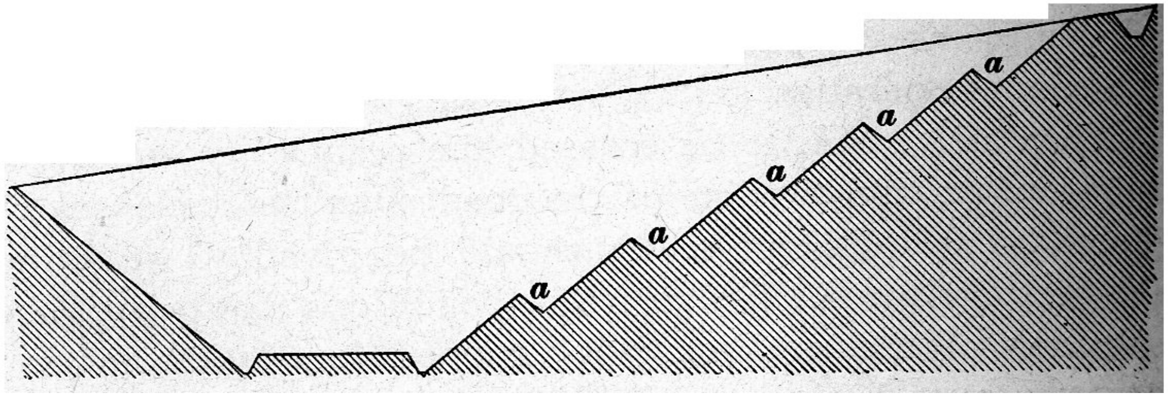
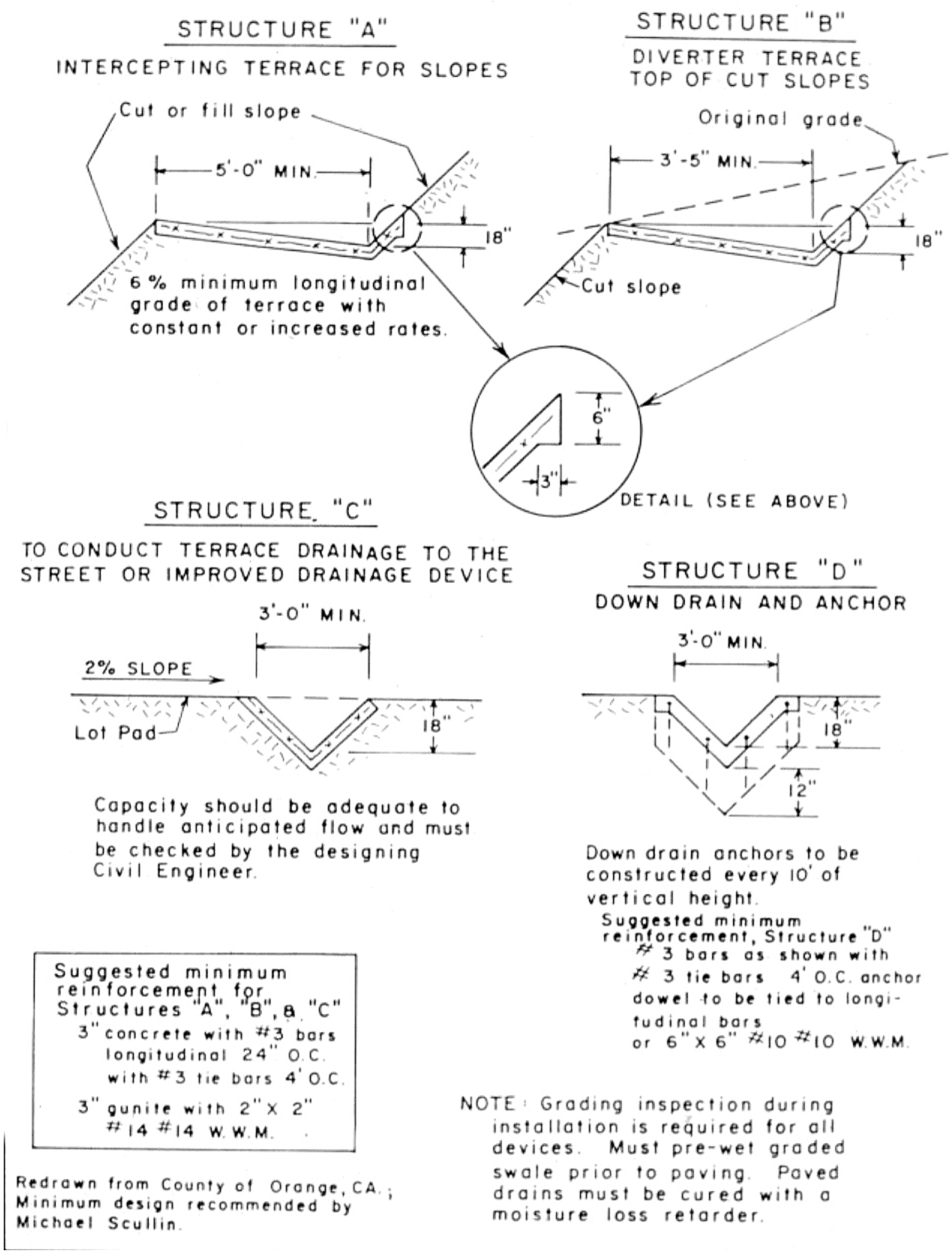
Part 2

