
FLAGSTAFF- SHADOW MOUNTAIN DRAINAGE DESIGN

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CENE476

DECEMBER 9, 2022

AB Stormwater Management Co.

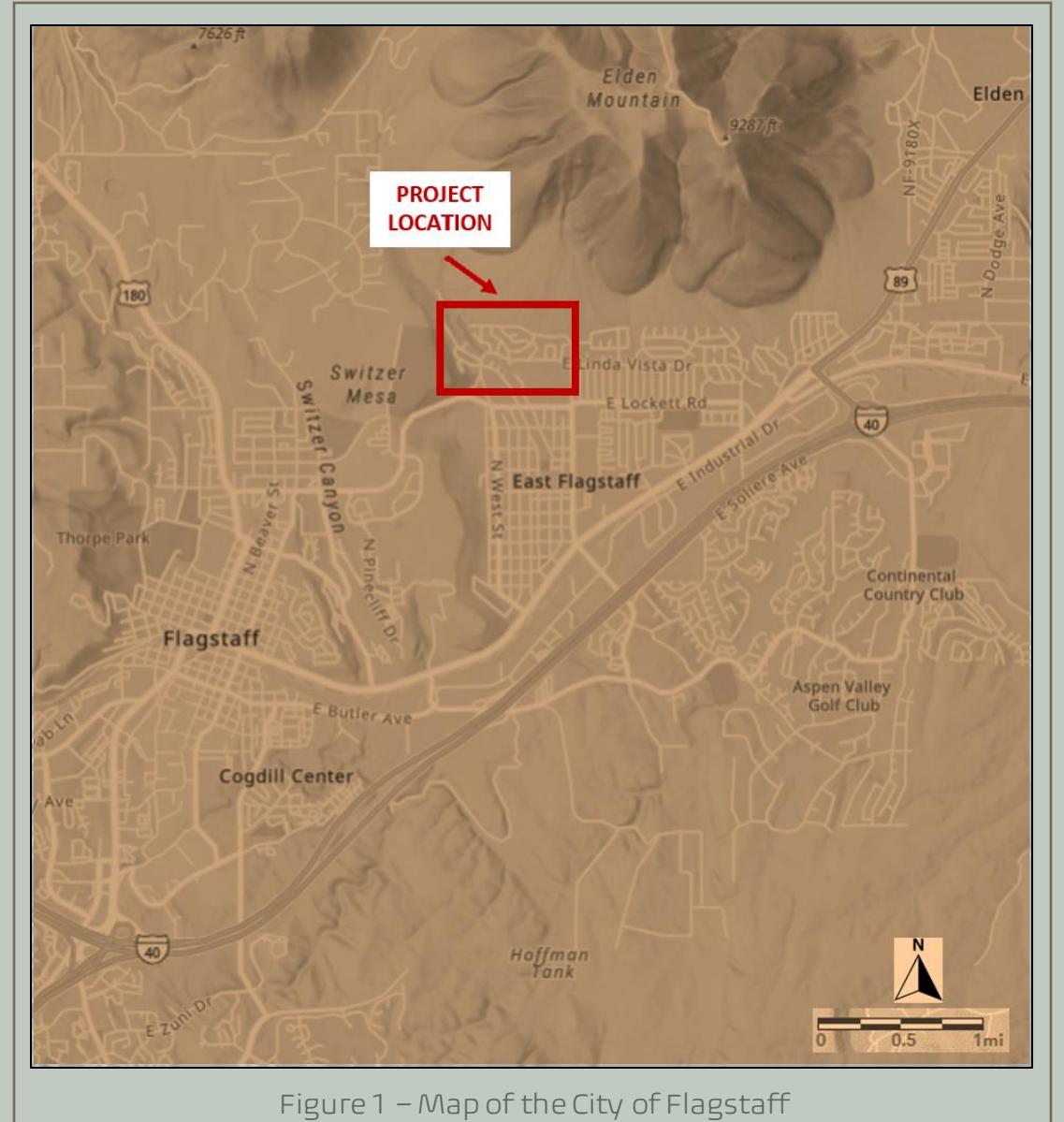


Figure 1 – Map of the City of Flagstaff

01 PROJECT UNDERSTANDING

Purpose: Alter the terrain to reduce the impact of flooding

Client: Chase McLeod - Flagstaff Stormwater Department

Background:

