



Hydroelectric Energy Recovery Opportunities at Two PRV Stations in the Tualatin Valley

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Acknowledgements

- Energy Trust of Oregon
- Tualatin Valley Water District
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 - Troy VanRoekel
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- Bryan Hemphill, Kristi Nelson, Jeff Blank, Andrea Heckman (HDR)



Outline

- Project Background
- Conditions at Two Study Sites
- Description of the Technology
- Evaluation of Turbine Alternatives
- Summary of Project Payback and Carbon Offset

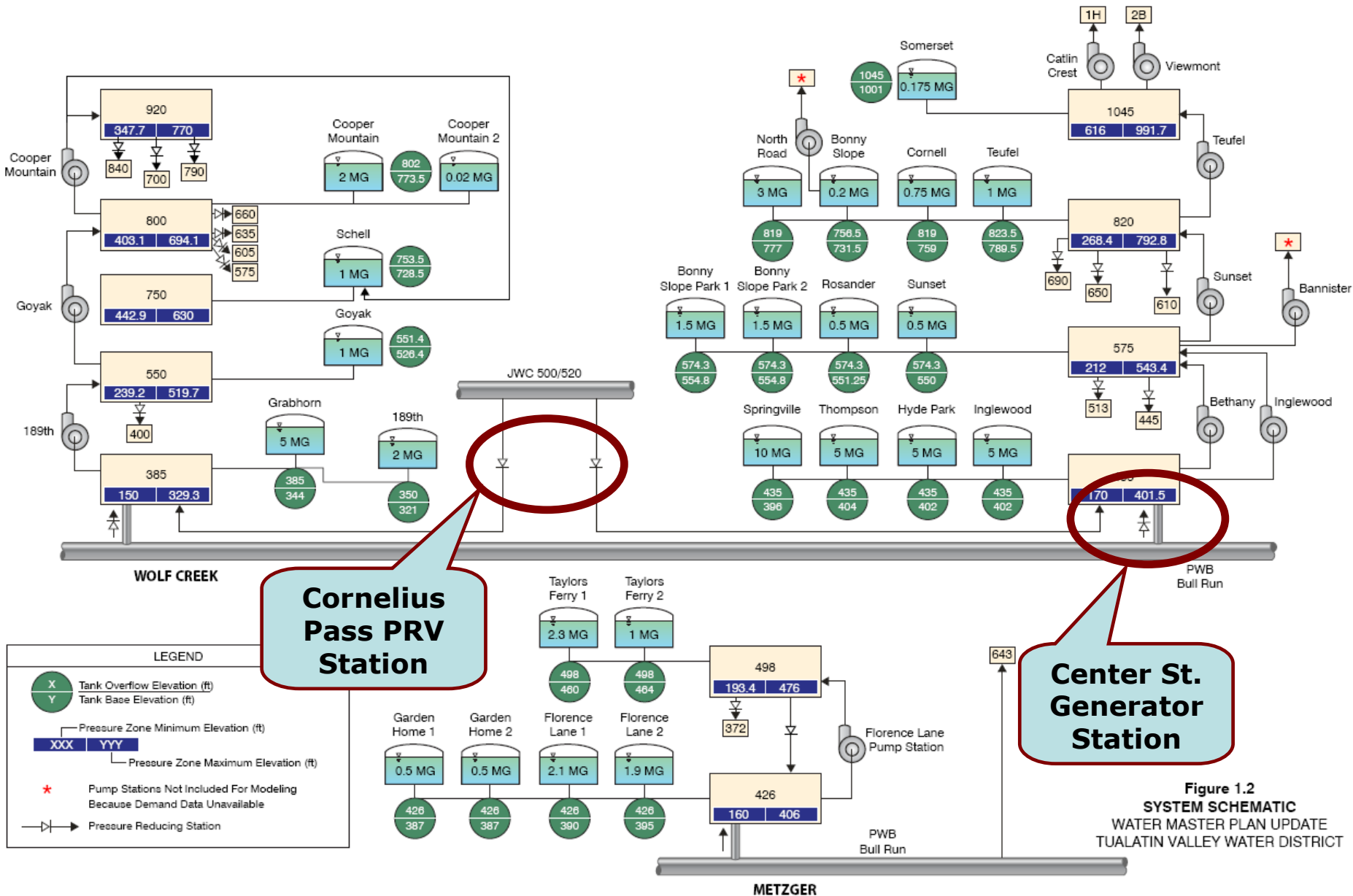
**Cornelius
Pass PRV
Station**

The map shows several water districts: Tualatin Valley Water District (Wolf Creek) in the north, West Slope Water District in the center, Tualatin Valley Water District (Metzger) in the south, and Valley View Water District to the east. Major roads like I-5 and I-205 are visible, along with the Willamette River. Callouts with red borders and light blue backgrounds point to specific locations on the map.

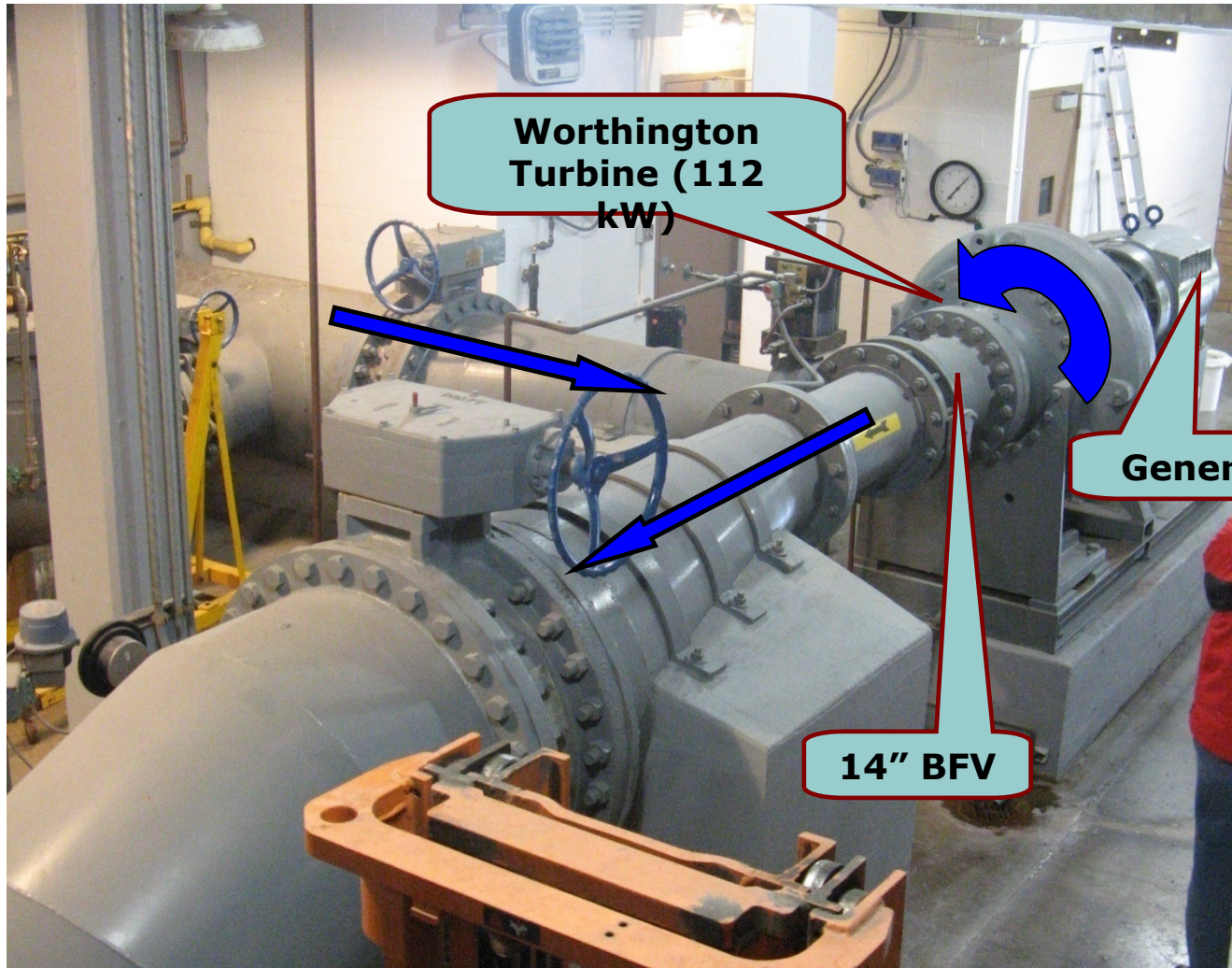
**Center St.
Generator
Station**

**TUALATIN VALLEY
WATER DISTRICT
(METZGER)**

2007 TVWD Master Plan Update System Schematic



Center St. Generator Station



Cornelius Pass PRV Station



435 Zone
PRV

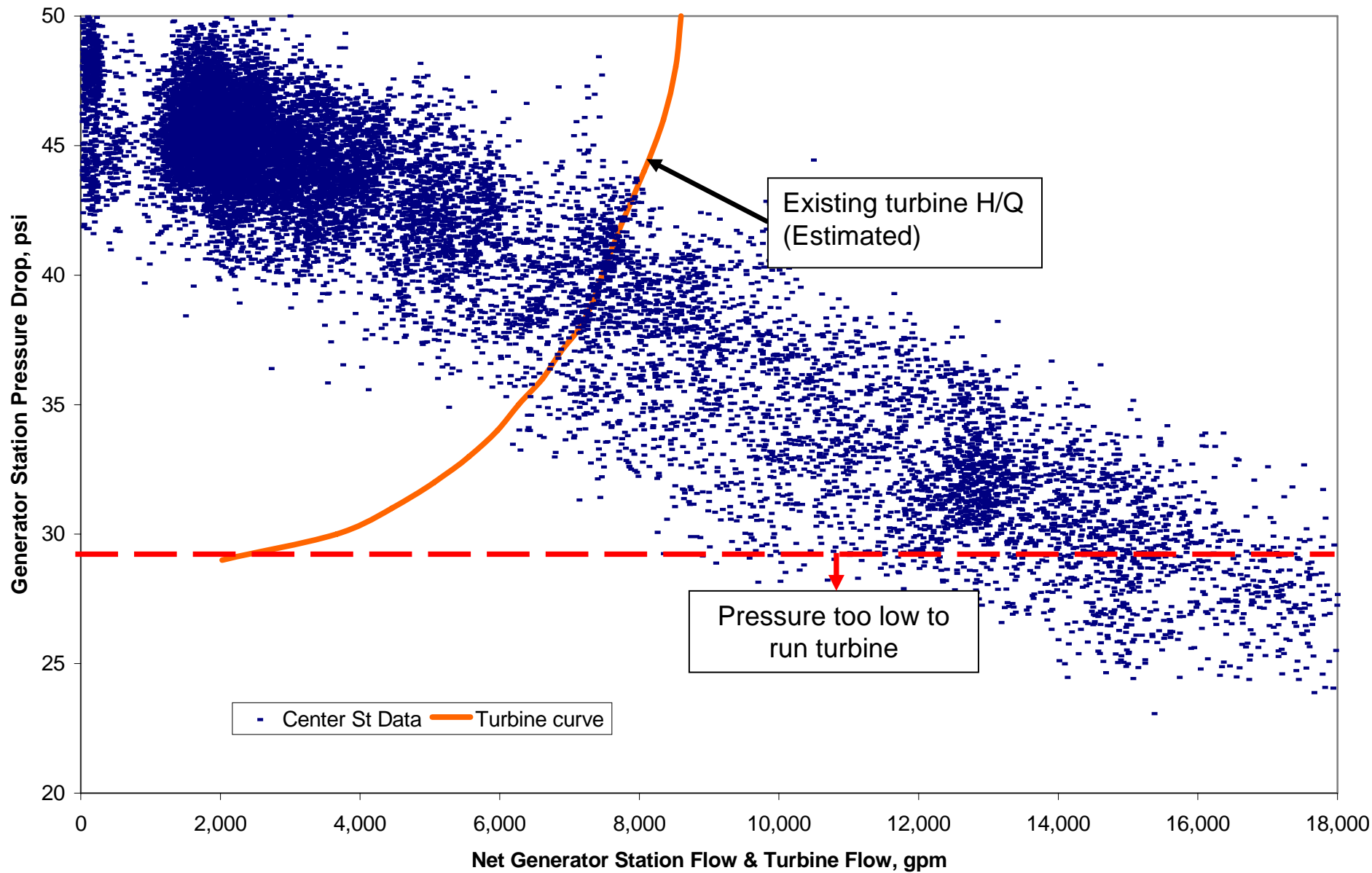
385 Zone
PRV



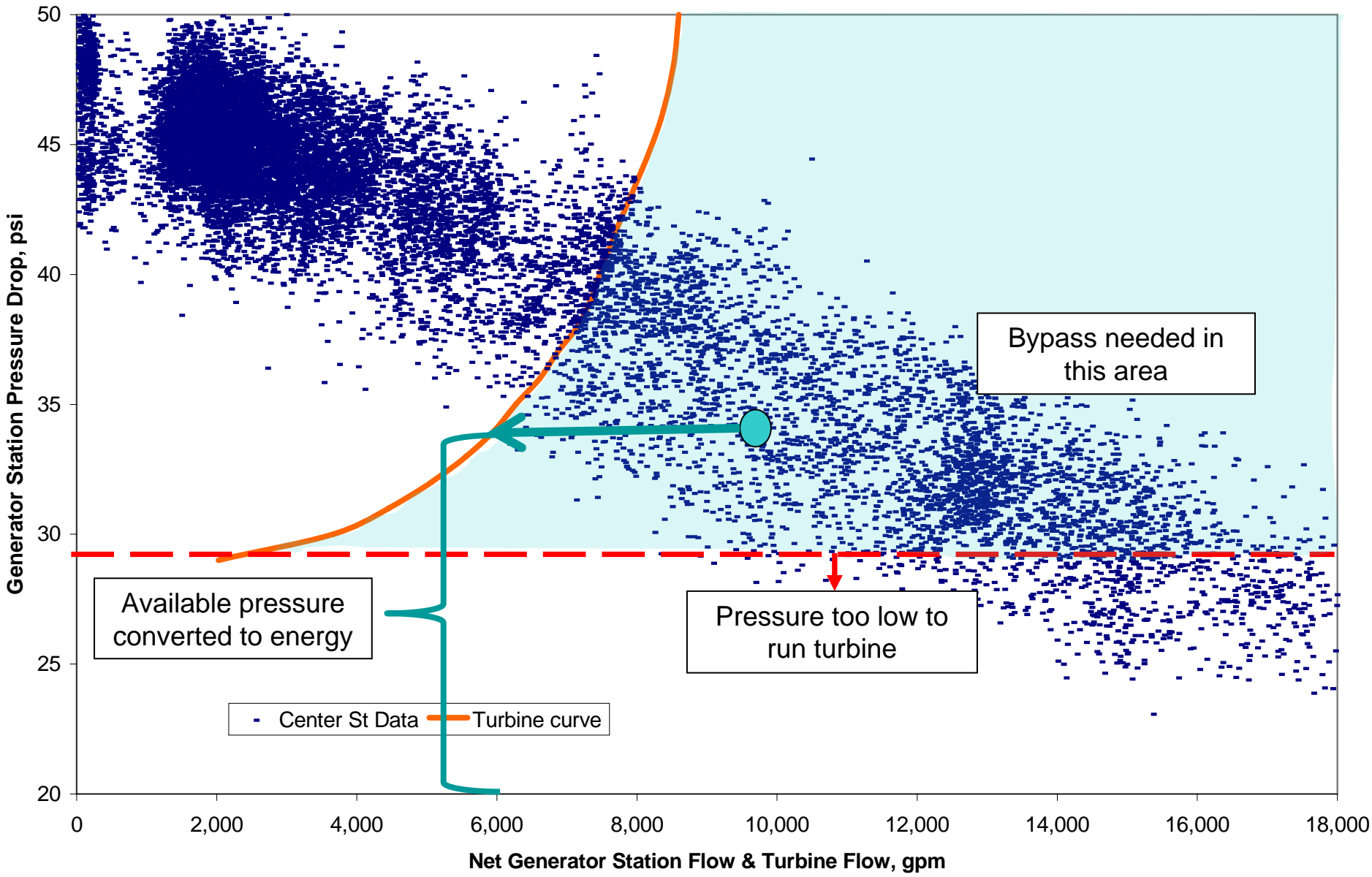
Basic Concept – Energy Recovery

- Pressure from sources is too high and must be reduced
- Typically done with pressure reducing valves (PRVs)
- By using a turbine generator, part of energy is converted to power
- Energy = Flow x Pressure Drop