DRAINAGE INTERCEPTOR DITCHES

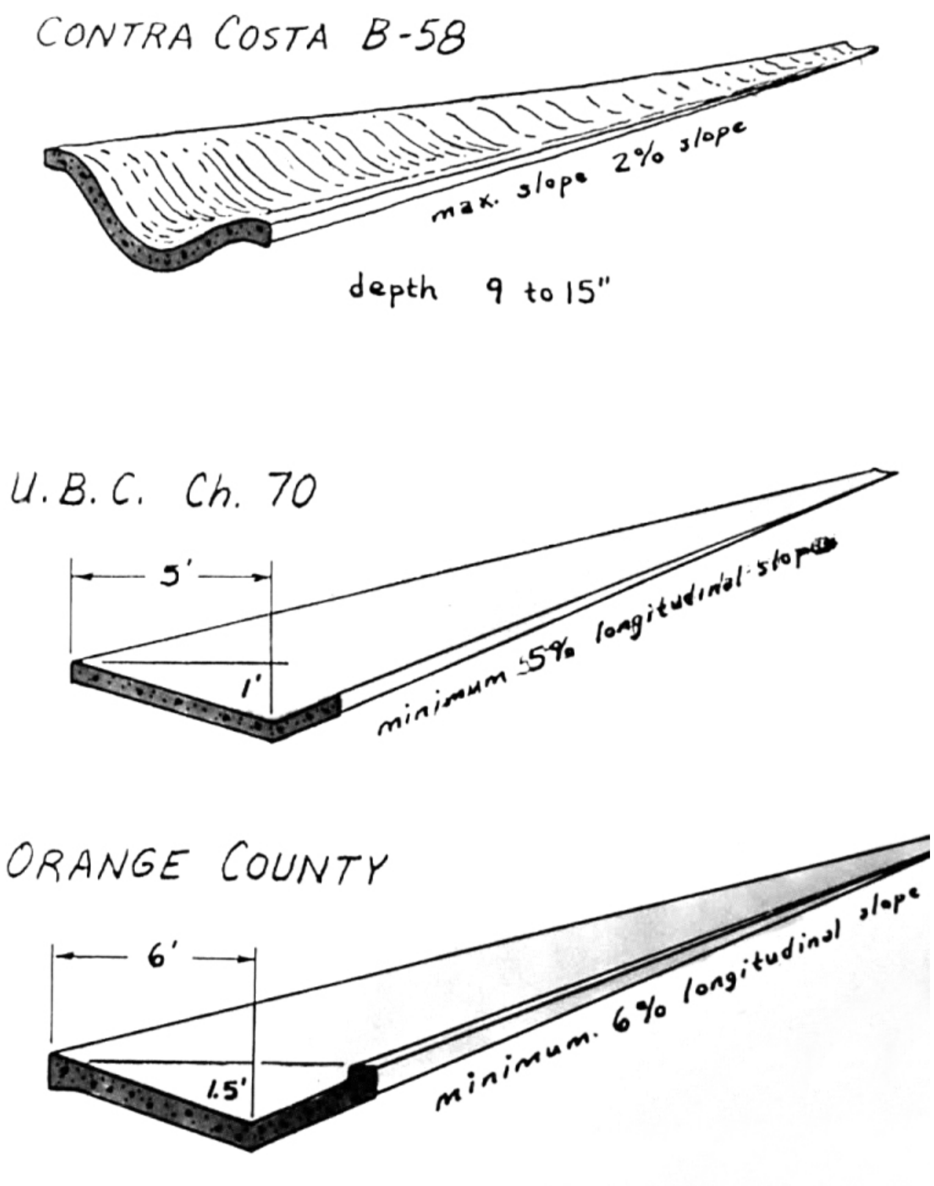
Drainage Interceptor Ditches



- **Drainage interceptor ditches** have been used for over 100 years to mitigate development of erosion rills and gullies on cut or fill slopes. This example is taken from a civil engineering reference book published in 1902.



- **Typical paved drainage interceptor ditch details**
- **Brow ditches are placed above cut slopes**
- **The UBC mandates downdrains for every 13,500 sq ft of tributary slope area**
- **Downdrains need 12 in deep shear keys**
- **Concrete ditches should be reinforced**



- There are many varieties of paved drainage interceptor ditches
- The most important aspect is watching the longitudinal hydraulic grade
- A grade of 5% to 6% helps ditches to be "self-cleaning" by increasing velocity sufficiently to carry off soil and debris that collects on the ditch

- Concrete interceptor ditches are usually poured using a concrete pump rig. Welded wire mesh (WWM) provides minimum [temperature] reinforcement on non-expansive soils. Additional reinforcement is usually provided if the ditches are constructed on shales or expansive soils, to better resist differential heave.

