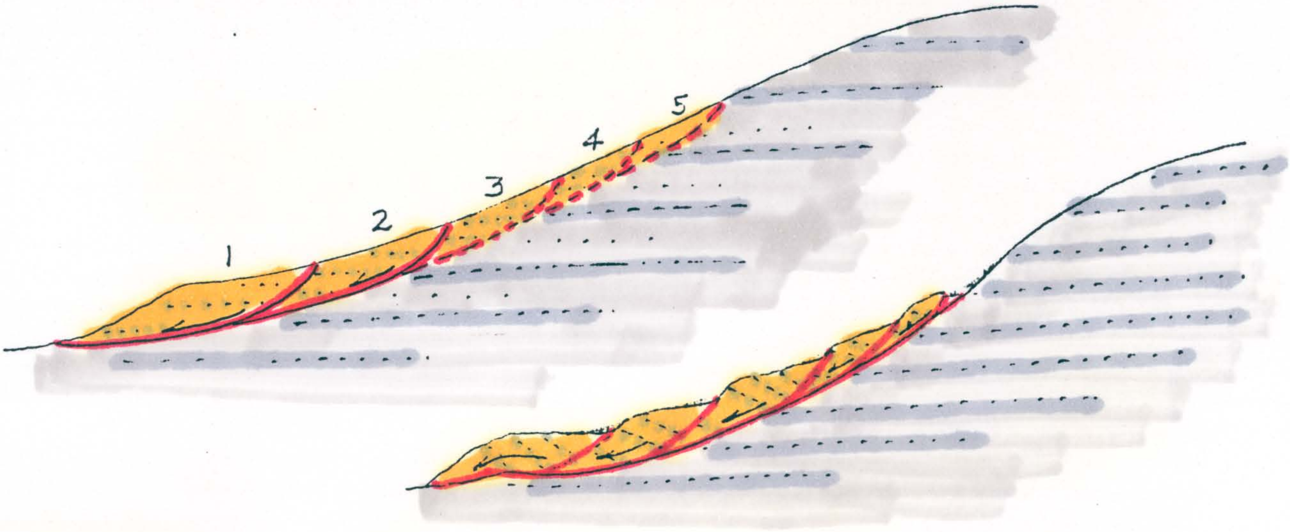
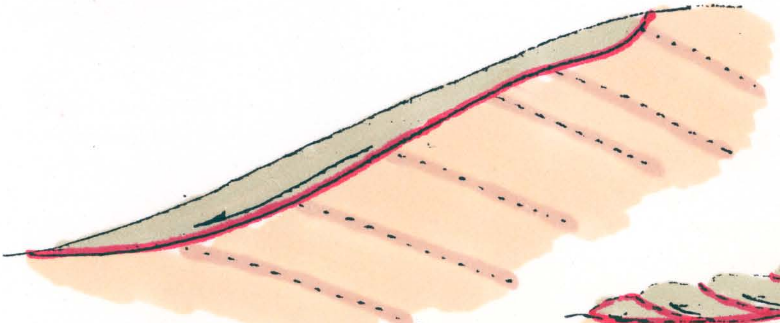
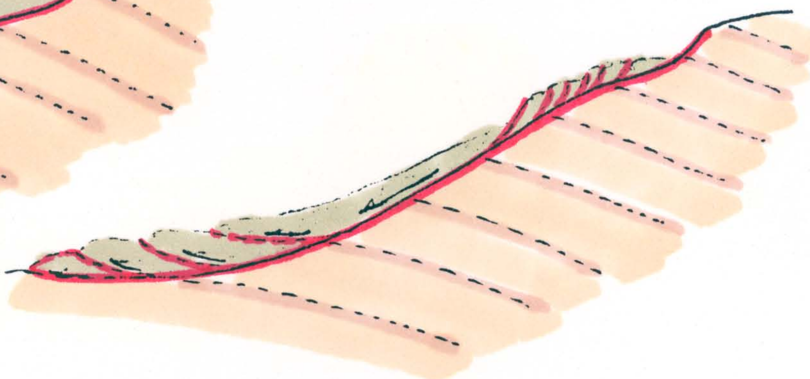
Brief Overview of Types of Slope Failures

