THE WORLD BANK / PMGSY NRIDA

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NEW TECHNOLOGIES AND INNOVATIONS IN RURAL ROADS

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CHALLENGES IN THE INDIA HILL ROADS PROGRAM

- Steep, Unstable Terrain and High Rainfall
- Short Construction Season
- Difficult Working Conditions
- High Construction Costs-$$$
- Inexperienced Contractors
- Difficult to Find Trained Engineers
- Other Regions are Very Flat-Drainage is Difficult

Innovative, Appropriate Technologies

HILL ROADS

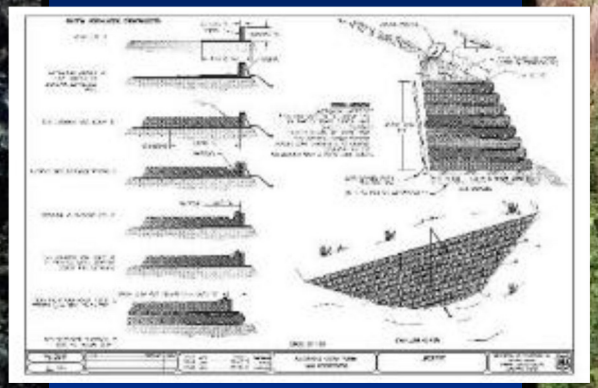
OTHER ROADS

Innovative Measures/Techniques/Tools

- USE OF GEOSYNTHETICS
  - GRS/MSE Retaining Structures
  - Reinforced Soil Structures / Deep Patch
  - Geocells, TRM & Erosion Control
- BRIDGE & DRAINAGE WORKS
  - ABC for Bridges
  - GRS Bridge Abutments; Buried Bridges
  - Stream Simulation & Fill Overtopping Protection
- TOOLS AND INFORMATION
  - DCP/Site Characterization
  - Soil Bioengineering
  - GIS/ESRI; LIDAR; Drones
  - Climate Models / VIC
  - Asset Management
- BMPs

