



Protect Our Water Conference

November 18, 2020



Lessons Learned: DOT Slope Improvements for Erosion Control



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DOT Municipal Separate Storm Sewer System (MS4)

- MS4 Permit identifies requirements for storm water runoff and non-storm water runoff
- Storm Water Management Program (SWMP) addresses how MS4 permit conditions will be met

PERMIT NO. HI S000001

**AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM**

In compliance with the provisions of the Clean Water Act, as amended, (33 U.S.C. §1251 et. seq.; the "Act"); Hawaii Revised Statutes, Chapter 342D; and Hawaii Administrative Rules (HAR), Department of Health (DOH), State of Hawaii, Chapters 11-54 and 11-55;

**STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION (DOT-HWYS)**

(PERMITTEE)

is authorized to discharge storm water runoff and certain non-storm water discharges as identified in Part B.2. of this permit from the DOT-HWYS Municipal Separate Storm Sewer System (MS4); storm water runoff from the Keehi, Kakoi, Pearl City, Waianae, and Windward Baseyards; and additional storm sewer outfalls that may be identified from time to time by the Permittee,



Post-Construction Storm Water Management in New Development and Redevelopment

- Outfall Repairs
- Trash and Sediment Capture
- Bioswales
- Slope Improvements



Eroded Slopes



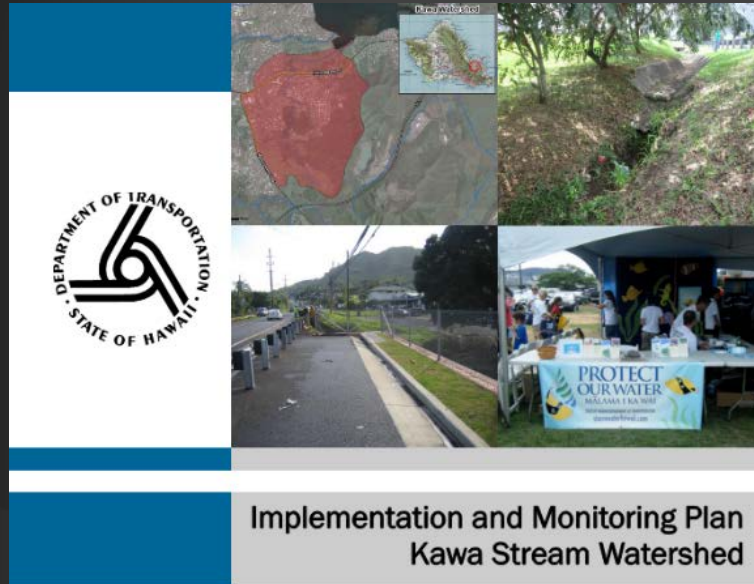
Slope Improvement Considerations

- Slope Location
- Slope Gradient
- Soil Type
- Cost

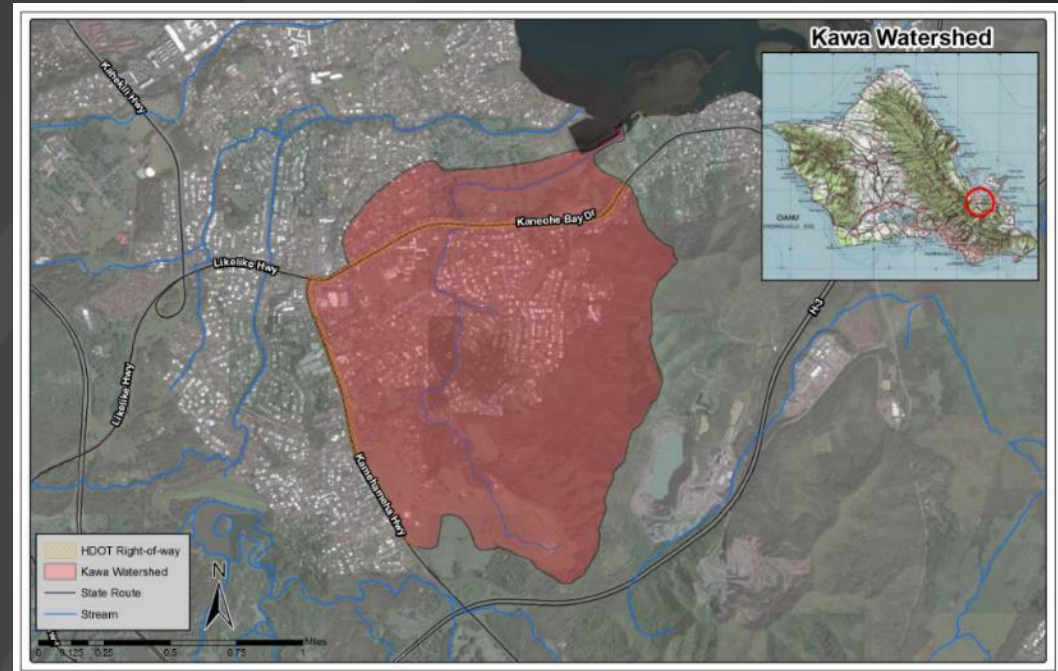


Slope Improvement Considerations

- Slope Location



Hawaii State Department of Transportation
Highways Division, Oahu District
Storm Water Management Program
NPDES Permit No. HI S000001
April 2015



	TSS (KG per year)	TN (KG per year)	TP (KG per year)
Reduction Required	1,276	35	5



Slope Improvement Considerations

- Slope Location



Slope Improvement Considerations

- Slope Location



Slope Improvement Considerations

- Slope Gradient
- Soil Type



Types of Slope Improvements

- Slope Grading
- Erosion Control Matting
- Grouted Rip Rap
- Articulated Concrete Blocks
- Concrete Fabric
- Vegetation



