
1	**Consultant NTP**	0 days	12/15/17	12/15/17
2	**Task 1 - Task Order Management**	740 days	12/15/17	10/15/20
6	**Task 2 - Predesign**	234 days	12/15/17	11/7/18
45	**Task 3 - Final Design**	98 days	11/20/18	4/4/19
51	**Task 5 - Bid & Award**	60 days	4/5/19	6/27/19
54	**Task 6 - Construction**	340 days	6/28/19	10/15/20
55	Submittals	3 mons	6/28/19	9/19/19
56	Procurement	8 mons	9/20/19	4/30/20
57	Construction	6 mons	5/1/20	10/15/20



Construction

Rotschy was the one point of contact,
was hugely beneficial to have a GC instead of multiple contracts

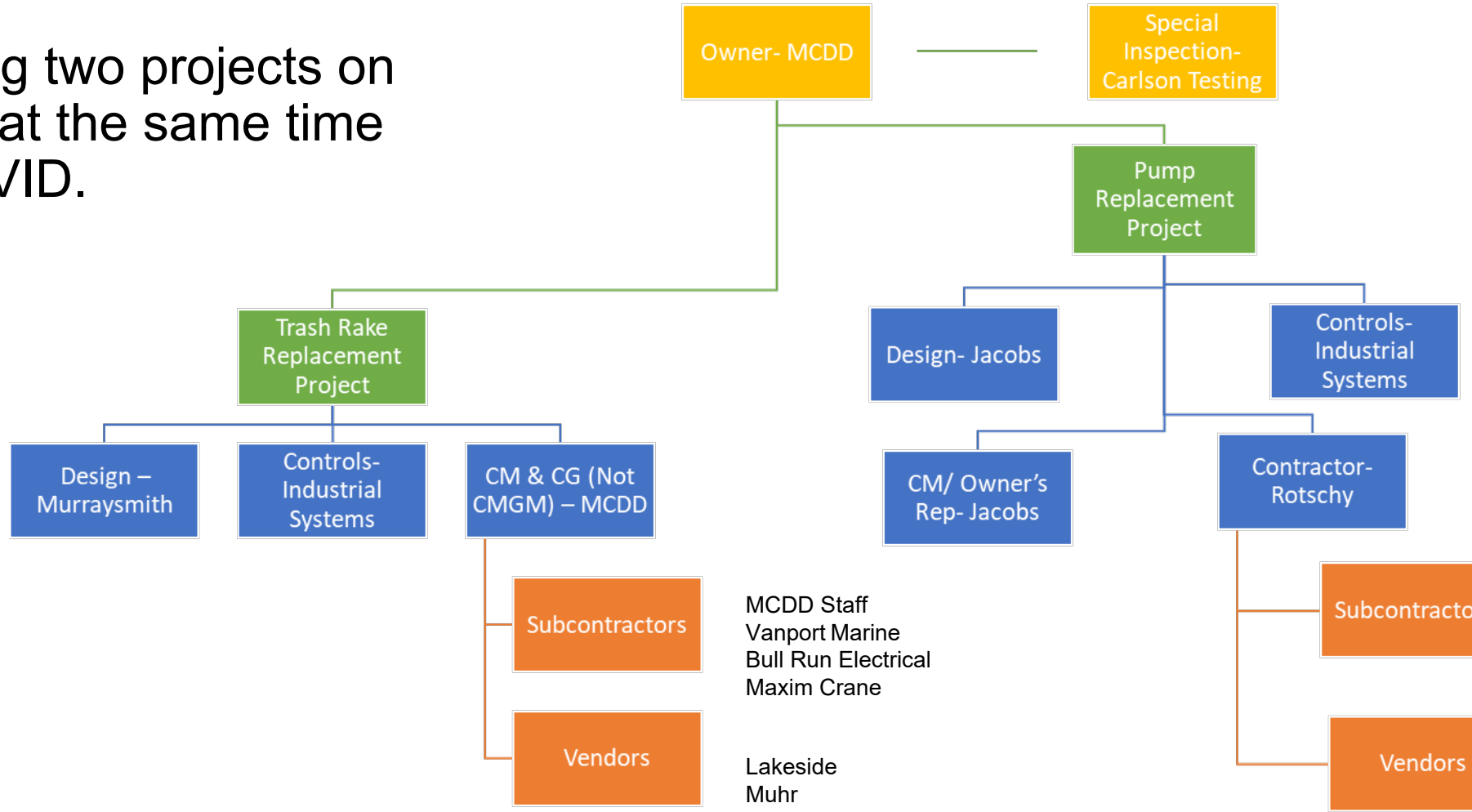
Construction

Pump testing, how did we manage testing without the VFD. The motors? Motors have all had issues since. Didn't know about the frequency during test, issue with the VFDs or the motor.

