

Comment Disposition Table

The Geotechnical Roadmap was drafted during FY20 and submitted for an external peer review during the first quarter of FY21. Review comments were solicited from industry experts both within and outside of Reclamation. Editorial comments were addressed directly and are not documented in this tracking sheet.

#	Reviewer, Org	Comment	Resolution
1	Nick Casamatta, Reclamation	Suggest update of language for added clarity and consistency on what was the survey vs what are the recommendations of the report (pretty minimal but should help the reader)	Language updated for clarity per reviewers suggestions.
		Next Steps - For the full road map. Schedule, funding, order of importance, who, method of dissemination	Added language to the executive summary.
		Next Steps - For an individual research topic, esp those that are very general. Is a standard process for example that will be implemented for each idea. Up to you guys on how far you want to go down this road. I think they will be natural questions of a reader and if some are addressed, even minimally, will strengthen the report.	Added language to the executive summary.
2	David Gillette, Reclamation	Remove apostrophe from Lessons Learned.	Apostrophe removed.
		Filter and Berm Reliability and Improvements section "Needs to be reworded. I don't believe I've seen soil-cement or RCC for a "buttress," only for shear resistance in the narrowest bottom part of a key trench."	Re-worded to describe a buttress versus a shear key.
		Filter and Berm Reliability and Improvements section "A bit of exaggeration here. You aren't really going to confirm field performance is being accurately predicted this way, but modeling of models can confirm codes and constitutive models against lab shear tests and centrifuge models of known properties."	Reworded to reflect the reviewers comment.
		Dewatering Concepts section "I believe this is an entirely separate issue, pertaining only to some existing embankment dam instrumentation, and it is not relevant to dewatering. Including it in a dewatering investigation would just be a distraction. It is its own topic. Also, define what's meant by "a fully grouted" piezometer. If you're not sure, ask XYZ who, I'm fairly certain is the one that brought it up. Hyphen is not needed after "ly.""	Moved this topic to the data collection, analysis and 3D presentation section as its own paragraph.
		Improved laboratory testing, cyclic behavior of soils "Emphasis on large strain! I'm not even halfway joking when I say that nothing interesting happens at small strains."	Sentence about large-strain behavior included.
		Noted that advancements with seismic design methods (soil behavior to earthquake loads, etc.) is a significant issue that is only mentioned in Q24 response #1 in survey results.	Included under the Research Roadmaps Topics section.
		Large-strain undrained behavior of materials during dynamic/cyclic loading, including effects of strain rate and material nonuniformity.	Included under the Research Roadmaps Topics section.
		Improved detection of voids and assessment of seepage conditions in situ, especially rapid and non-invasive methods.	Included under the Research Roadmaps Topics section.

		<p>The self-healing stages of internal erosion risk analysis, such as upstream crack-stopper materials, and the ability of "nonstandard" filter materials to deform plastically (not cracking) with embankment movements. These are for both analyzing existing dams and designing new ones, especially assessing whether on-site material could be used as a dam filter even if it contains too many fines by standard filter criteria, if the overburden pressure is high enough. Processed filter material that has to be hauled a long distance can be very expensive.</p>	<p>Included under the Research Roadmaps Topics section.</p>
		<p>Methods for determining rock mass permeability for dam foundation seepage analysis.</p>	<p>Included under the Research Roadmaps Topics section.</p>
		<p>Formation of transverse embankment cracks due to consolidation settlement or dynamic deformation (a three-dimensional problem).</p>	<p>Included under the Research Roadmaps Topics section.</p>
		<p>Conditions at contacts between embankments and irregular rock foundations – how well does embankment fill conform to the surface and seal gaps?</p>	<p>Included under the Research Roadmaps Topics section.</p>
		<p>Other topics:</p> <p>Create lab-scale models to further investigate structural modification – Refer to geotechnical centrifuge literature, where some relevant work has been done (but probably not the exact problems we are interested in). UC Davis has done experiments with embankment dynamic stability, but may not have done any with the sort of modifications being discussed here. (For many problems, shake-table experiments at 1 g will not suffice.)</p>	<p>Included under the Research Roadmaps Topics section.</p>
3	Douglas Boyer, FERC	<p>Characterization and estimation of seismic properties of gravelly soils. Many western US embankment dams are founded on alluvial deposits that contain a mixture of some to large amounts of gravelly materials. The estimation of seismic properties of gravelly soils is very difficult. Empirical curves of seismic properties of sands don't necessarily apply to gravelly soils and extrapolation of such data to gravelly soils is questioned. Additional research is needed to better understand the seismic properties of soils with a range of gravelly materials.</p>	<p>Included under the Research Roadmaps Topics section.</p>
		<p>Review of case history data, comparing and contracting methodologies, and standardization of equipment and procedures related to the collection of iBPT data. Different companies are now performing the collection of iBPT and iBPT-ish data for the evaluation of seismic properties of soils. There are noted and subtle differences in the methodologies and equipment used to collect this data. A review of the approaches and data would be helpful to discern differences in the methodologies and potentially aid in the development of a more standardized approach for the collection of such information.</p>	<p>Included under the Research Roadmaps Topics section.</p>