- **Engineer checking v-ditch dimensions, including maximum depth (shown here) and longitudinal grade. Note smooth upslope transition between concrete and the slope**

- **Concrete-lined drainage interceptor ditches should be designed with adequate freeboard and backslope to accommodate modest volumes of spillage off the slopes**

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- **The intended purpose of paved drainage interceptor ditches is to prevent rill erosion and surficial failures of graded slopes**

- **Terraced slopes should be vegetated to reduce surface erosion, increase unit shear strength through root development, and retard desiccation of cohesive soils**

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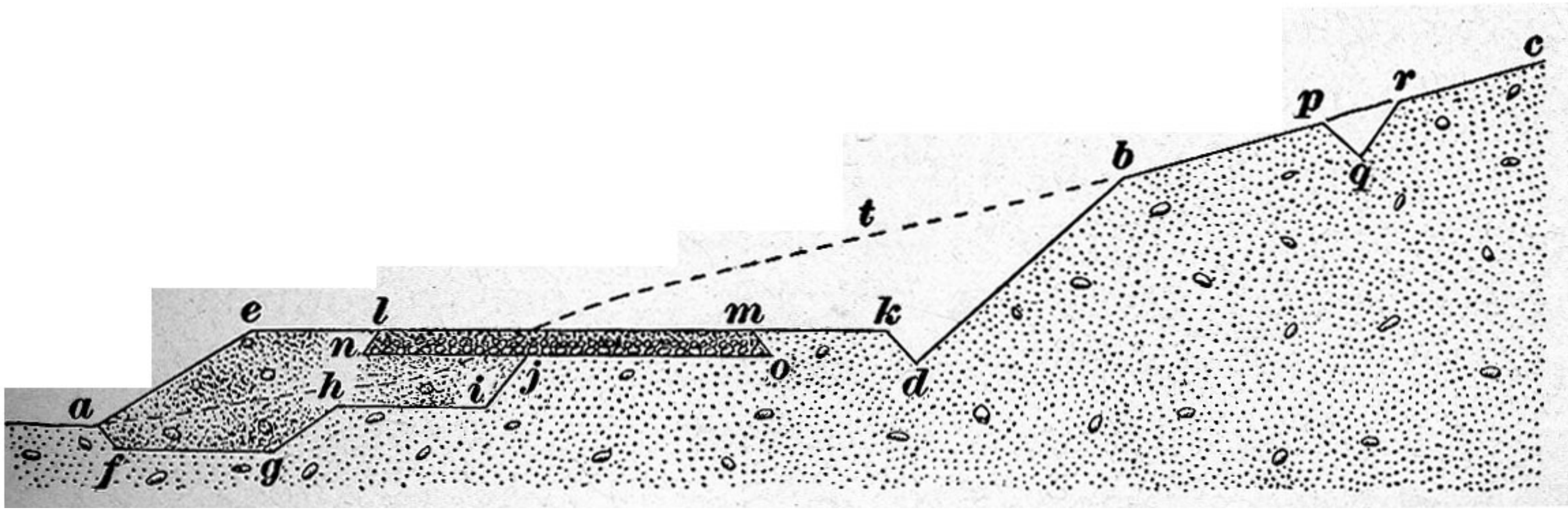
Interceptor Ditches at brow of cut slopes



- Here is another "standard grading detail," taken from a general engineering text around 1900
- It shows a drainage interceptor ditch (p-q-r) above the brow of a cut slope. Note the drainage ditch cut along the upslope heel of the highway, at k-d, and the toe-of-fill keyway at a-f-g-h.

