



Portland Water Bureau Micro Hydro Case Study

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Outline

- Project Background
- Site Selection and Evaluation
- Design Process Requirements
- Installation
- Lessons Learned and future considerations



Portland Water Bureau System



- Bull Run Elevation at Headworks 750 feet
- Approximately 257 active pressure regulators throughout distribution network

PWB Turbine History



- 1894 Installed (2) Pelton wheel turbines

Portland Water Bureau – Renewable Energy Projects

- Solar Generation

- 267 kW Groundwater
- 12 kW Meter Shop
- 9.8 kW Groundwater chemical
- 7.92 kW Powell Butte (In Construction)
- 100 kW Interstate Shop (In Construction)

- Hydro

- 35 MW Bull Run Hydro
- 170 kW Lucid



Pre Project Site Selection

- Power Available
- Existing Vault
- Power use at site
- Feasibility
- O&M/Safety
- Water Quality
- Capital Cost
- Environmental Impacts
- Social Impacts
- Revenue Generation



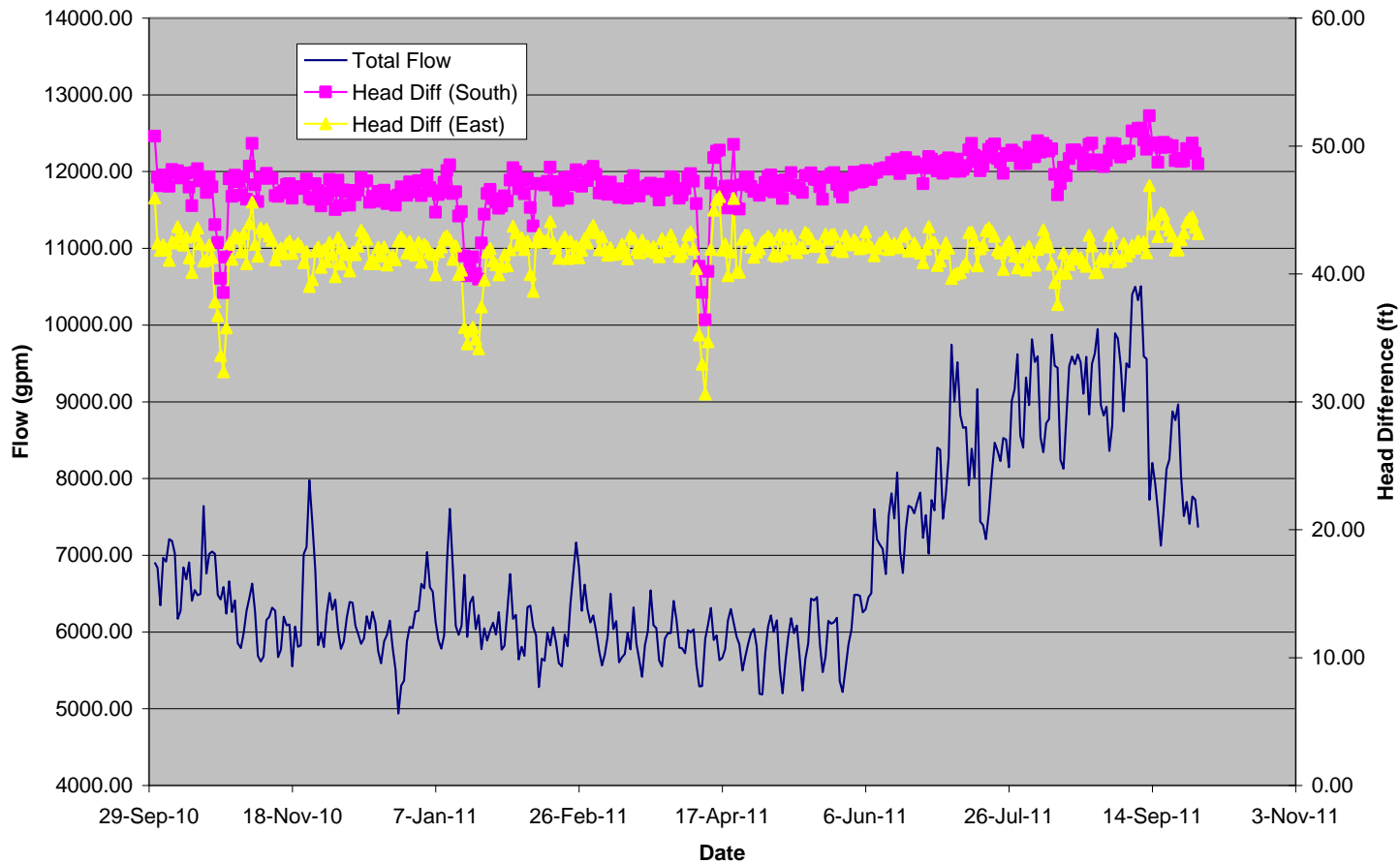
Vernon Site Characteristics

- 3 existing vaults
- Off street location
- 3-phase power available at the site
- High flow rate and head pressure



Vernon Site Characteristics

Vernon Flow vs. Head



Step 1 – Obtain Permission

- Oregon Water Rights
 - 6 month wait
 - Send letter to approximately 30 agencies inviting comments
 - Public meeting at the site
- Apply for Conduit Exemption with Federal Energy Regulatory Committee
 - Wait
 - And wait
 - Proceed with design



Step 2 - Agreements

- Facility Study
- Power Purchase
- Infrastructure Connection
- Energy Trust
- American Recovery and Reinvestment Act (ARRA)
- Neighborhood Association
- State of Oregon - BETC



Step 3 – Design Requirements

- Replace 16" regulator with turbine in existing vault
- Restore 6" regulator in vault
- Maintain working clearances to meet electrical and safety codes



