Low Impact Roads

Reducing Road Related Sediment Inputs into our Stream Systems

NAPA COUNTY
RCD
Resource Conservation District

Roads influence the hydrology of a watershed

- Poorly constructed roads concentrate runoff, increase erosion, and sediment delivery to streams

- Significant source of sediment – studies demonstrate that up to half of all anthropogenic sediment entering streams comes from roads

Poorly designed roads have greater potential for failures during storm events

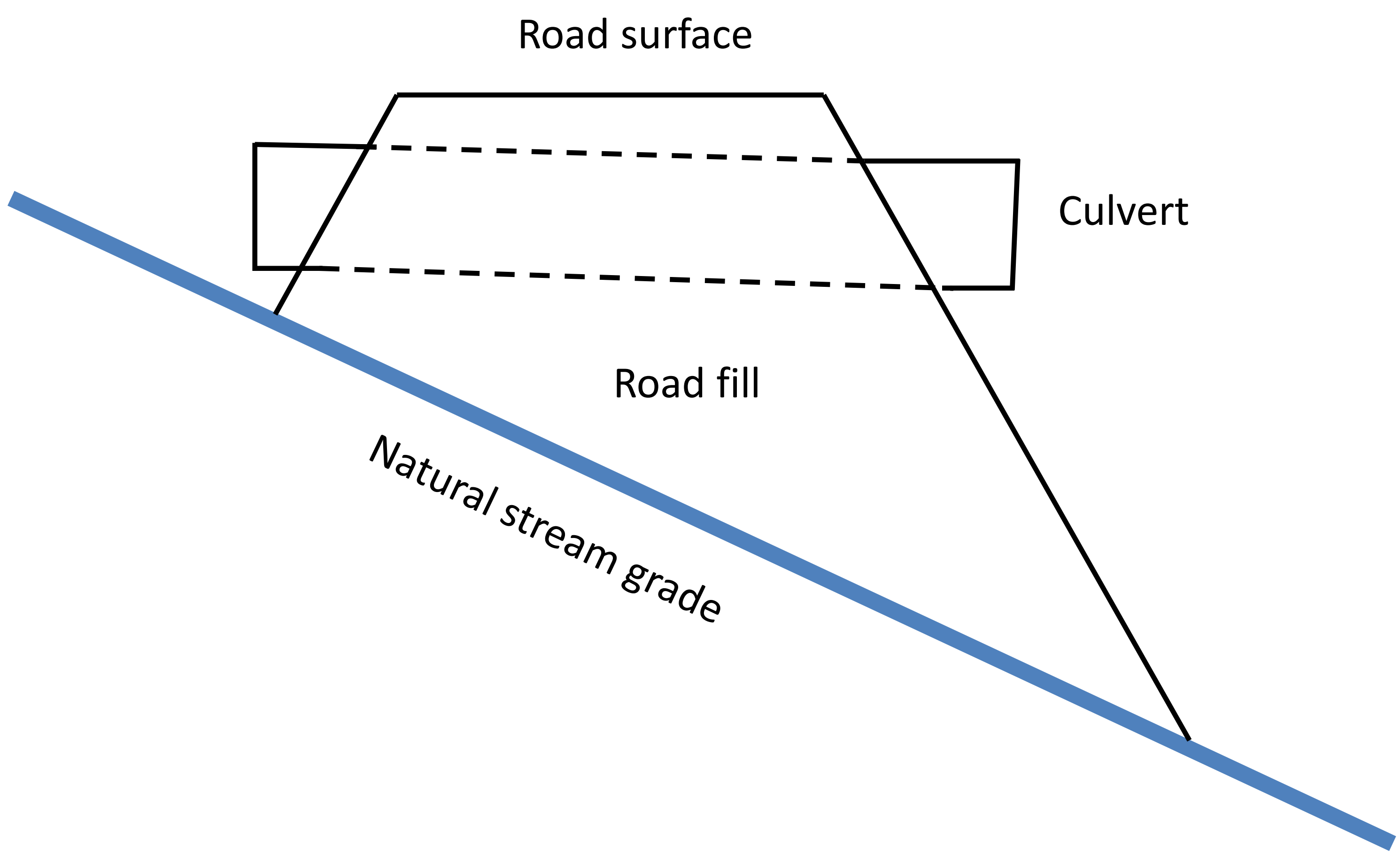
- Restricts access
- Increases maintenance costs

Sediment delivery from road-related erosion can be episodic or chronic

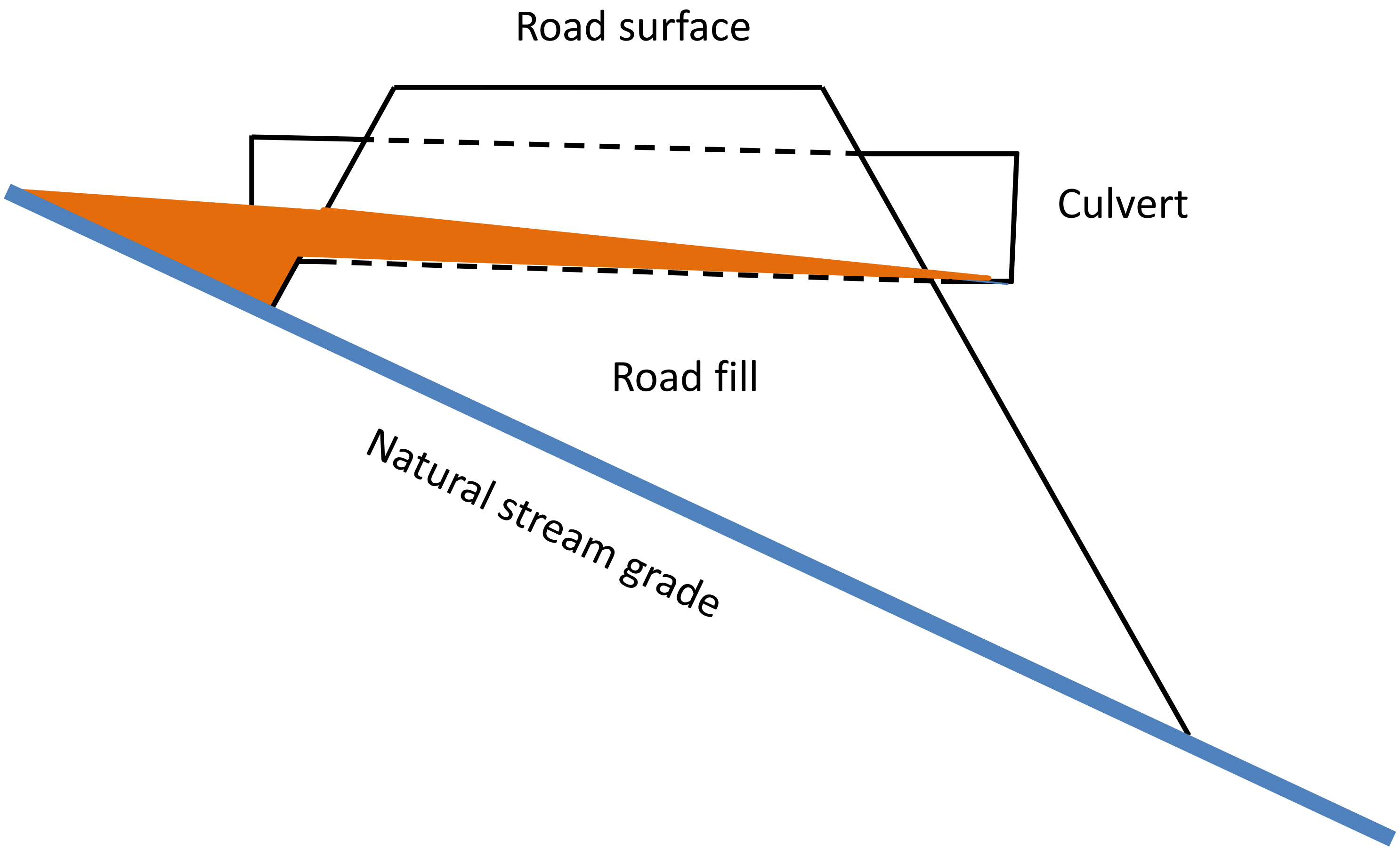
- EPISODIC sediment delivery
  - Sediment delivery is ***episodic*** when it occurs as soils fail in response to storm events or other triggers. The delivery from a site may occur once, or in pulses over an indeterminate time period. Stream crossing washouts, road-related landslides, and gullying can produce episodic sediment delivery.