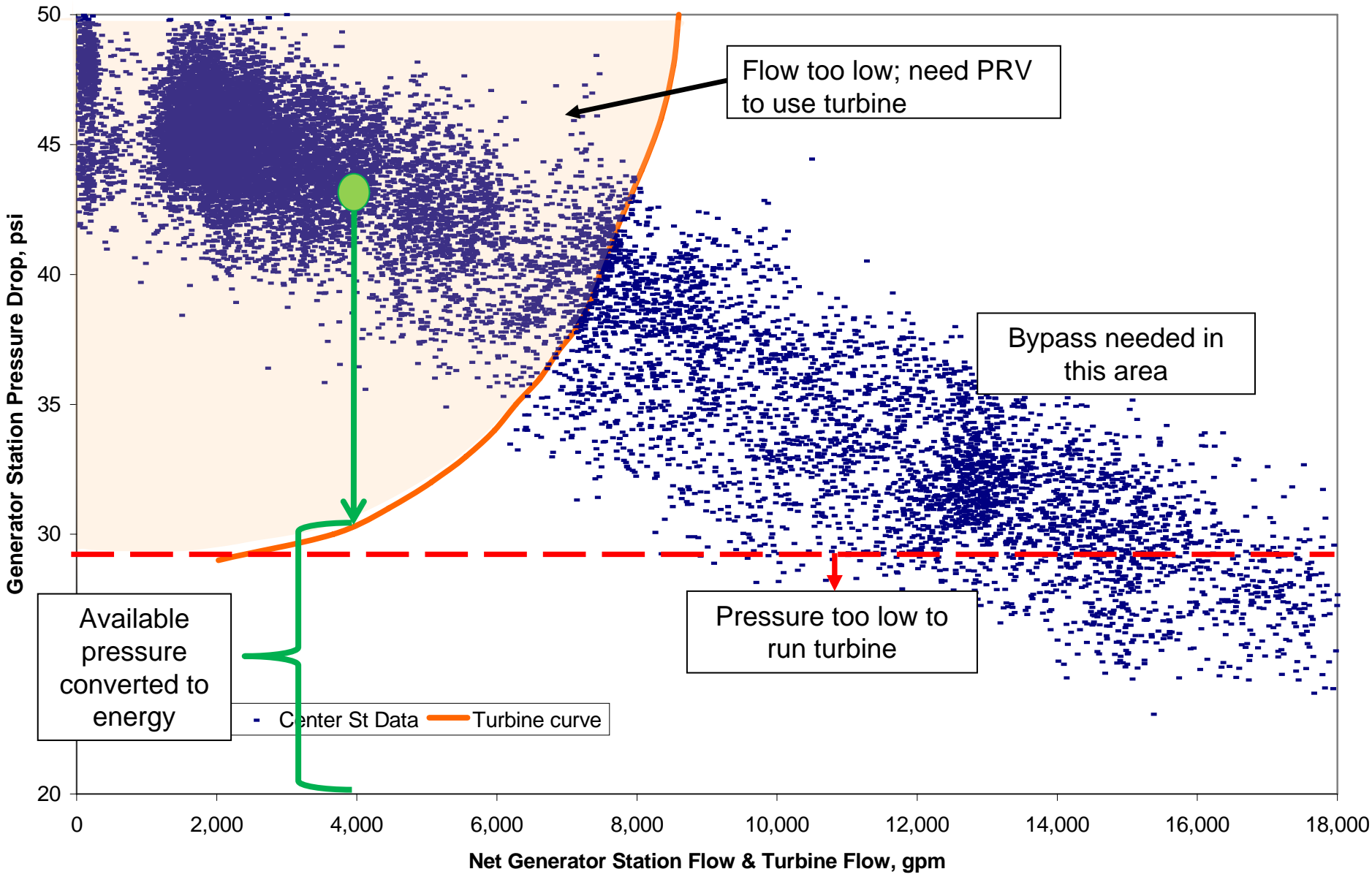
Center St. Generator Station - Δ Pressure vs. Flow (2006-07)



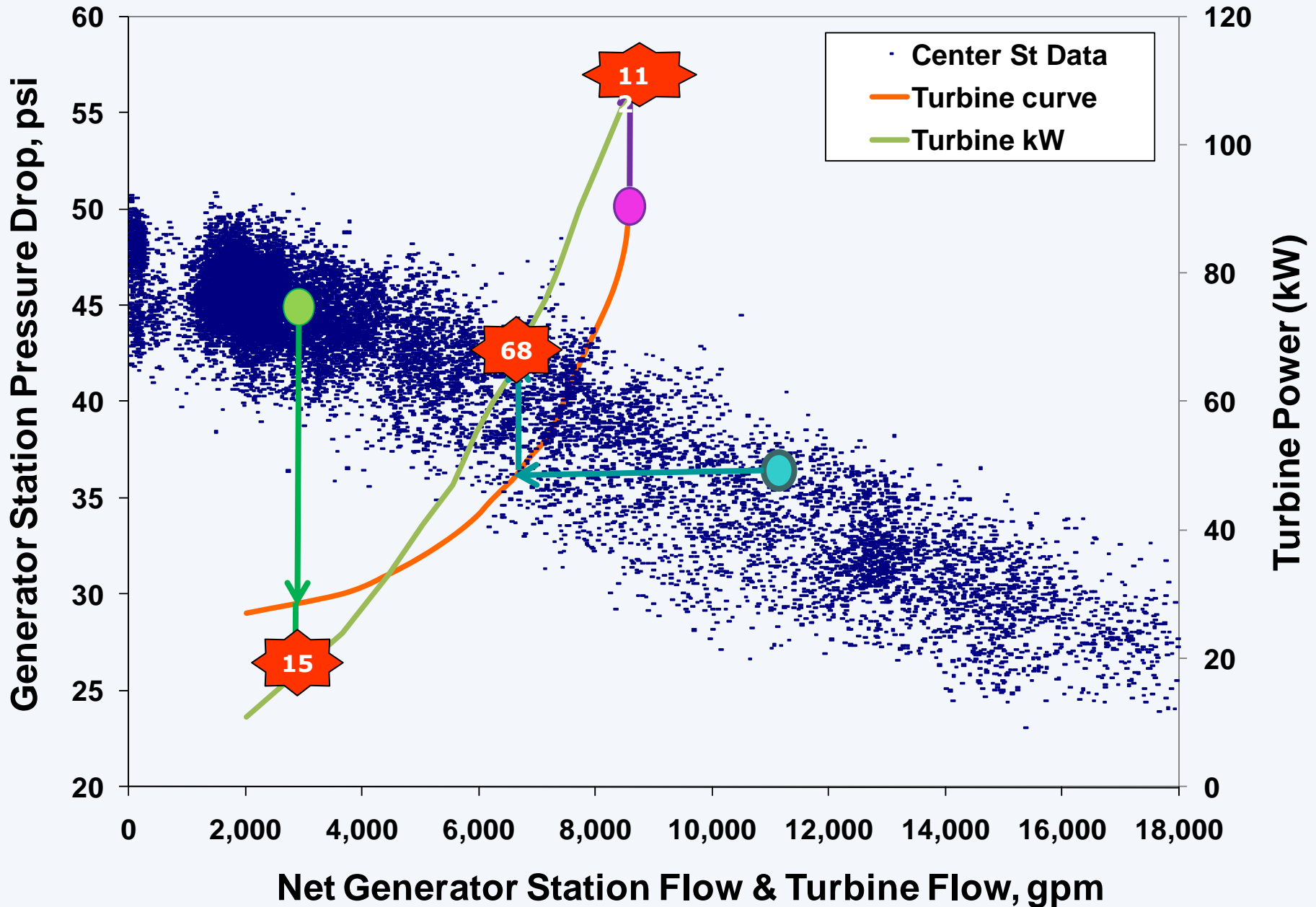
Center St. Generator Station - Δ Pressure vs. Flow (2006-07)



Center St. Generator Station - Δ Pressure vs. Flow (2006-07)



Center St. Generator Station - Δ Pressure vs. Flow (2006-07)



Evaluation Approach

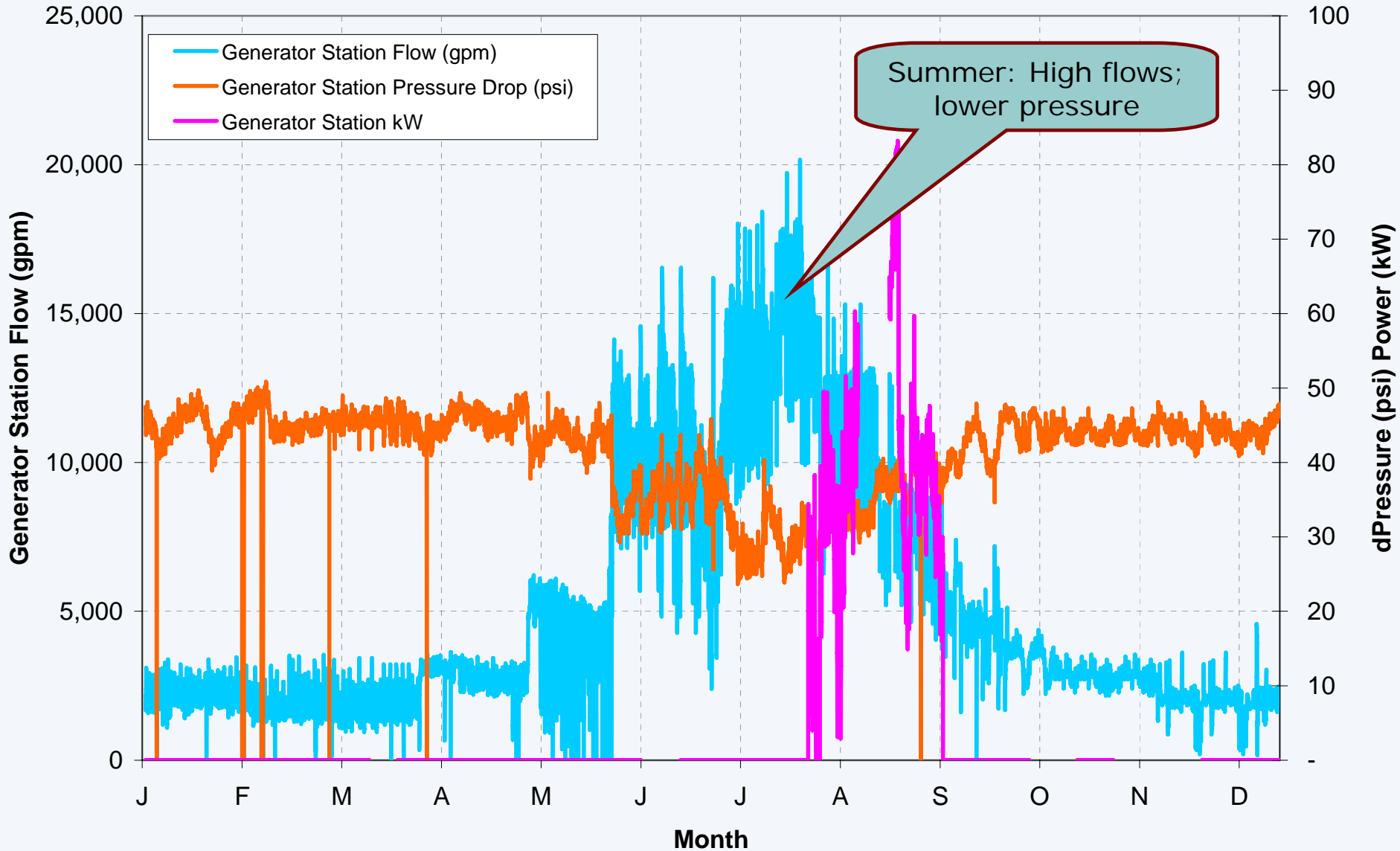
- Develop hourly flow & pressure projections for evaluation period
 - Capture diurnal and seasonal variabilities
 - Future system growth and changes
- Calculate generator kW for each hour during evaluation period
- Determine project cost and construction/retrofit feasibility for alternatives
- Compare alternatives:
 - Determine project payback period (assume \$0.05/kWh)
 - Calculate carbon offset for each alternative (1 kWh = 1 lb CO₂)



