

# Concrete Canoe



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PONDEROSA PINECONES

CENE 476

12/3/2021

# Purpose and Client

- Build a concrete canoe
- Follow guidelines provided by the ASCE concrete canoe competition
- Race canoe in ISWS competition



Figure 2: Mark Lamer, PE; Client [2]

Categories	Maximum Points
Project Proposal	25
Enhanced Focus Area	5
Technical Presentation	20
Final Product Prototype	25
Race Demonstration (5 events)	25
Total Possible	100

Figure 1: Competition Point Breakdown by Category [1]

- Client is Mark Lamer, PE
- Interest in this project due to past participation in event
- NAU's Student Chapter of ASCE faculty advisor

# Location and Background

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- Conference held at UNLV in April 2022
- Region is the Intermountain Southwest Symposium
- Region includes schools from Arizona, Nevada, Utah, and Idaho
- NAU has Built Concrete Canoes since 1977
- First Concrete Canoe Competition was in 1988
- Last Year's Team Place 4<sup>th</sup> Overall in Region
- 2019-2020 Team Placed 9<sup>th</sup>
- 2018-2019 Team Placed 11<sup>th</sup>



Figure 3: VolCanoe Concrete Canoe Team, 2018-2019 [4]

# Constraints

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## Capstone

- Must follow guidelines and rubrics provided by grading instructor for all deliverables



Figure 5: ASCE Concrete Canoe Competition Logo [1]

## ASCE Concrete Canoe Competition

- Max Hull Length: 22 ft
- A minimum of 50% of the total aggregate volume shall be composed of:
  - (a) Commercially-available lightweight aggregate (meeting the requirements of ASTM C330)
  - (b) Recycled concrete aggregate (RCA)
  - (c) A combination of these.

# Scope of Services

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- Task 1: Enhanced Focus Area
- Task 2: Mix Design
  - Task 2.1: Mix Design Research
    - Task 2.1.1 Cementitious Materials
    - Task 2.1.2 Aggregates
    - Task 2.1.3: Admixtures
  - Task 2.2: Develop an Initial Mix
  - Task 2.3: Mix Design Testing
    - Task 2.3.1: Slump Test
    - Task 2.3.2: Unit Weight of Mix
    - Task 2.3.3: Compressive Strength
    - Task 2.3.4: Tensile Strength
  - Task 2.4: Iterative Mix Design and Testing
  - Task 2.5: Final Mix Design

- Task 3: Hull Design
  - Task 3.1: Hull Design Research
  - Task 3.2: Software Modeling
    - Task 3.2.1: Solidworks
    - Task 3.2.2: MaxSurf
  - Task 3.3: Structural Analysis
  - Task 3.4: Final Hull Design



Figure 6: Ponderosa Concrete Canoe Team, 2020-2021, Mentees Performing Slump Test [5]

# Scope of Services

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- Task 4: Reinforcement
  - Task 4.1: Research
  - Task 4.2: Analysis and Testing
  - Task 4.3: Final Reinforcement Design

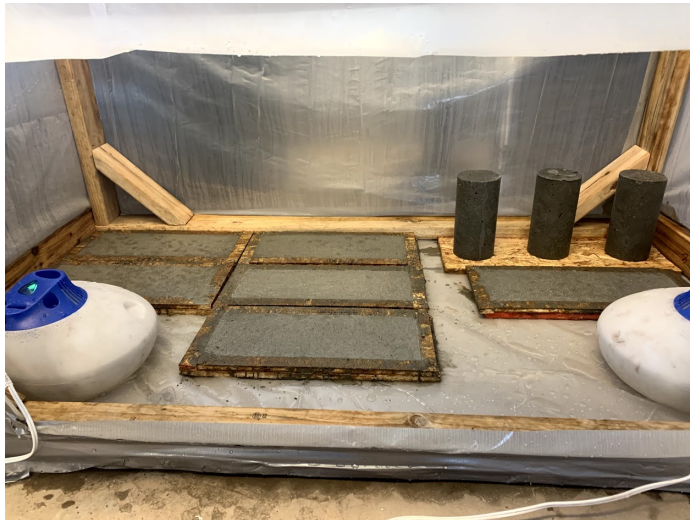


Figure 7: Ponderosa Concrete Canoe Team, 2020-2021, Mini Beams Curing in Curing Chamber[5]