- CHRONIC sediment delivery
  - Sediment delivery from road surfaces and cutbanks is ***chronic*** because it occurs continuously during rainfall events that produce surface runoff.

Increased failure potential resulting from poorly designed stream crossing

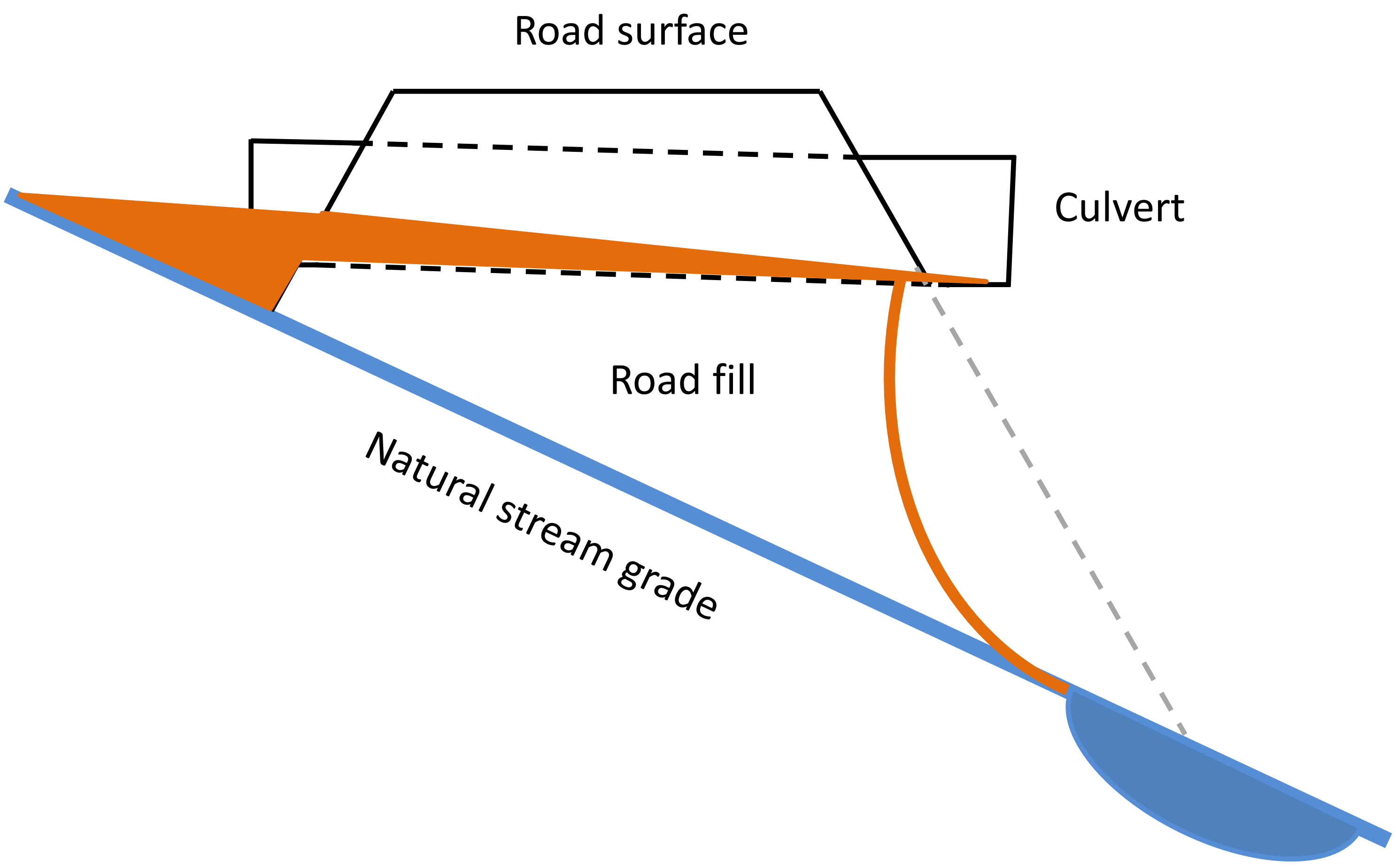


Culvert inlet set high in fill and shallow relative to channel grade increases plug potential