- Built in the late 1970's
- Minimal existing stormwater infrastructure
- Annual floods, sediment deposits, and destruction to property

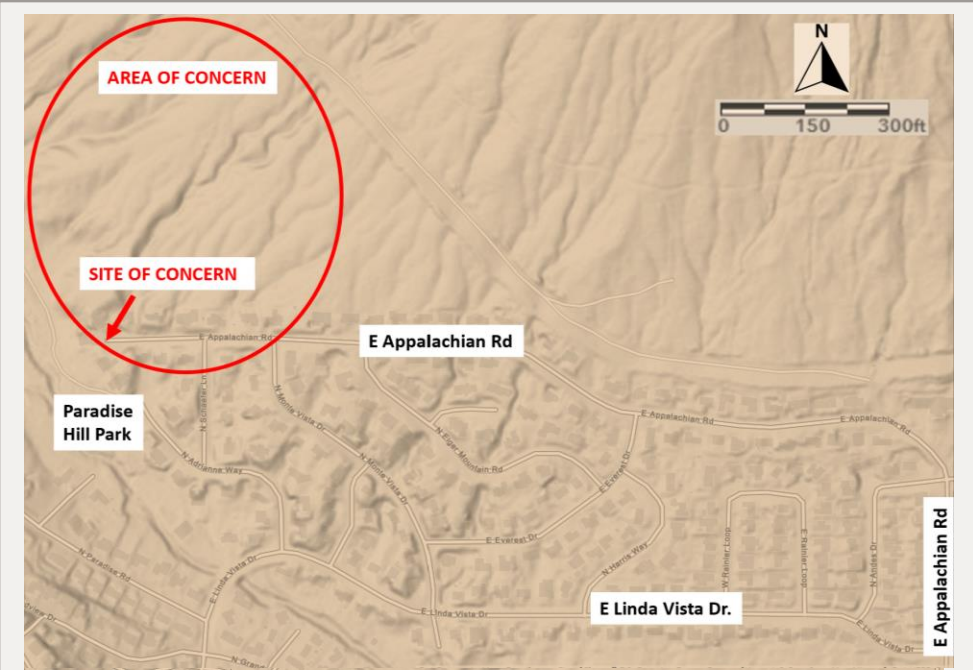


Figure 2 – Map of the Shadow Mountain Community



Figure 3 – Sandbags



Figure 4 – Site flooding in Summer 2022

02 SCOPE OF SERVICES

TASK 1 RESEARCH

TASK 1.1 DOCUMENTS OF EXISTING STRUCTURES/GIS

TASK 1.2 RESEARCH RETENTION/DETENTION OPTIONS

TASK 1.3 FEMA FLOODPLAIN INFORMATION

TASK 1.4 IDENTIFY DESIGN REQUIREMENTS FOR FLAGSTAFF

TASK 1.5 REVIEW EXISTING PLANS/STUDIES

TASK 1.6 CREATE A PLAN FOR THE FIELD SITE INVESTIGATION

