Effectiveness of best management practices to reduce sediment delivery from reopened legacy roads at forest stream crossings

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Forest roads at stream crossings

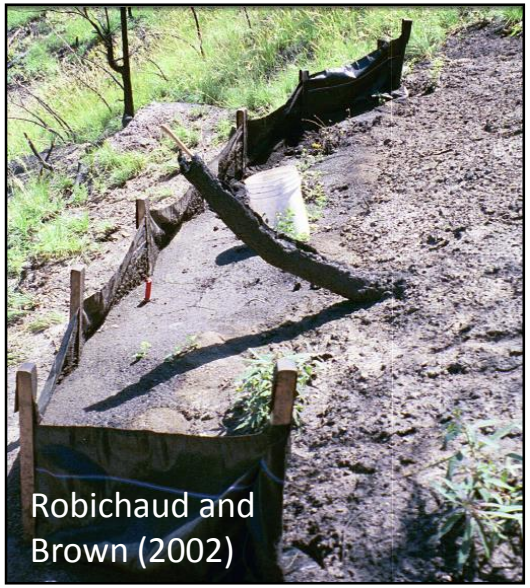
- Sediment delivery potential is greatest at the road-stream interface
- Issue has sparked legislative debates about CWA permits and NPSP status of forest roads

Reopening legacy roads and potential impacts to water quality

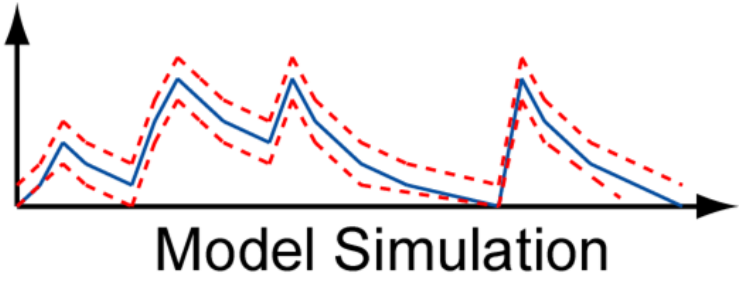
- Legacy roads may have inadequate BMP implementations
- Common problems include poor grade control, insufficient water control structures, and concomitant bare soil

Need to document the efficacy of BMPs to reduce sediment delivery from roads… **How?**

Turton et al. (2009)


Robichaud and Brown (2002)

FSWEPP



Field study 1: Sediment trapping

- **Objective:** Quantify annual sediment delivery rates for reopened (no gravel) and graveled stream crossing approaches

Field study 2: Rainfall simulation

- **Objective:** Quantify event-based surface runoff and sediment yield for reopened approaches with diverse intensities of BMP implementations

