

34th Annual WERC Competition
Task 1: Stormwater Management for
Community Resilience

CENE 476

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quattro

ENGINEERING

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Project Introduction

Purpose

Compete in WERC Environmental Design Contest: Task 1

- Design innovative, low-cost stormwater management system
- No typical solution

Location

Competition – New Mexico State University

Project Site – Joseph City, AZ

Client

New Mexico State University

Navajo County

Technical Advisor

Tom Loomis, PE



Figure 1:
Tom & Sue Loomis

Image Credit:
Tom Loomis

WERC Guidance

- Underserved/ disadvantaged
- Lack of stormwater infrastructure & funding
- Potential pollutants
- Climate change impacts

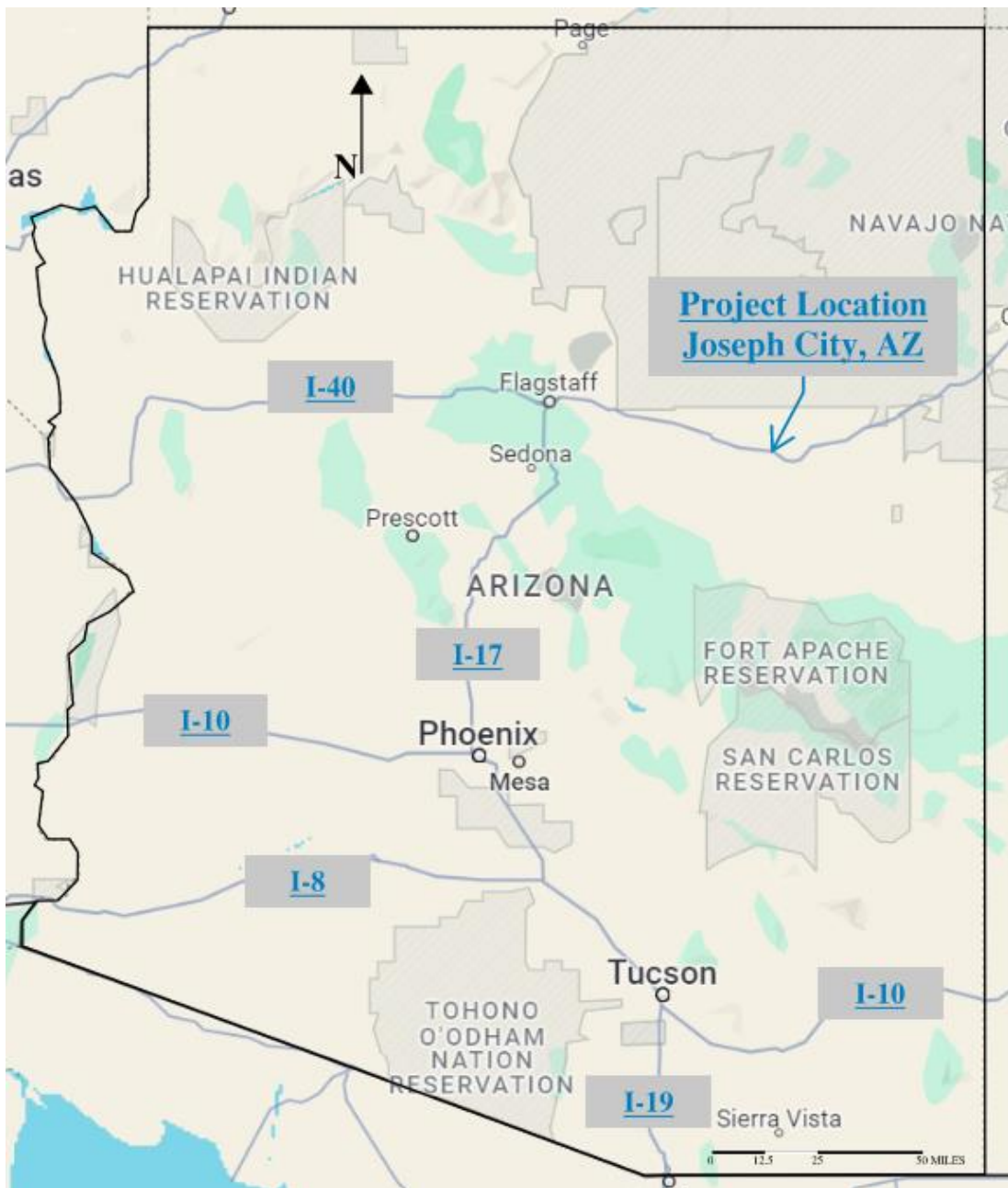


Figure 2: Project Location Map



Figure 3: Project Vicinity Map

Project Background

Issue

Overbank flooding

- Little Colorado River
- Joseph City Wash



Figure 4: Flood Visual

Photo Credit: Navajo County Public Works

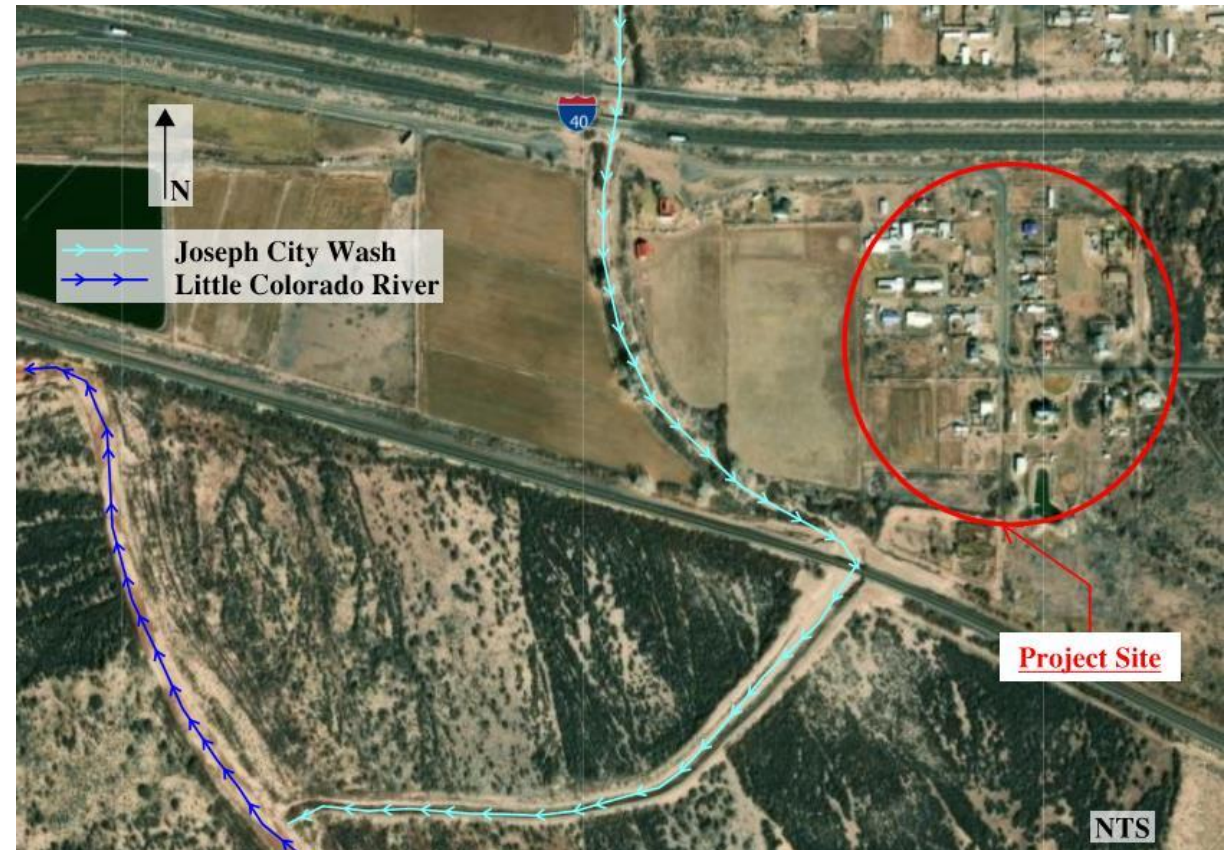


Figure 5: Project Site Map

Task 1 Literature Review & Background Research

Task 1.1 Code and Standards Review

