Safety of Earthen Stormwater Infiltration Best Management Practices Adjacent to Highways

Developing a set of scientific based parameters, protocols, and/or tool(s) in order to meet stormwater infiltration Best Management Practices (BMP) and provide for acceptable traffic safety.

WHAT IS THE NEED?

Caltrans is required to comply with the National Pollution Discharge Elimination (NPDES) permit, including the infiltration of stormwater runoff from the highway and implementing soil based best management practices (BMPs). The area available is typically in the clear recovery zone (CRZ), including embankments and slopes that must be traversable and recoverable to meet traffic safety requirements. The proposed study will determine the impact of these stormwater BMP strategies in highway right of way areas on the safety of the resulting roadside and deliver a tool to aid Caltrans engineers in selecting appropriate designs. This study is part of a greater goal for Caltrans to update its design guidance, tools, and specifications for the stormwater BMPs to comply with both the new NPDES permit and highway design manual goals of traffic safety.

WHAT ARE WE DOING?

The proposed study will develop a set of scientific based parameters, protocols, and/or tool(s) that can be applied to design or analyze different scenarios for the clear recovery zone in order to meet stormwater BMPs and provide for acceptable traffic safety. The design methodology will be applicable to the range of cross-sections employed by Caltrans as well as the soils that exist in California. The resulting guide will allow engineers to determine if the BMPs currently cause soft shoulders, clear recovery zone (CRZ) issues, traversability issues, or rutting to a degree that there exist traffic safety issues and then develop an appropriate BMP design that does not compromise traffic safety. For example, as part of the effort, it will be determined if there is an acceptable setback from the edge of pavement to which this type of soil modification can be implemented.
The research plan developed to scientifically assess the issue of traffic safety for roadsides that incorporate stormwater BMP will involve five individual tasks. The ultimate product of this research will be a design and analysis tool that will guide engineers in the deployment of BMP strategies. The plan starts with a literature review of the stormwater BMPs, vehicle dynamics, roadside terrain conditions with and without amended soils, the interactions between vehicles and these roadsides, and the effect of amendments and density changes on the mechanical properties. During this step the research team will also familiarize itself with Caltrans design standards and practices. In the next step, the research will use computer simulations to quantify the current safety of Caltrans roadside soil procedures and compare with the safety of roadsides that incorporate BMP strategies. This comparison will include both material and geometrical factors. To accomplish this step the mechanical and hydraulic properties of soils with and without soil amendments and at different relative densities will be first measured. Then, vehicles traversing typical archetype roadsides will be simulated using Msma3d software and a soft soil model with properties representing existing Caltrans practice. Finally, the simulations will be repeated, but with soil properties and geometrical characteristics consistent with BMP strategies. The results from these simulations will be articulated around an Excel (or other equivalent form convenient for Caltrans deployment) design and analysis tool. In the final tasks the research team will develop a final report that will be reviewed and refined with feedback from the Technical Advisory Panel and deliver a final workshop on the project findings.

WHAT IS OUR GOAL?
The goal of the research team is to integrate soil deformation models into simulations of vehicle dynamic response with site specific cross-sectional details and predictions of infiltration rates for various best management strategies. A systematic series of scenarios with different cross-sections and BMPs will be simulated and then evaluated to develop a user friendly design guide in the form of an Excel spreadsheet or other compatible form.

WHAT IS THE BENEFIT?
The ultimate benefit from this proposed research and the resulting design guidance tool will be substantial. Currently designers are faced with a need to maximize the stormwater infiltration in the Caltrans right of way. This area is limited and designers are having difficulty finding enough areas to infiltrate the required volume of stormwater. Thus, they have begun to incorporate soil amendments at a variety of depths and rates, which is inconsistent with standard Caltrans embankment specifications. As a result these strategies are having an unknown effect on the safety and future maintenance of the roadside. Providing a guide that allows engineers to ensure appropriate safety conditions exist in the right of way for a given amendment strategy will benefit these engineers and Caltrans as a whole by ensuring that the roadside design strategy maximizes infiltration rate and provides a safe and easy to maintain roadside.

WHAT IS THE PROGRESS TO DATE?
Contract has not been executed as of 07/2016