No gravel

10-19% cover

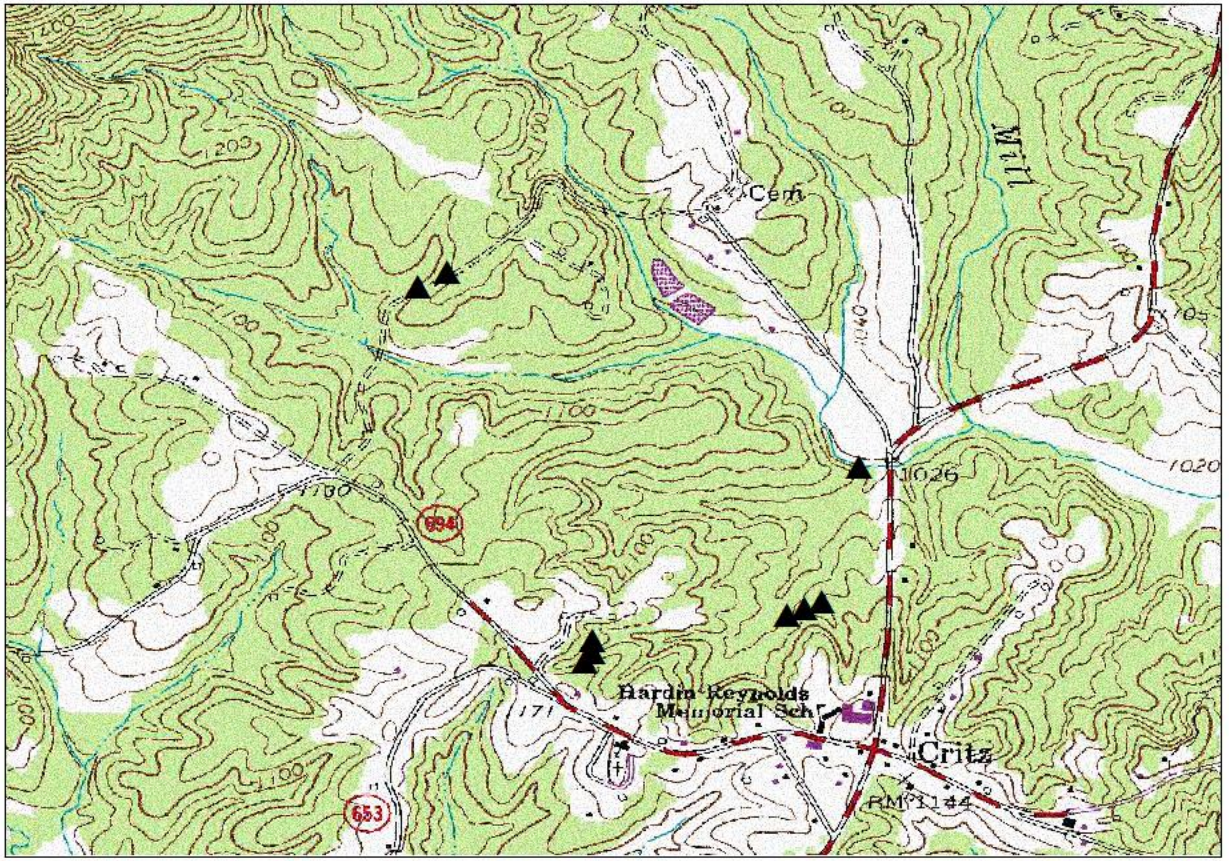
Low gravel

34-60% cover

High gravel

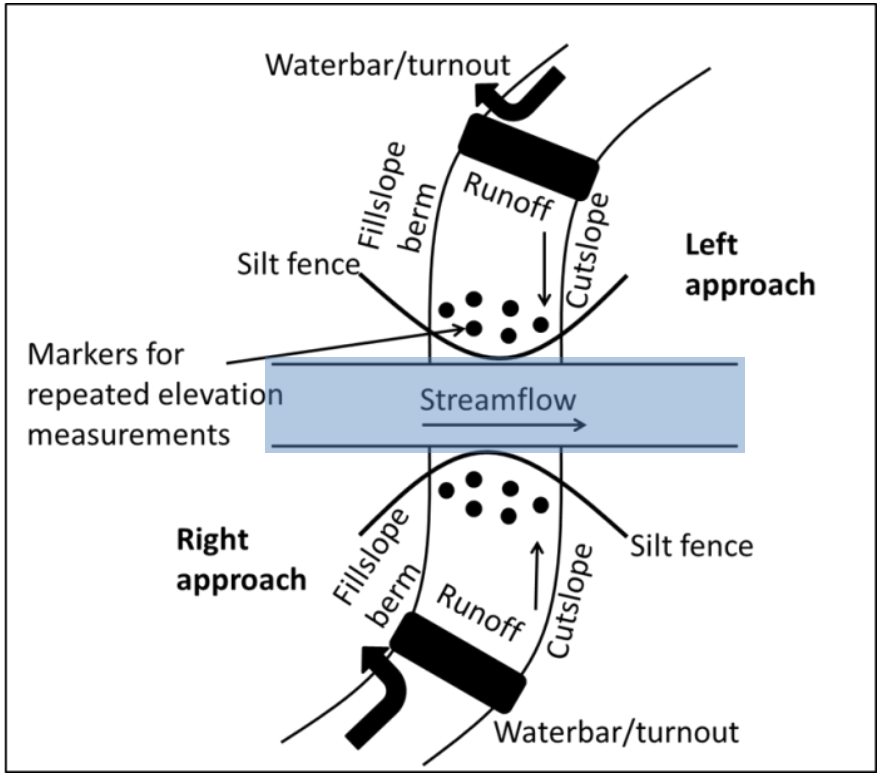
50-99% cover

Sediment trap sites at the Reynolds Homestead