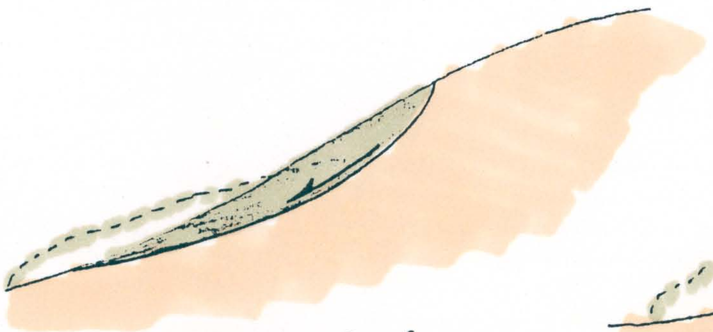


Retrogressive Slump Blocks

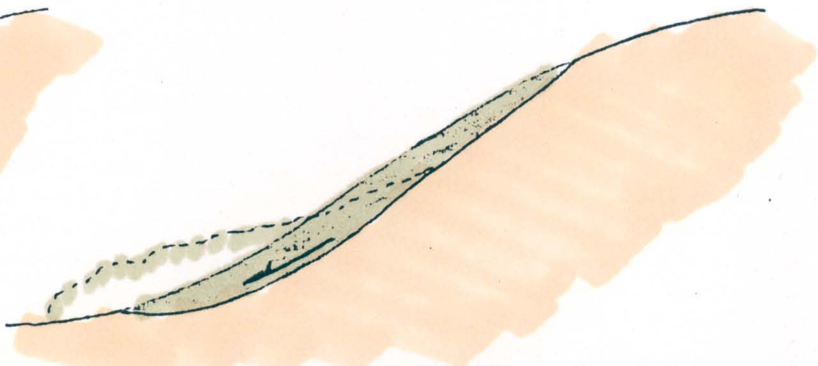




TRANSLATIONAL SLIDE

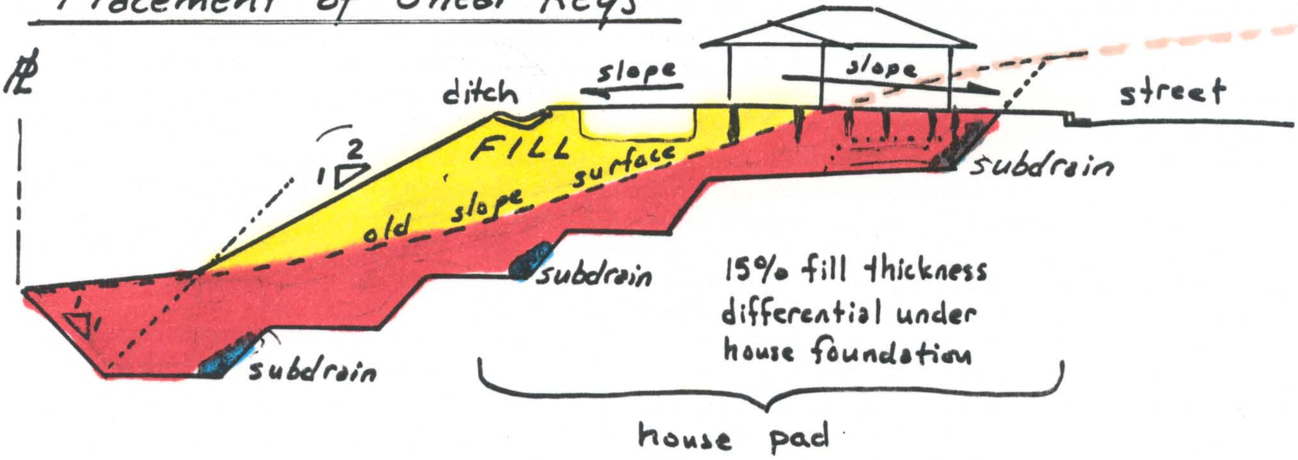


Circular Failure Surfaces in Clays

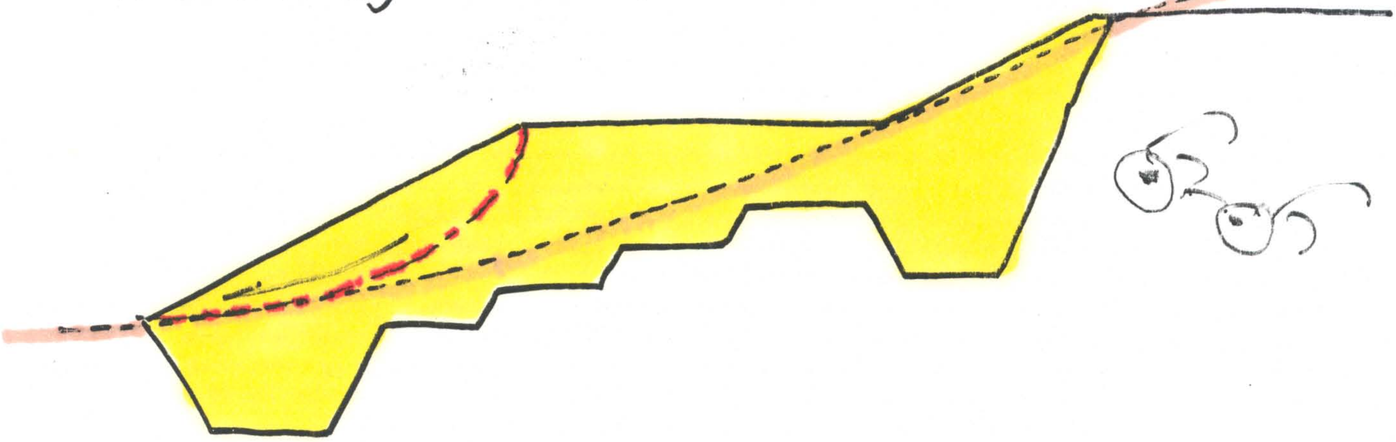


More Planar Failure Surfaces in Sandy Mtls or bedrock

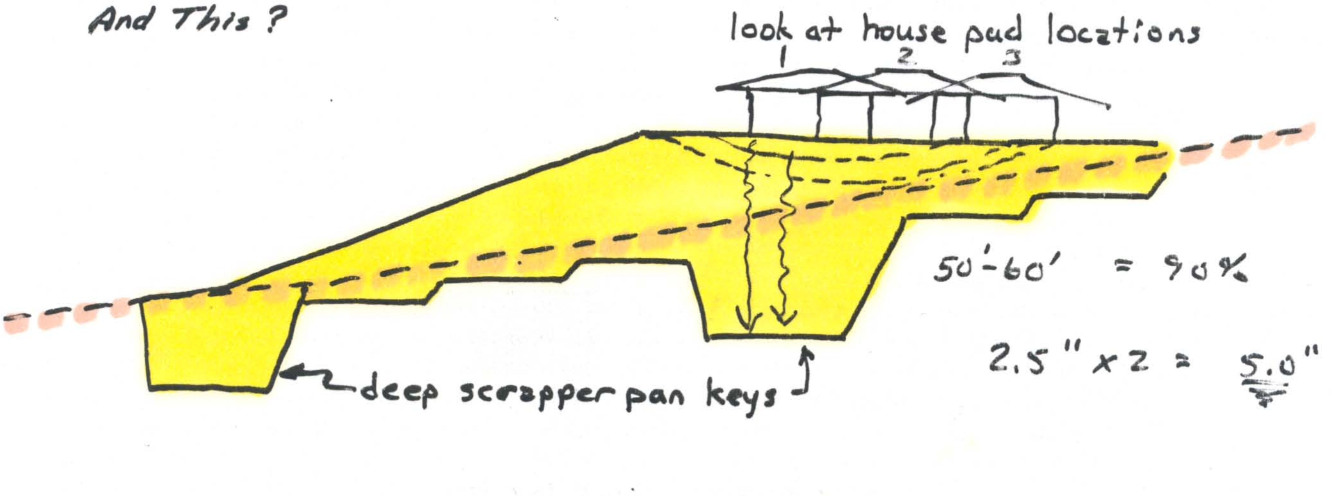
Placement of Shear Keys

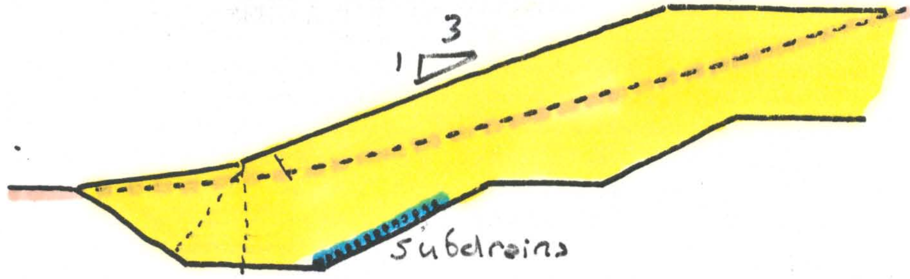


What's Wrong With This ?