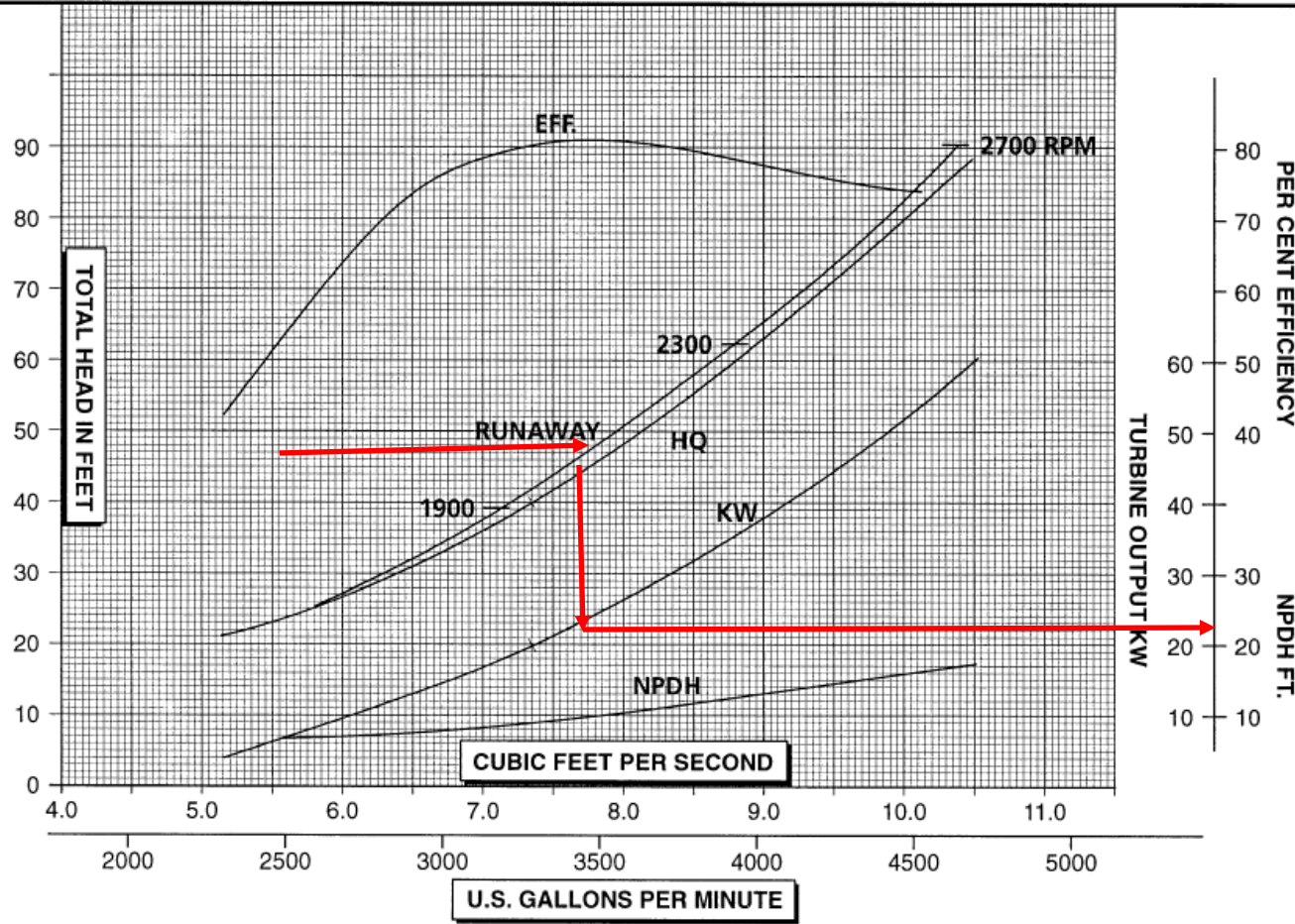
Step 3 - Design Requirements

- Safety Improvements
 - Improved Access
 - Lights in Vault
 - Ventilation Fan
 - Intruder Alarms



Step 3 - Turbine Selection

INLET = 10.0 IN. EXHAUST = 10.0 IN.	$N_S = 4100$	SPEED = 1225 RPM	TURBINE MODEL - 10 TR1
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10 TR1	CORNELL PUMP COMPANY • PORTLAND, OREGON	CORNELL
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Step 4 – Pre-Construction

- Equipment Purchase Contract
- FERC final review and site evaluation with 3 month wait
- Utilize City Electrical Contract
- PWB M&C crews used for Installation