- Task 5: Construction
  - Task 5.1: Mold Procurement
  - Task 5.2: Cure Chamber Procurement
  - Task 5.3: Reinforcement Placement
  - Task 5.4: Concrete Placement
  - Task 5.5: Curing and Removal from Mold
  - Task 5.6: Apply Aesthetics
  - Task 5.7: Create Stand

# Scope of Services

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- Task 6: Conference Deliverables
  - Task 6.1: Complete Conference Technical Proposal
  - Task 6.2: Complete Enhanced Focus Areas Report
  - Task 6.3: Give Conference Presentation
  - Task 6.4: Transport Canoe
  - Task 6.5: Race Canoe
- Task 7: Deliverables for CENE 486
  - Task 7.1: Complete 30% Deliverables
  - Task 7.2: Complete 60% Deliverables
  - Task 7.3: Complete 90% Report
  - Task 7.4: Complete Final Report
  - Task 7.5: Complete Final Website
  - Task 7.6: Give Final Presentation



Figure 8: VolCanoe Concrete Canoe Team, 2018-2019, ASCE Members at Conference [4]



# Scope of Services

- Task 8: Project Management
  - Task 8.1: Project Meetings
    - Task 8.1.1: Team Meetings
    - Task 8.1.2: GI/Client Meetings
    - Task 8.1.3: TA Meetings
  - Task 8.2: Budget Management
  - Task 8.3: Schedule Management
  - Task 8.4: Fundraising
- Task 9: Impacts
  - Task 9.1: Social
  - Task 9.2: Economic
  - Task 9.3: Environmental

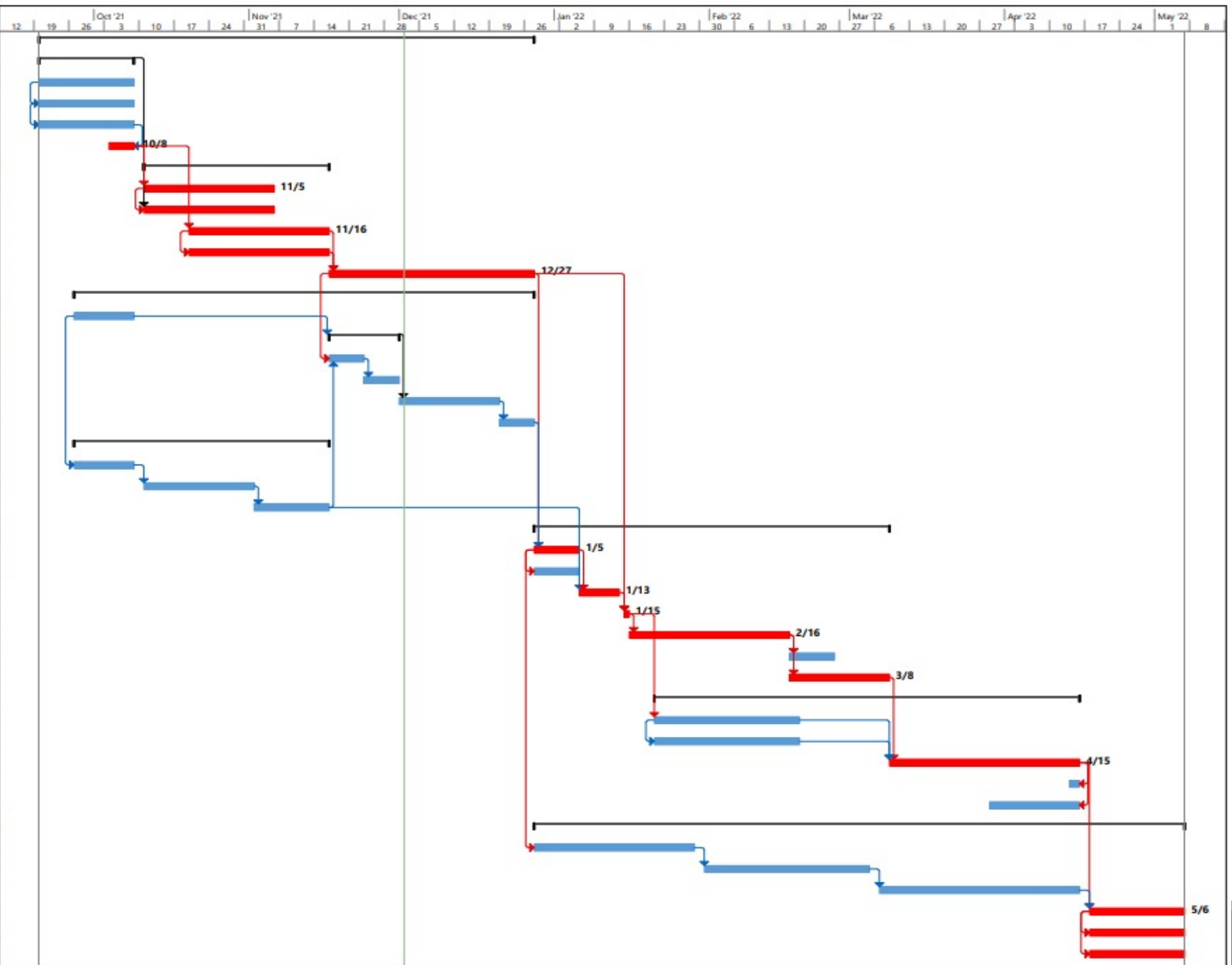
- Exclusions: No Exclusions within the Project Scope
  - All Aspects of Project Outlined to Reflect and Achieve Deliverables According to CENE 486 and C4 RFP

