City of Flagstaff Low Impact Development (LID) Bio-Remediation Soil Design

Proposal Presentation

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Engineering Team:

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Project Background and Purpose

- Low Impact Development (LID)
  - Stormwater management systems that integrate natural components to collect and remediate runoff.
- Soil Matrix
  - Infiltrates and treats stormwater runoff through different soil layers.
- Capstone Project
  - Continuation project
  - Designing a soil matrix ONLY with local materials that infiltrates first 1" of stormwater in 1 hour.

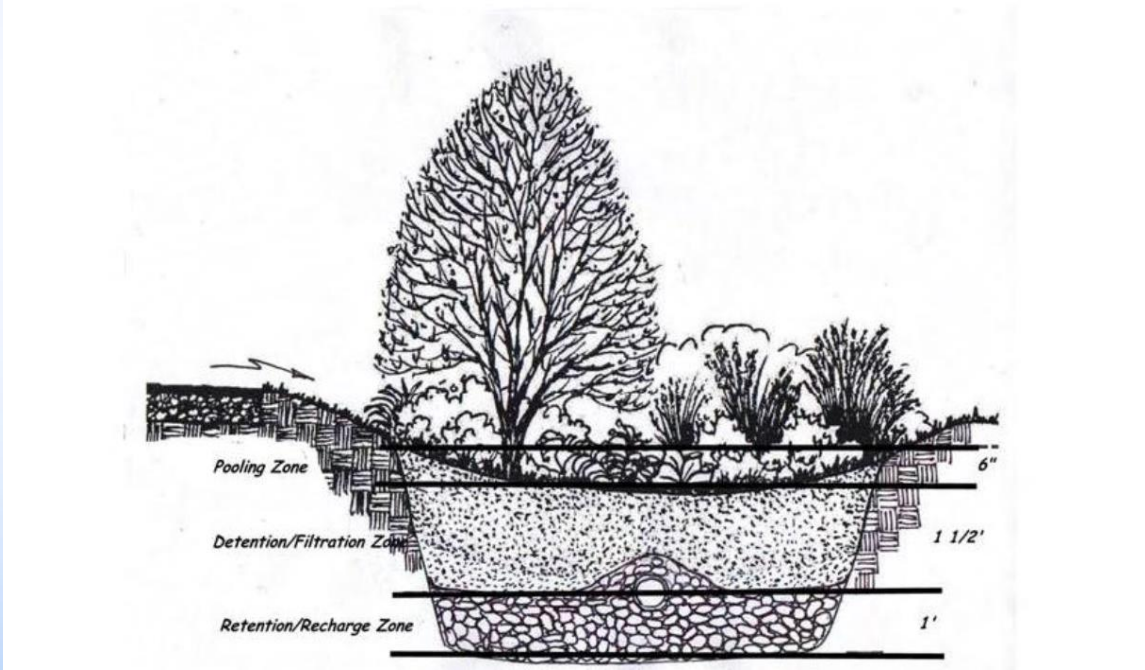

Figure 1. LID Cross-section View Example [1]

Task 1: Soil Identification

Figure 2. Soil Image [2]

- Task 1.1: Local Soil Identification
  - Local soil research
  - Contacting local material providers
- Task 1.2: Obtaining Local Soils
  - Purchasing materials
  - Obtaining them from NAU Facility Services

Task 2: Soil Testing

- Performing tests for each soil layer
- Task 2.1: Hydraulic Conductivity
  - Flow rate through the void space
  - ASTM D5084-16a
- Task 2.2: Specific Gravity
  - Density to density of water
  - ASTM D854
- Task 2.3: Saturated Soil Dry Test
  - Volume and mass of soil
  - ASTM D2980-17