- This was our first remote pump test witnessing
- Double shipping, manufacturing

Construction

Managing two projects on one site at the same time with COVID.



Construction

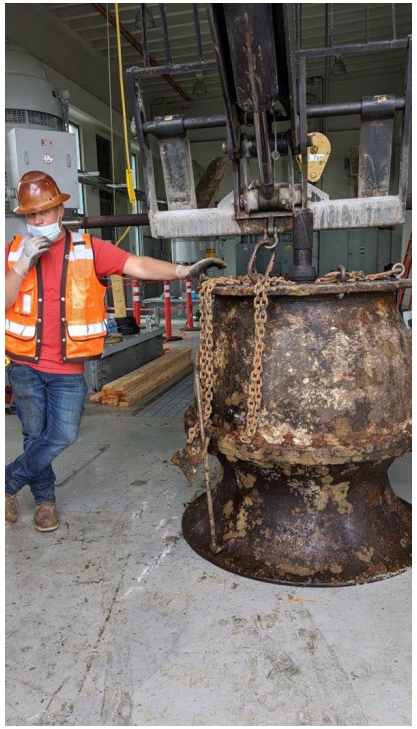
Managing two projects on one site at the same time with COVID.

Rotschy & Subs (Pump Replacement Contractor)

- Mill Plain Electric
- Siemens
- Northwest Motors
- Triangle Pump
- ABB
- Stewart Mechanical
- Taurus Electric

MCDD Staff

- Vanport Marine (Trash Rake Hydraulic Line Fitter)
- Bull Run Electric (Trash Rake Electrician)
- Maxim Crane
- Industrial Systems (Separate Contracts and Programmers for Pump Replacement & Trash Rakes)
- Carlson Testing (Separate Contracts for Pump Replacement & Trash Rakes)

