HCC 2026
Site Selection Process

Team

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Project Description

HCC

1. **Siting Challenge** - Perform a hydropower site selection process for a potential NPD with a generation capacity between 1 MW and 10 MW.
2. **Design Challenge** - Choose between a conceptual facility design, or a component deep dive.
3. **Community Connections** - Engage with with professionals, and develop unique solutions to to address challenges, and then take action towards one. Engage with the community such as schools to create interest in the STEM field.(11/1 @ Willow Bend Education Center)
4. **Build and Test (Optional)** - Build and test a scaled prototype.

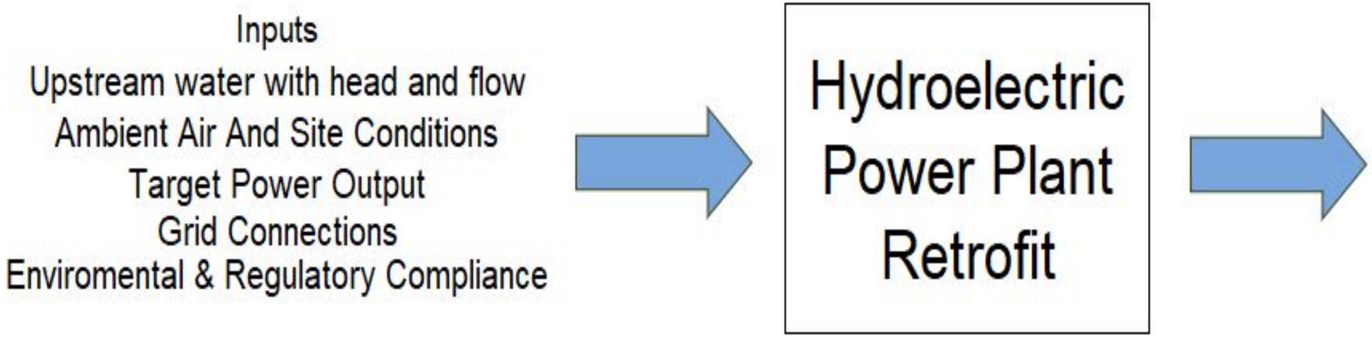
Why is this important?

- Continually growing energy needs
- Hydropower is a sustainable source of energy
- Interests next-generation engineers for hydropower industry

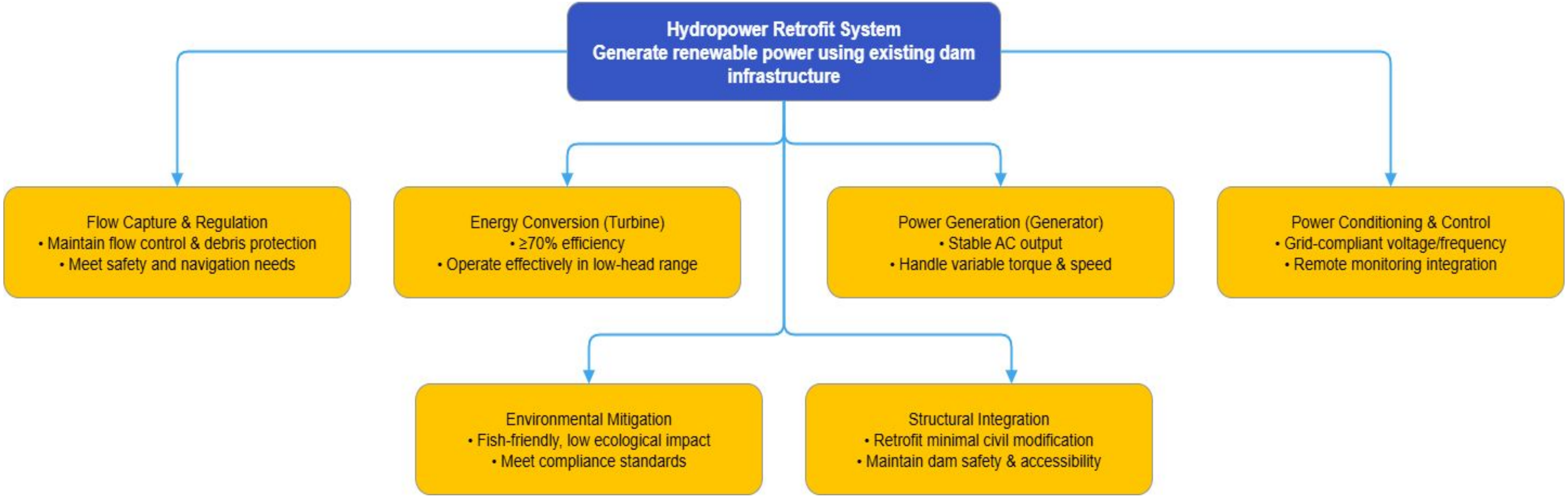
Sponsored by:

- Carson Pete
- U.S. Department of Energy (DOE)