Slope Grading

- Reduce steepness of slope
- Remove overhanging condition
- Decreases erosion
- Right-of-Way limitations
- Typ. at 1H:1V slope



Erosion Control Matting

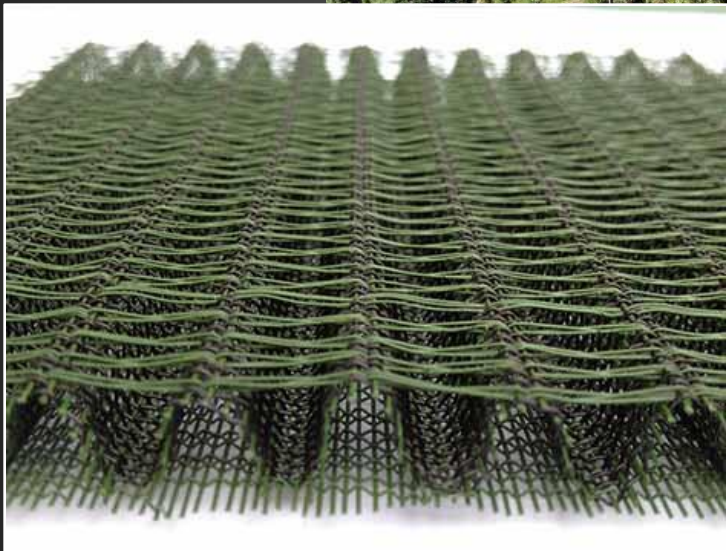
- For slopes $> 3H:1V$
- Install from top – down
- Overlap adjacent rolls
- Aids plant growth and prevents surface erosion



Erosion Control Matting (Medium Duty)



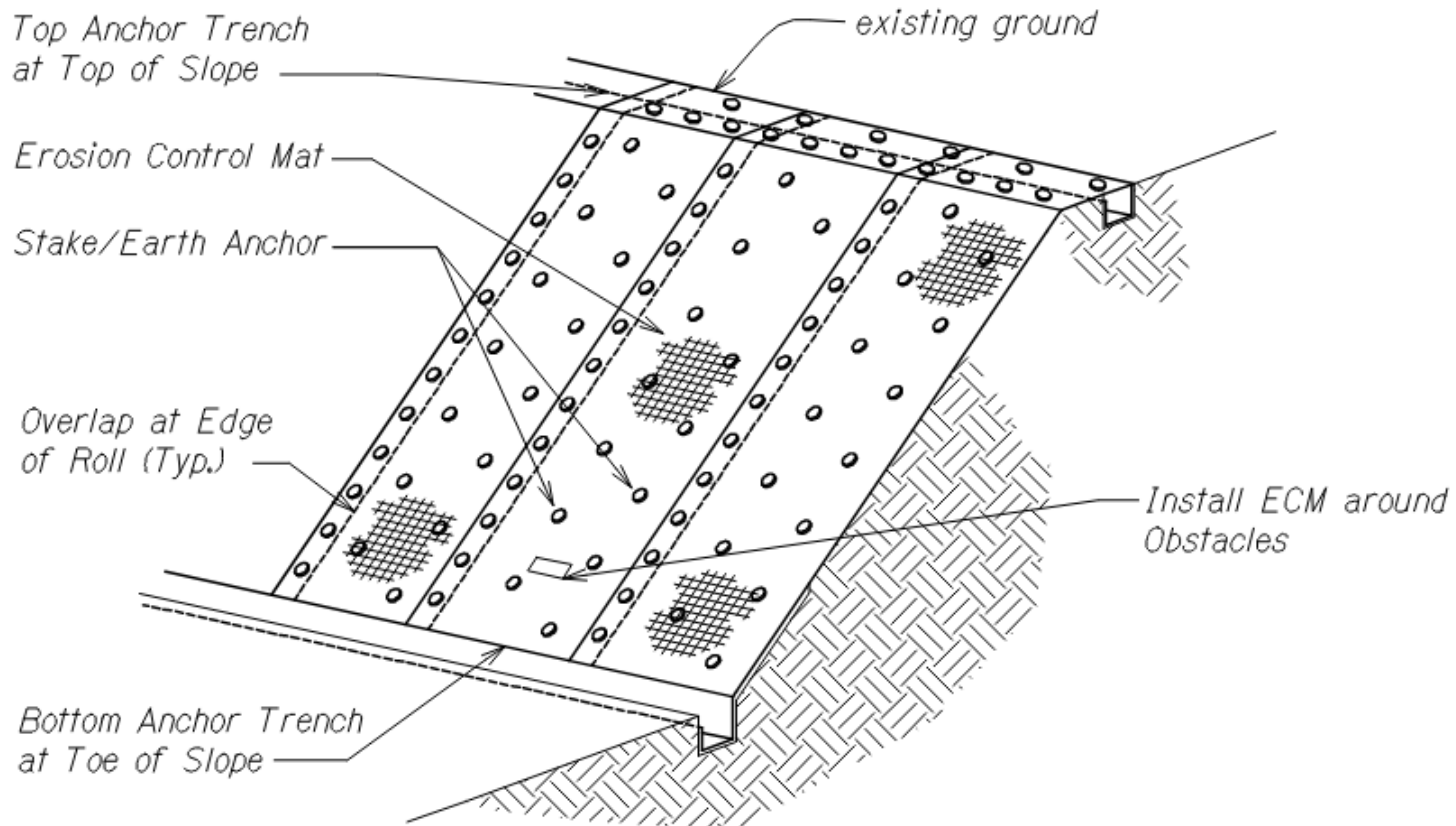
Erosion Control Matting (Heavy Duty)