TASK 2 FIELD SITE INVESTIGATION

TASK 2.1 FIELD SITE VISIT

TASK 2.2 FIELD SITE ASSESSMENT

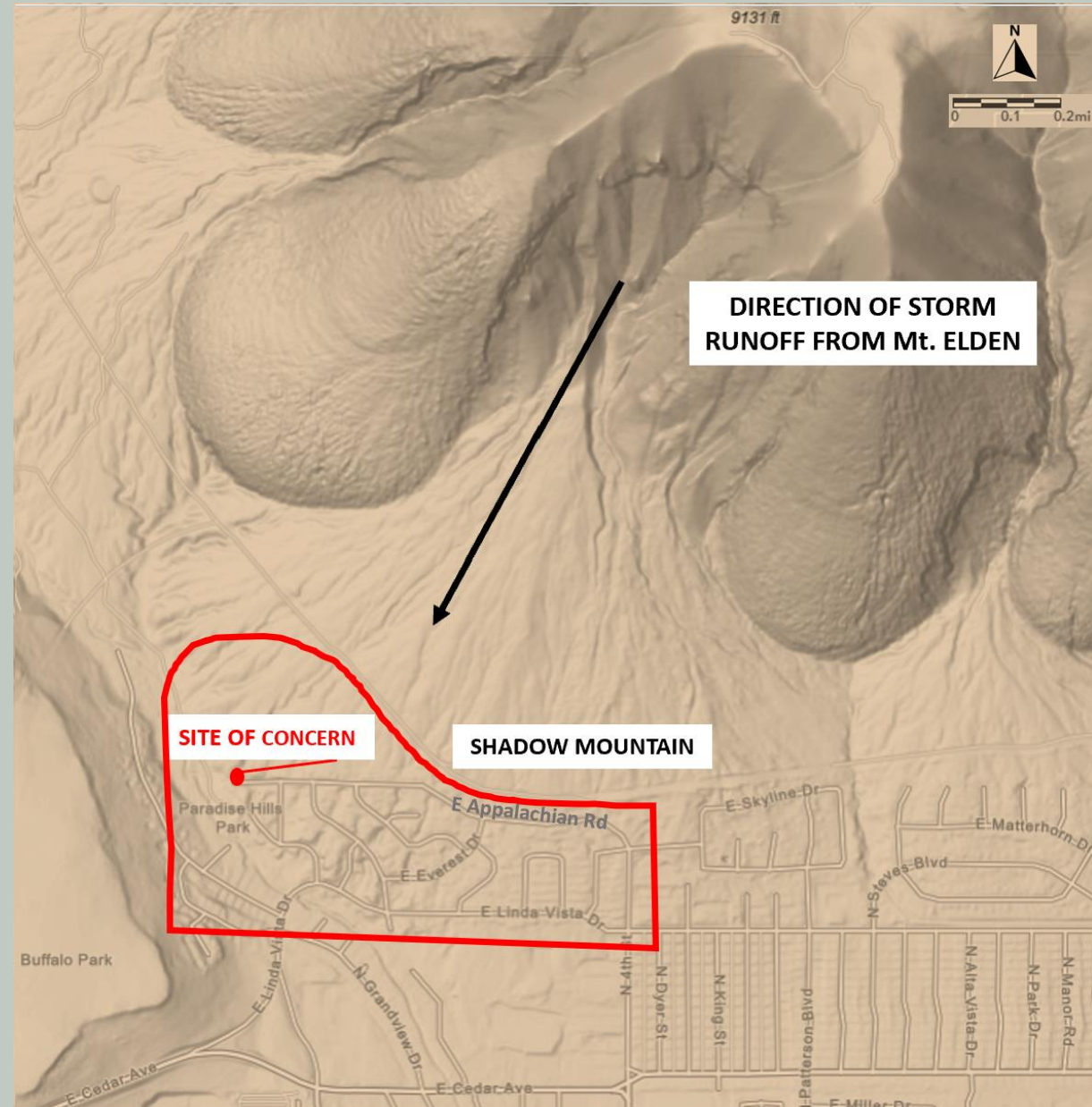


Figure 5 – Map of the Shadow Mountain Community and the Mt Elden Runoff

02 SCOPE OF SERVICES

TASK 3 HYDROLOGIC ANALYSIS

TASK 3.1 WATERSHED DELINEATION

TASK 3.2 DETERMINE TIME OF
CONCENTRATION

TASK 3.3 DETERMINE WATERSHED
ROUGHNESS COEFFICIENT

TASK 3.4 DETERMINE DESIGN STORM
INTENSITIES

TASK 3.5 DETERMINE NATURAL
RUNOFF

TASK 3.6 ANALYZING EXISTING SUB-
BASIN STORAGE



Figure 6- Flooding at the cul-de-sac on E. Appalachian Rd (site of concern)