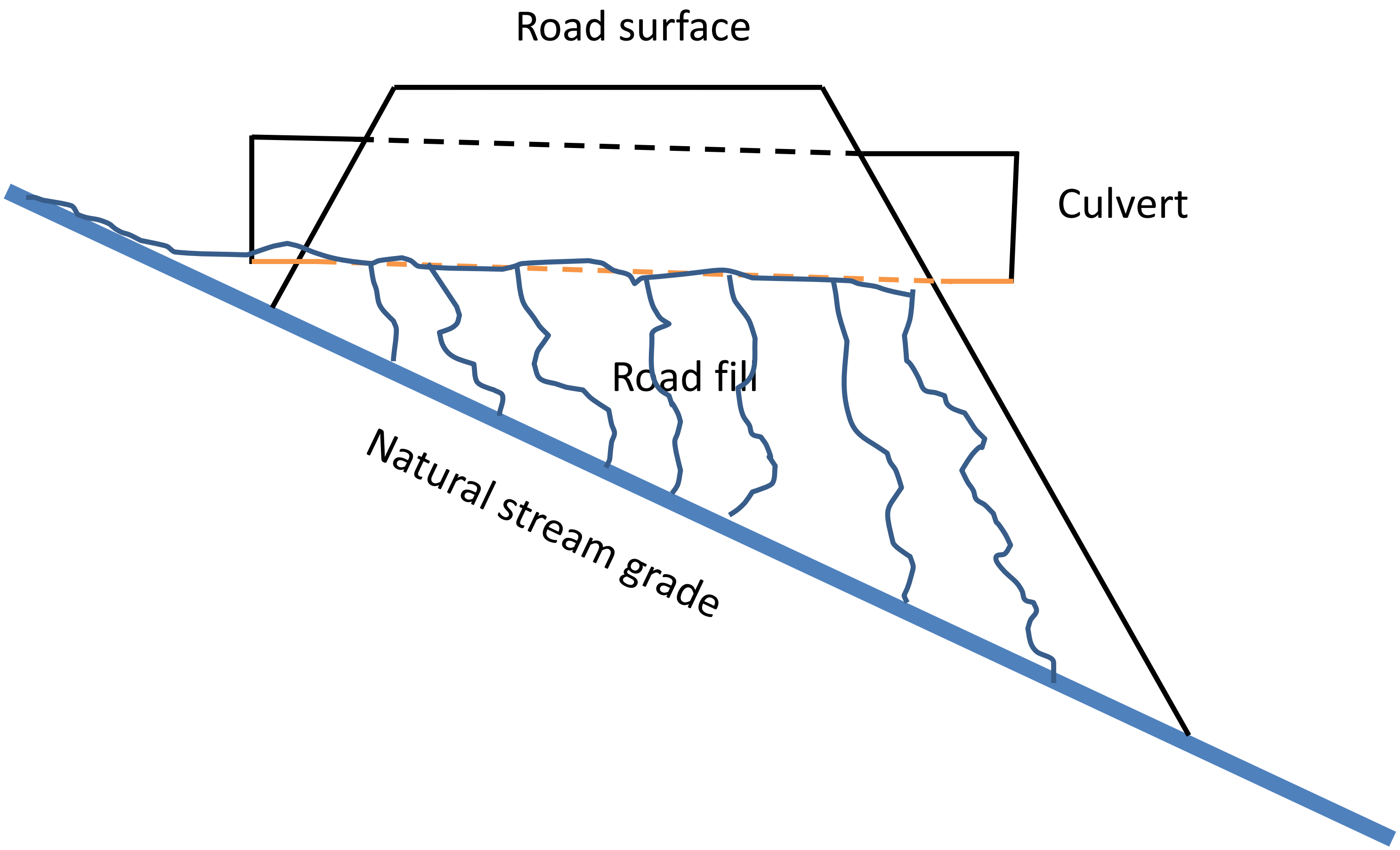
Aggraded sediments above inlets can cause crossings to wash out

Shotgunned culvert outlets cause scour of the fillslope and channel bottom



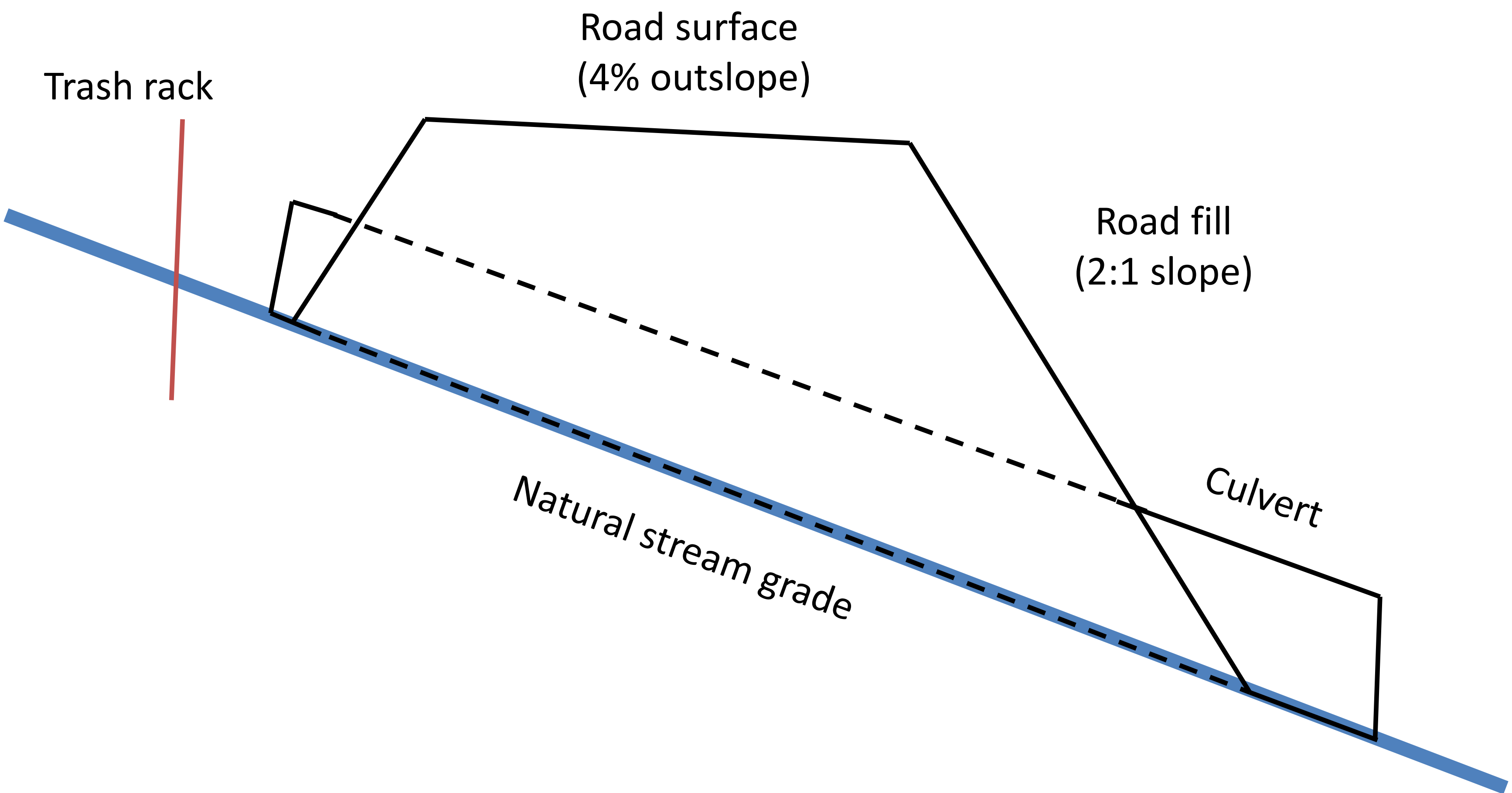
Channel scours below outlet

As culvert bottoms rust out, culverts set high in fill can cause crossing fail via subsurface piping.