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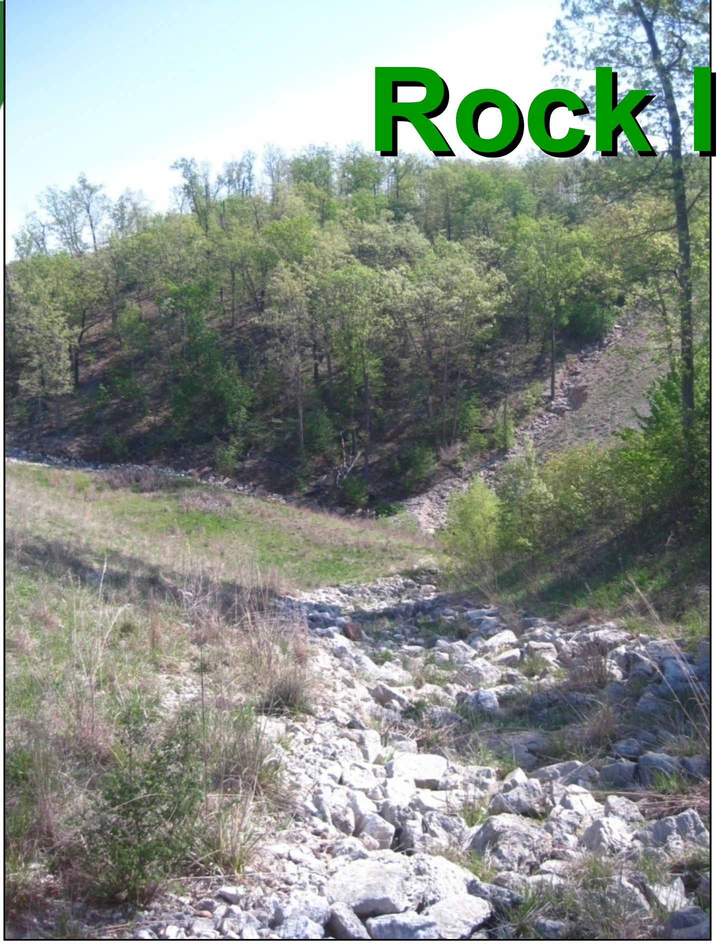
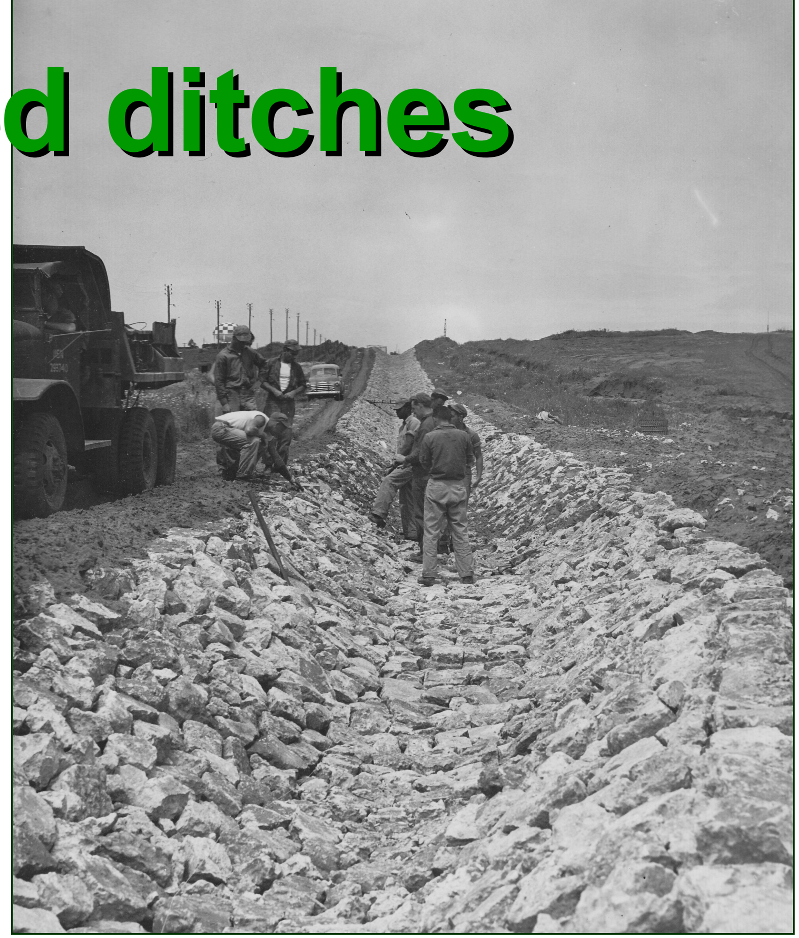
Rock lined ditches





- **Rock-lined drainage interceptor ditches** have been employed for over 150 years
- They may or may not work well, depending on grade, the quantity of runoff that they convey, and the cohesion of the underlying soil being protected.
- Sometimes, filters are needed between the rock and the underlying soil (especially with loess, silt, or loose sand).

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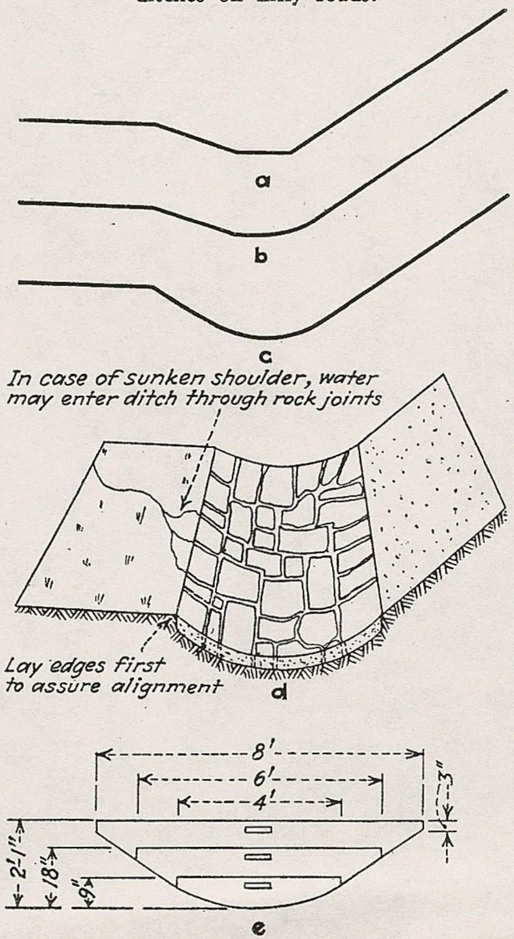
Rock-lined Ditches