Task 1.2 Soil Classification Review

Task 1.3 Typical Pollutant Research

Task 1.4 Existing Plans Research

Task 1.5 Existing Topography Data Review

Task 1.6 Competition Preparation

Task 1.6.1 Competition Registration

Task 1.6.2 Short Course Enrollment

Task 1.7 NAU Civil Water Lab Access

Task 2 Site Investigation

Task 2.1 NAU Field Safety Checklist

Task 2.2 Land Survey

Task 2.2.1 Survey Preparation

Task 2.2.2 Survey Fieldwork

Task 2.3 Observational Survey

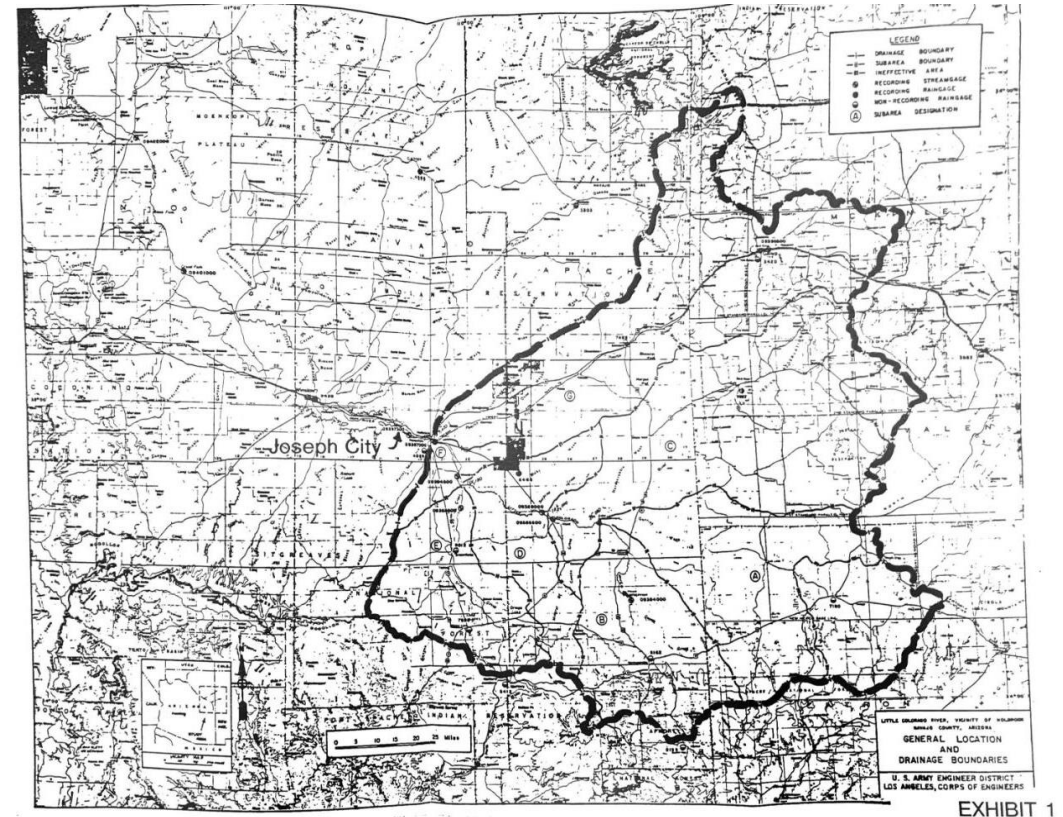


Figure 6: Little Colorado River Watershed
Image Credit: Navajo County Public Works