Table 1: Summary of Important Dates/Deadlines [1]

ITEM	DATE
Issuance of 2022 Request for Proposal Solicitation	September 7, 2021
Deadline for Submission of <i>Preliminary Project Delivery Schedule, Letter of Intent, and RFQ Pre-Qualification Form</i>	November 5, 2021
Last Day to Submit RFI's to the C4	January 21, 2022
ASCE Student Chapter Annual Reports/Dues Deadline	February 1, 2022
Issuance of RFI Summary	On or about February 1, 2022
<i>Project Proposal, Enhanced Focus Area Report, and MTDS Addendum</i> Deadline (Symposia Competitions)	February 18, 2022
ASCE Student Symposia Competitions	March to Late April 2022
<i>Project Proposal, Enhanced Focus Area Report, and MTDS Addendum</i> Deadline (Society-wide finals)	May 10, 2022
2022 ASCE Concrete Canoe Competition, hosted by Louisiana Tech University, Ruston, LA	June 3-5, 2022



ID	Task Name	Duration	Start
1	<b>Task 2: Mix Design</b>	<b>71 days</b>	<b>Mon 9/20/21</b>
2	<b>Task 2.1: Mix Design Research</b>	<b>15 days</b>	<b>Mon 9/20/21</b>
3	Task 2.1.1: Cementitious Materials	15 days	Mon 9/20/21
4	Task 2.1.2: Aggregates	15 days	Mon 9/20/21
5	Task 2.1.3: Admixtures	15 days	Mon 9/20/21
6	Task 2.2: Develop an Initial Mix Design	5 days	Mon 10/4/21
7	<b>Task 2.3: Mix Design Testing</b>	<b>27 days</b>	<b>Mon 10/11/21</b>
8	Task 2.3.1: Slump Test	20 days	Mon 10/11/21
9	Task 2.3.2: Unit Weight of Mix	20 days	Mon 10/11/21
10	Task 2.3.3: Compressive Strength	20 days	Wed 10/20/21
11	Task 2.3.4: Tensile Strength	20 days	Wed 10/20/21
12	Task 2.4: Final Mix Design	29 days	Wed 11/17/21
13	<b>Task 3: Hull Design</b>	<b>66 days</b>	<b>Mon 9/27/21</b>
14	<b>Task 3.1: Hull Design Research</b>	<b>10 days</b>	<b>Mon 9/27/21</b>
15	<b>Task 3.2: Software Modeling</b>	<b>10 days</b>	<b>Wed 11/17/21</b>
16	Task 3.2.1: Solidworks	5 days	Wed 11/17/21
17	Task 3.2.2: MaxSurf	5 days	Wed 11/24/21
18	<b>Task 3.3: Structural Analysis</b>	<b>14 days</b>	<b>Wed 12/1/21</b>
19	<b>Task 3.4: Final Hull Design</b>	<b>5 days</b>	<b>Tue 12/21/21</b>
20	<b>Task 4: Reinforcement</b>	<b>37 days</b>	<b>Mon 9/27/21</b>
21	<b>Task 4.1: Research</b>	<b>10 days</b>	<b>Mon 9/27/21</b>