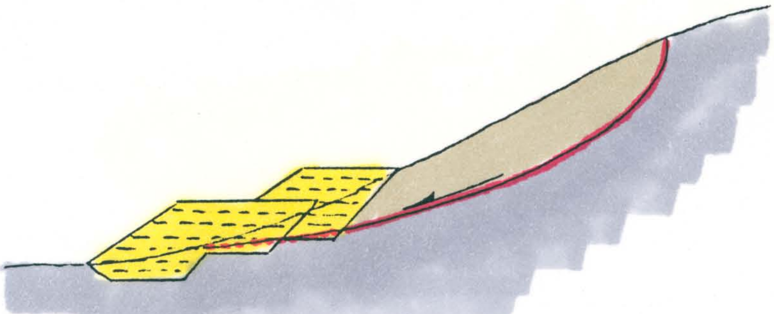


And This ?

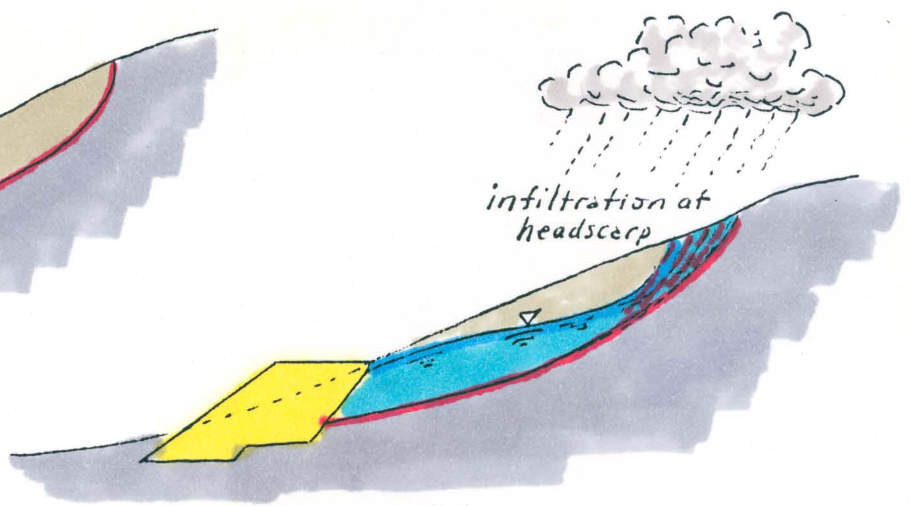




Types of Buttress Fills

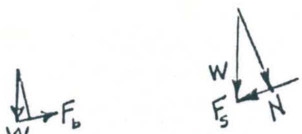


TOE BUTTRESS



Excessive Groundwater Pressures Can Build Up Behind Toe Buttresses

FORCES



Dead Weight W of buttress resists sliding thru

F_s is lateral force exerted by landslide

$N = W \cos \alpha$

Shear Strength $S = (N - \mu) \tan \phi + c'$

where:

α = slope inclination

N = Normal Force on Potential Slide Plane

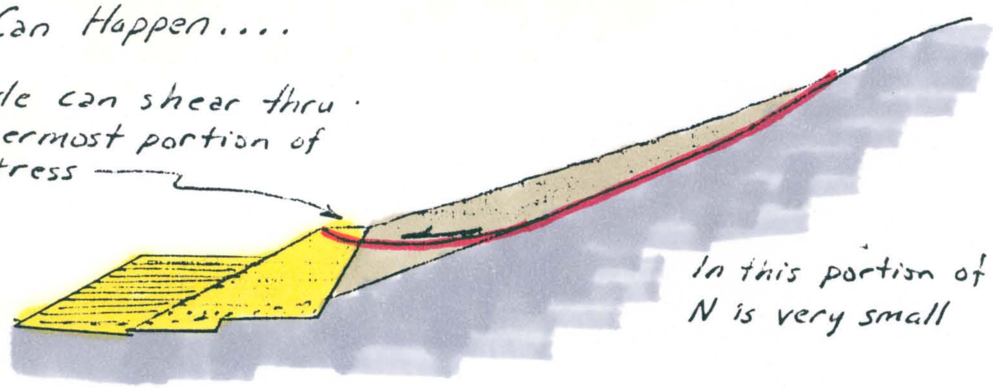
ϕ = Angle of Internal Friction of Soil

μ = Water Pressure = $\gamma_w h$

c' = effective cohesion of Soil

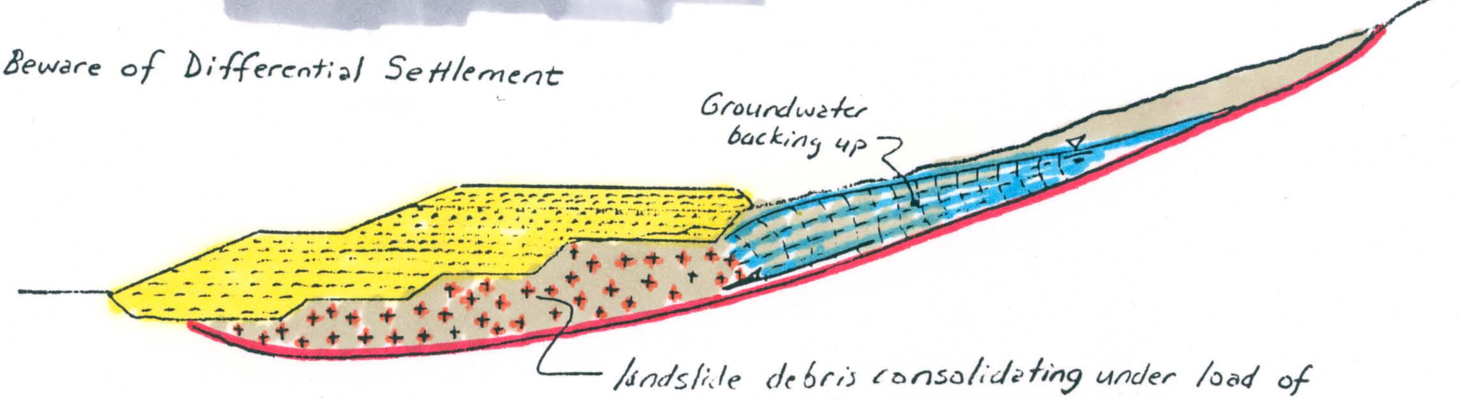
What Can Happen....

slide can shear thru uppermost portion of buttress



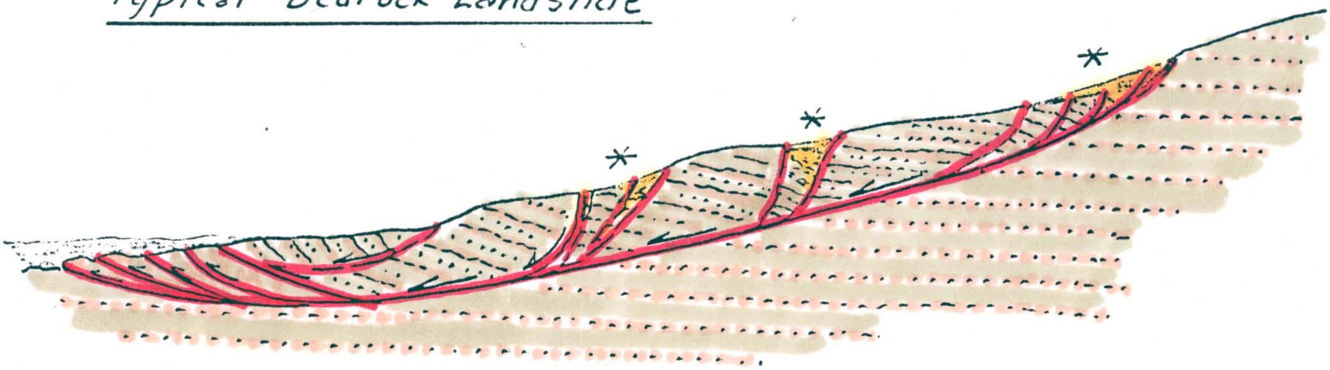
In this portion of buttress N is very small