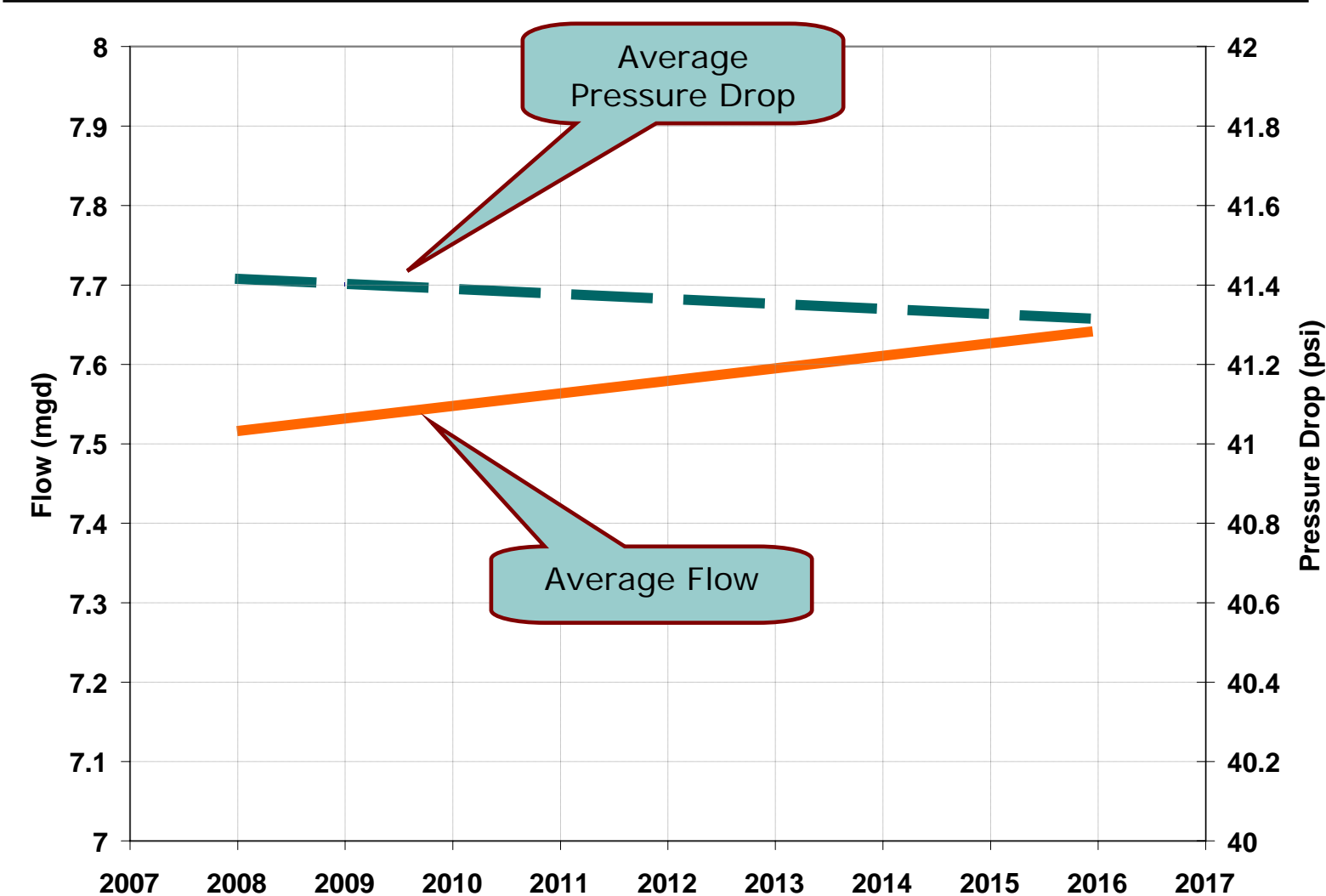
Analysis Approach: Center St Generator Station

- Identify evaluation period and projected flows and pressures through station
- Identify and evaluate alternatives:
 - Existing 112 kW turbine (baseline scenario)
 - Existing turbine with D/S PRV
 - Replacement of existing turbine with Cornell 44, 50, 83, and 96 kW turbines (w/ and w/o D/S PRV)

Center St. Generator Station 2007 Flow and Pressure



Center St. Flow and Pressure Projections



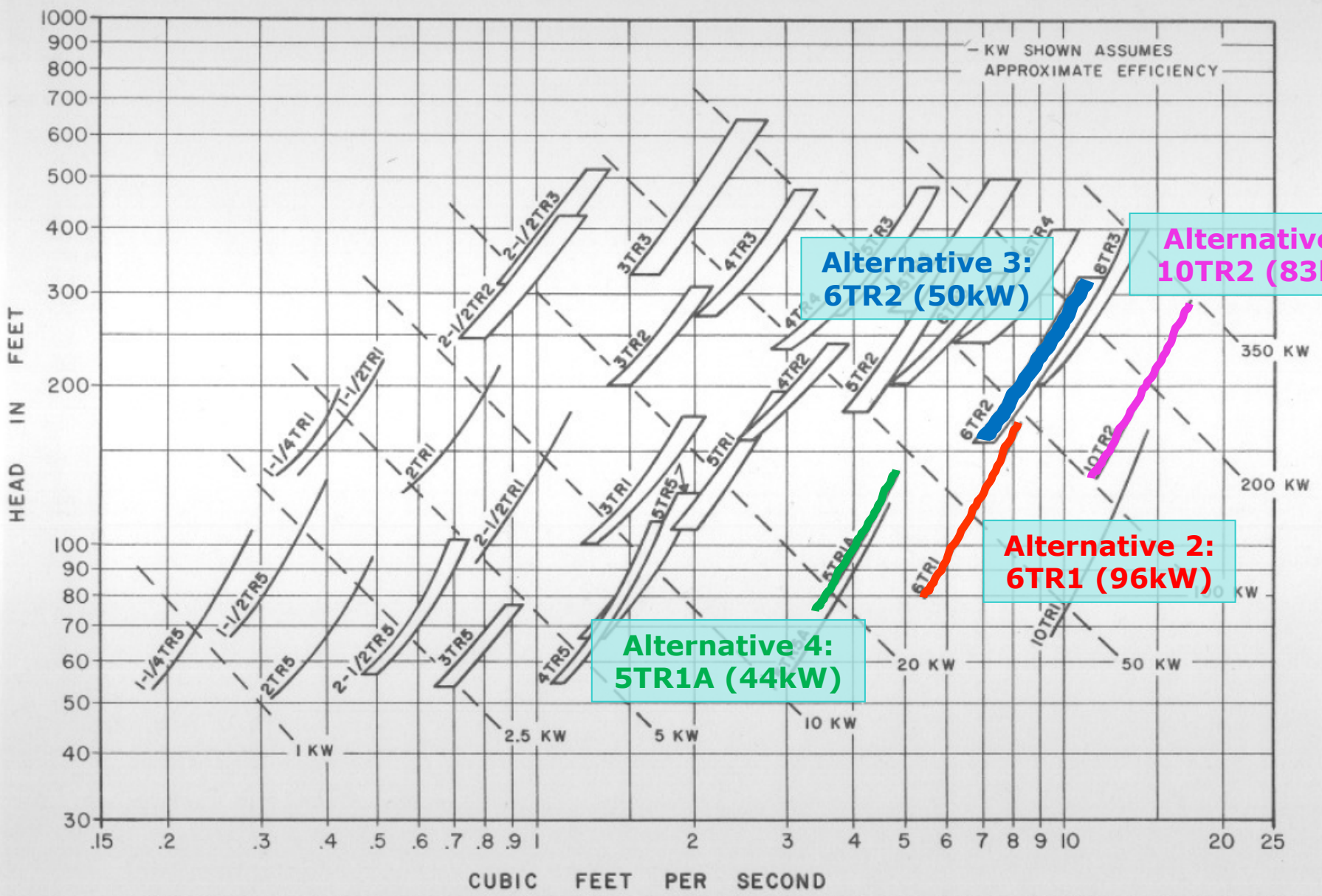
TURBINE SELECTION CHART CORNELL CAST RUNNERS