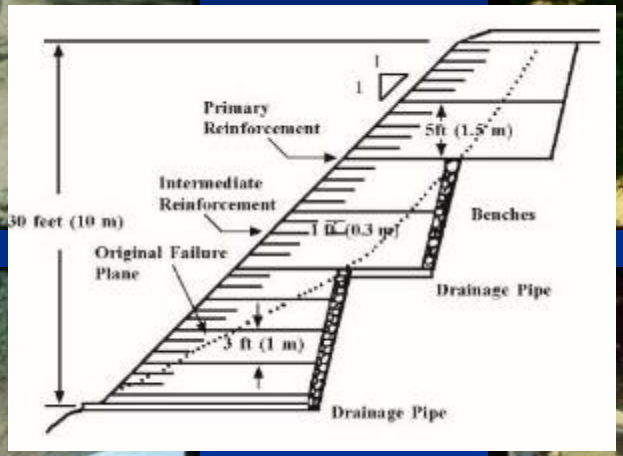
Geosynthetics in Retaining Structures

MSE/GRS Retaining Structures



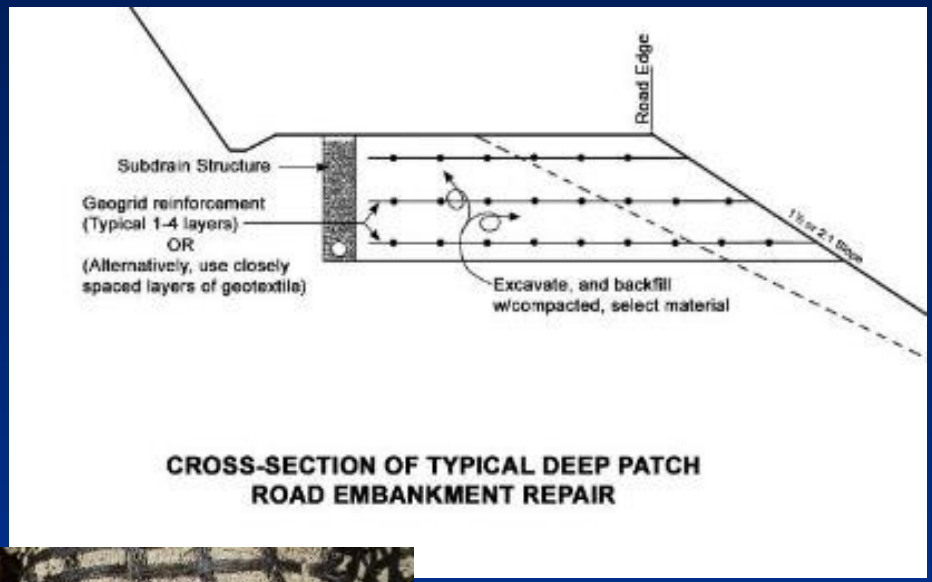
Geosynthetics in Retaining Structures

RSS Fills / Embankments



Landslide Prevention and Mitigation

Deep Patch



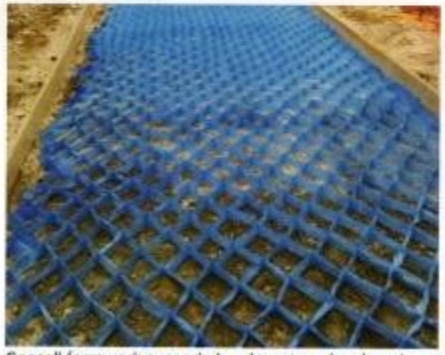
Use of Geocells & TRM

Use of Geocells & TRM

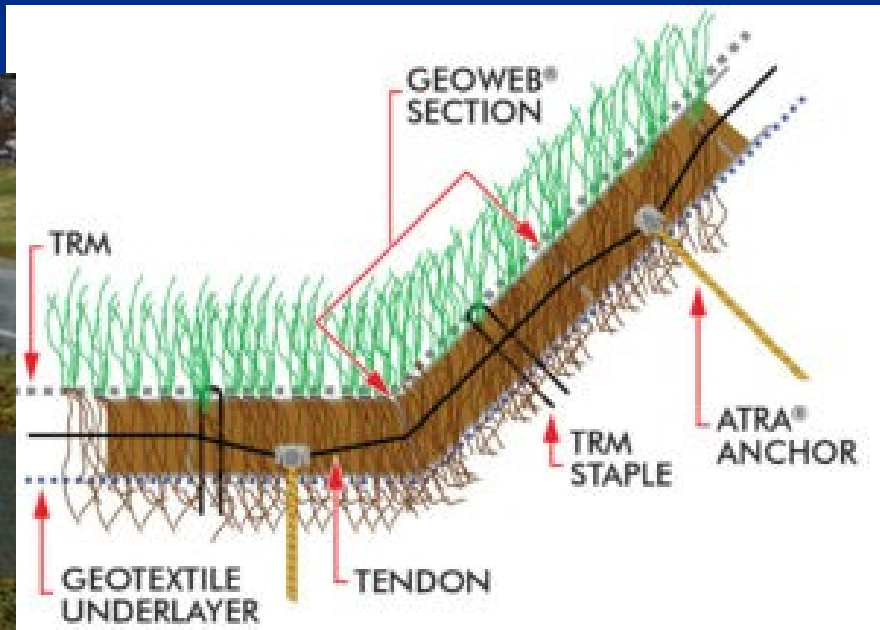
Road and drain incorporated. Drain can also be to side of road. (Hall & Hall 2007).

Dimpled formwork creates interlock between cells poured in situ (thin geocell formwork). (Hall & Hall 2007).

Strips of thick (>20 mm) geocell formwork (National Rural



Geocell formwork expanded and tensioned and ready



Geosynthetic Erosion Control Products

Bridges and Drainage Works

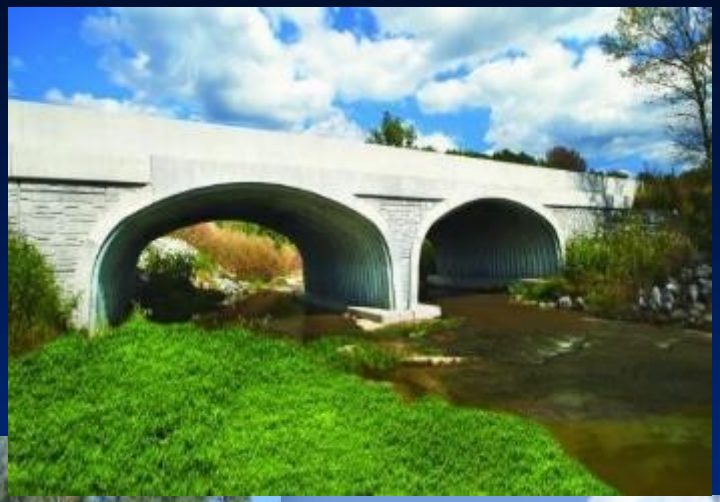
ABC and GRS Bridge Abutments

Accelerated Bridge Construction (ABC) & Modular Units

Justin Dahlberg, PE
Iowa State University
Bridge Engr. Center

GRS-IBS
Abutments

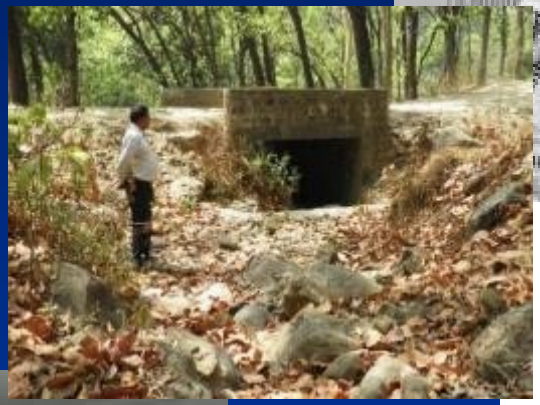
Buried Bridges
(Flexible Long-Span Structures)