Fig. 1—Diagram sections, templets and pavement details of stone paving for side ditches on hilly roads.

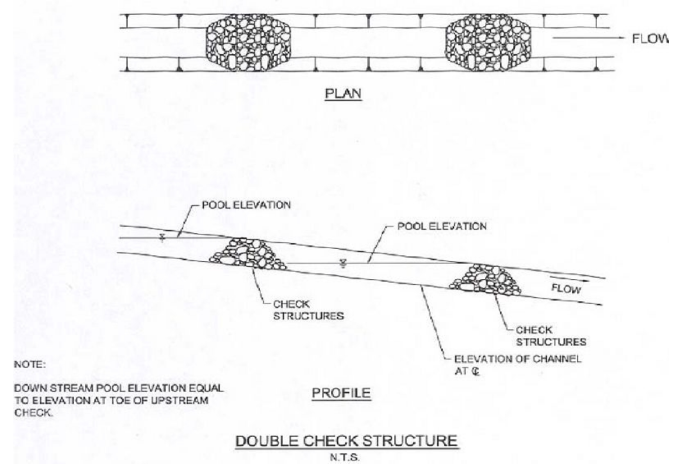


Neat-stacked rock-lined ditch

Unlined ditches often degrade, clogging culverts

Drainage conveyance ditches are usually lined if inclined > 2 degrees, to check scour-induced bed erosion. Design template at lower left was developed by the Indiana State Highway Commission in 1933

Watch longitudinal profile of your ditches!



- **Check dams** are commonly employed to reduce rill and gully erosion along highways to retard bed down-cutting
- Empirical procedures exist to determine the spacings between drop structures

- **This failure occurred because the interceptor ditches were not paved, although the downdrain was. The colluvium shown here was very susceptible to erosion because of low cohesion**

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Material	Mean Velocity	
	Clear water, ft/sec (m/sec)	Silty water, ft/sec (m/sec)
Fine sand, colloidal	1.50 (0.457)	2.50 (0.762)
Sandy loam, noncolloidal	1.75 (0.533)	2.50 (0.762)
Silt loam, noncolloidal	2.00 (0.610)	3.00 (0.914)
Alluvial silts, noncolloidal	2.00 (0.610)	3.50 (1.067)
Ordinary firm loam	2.50 (0.762)	3.50 (1.067)
Volcanic ash	2.50 (0.762)	3.50 (1.067)
Stiff clay, very colloidal	3.75 (1.143)	5.00 (1.524)
Alluvial silts, colloidal	3.75 (1.143)	5.00 (1.524)
Shales and hardpans	6.00 (1.829)	6.00 (1.829)
Fine gravel	2.50 (0.762)	5.00 (1.524)
Grade loam to cobbles, noncolloidal	3.75 (1.143)	5.00 (1.524)
Graded silts to cobbles, noncolloidal	4.00 (1.220)	5.50 (1.676)
Coarse gravel, noncolloidal	4.00 (1.220)	6.00 (1.829)
Cobbles and shingles	5.00 (1.524)	5.50 (1.676)

- **Unlined channels are capable of conveying runoff with modest velocities, as suggested in this table of limiting values**