Task 3 Site Analysis

Task 3.1 Existing Topographic Map

Task 3.2 Hydrologic Assessment

Task 3.2.1 Define Watershed

Task 3.2.2 Calculate Time of Concentration

Task 3.2.3 Determine Storm Intensity

Task 3.2.4 Calculate Runoff

Task 3.3 Hydraulic Assessment

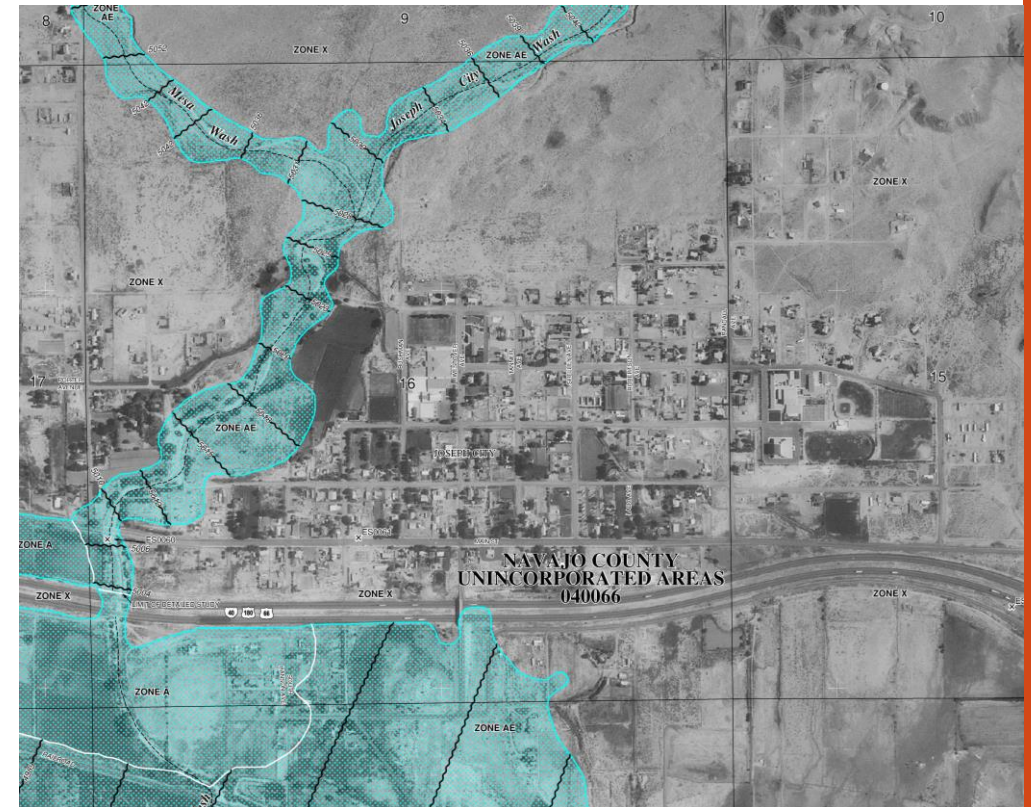


Figure 7: 100 Year Storm Analysis
Image Credit: FEMA

Task 4 Design

Task 4.1 Define Requirements and Criteria

Task 4.2 Develop Design Alternatives

Task 4.3 Analyze Alternatives and Select Best

Table 1: Example Decision Matrix

	Land Use	Cost	Green Space	Waterway Preservation	TOTAL
Option 1	0	+	0	+	+
Option 2	-	-	+	0	-
Option 3	-	-	+	+	0