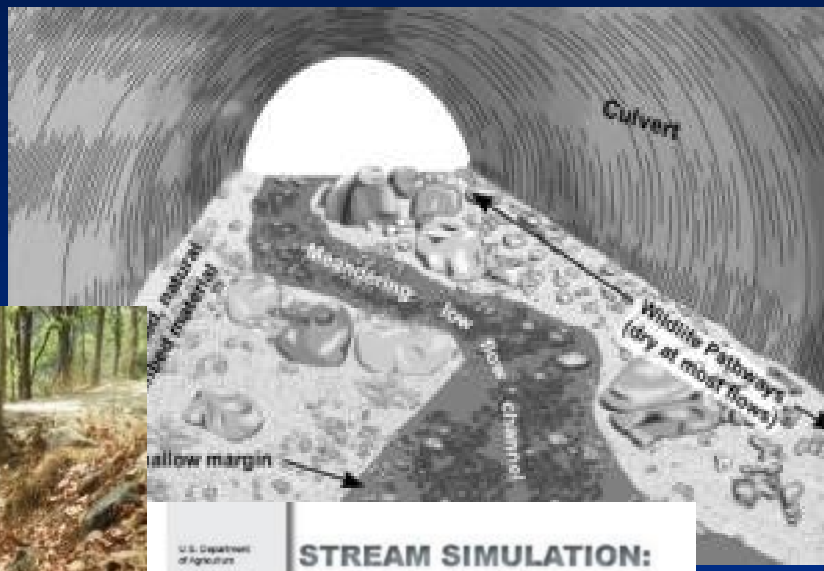


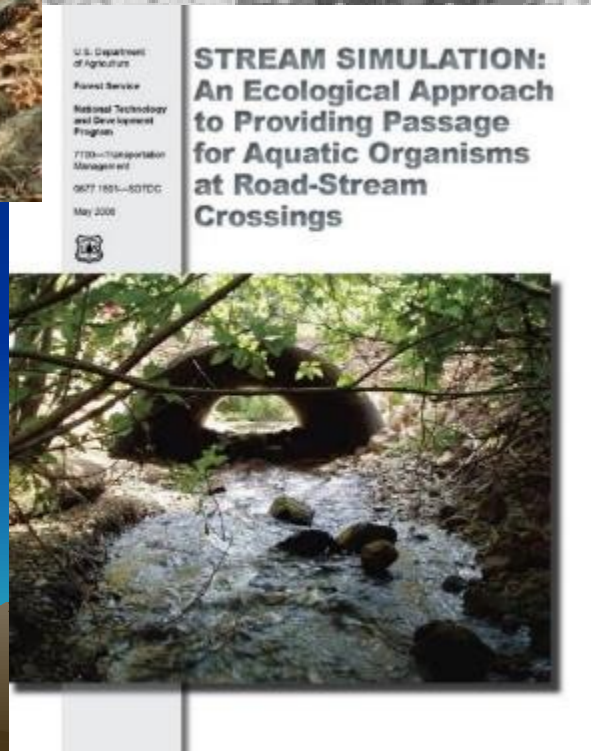
Joel Hahm, PE

Flooding and Drainage Mitigations

Stream Simulation Structures





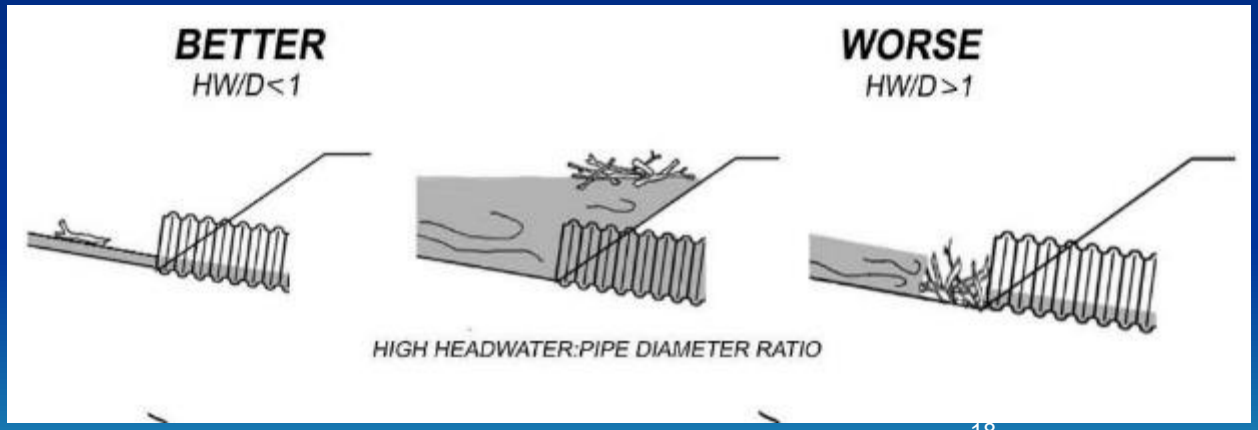


FLOOD RESISTENT CULVERT DESIGN

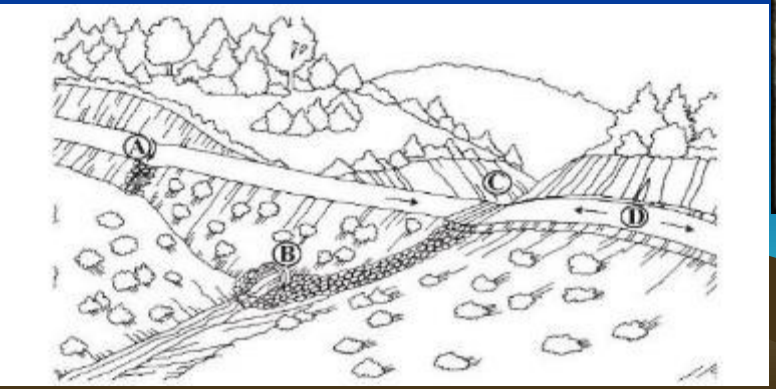
-Q50-100 vs Q25--SS

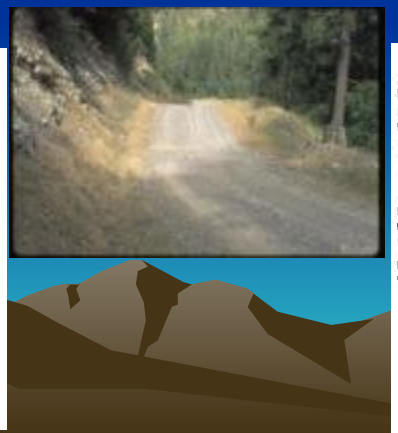
-Span ≥ Bankfull Width-SS

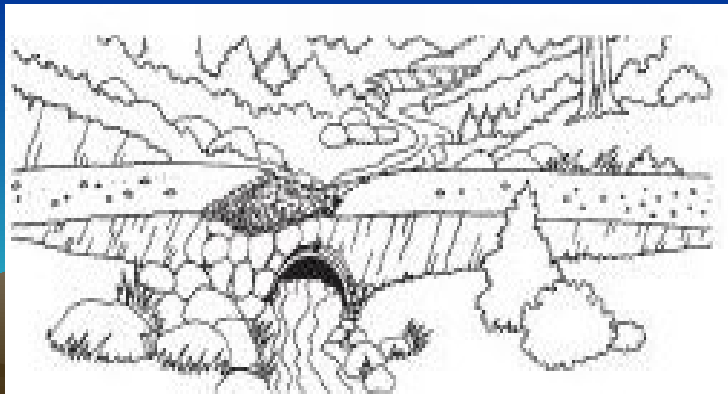
-HW/D ≤ 1.0



Fill Overtopping Protection







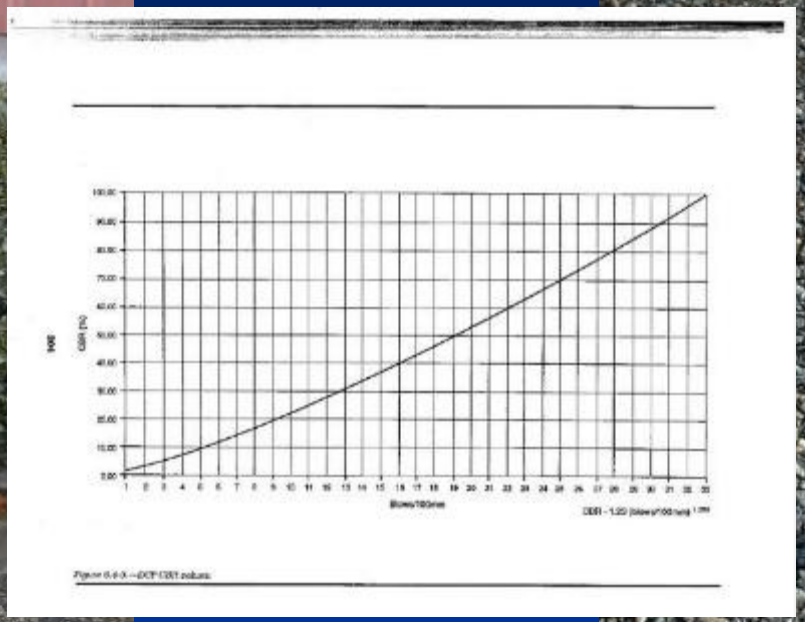
Overtopping Protection

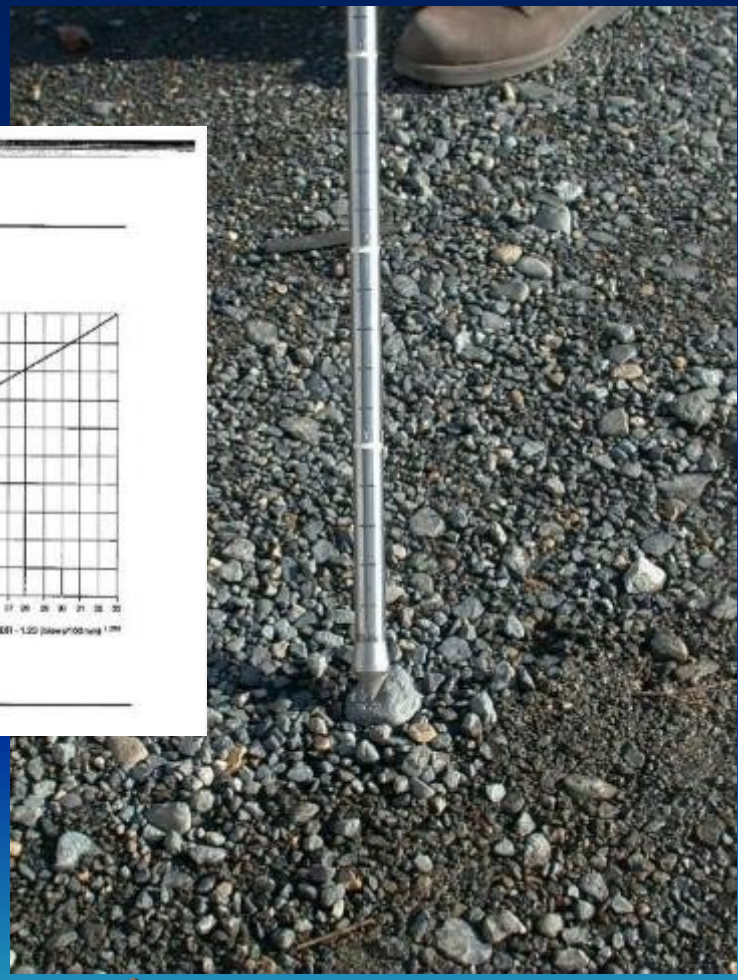