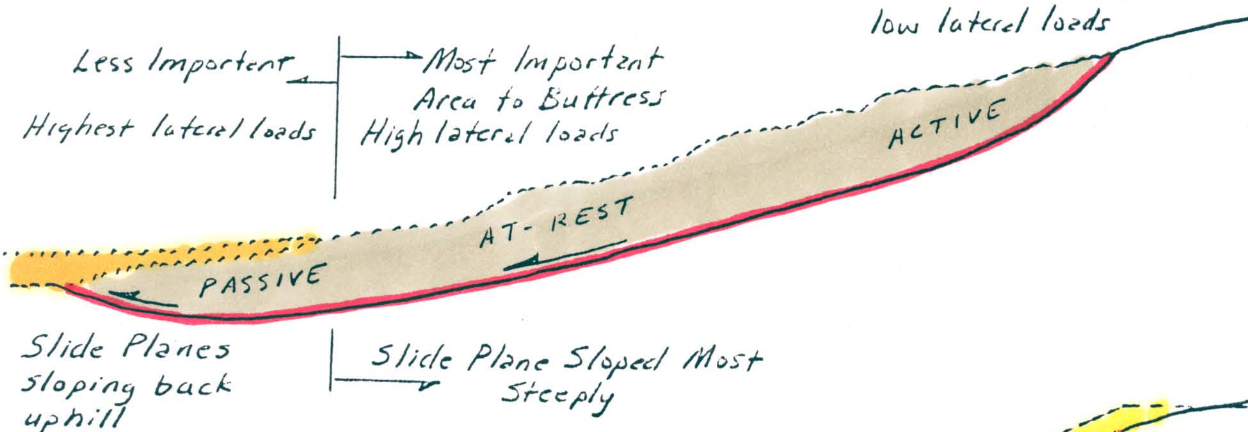
Beware of Differential Settlement

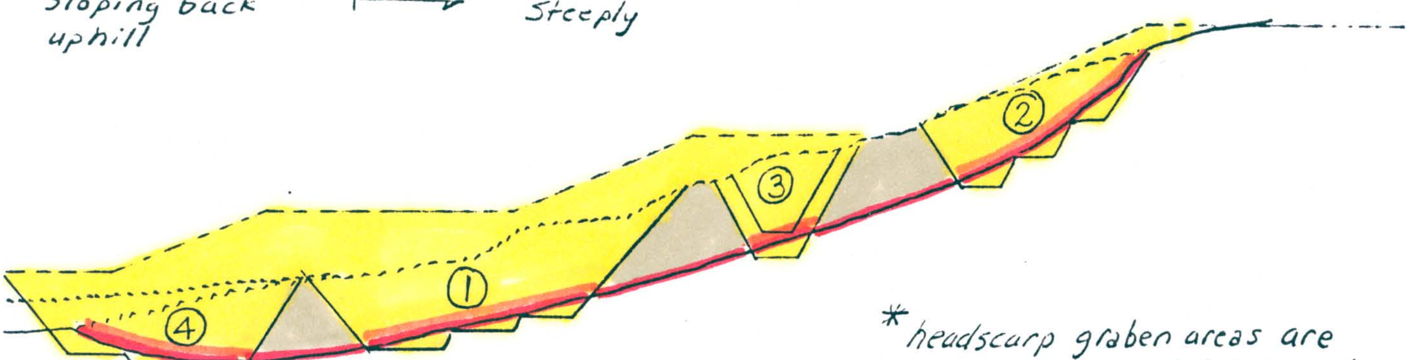


landslide debris consolidating under load of toe buttress. Groundwater backs up underneath fill due to decreased permeability

