



KERR WOOD LEIDAL
consulting engineers

An aerial photograph of a river flowing through a dense forest. The river has several rapids and small waterfalls, with white water visible. The surrounding area is covered in lush green trees.

Rapid Hydropower Assessment Model Identifying Hydroelectric Sites Using GIS

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- About Kerr Wood Leidal and BC Hydro
- What is RHAM
- Application of RHAM
- Model Development
- Storage Analysis
- RHAM Online

- Engineering consulting company located in Vancouver, BC
- Employee owned (130 full-time employees)
- ESRI users since 1998 (ArcView 3.2)
- Now run ArcGIS Desktop & ArcGIS Server 10.1
- Over 35 staff use ArcMap weekly or daily

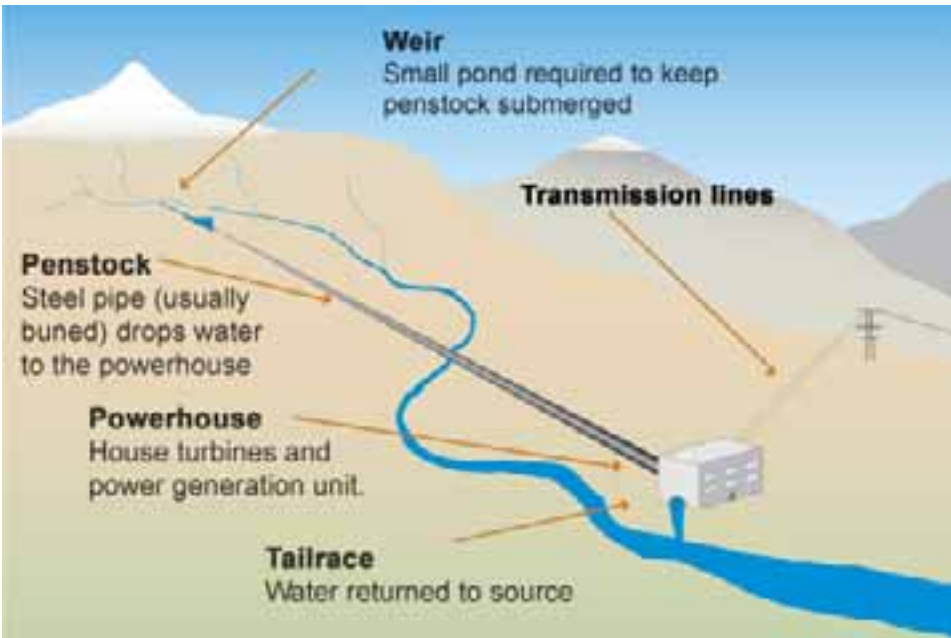


- A provincial crown corporation and Canada's third-largest electric utility headquartered in Vancouver, BC
- Reports to the BC Ministry of Energy and Mines, and is regulated by the British Columbia Utilities Commission

- Has approximately 1.8 million customers and serves 95 per cent of B.C.'s population by delivering electricity safely and reliably at competitive rates
- Operates 31 hydroelectric facilities and three natural gas-fired thermal generating plants totaling 12,000 megawatts (MW) of installed generating capacity



- Created to identify new clean energy sources
- Determines potential for small hydro projects
- Works anywhere in the world (where data is available)
- 2008 Consulting Engineers of BC Award of Merit
- 2009 GeoTec Conference & Exhibition Map Gallery Competition Winner