Black Box Model



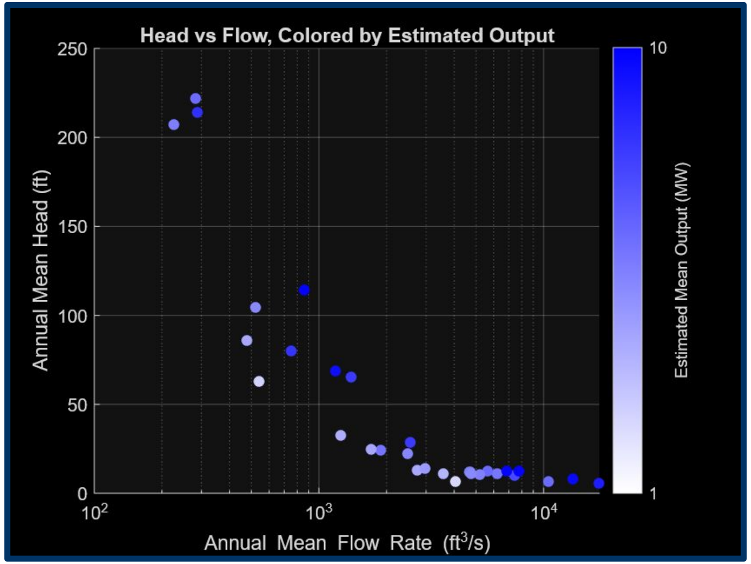
Functional Decomposition

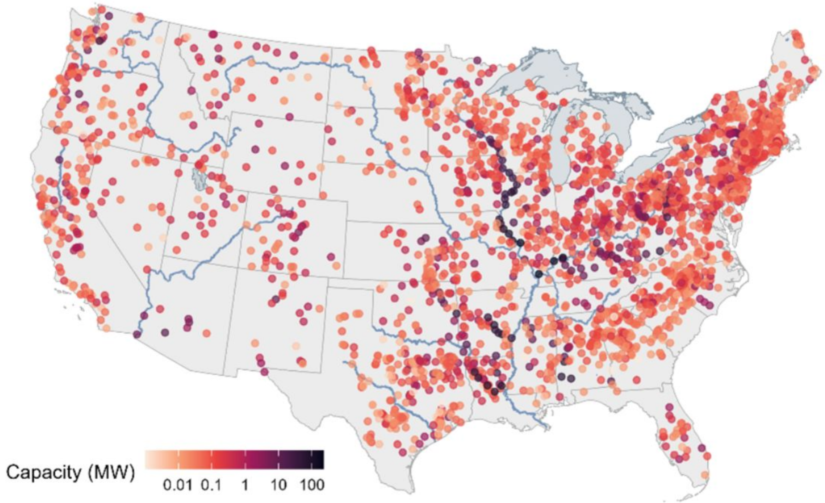


- Helps concept generation by highlighting the main components of a successful NPD retrofit.

Concept Generation

- Database of thousands of dams, along with location info, flow and head data, etc.
- Used Matlab to filter out dams that did not fit our 1-10 MW requirements





- Generate renewable sustainable energy
- Deliver cost effective power
- Minimize environmental impacts
- Minimal excavation

Concept Generation

- Matlab code narrowed down database of ~2.5k dams to 31
- Filtered through based on key inputs
- Four Finalists

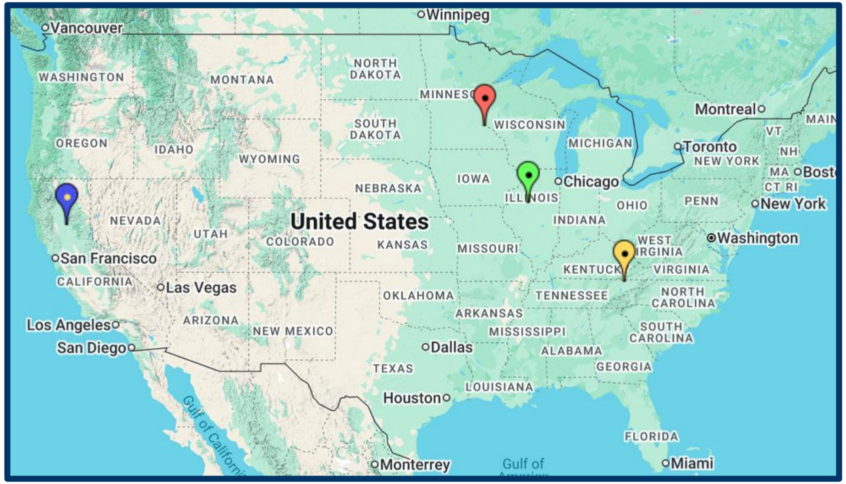


Table A-18. Necessary inputs for foundation technology design. Adapted from Appendix F of Witt et al. (2017)