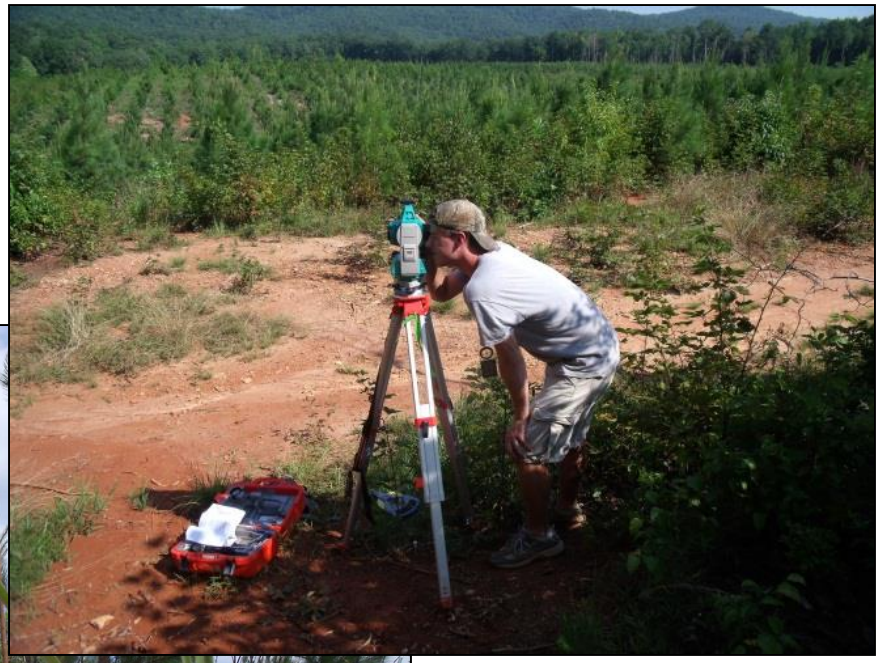
Road approach study sites

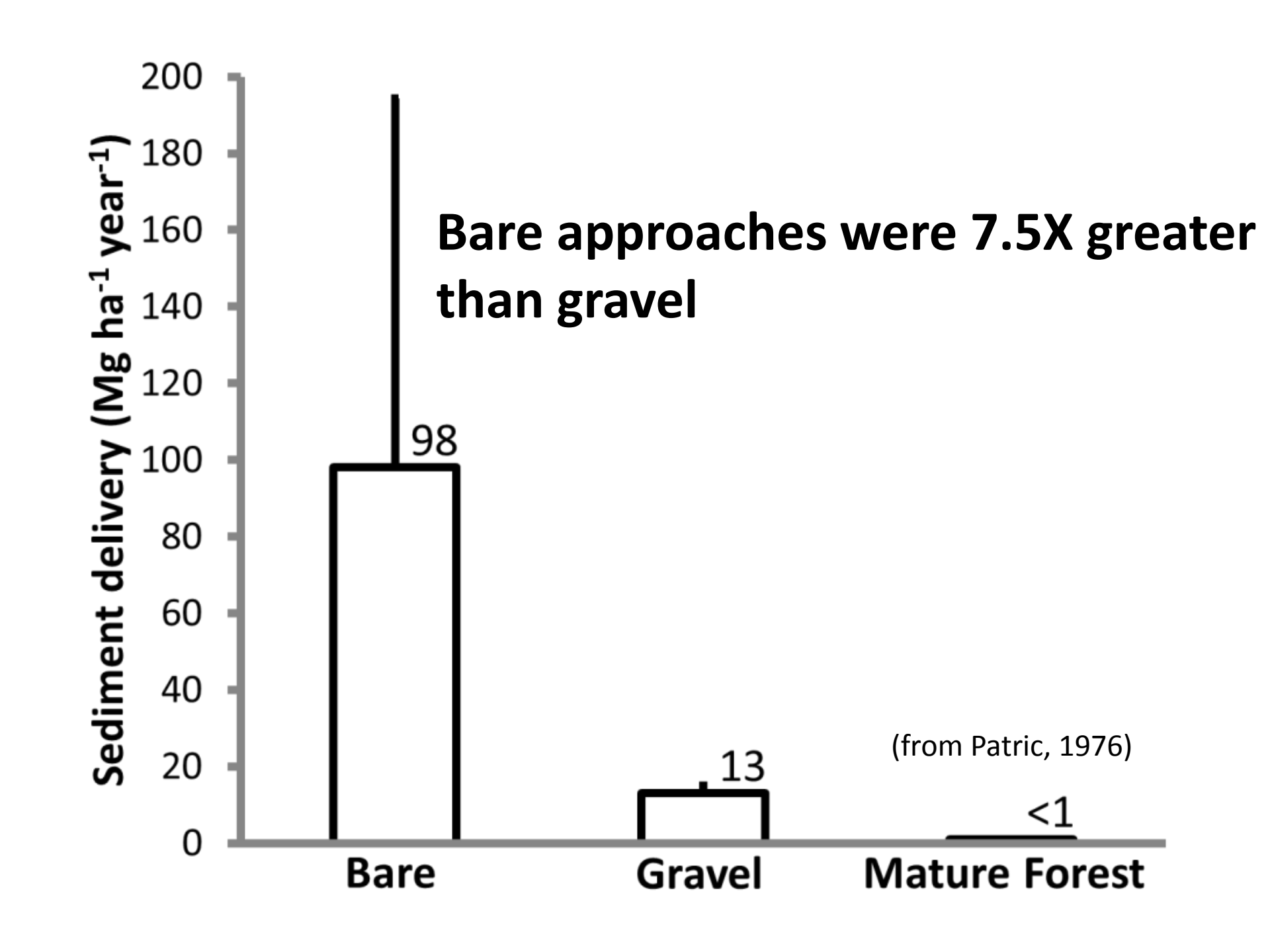
Site Bare 3 after a thunderstorm on 22-Jun-2012.



Plan view of two idealized stream crossing approaches.