Intake Weir



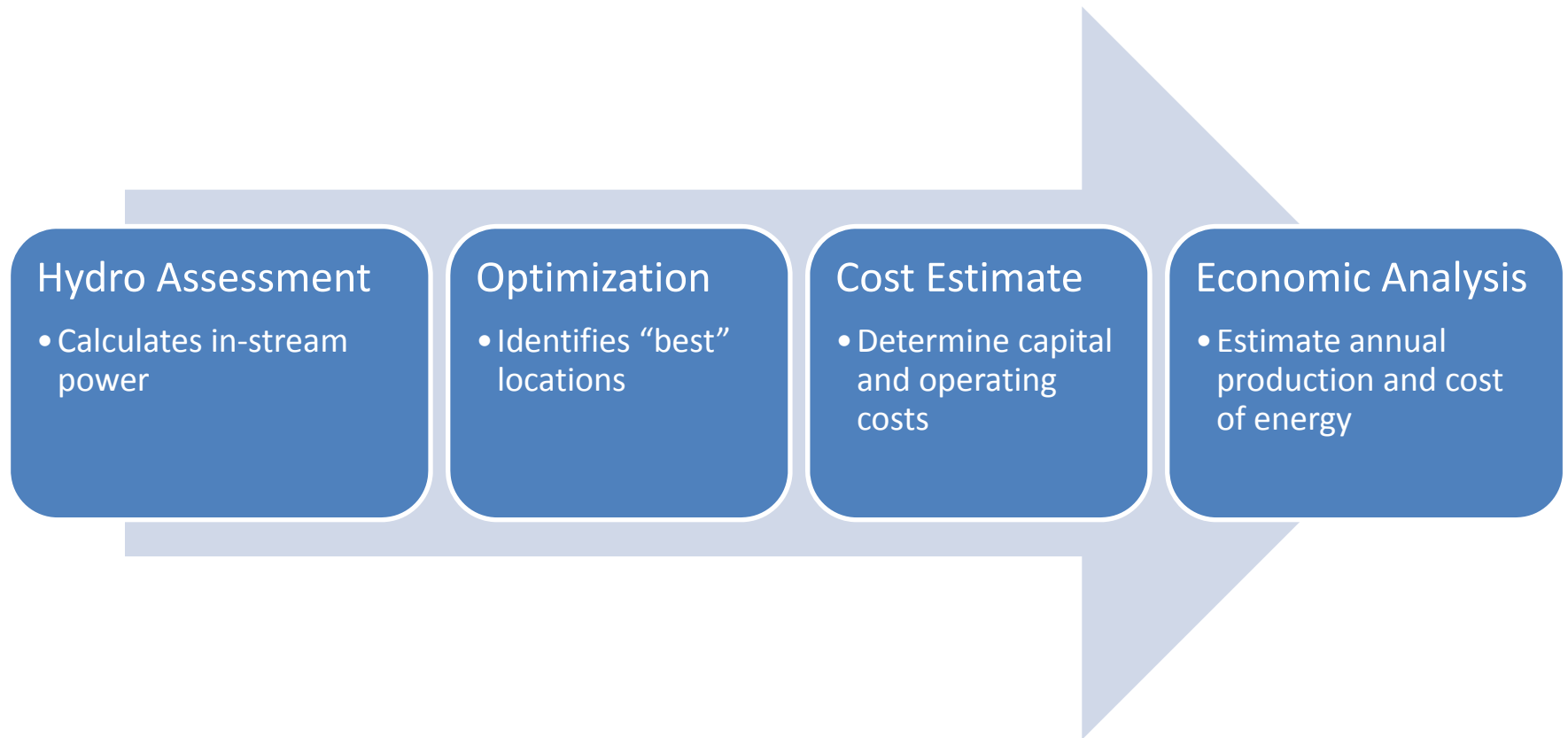
Penstock



Powerhouse

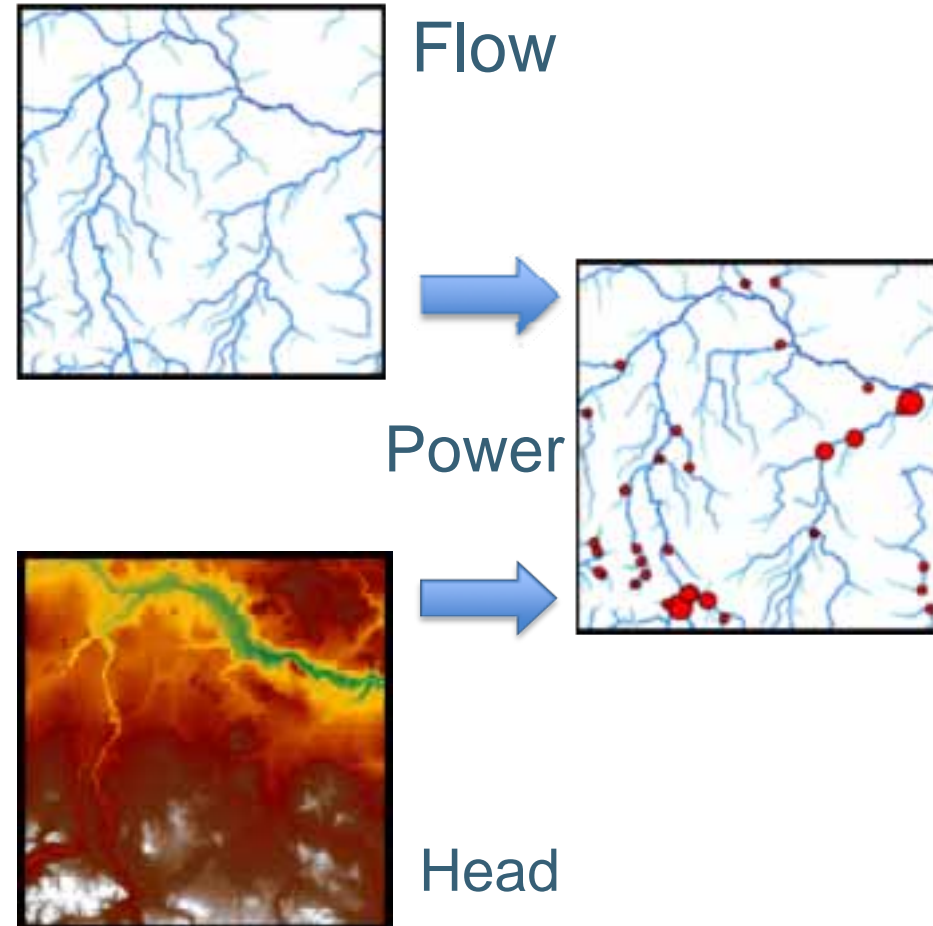
- RHAM projects to date:
 - British Columbia
 - Yukon
 - Mexico
 - Southeast Asia
- Can be used on large areas (e.g. BC) or small scale (watershed-level)





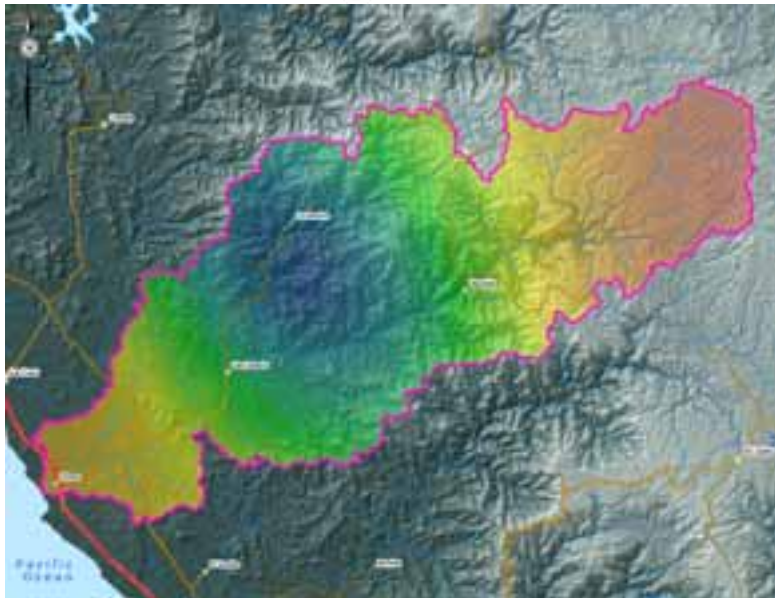
$$\text{Power} = \gamma_w Q H \eta$$

- γ_w unit weight of water
- Q (flow) from regional hydrologic model
- H (head) from digital elevation model
- η efficiency