Erosion Control Matting (Temporary)



Erosion Control Matting System



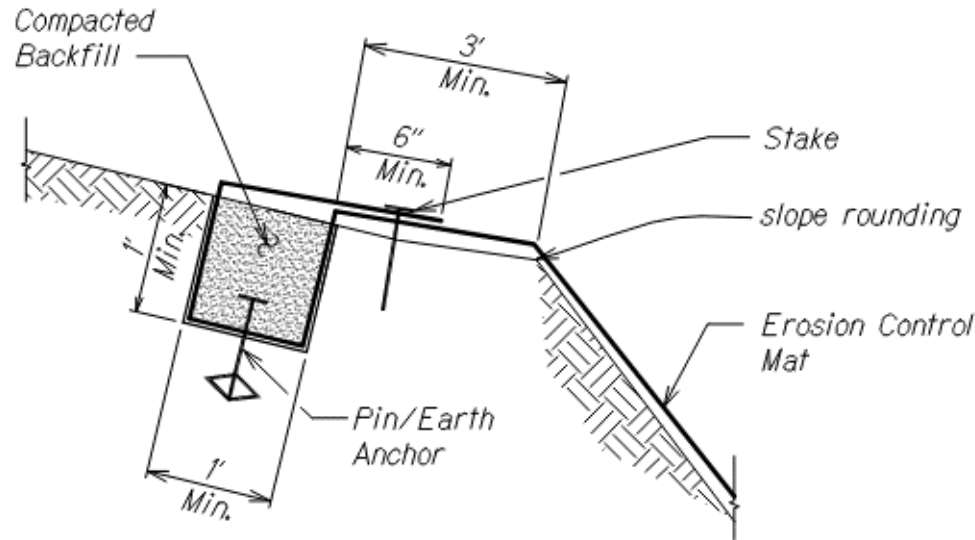
OVERVIEW OF EROSION CONTROL MATTING SYSTEM

Scale: Not to Scale

1
EC-01/EC-01



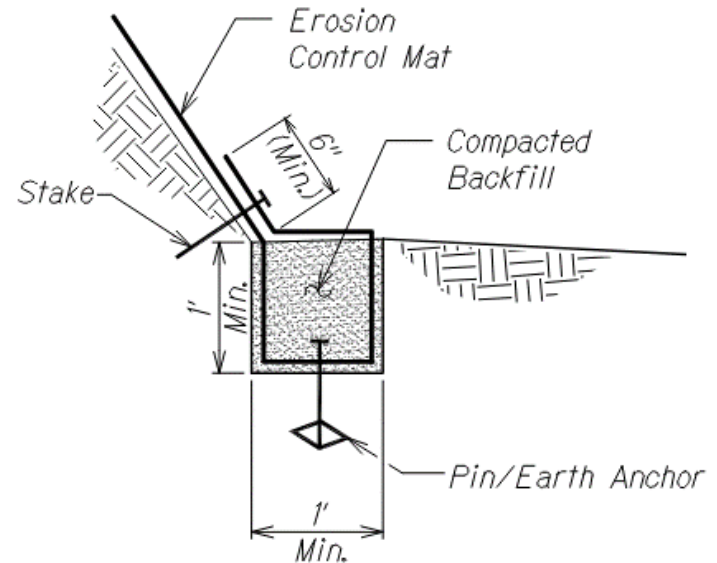
Erosion Control Matting (Trenches)



TOP OF SLOPE
ANCHOR TRENCH DETAIL

Scale: Not to Scale

2
EC-01/EC-01



BOTTOM OF SLOPE
ANCHOR TRENCH DETAIL

Scale: Not to Scale

3
EC-01/EC-01



Erosion Control Matting (Anchor Devices)



Erosion Control Matting (Anchor Devices)

- Needs good contact with ground



Erosion Control Matting (Anchor Devices)

- Steel Pins
- Wooden Stakes
- Earth Anchors
- Biodegradable Stakes



Erosion Control Matting (Anchor Devices)