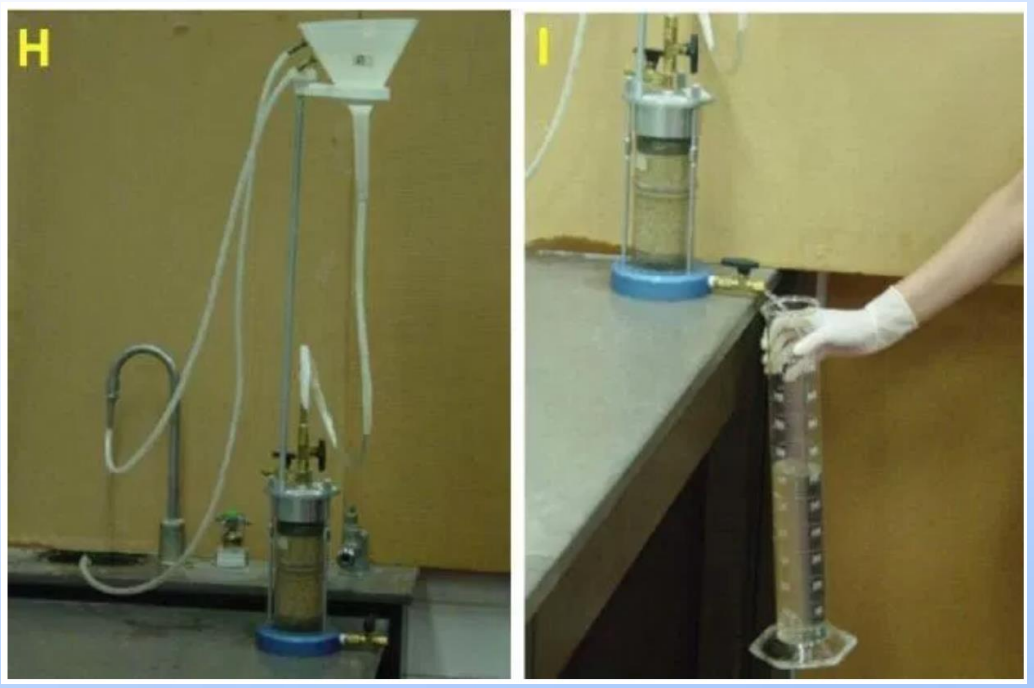

Figure 3. Hydraulic Conductivity Test [2]

Task 3: Soil Matrix Design

Task 3.1: 2017 Capstone Design Re-testing

- Testing best two final soil media designs

Task 3.2: Topsoil Testing

- Testing 3 columns with one type topsoil and 3 with another type

Figure 4. Soil Matrix Infiltration Testing Method [3]

Task 4: Vegetative Coverage Testing

- Task 4.1: Identify Native Species
  - Research on cost, availability, and cultivation times
- Task 4.2: Cultivate Vegetative Coverage
  - Growing grass on separate top soil layer
- Task 4.3: Assess Impact of Vegetative Layer
  - 3 Columns with vegetation AND 3 columns without

Figure 5. LID Vegetation Example [4]