Identification of key inputs	Rationale
Flow variables	The range of flow rates, average hydraulic head, water depth, velocity, turbulence parameters, friction factor, watershed hydrologic characteristics, flood frequency and magnitude, and inflow design flood are all important variables used to inform foundation design.
Head	The average hydraulic head and hydraulic head at flood conditions are important to inform foundation design.
Superstructure loads	The envelope of loads (static and dynamic) resulting from normal operation of the superstructure systems is an important input for foundation design.
Geomorphologic variables	The riverbed slope, bed topography, friction factor, channel sinuosity, substrates, soil type, depth to bedrock, structure of strata (strength, thickness, inclination, fracturing, porosity, gradation, angularity, shape, moisture, shear strength, and permeability) are used to inform foundation design and treatment requirements.
Sediment characteristic variables	The sediment grain size distribution (e.g., median grain diameter, geometric standard deviation), friction factor, sediment fall velocity, sediment angularity, sediment shape, and relative protrusion are important design variables.
Stream cross sectional area	The stream's bottom width, wetted perimeter, depth, and side slope are important to inform foundation system geometry and design.
Location of potential failure planes	The most vulnerable areas where imposed loads will cause failure is important for informing foundation design and treatment.
Externally imposed force variables	The expected magnitude of hydrostatic forces, hydrodynamic force, and earth and silt forces, is important for informing failure mode identification and foundation design.
Superstructure dimensions	The superstructure dimensions are important for informing the foundation system dimensions.
Foundation construction material	The density, strength, stiffness, porosity, permeability, and erodibility of foundation material are important for engineering design of the foundation design.
Foundation anchor design	The anchoring material properties, dimensions, and installation method are important for informing foundation design.

Concept Generation

- John Sevier Dam
  - Holston River, TN
- Fish Barrier
  - Feather River, CA
- Mississippi River Lock & Dam 3
  - Mississippi River, MN
- Peoria Lock & Dam
  - Illinois River, IL

Among the narrowed list, these had minimal apparent issues

Engineering Calculations - Peoria L&D

How much power can Peoria L&D generate, and which turbine is best suited?

Inputs Table

Parameter	Values	Notes
Head (*H*)	3.05 m	Pool-tail Diff
Flow (*Q*)	268 m³/s	USGS 05559900
Usable flow	113 m³/s	~40% of total
Efficiencies (η)	CF=0.68 Kap=0.79	Literature avg

Hydraulic Power:
$$P_{\square}=\rho g Q H$$

Electrical Power Output:
$$P_e=P_{\square}\eta_o=\rho g Q H \eta_o$$

Peoria Lock & Dam has viable low-head hydropower potential (~2–6 MW); Kaplan maximizes energy capture, while Crossflow simplifies implementation.

Results Table

Case	Turbine	P_e (MW)
Full River	Kaplan	**6.36**
Full River	Crossflow	**5.47**
Usable Subset	Kaplan	**2.69**
Usable Subset	Crossflow	**2.31**

Engineering Calculations - John Sevier

Variable	Name	Value	Unit
Q	Flow rate	65.1	m^3/s
H	Net Head	5.5	m
P	Power Generation	-	MW
η	Efficiency	.85	-
d	diameter	-	mm
T_R	Rated Torque	-	kN*m
T_{Design}	Design Torque	-	kN*m
g	Gravity	9.81	m^2/s
ω	Angular Speed	18.84	rad/s
P_m	Shaft Power	3.06	MW

- Data offers power, and ability to optimize kaplan bulb turbine(profile,pitch)
- Projected diameter to feed into generation unit
- Kaplan bulb runner and wicket gates: **ASTM A743 CA6NM (12Cr-4Ni)** cast stainless; machined and balance-graded.

Notable problems following calculations

- ~30-40% overflow on max output days
- Irregular water conditions(low flow)

Solutions

- Incorporate an active flow cap, to accommodate irregularities.

Equation	Results
$P = \rho g Q H \eta$	*2.99 MW estimated*
$n_p = nQ^{1/2}/H^{3/4}$	404, leads to kaplan
$T_R = P_m/\omega$	*162 kN*m*
$T_{design} = 2.5(T_R)$	*365 kN*m*
$d = 16T/\pi T_{allo}$	*314mm to 320mm*

- Targets engineering requirements in terms of power, flow, and head.
- Meets customer required power generation, low environmental impact, long life expectancy, and regulatory needs.

Engineering Calculations - Fish Barrier

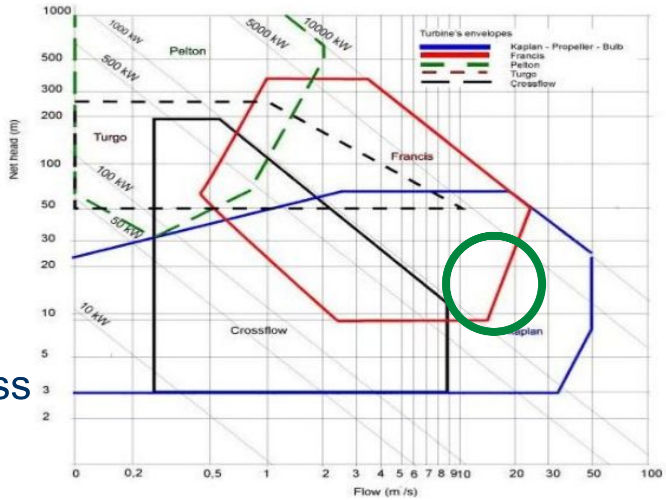
Variable	Value	Unit
Power (estimated)	2.36	MW
Avg. Head	18.2	m
Avg. Flow Rate	15.5	m^3/s
Avg. Capacity Factor	0.88	-
Efficiency	0.85	-
Rated Speed	550	RPM
Specific Speed	827	RPM