Stream crossing fails and produces episodic sediment delivery

Low impact design for a culverted stream crossing on a non fish-bearing stream

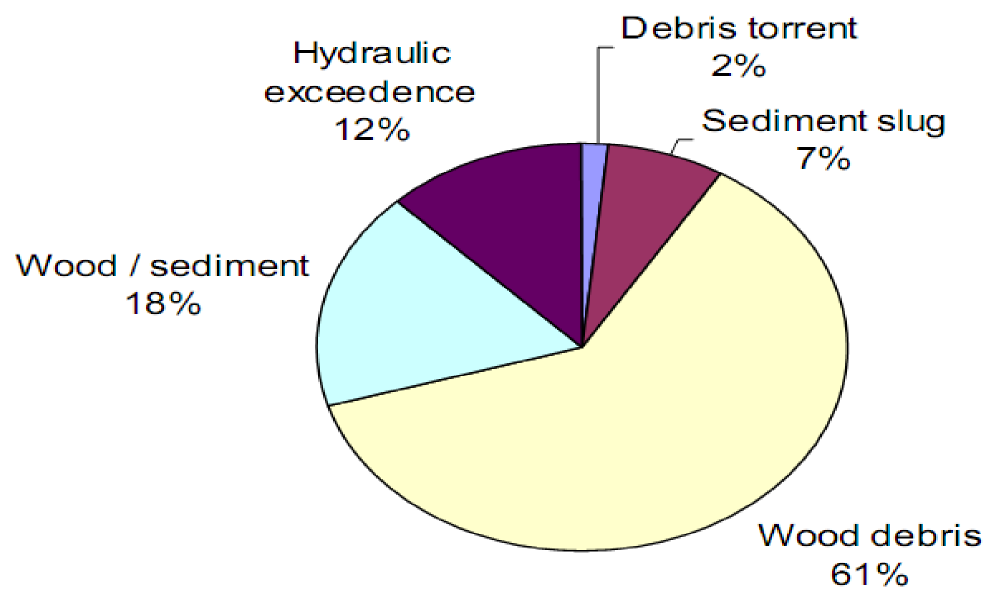



20 12 2002

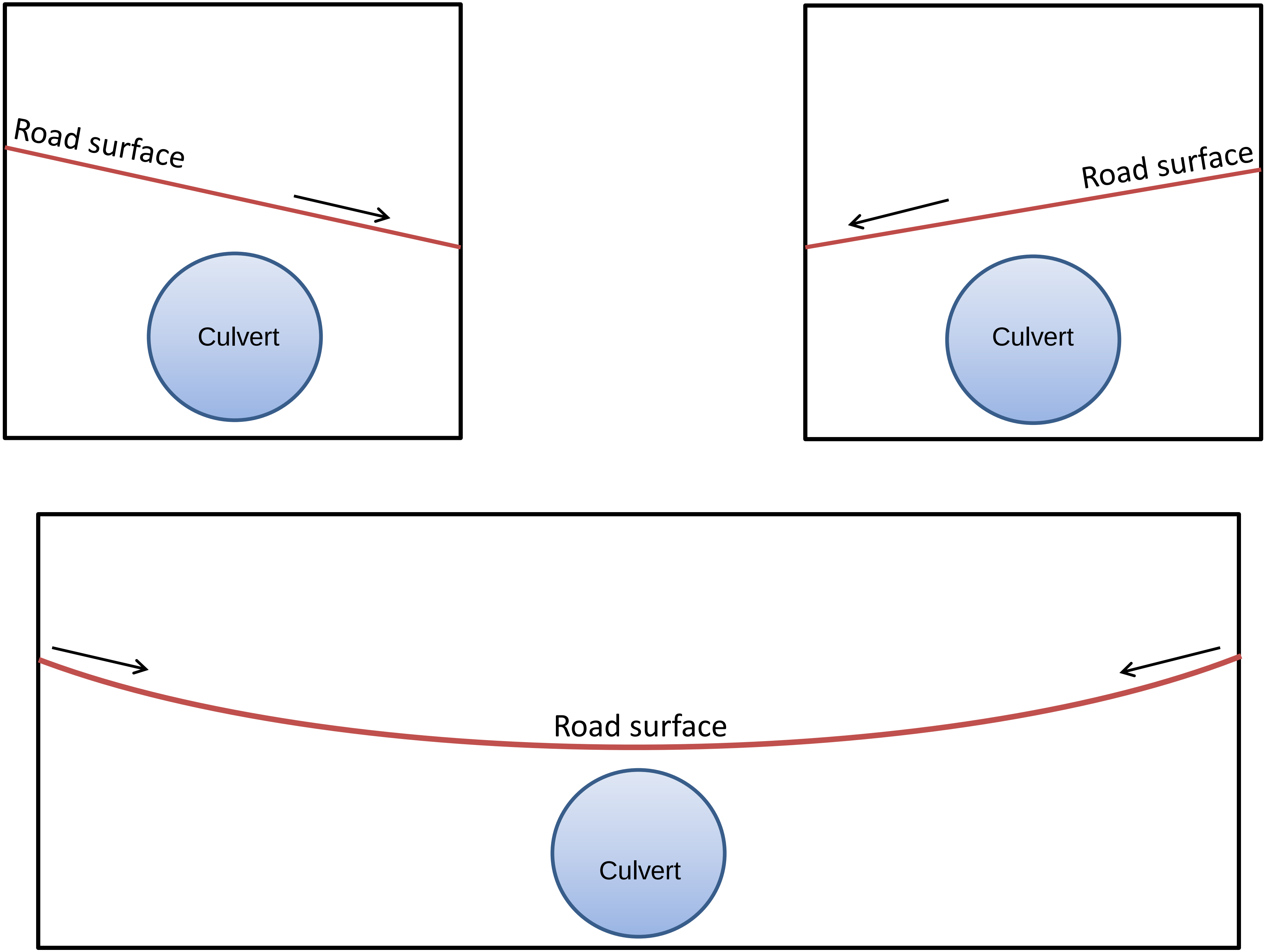
Culvert failure mechanisms

Furniss et al. 1998

Failure Mechanisms for NW California (<12 year event)



Fail-safe features reduce plugging potential of culverts and minimize sediment delivery if crossing floods


Road surface
Culvert
Road surface
Culvert
Road surface
Culvert

Example of a diverted stream crossing

Emergency overflow Culverts installed where critical dips cannot be constructed.