Task 5: Soil Matrix Design Selection

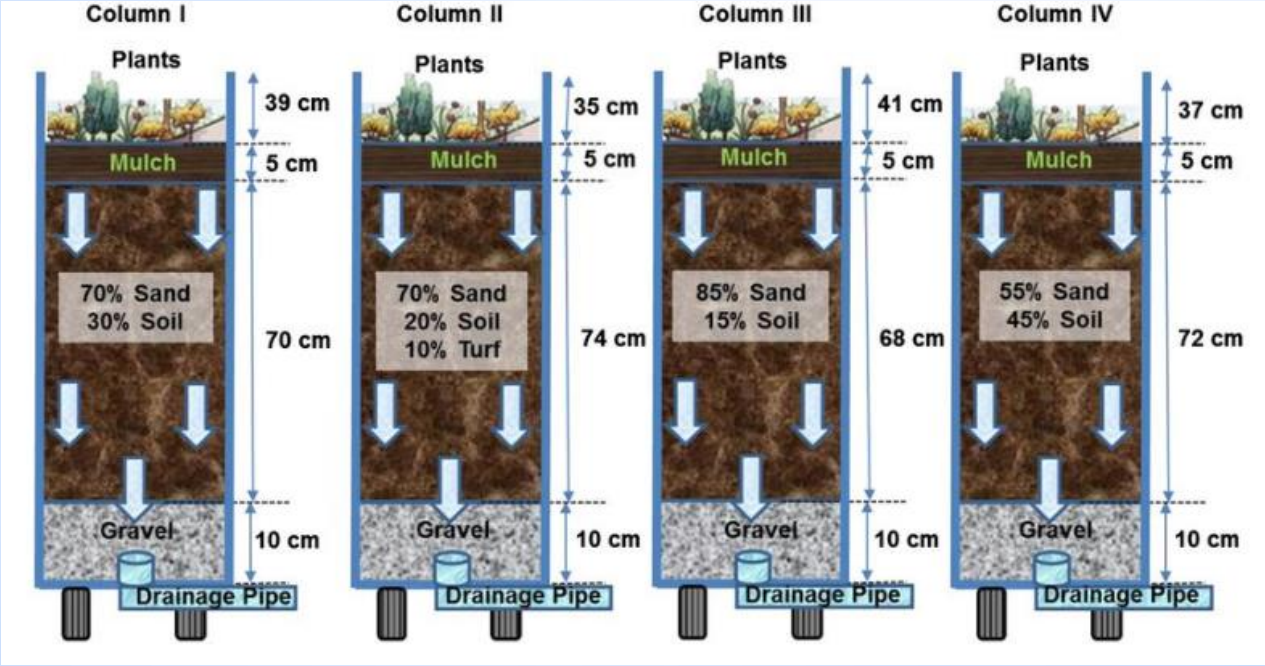

Figure 6. Soil Matrix Column Example [3]

- Soil media design selection based ONLY on infiltration rates according to soil layer ratios.

Task 6: Stormwater Runoff Sampling

- Task 6.1: Alternative 1
  - If precipitation occurs
  - 6 Samples total from storm drains near the wash
- Task 6.2: Alternative 2
  - Artificially contaminated samples

