NORTHERN ARIZONA UNIVERSITY

HCC PROTOTYPE DEMONSTRATION

December 5th, 2023

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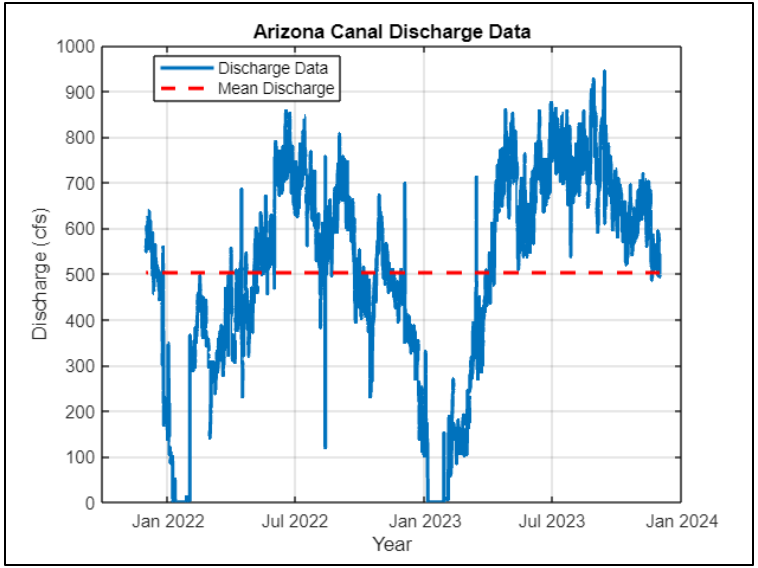
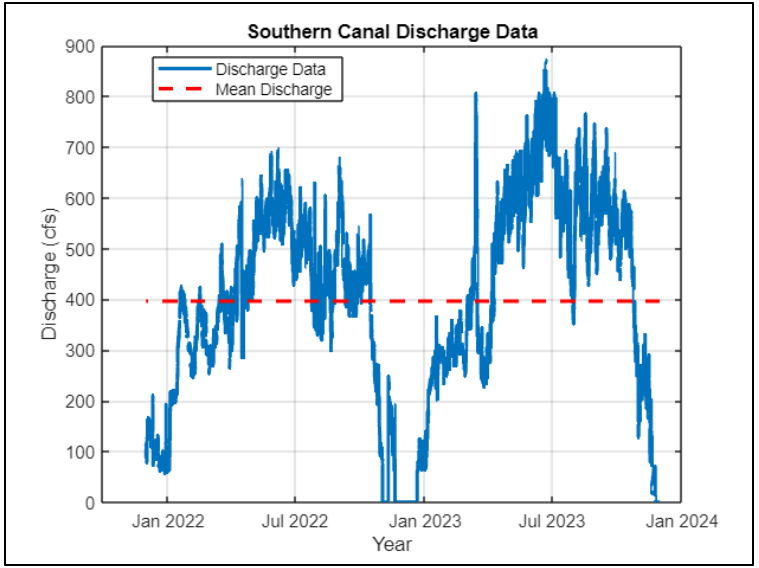
VIRTUAL PROTOTYPE 1

- **Question:** Given daily flow data for both canals, does Granite Reef currently have the necessary flow and gross head to support the installation of the Voith turbine units?