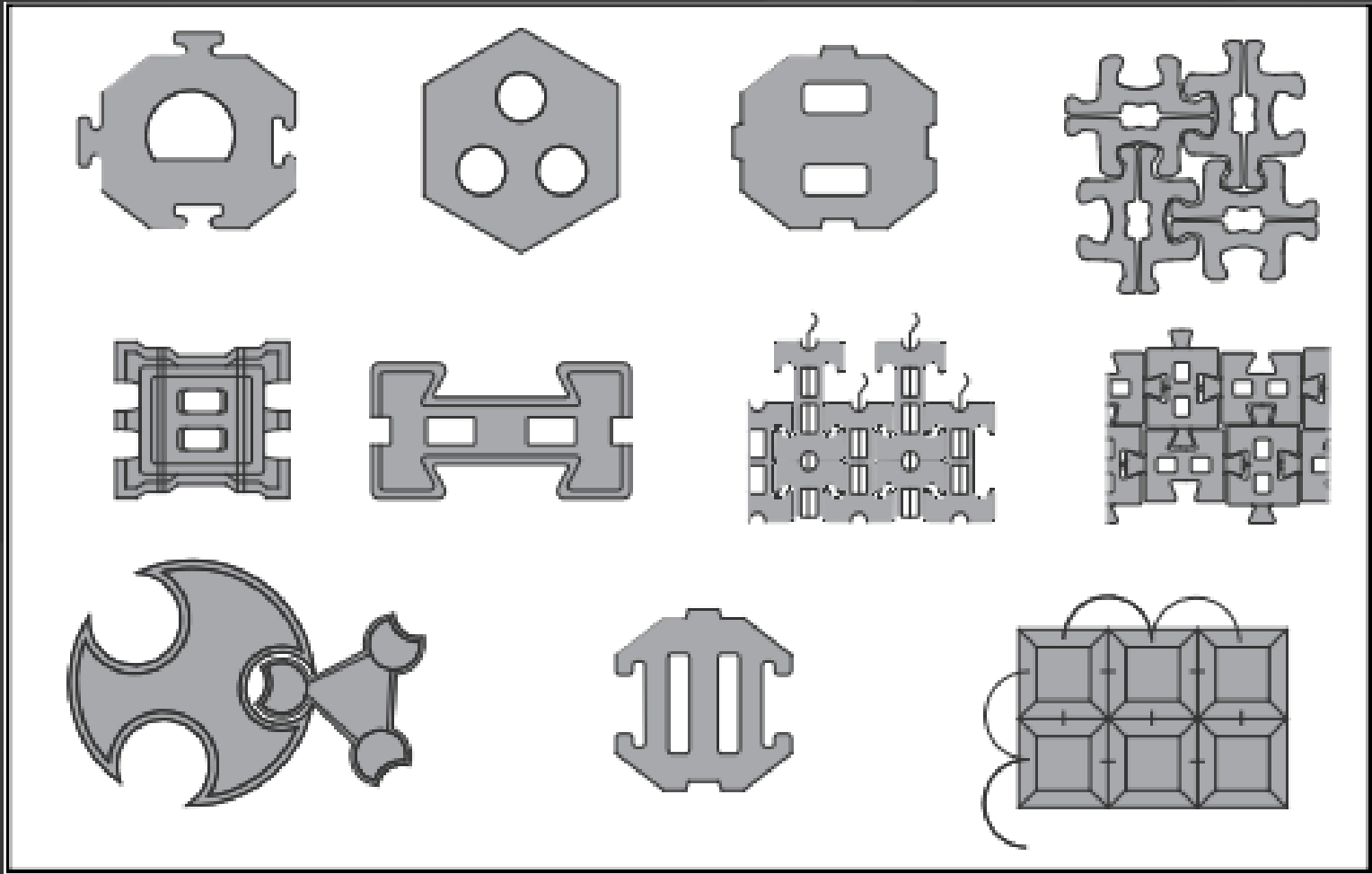
- Steel Pins: Prone to corrosion
- Wooden Stakes: Food for termites
- Earth Anchors: Stray cables
- Biodegradable Stakes



