

Project Completion Report Rocky Mountains Cooperative Ecosystem Studies Unit (RM-CESU)

Project Title: GEOLOGIC STUDIES ON THE NORTH ENTRANCE ROAD

Project Code: UWY-170; P12AC10799

Type of Project: RESEARCH

Funding Agency: National Park Service

Partner University: UNIVERSITY OF WYOMING

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Start Date of Project: July 15, 2012

End Date of Project: December 31, 2014 (Project completed one year early to begin Phase 2 of the North Entrance Geologic Study)

Funding Amount: \$50,000

Project Summary: Report not restricted. The report is on file at YNP Heritage and Research Center Library, in the Branch of Cultural Resources and Geology Department of the Yellowstone Center for Resources, NPS Technical Information Center, The Office of the Wyoming State Archaeologist, and in the YNP Chief of Maintenance Division Office.

Number of students participating in this project: undergraduates, graduate students, degrees conferred. 1 graduate student

Lessons Learned from this project.

At the time of its construction in 1936 (reconstruction of an earlier road alignment), the North Entrance Road was a well-engineered modern road, conforming to highway standards of the time and constructed with a sensitivity to the park environment. It was constructed with little encroachment in to the Gardner River and laid relatively lightly on the land by using a curvilinear alignment to follow the ground contours and minimize cuts and fills. Highway engineering at the time tended to build over-steepened cut slopes and did not have a high emphasis on preventing rockfall. The culvert designs recognized a need to accommodate rocks clogging the ditches, but the culverts aren't sized large enough to accommodate larger events like debris flows. There were landslides in the first few years after construction and it is likely that most of these were related to the over-steepened cut slopes. Landslides in the cut slopes are not common today --the big challenges today are rockfall and debris flows.

Gardner Canyon spent the last 15,000 years since the glaciers trying to reach equilibrium between the slopes, the river, and the landslides across the river. It is safe to say that that balance was not achieved by nature before the highways construction. The road construction set back this process a bit and increased erosion in some of the most problematic areas evident today. This erosion undercuts the cliffs, causing rockfall, and feeds the channels with sediment with sediment where debris flows occur. Drainage channels tend to stabilize when they are allowed to build up material at their toe, but this can't be allowed to occur on the road bench, and the debris is removed. This tends to keep the drainages actively eroding upslope. It is impossible to tell how much of the challenges along this alignment are the result of the road and how much would be happening if no road was there. In the end it is irrelevant, the road needs to serve its purpose to provide safe access to its users. The report looks at questions about what can or should be done to improve access. Should the road be relocated? Can it be fixed where it is?

There are several approaches: one is to look at alternate routes within the Gardner canyon -- ways to adjust the alignment to move it to more stable locations in the canyon. Another is to look at alternative alignments outside the Canyon. Recognizing that any significant relocation alignment will require at least five years of study and design before construction can begin to be implemented, actions have to be taken to maintain the road for use until the new alignment would be available. What needs to be done; and are there ways to pick smaller pieces and work on them over a longer time to generally improve access and safety? These fall into short term and long term actions. The report first considers alternatives to the existing alignment, then provides recommendations for maintaining and moving toward improving the road on the current alignment. The report also discusses additional studies that can be conducted to further the park's knowledge and ability to plan for the future. Additional studies suggested for phase 2 include looking at scour; debris flow zones; alternate alignments; the Gardner High Road; rockfall hazard assessment; and stabilization of the shale cliffs.