Task 5 Final Design

Task 5.1 Full-Scale Model

Task 5.1.1 Hydraulic Design

Task 5.1.2 Pollutant Treatment

Task 5.2 Develop Bench-Scale Model

Task 5.2.1 Bench-Scale Model Scaling

Task 5.2.2 Model Design

Task 5.2.3 Model Construction

Task 5.2.4 Model Testing

Task 5 Final Design

Task 5.3 Construction Drawings Plan Set

Task 5.3.1 Cover Sheet

Task 5.3.2 General Notes Sheet

Task 5.3.3 Details Sheet

Task 5.3.4 Existing Site Sheet

Task 5.3.5 New Site Sheet

Task 5.3.6 Schematic Plan Sheet

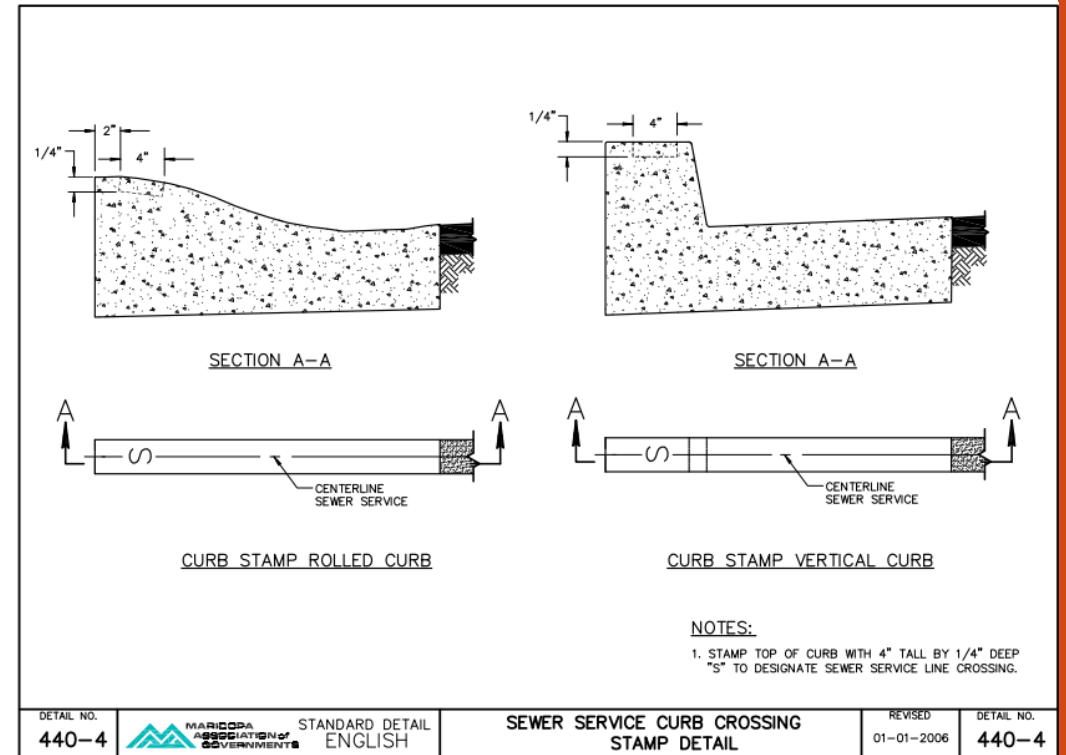


Figure 8: Example Detail
Image Credit: Maricopa County of Associated Governments

Task 6 Techno-Economic Analysis

Task 6.1 Short Course Attendance

Task 6.2 Techno Analysis

Task 6.3 Economic Analysis

Task 6.3.1 Engineers Opinion of Probable Cost

Task 6.3.2 Operation and Maintenance Cost

Task 6.3.3 Life-Cycle Cost

Task 7 Project Impacts

Task 8 Deliverables

Task 8.1 30% Submittal; Tasks 1-2

Task 8.2 60% Submittal; Tasks 1-4

Task 8.3 90% Submittal; Tasks 1-7

Task 8.4 Final Presentation; All Tasks

Task 8.5 Final Submittal; All Tasks

Task 8.6 Competition Deliverables

Task 8.6.1 Experimental Safety Plan

Task 8.6.2 30% Project Review

Task 8.6.3 Technical Report Audits

Task 8.6.4 Final Technical Report