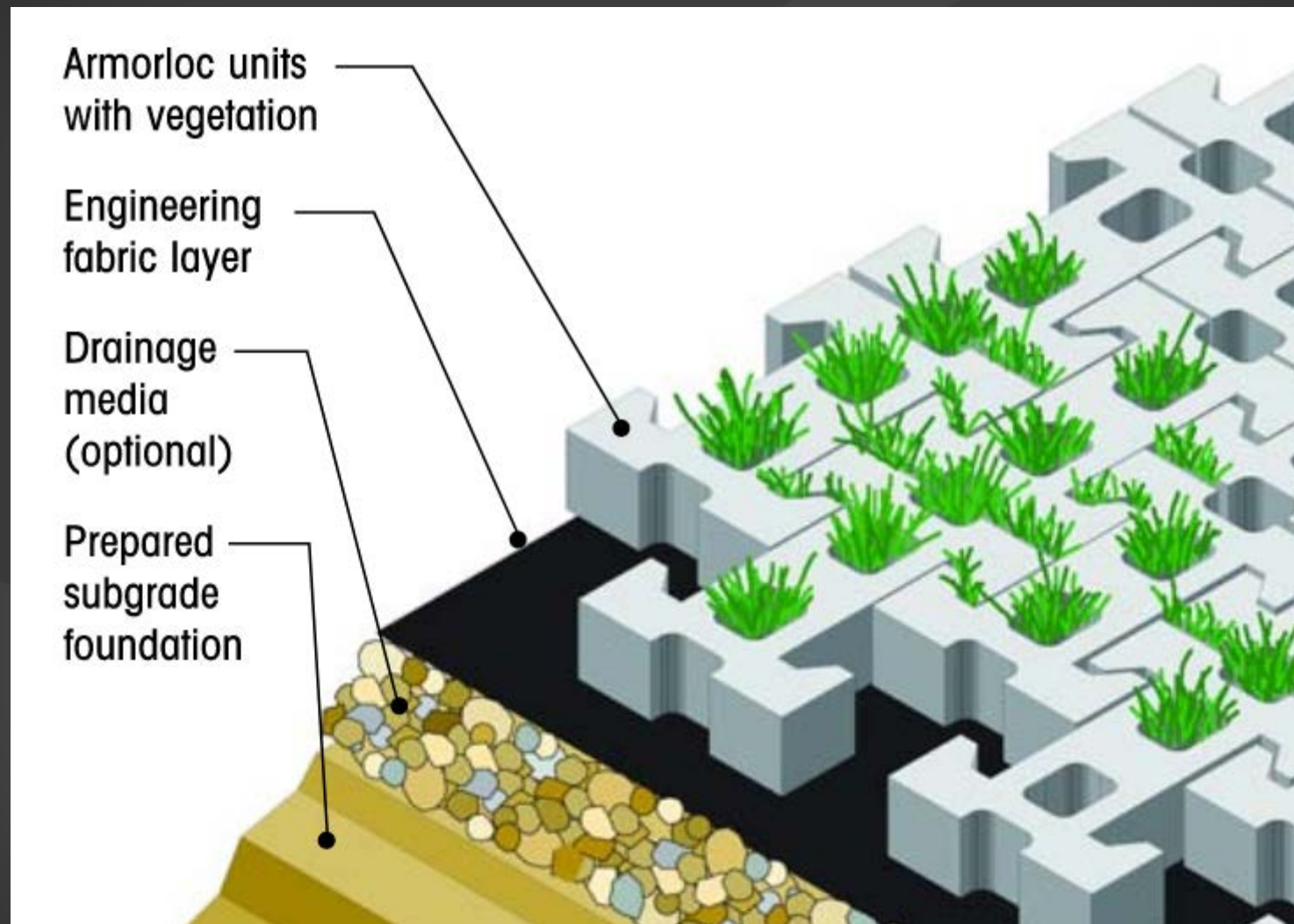
Articulated Concrete Blocks



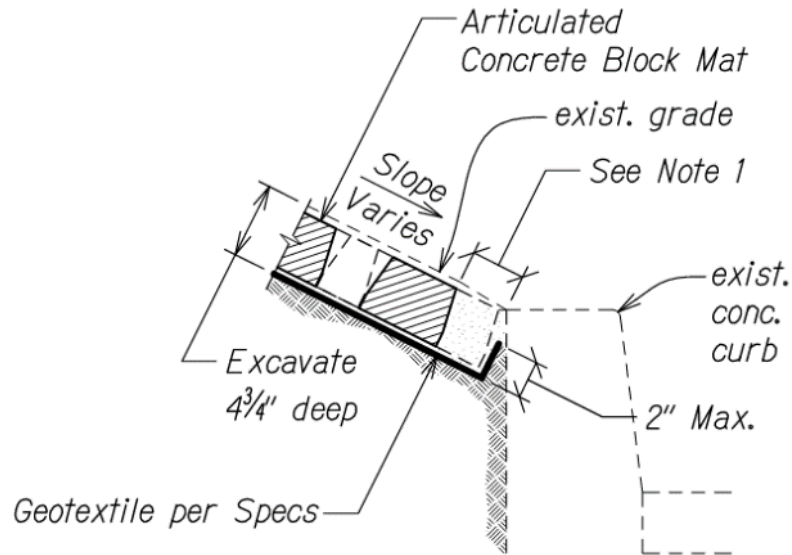
Articulated Concrete Blocks



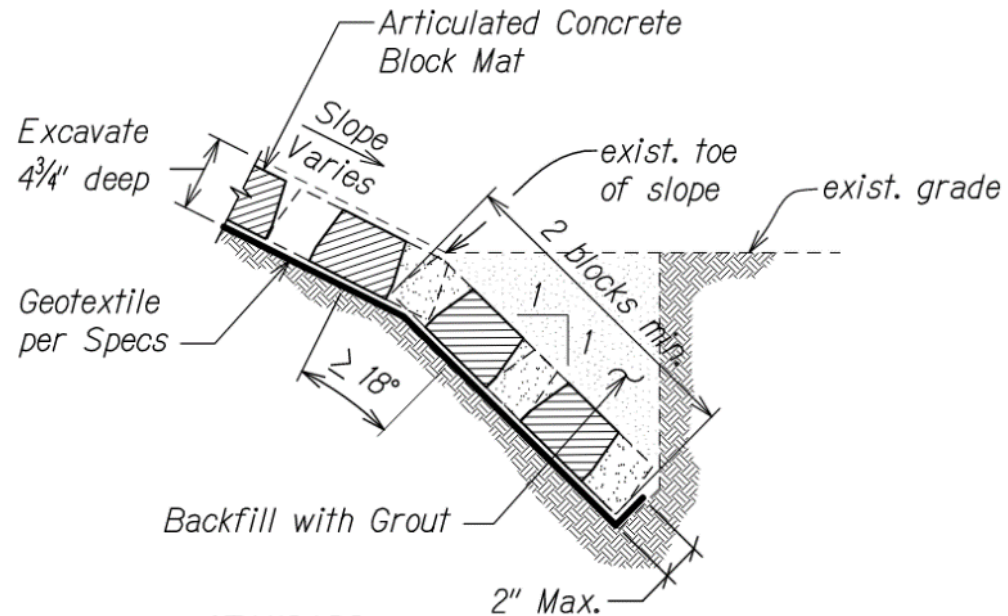
Articulated Concrete Blocks



Articulated Concrete Blocks



AT TOE WHEN
MEETING EXIST. CURB



STANDARD
TOE CONDITION

Articulated Concrete Blocks



Grouted Rip Rap



Grouted Rip Rap (Before)



