
Chapter Summaries

The NRCS Stream Restoration Design Handbook (NEH654) presents a variety of engineering and ecological assessment and design tools. This handbook is not meant to be read linearly as a book; it is a set of tools and approaches that can be applied to stream restoration designs. The terms river or stream may be used in this handbook, but the terms do not denote a statutory size or watershed drainage area limitation or requirement. Any work performed on rivers and streams is under the purview of all applicable Federal, state, tribal, and local guidelines.

Chapter 1 Introduction: Ecological and Physical Considerations for Stream Projects

The NRCS Stream Restoration Design Handbook provides guidance for teams of engineers, biologists, geomorphologists, hydrologists, landowners, and resource managers who are planning and designing stream restorations. Goals may include controlling floods or sediment sources, improving stormwater drainage, stabilizing banks, improving fish habitat, or restoring the ecological functions and processes of a stream and its flood plain. Many approaches and techniques can be used to reach these goals, but a good understanding of the living and nonliving components of the stream ecosystem, its watershed, how they interact and affect each other, and the timeframes over which stream processes occur will improve the probability of desirable outcomes. Chapter 1 presents a brief overview of current knowledge regarding stream ecosystem processes and functions important to consider when designing stream improvements. For a more comprehensive treatment of these processes, readers may wish to review one of several excellent references, including Stream Corridor Restoration: Principles, Processes, and Practices, developed by the Federal Interagency Stream Restoration Working Group.

Chapter 2 Goals, Objectives, and Risk

Chapter 2 addresses the development of goals and objectives and the assessment of risk from an ecological, as well as a life and property perspective. Identification of stream problems and their causes is a critical step in the overall planning process. Understanding the true nature of stream problems is challenging because of the dynamic nature of streams, their seasonal changes, responses to disturbances, and their ability to recover. Recognizing the current condition of a stream, comparing it to historical conditions, and projecting its future conditions are challenging; nonetheless, the conditions to be documented determine goals and objectives met through the outcomes of the plan. Risk and risk assessment is introduced in this chapter and also described throughout this handbook.

Chapter 3 Site Assessment and Investigation

Chapter 3 describes procedures for assessing watershed and site conditions. Stream corridor inventory and assessment techniques are identified and compared. Information is provided on stream stability, as well as geological and biological assessments. A description of the uses, advantages, and disadvantages of various geomorphic stream classification systems is also provided. This chapter addresses fluvial processes and broader geologic issues related to ecological function, as well as stream design and behavior.

Chapter 4 Stream Restoration Design Process

Conservationists are frequently faced with conditions along and in streams that are characterized as problems because certain functions are not being provided or simply that the overall character of the stream system has changed. It may be that the system is damaged and needs to be repaired or that a shift in perception of stream functions and values has occurred, spurring some sort of action to be taken.

Often, solutions to identified stream problems are suggested at the time that they are identified, such as: “The streambank is sloughing in. We need to put rock riprap on it.” It could be that the problem merits that response. It could also be that the nature of the bank erosion problem is more complex and may be related to a general instability of the stream system. This chapter describes design approach that is applicable to the variety of potential treatment alternatives that are employed.

Chapter 5 Stream Hydrology

Stream restoration designs should consider a variety of flow conditions from both an ecological, as well as a physical perspective. A wide variety of sources and techniques for obtaining hydrologic data are available to the designer. Chapter 5 provides a description of the flows and their analysis that should be considered for assessment and design. The computation of frequency distributions is presented. Transfer equations, risk, and low flow methods are also addressed. This chapter also describes advantages and limitations of four general approaches for estimating channel-forming discharge or dominant discharge for stable channel design.

Chapter 6 Stream Hydraulics

Human intervention in the river environment, especially with projects intended to restore a riverine ecosystem to some healthier state, must take full consideration of streamflow, or stream hydraulics. Chapter 6 provides working professionals, both engineers and non-engineers, with practical information about hydraulic parameters and associated computations. It provides example calculations, as well as information about the role of hydraulic engineers in the project design process.

Chapter 7 Basic Principles of Channel Design

Channel design may involve the stabilization or realignment of an existing stream, or it may involve the creation of an entirely new channel. A wide variety of sources and techniques for designing stable channels are available to the designer. These techniques may focus on open channel design work ranging from natural stream restoration to primarily structural rehabilitations. The purpose of chapter 7 is to provide a framework to the designer to assess the use and application of several analysis and design techniques, which are presented in greater detail in subsequent chapters. Chapter 7 provides background that should be useful in the evaluation of the appropriateness of these techniques to address specific goals, constraints, and conditions. To provide a context for the different design techniques, a clear description of threshold and alluvial channels is presented. In addition, a general description of channel design variables and approaches is presented. These broad and occasionally overlapping categories of stream types and design approaches can be used to evaluate the appropriateness of the design techniques for a specific objective and site.

Chapter 8 Threshold Channel Design

Threshold channel design techniques are used for rigid boundary systems. In a threshold channel, movement of the channel boundary is minimal or nonexistent for stresses at or below the design condition. Therefore, the design approach for a threshold channel is to select a channel where the stress applied during design conditions is below the allowable stress of the channel boundary. There are a wide variety of sources and techniques for designing stable threshold channels that are available to the designer. Chapter 8 provides an overview and description of some of the most common threshold channel design techniques. Examples are provided to illustrate the methods.