Rock Mattress 6 Years Later

French Fire, Sierra NF

Newly Installed TRM

Dynamic Cone Penetrometer
DCP

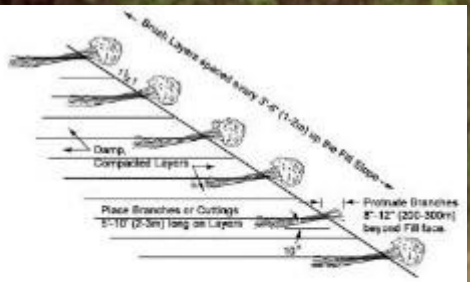




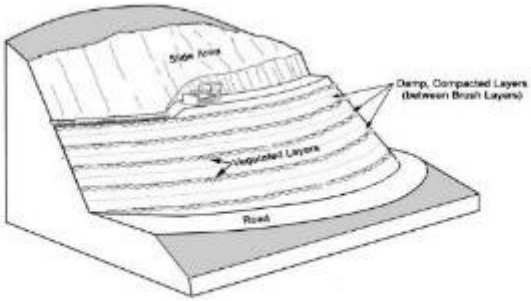
DCP-DN Design

Soil Bioengineering and Biotechnical Slope Stabilization

Plan View of Large Fill Slope Brush Layering

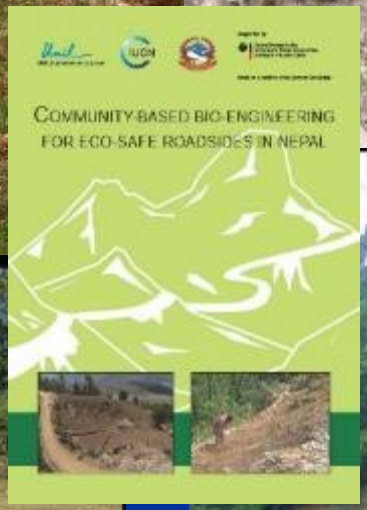


Cross-Section of Large Fill Slope Brush Layering



Perspective View of Slope with Brush Layering

Adapted from NCRS Engineering Field Handbook, Chapter 18 (1992).



THE VETIVER NETWORK (INTERNATIONAL)