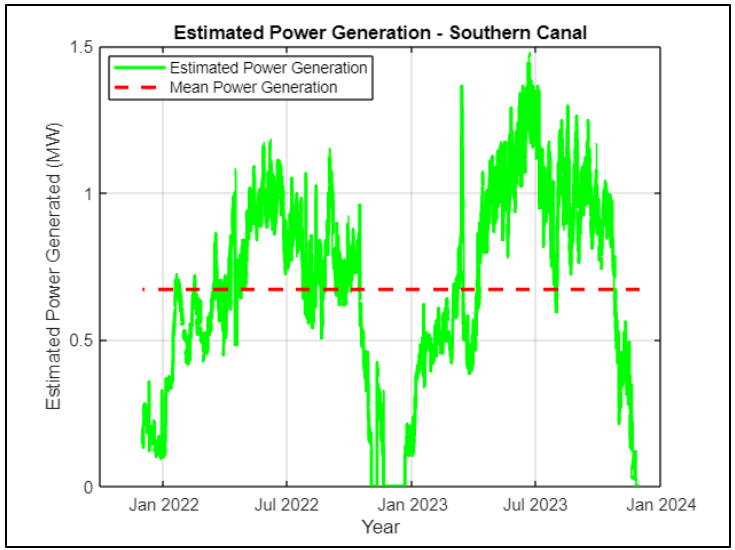


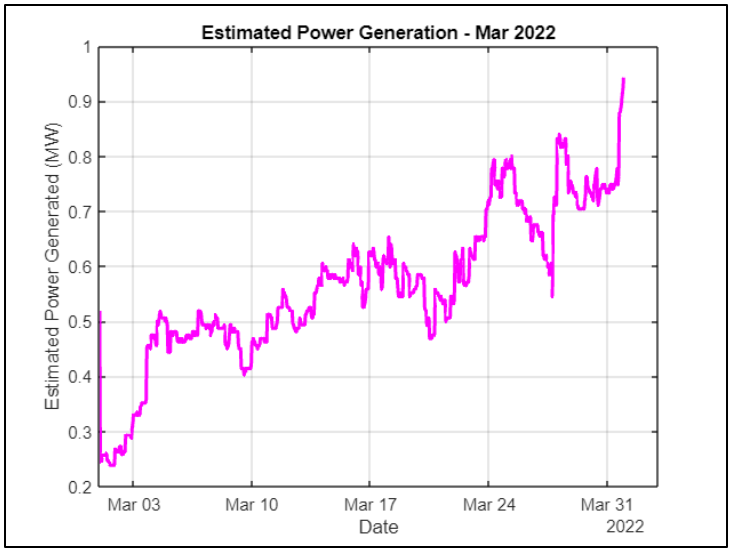


Evan Higgins

VIRTUAL PROTOTYPE 1

- **Answer:** Yes, power curves show potential power reaching 1 MW, meeting competition requirements
- Highlights specific periods of increased/decreased energy output in response to flow.





Evan Higgins

HOW WILL THIS INFORM OUR DESIGN?

- Provide insights into Siting Challenge for midyear competition submission in January
- Help us inform Voith with turbine selection and explore risk mitigation for competition
  - Assessment of capacity factor and interconnecting with the grid

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Arizona Canal: Capacity Factor for December 2021 - November 2022:
    0.4613

Arizona Canal: Capacity Factor for December 2022 - November 2023:
    0.5108
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Southern Canal: Capacity Factor for December 2021 - November 2022:
    0.3537
Southern Canal: Capacity Factor for December 2022 - November 2023:
    0.4127
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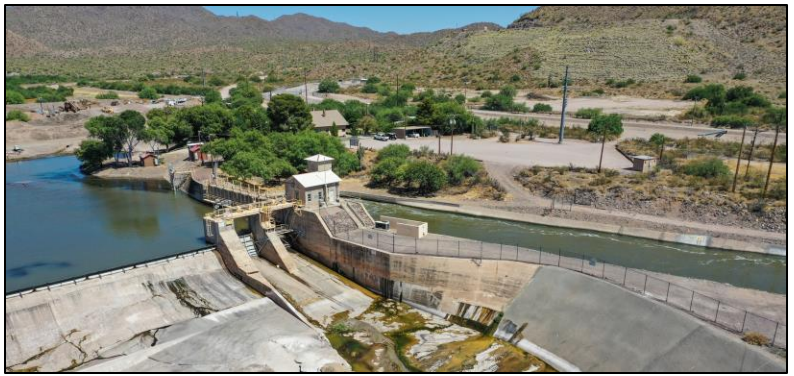


VIRTUAL PROTOTYPE 2

- **Question:** For the Optional Build and Test Prototype challenge, how will we scale down our flow for the experiment?
- **Answer:** Using Buckingham's Pi theorem for non-dimensional analysis

Considering flowrate, Q, as a function of net head, H, fluid velocity, V, penstock length, L_p, penstock cross-sectional area, A_p, gravity, g, fluid density, ρ, and dynamic viscosity, μ:

$Q = f(H, V, L_p, A_p, g, \rho, \mu)$

Using g, ρ, μ as repeating parameters, the following non-dimensional terms and functional relationship were generated:

$$\Pi_1 = \frac{Q}{VL_p^2}$$

$$\Pi_2 = \frac{H}{L_p}$$

$$\Pi_3 = \frac{A_p}{L_p^2}$$

$$\Pi_4 = \frac{V^2}{gL_p^2} \ (Froude\ Number)$$

$$\Pi_5 = \frac{\rho V L_p}{\mu} \ (Reynold's\ Number)$$

$$\frac{Q}{VL_p^2} = f\left(\frac{H}{L_p}, \frac{A_p}{L_p^2}, Fr, Re\right)$$

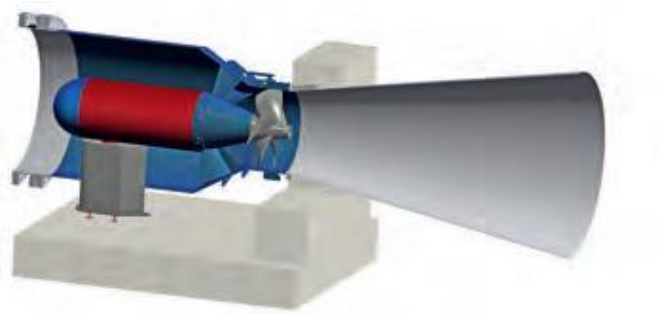
Using the given relationship, we can calculate the proportional dimensions of our model that would allow an accurate representation of the Granite Reef Diversion Dam

Riley Frisell

HOW WILL THIS INFORM OUR DESIGN?

- Established a scaled experimental environment maintaining fluid dynamic characteristics of Granite Reef
- Iterative approach for refining experimental setup, instrument calibration, test parameters, etc.

F1-10 Hydraulics Bench



Voith StreamDiver Unregulated Flow Model

THANK YOU!

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