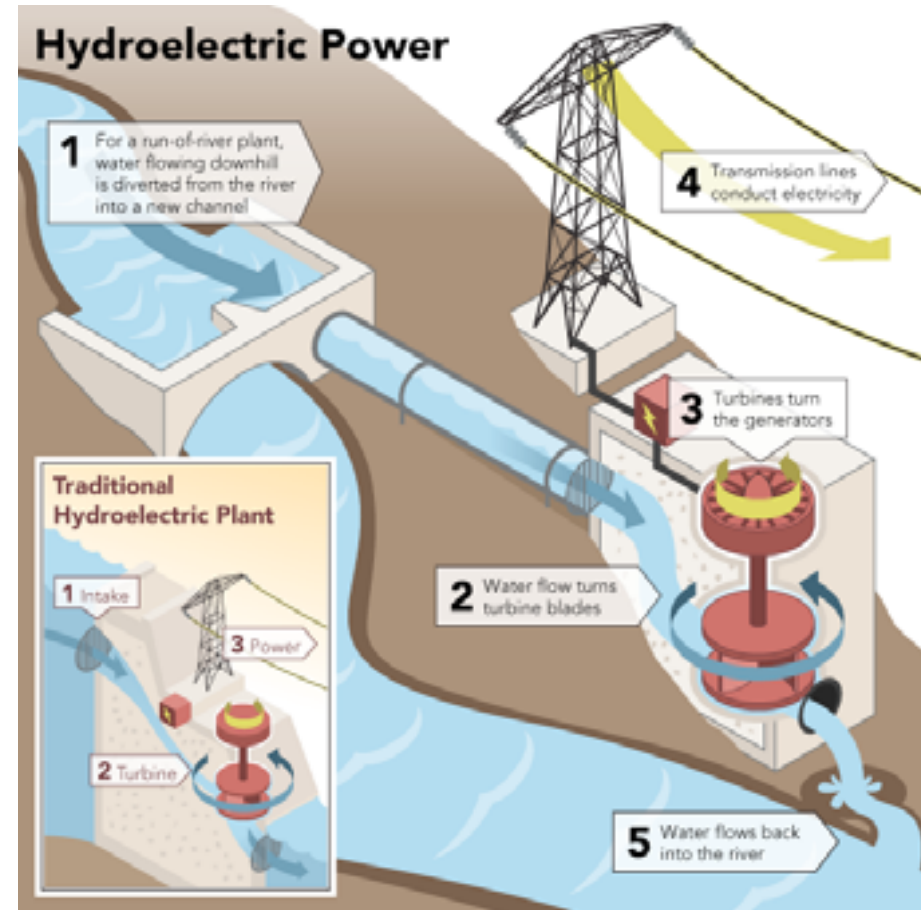
How to find this... →

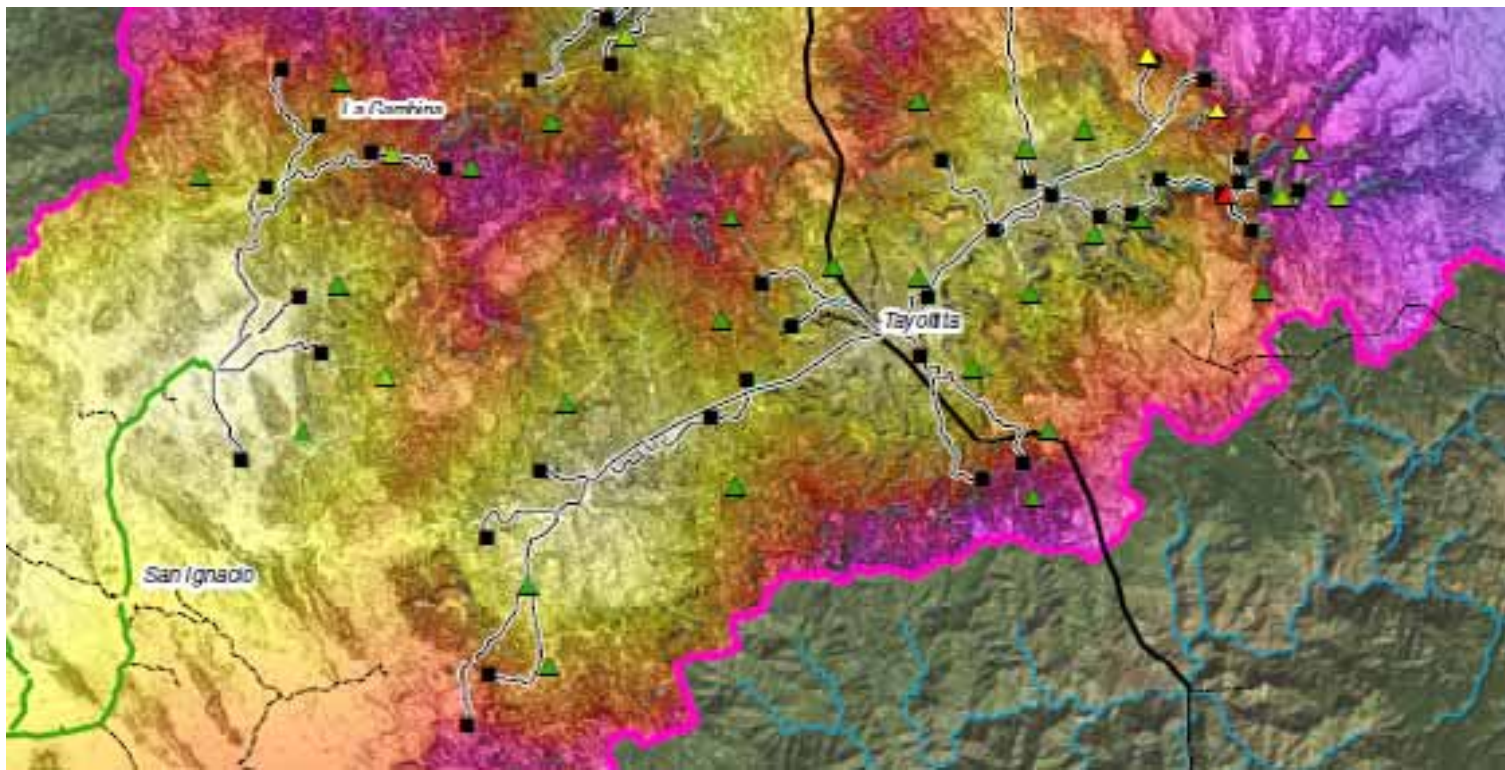
...using this



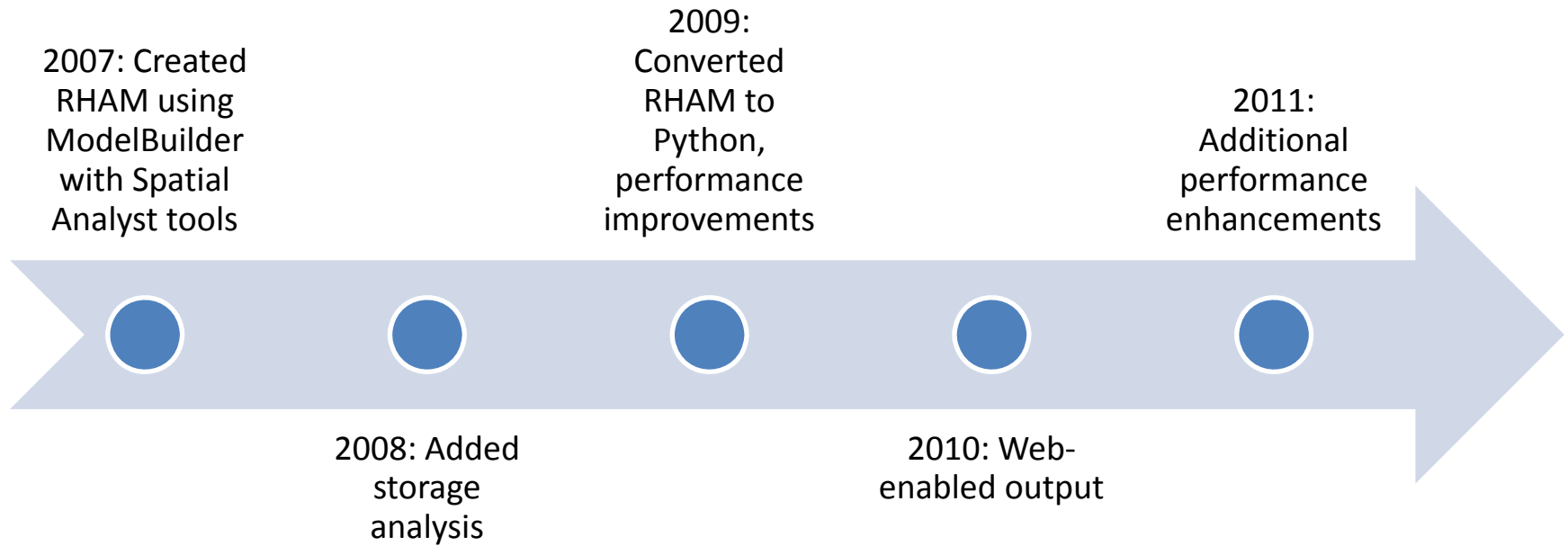
...for the least \$

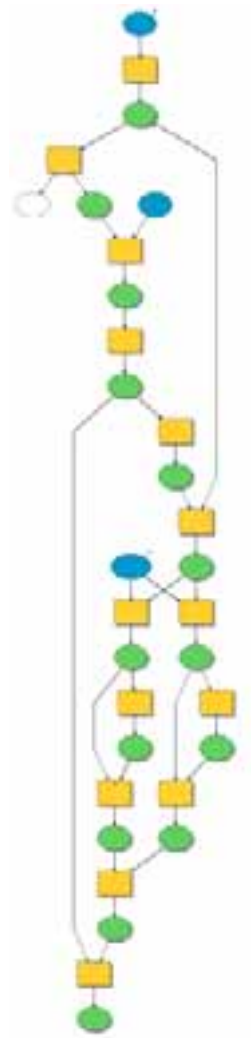
- Site-Based Costs
 - Intake
 - Penstock
 - Powerhouse
 - Electrical Generating Equipment
- Access Costs
 - Road
 - Powerline



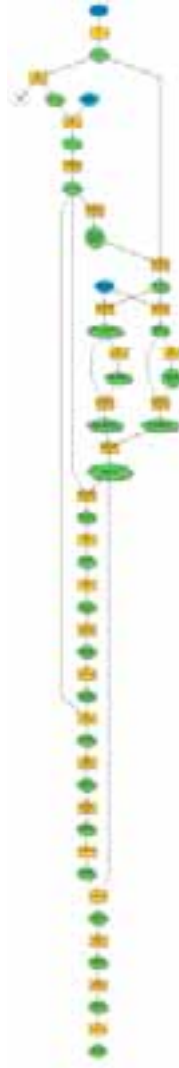


- Roads and Powerlines
- Terrain Model to Cost Surface (DEMS, etc.)
- Generate Pathways for Roads, Powerlines, etc.