ESRI/GIS/LIDAR

Vermont DOT

Terry Bills, ESRI

Burn Severity and Debris Slide Risk Mapping

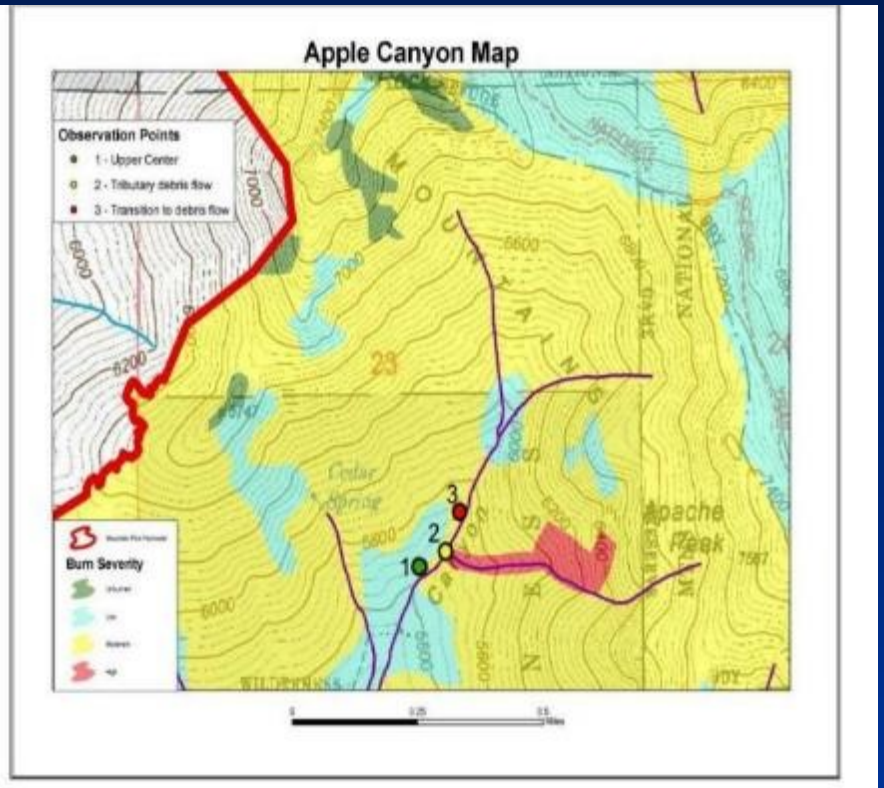
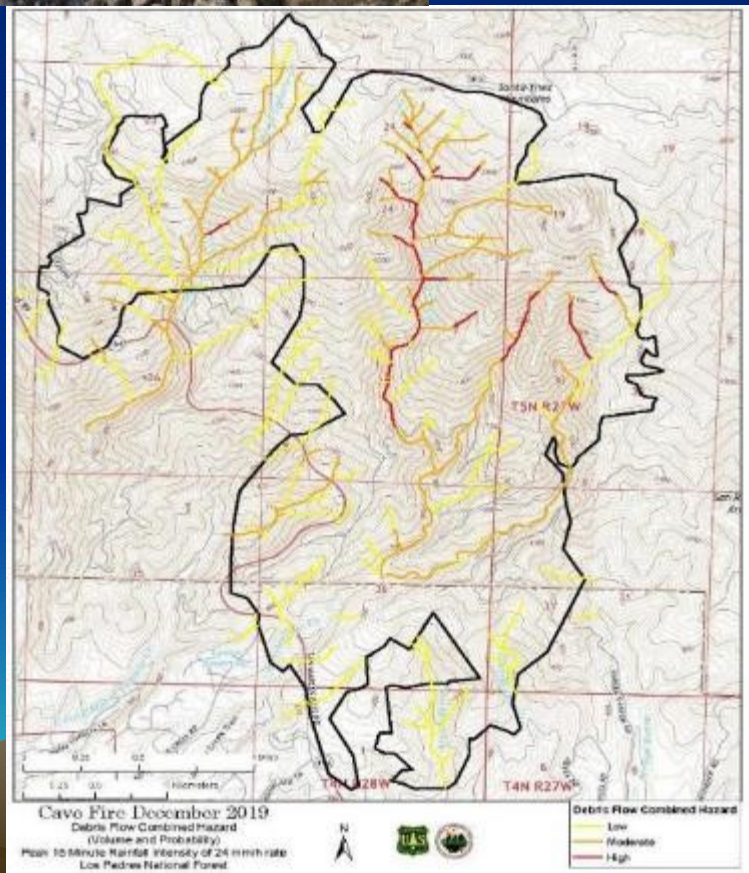


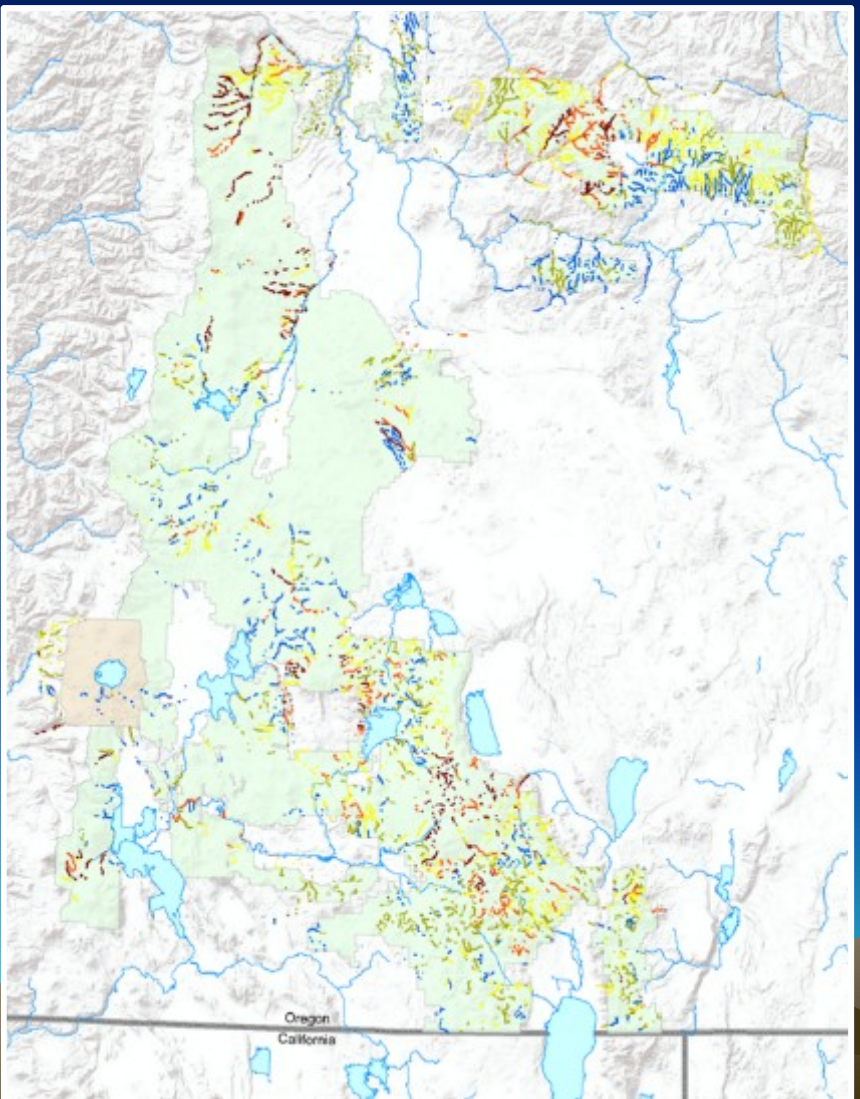
Figure 1. Map of the watershed which was the source of the debris flow impacting the Yokoji-Zen Mountain Center. The point locations (1-3) are referred to in the text.



