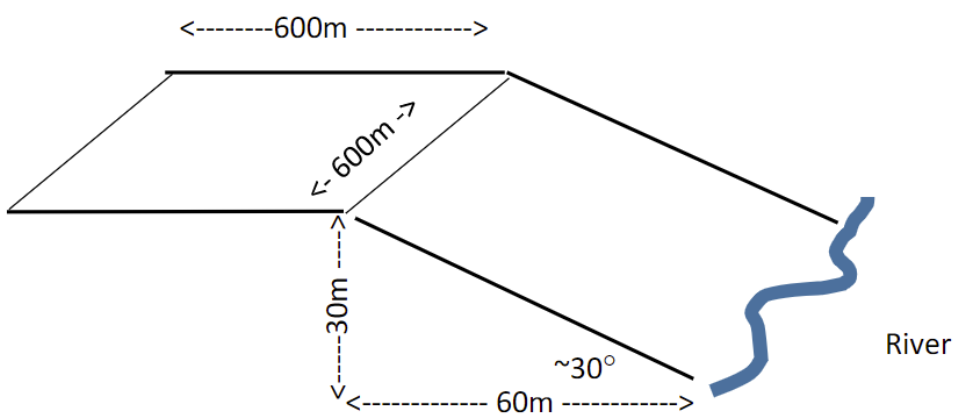
10/27/21 (in class)
Electronic Signatures: Ella Barnes, Heather Mello, Fahim Hossain, John Kang

- Evaluated which other factors to consider--decided to not add any other factors as they all were believed to be insignificant
- Established basic code framework and order of operations for coding
- Ran through basic traits of each site
    - Different requirements and restrictions (height limits potential energy storage, access road costs, potential additional costs, etc.)
- Made a decision matrix summarizing all additional costs:

Sites					
Customer Needs	**Technical Needs**	**Weight**	**Zone 1**	**Zone 2**	**Zone 3**
Water capacity	Surface Area (m^2)	2	360,000	25,620	39,760
Energy storage	Height (m)	2	30	100	65
Pipe cost	Distance from River (m)	1	60	130	91.2
Road Cost	Access Road Cost ($)	1	40,000	100,000	150,000
Cost (misc)	Additional Costs ($)	1	10,000	8,000	63,600
Terrain Preparation	Prep Cost ($)	0.5	90,000	12,810	2,386
Sum of Scores			4.715	3.779	2.306

- Zone 1 was selected:



10/29/21 (in class)
Electronic Signatures: Ella Barnes, Heather Mello, Fahim Hossain, JohnKang

- Made a framework for the poster
- Started defining functions for finding the relevant program input values

10/30/21 (7:00-9:00)

Electronic Signatures: Heather Mello, Ella Barnes, Fahim Hossain, John Kang

- Wrote down the necessary equations and translated them into code
- Finished defining program input functions
- Reformatted parts data into readable text files
    - Created read sequence for all relevant files
- Made a nested for loop that iterates through all the possible data values to maximize efficiency given fixed values
- Determined that effects on efficiency due to people, animals, or objects falling into the reservoir will not be taken into account
- Updated Poster: project management section
- Drafted notes for the discussion section of the written report

Boiled down Equations

$$V_{Down} = \frac{Q_{Turbine}}{Area_{pipe}} \qquad V_{up} = \frac{Q_{pump}}{Area_{pipe}}$$

$$M\ (mass) = \frac{\left(E_{out} + E_{in}\left(\frac{1}{\eta_{turbine}} - 1\right)\right)}{g\underbrace{(H + d/2)}_{\text{effective elevation}} - (f(L/D)(V_{down}^2/2)) - (\varepsilon_1 V_{down}^2/2) - (\varepsilon_2 V_{down}^2/2)}$$

$$E_{in} = m(f(L/D) \cdot V_{up}^2/2) + m(\varepsilon_1 V_{up}^2/2) + m(\varepsilon_2 V_{up}^2/2) + E_{out} + E_{out}((1/\eta_{turbine}) - 1) + m((f L/D) V_{up}^2/2) + m(\varepsilon_1 V_{down}^2/2) + m(\varepsilon_2 V_{down}^2/2)$$

