

2004 LANDSLIDE WORKSHOP
UTAH GEOLOGICAL SURVEY

**BUILDING ON LANDSLIDES – WHAT IS THE STANDARD OF CARE
AND RECOMMENDED LEVEL OF STUDY AND HAZARD REDUCTION?**

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- Purpose: To discuss the types and extent of geologic and geotechnical investigations needed to assess stability of existing landslides prior to residential development, and the standard of practice and regulation in other states relative to Utah
- Format: Open, informal discussion of topics listed below.

Geologic characterization

- 1) How are age constraints on movement used in assessing stability, i.e. is a lack of evidence for Holocene movement considered sufficient to indicate long-term stability?
- 2) How common is minor (but damaging) Holocene movement in landslides whose last major movement was likely during the Late Pleistocene?
- 3) How conclusive are undeformed beds on landslides in indicating a lack of movement, i.e., how much deformation can occur without visible signs in sediments?
- 4) Are simple maps showing only landslide boundaries sufficient for designing the scope of a landslide investigation? Should detailed surficial geologic maps defining landslide limits, internal structures, source areas, and surrounding geology be required?
- 5) How effective is trenching as a geologic technique to investigate landslides? Describe the best approach in locating trenches on a landslide.

Geotechnical-engineering studies

- 1) What do you do when landslide size, depth or other issues preclude collecting sufficient data to reasonably obtain a realistic FS?
- 2) How successful are attempts to collect samples of basal shear surfaces in boreholes? What drilling methods have been utilized to increase success?
- 3) What borehole sampling intervals (continuous?) and methods are typically used in landslide studies?
- 4) What information do you require (like to see) on borehole logs (sample recovery, etc.)?
- 5) How are sensitivity analyses used as a basis for stability judgments?
- 6) Do you see computer stability analyses used in error by those not sufficiently

trained in their use and limitations?

- 7) What confidence do you have in single shear-strength tests from a sample obtained from a borehole/trench? How many tests do you like to see?
- 8) What types of lab tests are best for residual strengths?
- 9) Do you believe that strength is recovered along slide surfaces over time? (i.e., if ground-water conditions haven't changed, why would a landslide be more stable now than when it stopped, presumably at a FS of 1?).
- 10) What role does momentum and dewatering play in stopping movement, i.e., is it reasonable to assume a factor of safety of 1 at cessation of movement under the present topography when back-calculating parameters?

Dynamic slope stability

- 1) What earthquake probability (2% vs. 10% in 50 years) do you use in dynamic stability analyses? How does proximity to an earthquake source affect slope stability or deformation analyses? We have some projects with steep slopes within hundreds of feet from the Wasatch fault. Should less active areas like Utah use a lower probability than California? How much do earthquake considerations drive development decisions?

Dealing with uncertainties

- 1) How do you convey uncertainties to non-technical regulators (planners, developers) to help them make decisions?
- 2) What is a realistic target for reducing uncertainties, i.e. how much data are enough?
- 3) Do consultants adequately characterize uncertainties in their reports?
- 4) What are your local government's philosophies with respect to acceptable risk?

Liability

- 1) Where do you think liability is assigned when you accept a consultant's reports and approve a project? How have your attorneys advised you? How much do you consult w/ your attorneys? How much liability does the permitting agency carry? What have the courts said?
- 2) Do local governments try to reduce their liability through disclosure, hold-harmless agreements, "develop at you own risk" warnings, etc.?

Hazard reduction

- 1) What is your experience with Geologic Hazard Abatement Districts or equivalents, i.e., do they work and how are they administered?
- 2) Do local governments have a way to enforce consultant recommendations for setbacks, no-build zones, and landscaping and site drainage to reduce landslide hazards?
- 3) What do you think about imposing a requirement for hazard-reduction measures to improve the FS by some percentage on all existing landslides prior to building?
- 4) What are the circumstances under which drains are allowed as a requirement for approval?

Policy

- 1) Do you find developers willing to spend and local governments willing to require adequate studies?
- 2) What is the extent of technical review prior to approval, and who provides technical support to local governments?
- 3) Typically, how extensive are review comments on consultant's reports?
- 4) Who pays for the reviews, the agency, or the developer? How much do you charge applicants? What is the review fee?
- 5) Do issues arise regarding the relative responsibilities of engineers and geologists?

Standard of practice

- 1) To what documents do you refer consultants to establish the standard of practice?
- 2) How much does a typical study of an existing large landslide cost?
- 3) What role does the state geological survey play in reviews?
- 4) What is the level of landslide expertise and experience of local consultants?
- 5) How do property values affect the standard of practice and expense of studies?
- 6) What steps are being taken to train consultants and reviewers?
- 7) Do you think a state-level review panel would be effective in improving and standardizing practice?