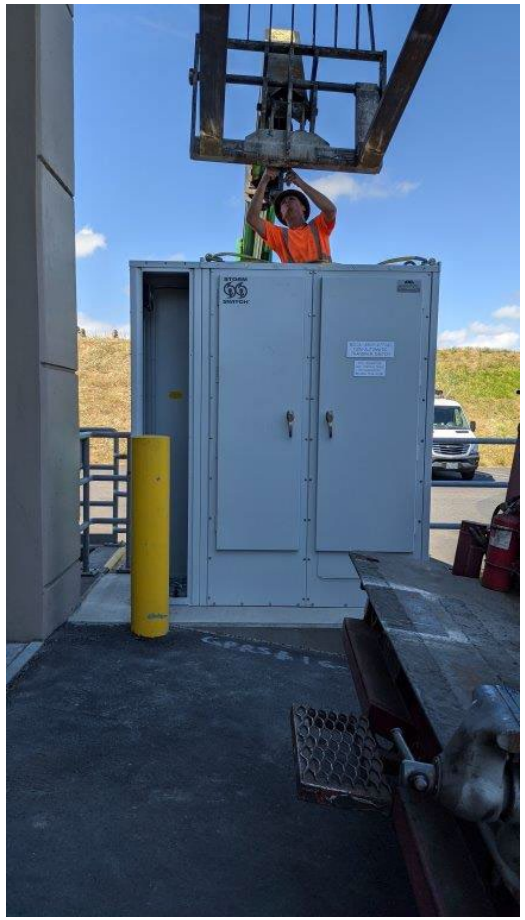


Construction

Weather was major project driver

Construction

Generator – Bring in a portable if necessary, permanent install later

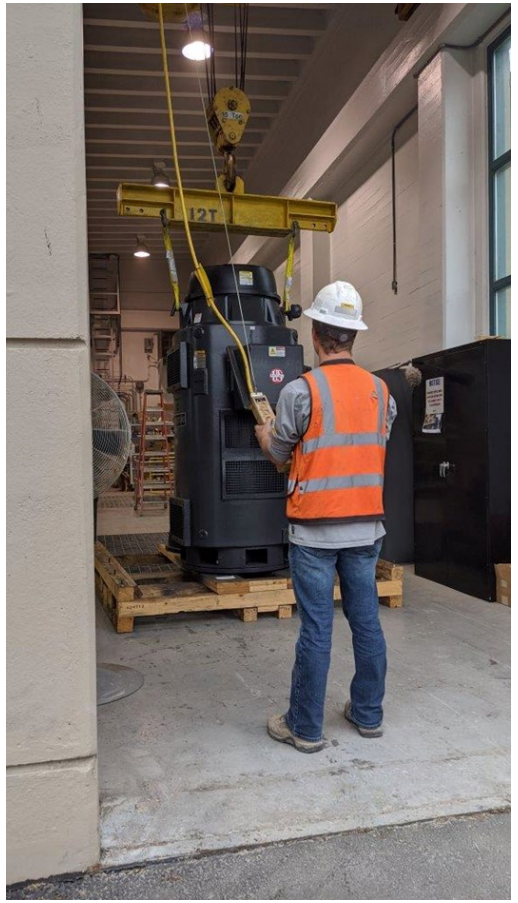


Multnomah County Drainage District - Pump Station 1

Energy Trust of Oregon – Aspired Benefit

Construction – Close Out

ETO why we didn't get full rebate



Construction – Close Out

ETO why we didn't get full rebate

- Final Incentive is the lesser of project cost cap and energy savings cap

Fraction of Project Cost Cap – 50%

	Estimated	Actual
HVAC to Accommodate VFDs	$ 58,872.00	$ 30,570.00
Modify MCC to Accommodate VFDs	$ 196,574.00	$ 254,599.00
Furnish and install 480V Transformer	$ 148,559.00	$ 80,600.00
Furnish and install VFDs	$ 352,406.00	$ 416,616.00
Mobilize, Documentation, CM		$ 58,482.00
SCADA Programming and Sequencing	$ 20,000.00	$ 20,000.00
Design Fees	$ 30,813.00	$ 30,813.00
Construction Costs	**$ 807,224.00**	**$ 891,680.00**
Potential Incentive	**$ 403,612.00**	**$ 445,840.00**

Energy Savings Cap – Annual Savings x $0.32/kWh

	Estimated (kWh/year)	Verified (kWh/year)
Baseline Operation	1,897,839	1,897,839
Upgraded Operation	499,510	761,637
Energy Reduction Per Year	1,398,329	1,136,202
Annual Cost Savings	**$ 70,335.95**	**$ 57,150.96**
Savings (%)	**74%**	**60%**
Potential Incentive	**$ 447,465.28**	**$ 363,584.64**

Return on (Energy Efficiency) Investment with ETO Incentive – 5.9 years!!!

Multnomah County Drainage District - Pump Station 1

LESSONS LEARNED / CONSIDERATIONS

Lessons Learned/Considerations

- Procurement was “easy enough” at the beginning of global pandemic
- Pre-Bid going through in great detail what is required – was very important to understand who could actually work this pump curve
  - Two-step process, pre-qual then bid?
  - Best value?
- Don’t plan on doing multiple projects on the same site at the same time (obviously, eye roll)
- Understanding the sequencing was essential for design, bid and construction
- Warranty - Extend
- Start-Up – Would performing pump testing differently have changed outcomes?