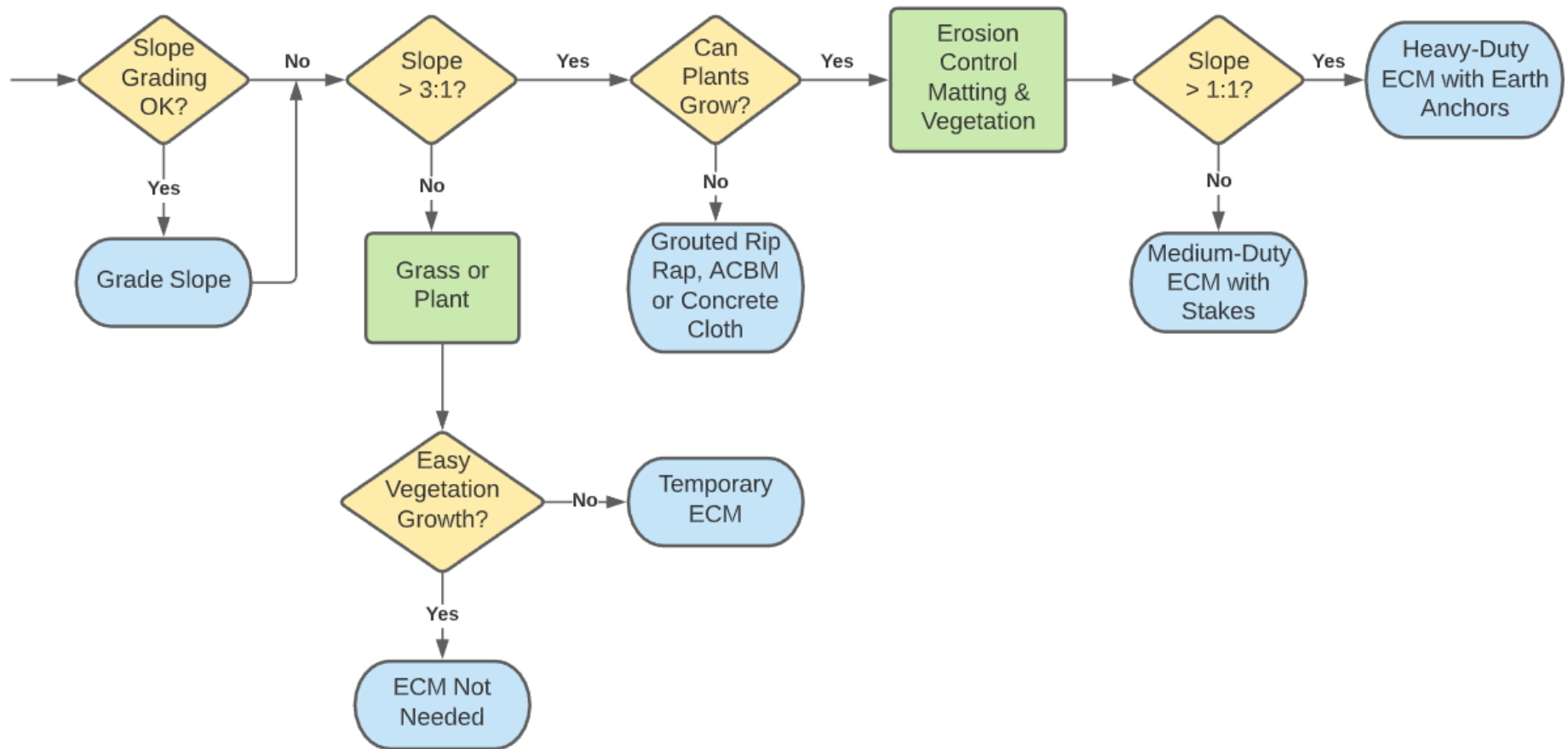
Grouted Rip Rap (After)



Concrete Fabric



Slope Improvement Selection Criteria



Approximate Costs

- Medium-Duty ECM ~ \$20 - \$60/sy
- Heavy-Duty ECM ~ \$60 - \$150/sy
- Temporary ECM ~ \$15 - \$25/sy
- Articulated Concrete Blocks ~ \$200 - \$500/sy
- Grouted Rip Rap ~ \$400 - \$800/cy