1800 RPM

OCT. 1982

JANUARY 1987

280-1



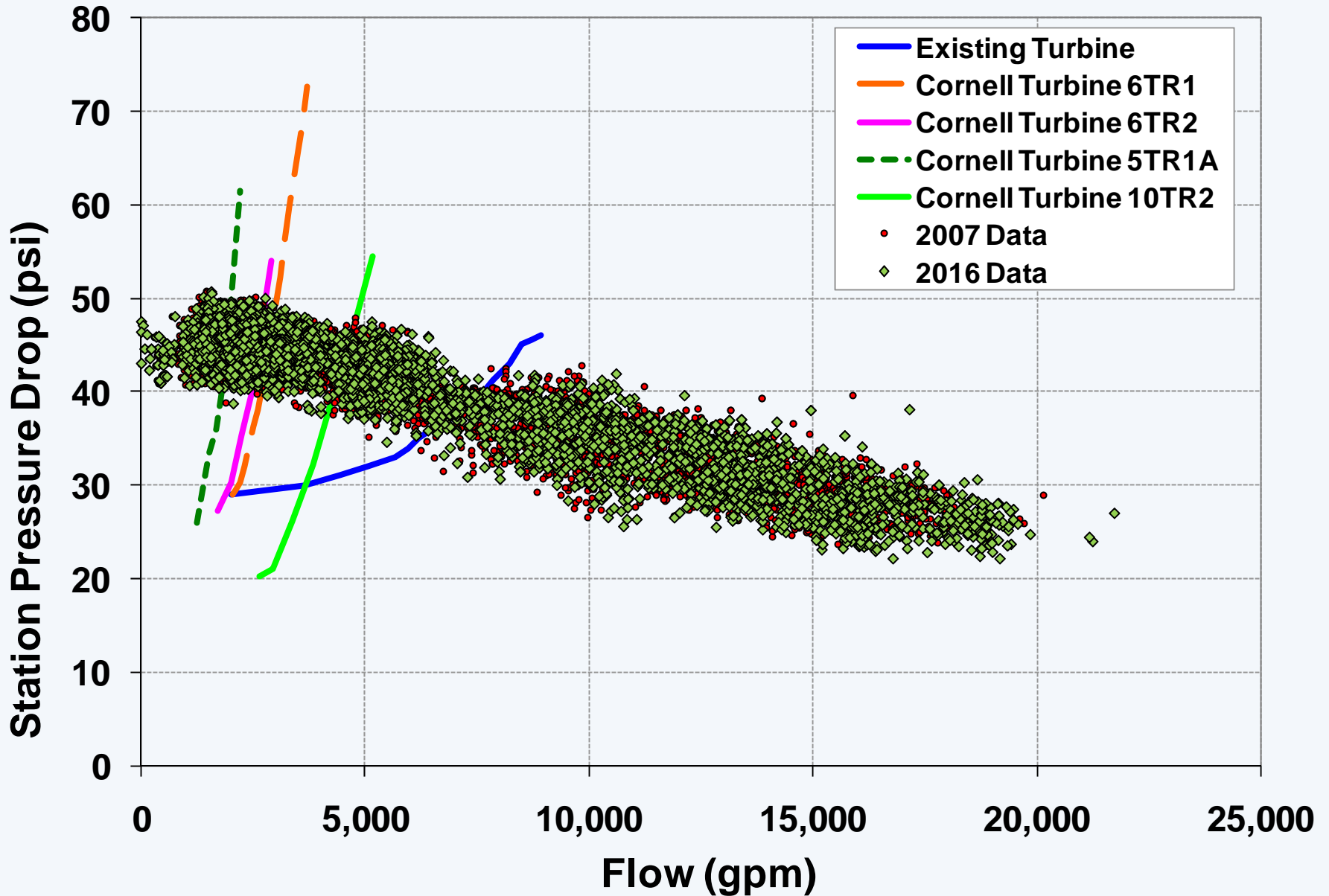
**Alternative 3:
6TR2 (50kW)**

**Alternative 5:
10TR2 (83kW)**

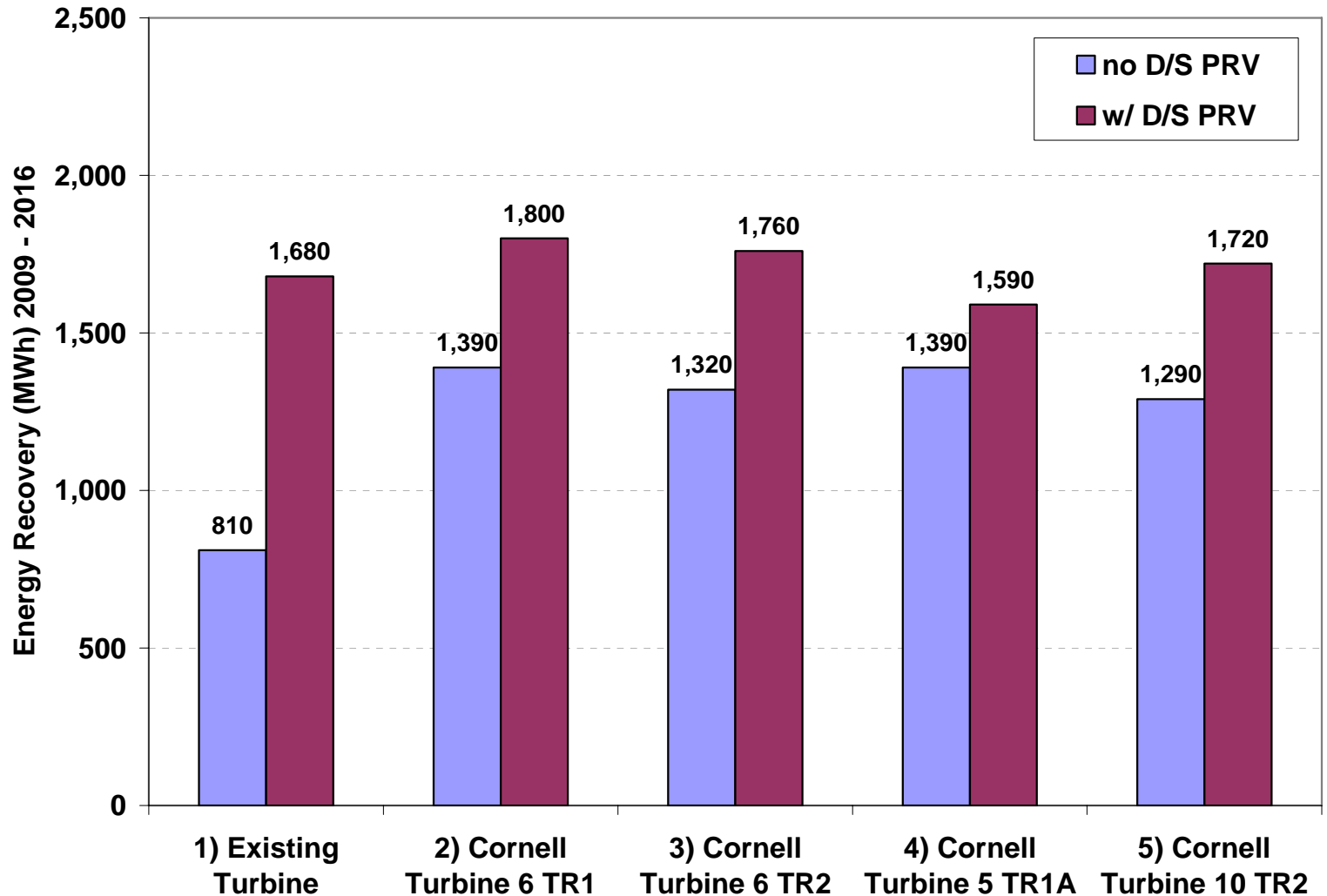
**Alternative 2:
6TR1 (96kW)**

**Alternative 4:
5TR1A (44kW)**

Center St. Alternative Turbines

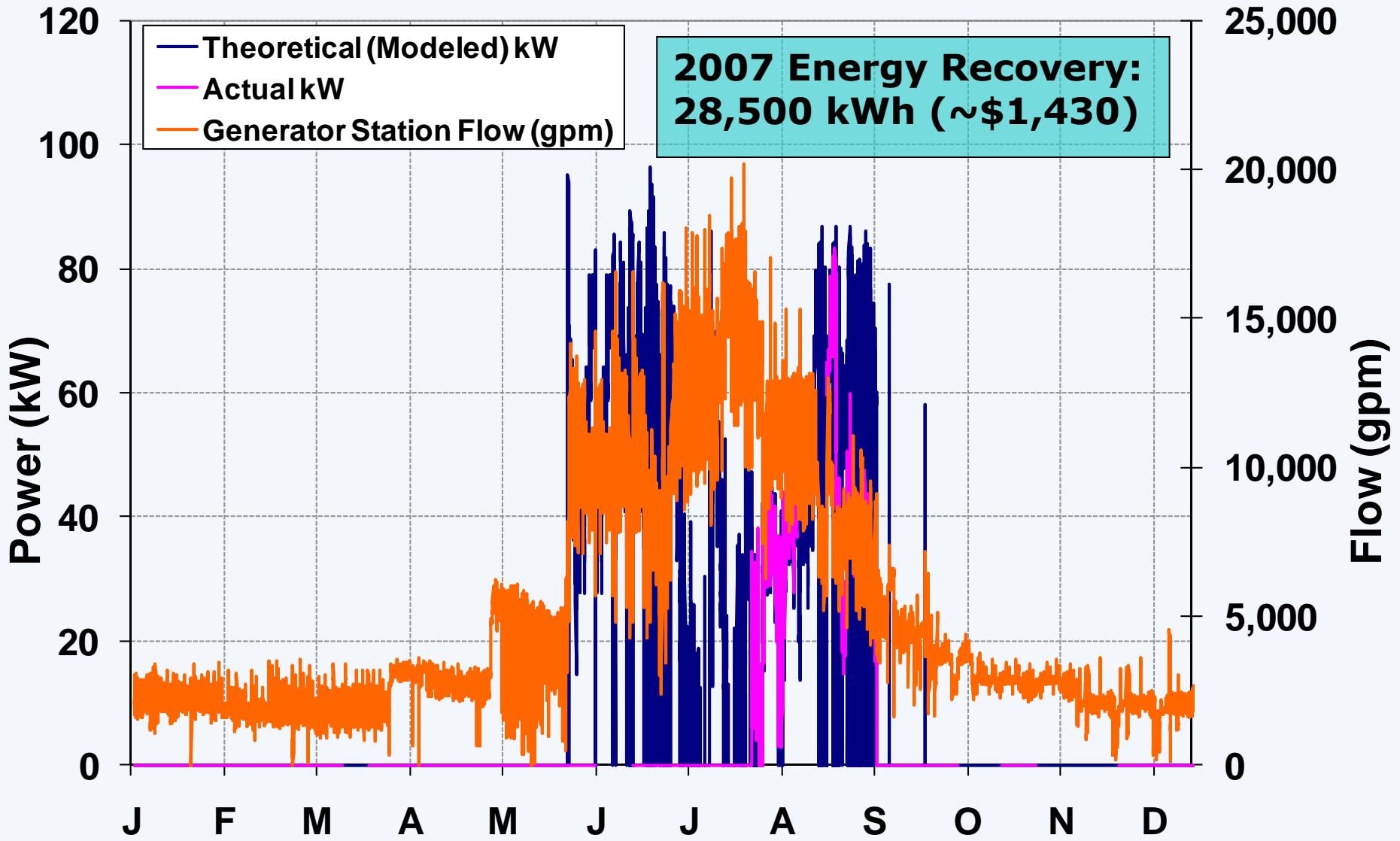


Center St. Alternatives – Energy Recovery



Center St Generator Station

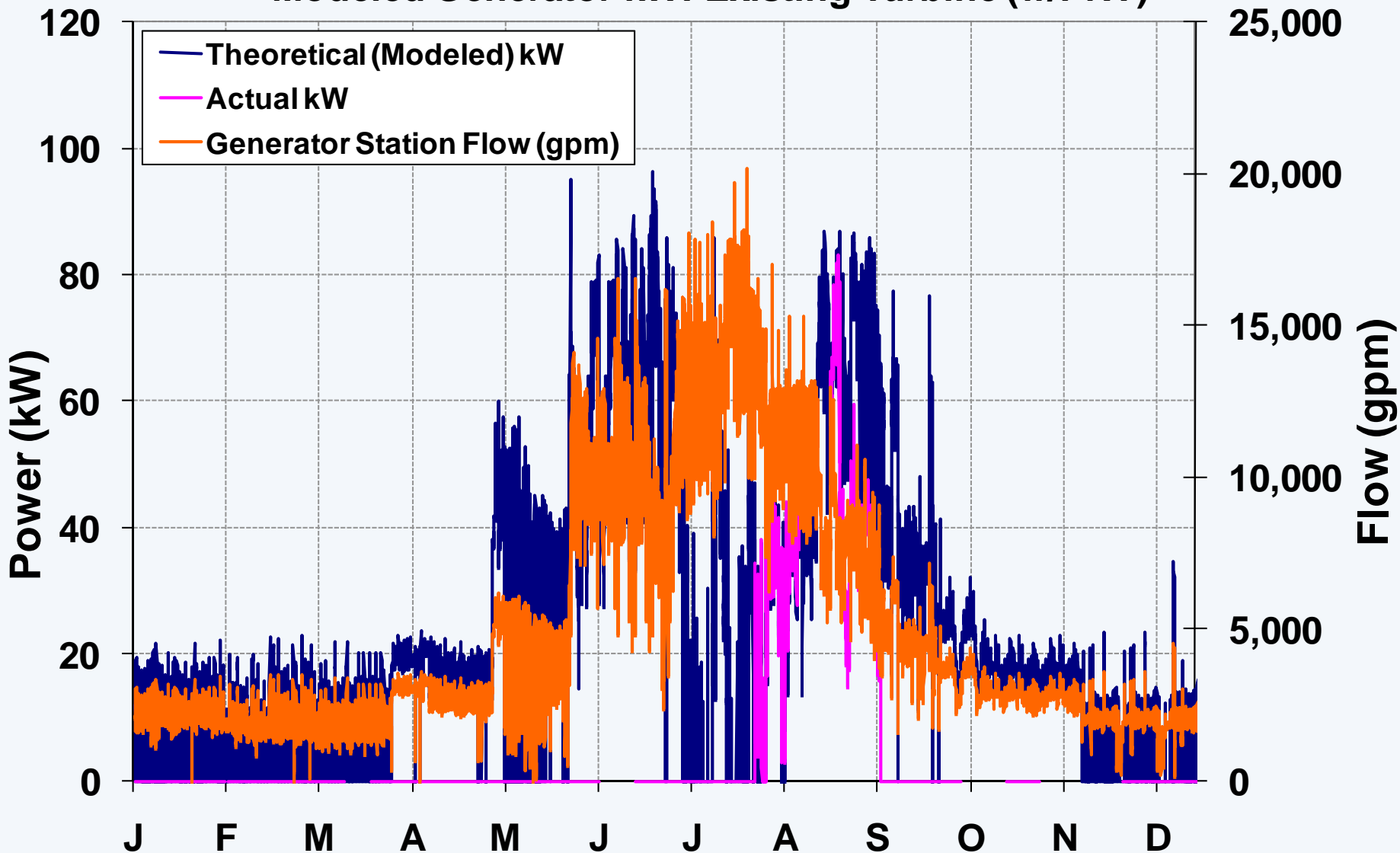
Modeled Generator kW: Existing Turbine (no PRV)



**Estimated 2009-16 Energy Recovery:
810 MWh (~\$40,000 or ~\$5,700/yr)**

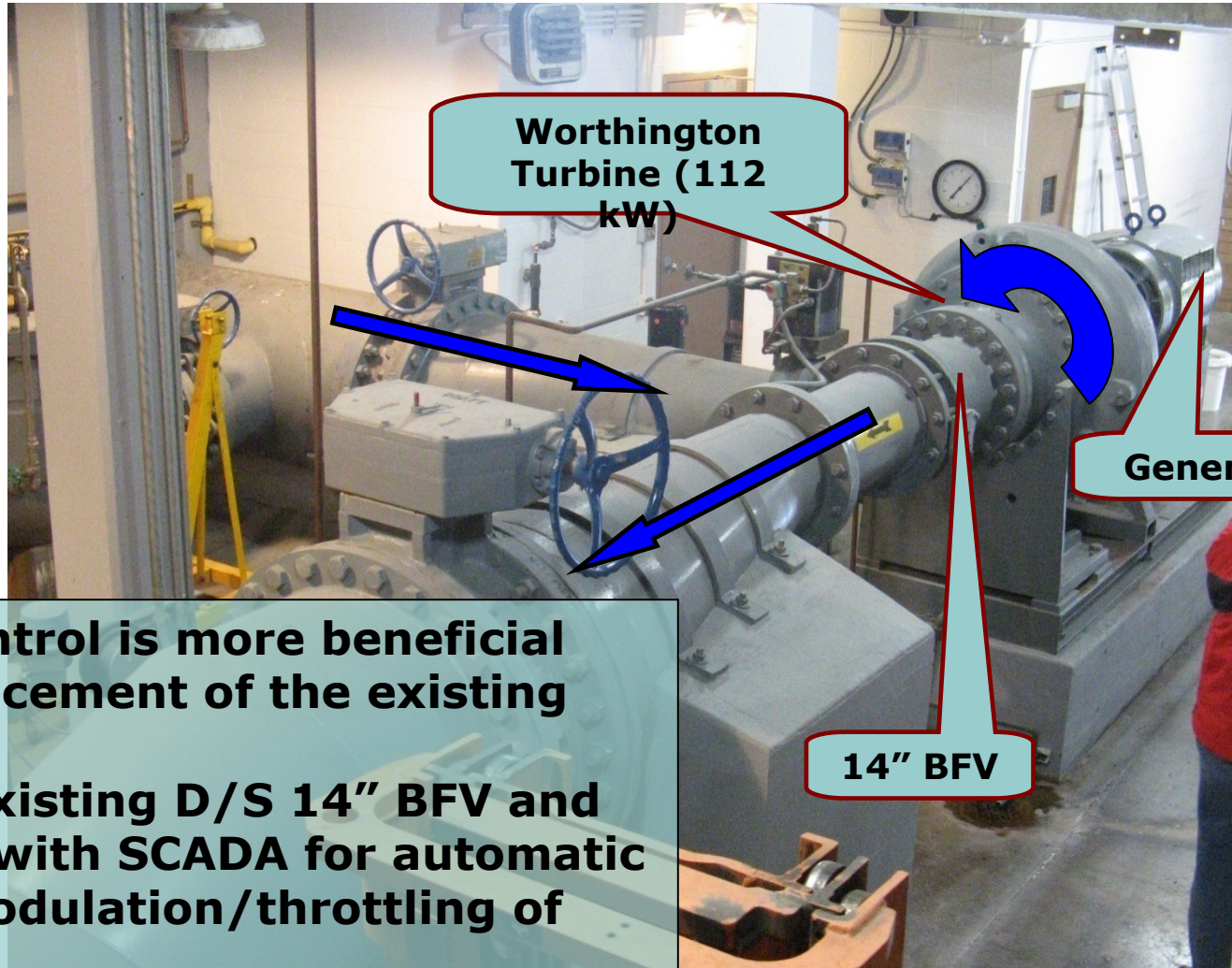
Center St Generator Station

Modeled Generator kW: Existing Turbine (w/PRV)



**Estimated 2009-16 Energy Recovery:
1680 MWh (~\$84,000 or ~\$12,000/yr)**

Recommendations for Center St

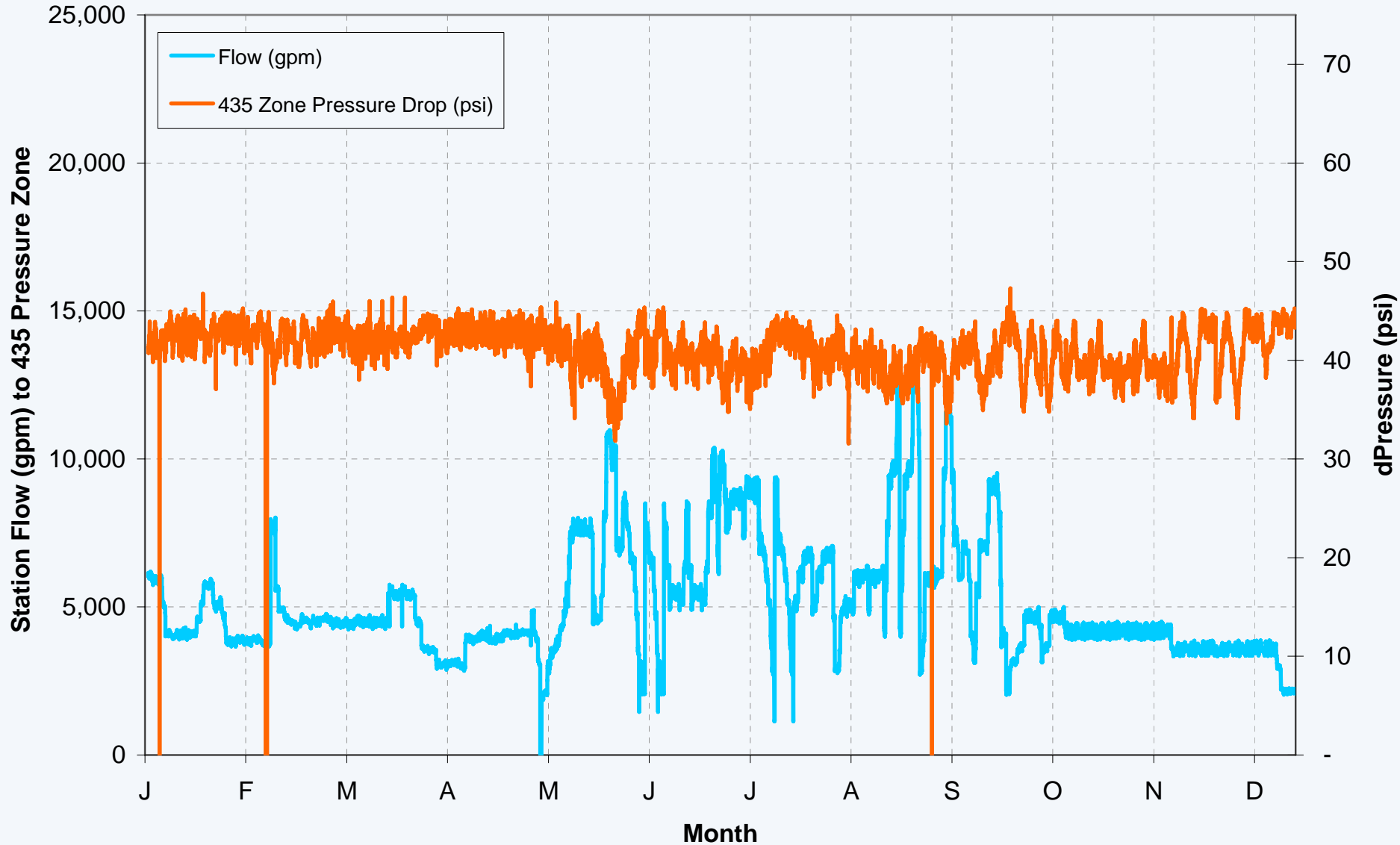


- Flow control is more beneficial than replacement of the existing turbine
- Modify existing D/S 14" BFV and integrate with SCADA for automatic remote modulation/throttling of flow