Methods used:

- “Rule of Thumb”
- Scientific Method

Based on these Calculations:

- Francis Turbine



Francis Turbines are best with medium head and flow and less of a threat to fish

Issues with Calculations:

- Limited dataset
- Estimated Power assumes 100% of flow is used (unrealistic), could potential dip out of 1-10 MW throughout the year

Engineering Calculations - Lock & Dam 3

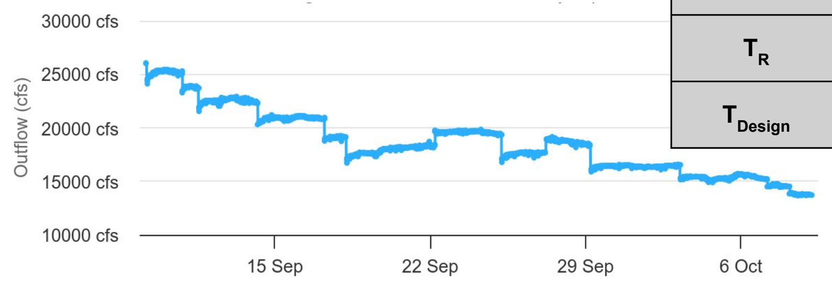
Mississippi River lock and dam #3

Variable	Name	Value	Unit
P	Power	9.538	MW
P_m	Shaft Power	8.107	MW
h	Head/Height	5.428	m
n	Efficiency	0.85	
Q	Outflow	526.82	m^3/s
Q_U	Usable Outflow	210.73	m^3/s

- The ideal turbine due to low head and high flow rate would be a Kaplan turbine.
- Kaplan turbines d range: .8-11m
- More $\nearrow P_m = \nearrow d$
- $T_{Design} = Fs * (P_m/\omega)$
- $\omega = v/(d/2)$
- $v = Q/A$

Variable	Name	Value	Unit
d	Diameter	6	m
A	Area	28.274	m^2
v	Velocity	7.453	m/s
ω	Angular Velocity	2.484	rad/s
T_R	Rated Torque	3762.4	kNm
T_{Design}	Design Torque	9406.1	kNm

$$Power = \eta * \rho * Q_U * g * h$$



Concept Evaluation

Criterion	Weight	Fish Barrier CA00034 Score out of 100	Fish Barrier CA00034 Weighted Sco	Peoria Lock & Dam IL01014 Score out of 100	Peoria Lock & Dam IL01014 Weighted Sco	Mississippi River Lock & Dam 3 MN00595 Score out of 100	Mississippi River Lock & Dam 3 MN00595 Weighted Score	John Sevier Dam TN07305 Score out of 100	John Sevier Dam TN07305 Weighted Score
Estimated Mean Output	25%	22.68	5.67	45.58	11.40	40.42	10.11	16.50	4.13
Flow Rate Consistency (1-CV)	7.50%	98.35	7.38	60.68	4.55	43.28	3.25	55.80	4.18
Head Consistency (1-CV)	7.50%	96.33	7.23	76.49	5.74	76.49	5.74	76.49	5.74
Poximity to Infrastructure	10%	95.00	9.50	90.00	9.00	94.00	9.40	100.00	10.00
Risk	10%	100.00	10.00	65.00	6.50	65.00	6.50	65.00	6.50
Ownership and Regulation	10%	60.00	6.00	70.00	7.00	50.00	5.00	80.00	8.00
Structure	10%	70.00	7.00	90.00	9.00	90.00	9.00	70.00	7.00
Accessibility	10%	100.00	10.00	80.00	8.00	60.00	6.00	70.00	7.00
Local Need	10%	60.00	6.00	80.00	8.00	50.00	5.00	50.00	5.00
Total	100%		68.77		69.18		59.99		57.55
Rank		2		1		3		4	

- Flow & Head Consistency - Coefficient of Variance
- Nearby Power Lines
- Inspection Evaluations - Availability of Condition Assessments & EAP Preparation

*Fish Barrier and Peoria L&D are more or less tied

Concept Selection - Lock & Dam 3

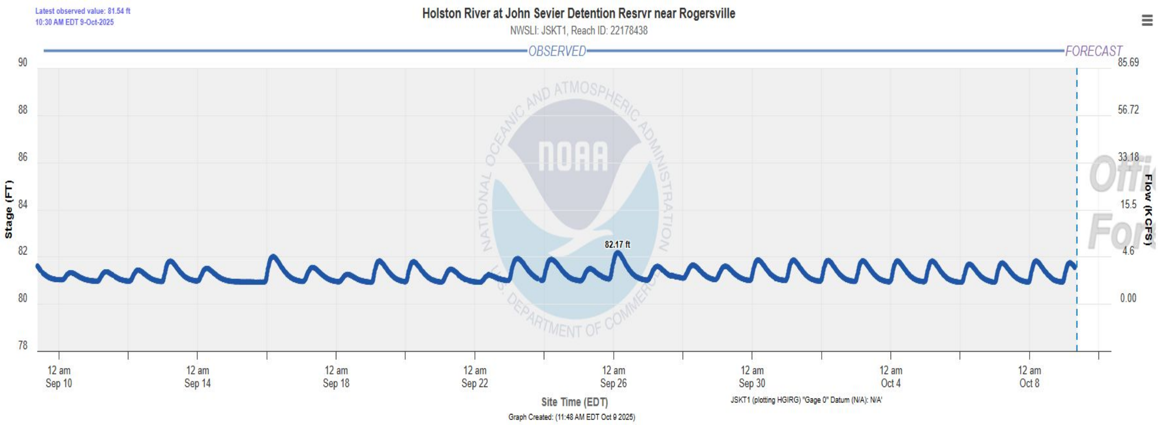
Pros:

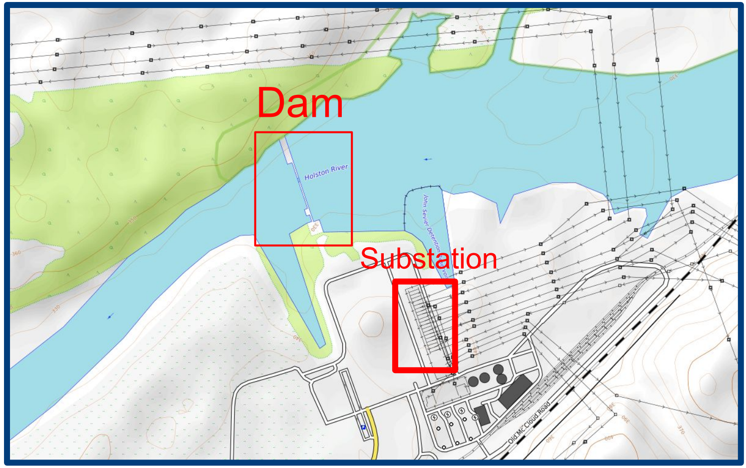
- High flow rate
- Safe navigation
- Low risk of structural failure
- Enhanced fish passage
- ~1400ft to nearest power line

Cons:

- Low head
- Potential collision hazards to recreational and commercial boats
- Potential flooding
- Poor miter gate conditions

Concept Selection - John Sevier





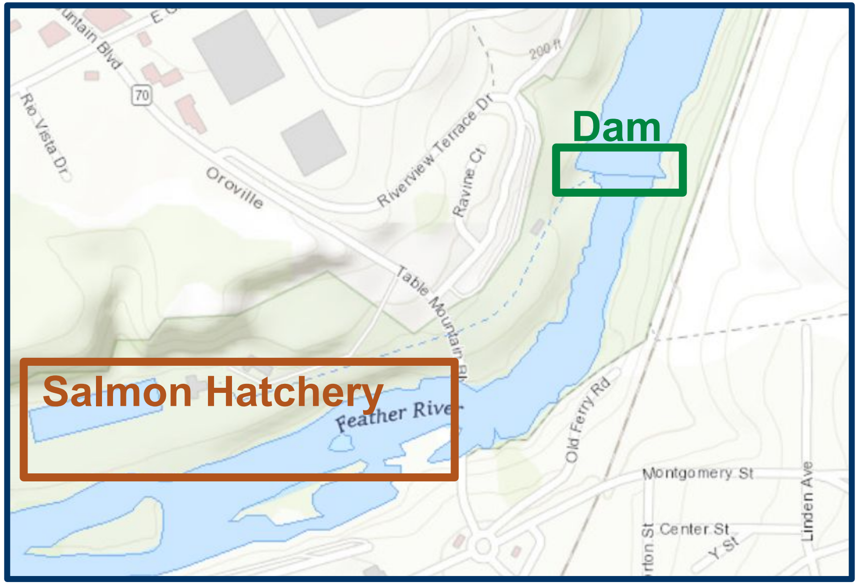
Pros

- Existing dam & abutment enable a short intake, short conduit, compact powerhouse, smaller excavation
- No new reservoir; flood routing unchanged
- Existing industrial corridor and likely nearby 13.8 kV intertie; access roads, laydown, and utilities already on site.

Cons

- Dam height (~5.5m) caps head; even with high flows, limited to ~3 MW and spill ≈ 40% of the time with Qcap=2,300 cfs(65.1m^3/s)
- flood contingency and seasonal constraints.
- Detention pool can drive high trash/sediment loading → larger racks, cleaning systems, and O&M.