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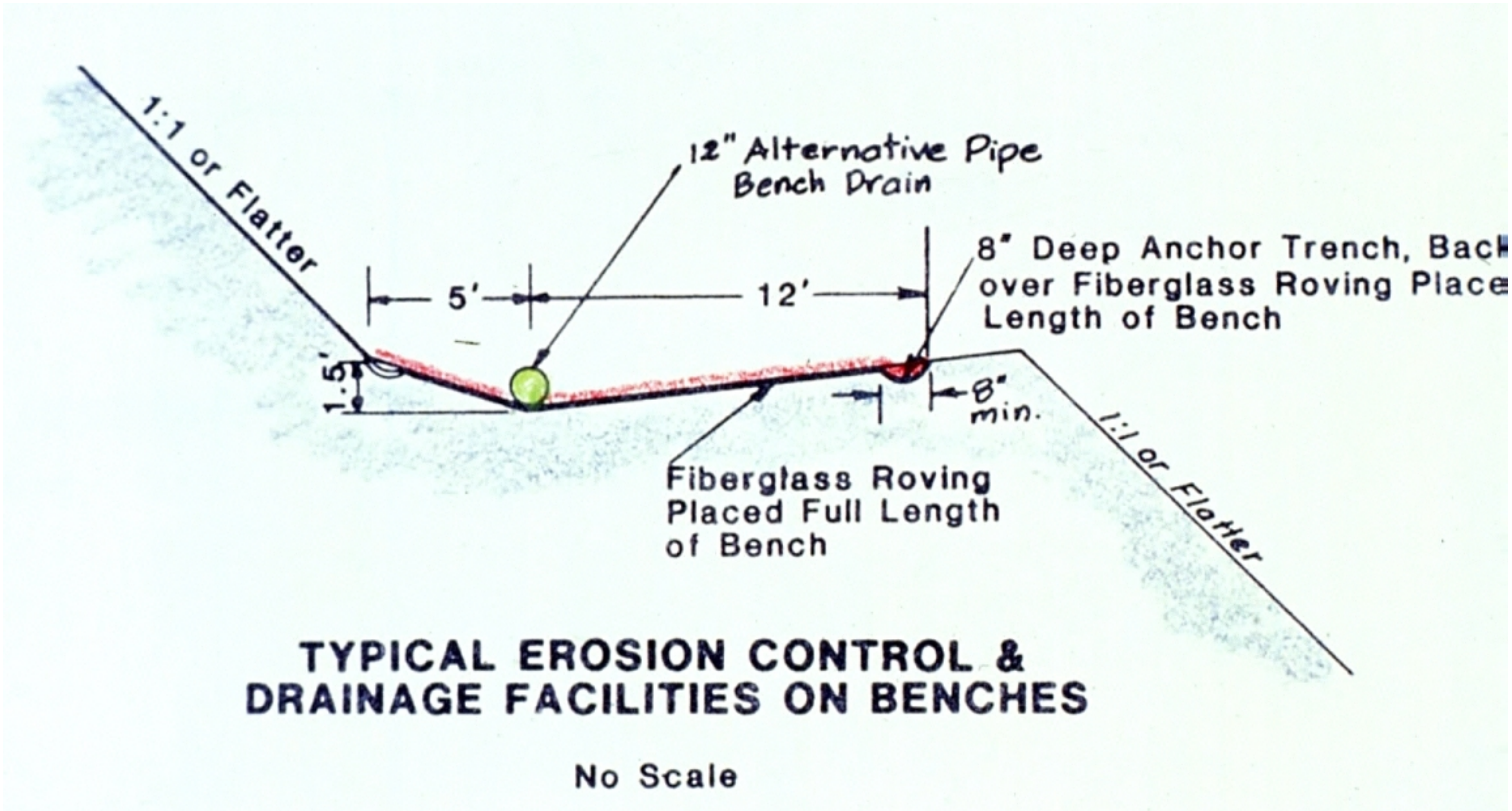
- Fiberglass threads, termed “roving”, can be used to reinforce cohesionless soils, like this cylinder of sand
- The fiberglass threads engender considerable shear strength to the soil mass, increasing it’s strength and resistance to erosion



- **Section through drainage interceptor ditch lined with fiberglass roving soil reinforcement**

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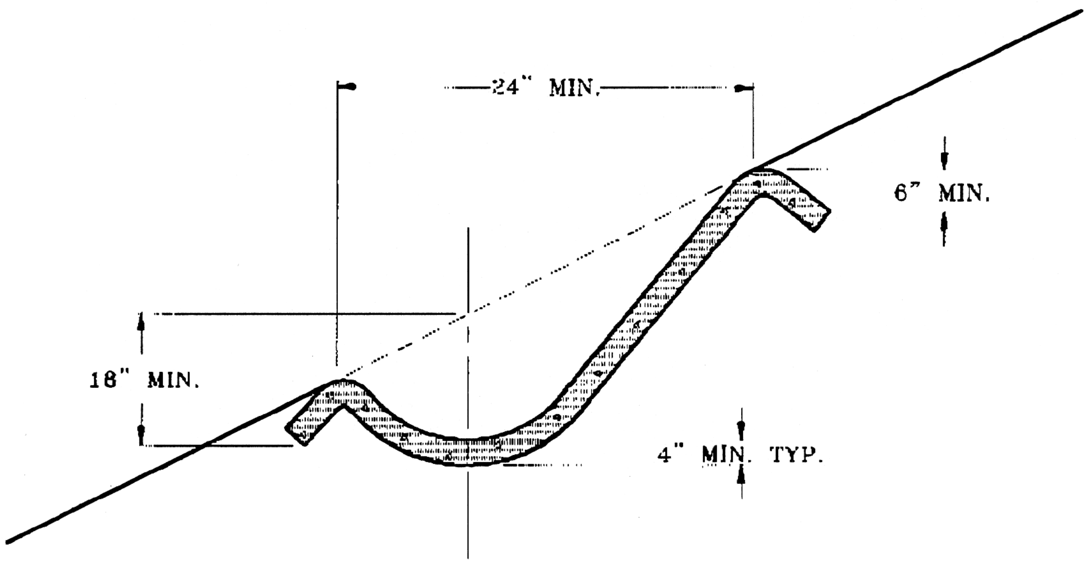
- **Fiberglass roving was used to reinforce this drainage interceptor ditch in lieu of paving at Redwood National Park in northern California**