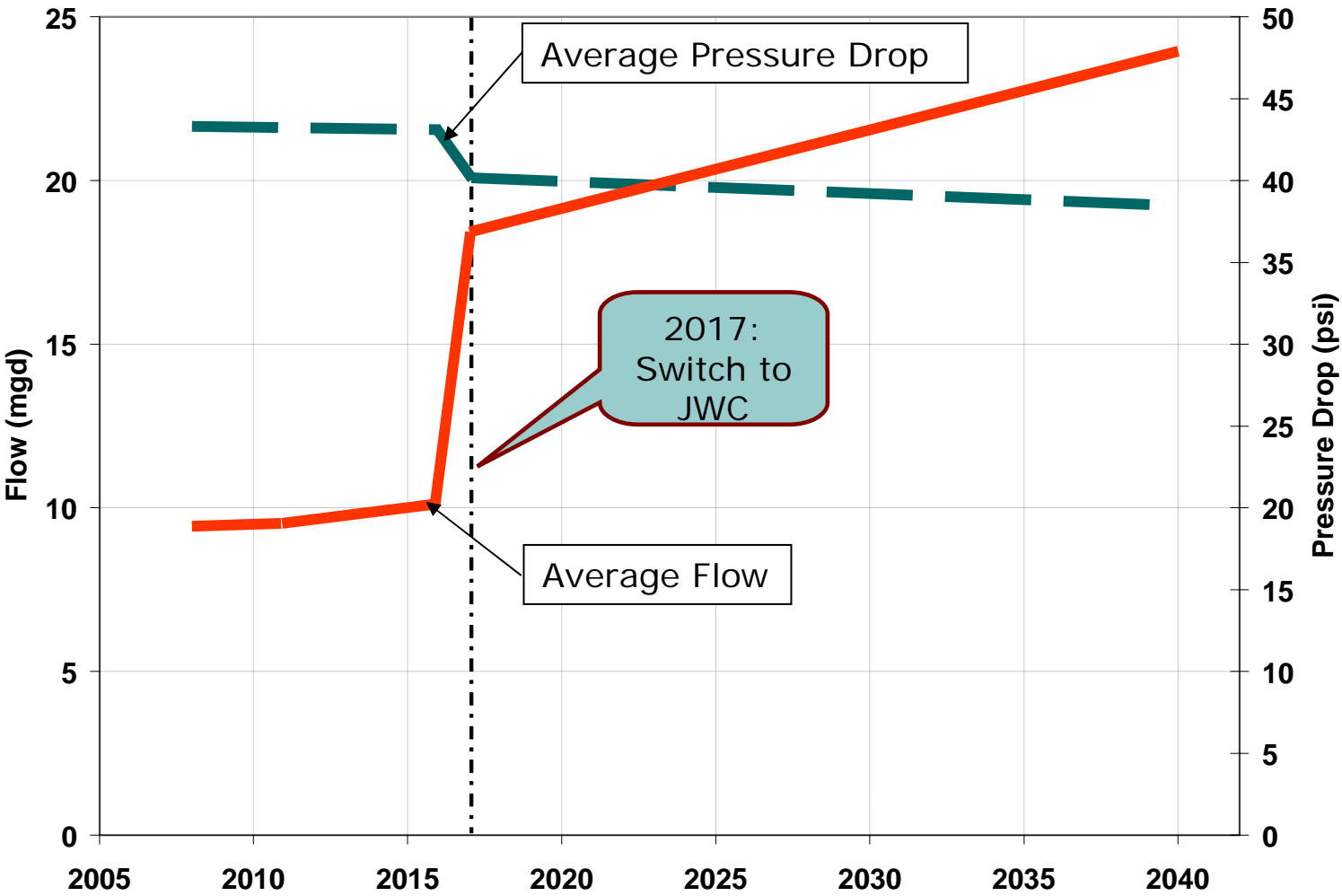
Cornelius Pass Approach

- PRV station supplies two pressure zones:
 - Elev. 385 (extra 50' of pressure, but lower flow)
 - Elev. 435
- Considered four arrangements for turbine:
 - 435 zone only
 - 385 zone only
 - Full station taking all flows
 - One each on 385 and 435 linesEach considered several turbine sizes

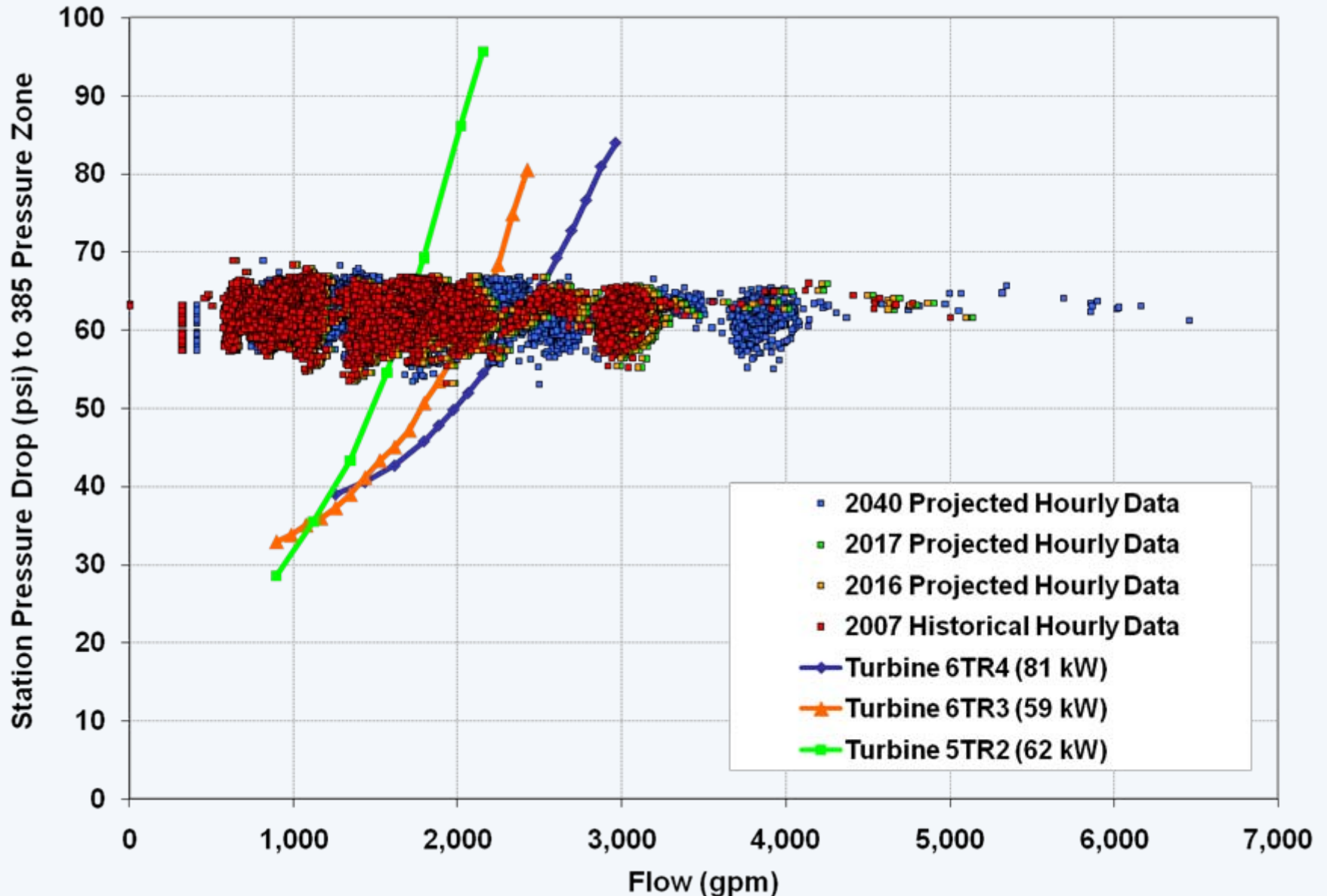
Cornelius Pass PRV Station 2007 Flow and Pressure