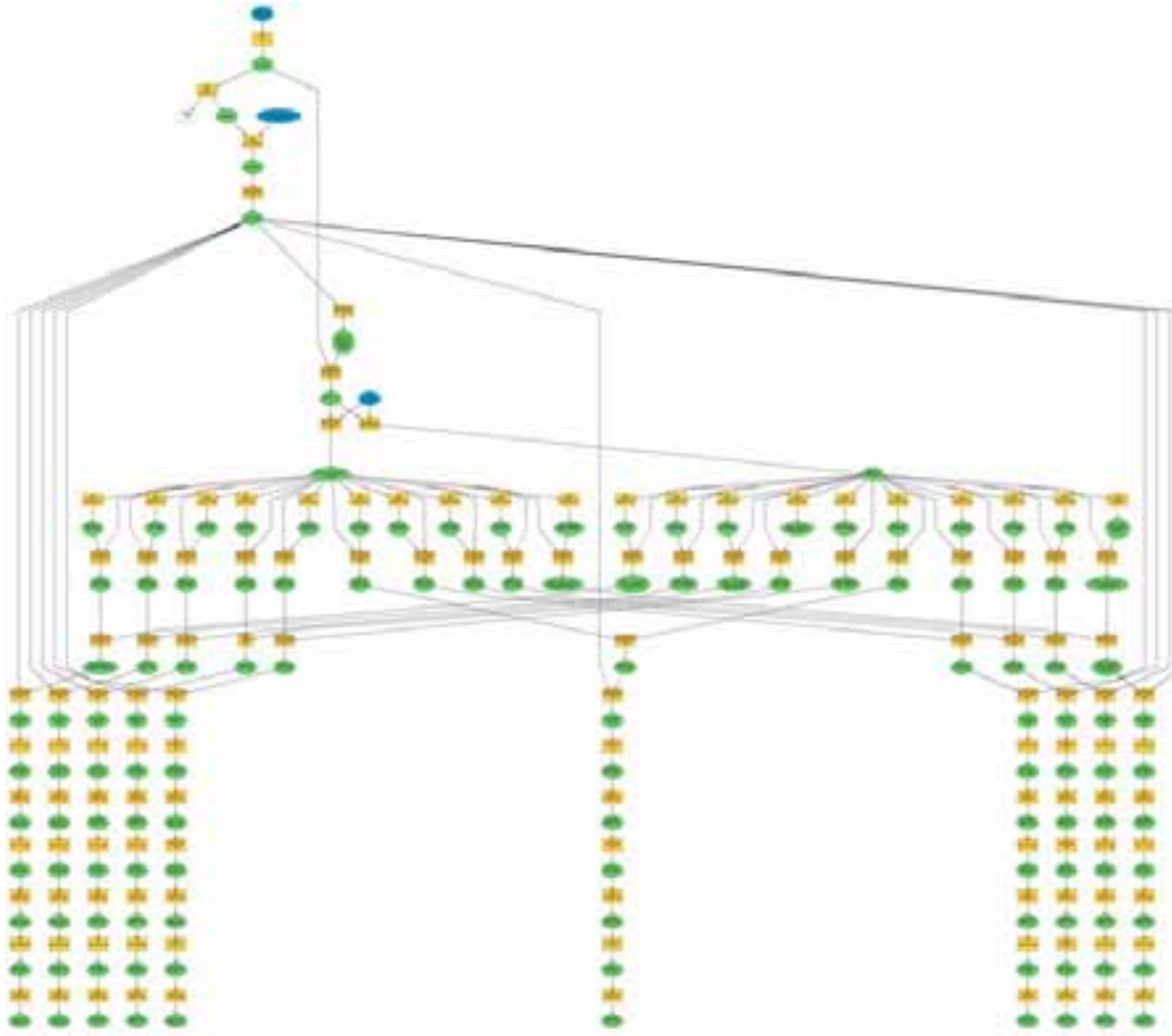




RHAM Model History (v.2)



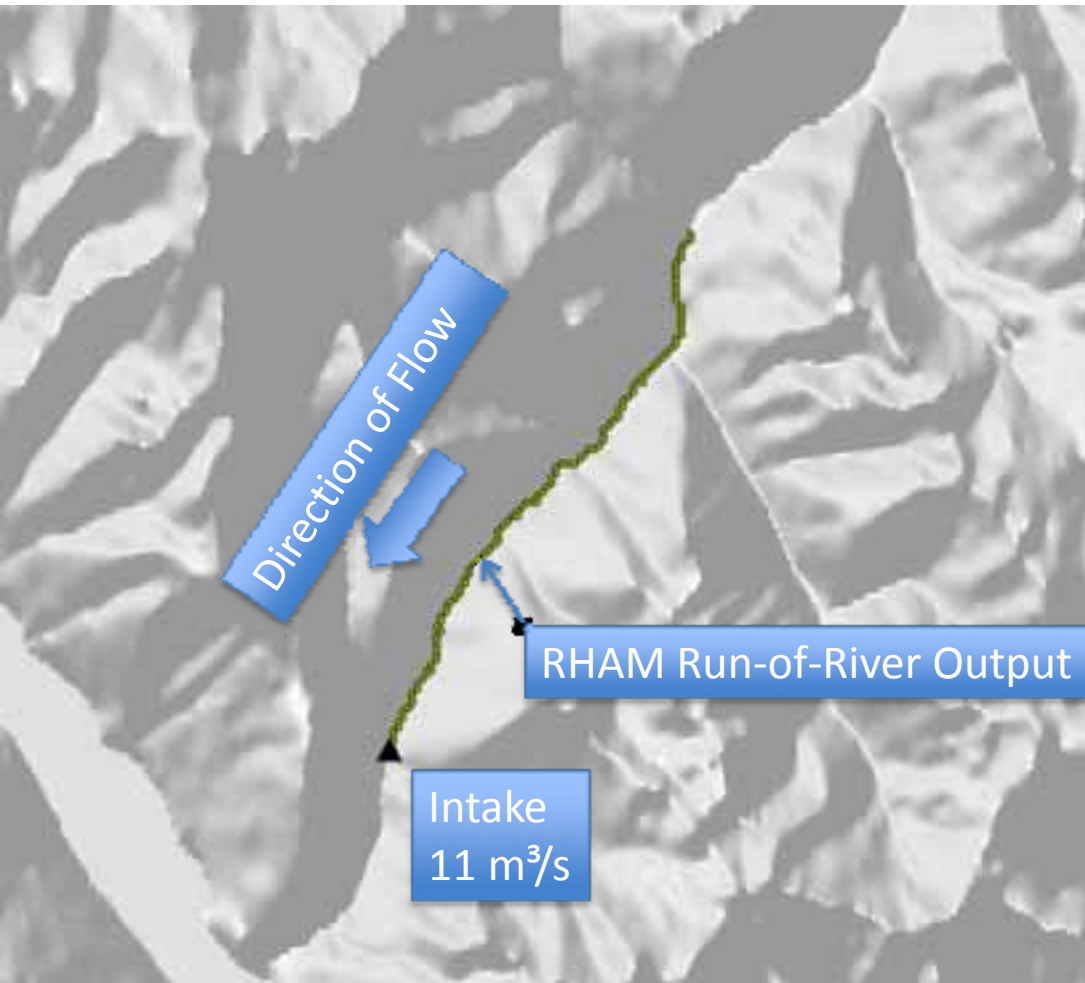
RHAM Model History (v.3)