TASK 4
HYDRAULIC
ANALYSIS OF
EXISTING
STRUCTURES

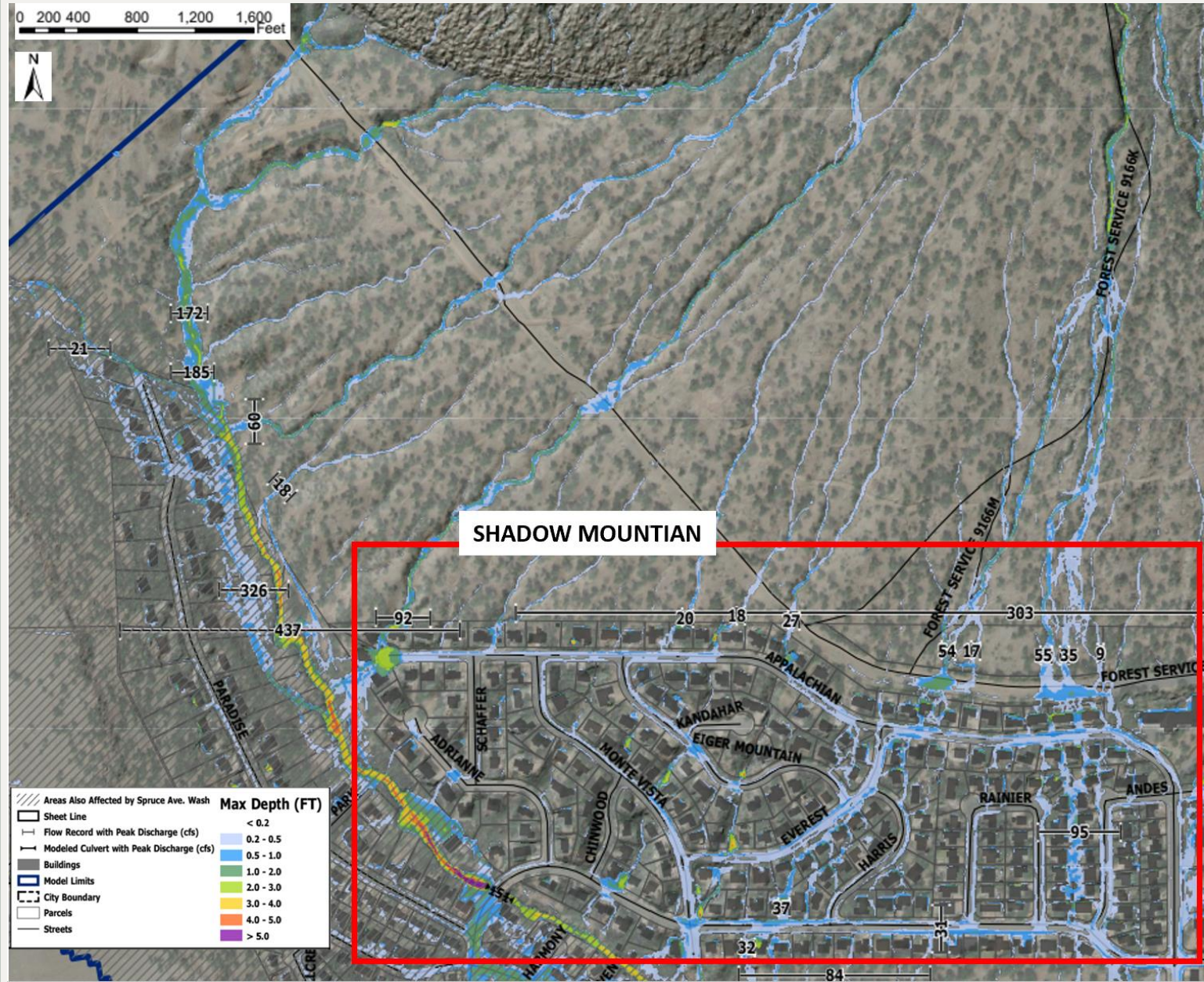


Figure 7- Impact of 1% Frequency 24 Hour Duration of runoff from Mt Elden on Shadow Mountain