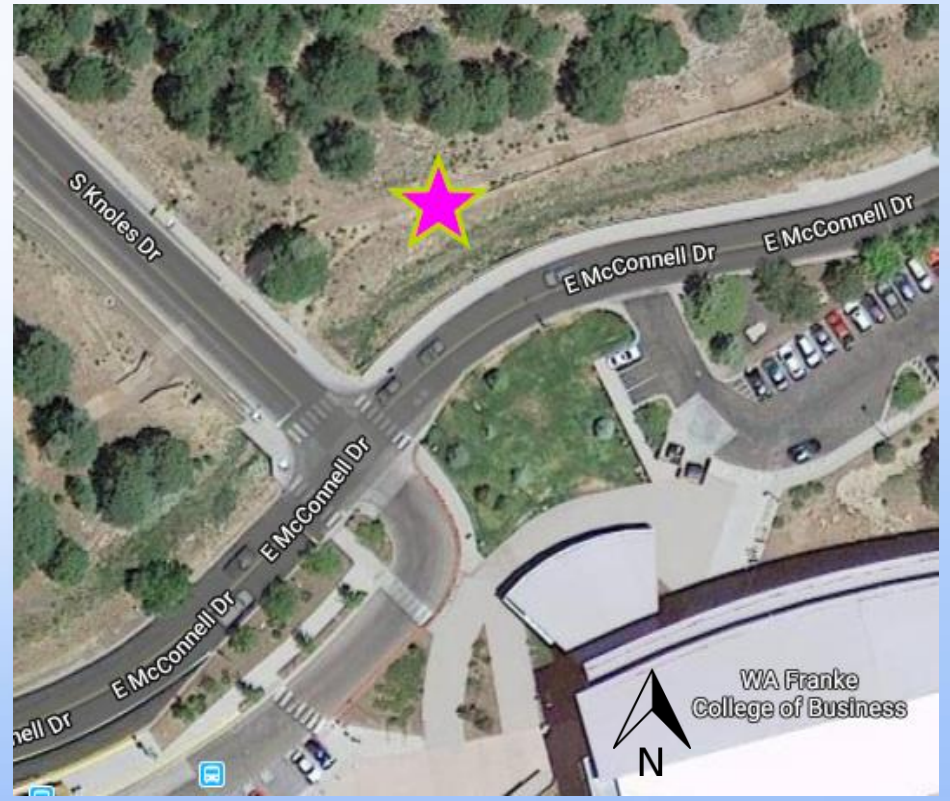

Figure 7. Proposed Sampling Site

Task 7: Stormwater Runoff Testing

- Task 7.1: Fecal Coliform
  - HACH 8074
- Task 7.2: Nutrients
  - HACH 10071 and HACH 10127
- Task 7.3: Petroleum Hydrocarbons
  - ASTM D6855-12
- Task 7.4: Turbidity
  - ASTM D6855-12
- Task 7.5: Metals
  - ASTM D1971-16

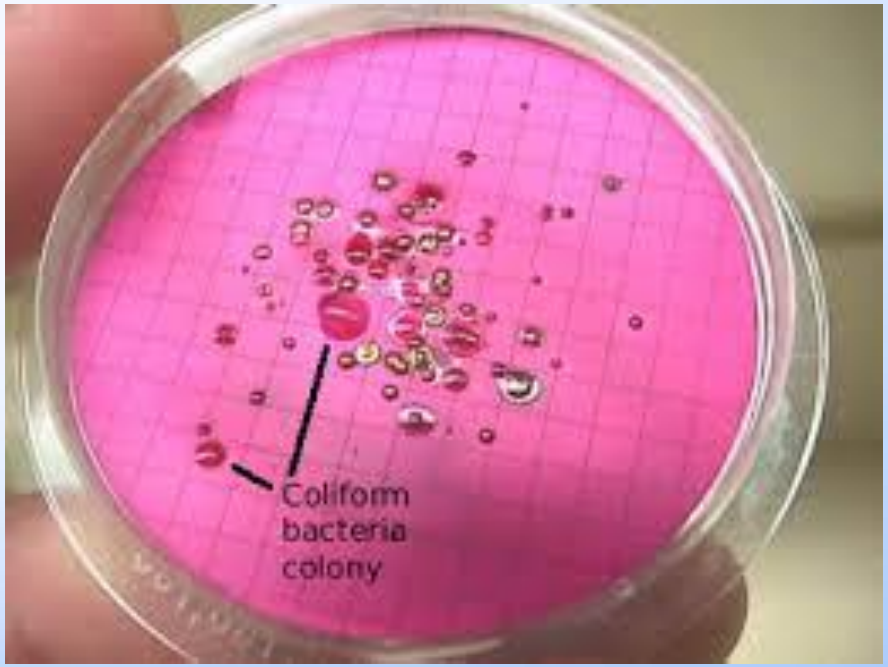

Figure 8: Example of agar plate with fecal coliform bacteria colonies [5]

Task 8: Design Economics

- Cost analysis based on material ratio and costs

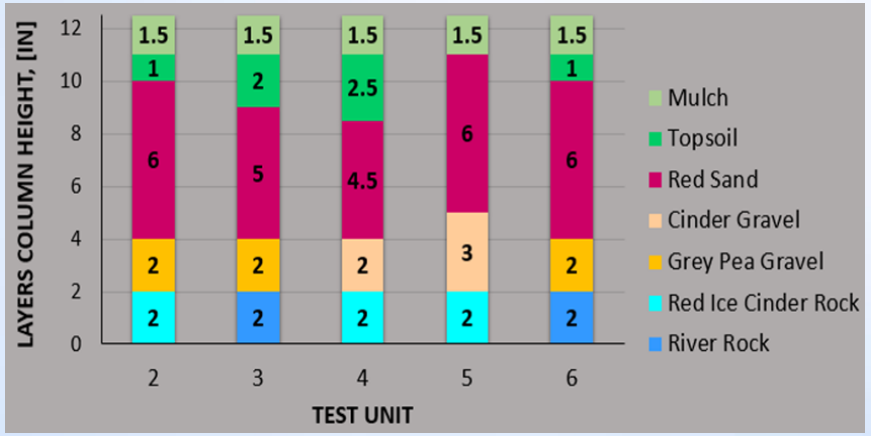

Figure 9. Soil Matrix Column Ratios Example [3]

Task 9: Final Matrix Design

- Based on infiltration rate, ability to remediate stormwater runoff, and cost.