Repeated measurements of sediment delivery

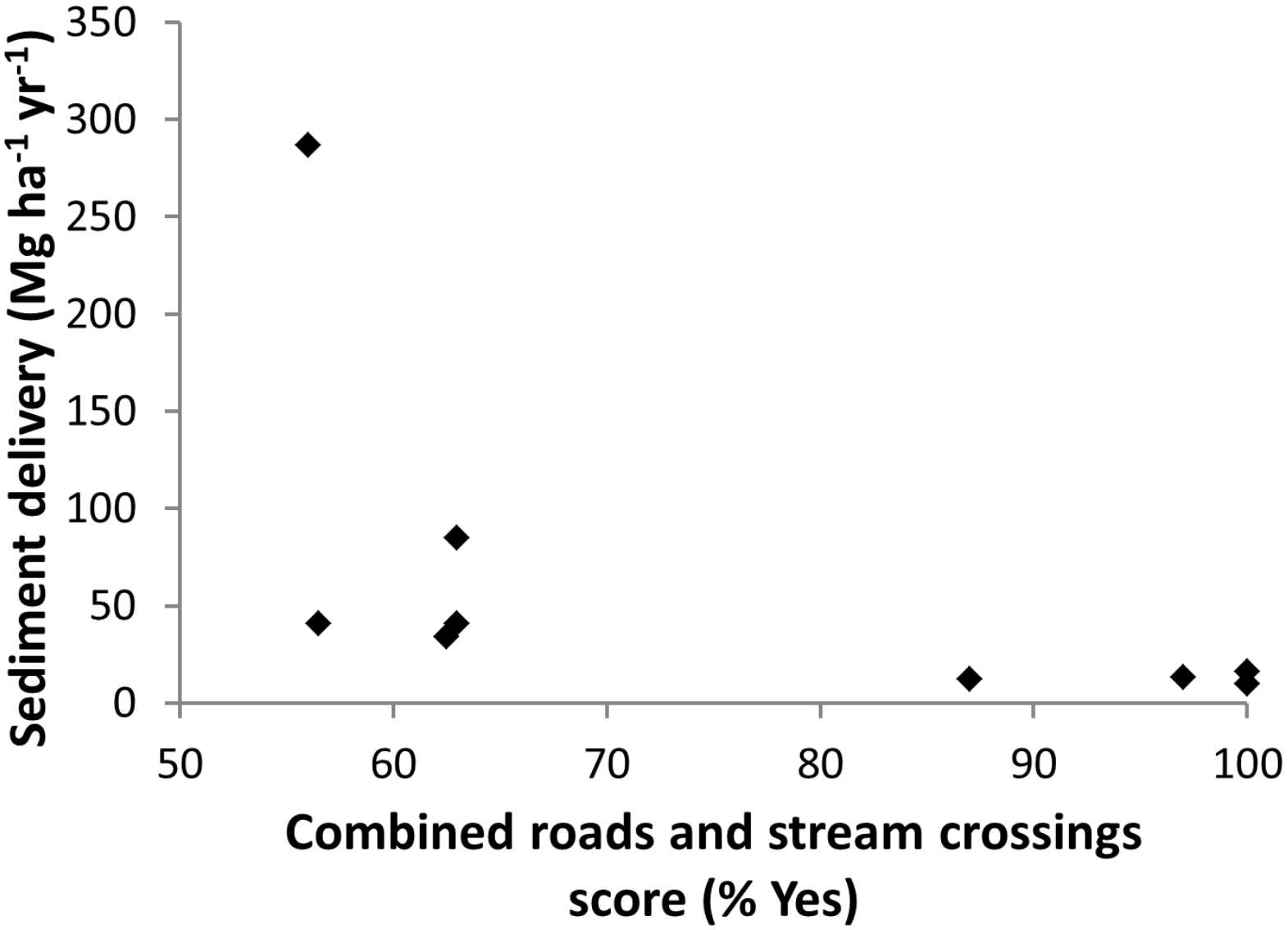



Sediment delivery (Mg ha-1 year-1)
200
180
160
140
120
100
80
60
40
20
0
98
13
<1
Bare
Gravel
Mature Forest
Bare approaches were 7.5X greater than gravel
(from Patric, 1976)

Problem road segments

- Surface runoff traveled 75 and 130 m between the nearest water control structure and the silt fence
- 90 to 100% bare soil conditions throughout the year