02 SCOPE OF SERVICES

TASK 5 ANALYSIS OF ALTERNATIVES

TASK 5.1 DETERMINE CONSTRAINTS AND CRITERIA OF DESIGN

TASK 5.2 DEVELOP ALTERNATIVE DESIGNS TO REDUCE RUNOFF

TASK 5.3 SELECT BEST ALTERNATIVE

TASK 6 FINAL DESIGN

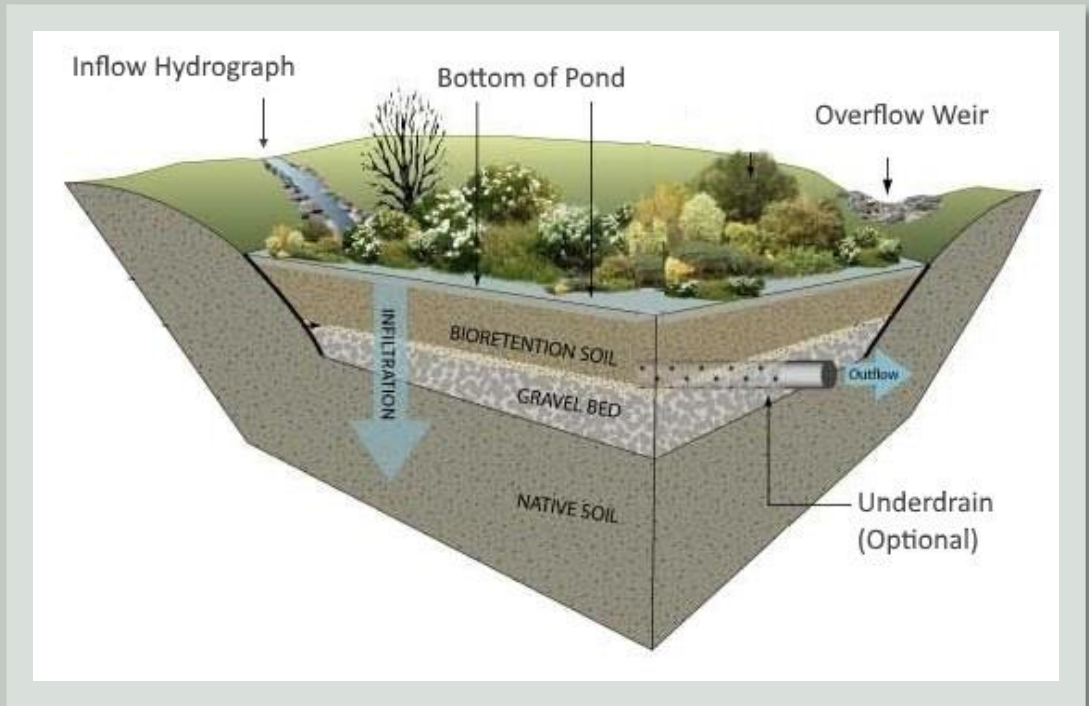


Figure 8 – Retention Basin Design

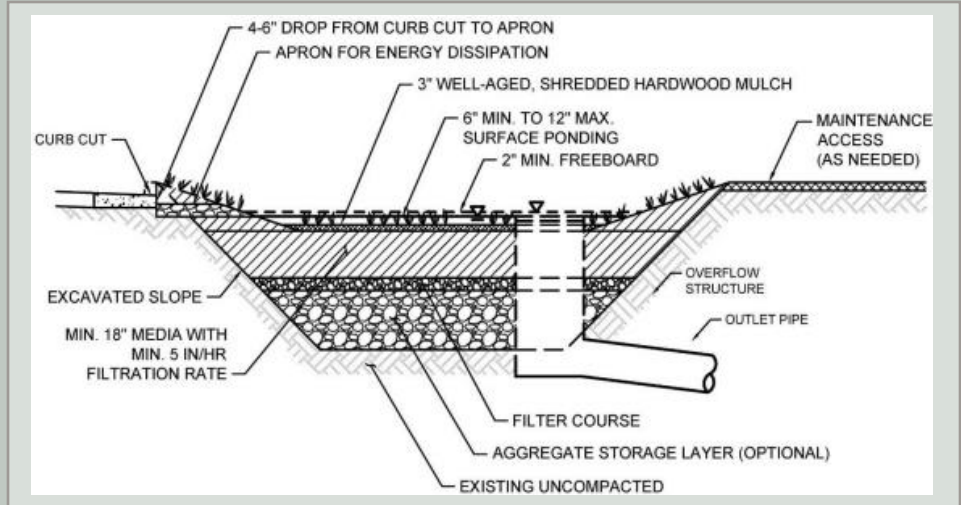


Figure 9- Detention Basin Design Plan

02 SCOPE OF SERVICES

TASK 7 CONSTRUCTION PLAN

TASK 7.1 EXISTING FLOODPLAIN MAP

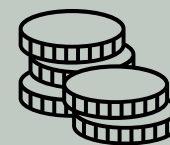
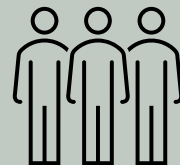
TASK 7.2 DESIGN OF RUNOFF CONTROL STRUCTURE SHEETS