11/01/21 (in class)

Electronic Signatures: Heather Mello, Ella Barnes, Fahim Hossain, john Kang

- Updated poster: translated finished sections from big chunks of text to bullet points
- Redid grizzly bear calculation with correct values for reservoir surface area and depth

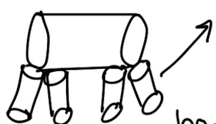
How many bears would have to fall into the reservoir for there to be a 1% change in volume of the water?

① V= (surface area)(height)

$= (106630\ m^2)(12.5m) = 1,332,875\ m^3$

② 1% of this volume: $13,328.75\ m^3$

③ Volume of a grizzly bear:



legs: $\pi r^2 h \times 4$

$= 4\pi(.254\ m)^2(.762\ m) = .618\ m^3$

body: $\pi r^2 h = \pi(1.07\ m)^2(2.5m)$

$= 8.99\ m^3$

total: legs + body $= 9.61\ m^3$

④ number of bears: $\frac{V\ reservoir}{V\ bear} = \frac{13,328.75\ m^3}{9.61\ m^3}$

$= 1,387$ bears

- Chose new values for reservoir wall height (12.5 m), the volumetric flow rate for the turbine (31 m^3/s)
- Incorporated cost with iteration in program
  - Used cost lists that are parallel with efficiency (or diameter)

11/1/21 9:00-10:30pm

Electronic Signatures: Ella Barnes, Heather Mello, John Kang, Fahim Hossain

- Worked on poster and outline of written report
- Put results into charts and graphs and put on poster
- Add discussion section to poster

Code outputs

---Winning efficiency = 0.8054965287424701

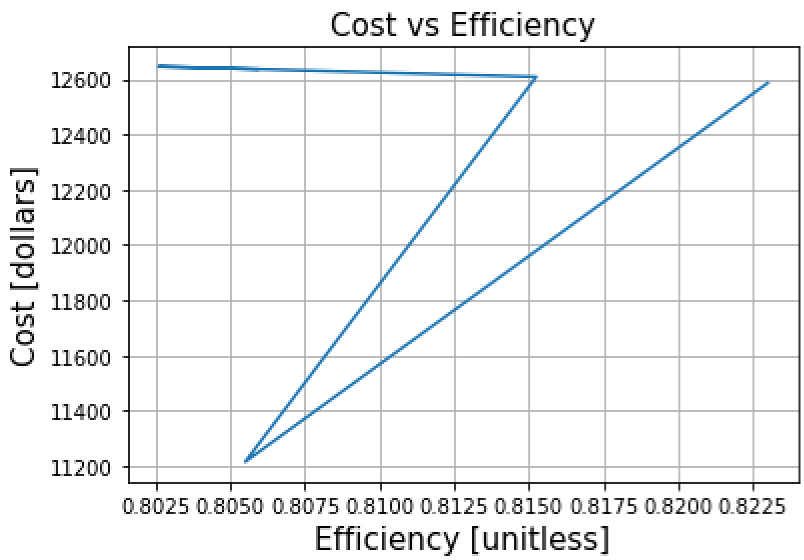
Pump efficiency = 0.92

---Pump Flow volume = 65
Pipe diameter = 3.0
--Pipe length = 67.08203932499369
Pipe friction = 0.002
--Depth = 12.5
--pipe reservoir elevation = 30
--K1 = 0.15
---K2 = 0.15
Turbine Efficiency = 0.92
--Turbine Flow volume = 31
Mass = 1304507128.8817587