Questions?

A special thank you to Cameron Isaman with Jacobs for presentation preparation and technical advisory!

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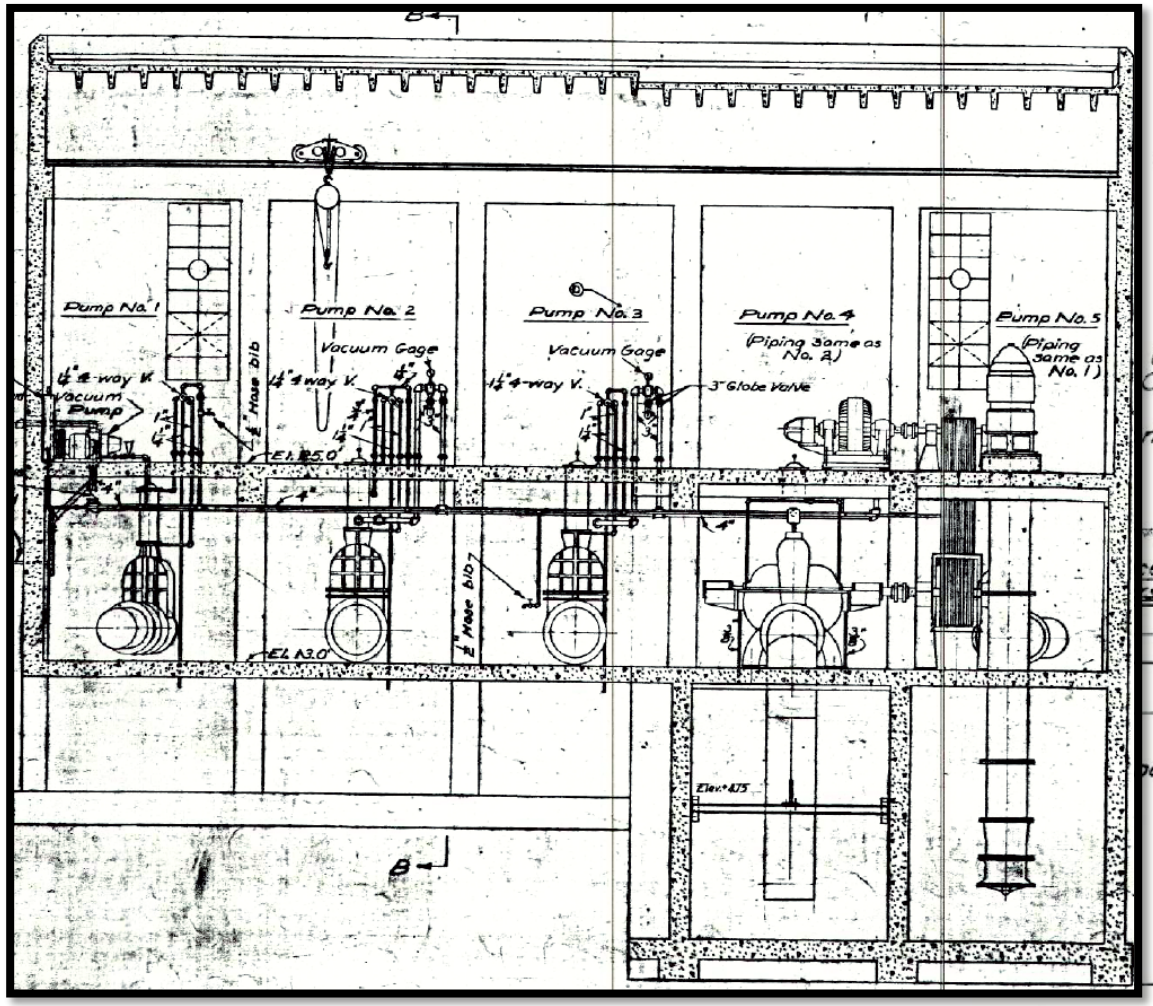
Important