TASK 7.3 GENERAL PROJECT DETAILS

TASK 7.4 PROJECT NOTES AND SPECIFICATONS

TASK 8 CONSTRUCTION COST ESTIMATE

TASK 9 PROJECT IMPACTS EVALUATION



02 SCOPE OF SERVICES

TASK 10 PROJECT DELIVERABLES

TASK 10.1 30% SUBMITTAL – Tasks 1-3.4

- 30% REPORT
- 30% PRESENTATION

TASK 10.2 60% SUBMITTAL – Tasks 3.5 - 5

- 60% REPORT
- 60% PRESENTATION

TASK 10.3 90% SUBMITTAL – Tasks 6-7

- 90% REPORT
- 90% PRESENTATION
- 90% WEBSITE

TASK 10.4 FINAL SUBMITTAL – Tasks 8-9

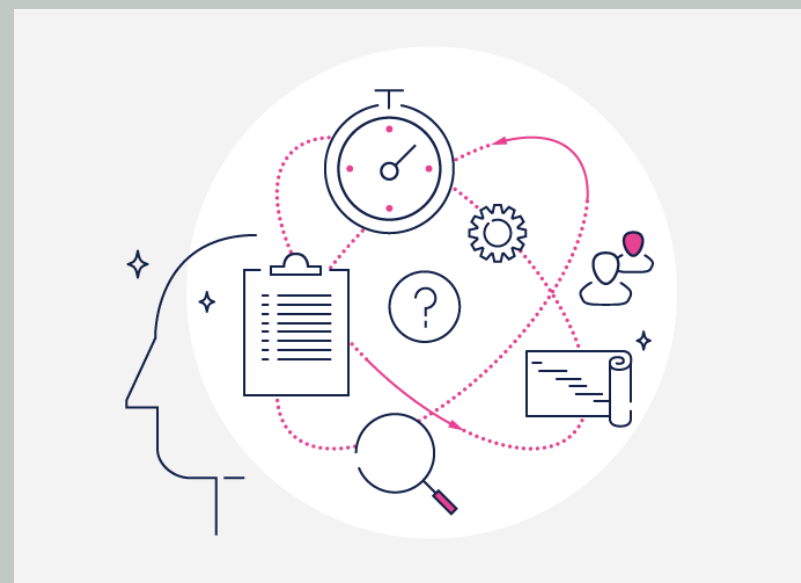
- FINAL REPORT
- FINAL PRESENTATION
- FINAL WEBSITE

TASK 11 PROJECT MANAGEMENT

TASK 11.1 PROJECT MEETINGS

TASK 11.2 SCHEDULE MANAGEMENT

TASK 11.3 RESOURCE MANAGEMENT