Step 5 - Construction



Final Mechanical Layout

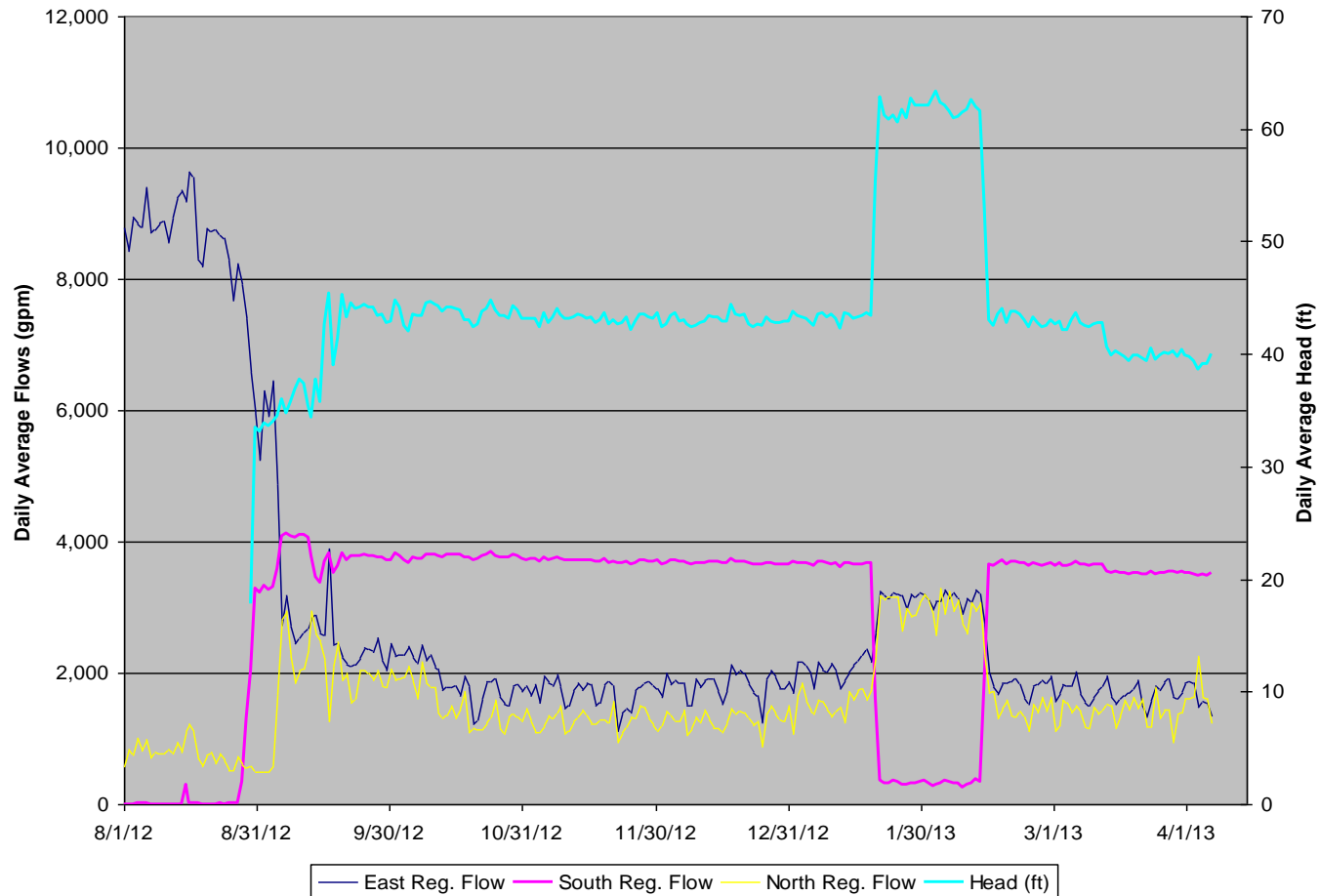


Final Electrical



Hydro Performance

Vernon Micro Hydro



Production Summary

Actual Production

Month	Avg Flow (gpm)	Avg Head Difference (ft)	Days	On peak Energy Generated (kWh)	Off Peak Energy Generated (kWh)	Total Power Production (kWh)
Sep-12	3739	39.43	30	5854	4867	10721
Oct-12	3775	44.01	31	7603	5379	12982
Nov-12	3715	43.20	30	7403	5001	12404
Dec-12	3683	43.06	31	7387	5432	12819
Jan-13	2419	50.25	31	4570	3548	8118
Feb-13	2300	52.0	28	3616	2370	5986
Mar-13	3500	39.5	31	6588	5068	11656
Apr-13	0	0.0				12000
May-13	0	0.0				12000
Jun-13	0	0.0				12000
Jul-13	0	0.0				12000
Aug-13	0	0.0				12000

Avg Annual Power Production

135000

* System came online September 8th

** Broken Solenoid system went down on January 20th

PWB Energy Use

Electricity Use

In 2011, PWB's electricity use was 23,335,253 kilowatt hours (kWh), a 21 percent increase from calendar year 2010 (see Table 6).

Table 6. PWB Electricity Use and CO₂e Emissions, Calendar Years 2007-2011

Category	CALENDAR YEARS				
	2007	2008	2009	2010	2011
Electricity (kWh) ^a	27,335,981	22,857,002	24,208,091	19,236,332	23,335,253
CO ₂ e Emissions (MT) ^b	11,420	9,549	10,113	8,036	9,138