Task 10: Project Impacts

- Task 10.1: Environmental Impacts
  - Reduction of sediments, nutrients, and petroleum hydrocarbons
- Task 10.2: Economic Impacts
  - Reduction of groundwater treatment cost
  - Prevention of property damages
- Task 10.3: Social Impacts
  - Community aesthetics enhancement

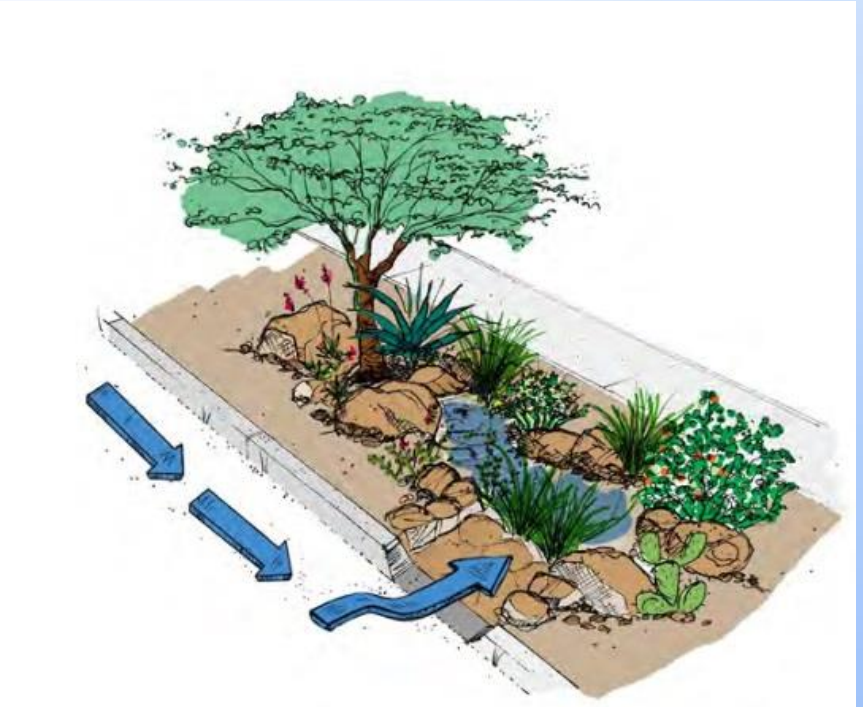

Figure 10. An example of an LID project [6]

Task 11: Project Management

- Task 11.1: Meetings
  - Client, team, technical advisor, grading instructor
- Task 11.2: Meeting Minutes and Agendas

Figure 11. Project Management [7]

Task 12: Project Deliverables

- Task 12.1: 30% Report
- Task 12.2: 60% Report
- Task 12.3: Final Report
- Task 12.4: Final Project Presentation
- Task 12.5: Reflection Document
- Task 12.6: Website

Figure 12. Checklist

Project Schedule

WBS	Task Name
1	Soil Identification
2	Soil Testing
3	Soil Matrix Design
4	Vegetative Coverage Testing
5	Soil Matrix Design Selection
6	Stormwater Runoff Sampling
7	Stormwater Testing
8	Design Economics
9	Selection of Final Matrix Design
10	Project Impacts
11	Project Management
12	Project Deliverables