Chapter 9 Alluvial Channel Design

Alluvial channel design techniques are generally used for movable boundary systems. In an alluvial channel, there is a continual exchange of channel boundary material with the flow. Therefore, the design of an alluvial channel requires an assessment of sediment continuity and channel performance for a range of flows. Many sources and techniques for designing stable alluvial channels are available to the designer. Chapter 9 provides an overview and description of some of the most common alluvial channel design techniques. The use and application of regime, analogy, hydraulic geometry, and analytical methods are presented and described. Examples are provided to illustrate the methods.

Chapter 10 Two-Stage Channel Design

Constructed channels are part of extensive portions of productive agricultural land in the United States. These channels provide important drainage and flood control functions. However, these agricultural channels are often constructed as traditional trapezoidal ditches using threshold design techniques. While this approach is suitable in some areas, channels of this design can require frequent and expensive maintenance in other parts of the country. This maintenance is often in the form of dredging and clean-out of deposited sediment. In addition, natural ecological functions can be lost. This chapter presents an alternative design to the conventional drainage channel, which seeks to mimic natural alluvial channel processes through the use of a two-stage channel design. This two-stage channel system incorporates benches that function as flood plains. However, these two-stage channels are not an exact copy of natural streams, as the width of the benches is often small due to the confining geometry of the constructed channel. This chapter outlines measurement and analysis procedures that can be used to design two-stage channel systems that are more self-sustaining than conventional one-stage constructed channels.

Chapter 11 Rosgen Geomorphic Channel Design

Chapter 11 outlines a channel design technique based on the morphological and morphometric qualities of the Rosgen classification system. This approach has been implemented throughout numerous locations in the United States and is often referred to as the Rosgen design approach. The essence for this design approach is based on measured morphological relations associated with bankfull flow, geomorphic valley type, and geomorphic stream type. This channel design technique involves a combination of hydraulic geometry, analytical calculation, regionalized relationships, and analogy in a precise series of steps. While this technique may appear to be straightforward in its application, it actually requires a series of precise measurements and assessments.

Chapter 12 Channel Alignment and Variability Design

Natural channel design includes establishment of a stable planform and often the incorporation of variability within the channel. The designer of a channel is also often asked to provide an assessment of natural bankline migration, as well. The purpose of chapter 12 is to provide systematic hydraulic design methodologies that can be used in the performance of these tasks. A wide variety of sources and techniques for these assessments are available to the designer. An overview and description of some of the most common design techniques are described. Examples are provided to illustrate the methods.

Chapter 13 Sediment Impact Assessments

Sedimentation analysis is a key aspect of design since many projects fail due to excessive erosion or deposition. A sediment impact assessment is conducted to assess the effect that a full range of natural flows will have on possible significant aggradation or degradation within a project area. Chapter 13 provides a brief overview of several types of sediment impact assessments along with their rigor and level of uncertainty. The focus of this chapter is primarily on techniques that are appropriate for the analysis of alluvial channel, but threshold channels are also described. While there are variants in each of the presented techniques, and more information may be required to perform the assessments described, it is the intent of this chapter to provide the reader with an introduction to sediment impact assessments sufficient to select the appropriate approach for many circumstances. References are provided that outline specifics regarding the mentioned techniques.

It should also be supplemented that while this analysis of the sediment impact assessment is presented in the context of following the channel design, much of this analysis should also be done in the sediment assessment phase of the design process that precedes channel design. However, it is supplemented here as an important closure loop on any proposed design.

Chapter 14 Treatment Technique Design

Stream design and restoration often includes specific treatments on the riparian area, on the bank, or in the bed of a stream. Treatments can include techniques that provide ecological enhancement, as well as protection of these areas. This chapter provides an overview of some of the frequently used treatment techniques for bank protection, grade protection, and habitat enhancement, using a wide range of plant materials, rock, and other inert materials. In addition, analysis techniques that are needed for the successful design of these and other techniques are provided. Where information is available, the benefits, flexibility, risks, and costs of each technique are described from a physical, as well as an ecological perspective.

The list of techniques in this chapter should not be interpreted as an endorsement of any product that is mentioned, nor should it be inferred that one treatment or approach is superior to another. The approaches listed are not exhaustive. Other techniques, as well as variations of each of the ones described, exist and may be appropriate and applicable for use in restoration designs. This chapter provides techniques which often focus on the treatment of local problems, but these techniques and other design elements are often used to provide a holistic approach in larger or more complex restoration projects.

Chapter 15 Project Implementation

Chapter 15 addresses general project implementation issues with an emphasis on NRCS programs, requirements, and guidance. The four phases involved in project implementation are planning, design, contracts and agreements, and installation. This chapter describes how each phase is interrelated, how each phase requires knowledge of the limitations or restrictions of the other phases, and provides a general overview of project implementation.

Chapter 16 Maintenance and Monitoring

Maintenance and monitoring are actions intended to ensure the objectives of the stream restoration project are met over time. Continued performance of the project features and stream system health are dependent on appropriate maintenance and monitoring of the system. Chapter 16 provides an overview of key issues in the development of monitoring and maintenance plans. Incorporation of adaptive management as a component of operations is included as a possible approach to maintenance and operation of the project.

Chapter 17 Permitting Overview

Stream design and restoration design activities are subject to various local, state, and Federal regulatory programs. Most of these regulations are aimed at protecting natural resources and the integrity of the Nation's water resources. Chapter 17 provides a brief overview of the regulatory authorities and programs that may be applicable to stream design work. The focus is providing an awareness-level understanding of this important issue and sources to obtain more and current information. The reader should not interpret the description provided in this chapter as the only source of regulatory requirements. Local, state, and Federal regulatory authorities should be consulted as part of the planning and design efforts.