Concept Selection - Fish Barrier



Pros:

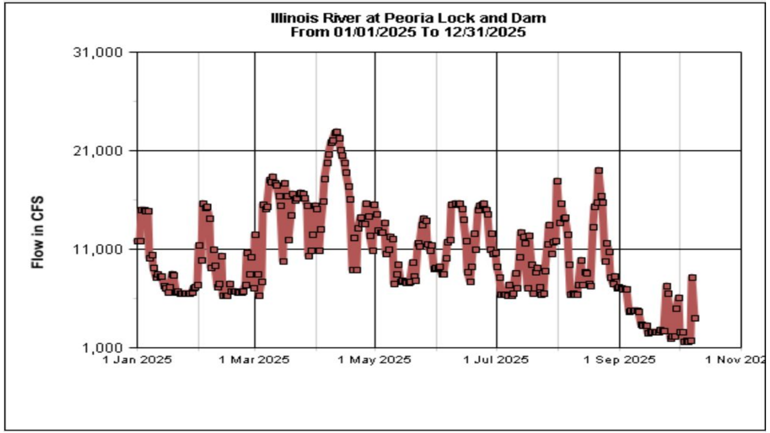
- Fish do not need to pass through
- Consistent head and flow
- Near necessary infrastructure

Cons:

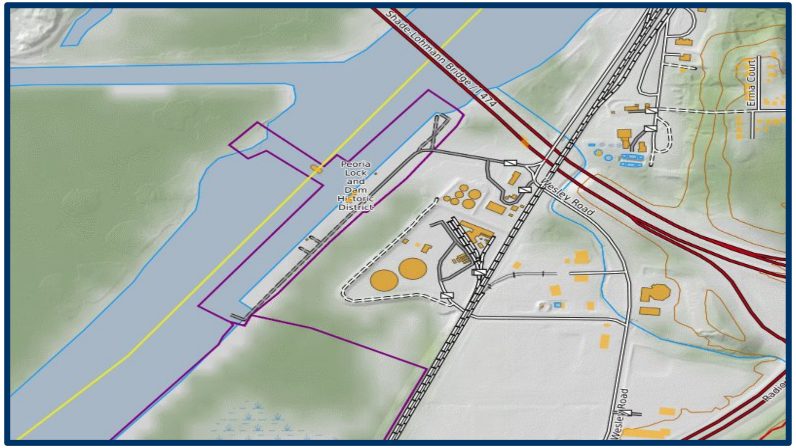
- Operation and construction could interrupt hatchery
- Small estimated output
- Strict regulations
- CA DWR can be slow to work with
- Nearest powerline is ~0.5 miles to the east

Concept Selection - Peoria L&D

Annual Discharge Hydrograph (USACE)



Topo Map



Pros

- Existing dam — no new impoundment needed
- ~3 m head, ~9 000 cfs average flow → 2–6 MW potential
- Strong grid and road access in Peoria
- Retrofit = low environmental impact

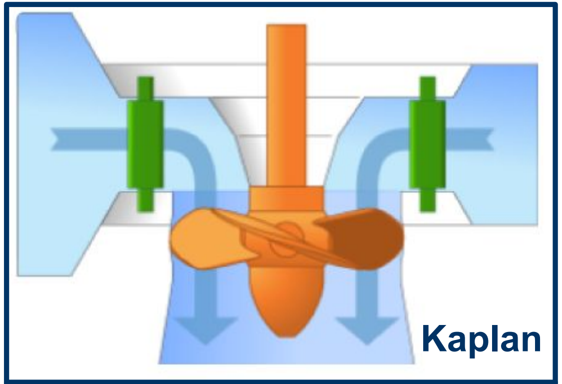
Cons

- Low head → only Kaplan or Crossflow feasible
- Seasonal flow variation (1 000–25 000 cfs)
- High sediment/debris → more O&M
- Navigation lock limits structural changes

Concept Selection - Turbine

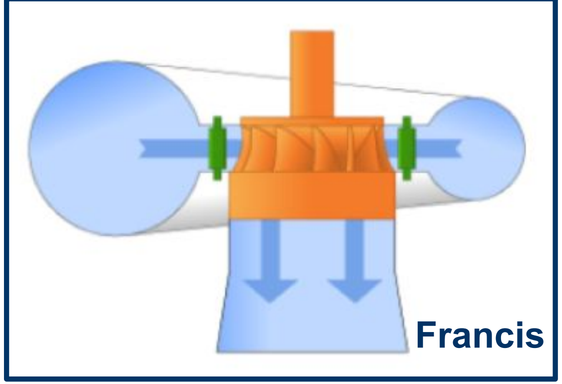
Kaplan Turbine:
- Peoria L&D
- John Sevier
- Mississippi River L&D 3

Kaplan Turbines optimize for Low Head, High Flow



Francis Turbine:
- Fish Barrier

Francis Turbines optimize for Medium Head, Medium Flow



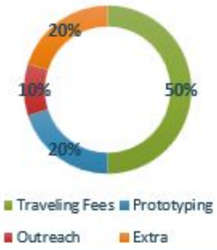
*Note - Approved by Prof. Willy to not have final selection,prototype.

Budget

How much do we have?
Initial Amount
$20,000.00
Total Expenses
$16,000.00
Potential Savings
$4,000.00

Where Do We Want To Allocate Money?

Traveling Fees	50%	$10,000
Prototyping	20%	$4,000
Outreach	10%	$2,000
Extra	20%	$4,000
Total	100%	$20,000



What is our income?

What is our Income?

Description	Date	Amount
Project Application	9/18/2025	$5,000.00
January Submission	1/26/2026	$5,000.00
Febuary Submission	2/23/2026	
Build & Test Submission	2/23/2026	$3,000.00
Build & Test Presentation	2/23/2026	$2,000.00
Final Event	TBD	$5,000.00
	Total Income	$20,000.00

What are our expenses?