Road erosion treatments - upgrading

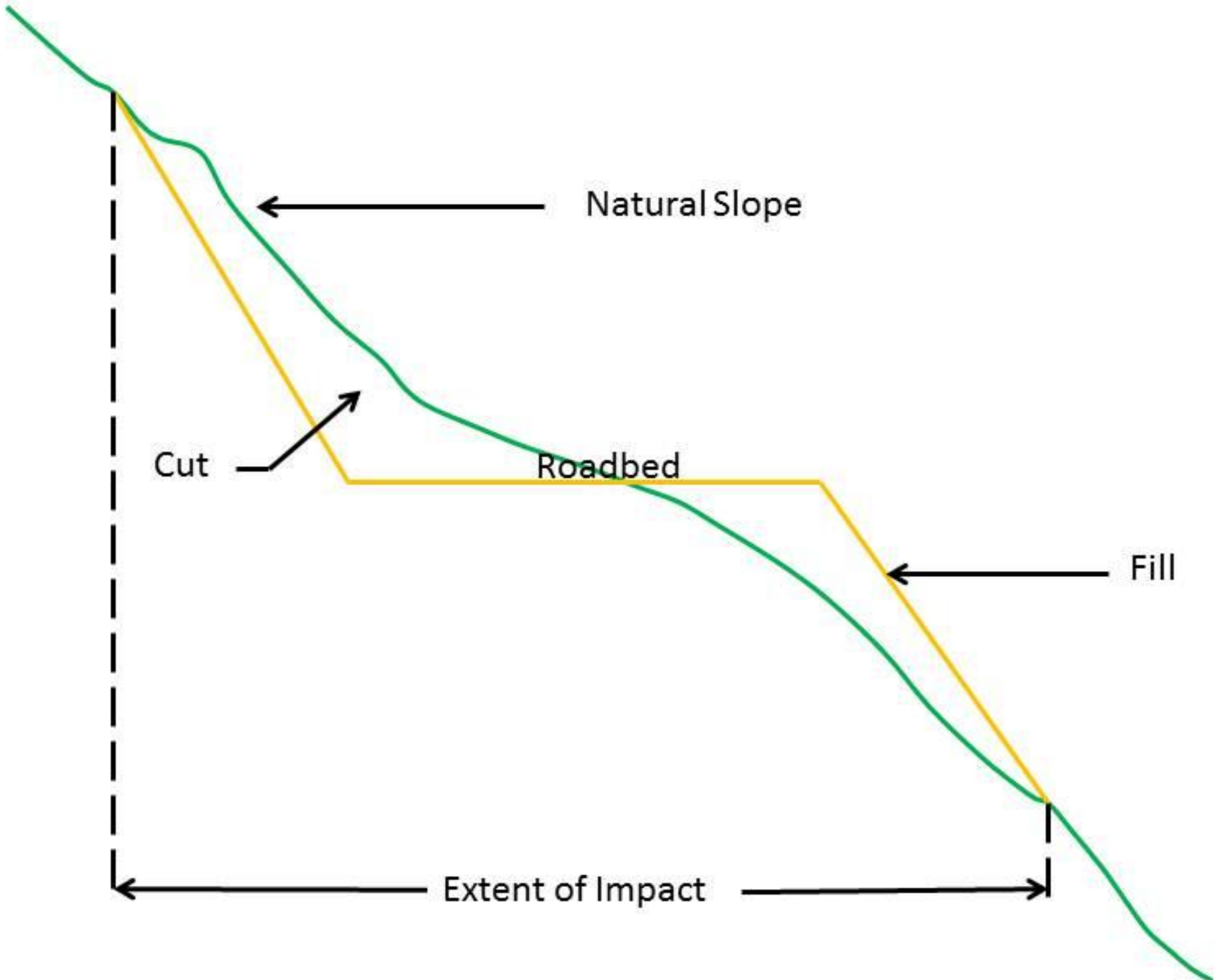
Sediment delivery from road-related erosion can be episodic or chronic

- EPISODIC sediment delivery

– Sediment delivery is ***episodic*** when it occurs as soils fail in response to storm events or other triggers. The delivery from a site may occur once, or in pulses over an indeterminate time period. Stream crossing washouts, road-related landslides, and gullying can produce episodic sediment delivery.

- CHRONIC sediment delivery

– Sediment delivery from road surfaces and cutbanks is ***chronic*** because it occurs continuously during rainfall events that produce surface runoff.


Natural Slope
Cut
Roadbed
Fill
Extent of Impact

Examples of connectivity Results reported in the Napa Valley				
Watershed	**Road Length assessed (mi)**	**Connected road length (mi)**	**% of total road length that is connected**	**Reference**
Sulphur Creek	23.7	10.75	45%	NCRCD, PWA (2003)
Dry Creek	18	12.11	65%	NCRCD, PWA (2004)
Carneros Creek	23.5	11.4	49%	NCRCD, PWA (2003)

Fine sediments are generated as vehicles mechanically break down the road surface

This is what happens to that powdery dust when it rains

Chronic Sediment delivery over the next 2 decades (assuming all sites erode)					
Watershed	**Total road Miles Assessed**	**Total Sediment Delivery (yd^3)**	**Total chronic sediment volume (yd^3)**	**% of total Sediment volume that is from chronic**	**Reference**
Sulphur Creek	23.7	22,501	16,218	72%	NCRCD, PWA (2003)
Dry Creek	22	20,910	8,635	41%	NCRCD, PWA (2004)
Carneros Creek	23.5	16,950	11,030	65%	NCRCD, PWA (2003)

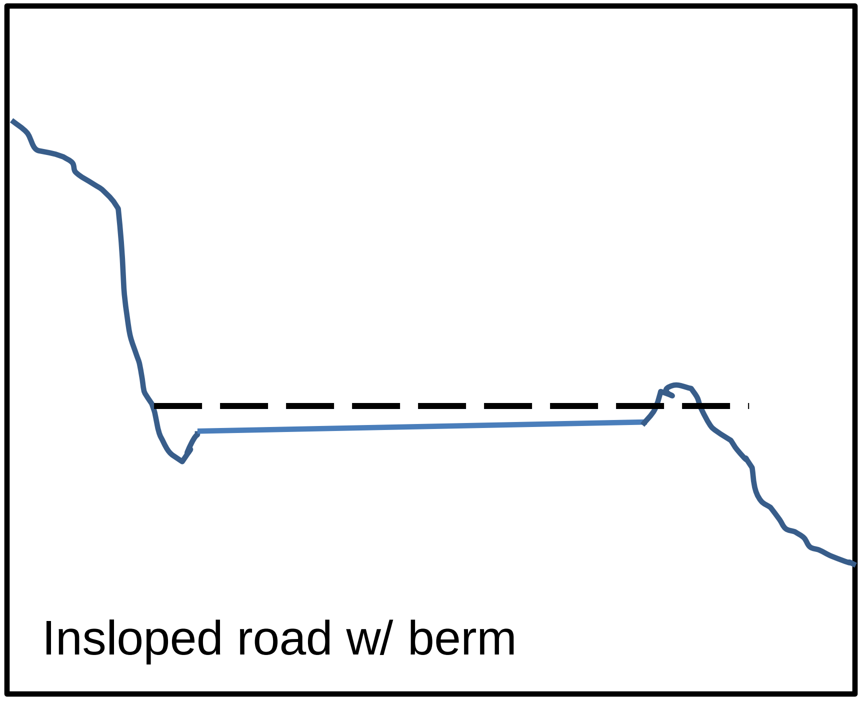
Physical features show surface lowering over time