BMP audit score vs. annual sediment delivery

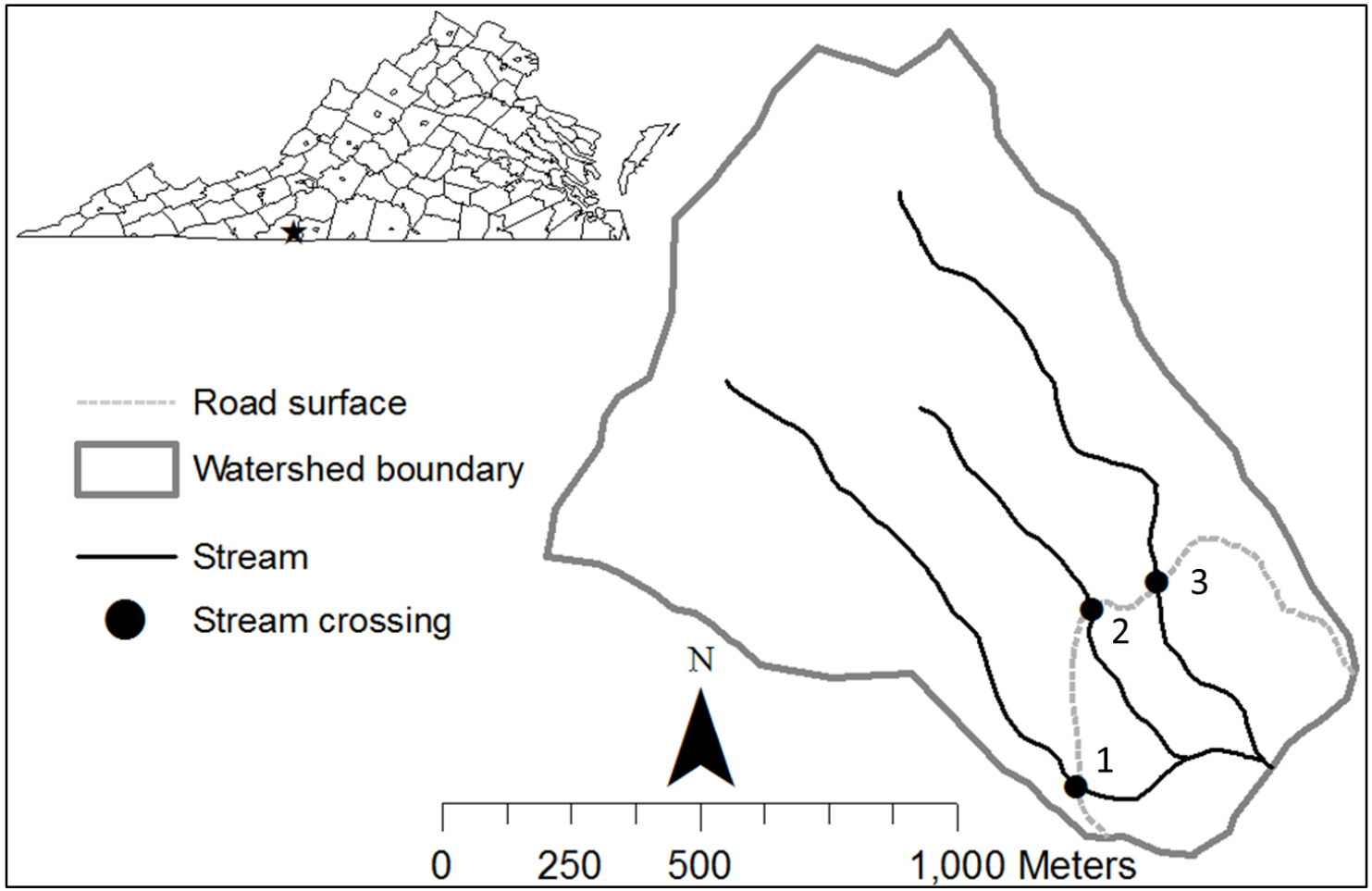


Field study 1 conclusions

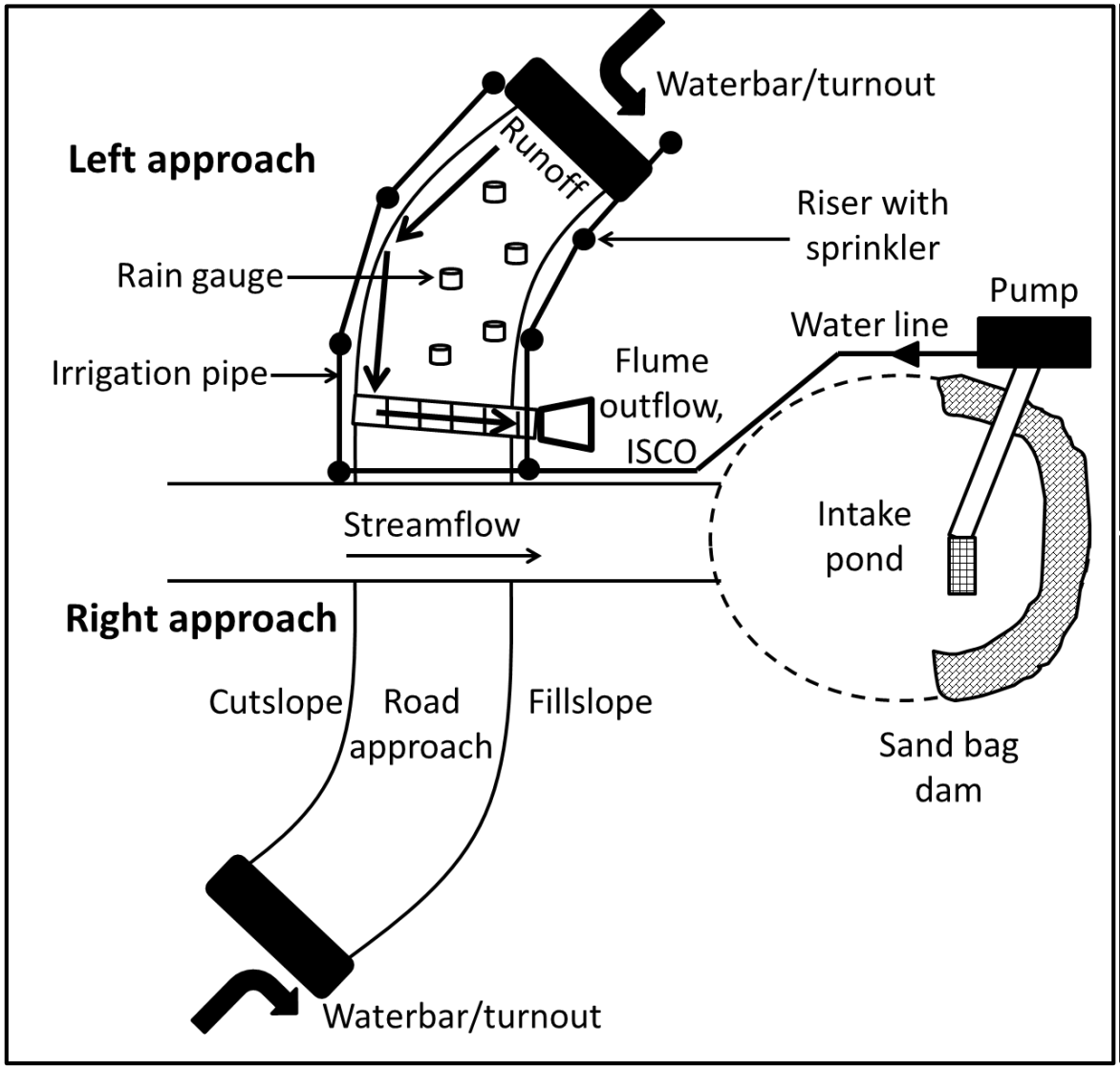
- Legacy roads may require additional measures to protect water quality upon reopening