Description		Expense amount	Distribution	
In Person Workshops	c	$2,500.00		
In person Conferences		$7,500.00	Prototype 1	$400
Prototyping Materials		$3,500.00	prototype 2	$1,200
Mapping Software		$500.00	Final Prototype	$1,900
Community Outreach		$2,000.00	Outreach Model	$500
Total Expenses		$16,000.00		$4,000.00

Theoretical Budget

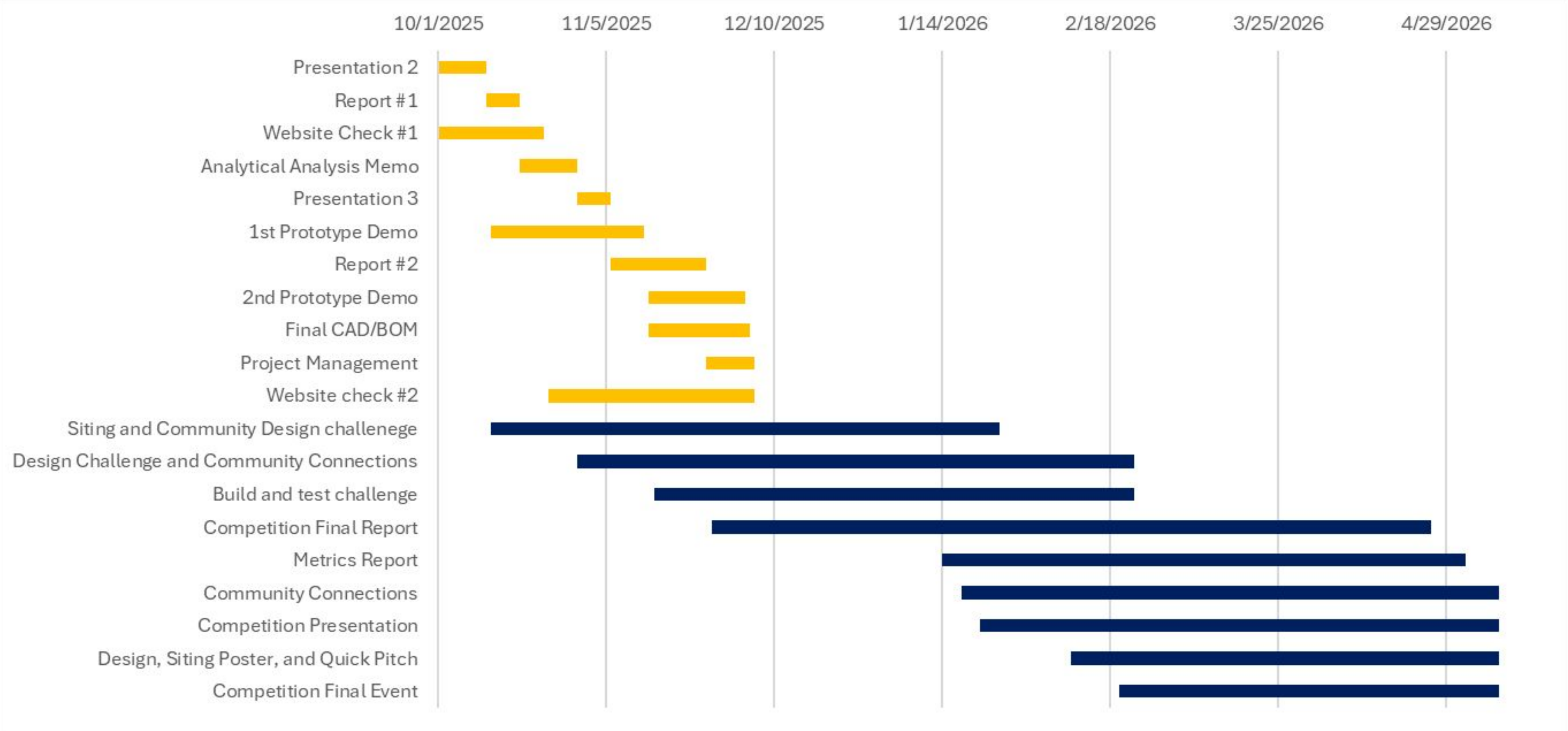
Total Project Cost Estimate		$24,600,000.00
Civil Works	Cofferdams & Dewatering	$1,600,000.00
	Intake Structure,Trash Rack, Stoplogs, Isolation Gate	$1,200,000.00
	Powerhouse bay, crane,rails	$2,500,000.00
	Bulb Pit, Draft Tube Concrete	$1,400,000.00
	Vertical Fish Ladder	$2,700,000.00
Electromechanical	Kaplan Bulb Turbine Generator Package, Lube, Cooling, Liner, Instalation	$6,900,000.00
	Wicket Gates & Servos	$800,000.00
	Overhead Crane	$350,000.00
	Automated Trashrack Cleaner	$250,000.00
Electrical and Balance	Generator Switchgear, Protection/SCADA	$900,000.00
	Unit Transformer	$800,000.00
	13.8kV Feeder/POI connections & Intertie	$600,000.00
	Cables, Ductbank, Grounding	$300,000.00
Soft Costs & Contengincy	Permitting, Envirmoantal Studies,CM	$1,800,000.00
	Utility, Legal, Financing	$400,000.00
	Contengincy Construction	$2,100,000.00
Total Price Point		$24,600,000.00

