Low-Water Crossings: Geomorphic, Biological, and Engineering Design Considerations

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Kim Clarkin, Hydrologist
San Dimas Technology and Development Center

Gordon Keller, Geotechnical Engineer
Plumas National Forest

Terry Warhol, Civil Engineer
Umatilla National Forest

Suzan Hixson, Hydrologist
Prescott National Forest

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Foreword

Low-water crossings are road-stream crossing structures designed to be overtopped by high flows or by debris- or ice-laden flows. They can be desirable alternatives to culverts and bridges on very low-volume roads and trails, and they can offer substantial environmental advantages in some stream environments. They are useful, for example, where streamflow is highly variable and large amounts of woody debris pose a risk to crossing structures. This publication reviews both the advantages and disadvantages of different low-water crossing structures in various stream environments and illustrates situations in which low-water crossings may be the optimal choice of crossing structure. The publication aims to provide multidisciplinary teams planning and designing road-stream crossing structures with answers to questions about where and how to best use overtoppable crossing structures.

The publication's four objectives are as follows:

(1) To address how low-water crossing structures affect stream functions and stability in various environments.

(2) To provide guidance for selecting low-water crossing structures that minimize disruption of channel processes and habitats.

(3) To summarize basic design parameters and requirements.

(4) To examine a wide range of field examples that illustrate the performance, problems, and advantages of different types of low-water crossings.

This publication is unique because it specifically deals with providing for aquatic organism passage and minimizing damage to channel stability and habitats. It focuses on the geomorphic and road management conditions that favor using low-water crossings as a means of minimizing negative effects to structures, stream channels, and aquatic habitats. It provides guidance on locating, selecting, and designing low-water crossings to fit the channel so they are less likely to obstruct stream functions, damage the aquatic system, and sustain structural damage during floods.

Meeting road management objectives while fulfilling site-specific biological and geomorphic goals requires a true interdisciplinary approach in which a biologist, and hydrologist, or geomorphologist work with the design engineer. Biologists and hydrologists do not usually have backgrounds in structural requirements for roads, traffic safety, road alignment issues, and the like. Engineers are not generally familiar with the swimming abilities and passage needs of fish or with fluvial geomorphology or sediment transport issues. A successful structure must

integrate the engineering requirements with hydrologic and biological factors. No one person or discipline has all this knowledge and range of experience. Many crossings that later failed were built by individuals who either had limited knowledge about these structures or did not consider all the relevant factors. Thus an interdisciplinary planning and design approach is critical to the overall success of a low-water crossing structure.

The publication is organized into five chapters.

Chapter 1 defines and introduces the various types of low-water crossings and explains in general terms where and when they can be useful.

Chapter 2 addresses key questions necessary for evaluating roads and sites in the larger context of the watershed and transportation system. This evaluation is critical in successfully launching a crossing replacement or construction project.

Chapter 3 describes the process of selecting the best structure for a site. For example, if the structure should be a low-water crossing, then what type of low-water crossing should be used? What considerations go into these decisions?

Chapter 4 brings together the basic tools and procedures for engineering design of low-water crossings, and shows how applying these tools and procedures can achieve various objectives.

Chapter 5 summarizes the authors' observations and recommendations about the benefits and risks of 11 types of low-water crossings.

Appendix A contains 21 case studies, some with plans and drawings from the actual construction contracts. Appendix A also lists the names of forest staff employees and others who provided the information and sometimes the photos for each case study. In addition, several case studies include information on similar structures in other locations.

Appendix B contains the Hydraulic Structure-Site Examination Form. Purpose and uses of the form are described in Chapter 4, section 4.2.

The authors trust this publication will help managers recognize—and develop designs for— sites where low-water crossings are likely to benefit the aquatic system. The publication also serves as a useful warning about unintended detrimental effects that low-water crossings can have on streams and aquatic species.

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