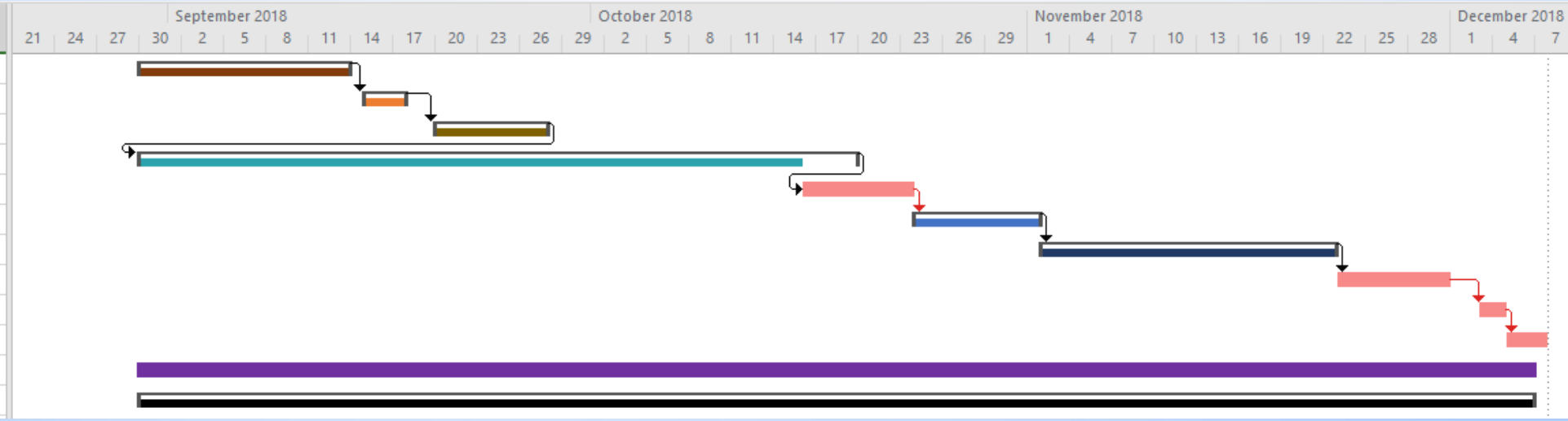

Figure 13. Capstone Project Schedule

Project Staffing

Staffing Hours				
Task	**Senior Engineer (hr)**	**Lab Manager/P.E (hr)**	**Lab Tech (hr)**	**Field Tech (hr)**
1. Soil Identification	2	2	0	0
2. Soil Testing	3	3	20	0
3. Soil Matrix Design	5	10	10	0
4. Vegetative Coverage Testing	3	10	30	0
5. Soil Matrix Design Selection	2	5	48	0
6. Stormwater Run-off Sampling	2	10	0	40
7. Stormwater Testing	5	7	5	0
8. Design Economics	3	10	0	0
9. Selection of Final Soil Matrix Design	5	10	5	0
10. Project Impacts	3	6	0	0
11. Project Management	98	98	98	98
12. Project Deliverables	36	36	36	36
SUBTOTAL HOURS	167	207	252	174
			TOTAL HOURS	800

Table 1. Project Total Staff Hours

Project Costs

Item	Senior Engineer	Lab Manager/P.E.	Lab Tech	Field Tech
Pay ($/hr)	$92	$38	$18	$18
Multiplier	1.9	2.5	3.7	3.7
Cost ($/hr)	$175	$95	$65	$65
TOTAL HOURS	167	207	252	174
SUBTOTAL STAFF COST	**$29,192**	**$19,665**	**$16,317**	**$11,267**
			TOTAL STAFF COST	**$76,440**

Table 2. Staff Cost

Item	Unit	Unit Cost	Unit Total	Cost
2. Soil Testing	Days	$100	2	$200
3. Soil Matrix Design	Days	$100	1	$100
4.Vegetative Coverage Testing	Days	$100	1	$100
5. Soil Matrix Design Selection	Days	$100	2	$200
6. Stormwater Sampling Alternative 2	Days	$100	1	$100
7. Stormater Testing	Days	$100	2	$200
		TOTAL LAB COST		**$900**

Table 3. Lab Cost

Project Costs

Item	Cost
Staffing Cost	$76,440.00
Lab Cost	$900.00
Materials Cost	$900.00
TOTAL ENGINEERING DESIGN COST	**$78,240.00**

References

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- [2] Compass.astm.org. (2018). Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer. [online] Available at: https://compass.astm.org/download/D854.26525.pdf
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