22	<b>Task 4.2: Analysis and Testing</b>	<b>16 days</b>	<b>Mon 10/11/21</b>
23	<b>Task 4.3: Final Reinforcement Design</b>	<b>11 days</b>	<b>Tue 11/2/21</b>
24	<b>Task 5: Construction</b>	<b>53 days</b>	<b>Tue 12/28/21</b>
25	<b>Task 5.1: Mold Procurement</b>	<b>7 days</b>	<b>Tue 12/28/21</b>
26	<b>Task 5.2: Cure Chamber Procurement</b>	<b>7 days</b>	<b>Tue 12/28/21</b>
27	<b>Task 5.3: Reinforcement Placement</b>	<b>6 days</b>	<b>Thu 1/6/22</b>
28	<b>Task 5.4: Concrete Pours</b>	<b>1 day</b>	<b>Sat 1/15/22</b>
29	<b>Task 5.5: Curing and Removal from Mold</b>	<b>24 days</b>	<b>Sun 1/16/22</b>
30	<b>Task 5.6: Aesthetics</b>	<b>7 days</b>	<b>Thu 2/17/22</b>
31	<b>Task 5.7: Stand</b>	<b>14 days</b>	<b>Thu 2/17/22</b>
32	<b>Task 6: Conference Deliverables</b>	<b>61 days</b>	<b>Fri 1/21/22</b>
33	<b>Task 6.1: Conference Technical Proposals</b>	<b>21 days</b>	<b>Fri 1/21/22</b>
34	<b>Task 6.2: Enhanced Focus Areas Report</b>	<b>21 days</b>	<b>Fri 1/21/22</b>
35	<b>Task 6.3: Conference Presentation</b>	<b>28 days</b>	<b>Wed 3/9/22</b>
36	<b>Task 6.4: Transportation of Canoe</b>	<b>2 days</b>	<b>Thu 4/14/22</b>
37	<b>Task 6.5: Racing</b>	<b>14 days</b>	<b>Tue 3/29/22</b>
38	<b>Task 7: Deliverables for 486</b>	<b>96 days</b>	<b>Tue 12/28/21</b>
39	<b>Task 7.1: 30% Submittal</b>	<b>26 days</b>	<b>Tue 12/28/21</b>
40	<b>Task 7.2: 60% Submittal</b>	<b>25 days</b>	<b>Mon 1/31/22</b>
41	<b>Task 7.3: 90% Report</b>	<b>30 days</b>	<b>Mon 3/7/22</b>
42	<b>Task 7.4: Final Report</b>	<b>15 days</b>	<b>Mon 4/18/22</b>
43	<b>Task 7.5: Website</b>	<b>15 days</b>	<b>Mon 4/18/22</b>
44	<b>Task 7.6: Final Presentation</b>	<b>15 days</b>	<b>Mon 4/18/22</b>



# Staffing

- Predicted number of hours for each staffing position
- Staffing positions and abbreviations are described below

Table 3: Staffing

Staff Positions	
Title	Abbreviation
Principal Design Engineer	PDE
Design Manager	DM
Project Construction Manager	PCM
Construction Superintendent	CS
Project Design Engineer (P.E.)	PE
Quality Manager	QM
Graduate Field Engineer (E.I.T.)	EIT
Technician/Drafter	TD
Laborer/Technician	LT
Clerk/Office Admin	OA
Outside Consultant	OC