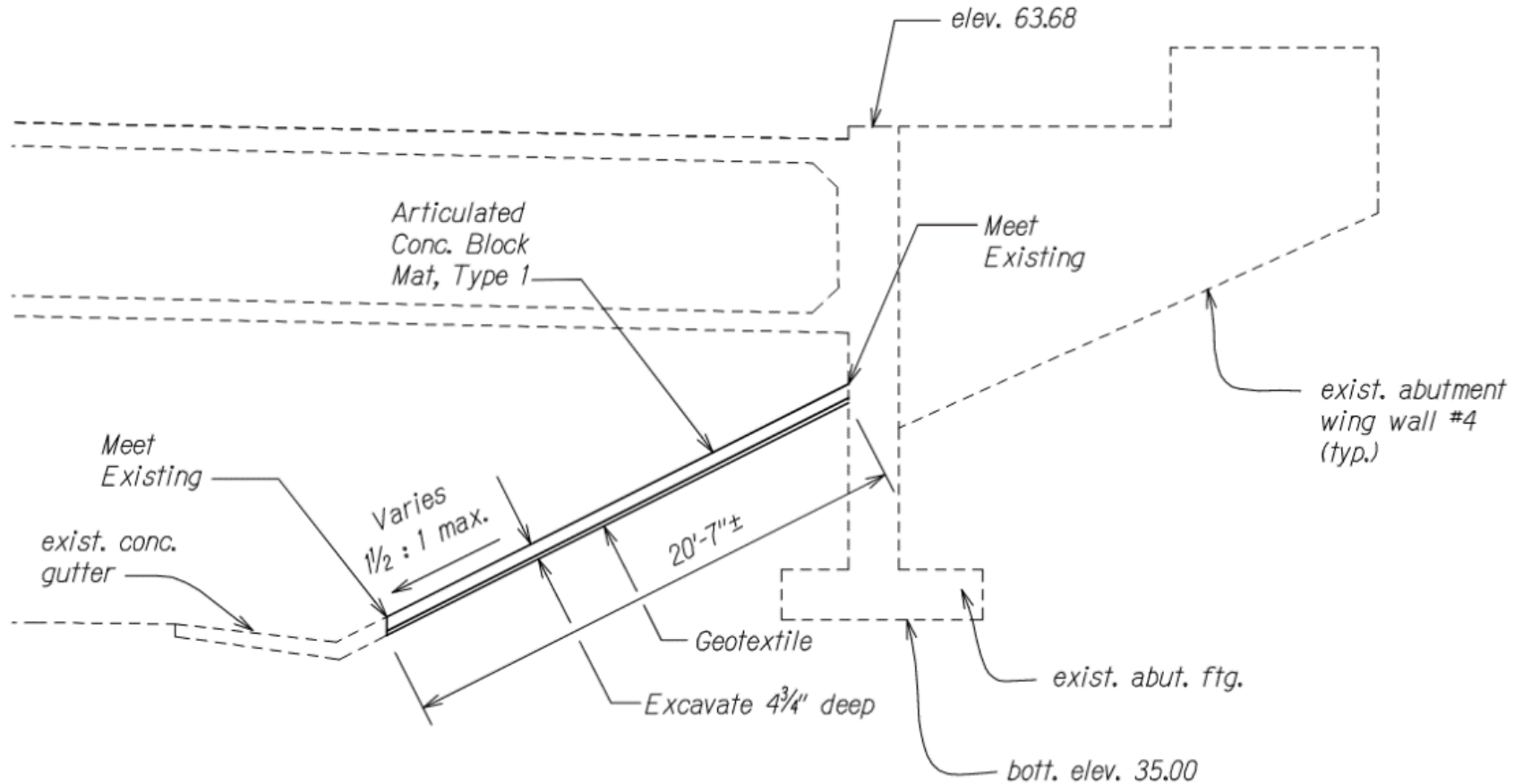
Other Lessons Learned

- Seasonal vegetation



Other Lessons Learned

- Topographic Survey



Other Lessons Learned

- Eucalyptus Trees



Other Lessons Learned

- Eucalyptus Trees



Case Studies

- Kalanianaʻole Highway (Kailua town-bound)



Case Studies

- Kamehameha Highway (near Mililani)



Case Studies

- H-2 Freeway (near Mililani)





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STATE OF HAWAII DEPARTMENT OF TRANSPORTATION

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Thank You!

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Lessons Learned: DOT Slope Improvements for Erosion Control

Why Vegetation for Slope Protection?

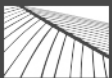
- Mitigate erosion risk
- Helps stabilize loose/erosive soils
- Long-term stabilization and improved soil quality

How does vegetation do this?

- Reduces the impact of rainfall on exposed soil with leaves and leaf litter on the ground
- Reduces runoff velocity by creating a rougher surface for water to travel over (plants and leaf litter)
- Root systems bind the soil and helps provide structural integrity at the root zone of plants.
- Helps remove sediment from runoff before conveyance to waterway (plants and leaf litter)
- Increases water infiltration and percolation into the soil
- Increases evapotranspiration by moving water through the soil to the air through the plant structure

Considerations For Vegetation Selection

- Site location



Considerations For Vegetation Selection

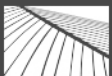
- Site location
- Sun exposure and duration

Considerations For Vegetation Selection

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- Soil Classification

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- Site location
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- Access for maintenance



Considerations For Vegetation Selection

- Site location
- Sun exposure and duration
- Soil Classification
- Access for maintenance
- Access to water

Considerations For Vegetation Selection

- Site location
- Sun exposure and duration
- Soil Classification
- Access for maintenance
- Access to water
- Use of native Hawaiian and Polynesian-introduced plants in public landscaping
 - More information online: https://spo.hawaii.gov/wp-content/uploads/2018/12/Act-233-Hawaiian-Plants_Info_12-26-18.pdf

H-3 & Likelike Interchange

- Mostly shaded
- Soil considered heavy, high pH
- Good access to site
- Temporary irrigation



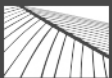
H-1 Outbound (Toward Kunia)

- Full sun
- Clayey silt & weathered basalt, high pH
- Wide shoulder area
- Temporary irrigation



Pali Highway (Inbound from Kailua)

- Mostly shaded
- Soil considered heavy (clayey silt)
- Narrow shoulder area
- Temporary irrigation

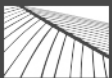


Kamehameha Highway (Outbound from Hale'iwa To Wahiawā) (Before & After)

- Full sun
- Soil considered heavy clay, high pH
- Narrow shoulder area
- Temporary irrigation



Kamehameha Highway (Continuation)



PBR HAWAII
& ASSOCIATES, INC.

H-2 Freeway (Outbound from Mililani)

- Full sun
- Clayey silt, low pH
- Fairly wide shoulder area
- Accessible water



Kamehameha Highway (Outbound Between Wheeler AAF & Mililani)

- Full sun and partial shade
- Clayey silt, low pH
- Narrow shoulder area
- Temporary irrigation



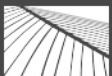
H-2 Freeway (Outbound from Mililani)

- Full sun
- Clayey silt, low pH
- Fairly wide shoulder area
- Temporary irrigation



Kunia Road (Toward Wahiawā)

- Mostly shaded
- Clayey silt, weather basalt; neutral pH
- Narrow shoulder
- Temporary irrigation



H-1 Outbound (Toward Kunia)

- Full sun
- Clayey silt & weathered basalt, high pH
- Wide shoulder area
- Temporary irrigation