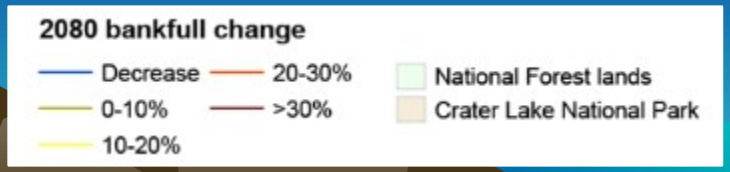
REMOTE SENSING-GIS, LIDAR, AIR PHOTOS,

Use of Drones

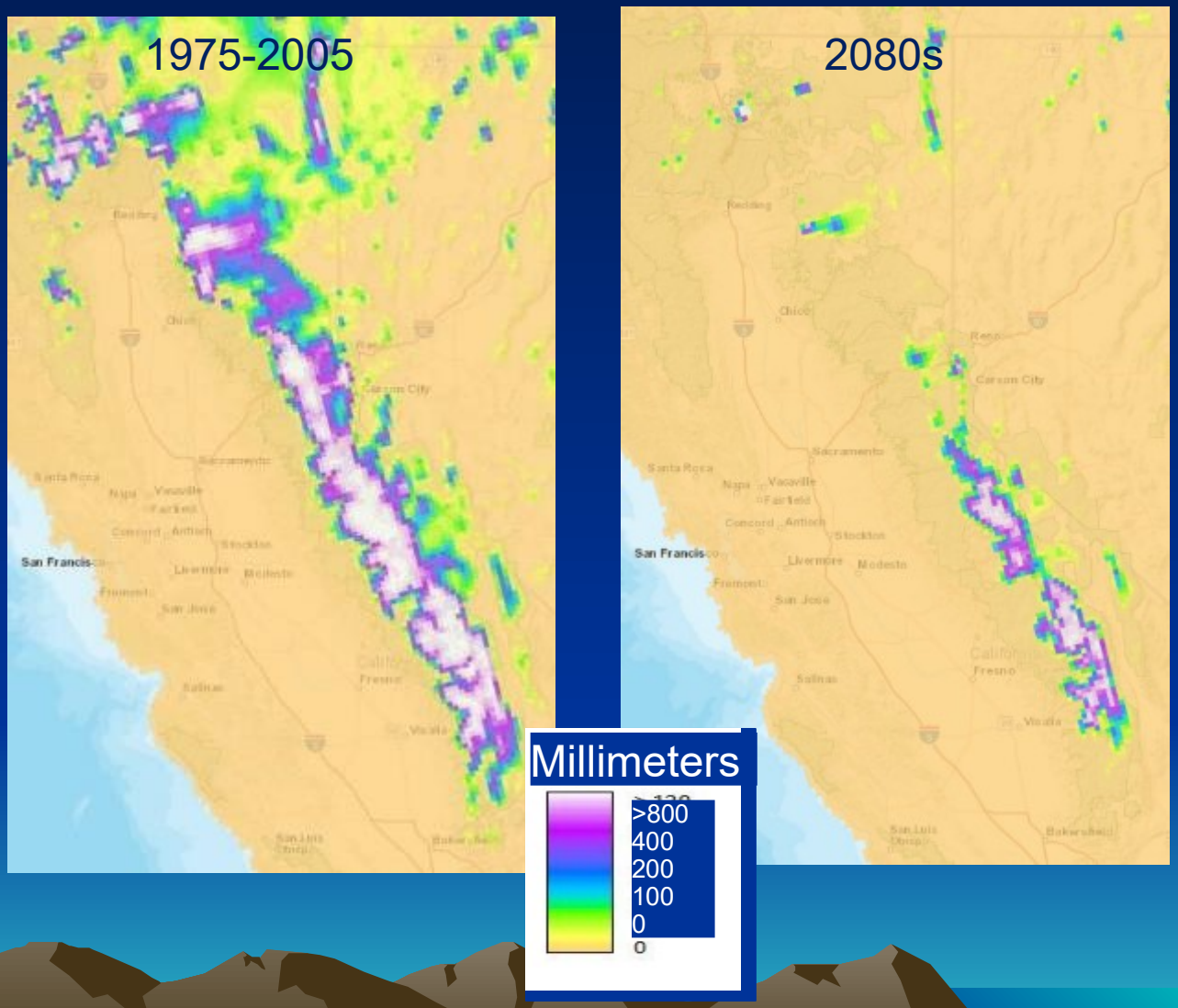
Climate Models- VIC
Variable Infiltration Capacity



Percent change in bankfull flow between historical and future (2080s) time periods for road segments within 90 m (200 feet) of streams.