Typical Bedrock Landslide



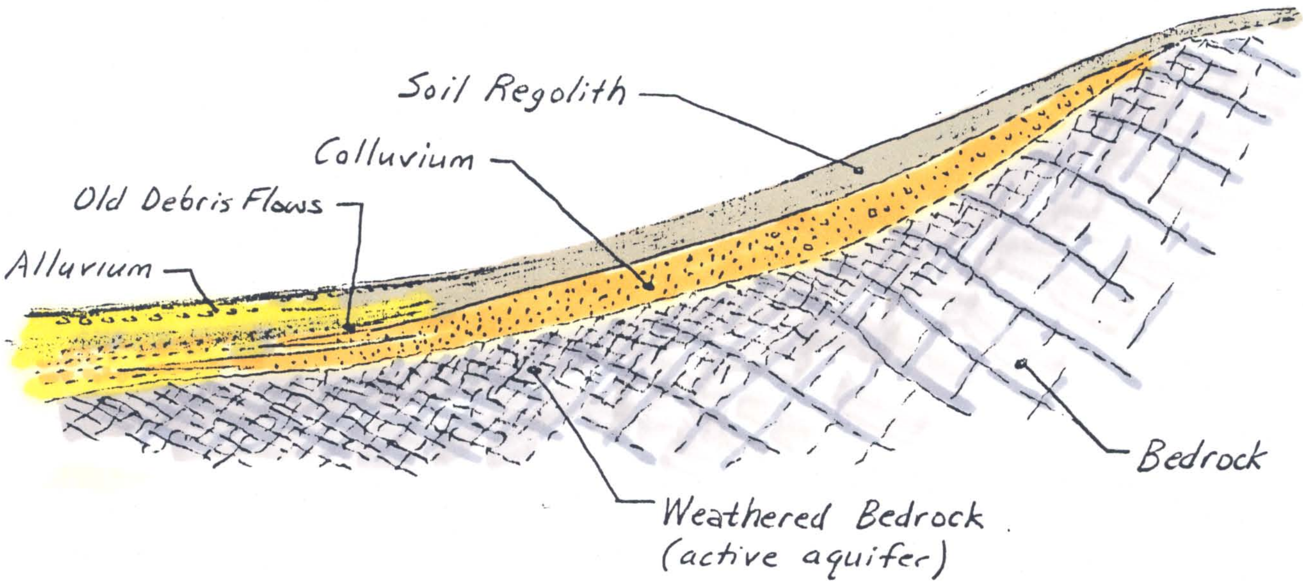




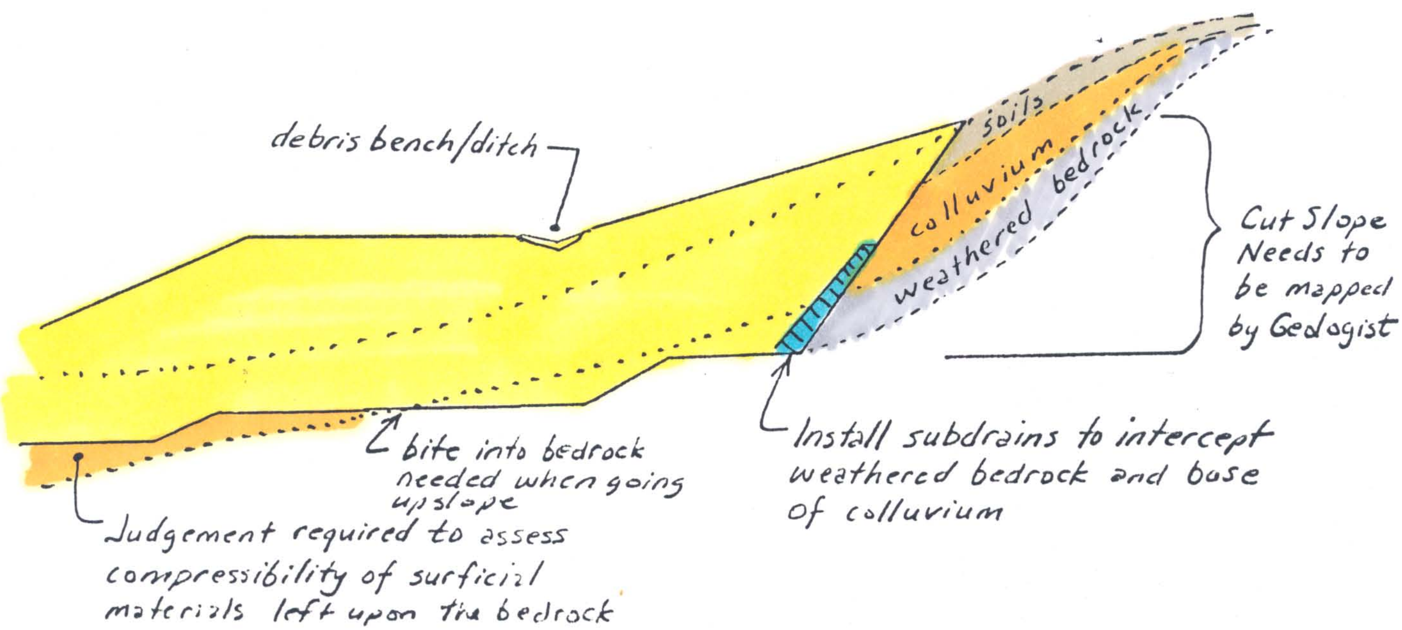
* headscarp graben areas are generally very dilated and loose. Fills on these areas will be subject to settlement

Most Geotechnical Practioners recommed toe buttresses first, and tend to leave uphill portions of ancient landslide slip planes in-place. From a slope stability viewpoint, the toe area is inherently most stable, as the slip surfaces level out and turn uphill. Intercepting the slide plane and installing subdrainage is most critical where the slide plane is steeply inclined downslope. The effectiveness of the buttress is a function of overburden height and subdrainage. Highly cohesive soils better resist short-term earthquake loading.

Standard Buttress Design



Amount of Near-Surface Groundwater Increases Downslope due to aereal accretion. Weathered Zone geneally increases downslope, mimicing groundwater flow patterns, and vice versa



LECTURE NOTES ON

VARIOUS ASPECTS OF

RECOMPACTED BUTTRESS FILLS

PRESENTED BY:

J. DAVID ROGERS, Ph.D., G.E., C.E.G.
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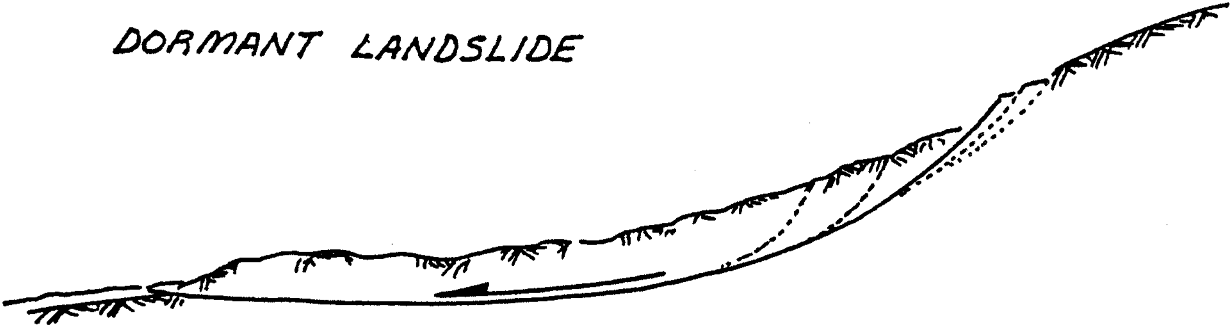
ROGERS/PACIFIC, INC.
PLEASANT HILL, CALIFORNIA

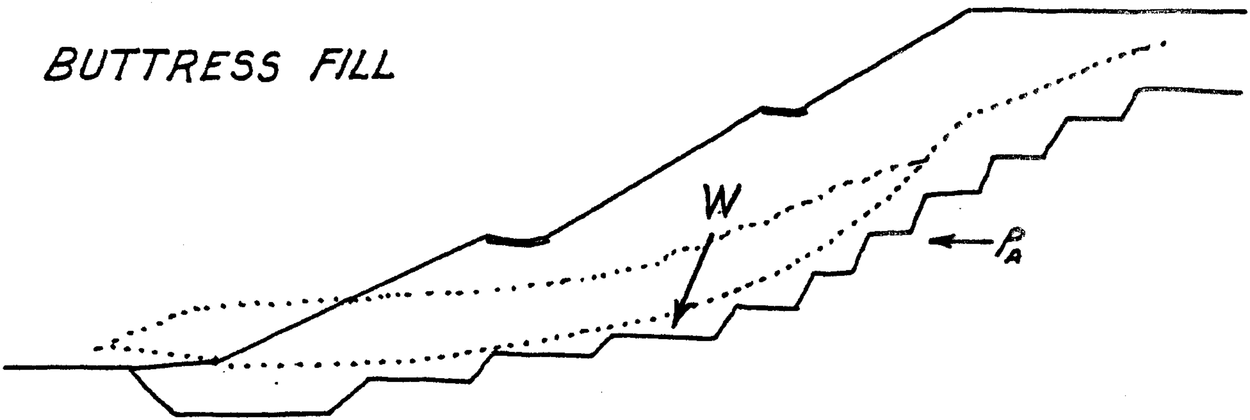
For
INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS
EXCAVATION AND GRADING
"INSPECTION AND CONTROL"