Task 8.6.5 Competition



Figure 9: 34th WERC Logo
Image Credit: New Mexico State University

Task 9 Project Management

Task 9.1 Project Meetings

Task 9.2 Schedule Management

Task 9.3 Resource Management

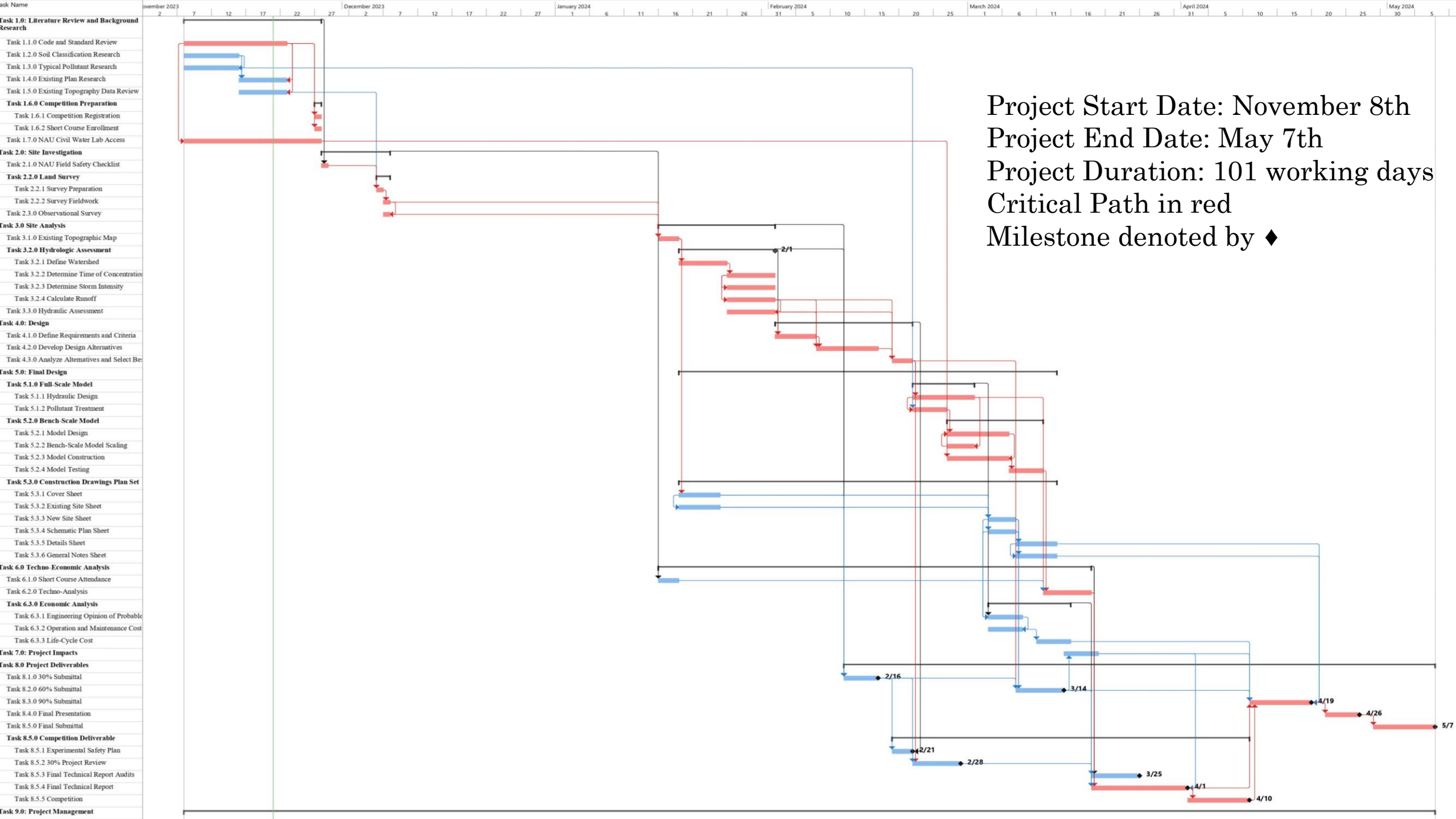
Exclusions

Pollutant Sampling

Community Outreach



Figure 10: Joseph City Wash, 1998
Image Credit: National Weather Service, Navajo
County



Staffing Plan

Senior Engineer (SENG):

- Reviewing and managing project
- PE, 5+ years of experience, B.S. Engineering

Engineer (ENG):

- Design, evaluation, and development of proposed solution
- FE, 3+ years of experience, B.S. Engineering

Engineer Technician (TECH):

- Data collection & processing, lab work, and model construction
- Registered land surveyor (RLS), 1-3 years of experience, associate's degree

Staffing Plan

Table 2: Staffing Hours by Task

TASK NAME	SENG (hours)	ENG (hours)	TECH (hours)	TOTAL TASK HOURS
Task 1.0: Literature Review & Background Research	2	28	21	51
Task 1.1.0: Code & Standard Review	0	8	3	11
Task 1.2.0: Soil Classification Research	0	4	4	8
Task 1.3.0: Typical Pollutant Research	0	4	4	8
Task 1.4.0: Existing Plan Research	0	9	4	13
Task 1.5.0: Existing Topography Data Review	0	3	4	7
Task 1.6.0: Competition Preparation	2	0	0	2