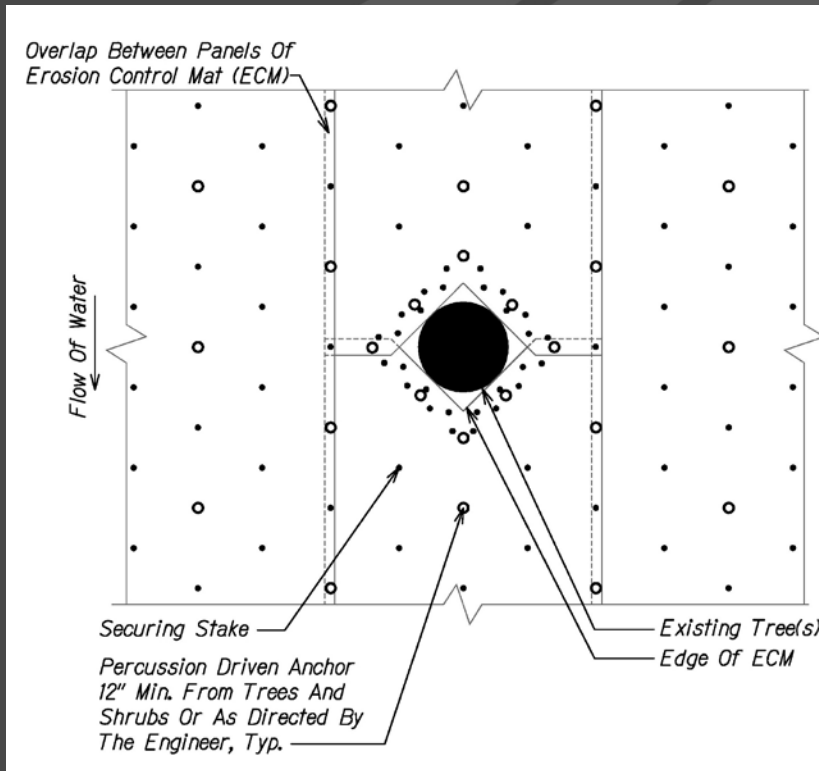
UH Cloverleaf East

- Full sun
- Gravel
- Limited vehicular access
- Temporary irrigation

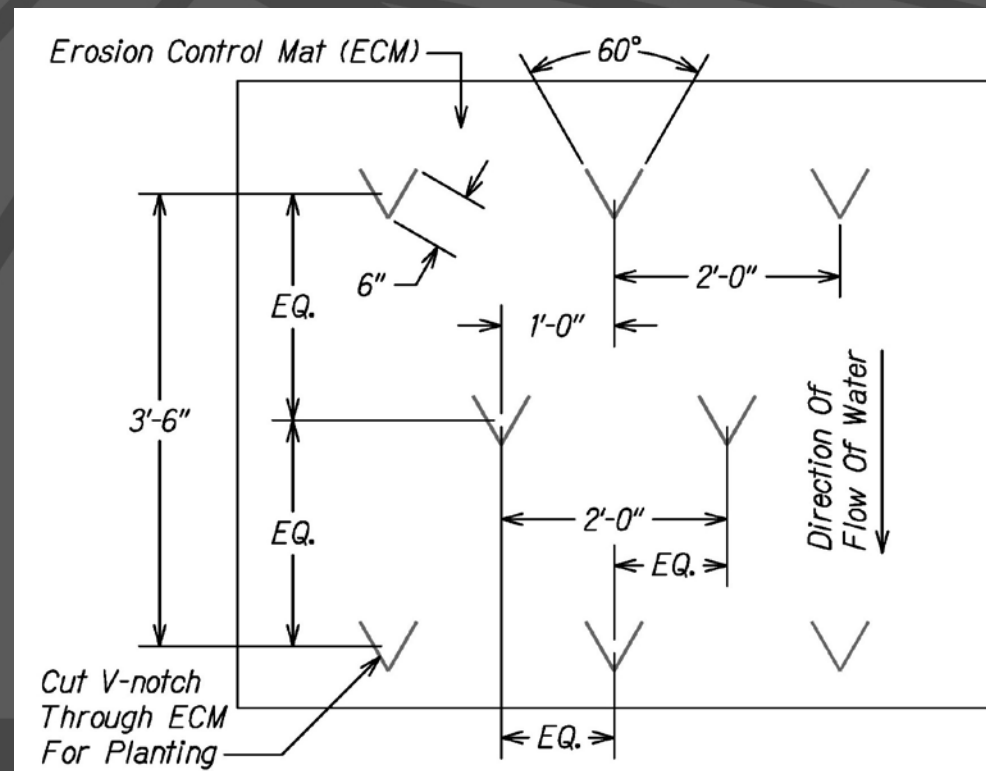


Lessons Learned

- Various options explored to enhance plant survivability. Slope shaping, wattles, and terracing options were considered. Only shaving of the slopes (removal of loose material) was allowed so mixing of amendment into existing soil (tilling) was not permitted on the slopes themselves.
- Erosion control mat selected for slopes with grades greater than 3:1. Erosion control mat aids with collection of sediment and organic matter. This in turn aids with improving soil health.
- Soil stabilizers and tackifiers mixed with hydraulically applied mulch on slopes with grades less than 3:1 help protect exposed soil during plant establishment.
- Because the use of mulch allowed distribution of fertilizers and amendments, mulch was also applied to slopes with grades greater than 3:1 before erosion control mat installation. Mulch application allowed for hydraulic distribution of amendments.



- Installation of erosion control mat around existing trees (individually and groups of trees) required creative anchoring methods which complied with the anchor spacing determined by the Geotechnical Engineer.



- Installation of plants through the erosion control mat also required alternative methods. The challenge faced was developing a way to incise the mat to allow planting while preserving the integrity of the mat and preventing runoff from getting below the incision to create a scouring effect.



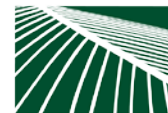
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Thank You!

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