AUGUST 9-10, 1993 AND NOVEMBER 15-16, 1993
WHITTIER, CALIFORNIA

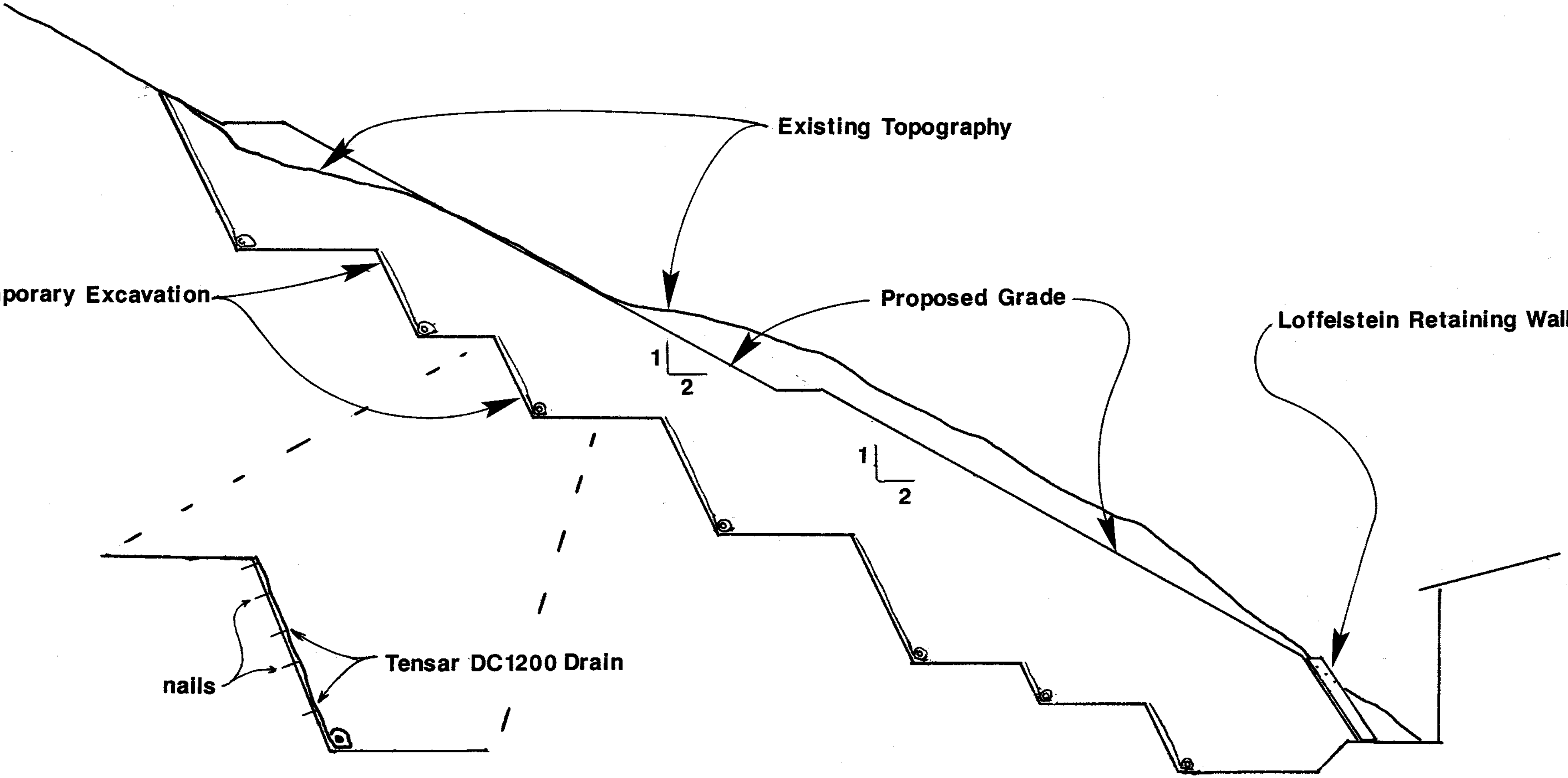
DORMANT LANDSLIDE



BUTTRESS FILL



DEAD WEIGHT OF FILL, W, RESISTS LATERAL PRESSURE OF THE ADJACENT SLOPE, P_A



Perforated pipe subdrain min. 4" dia.
Slope pipe at min. 2% grade.