Task 1.6.1: Competition Registration	1	0	0	1
Task 1.6.2: Short Course Enrollment	1	0	0	1
Task 1.7.0: NAU Civil Water Lab Access	0	0	2	2
Task 2.0: Site Investigation	0	7	18	25
Task 2.1.0: NAU Field Safety Checklist	0	1	4	5
Task 2.2.0: Land Survey	0	4	12	16
Task 2.2.1: Survey Preparation	0	0	4	4
Task 2.2.2: Survey Fieldwork	0	4	8	12
Task 2.3.0: Observational Study	0	2	2	4
Task 3.0: Site Analysis	4	52	36	92
Task 3.1.0: Existing Topographic Map	0	1	8	9
Task 3.2.0: Hydrologic Assessment	0	24	12	36
Task 3.2.1: Define Watershed	0	6	3	9
Task 3.2.2: Determine Time of Concentration	0	6	3	9
Task 3.2.3: Determine Storm Intensity	0	6	3	9
Task 3.2.4: Calculate Runoff	0	6	3	9
Task 3.3.0: Hydraulic Assessment	4	27	16	47
Task 4.0: Design	4	55	0	59
Task 4.1.0: Define Requirements & Criteria	0	6	0	6
Task 4.2.0: Develop Design Alternatives	2	40	0	42
Task 4.3.0: Analyze Alternatives & Select Best	2	9	0	11
Task 5.0: Final Design	5	53	87	145
Task 5.1.0: Full-Scale Model	2	33	0	35
Task 5.1.1: Hydraulic Design	2	25	0	27
Task 5.1.2: Pollutant Treatment	0	8	0	8
Task 5.2.0: Bench-Scale	3	10	61	74
Task 5.2.1: Bench-Scale Model Scaling	2	8	0	10
Task 5.2.2: Model Design	1	2	6	9
Task 5.2.3: Model Construction	0	0	40	40
Task 5.2.4: Model Testing	0	0	15	15