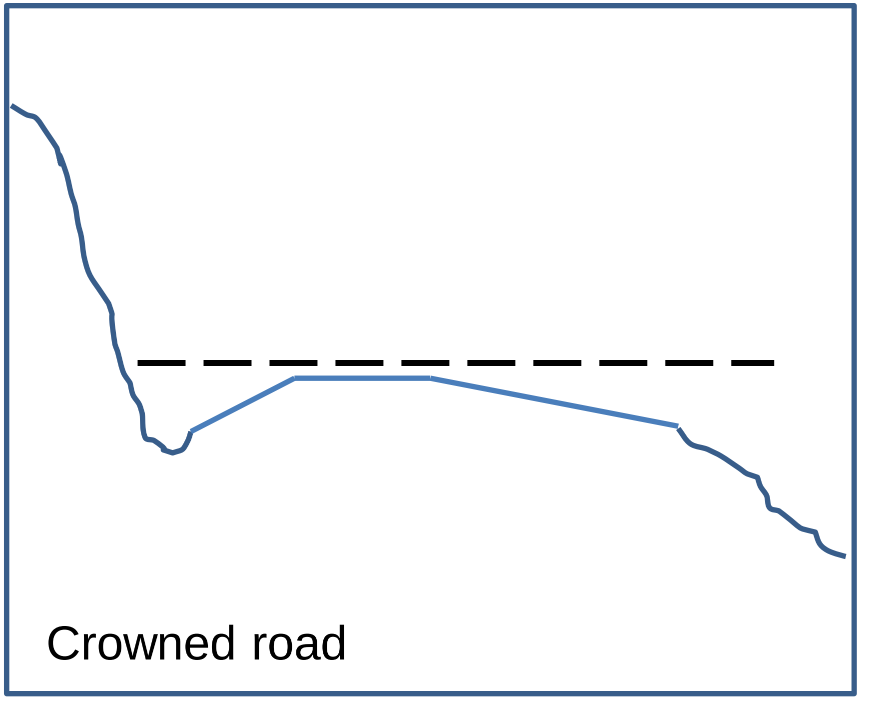
Road shape

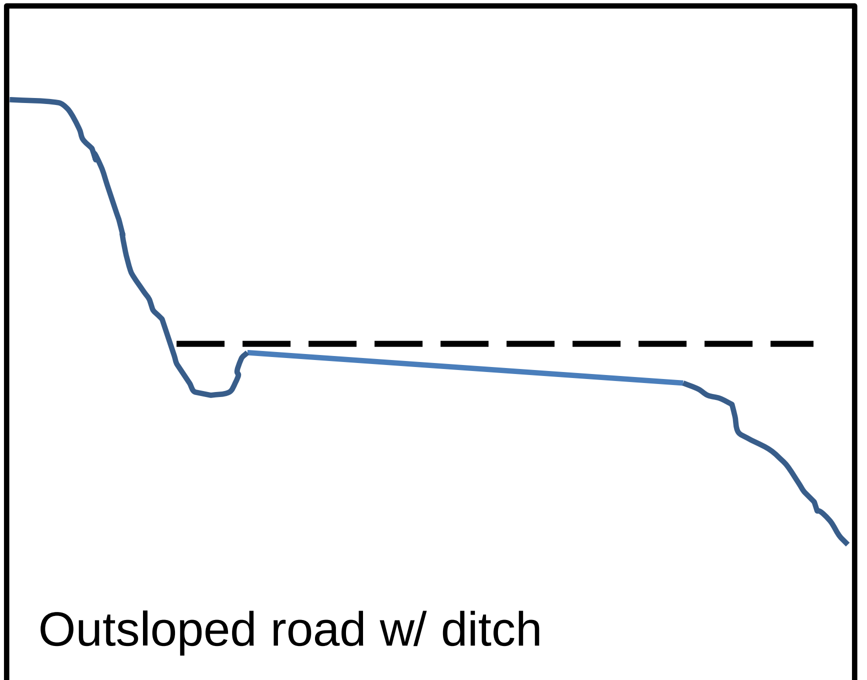
Insloped
with ditch –
100% connectivity

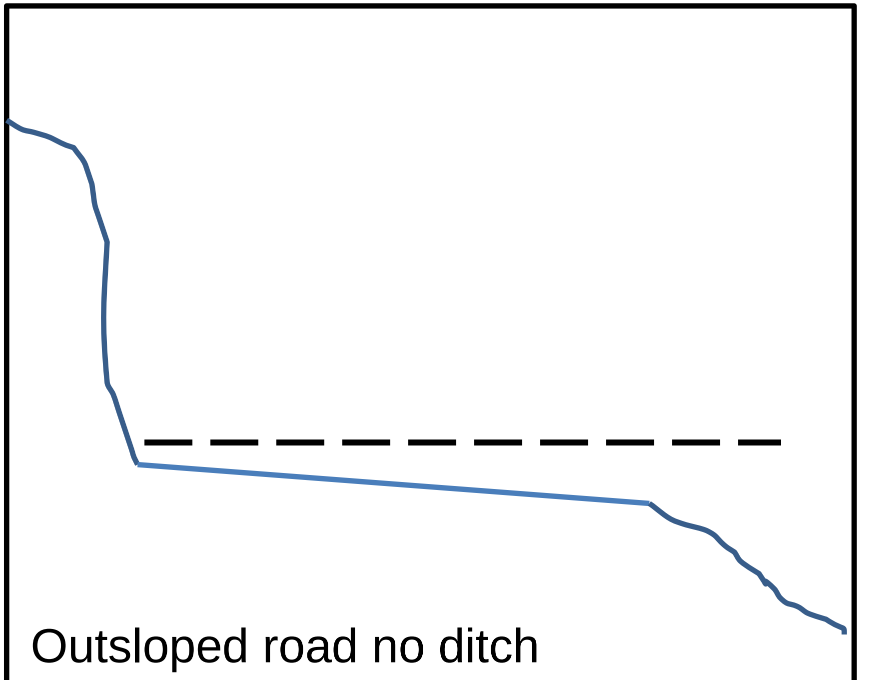
Outsloped, no ditch, with
rolling dips –
No connectivity