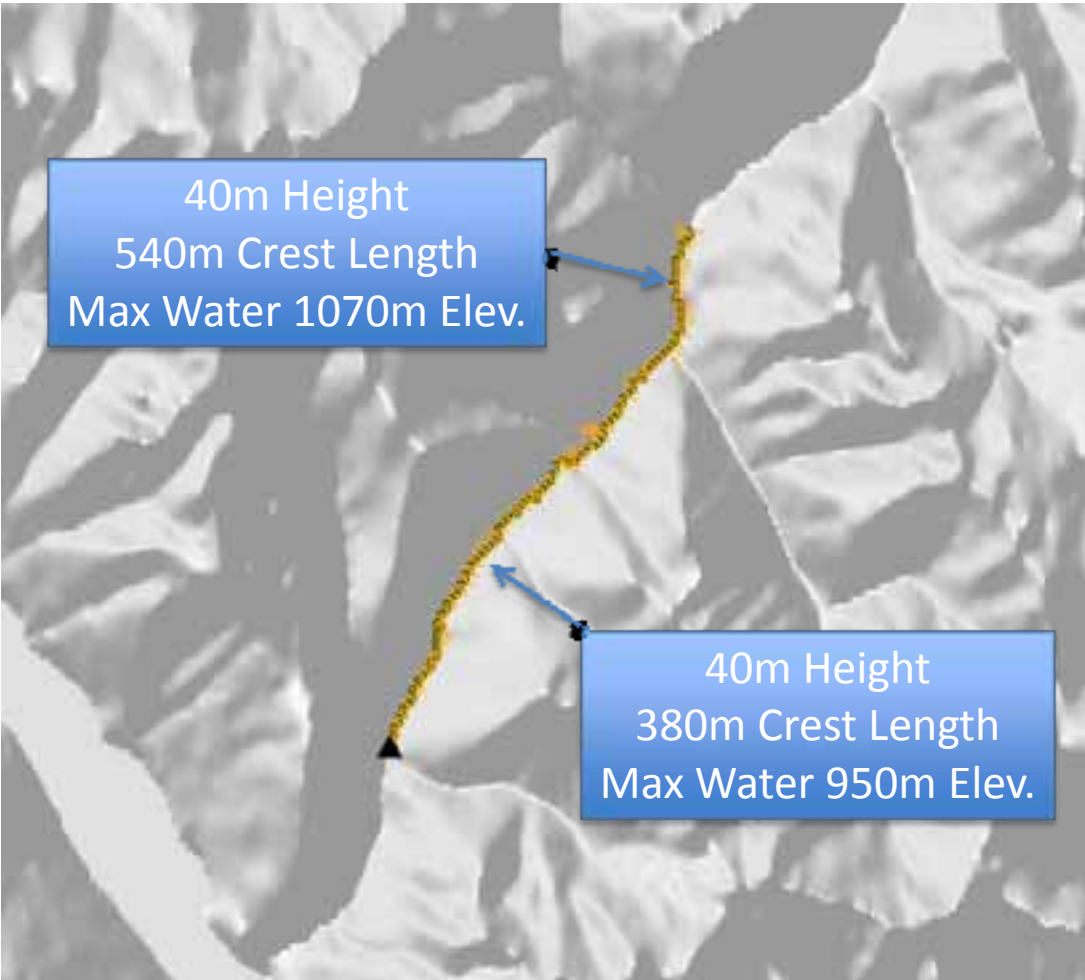
94 lines of Python code

- Increases Dependable Capacity
- Increases Energy Delivered when Needed by Customers
- Increases Energy Production
- Increases Flow for Aquatic Habitat
- Reduces Downstream Flood Risks