- Left above: Some equipment manufacturers produce special V-shaped buckets for excavation of drainage interceptor ditches
- Left below: A Hurricane Side-Arm ditcher is very effective for excavating ditches in flat-lying areas, where more volume and gentle side slopes prevail

"J" DITCHES



- **J ditches are useful because they can be built into existing cut or fill slopes, as shown. They require neat excavation and are typically placed using shotcrete**

- **This shows a ditch that was built by excavating an over-steepened cut into a recently graded fill slope, to create a terrace for the drainage ditch. Note surficial failures soon after placement**

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- **Another view of a interceptor ditch constructed on an over-steepened cut terrace. Raveling debris from the cut clogged the drop inlet and forced the water onto the slope, causing considerable erosion**

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- **Like most manufactured products, drainage ditches require consistent maintenance and upkeep if they are to perform as intended**

SLAKING

Some rocks slake, or spontaneously break down, when exposed to air or water. Volcanic rocks and sedimentary rocks containing bitumen are most common

- When hardened drainage improvements fail, the results can be significant. In this case, there was a cold pour gap in the drainage ditch which allowed runoff to infiltrate the fill slope below it, fostering its eventual failure

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- **Downdrains are placed at selected intervals to convey collected runoff down the slope to a suitable point of discharge**

- This shows a series of concrete-lined downdrains placed on a engineered fill slope
- Note the splash walls, which are intended to train debris-laden flows and keep them within the intended flow path
- Energy dissipation is required at the foot of such a system, or serious erosion will result

- This view shows a failed downdrain on a fill embankment
- The failure was precipitated by seepage through a cold pour, or construction joint, which opened up after the toe of the slope was being excavated for a retaining wall

- **Surficial erosion often occurs at the transition between the embankment face and the native slope, because runoff from the native slope flows to the edge of the fill face, as shown here.**

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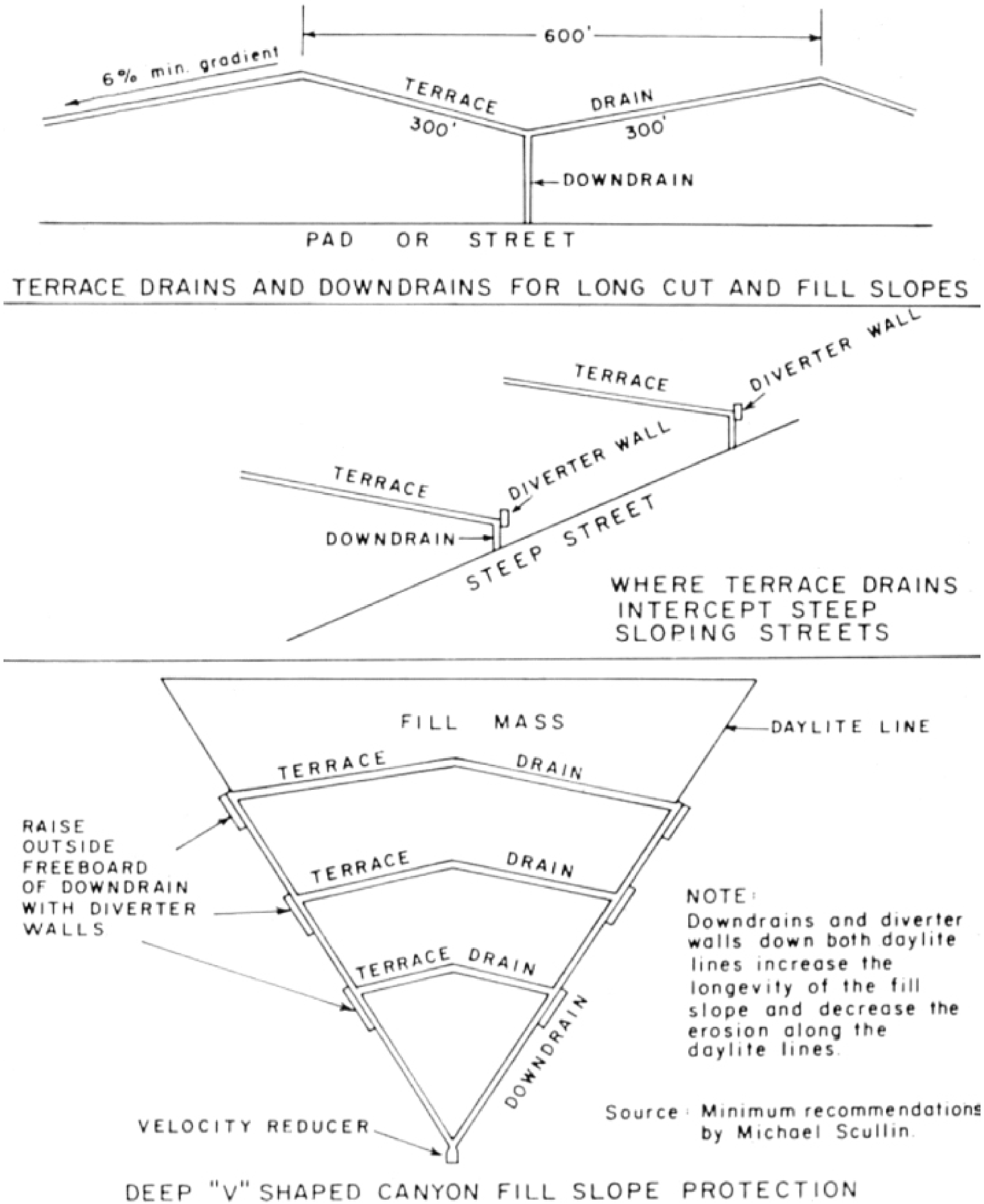
- **Downdrains along the daylight lines of canyon fills require special attention**