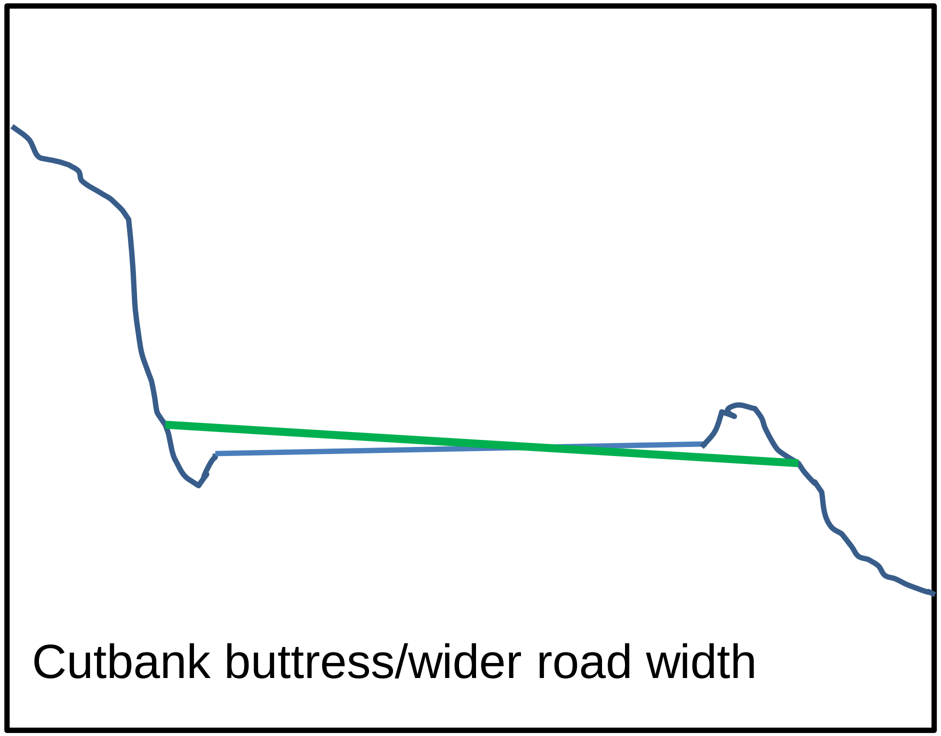

Rolling dips spacing
23 02 2003

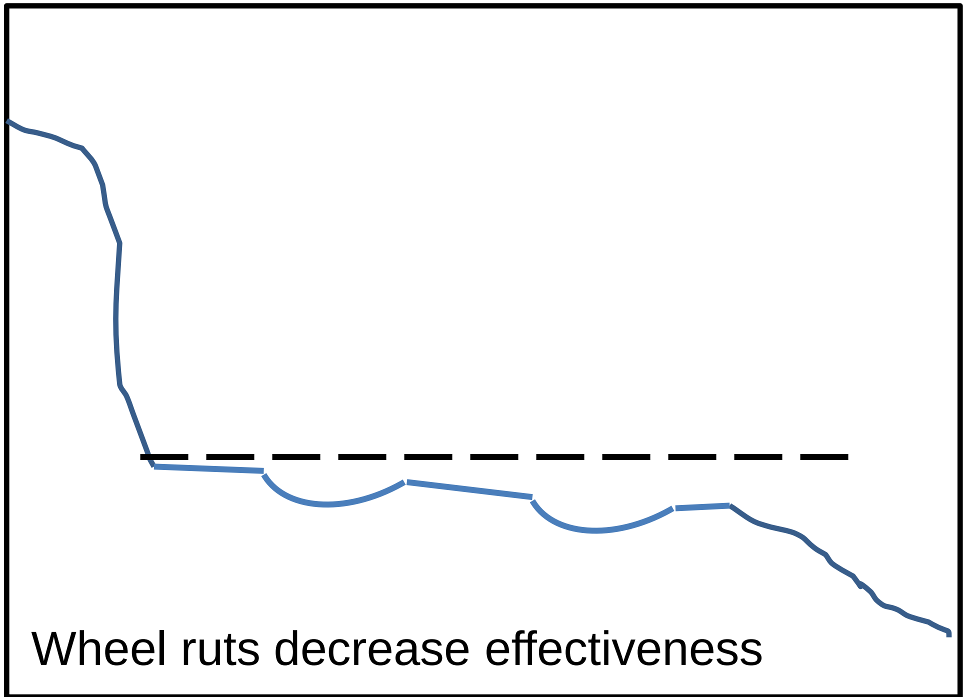

Insloped road w/ berm


Crowned road

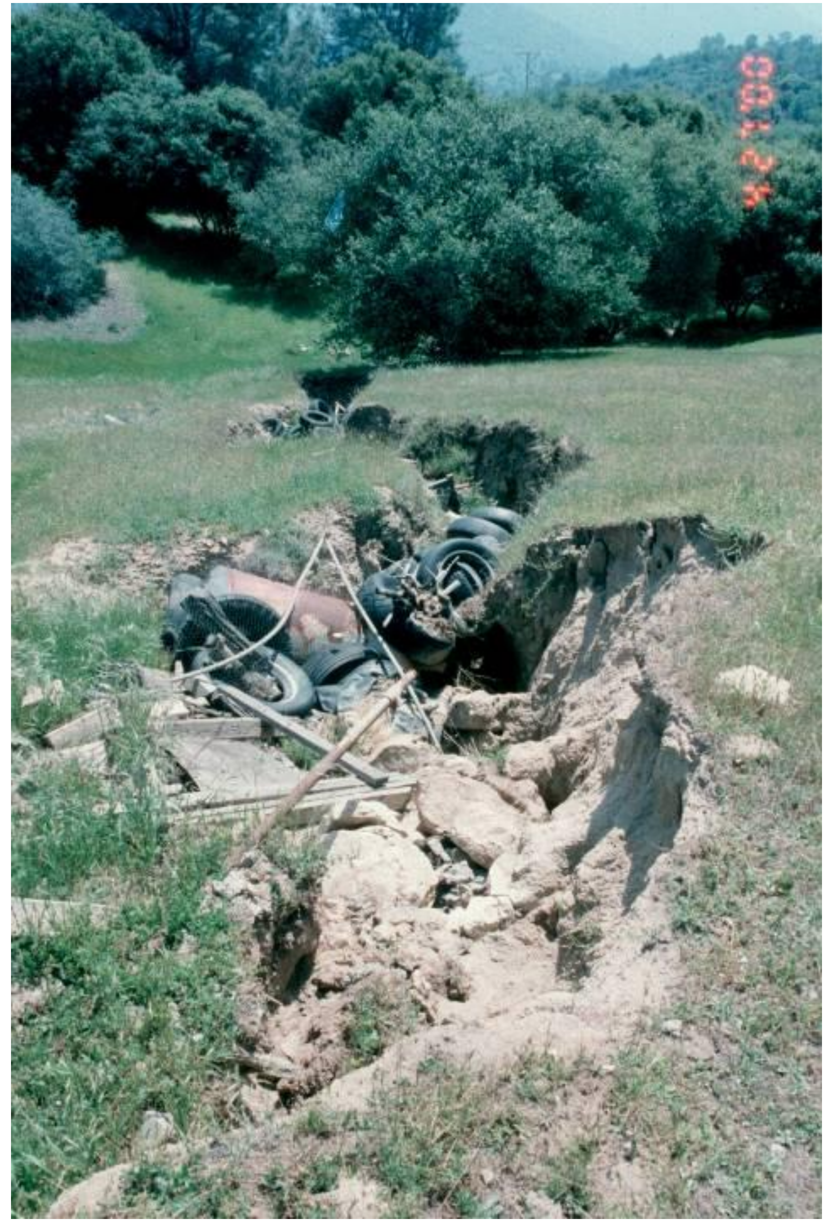

Outsloped road w/ ditch


Outsloped road no ditch

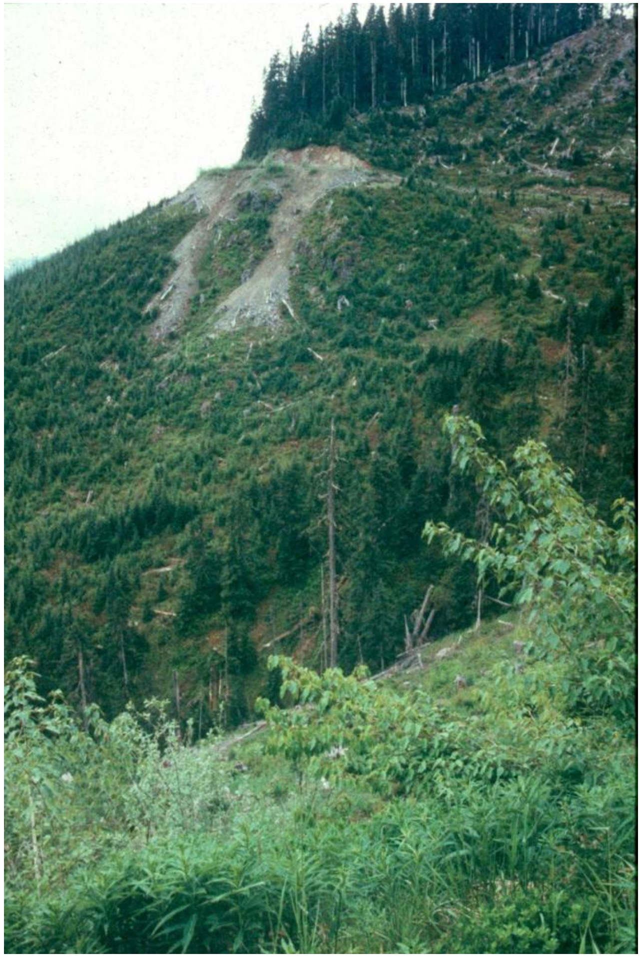

Cutbank buttress/wider road width

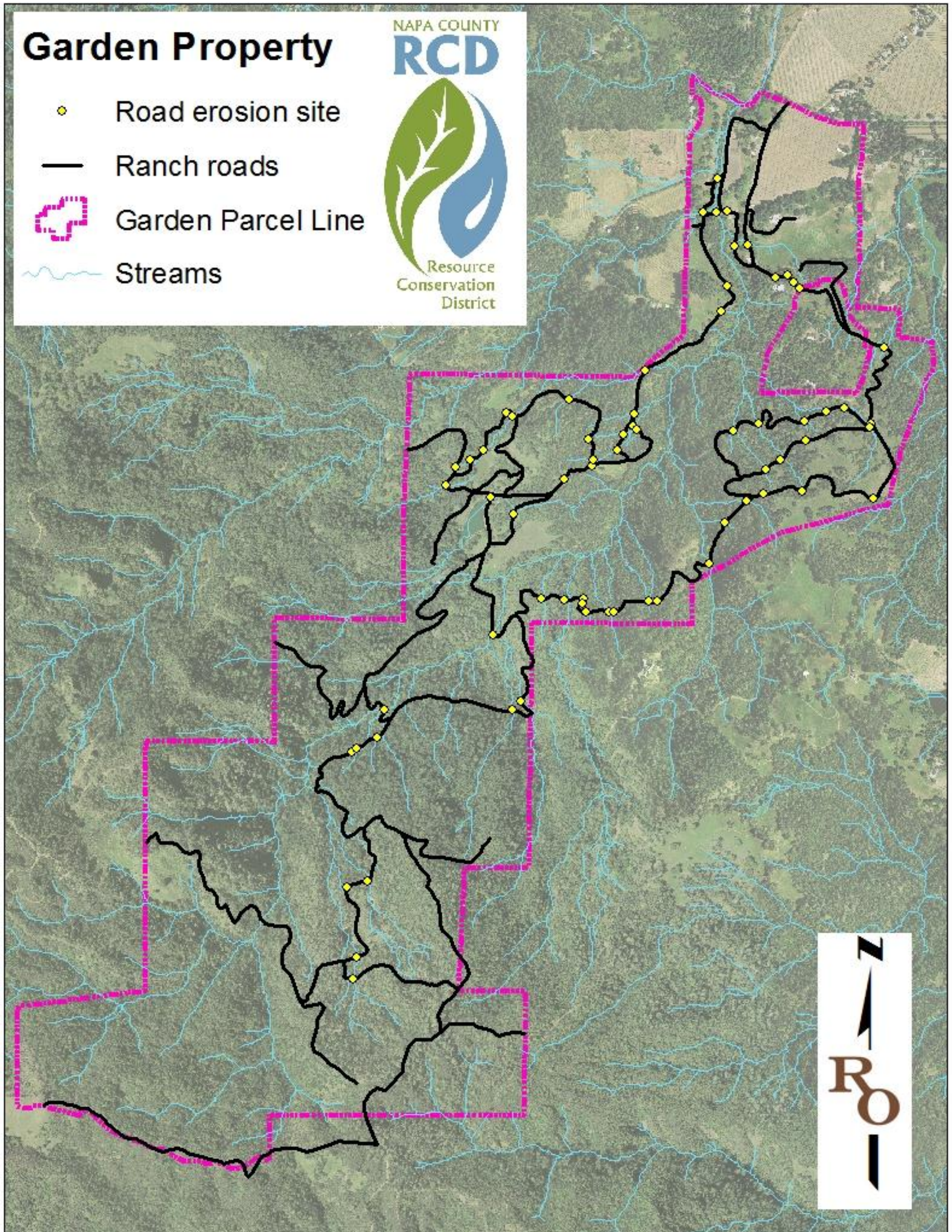

Wheel ruts decrease effectiveness

Treating the symptom will not cure the problem



Example of a non-delivery site





Garden Property Statistics:

Total road miles = 13.3
Total connected road length = 4.7 (35%)

Number of sites found = 68
Number of sites treated = 13 (H-HM only)

Sediment Savings (yd^3):
Total episodic = 1,440
Total chronic = 4,605 (76%)
Total = 6,045

$$ Construction Costs $$
Equipment (prevailing wage) = $171,500
Materials = $24,500
Totaling = $196,000*

$39,200/mile
$33/yd^3 sediment savings

* Costs not included are RCD and private consulting firm hours for reporting, project management, and permitting.

Developing a low impact road system based upon treatment priorities, transportation needs, and physical constraints

Transportation needs

- Road upgrade; year round vs. seasonal, vehicle usage, road user
- Legacy road network
- Road decommissioning; a very cost effective way to reduce road maintenance on unneeded roads
- Road to trail conversion; quad use, horse use, hiking trail use.

Developing a low impact road system based upon treatment priorities, transportation needs, and physical constraints

Transportation needs

- Road upgrade; year round vs. seasonal, vehicle usage, road user