4	Nathaniel Gee, Reclamation	<p>I don't know that I have other needs but I would like to have seen some more specifics when it came to tools we know/don't know that can meet these needs. To me when I think or review the needs outlined in this document the need for more geophysical tools and knowledge of how to use those tools is high at Reclamation. For example, the document calls out some very standard tests such as SPT or Cone tests, but what about neutron density, sonic, gamma ray and other common logging tools that can effectively inform us about subsurface and foundation materials. This is just one example. I think the amount of need for research to better use geophysical tools when it comes to detecting erosion, voids, seepage etc... is huge, and deserves some specific note in this document. The problem I see is very few really understand these tools (and even fewer really use them correctly) and therefore they rarely come to mind or show up on surveys like the one you sent out.</p>	<p>Included under the Research Roadmaps Topics section.</p>
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5	Jason DeJong, UC Davis	<p>Data Collection, Analysis, and 3D Presentation</p> <ol style="list-style-type: none"> 1. Data quality rating system where each data set is tagged with a quality index. This would allow all downstream users of data to understand and appreciate the quality of the data as it was evaluated by the individual/group who generated the data. 2. Quantitative and/or statistical methods for evaluating the statistical distribution of data and for selection of representative properties for engineering analysis and design. Current practice, in general, exercises judgement in an ad-hoc manner to describe the range of measured data 	Included under the Research Roadmaps Topics section.
		<p>Dewatering</p> <ol style="list-style-type: none"> 1. Mapping spatial structure and connectivity of high permeability layers that are expected to control dewatering effectiveness. 2. Perform in-situ profiling at close spacings to improve mapping of subsurface units. 	Included under the Research Roadmaps Topics section.
		<p>Drilling and Sampling Methods</p> <ol style="list-style-type: none"> 3. Effect of vibrations induced by sonic drilling on subsequent SPT and CPT measurements. 4. Loss in energy delivered to SPT sampler due to drilling method and drill string length. 5. CPT for Vs and Vp profiling. 6. VST (FVT) to evaluate rate effects and rate of strain softening in soft sensitive clays. 7. Geophysics (in combination with other methods) for mapping higher permeability zones. 8. Methods used to characterize well-graded soils, including evaluation of penetration resistance and in-situ density. 	Included under the Research Roadmaps Topics section.
		<p>Improved Laboratory Testing</p> <ol style="list-style-type: none"> 1. Procedures on scalping of large particle soils for laboratory testing, and how to correct laboratory measurements for large particles omitted from testing. 2. Procedures for determining e_{max} and e_{min} of well-graded soils, and correction for effects of scalping. 3. Laboratory large strain ring shear test for residual strength measurement (from both intact and reconstituted specimens). 4. Laboratory characterization of softening and rate effects of clayey soils when subjected to cyclic and monotonic loading. 5. Improvement of numerical modeling platforms and constitutive models. 6. Improve ability to evaluate and predict earthquake induced deformations. 7. Consider physical centrifuge models to evaluate system performance and to provide an additional bridge between laboratory and field data and numerical modeling of full scale system. 	Included under the Research Roadmaps Topics section (where not previously addressed).

6	Bryant Robbins, USACE	<p>Yes, the needs identified are a reasonably representative collection of the science and technology needs facing our agency. That said, the needs specified regarding numerical modeling are too general and vague to be of any value. Specific gaps in geotechnical numerical modeling need to be identified and targeted (e.g., large strain modeling, liquefaction triggering, etc.).</p>	<p>Included under the Research Roadmaps Topics section.</p>
		<p>There remains much uncertainty regarding the ability to predict breach development in embankments. Work towards further validation and verification of breach models would be valuable. Another topic that would be beneficial is a thorough characterization of mechanical and erosion related properties of soil cements. These materials are being used in design of overtopping protection and canal linings, but very limited data sets exist regarding the long term properties of these materials.</p>	<p>Included under the Research Roadmaps Topics section.</p>
7	Wim Kanning and Han Knoeff, Deltares Geo Group (Netherlands)	<p>In general, it might be interesting to develop a prioritization as currently all needs implicitly carry an equal weight. This could be done using e.g. risk analysis. Hereby it can be identified which uncertainties (e.g. parameters, models) are the biggest risk drivers to address these first.</p>	<p>Added a note to the executive summary about prioritization.</p>
		<p>Internal erosion: we fully support the problem identification and plan by USBR. Also, for Dutch levees, backward erosion piping (BEP) is considered one of the main risk drivers. The strategy in the Netherlands is to look in an integral way to BEP by looking at the mechanics (laboratory and field tests, Finite Element Modeling), field data and observations in conjunction with subsoil characterization and geology. The last aspect (geology) is not explicitly mentioned in the USBR plan but might be interesting. Especially since the mechanisms is highly influenced by local soil conditions. For example, more layered deposits with e.g. high anisotropy in hydraulic conductivity (as along Dutch coastal areas) appear much more erosion resistant than the more homogeneous river deposits. Also, local field data and ground water flow measurement and modeling should play an important role in BEP assessments. It should be stressed though that BEP is important in the Netherlands, but it is not the only topic that needs attention.</p>	<p>Included under the Research Roadmaps Topics section.</p>
		<p>Some additional points that might be of interest are:</p> <ol style="list-style-type: none"> 1. How to relate the research with design questions? 2. How do the various research topics relate, which overlaps are there? 3. How to deal with uncertainties, how to relate the research with safety standards and risk analysis. 	<p>Included under the Research Roadmaps Topics section. Research topics are meant to be applied directly to design and risk analysis.</p>