TASK NAME (cont.)	SENG (hours)	ENG (hours)	TECH (hours)	TOTAL TASK HOURS
Task 5.0: Final Design (cont.)	5	53	87	145
Task 5.3.0: Construction Drawings Plan Set	0	10	26	36
Task 5.3.1: Cover Sheet	0	1	3	4
Task 5.3.2: Existing Site Sheet	0	1	5	6
Task 5.3.3: New Site Sheet	0	2	5	7
Task 5.3.4: Schematic Plan Set	0	2	5	7
Task 5.3.5: Details Sheet	0	2	5	7
Task 5.3.6: General Notes Sheet	0	2	3	5
Task 6.0: Techno-Economic Analysis	7	57	0	64
Task 6.1.0: Short-Course Attendance	2	2	0	4
Task 6.2.0: Techno-Analysis	2	16	0	18
Task 6.3.0: Economic Analysis	3	39	0	42
Task 6.3.1: Engineering Opinion of Probable Cost	1	13	0	14
Task 6.3.2: Operation and Maintenance Cost	1	13	0	14
Task 6.3.3: Life-Cycle Cost	1	13	0	14
Task 7.0: Project Impacts	4	14	0	18
Task 8.0: Project Deliverables	10	135	14	159
Task 8.1.0: 30% Submittal	1	23	1	25
Task 8.2.0: 60% Submittal	1	23	1	25
Task 8.3.0: 90% Submittal	1	23	1	25
Task 8.4.0: Final Presentation	1	8	1	10
Task 8.5.0: Final Submittal	1	23	1	25
Task 8.6.0: Competition Deliverables	5	35	9	49
Task 8.6.1: Experimental Safety Plan	1	2	6	9
Task 8.6.2: 30% Project Review	1	4	0	5
Task 8.6.3: Final Technical Report Audits	1	3	0	4
Task 8.6.4: Final Technical Report	1	22	0	23
Task 8.6.5: Competition	1	4	3	8
Task 9.0: Project Management	35	55	20	110
Task 9.1.0: Project Meetings	10	25	18	53
Task 9.2.0: Schedule Management	10	15	1	26
Task 9.3.0: Resource Management	15	15	1	31
Subtotal Hours	71	456	196	723
Total Hours	723			

Cost of Engineering Services

Table 3: Cost of Engineering Services

Cost of Engineering Services				
1.0 Personnel	Classification	Hours	Rate (\$/time)	Cost (\$)
	SENG	71	\$340	\$ 24,140
	ENG	456	\$140	\$ 63,840
	TECH	196	\$80	\$ 15,680
Total Cost				\$ 103,660
2.0 Travel			Cost per (\$)	
Competition	Transportation	2 Vans 5 Days	\$65/day	\$ 650
	Mileage	1,736 miles, roundtrip	\$0.36/mile	\$ 625
	Hotel	3 Rooms, 4 Nights	\$98/night	\$ 1,176
	Per Diem	5 People, 4 Days	\$49/day	\$ 980
Site Visit	Transportation	1 Van, 1 Day	\$44/day	\$ 44
	Mileage	200 miles, roundtrip	\$0.23/mile	\$ 46
Total Cost				\$ 3,521
3.0 Supplies				
Lab Facilities	NAU Computer Lab	20 Days	\$100/day	\$ 2,000
	NAU Survey Lab	1 Days	\$100/day	\$ 100
	NAU Water Lab	10 Days	\$100/day	\$ 1,000
Materials	Bench-Scale Model Materials	LS		\$ 1,000
	Competition Poster	LS		\$ 40
Total Cost				\$ 4,140
4.0 TOTAL				\$ 112,321

References

[1] “WERC Environmental Design Contest.” Accessed: Oct. 26, 2023. [Online]. Available: <https://wercdesigncontest.nmsu.edu/>

[2] “Flood Maps | FEMA.gov,” *www.fema.gov*. <https://www.fema.gov/flood-maps>

[3] “Public Works | Navajo County, AZ,” *www.navajocountyaz.gov*. <https://www.navajocountyaz.gov/296/Public-Works> (accessed Dec. 08, 2023).



Figure 11:
WERC Team Photo

Image Credit:
Andres Garcia Rico