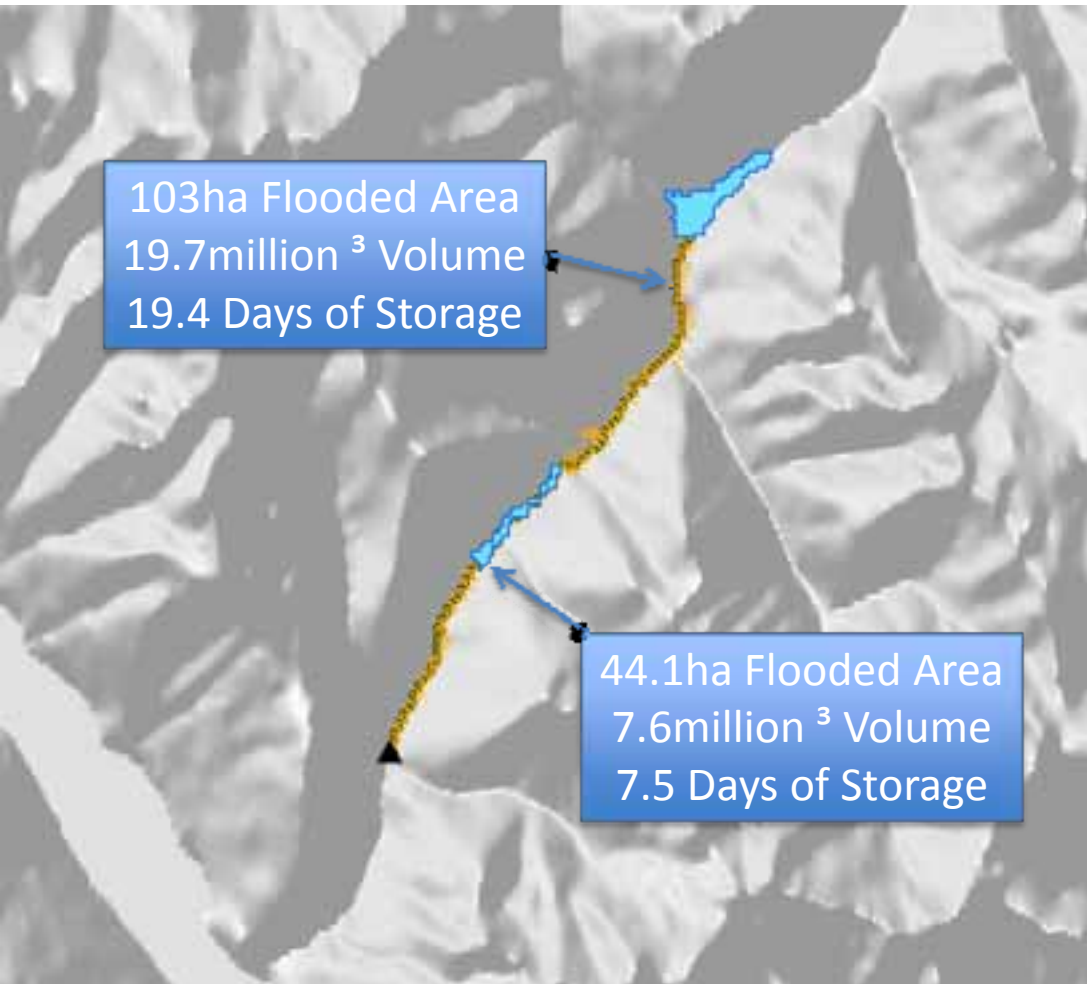
Inputs

- Use RHAM Run-of-River Output as Input
- Select Dam Heights (user defined)



Process

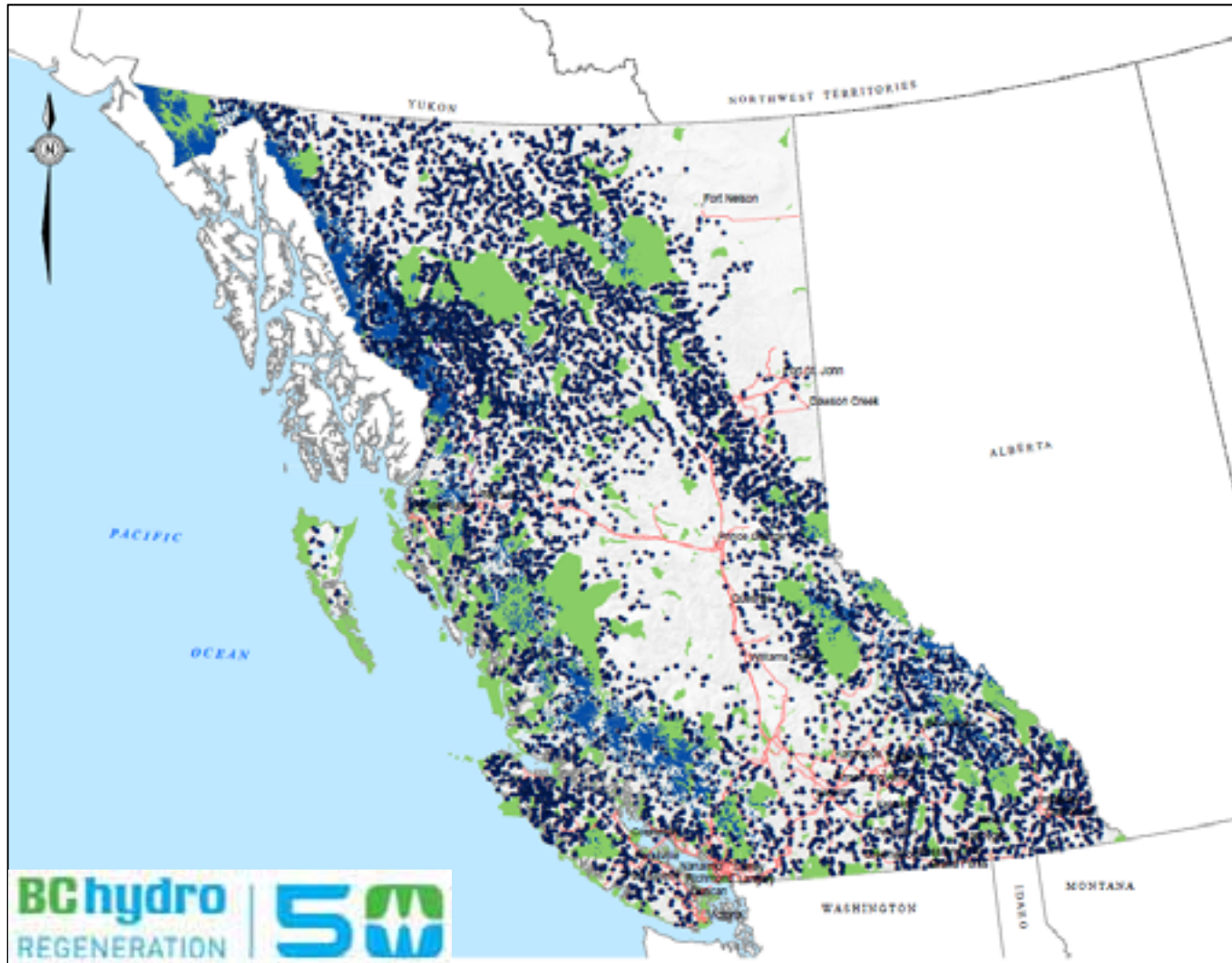
- Dam Height
- Dam Length
- Max Water Elevation