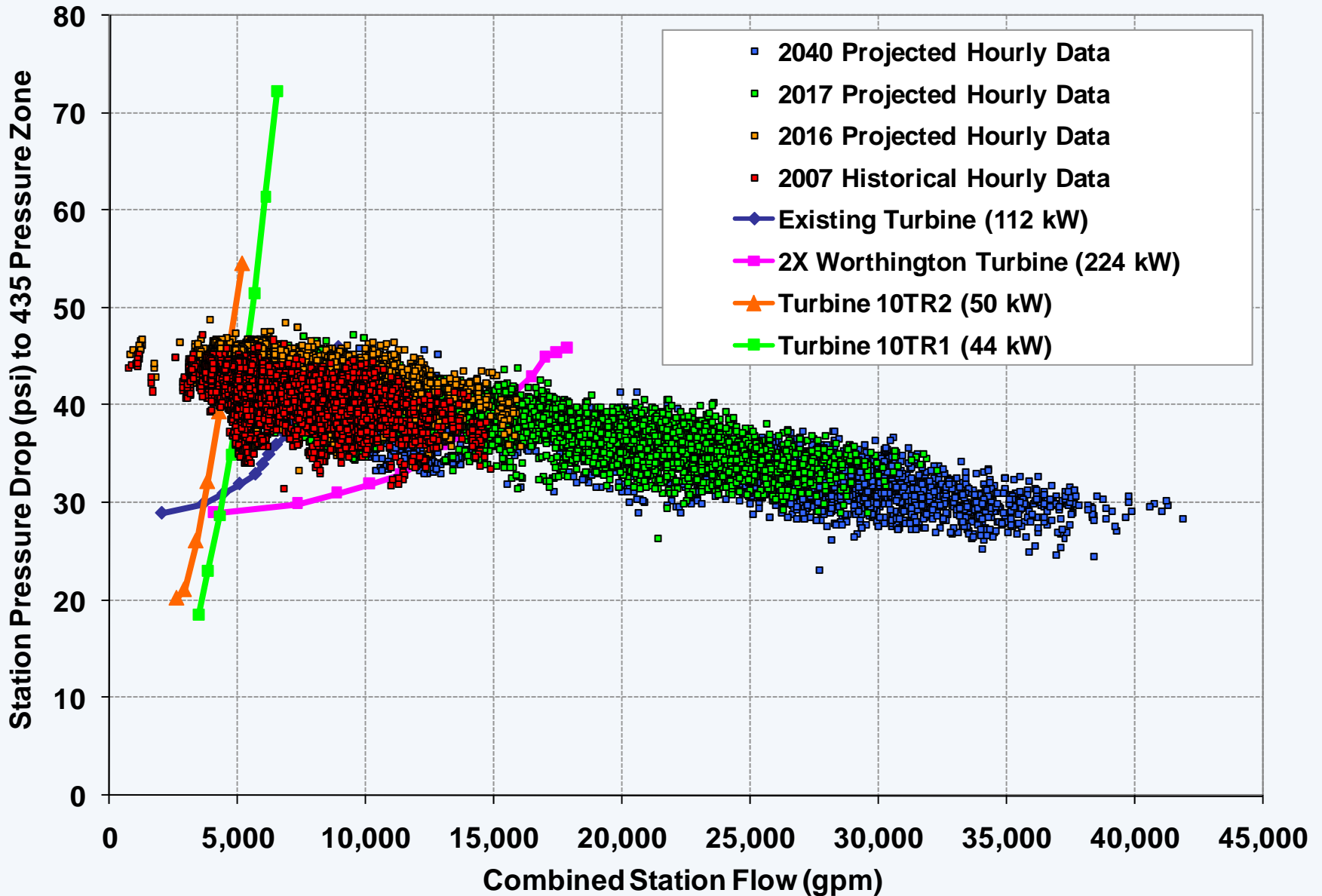
Cornelius Pass Trends



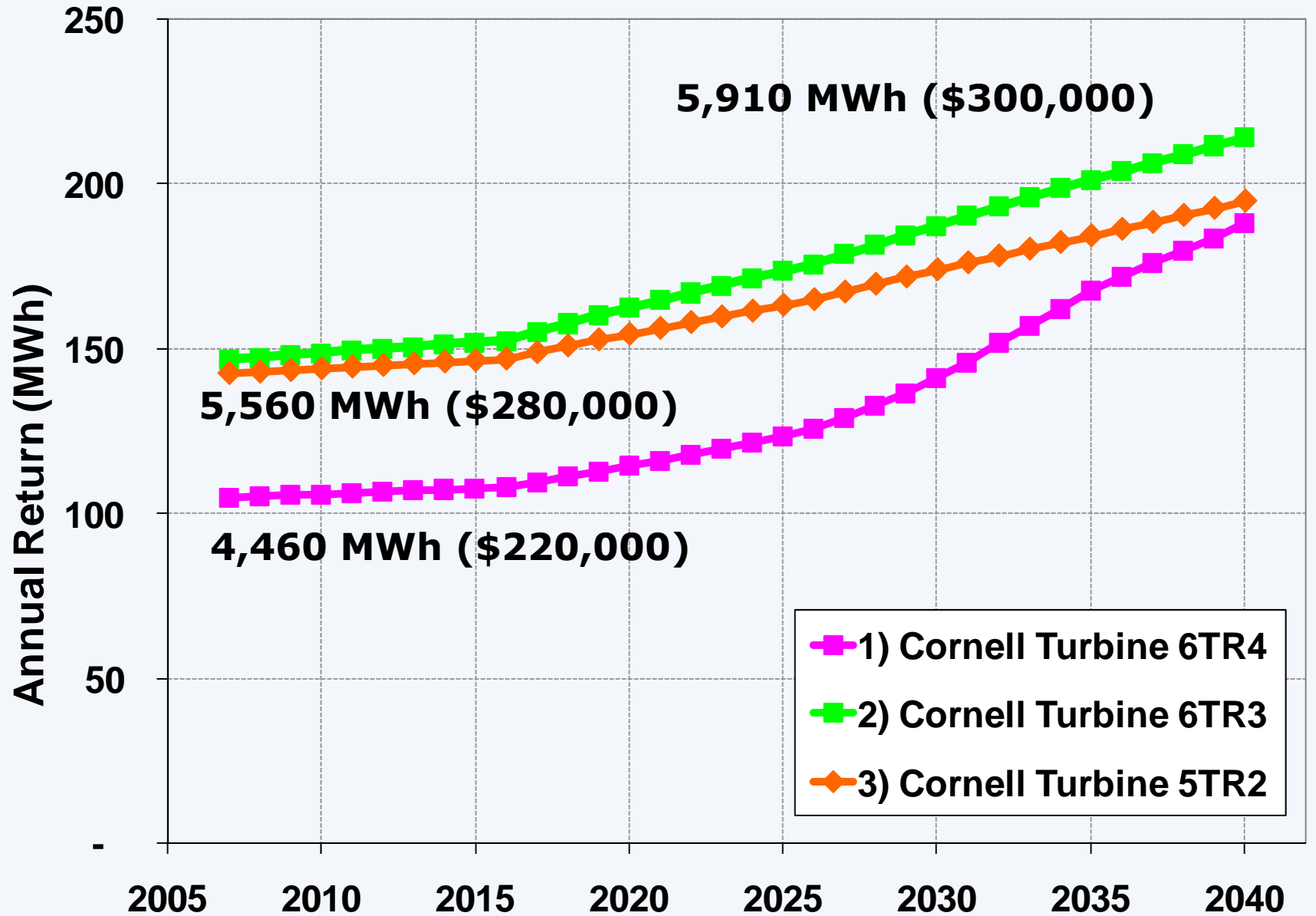
Turbine Curves for Cornelius Pass – 385 Zone Flow



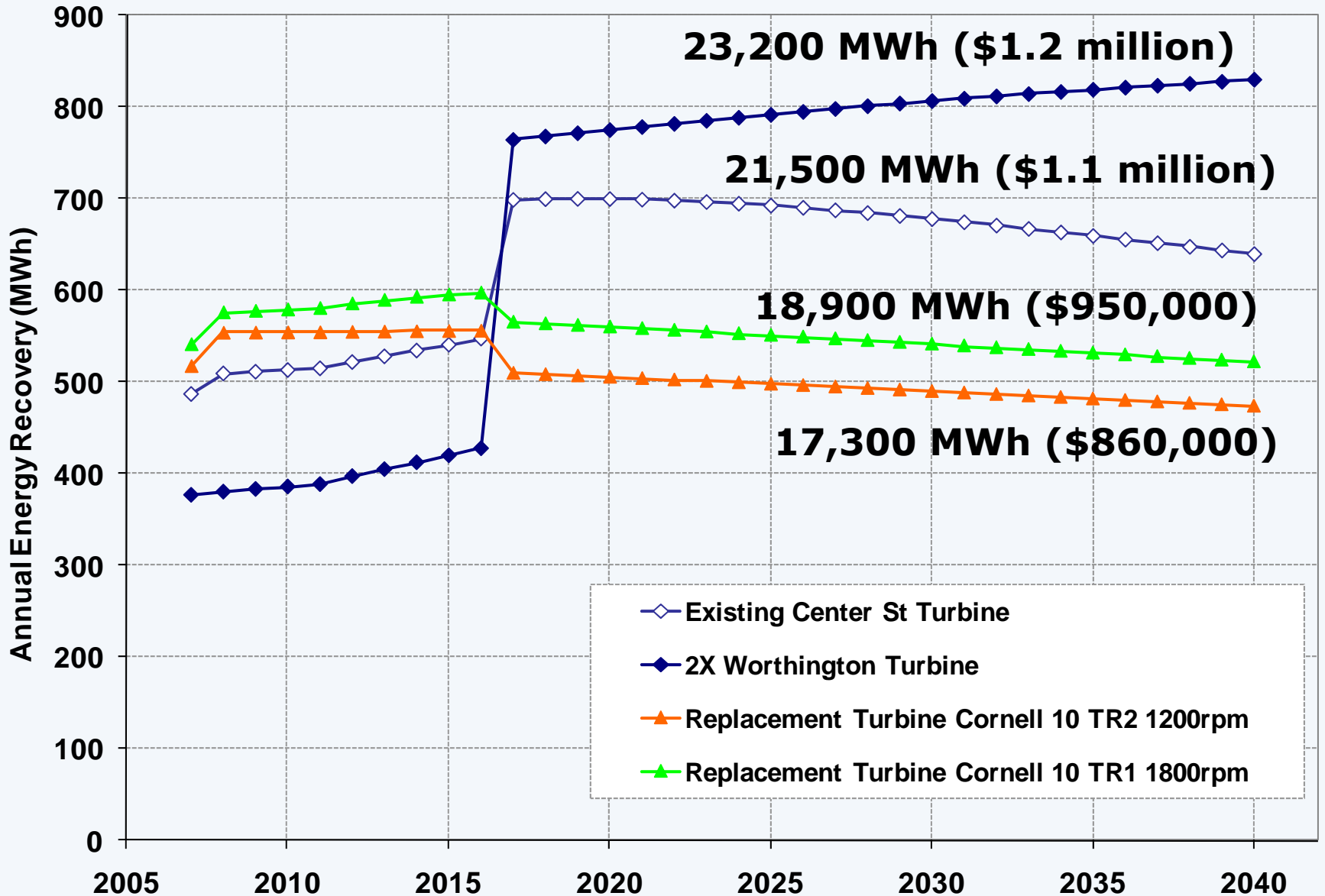
Turbine Curves for Cornelius Pass - Entire Station Flow



385 Zone Alternatives – Energy Recovery Estimates



Entire Station Alternatives – Energy Recovery Estimates



Evaluation of Project Payback

Zone	Selected Alternative	Project Cost	Incentivized Project Cost	Incentivized Payback (yrs)	Carbon Offset (tons CO2)
Entire Station	2X Worthington Turbine	\$670,000	\$380,000	9	10,700
385 Only	Cornell 6TR3 Turbine	\$460,000	\$260,000	24	2,960
435 Only	Worthington Turbine	\$620,000	\$350,000	13	8,190
385+435	6TR3, Worthington Turbine	\$1,000,000	\$560,000	16	11,100

Any questions??

Feel free to contact us at:

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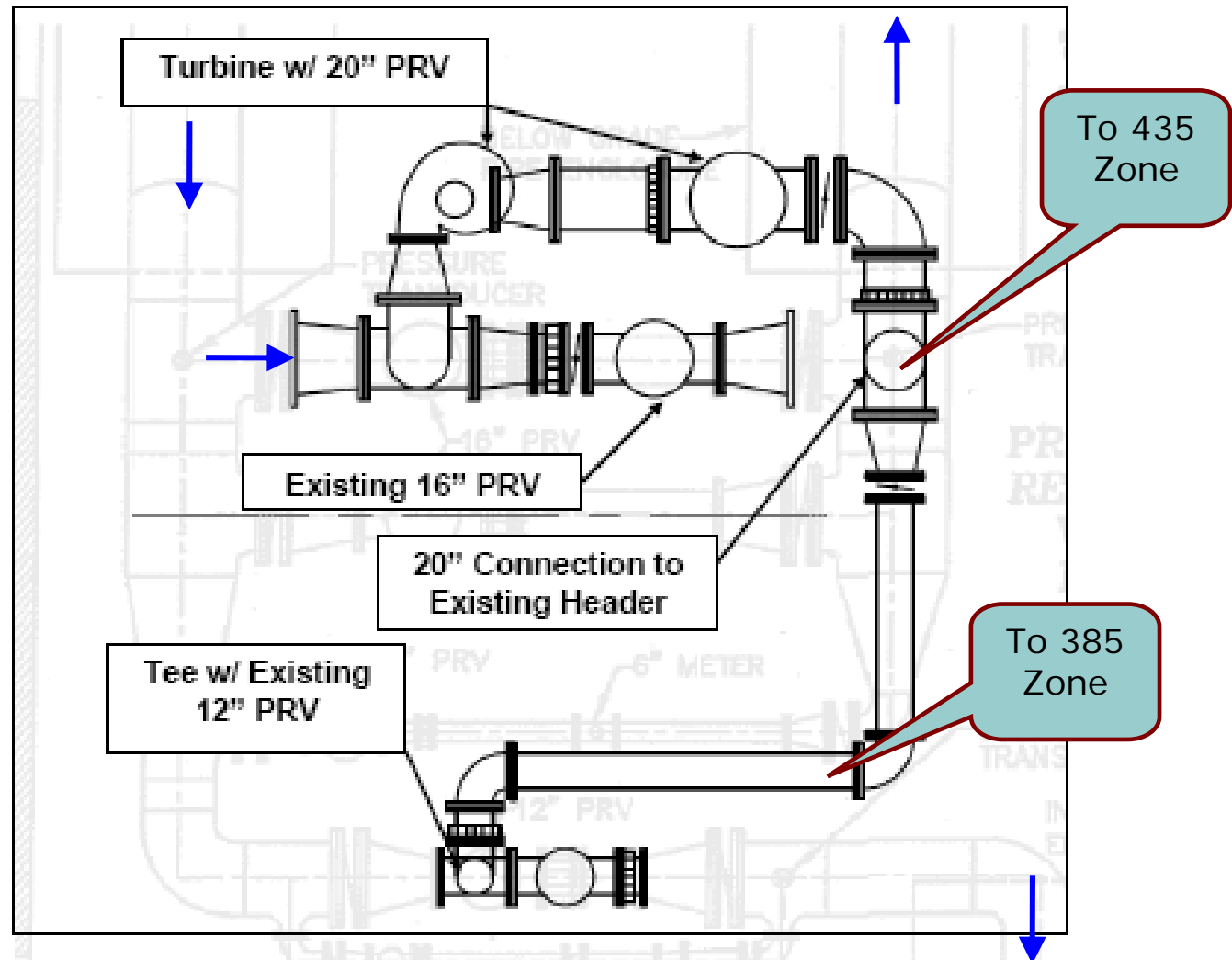
Cost Analysis – Cornelius Pass Alternatives; Part 2

Combined Zone	Un-Incentivized		Incentivized	
Estimated Project Capital Costs	\$	669,100	\$	378,100
2009 Annual Revenue	\$	21,369	\$	21,369
2040 Annual Revenue	\$	77,356	\$	77,356
Average Revenue	\$	53,521	\$	53,521
Payback Year		2022		2018
385 & 435 Zones	Un-Incentivized		Incentivized	
Estimated Project Capital Costs	\$	1,000,400	\$	565,300
2009 Annual Revenue	\$	19,206	\$	19,206
2040 Annual Revenue	\$	84,131	\$	84,131
Average Revenue	\$	53,821	\$	53,821
Payback Year		2032		2025

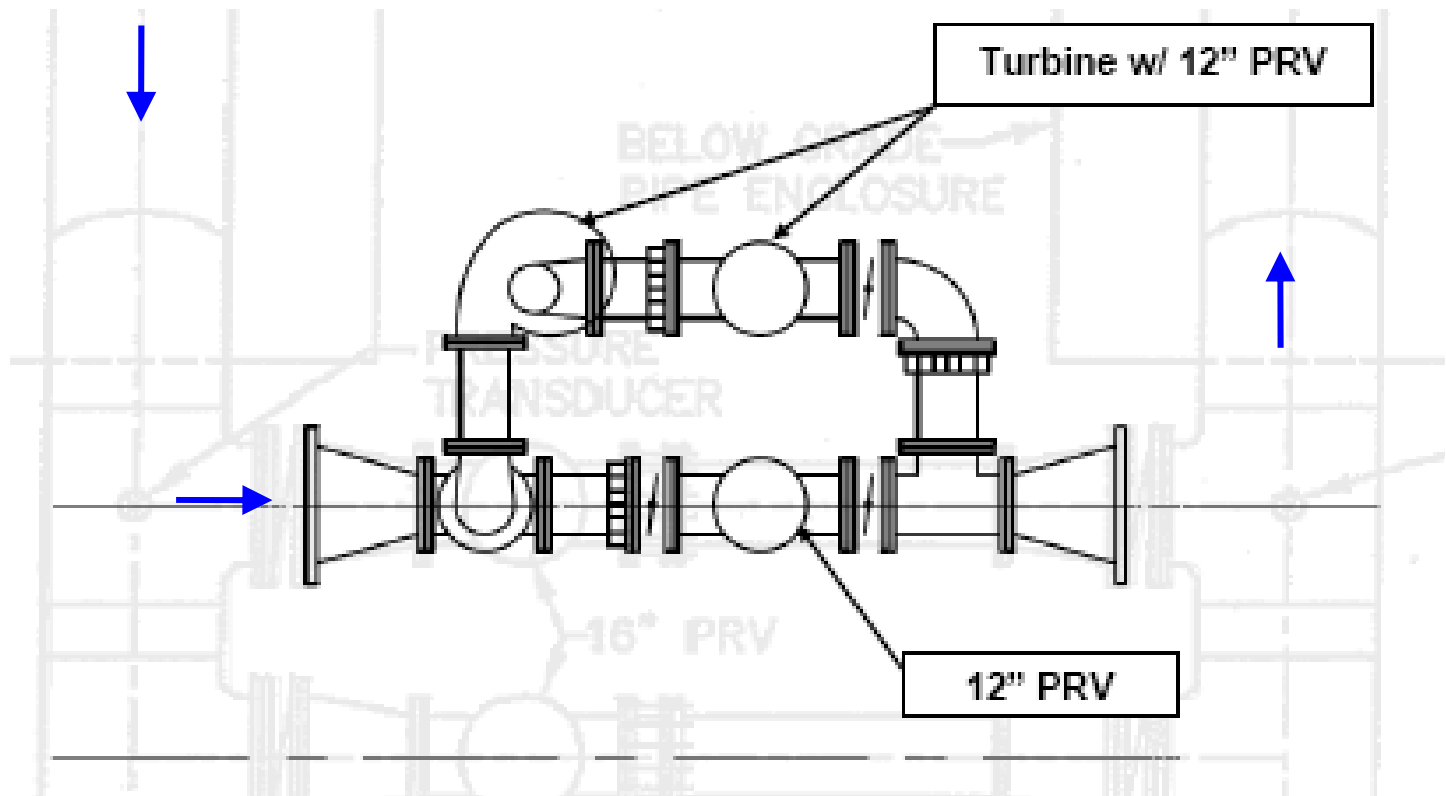
Summary – Cornelius Pass Alternatives

Alternative	Incentived Cost	Payback Year
435 only	\$350,000	2022
385 only	\$260,000	2033
Combined	\$380,000	2018
385 & 435	\$570,000	2025