B.O.M

Category	Line item	Qty	Unit	Size / Spec	Notes	Est. Cost (M)
Civil works	Cofferdams & dewatering	1	LS	Sheet-pile & pumps for abutment bay	Seasonal window; include flood contingency	1.6
Civil works	Intake structure (concrete)	1	LS	Opening 7.2 m × 6.0 m; approach 1.8 m/s	Includes walls/foundation for intake bay	0.9
Civil works	Trashrack assembly	1	System	Gross area ≈ 43.4 m²; clear spacing 38 mm	≈144 bars @ 6.5 m length (pitch ~50 mm)	0.2
Civil works	Stoplog set	14	ea	7.2 m length × 0.5 m height modules	12 required + 2 spares	0.06
Civil works	Upstream isolation gate	1	ea	Vertical lift ~7.2 m × 6.0 m opening	Motorized hoist + guides	0.04
Civil works	Powerhouse civil (bay, crane rails, floors, walls)	1	LS	Footprint ≈ 45 m × 16 m	Includes embedded parts	2.5
Civil works	Bulb pit & draft-tube concrete	1	LS	Concrete vol. ≈ 1200 m³ (est.)	Incl. formwork & rebar	1.4
Civil works	Tailrace & scour protection	1	LS	Riprap apron + toe key	Coordinate with hydraulic model	0.3
Civil works	Vertical-slot fish ladder	20	pools	Δh = 0.30 m/pool; width ≈ 3 m; L ≈ 55 m	Design flow ≈ 35 cfs; include entrance/exit	3
Civil works	Site works & access	1	LS	Roads, laydown, fencing, drainage		0.4
Electromechanical	Kaplan bulb TG package	1	set	Runner ≈ 4.0 m; 180 rpm; ~3.0 MW	Incl. governor, HPU, lube, cooling, liner, install	7.5
Electromechanical	Wicket gates	20	ea	Double-regulated, SS (CA6NM) vanes	Count typical for 4 m runner hub	0
Electromechanical	Servo actuators (wicket)	2	ea	Hydraulic cylinders	With servovalves & feedback	0.1
Electromechanical	Blade pitch system	1	set	Kaplan hub pitch mechanism	Vendor package	0
Electromechanical	Main shaft & bearings	1	set	Ø~320 mm solid or Ø329/197 mm hollow	Tilting-pad thrust + journal	0
Electromechanical	Overhead crane	1	ea	50 t bridge crane	Span to cover bay	0.35
Electromechanical	Automated trashrack cleaner	1	ea	Traveling rake	Includes guides & controls	0.25
Electrical & BOP	Generator breaker & switchgear lineup	1	lineup	Medium-voltage, protection & control	Includes synch, metering, SCADA	0.9
Electrical & BOP	Unit transformer	1	ea	3.5 MVA, 13.8 kV, ONAN/ONAF	NEMA/IEEE	0.8
Electrical & BOP	13.8 kV feeder to POI	250	m	3×1c 15 kV XLPE, 500 kcmil equiv.	In concrete-encased ductbank	0.6
Electrical & BOP	Ductbank & manholes	250	m	2–3 way, 100 mm conduits	Incl. MHs as required	0.15
Electrical & BOP	Station service & control cabling	1000	m	Tray-rated, multi-core	Panels, I/O, fiber	0.15
Electrical & BOP	Grounding grid	500	m	Bare copper conductor	Exothermic bonds, rods	0.07
Soft costs	Engineering, permitting, environmental, CM	1	LS	Studies, design, CM services		1.8
Soft costs	Owner's costs (utility, legal, financing setup)	1	LS			0.45
Contingency	Construction contingency (10% of direct)	1	LS	Applied to direct costs		2.1
Included in Kaplan Bulb TG Package						
Direct CAPEX (sum Civil+E&M+Elec/BOP)						25.62
TOTAL CAPEX (2025$)	Converted at a rate of 41.11% since 2012					36.15

Brewerstock Hydropower, 2.35MW Retrofit

Schedule



10/1/2025
11/5/2025
12/10/2025
1/14/2026
2/18/2026
3/25/2026
4/29/2026
Presentation 2
Report #1
Website Check #1
Analytical Analysis Memo
Presentation 3
1st Prototype Demo
Report #2
2nd Prototype Demo
Final CAD/BOM
Project Management
Website check #2
Siting and Community Design challenege
Design Challenge and Community Connections
Build and test challenge
Competition Final Report
Metrics Report
Community Connections
Competition Presentation
Design, Siting Poster, and Quick Pitch
Competition Final Event

Fundraising

SNOWBOWL

Meeting 10/25
With Ryan Hartl

SULPHUR SPRINGS VALLEY ELECTRIC COOPERATIVE - OWNED BY THOSE WE SERVE -

Ruth Bigelow
Contacted

CFturbo

Waiting on contact

VOITH

Waiting on contact

References

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THANK YOU!

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