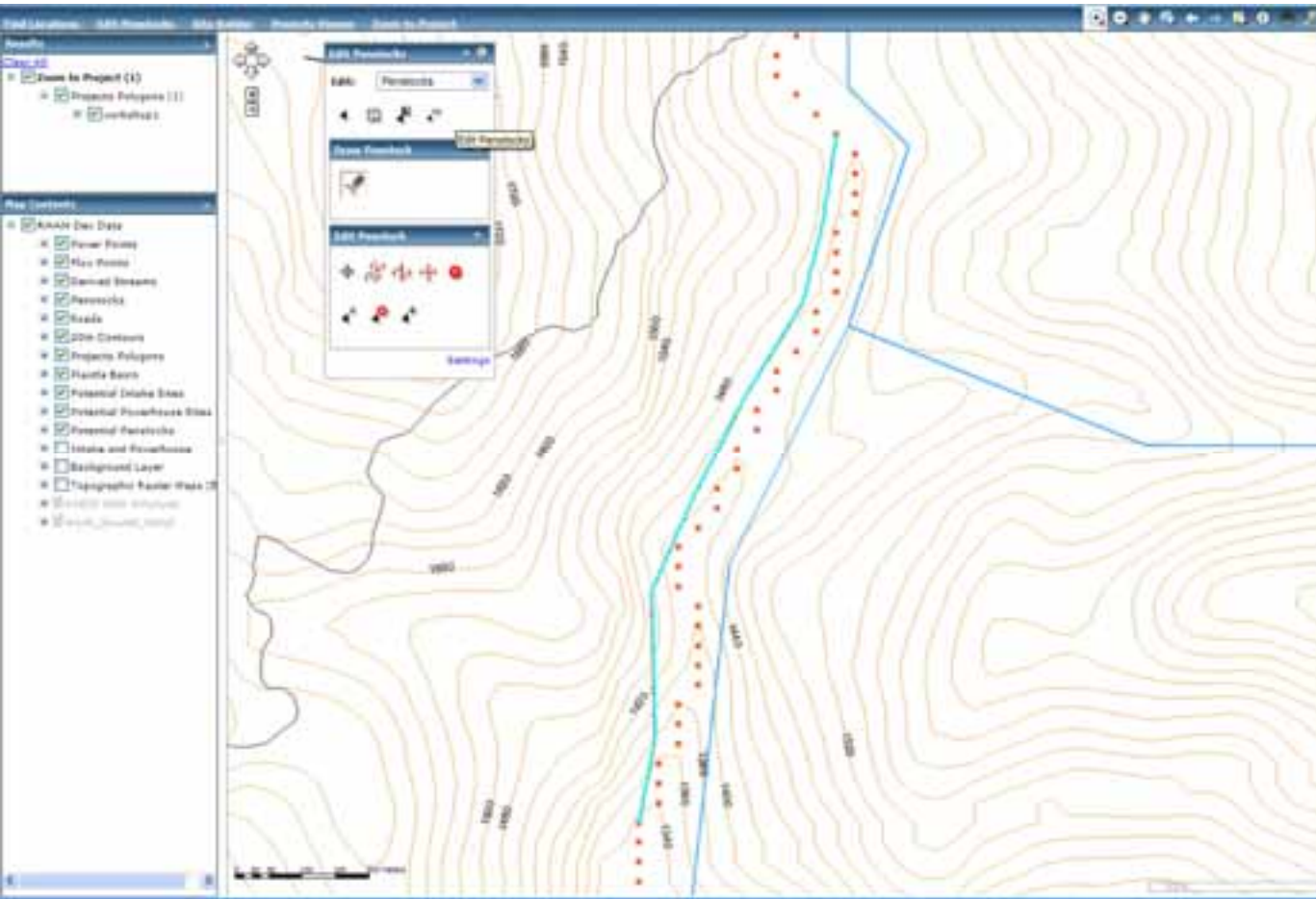


Output

- Lake Surface Area
- Lake Volume (m³)
- Storage Time

Potential Small Hydro in British Columbia





Project Name: Google Chrome
 66.1764.25 (New...)
Projects Viewer

Page through projects:
 SL 1, 2, 3

| | |
|---------------------------------|----------------------------|
| VERTICAL | 463 |
| Reach ID | 14469 |
| Site Name | working1 |
| Intake Location (DCL) | -109°42'30" W, 34°18'12" N |
| Powerhouse Location (DCL) | -109°42'32" W, 34°18'12" N |
| Intake Elevation (m ASL) | 1,891 |
| Powerhouse Elevation (m ASL) | 1,641 |
| Design Flow (CMS) | 1.20 |
| Gross Head (m) | 250 |
| Pipe length(m) | 2,440 |
| Pipe Diameter (Inch) | 24 |
| Pipe Material | Steel |
| Headloss (m) | 81 |
| Turbine Type | Pelton (201 - 300m head) |
| Efficiency | 0.88 |
| Output Power (MW) | 1.89 |
| Penstock Cost (\$) | 3,063,000 |
| Penstock Unit Cost (\$/m) | 1,291 |
| Civil Cost (\$) | 1,690,000 |
| Civil Unit Cost (\$/CM) | 1,292,000 |
| Equipment Cost (\$) | 1,381,000 |
| Equipment Unit Cost (\$/MW) | 1,260,000 |
| Road Cost (\$) | 12,000 |
| Road Unit Cost (\$/m) | 49,000 |
| Transmission Cost (\$) | 5,238,000 |
| Transmission Unit Cost (\$/m) | 212,800 |
| Subtotal Capital Works (\$) | 8,851,000 |
| Mobilization Cost (\$) | 276,000 |
| General Cost (\$) | 621,900 |
| Engineering Cost (\$) | 1,320,000 |
| Contingency Cost (\$) | 0 |
| Total Capital Cost (\$) | 10,050,000 |
| Total Capital Unit Cost (\$/MW) | 5,696,000 |
| Annual Finance | 1,356,000 |
| Annual O & M | 217,000 |
| Annual Water Rental | 1,900 |
| Annual Energy (MWh) | 4,938 |
| Annual Cost | 1,377,000 |
| Unit Energy Cost (\$/MWh) | 221 |

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