- **Typical details for terrace drains and downdrains on a canyon fill**
- **Downdrains along the daylight line of the canyon fill are less susceptible to long-term movements caused by settlement of the fill.**
- **Note diverter walls for training flows**

- **Drainage interceptor ditches require ongoing maintenance and periodic selective replacement. Hillside ditches have a design life of between 25 and 50 years**

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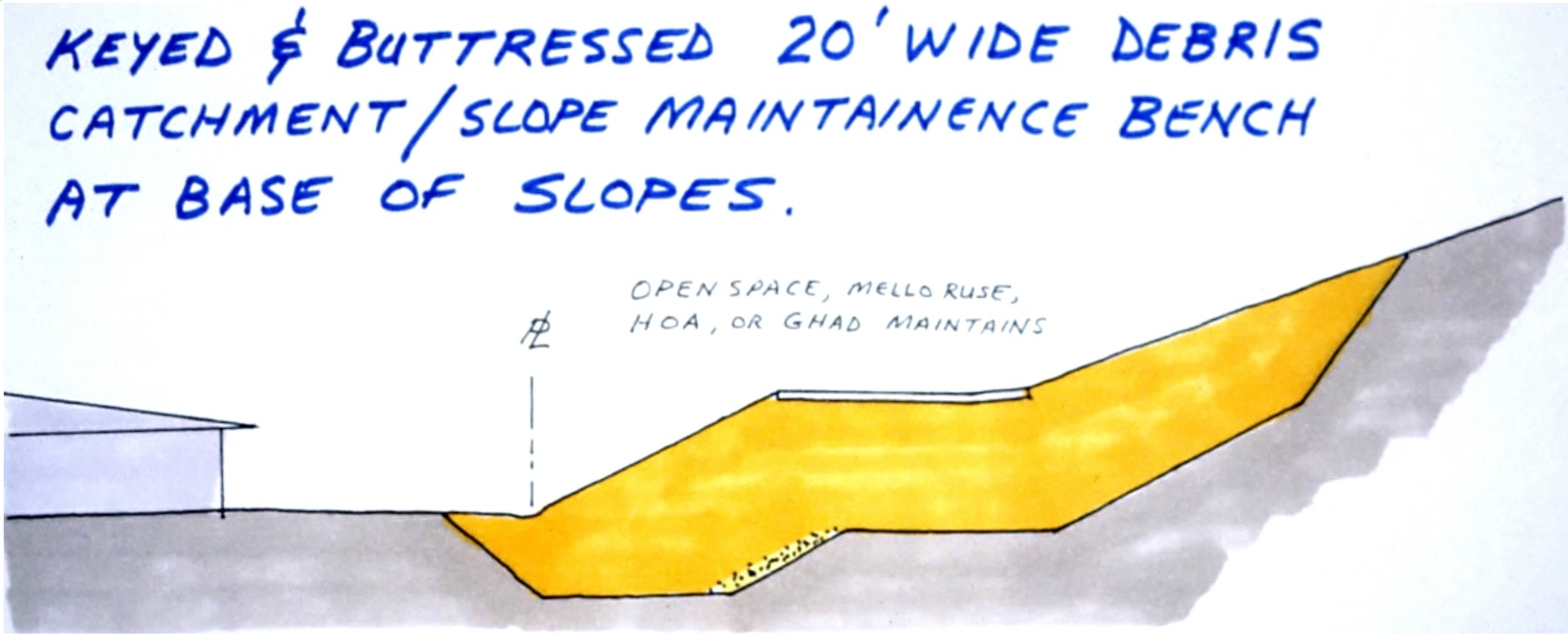

- **Debris benches can be used as a buffer between planned unit developments and landslide-prone open space uplands. Wide benches provide storage for fluidized debris and prevent it from impacting structures**

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