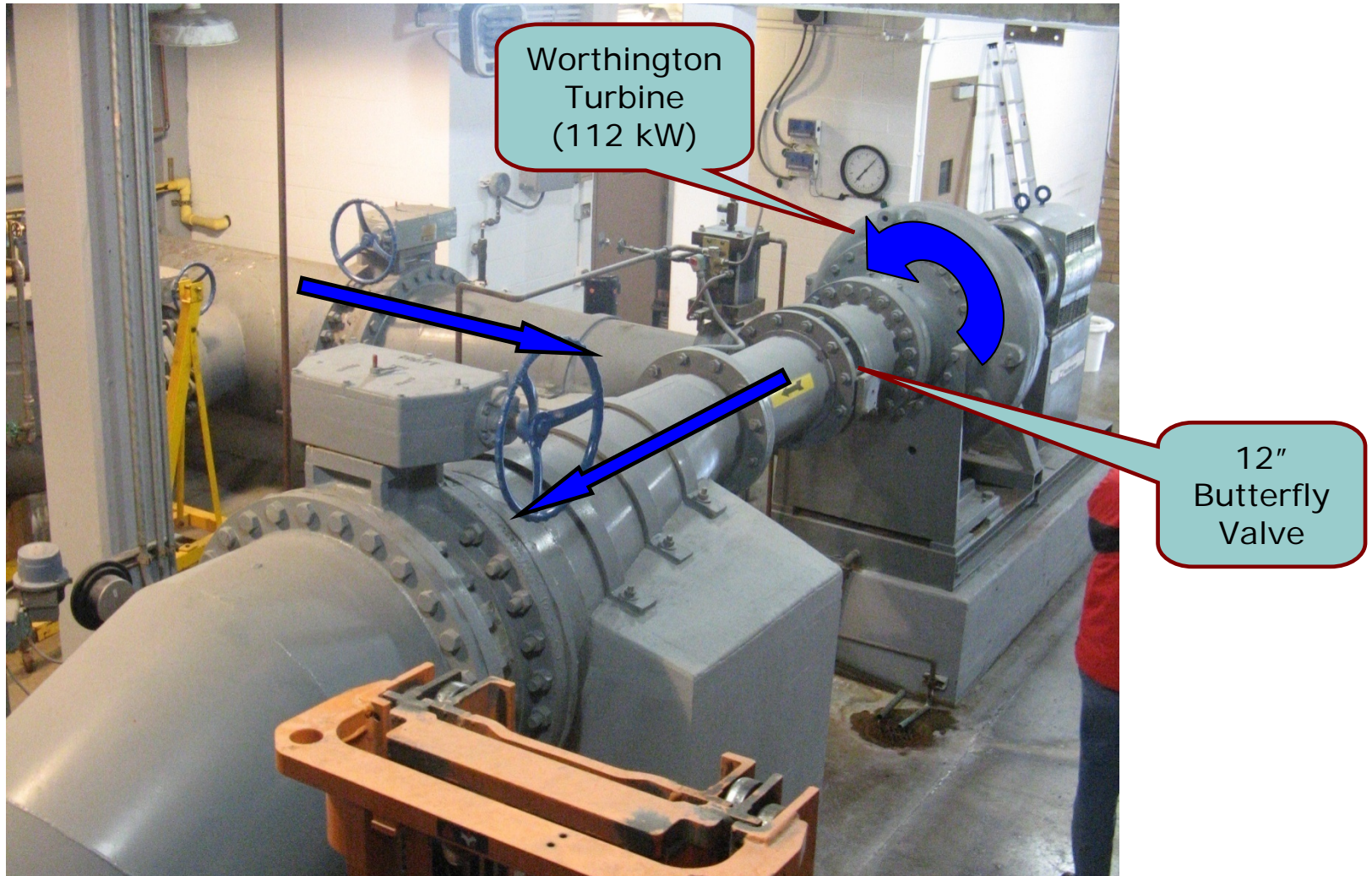
Cornelius Pass Full Station Installation



Cornelius Pass 435 Zone Installation



Center St. PRV Station

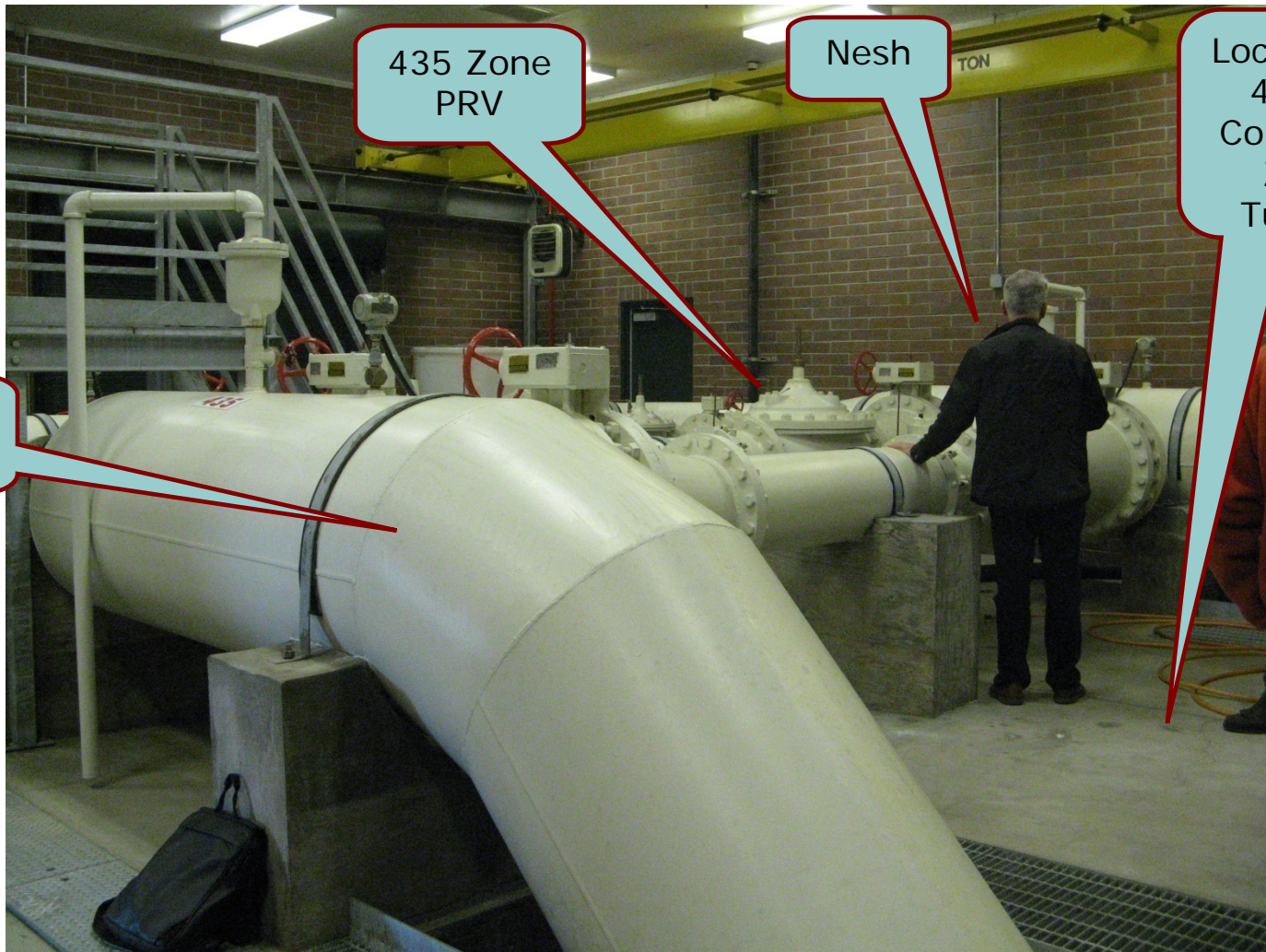


Cornelius Pass PRV Station

385 Zone
PRV



Cornelius Pass PRV Station



435 Zone
PRV

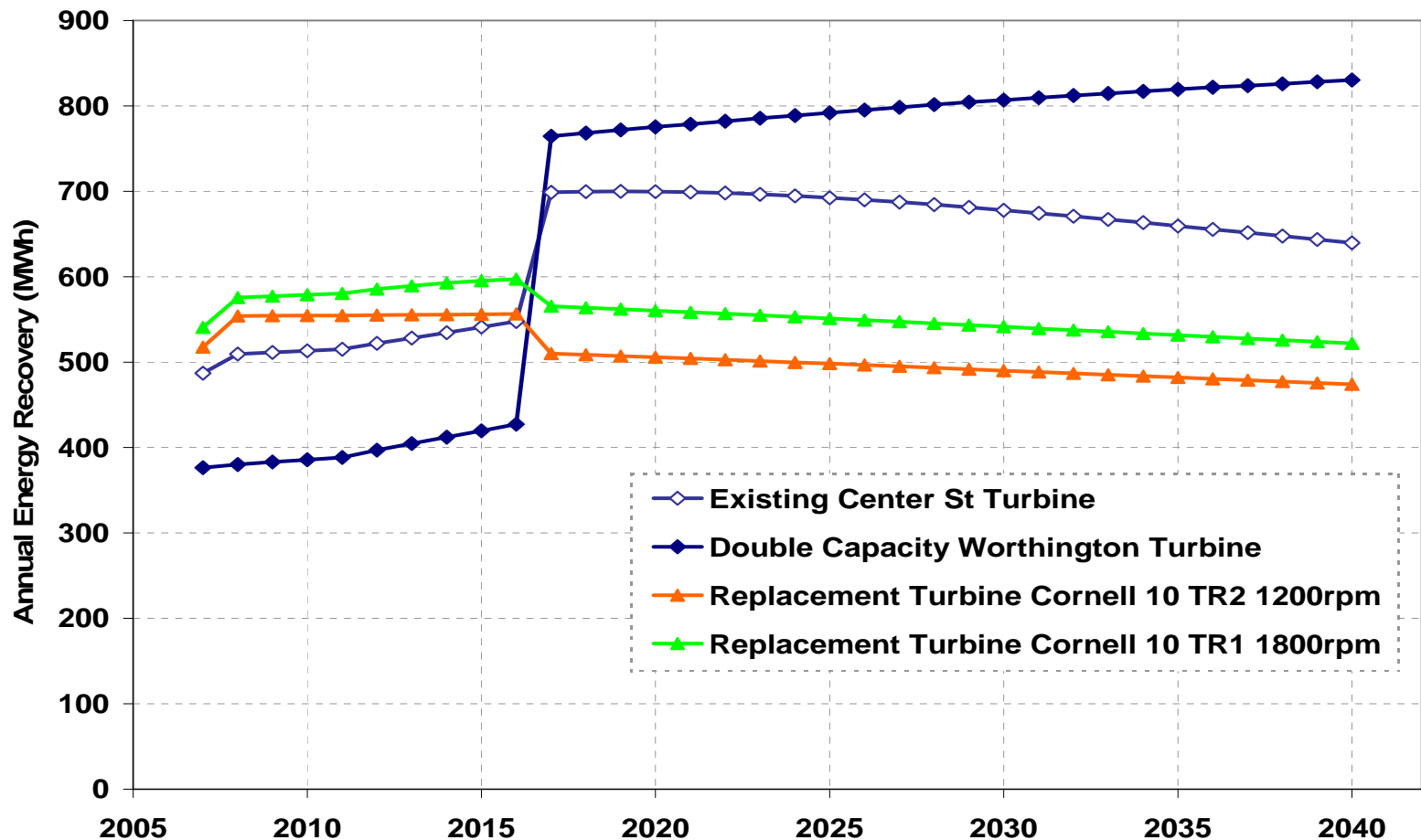
Nesh

Location of
435 or
Combined
Zone
Turbine

Pipe to
435 Zone

Things Change in 2017 – Must Review Assumptions!