02 SCOPE OF SERVICES

EXCLUSIONS



SCHEDULE

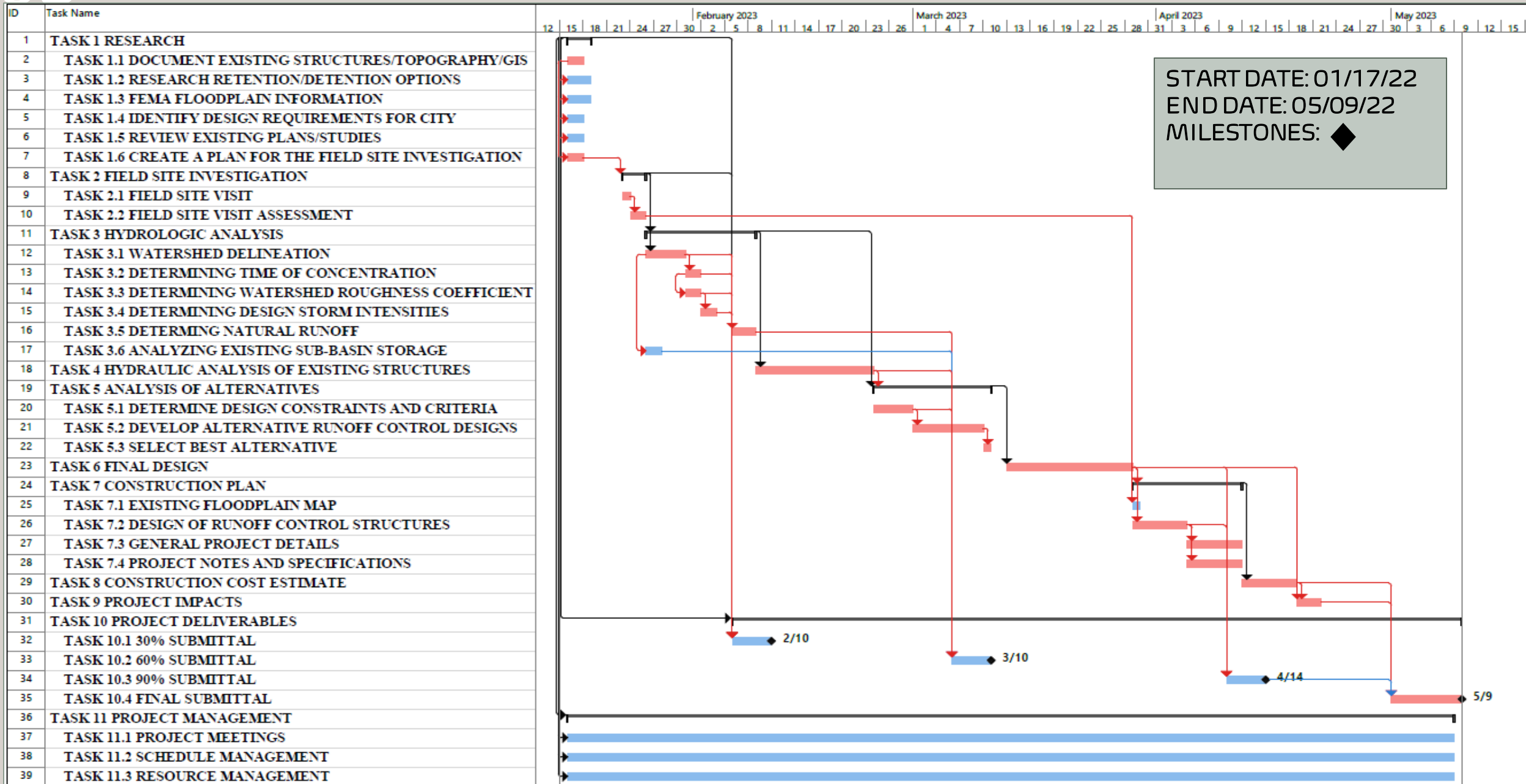


Figure 10- Gantt Chart

STAFFING PLAN

STAFFING PERSONNEL QUALIFICATIONS

- **SENG – SENIOR ENGINEER**
 - Min. 8 years of experience
 - PE License
 - BS Degree from ABET Accredited University

- **ENG – PROFESSIONAL ENGINEER**
 - Min. 5 years of experience
 - PE License
 - BS Degree from ABET Accredited University

- **EIT – ENGINEER IN TRAINING**
 - Passed Fundamentals Engineering Exam (FE)
 - In the Process of Receiving/Has BS Degree from ABET Accredited University

- **INT – ENGINEERING INTERN**
 - Studying Relevant Engineering Topics at an ABET Accredited University