Area of Reservoir = 106629.27836076984
Ein = 148.97643343956096
Efficiency = 0.8054965287424701
Fill Time = 5.696008459442833
Empty Time = 11.943243543993O4
--Total cost = 11214.558441597172

Pump Efficiency	0.92
Pipe Diameter	3.0 m
Pipe Friction	0.002
Turbine Efficiency	0.92
Mass	1,300,000,000 kg
Area of Reservoir	106630 m^2
E_{in}	149.0 MWh
Efficiency	.8055

Fill Time	5.70 hours
Empty Time	11.94 hours



	Description	Unit Cost	Quantity	Total Cost ($)
Pump	The total cost of the pump usage (the selected cost efficiency times the pump flow rate).	$456	65	29640
Pipe	The combined price of both pipes; up & down (the selected cost per meter times the total length of both pipes).	$1,011	134.16	135635.76
Bend 1	The upper bend on the pipe	$892	1	892

	going down (the selected bend unit cost).			
Bend 2	The upper bend on the pipe going up (the selected bend unit cost).	$892	1	892
Bend 3	The lower bend on the pipe going down (the selected bend unit cost).	$892	1	892
Bend 4	The lower bend on the pipe going up (the selected bend unit cost).	$892	1	892
Turbine	The total cost of the turbine usage (the selected cost efficiency times the turbine flow rate).	$684	31	21204
Pumphouse	The fixed price of the pump and turbine housing.	$100,000	1	100000
Road	The fixed price of Zone 1 access road.	$40,000	1	40000
Site Prep	The total cost of soil removal for the area (Zone 1 prep cost per meter times the area of the reservoir).	$0.25	106630	26657.5
Perimeter Wall	The total cost of walling around the reservoir (the selected cost per meter of walling times the perimeter of the reservoir).	$135	326.54	44082.9
Pipe Install Cost	The total cost of the base installation of the pipes (cost	$500	67.082	33541

	per meter times the length of pipe).			
Raised Pipe Cost	The total additional cost of raising the pipes (cost per square meter times the area under the pipes for Zone 1).	$250	900	225000
Other Costs	The fixed price of soil testing costs for Zone 1.	$10,000	1	10000
Overall Estimated Cost ($)				$669331.18

11/2/21 4:30-5:30

Electronic Signatures: Ella Barnes, Heather Mello, John Kang

- Finalized poster and practiced presenting (assigned sections, refined off-slide information)
- Added a drawing of final reservoir design
- Amended final cost to correct for a previous error (neglected to add the cost associated with having two pipes, one for pumping water up to the reservoir and a separate one for water flowing down)
- Added descriptions to price table
- Amended images on poster (replaced equations image, added drawing of full model to model image)

$$V_{down} = \frac{Q_{turbine}}{Area_{pipe}} \qquad V_{up} = \frac{Q_{pump}}{Area_{pump}}$$

$$M = \frac{\left(E_{out} + E_{in}\left(\frac{1}{\eta_{turbine}}\right) - 1\right)}{g(H + d/2) - f(L/D)(V_{down}^2/2) - \varepsilon_1 V_{down}^2/2 - \varepsilon_2 V_{down}^2/2}$$

$$E_{in} = m(f(L/D)V_{up}^2/2) + m(\varepsilon_1 V_{up}^2/2) + m(\varepsilon_2 V_{up}^2/2) + E_{out} + E_{out}\left(\left(\frac{1}{\eta_{turbine}}\right) - 1\right) + m(f(L/D)V_{up}^2/2 + m(\varepsilon_1 V_{down}^2/2) + m(\varepsilon_2 V_{down}^2/2)$$