- Findings support contemporary BMP recommendations to:
  - gravel the entire stream-crossing approach
  - place a water control structure at least 7.6 m before the stream crossing

Field study 2



Rainfall simulation



- **Objective:** Quantify event-based surface runoff and sediment yield for reopened approaches with diverse intensities of BMP implementations

No gravel

10-19% cover

Low gravel

34-60% cover

High gravel

50-99% cover

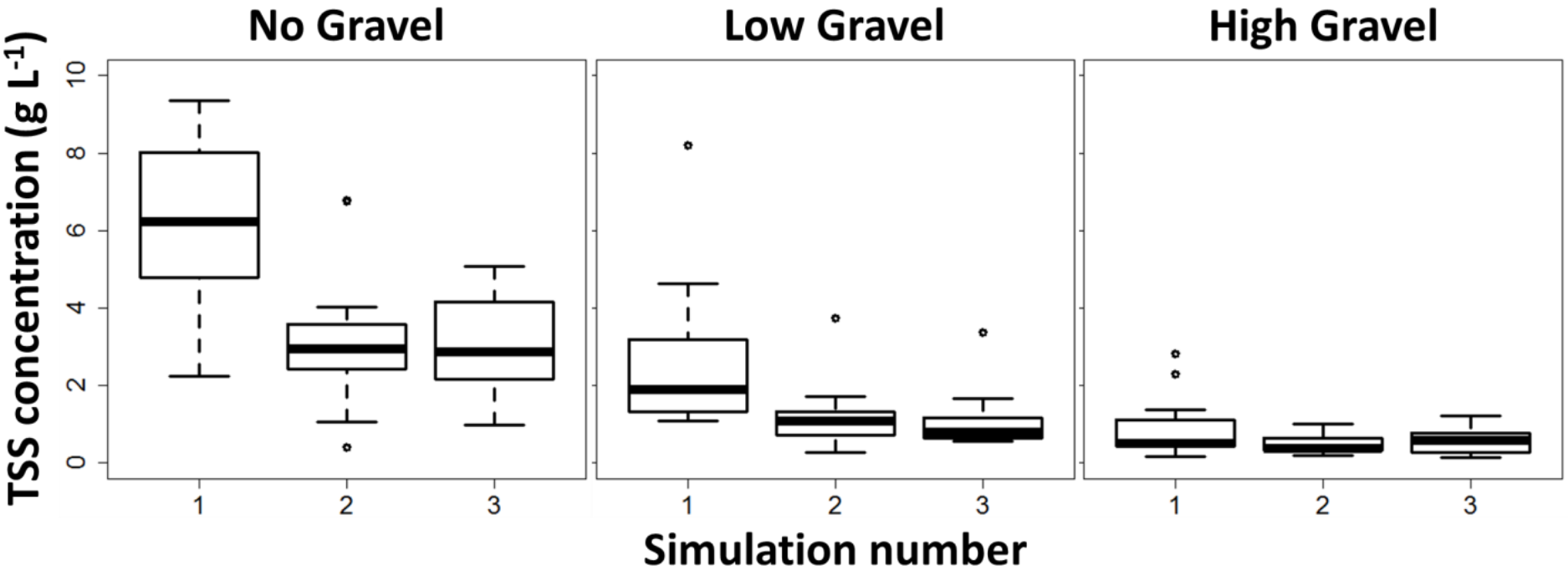
Gravel cost

Gravel cost ($) = Mass (tonnes) X $27.56/tonne

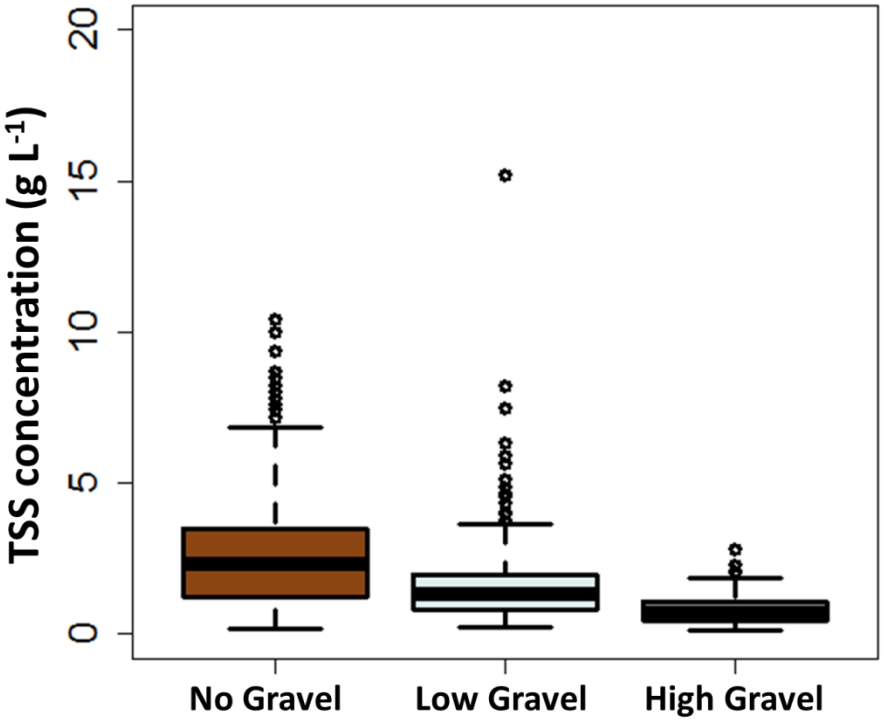
Mean cost for Low Gravel = $91.77; High Gravel = $183.54

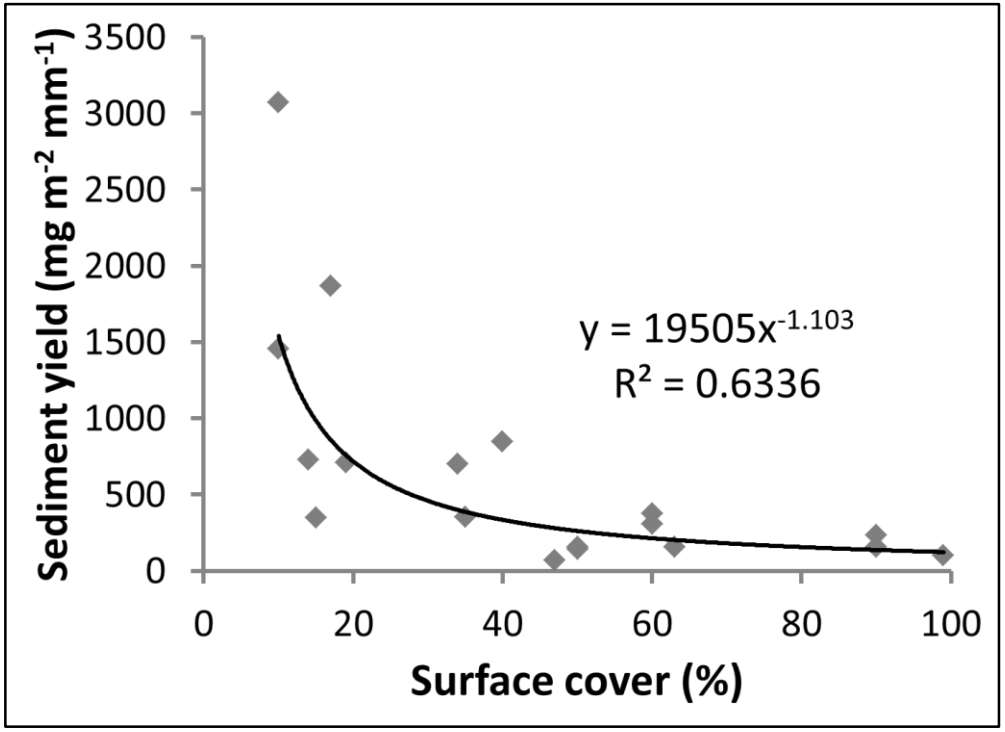
Sediment yield was reduced by:

- Successive rainfall events
- Increasing surface cover



Sediment-reduction efficacy of gravel





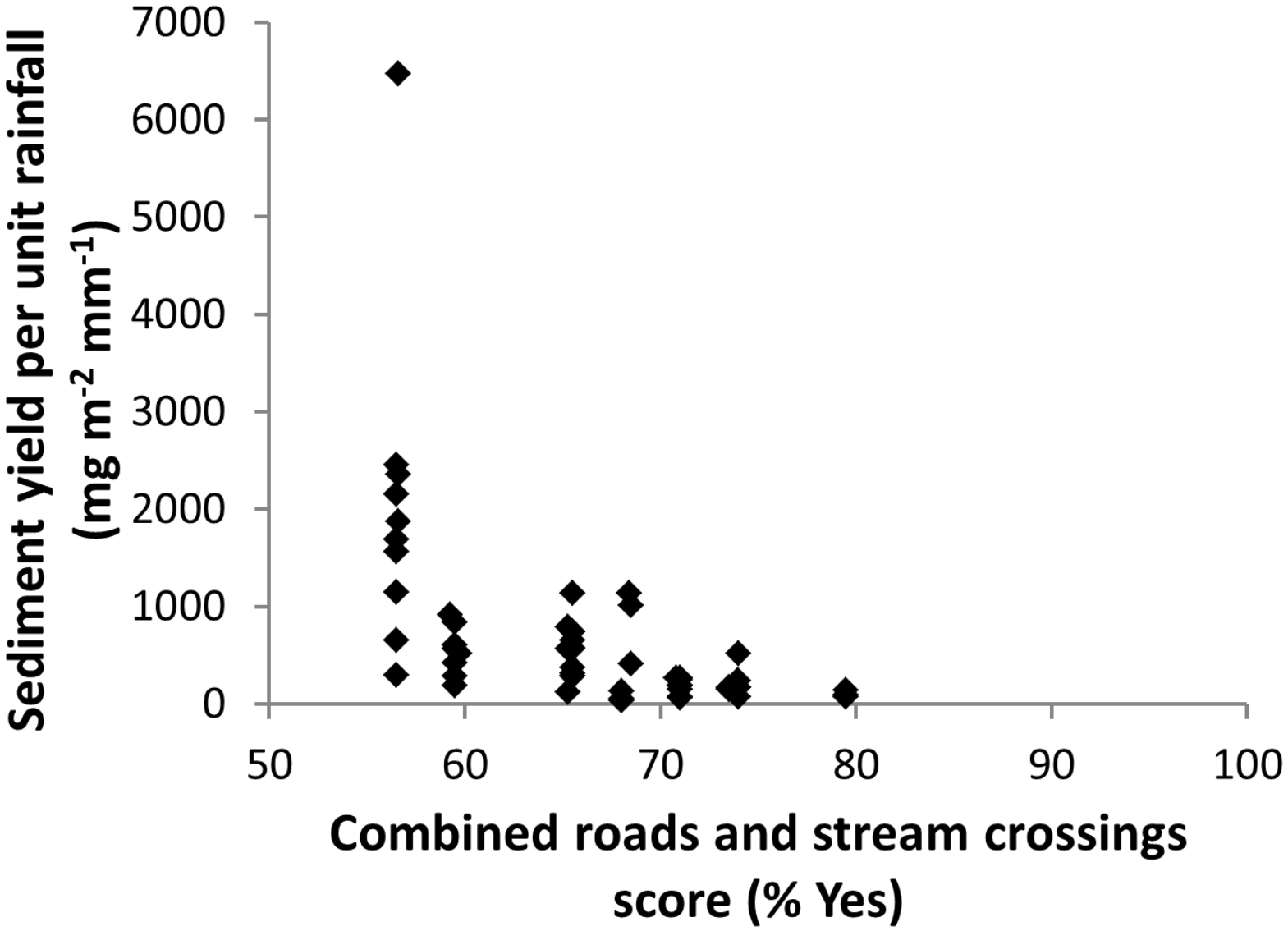
Median TSS concentration for the No Gravel treatment was 2.6 and 3.5X greater than that of the Low Gravel and High Gravel treatments, respectively

BMP effectiveness is site-specific.

However, sediment yield decreased with successive gravel treatments in 4 of 6 sites.

Site	Sediment yield ($mg\ m^{-2}\ mm^{-1}$)			Gravel cost ($)		Sediment yield difference from No Gravel (%)	
	No Gravel	Low Gravel	High Gravel	Low Gravel	High Gravel	Low Gravel	High Gravel
1	1458	351	233	100.96	201.92	-76	-84
2	350	850	158	81.42	162.84	143	-55
3	1867	374	158	104.22	208.44	-80	-92
4	3072	699	144	81.42	162.84	-77	-95
5	728	71	156	94.45	188.90	-90	-79
6	709	309	100	84.68	169.36	-56	-86

BMP audit score vs. event-based soil erodibility



Rainfall simulation study conclusions

- Reopened approaches represent significant sources of sediment delivery to streams

- Judicious and low-cost BMPs can be used to protect water quality

Overall conclusions

- Road planning is important!

- Gravel surfacing and adequate water control structures can improve problem roads


Questions?