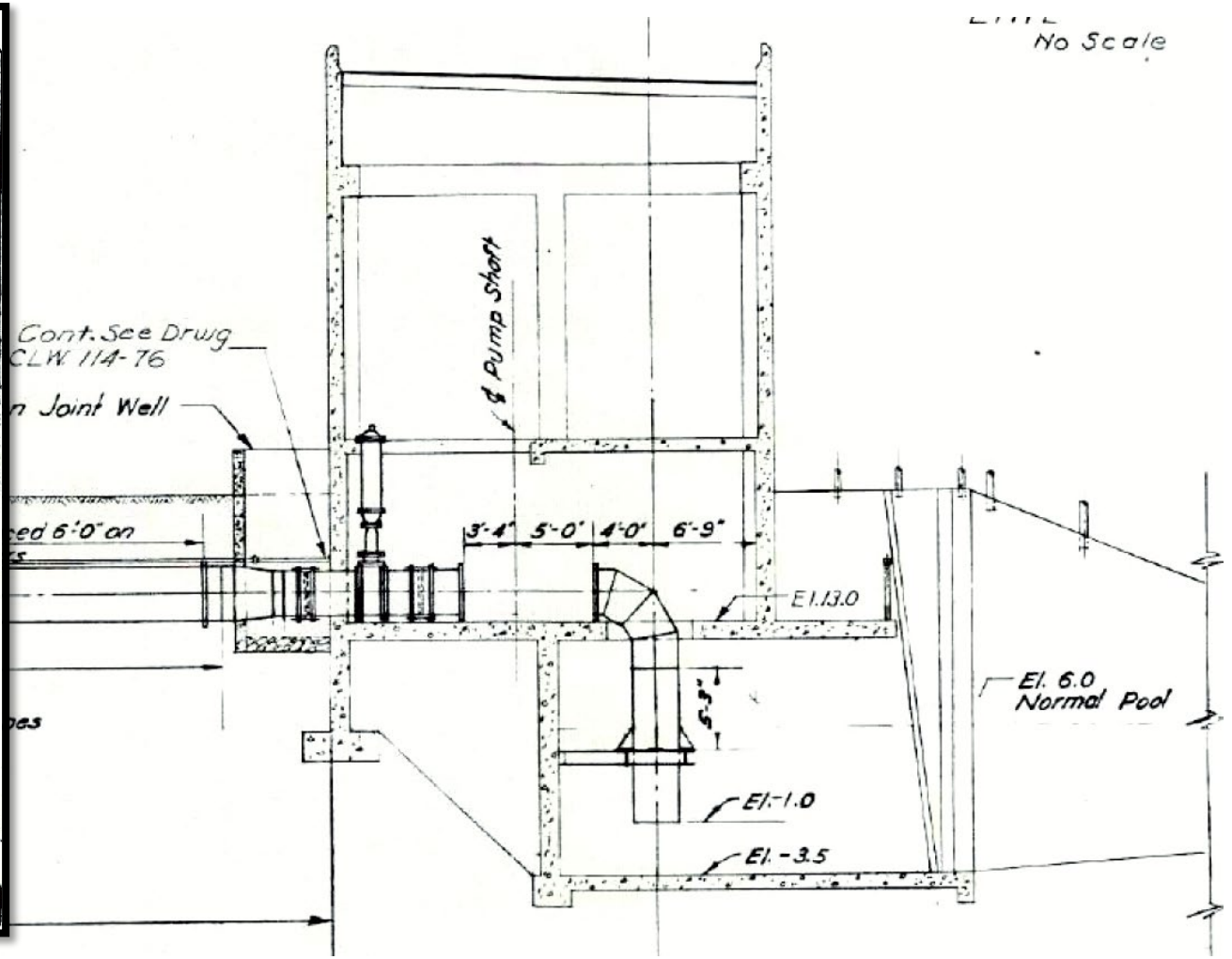
Jacobs

Challenging today.
Reinventing tomorrow.

Boneyard

Design – The Pumping Challenge Section from 1948 drawings





Pump Station 1 Design Solution - Mechanical