Table 2: Staffing Matrix

Task	PDE	DM	PCM	CS	PE	QM	EIT	TD	LT	OA	OC
<b>Task 1: Enhanced Focus Area</b>	4	4	4	0	4	4	4	4	4	0	0
<b>Task 2: Mix Design</b>	8	52	0	4	28	50	64	2	82	0	0
<b>Task 2.1: Mix Design Research</b>	3	30	0	0	6	0	12	0	0	0	0
<i>Task 2.1.1: Cementitious Materials</i>	1	10	0	0	2	0	4	0	0	0	0
<i>Task 2.1.2: Aggregates</i>	1	10	0	0	2	0	4	0	0	0	0
<i>Task 2.1.3: Admixtures</i>	1	10	0	0	2	0	4	0	0	0	0
<b>Task 2.2: Develop an Initial Mix</b>	0	6	0	0	6	10	20	0	40	0	0
<b>Task 2.3: Mix Design Testing</b>	4	16	0	4	16	40	32	0	42	0	0
<i>Task 2.3.1: Slump Test</i>	1	4	0	1	4	10	8	0	10	0	0
<i>Task 2.3.2: Unit Weight of Mix</i>	1	4	0	1	4	10	8	0	10	0	0
<i>Task 2.3.3: Compressive Strength</i>	1	4	0	1	4	10	8	0	20	0	0
<i>Task 2.3.4: Tensile Strength</i>	1	4	0	1	4	10	8	0	2	0	0
<b>Task 2.4: Final Mix Design</b>	1	0	0	0	0	0	0	2	0	0	0
<b>Task 3: Hull Design</b>	6	10	4	0	8	12	8	34	9	0	0
<b>Task 3.1: Hull Design Research</b>	1	6	0	0	6	6	6	0	0	0	0
<b>Task 3.2: Software Modeling</b>	2	4	0	0	0	4	0	32	8	0	0
<i>Task 3.2.1: SolidWorks</i>	1	2	0	0	0	2	0	16	4	0	0
<i>Task 3.2.2: MaxSurf</i>	1	2	0	0	0	2	0	16	4	0	0
<b>Task 3.3: Structural Analysis</b>	2	0	0	0	2	2	2	0	0	0	0
<b>Task 3.4: Final Hull Design</b>	1	0	4	0	0	0	0	2	1	0	0
<b>Task 4: Reinforcement</b>	11	24	8	0	0	10	8	10	10	0	0
<b>Task 4.1: Research</b>	8	8	0	0	0	2	2	2	2	0	0
<b>Task 4.2: Analysis and Testing</b>	2	16	4	0	0	8	6	8	8	0	0
<b>Task 4.3: Final Reinforcement Design</b>	1	0	4	0	0	0	0	0	0	0	0
<b>Task 5: Construction</b>	6	10	11	9	8	4	24	2	2	0	4
<b>Task 5.1: Mold Procurement</b>	0	2	2	1	2	0	10	2	2	0	4
<b>Task 5.2: Cure Chamber Procurement</b>	0	0	2	0	0	0	4	0	0	0	0
<b>Task 5.3: Reinforcement Placing</b>	6	6	2	6	6	0	2	0	0	0	0
<b>Task 5.4: Concrete Pours</b>	0	0	2	2	0	2	4	0	0	0	0
<b>Task 5.5: Curing and Removal from Mold</b>	0	0	2	0	0	2	2	0	0	0	0
<b>Task 5.6: Aesthetics</b>	0	2	1	0	0	0	2	0	0	0	0
<b>Task 6: Conference Deliverables</b>	32	12	0	0	46	10	58	0	0	0	0
<b>Task 6.1: Conference Technical Proposal</b>	16	0	0	0	30	6	16	0	0	0	0
<b>Task 6.2: Enhanced Focus Areas Report</b>	4	0	0	0	16	4	12	0	0	0	0
<b>Task 6.3: Conference Presentation</b>	12	12	0	0	0	0	0	0	0	0	0
<b>Task 6.4: Transportation of Canoe</b>	0	0	0	0	0	0	5	0	0	0	0
<b>Task 6.5: Racing</b>	0	0	0	0	0	0	25	0	0	0	0
<b>Task 7: Deliverables for CENE 486</b>	25	0	0	0	80	34	90	4	4	0	0
<b>Task 7.1: 30% Submittal</b>	2	0	0	0	12	4	26	0	0	0	0
<b>Task 7.2: 60% Submittal</b>	2	0	0	0	16	4	26	0	0	0	0
<b>Task 7.3: 90% Submittal</b>	4	0	0	0	30	4	16	0	0	0	0
<b>Task 7.4: Final Report</b>	8	0	0	0	16	4	6	0	0	0	0
<b>Task 7.5: Website</b>	1	0	0	0	0	10	12	4	4	0	0
<b>Task 7.6: Final Presentation</b>	8	0	0	0	6	8	4	0	0	0	0
<b>Task 8: Project Management</b>	41	9	9	9	9	9	9	9	9	27	9
<b>Task 8.1: Project Meetings</b>	9	9	9	9	9	9	9	9	9	9	9
<i>Task 8.1.1: Team Meetings</i>	3	3	3	3	3	3	3	3	3	3	3
<i>Task 8.1.2: Grading Instructor/Technical Advisor Meetings</i>	3	3	3	3	3	3	3	3	3	3	3
<i>Task 8.1.3: Client Meetings</i>	3	3	3	3	3	3	3	3	3	3	3
<b>Task 8.2: Budget</b>	10	0	0	0	0	0	0	0	0	6	0
<b>Task 8.3: Schedule</b>	12	0	0	0	0	0	0	0	0	6	0
<b>Task 8.4: Fundraising</b>	10	0	0	0	0	0	0	0	0	6	0
<b>Task 9: Impacts</b>	3	0	0	0	0	0	0	0	0	3	0
<b>Task 9.1: Social</b>	1	0	0	0	0	0	0	0	0	1	0
<b>Task 9.2: Economical</b>	1	0	0	0	0	0	0	0	0	1	0
<b>Task 9.3: Environmental</b>	1	0	0	0	0	0	0	0	0	1	0
<b>Total (EA- hours)</b>	136	121	36	22	183	133	265	65	120	30	13
<b>Project Total</b>	<b>1124</b>										