^a kWh is kilowatt hour

^b MT is metric tons

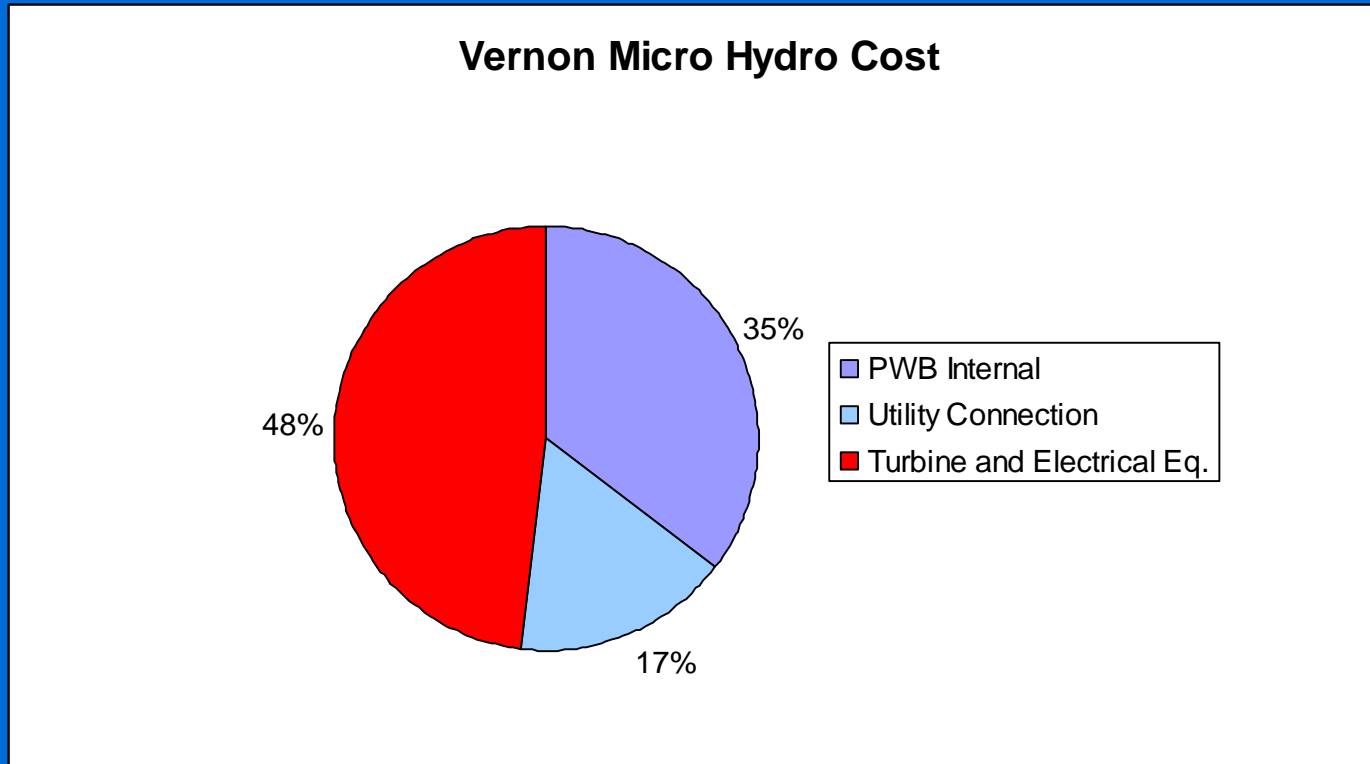
- Production Range of Vernon Micro hydro
- Minimum 112,000 kWh 66 CO₂ metric tons = 0.48% offset
- Maximum 213,000 kWh 125 CO₂ metric tons = 0.91% offset

Financial Incentives

- EnergyTrust of Oregon - \$65,000
- Business Energy Tax Credit - \$38,000
- American Recovery and Reinvestment Act of 2009 - \$65,000

- Total Cost to PWB after incentives
\$375,000

Cost Summary



- Cost increase of approximately \$120,000 due to no 3-phase power on site

Lessons Learned Future Design Considerations

- Understand FERC process
- Utility infrastructure in place?
- Utility willingness to participate?
- Can energy be used on site?
- What is the constructability of the site?



Acknowledgements

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Questions