Snow Water Equivalent



Asset Management

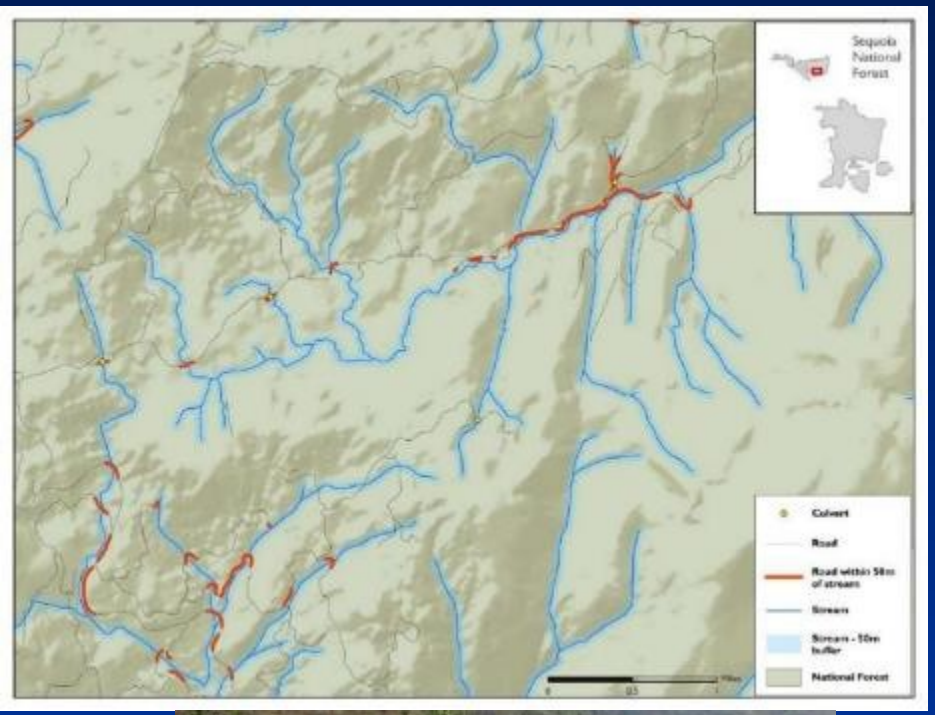
National Forest	Operational maintenance level					
	Basic custodial care (closed)[a]	High clearance Vehicles[b]	Suitable for passenger cars[c]	Moderate degree of user comfort[d]	High degree of user comfort[e]	Total
	----------Miles----------					
Ashley	23	974	339	157	88	1,581
Boise	1,527	2,503	542	14	--	4,587
Bridger-Teton	572	983	385	214	--	2,154
Caribou-Targhee	461	1,529	577	177	23	2,767
Dixie	992	2,075	460	49	15	3,592
Fishlake	43	1,710	168	12	7	1,941
Humboldt-Toiyabe	493	4,351	626	69	17	5,556
Manti-La Sal	302	1,616	290	9	--	2,217
Payette	842	1,649	428	36	4	2.959
Salmon-Challis	1,198	2,345	342	41	2	3,928
Sawtooth	268	1,341	270	17	21	1,916
Uinta-Wasatch-Cache	182	1,689	96	141	125	2,570
Total	6,903	22,764	4,863	936	302	35,768

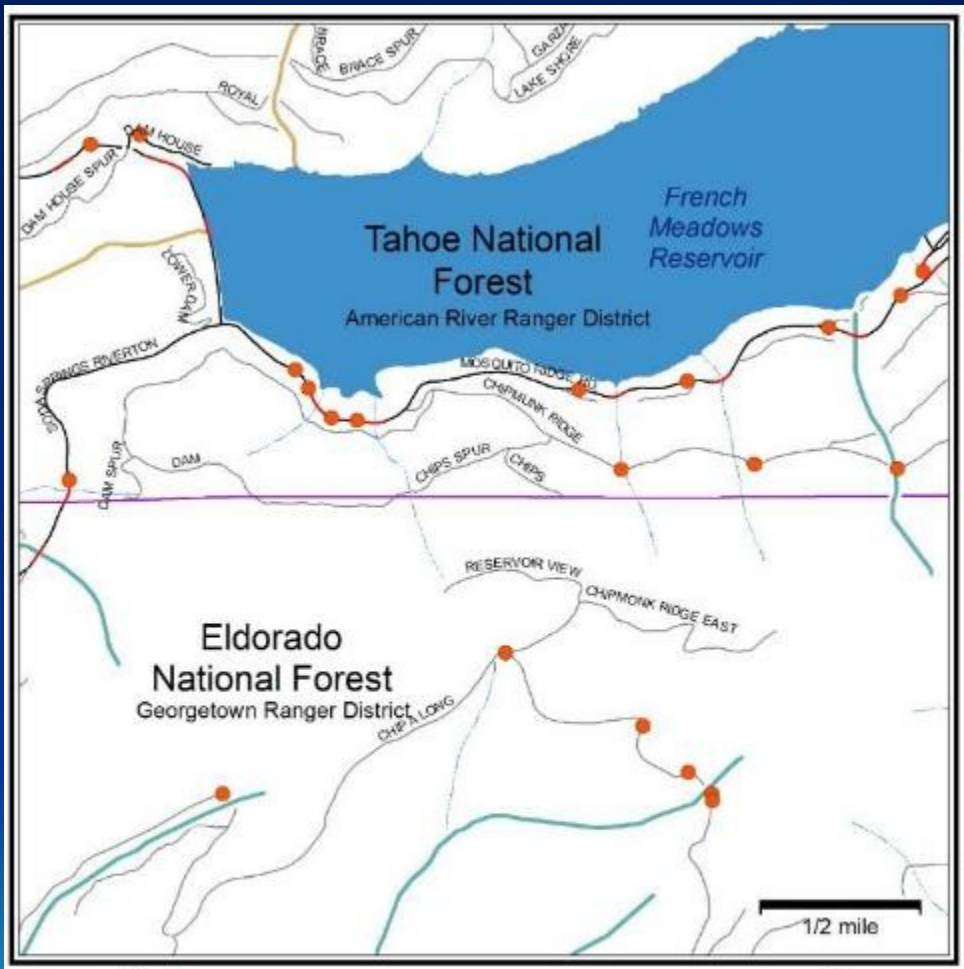
Table 3.3 Summary of Forest Bridges and Bridge Condition on FS land in the Sierra Nevada

National Forest	Adequate Bridges	Structurally Deficient Bridges	Total Bridges
ELDORADO	26	10	36
INYO	25	1	26
LASSEN	13	68	81
MODOC	14	0	14
PLUMAS	82	54	136
SEQUOIA	62	0	62
SIERRA	162	7	169
STANISLAUS	117	4	121
TAHOE	31	0	31
LTBMU	7	1	8
TOTALS	539	145	684

Note:
1. Numbers include major culverts (over 20 foot span) plus bridges.
2. The large number of structurally deficient bridges on some forests is likely due to coding differences in the INFRA database.