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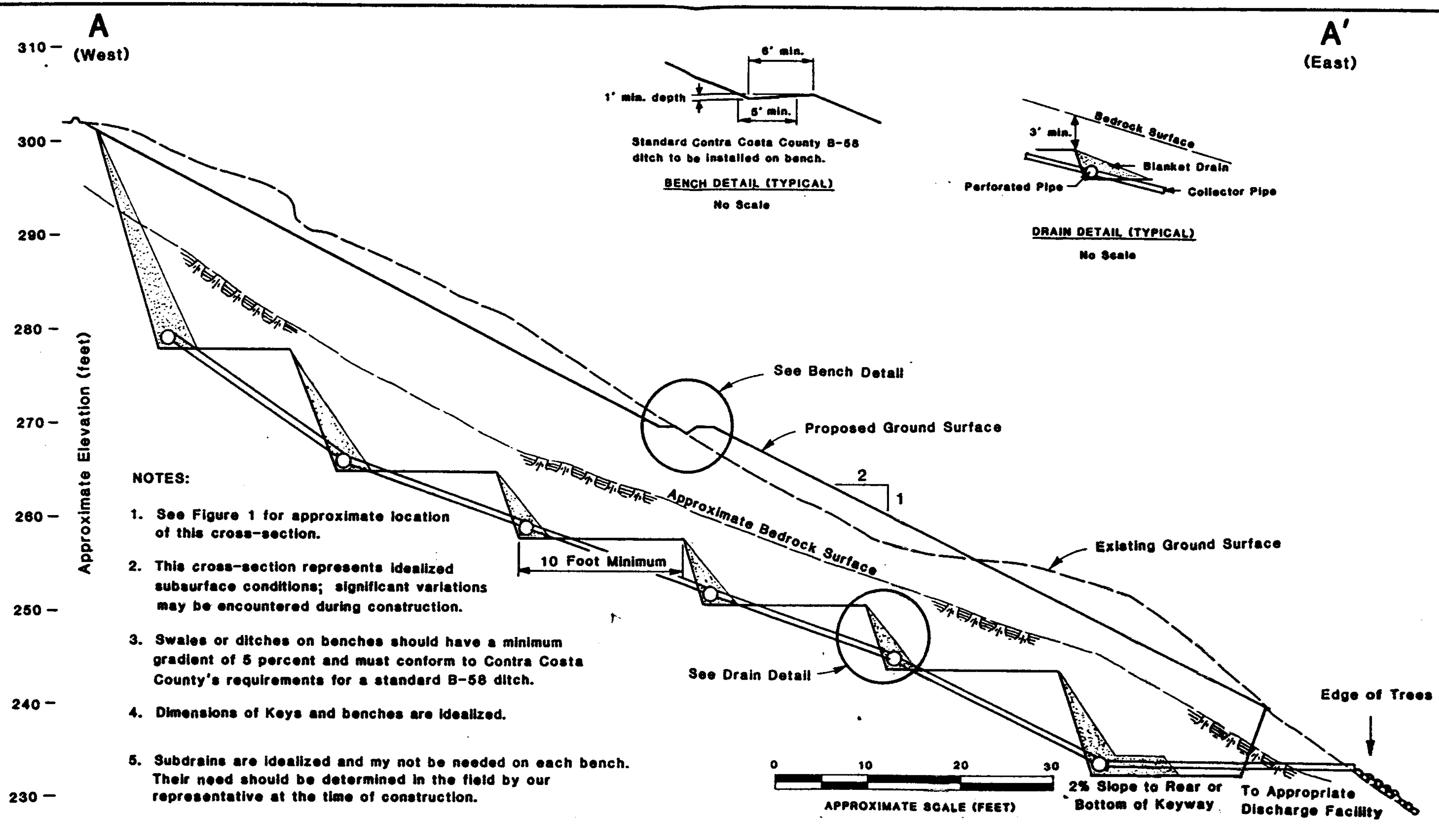
PROJECT NO.	DATE	Figure



NOTES:

1. See Figure 1 for approximate location of this cross-section.
2. This cross-section represents idealized subsurface conditions; significant variations may be encountered during construction.
3. Swales or ditches on benches should have a minimum gradient of 5 percent and must conform to Contra Costa County's requirements for a standard B-58 ditch.
4. Dimensions of Keys and benches are idealized.
5. Subdrains are idealized and my not be needed on each bench. Their need should be determined in the field by our representative at the time of construction.

ALAN KROPP & ASSOCIATES Geotechnical Consultants	IDEALIZED CROSS-SECTION A-A′		
	McMORROW RESIDENCE SLIDE Martinez, California		
	PROJECT NO. 838-1A	DATE June 1986	FIGURE 1

GRADING TO STABILIZE LANDSLIDES

1. Elimination

One common way to repair landslides is to remove the entire landslide mass. Following removal, the excavated area may remain or the excavation may be filled with either the previously removed material or imported material. A typical cross-section where soils are removed, subdrainage installed, and removed materials placed back and compacted is shown on Figure 1.

Among the advantages of this landslide elimination are:

- The entire slide mass is removed and the stability is not dependent on an accurate calculation of forces

- Earthwork is often cheaper than structural systems

- Engineer and/or geologist can make observations during excavation to confirm limits of slippage, areas of subsurface seepage and other important considerations

Among the disadvantages of this approach are:

- Disrupts a large area

- Large excavation may be required which may have unstable temporary cut slopes. Temporary shoring may be needed which is often expensive and difficult to work around (soil nailing may be a good alternative to conventional temporary shoring)

- Large stockpile area is needed if excavated material is to be re-used. May be stability problems with stockpile itself or in underlying materials as a result of the stockpile weight

- May be costly to dispose of excavated material and purchase imported material

- Excavated soils may have high water content and need drying or addition of lime or cement to achieve adequate compaction

- Difficult to work during adverse weather conditions

A recent development has been the use of geogrids to re-create slopes steeper than 2:1 (horizontal to vertical). This is very useful where a slope is being reconstructed in a location where adjacent slopes have inclinations of 1½:1 or 1:1. More discussion of this technique, as well as other forms of mechanically stabilized embankments (MSE), will be presented by John Walkinshaw. An example of such a system is presented in Hermann & Burd (1988).