Table 1 – Staffing Plan

TASK	SENG (hrs)	ENG (hrs)	EIT (hrs)	INT (hrs)	TOTAL (hrs)
1.0 RESEARCH (Person-Total Hours)	1	13	15	14	43
1.1 DOCUMENTATION OF EXISTING STRUCTURES/TOPOGRAPHY/GIS	0	2	2	4	8
1.2 RESEARCH RETENTION/DETENTION OPTIONS	0	3	2	3	8
1.3 FEMA FLOODPLAIN INFORMATION	0	1	2	2	5
1.4 IDENTIFY DESIGN REQUIREMENTS FOR THE CITY OF FLAGSTAFF	0	1	1	2	4
1.5 REVIEW EXISTING PLANS/STUDIES	0	5	8	3	16
1.6 CREATE A PLAN FOR THE FIELD SITE INVESTIGATION	1	1	0	0	2
2.0 FIELD SITE INVESTIGATION (Person-Total Hours)	1	4	4	2	11
2.1 FIELD SITE VISIT	0	1	1	1	3
2.2 FIELD SITE VISIT ASSESSMENT	1	3	3	1	8
3.0 HYDROLOGIC ANALYSIS (Person-Total Hours)	5	44	36	19	104
3.1 WATERSHED DELINEATION	0	1	2	1	4
3.2 DETERMINING TIME OF CONCENTRATION	0	15	10	5	30
3.3 DETERMINING WATERSHED ROUGHNESS COEFFICIENT	0	1	2	2	5
3.4 DETERMINING DESIGN STORM INTENSITIES	0	2	2	1	5
3.5 DETERMINING NATURAL RUNOFF	3	15	10	5	33
3.6 ANALYZING EXISTING SUB-BASIN STORAGE	2	10	10	5	27
4.0 HYDRAULIC ANALYSIS OF EXISTING STRUCTURES (Person-Total Hours)	5	30	15	5	55
5.0 ANALYSIS OF ALTERNATIVES (Person-Total Hours)	22	45	25	5	97
5.1 DETERMINE THE CONSTRAINTS AND CRITERIA OF THE DESIGN	2	10	10	5	27
5.2 DEVELOP ALTERNATIVE DESIGNS TO REDUCE OR MANAGE RUNOFF	10	30	15	0	55
5.3 SELECT BEST ALTERNATIVE	10	5	0	0	15
6.0 FINAL DESIGN (Person-Total Hours)	10	10	5	0	25
7.0 CONSTRUCTION PLAN (Person-Total Hours)	4	36	40	5	85
7.1 EXISTING FLOODPLAIN MAP	0	5	5	5	15
7.2 DESIGN OF RUNOFF CONTROL STRUCTURES SHEETS	2	15	10	0	27
7.3 GENERAL PROJECT DETAILS	1	8	10	0	19
7.4 PROJECT NOTES AND SPECIFICATIONS	1	8	15	0	24
8.0 CONSTRUCTION COST ESTIMATE (Person-Total Hours)	10	5	0	0	15
9.0 PROJECT IMPACTS EVALUATION (Person-Total Hours)	0	10	5	2	17
10.0 PROJECT DELIVERABLES (Person-Total Hours)	8	55	55	15	133
10.1 30% SUBMITTAL	2	10	10	5	27
10.2 60% SUBMITTAL	2	10	10	5	27
10.3 90% SUBMITTAL	2	15	15	5	37
10.4 FINAL SUBMITTAL	2	20	20	0	42
11.0 PROJECT MANAGEMENT (Person-Total Hours)	50	30	20	5	105
11.1 PROJECT MEETINGS	20	20	20	5	65
11.2 SCHEDULE MANAGEMENT	10	5	0	0	15
11.3 RESOURCE MANAGEMENT	10	5	0	0	15
11.3.1 STAFFING	5	0	0	0	5
11.3.2: BUDGET	5	0	0	0	5
TOTAL PERSONNEL HOURS	94	237	195	67	593

04 COST OF ENGINEERING SERVICES

Table 2 – Cost of Engineering Services

1.0 Personnel Cost	Classification	Hours	Rate, \$/Hr	Cost
	SENG	94	200	18,800
	ENG	237	137	32,469
	EIT	195	90	17,550
	INT	67	25	1,675
Total Personnel Cost				70,494
2.0 Travel Cost	Location	Miles	Rate, \$/Mile	Cost
	Flagstaff	0	0.40	0
Total Travel Cost				0
3.0 Supply Cost	Supply	Days	Rate, \$/Day	Cost
	Computer Lab	100	200	20,000
Total Cost of Supplies				20,000
4.0 Total Cost of Engineering Services			\$90,494	

REFERENCES

- [1] "City of Flagstaff GIS Portal," *Gis.flagstaffaz.gov*. [Online]. Available: <https://gis.flagstaffaz.gov/portal/home/webmap/viewer.html>. [Accessed: 05-Sep-2022].
- [2] Coconino County, *Coconino County Drainage Design Criteria Manual*, Coconino County, 2020. [Online]. Available: <https://www.coconino.az.gov/DocumentCenter/View/37392/Coconino-County-Drainage-DesignCriteria-ManualA> [Accessed 05 September 2022].
- [3] City of Flagstaff, *City of Flagstaff Stormwater Management Design Manual*, City of Flagstaff, 2009. [Online]. Available: <https://www.flagstaff.az.gov/DocumentCenter/View/58133/SWMgmtDesignManual-3-09?bidId=> [Accessed 05 September 2022].
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- [5] "Hourly rate for industry: Engineering Services," *PayScale*. [Online]. Available: https://www.payscale.com/research/US/Industry=Engineering_Services/Hourly_Rate. [Accessed: 01-Dec-2022].



Figure 11 - Mt Elden

QUESTIONS