Example – Combined Station:



Recommendations

- Center St.:
 - Engage butterfly valve/PRV to increase energy recovery (immediately)
- Cornelius Pass:
 - Carry 435 zone and combined system into predesign
 - Evaluate layout functionality
 - Confirm flow and energy recovery projections

Cornelius Pass – Carbon Offsets

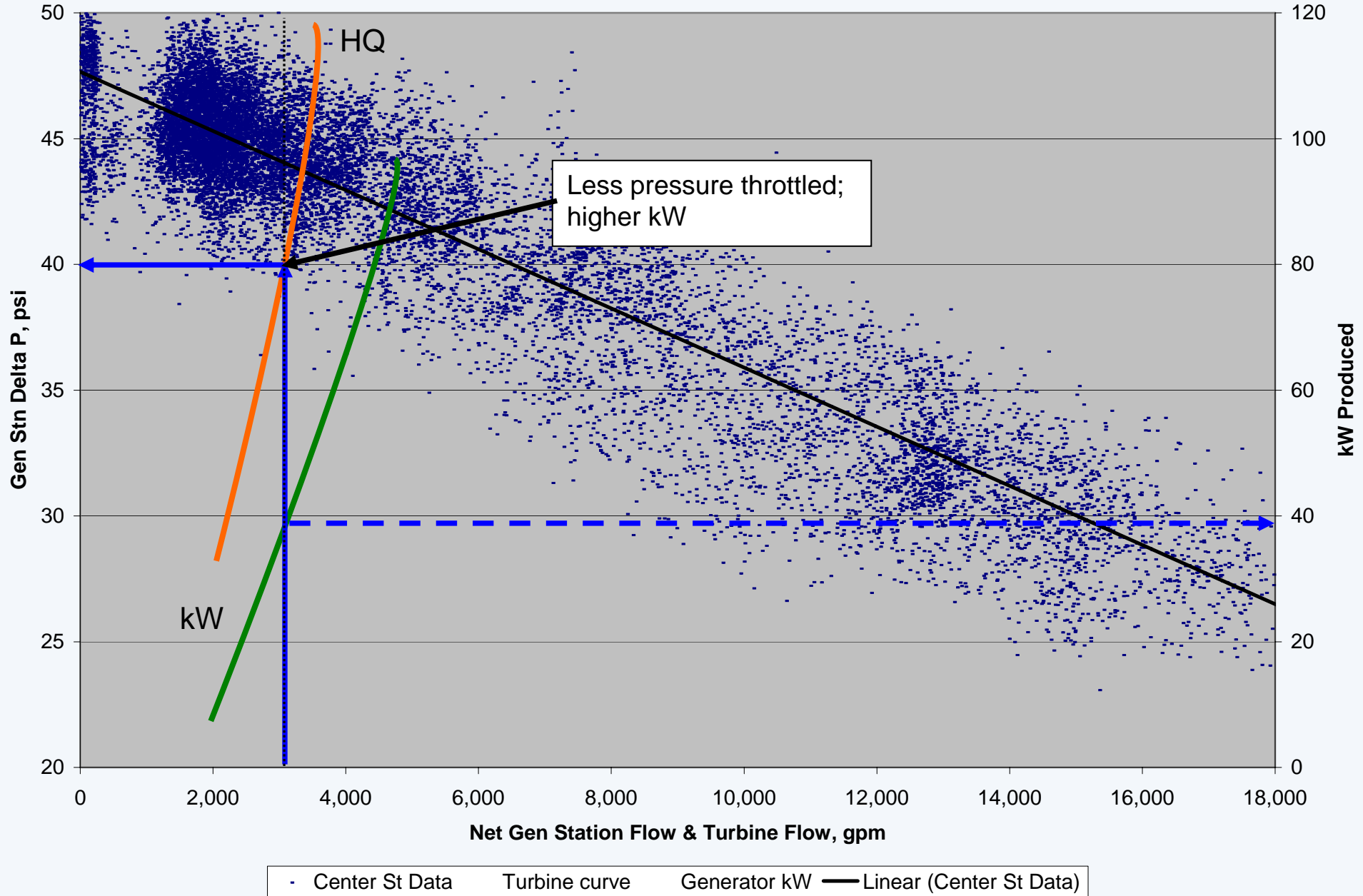
Alternative	Cumulative CO₂ Offset 2009 – 2040 (tons CO₂)
1) 385 Zone Only	2,960
2) 435 Zone Only	8,190
3) Entire Station Flow	10,700
4) 435 and 385 Zones	11,100



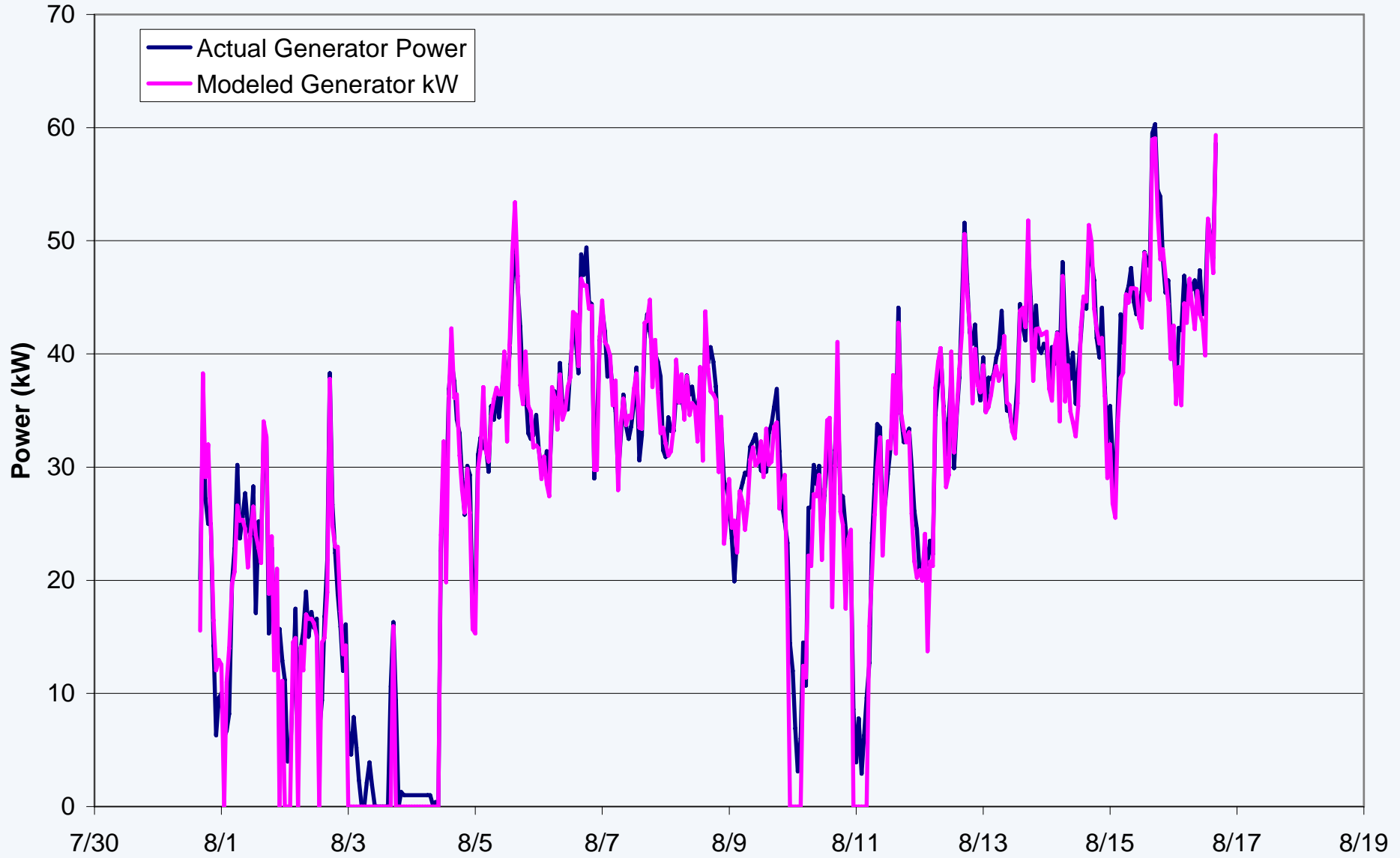
TVWD Hydroelectric Energy Recovery Feasibility Study

**Board of Commissioners Meeting
September 2, 2008**

Example – 3000 gpm in smaller turbine w/ PRV

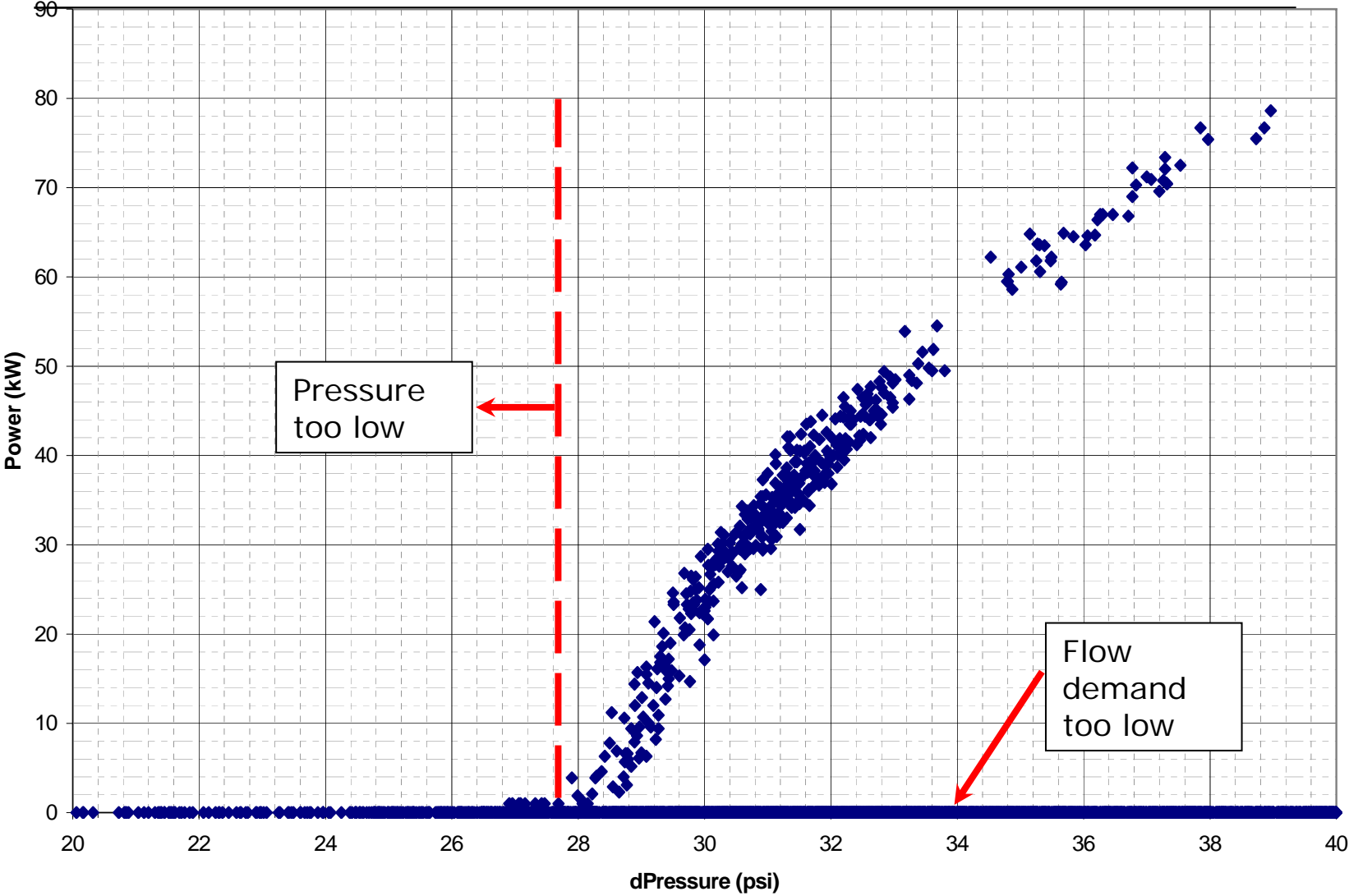


Summer 2007 Generator kW: Actual vs. Modeled

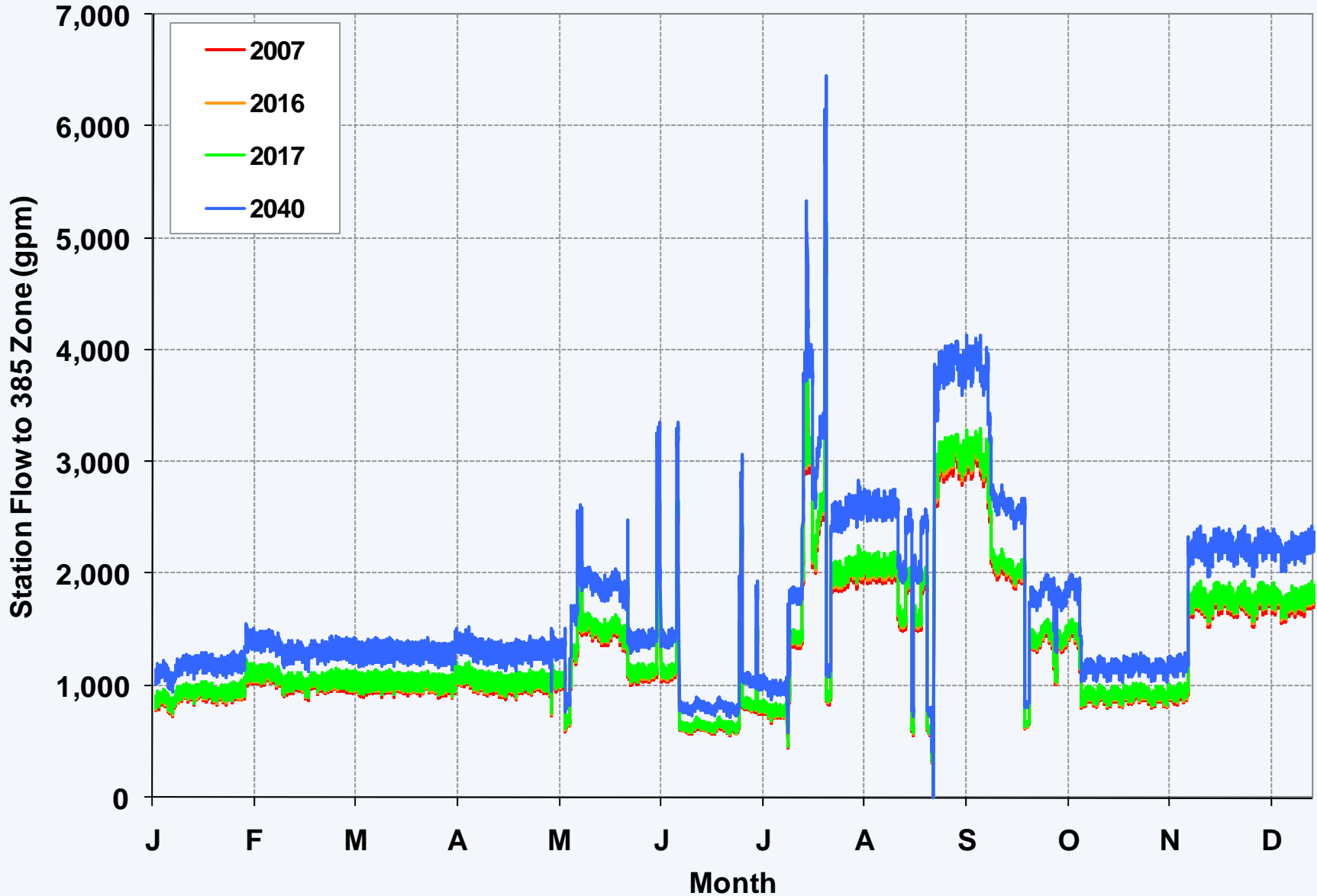


Center St. Turbine Performance

8/1/07-8/29/07



CP Station 385 Zone Flow Projections



CP Station Flow Projections