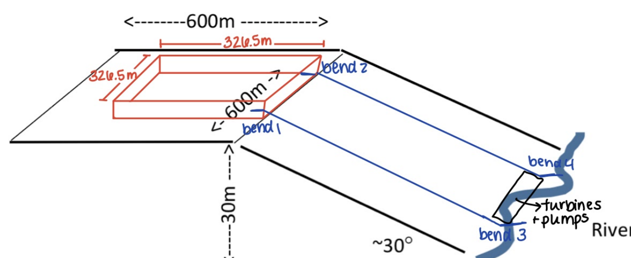
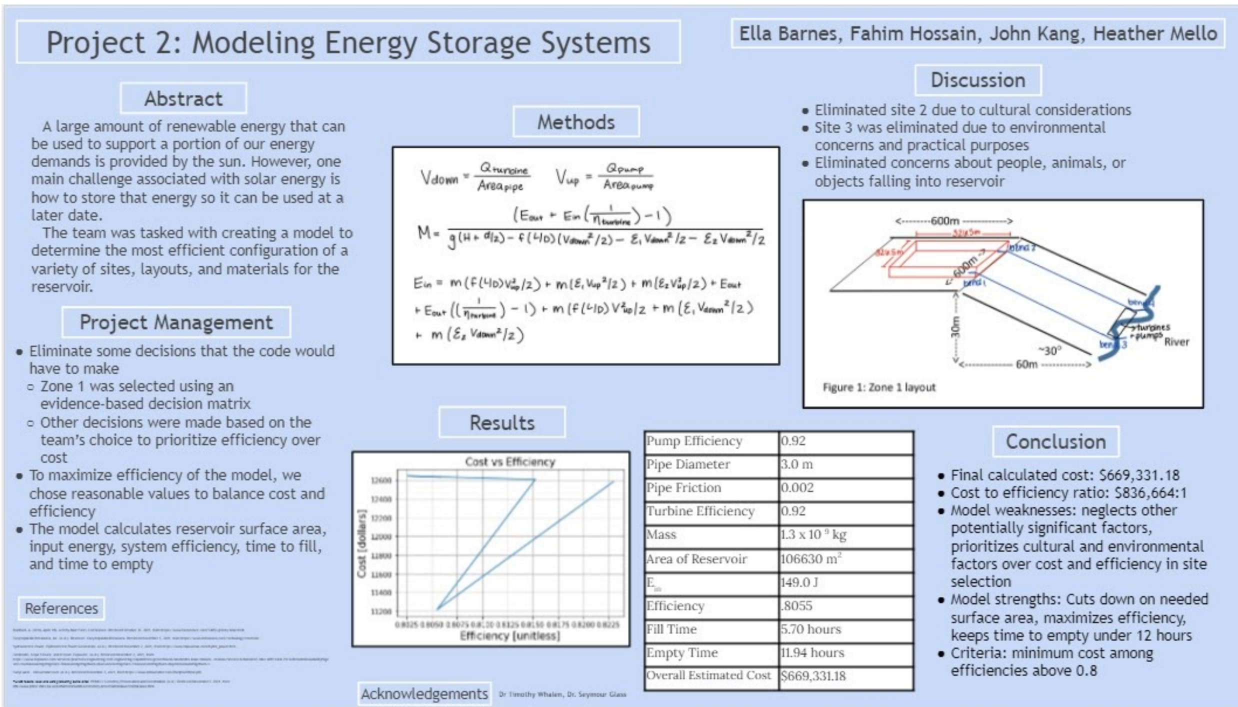


Figure 1: Zone 1 layout

11/3/21 (presentation day-in class)

Electronic Signatures: Ella Barnes, John Kang, Fahim Hossain, Heather Mello

- Presented



- Our presentation went really well, and the only critique that we got from Dr. Whalen was that we were a little bit quiet.

11/4/21 3:00-4:00pm

Electronic Signatures: Ella Barnes, Heather Mello, John Kang

- Worked on writing report: divided the work & decided who will be the main writer for each section
  - Ella: Cover letter, executive summary
  - Heather: Discussion, conclusion/recommendations
  - All: Cost impact analysis

11/5/21 3:40-

Electronic Signatures: Heather Mello, Ella Barnes, John Kang

- Finalized written report