# Costs

- Personnel types and rates provided by C4 RFP [1]

Table 5: Cost Summary

Cost of Engineering Services Summary	
Description	Cost
Personnel	\$ 39,600
Travel	\$ 1,795
Lab Use	\$ 1,000
Materials	\$ 1,514
<b>Total</b>	<b>\$ 43,909</b>

Table 4: Cost Estimate

Engineering Services Cost Estimate				
Description	QTY	Unit of Measure	Rate (USD/UM)	Cost
<b>PERSONNEL (direct employee costs + indirect employee costs)</b>				
Principal Design Engineer	136	HR	\$ 50	\$ 6,800
Design Manager	121	HR	\$ 45	\$ 5,445
Project Construction Manager	36	HR	\$ 40	\$ 1,440
Construction Superintendent	22	HR	\$ 40	\$ 880
Project Design Engineer (P.E.)	183	HR	\$ 35	\$ 6,405
Quality Manager	133	HR	\$ 35	\$ 4,655
Graduate Field Engineer (E.I.T.)	265	HR	\$ 25	\$ 6,625
Technician/Drafter	65	HR	\$ 20	\$ 1,300
Laborer/Technician	120	HR	\$ 25	\$ 3,000
Clerk/Office Admin	30	HR	\$ 15	\$ 450
Outside Consultant	13	HR	\$ 200	\$ 2,600
<b>Personnel Total</b>				<b>\$ 39,600</b>
<b>TRAVEL</b>				
<b>Travel for Material Acquisition</b>				
Transportation	800	Miles	\$ 0.46	\$ 368
Hotel Arrangements	1	Nights	\$ 191	\$ 191
<b>Travel for Conference</b>				
Transportation	600	Miles	\$ 0.46	\$ 276
Hotel Arrangements	4	Nights (for 2 rooms)	\$ 240	\$ 960
<b>Travel Total</b>				<b>\$ 1,795</b>
<b>Lab Use</b>				
General Lab Access	10	Days	\$ 100	\$ 1,000
<b>Lab Use Total</b>				<b>\$ 1,000</b>
<b>Materials</b>				
Cementitious Materials	10	Cubic Feet	\$ 10	\$ 100
Aggregates	12	Cubic Feet	\$ 15	\$ 180
Admixtures	2	Gallon	\$ 12	\$ 24
Reinforcement	15	Square Yard	\$ 14	\$ 210
Mold	1	N/A	\$ 1,000	\$ 1,000
<b>Materials Total</b>				<b>\$ 1,514</b>
<b>Project Total</b>				<b>\$ 43,909</b>

# References

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- [1] Committee on Concrete Canoe Competitions, "Concrete Canoe Competition - Request for Proposals," ASCE, Reston, 2021.
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# Questions?

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