Asset Management + GIS





Culverts > 36"

Paved road within 165' of a stream

Paved road

Unpaved road

Change in 25-year flood

-1500 to 0 cfs

0 to +1500 cfs

Forest boundary

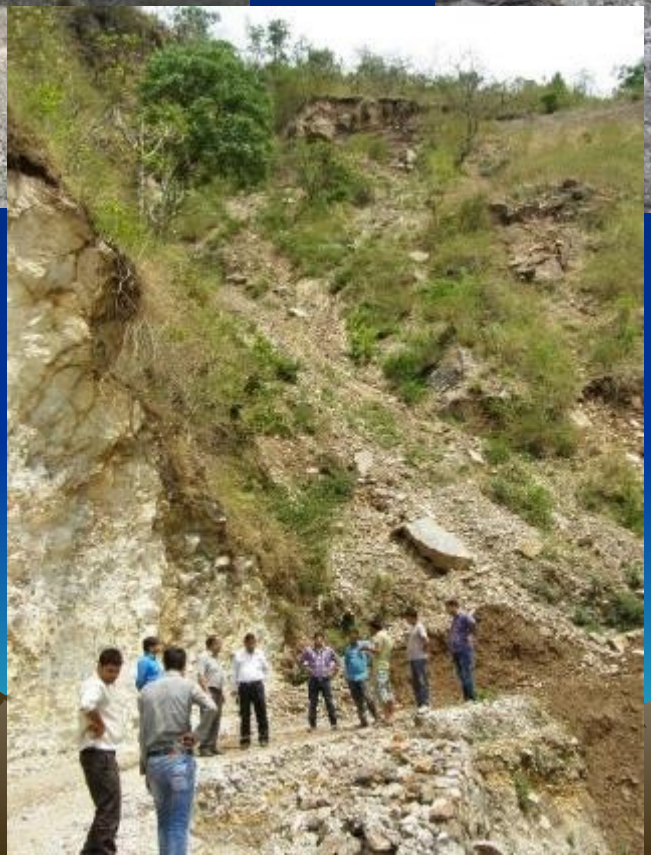
The Ongoing
Best Engineering Practices (BMPs)
(Stormproofing)

- Having Road Maintenance Current
- Improving Road Surface Drainage
- Having Adequate Cross-Drainage
- Culvert and Channel Cleaning
- Preventing Culvert Diversion
- Increasing Pipe Capacity
- Overflow Protection and Trash Racks
- Low-Water Fords vs Culvert Pipes

Adaptation/Mitigation Measures (Stormproofing)

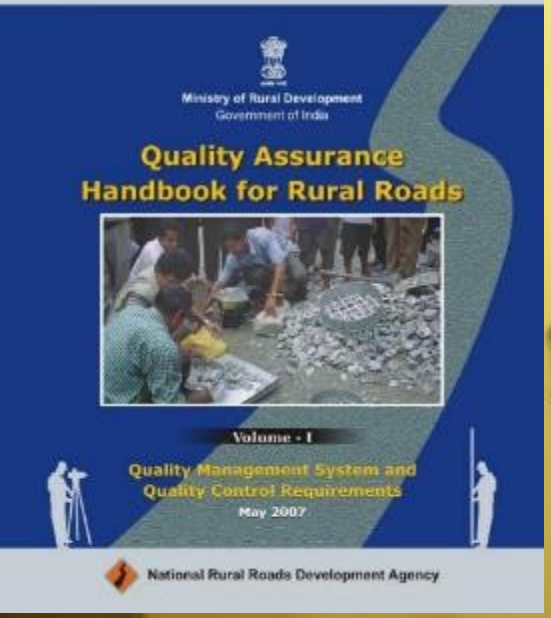
- Bridge Channel Cleaning & Scour Protection
- Road-Stream Encroachment-Moving Roads
- Thorough Vegetative Cover (Deep roots)
- Using Soil Bioengineering/Biotechnical Measures
- Gully Control and Prevention
- Local Slope Stabilization Measures, Drainage Pulling Back Unstable Fills, Deep Patch, Soil Nailing
- Changing Road Grade or Alignment, Closure

Coordination Between Agencies & Locals

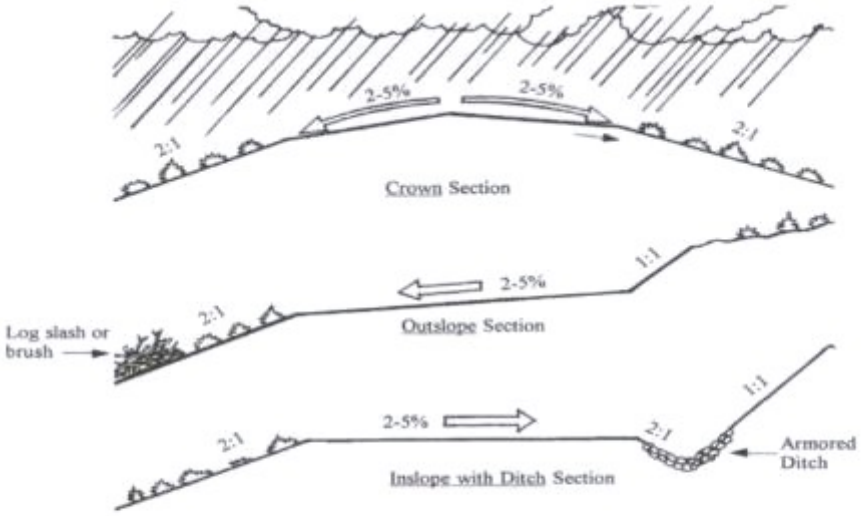


Maintenance

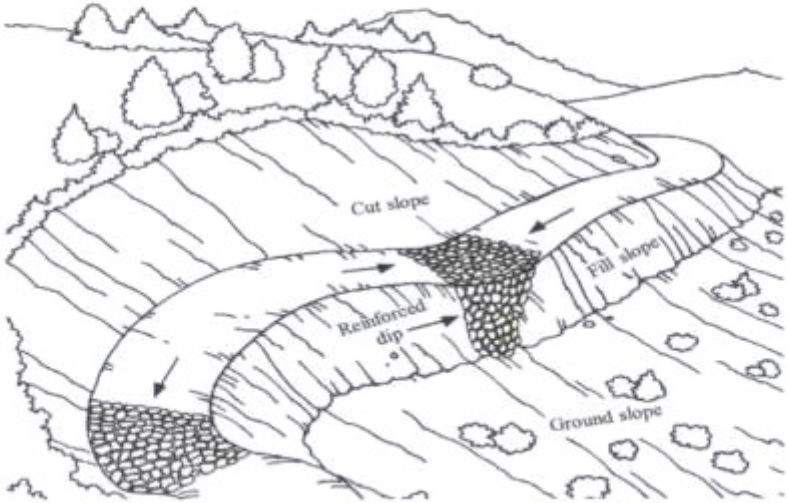
Quality Control
QA/QC



Surface Drainage



Typical Road Surface Drainage Options




“Ideas are a Dime a Dozen.
People who Put Them into Action
are Priceless”
That is YOU!


Thank
You