- Legacy road network
- Road decommissioning; a very cost effective way to reduce road maintenance on unneeded roads
- Road to trail conversion; quad use, horse use, hiking trail use.

Physical constraints

- Adjacent landowners
- Unstable hill slopes
- Public safety issues
- Existing infrastructure

Develop a low impact road system based upon transportation needs and physical constraints

Transportation needs

- Road upgrade; year round vs. seasonal, vehicle usage, road user
- Legacy road network
- Road decommissioning; a very cost effective way to reduce road maintenance on unneeded roads
- Road to trail conversion; quad use, horse use, hiking trail use.

Physical constraints

- Adjacent landowners
- Unstable hill slopes
- Public safety issues
- Existing infrastructure

Every site has individual needs and solutions. Therefore, a detailed assessment of the road system is the most accurate way to estimate implementation costs and most effectively reduce sediment delivery.

RCD and NRCS can assist with road improvement planning and projects

- Resources – maps, literature, videos, site visits
- Assessment of road systems & development of low impact road plans
- Support for implementation – grant $$ and oversight

So far, grant funding contributed to improvement of 10 miles of roads in Carneros and Sulphur Creek watersheds

Almost 18,535 yrd^3 prevented from entering Napa River

- Replaced culverts
- Installed rolling dips
- Outsloped and crowned road surfaces
- Added rock armor to buttress slopes
- Excavated stored sediment

Before

After