Guidelines for Bank Stabilization Projects

In the Riverine Environments of King County

King County
Department of Public Works
Surface Water Management Division
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PREFACE

These guidelines have been developed to assist scientists and engineers with the design of bank stabilization projects for river and streambank protection in Western Washington. This document include several types of methods that use various materials such as rock, timbers, soil, plants and natural fabrics. Together, these materials create a complex matrix that join with the native bank materials to provide erosion protection.

Bank stabilization projects that integrate vegetation with other materials have proved very effective at stabilizing bank failures in King County. Vegetative methods also provide a number of important benefits such as enhancing fish and wildlife habitat, reducing local stream velocities, and lowering long-term maintenance costs.

These guidelines are the first comprehensive effort by King County in presenting information on bank erosion and stabilization techniques for large river systems. Presented within are many types of bank stabilization methods. The document, however, does not include all types of erosion protection. Measures that require the use concrete, large amounts of wire or cable, or do not match the natural setting were not included because of their effects on the natural resources and recreation values in western Washington streams.

This document was produced by several authors who have extensive experience in a variety of scientific fields. In doing so, the guidelines reflect the multidisciplinary team needed to analyze erosion problems and develop bank stabilization solutions. An interdisciplinary team of soil and plant scientists, engineers, geologists, and fisheries biologists should be involved in every phase of the project to ensure that important design elements are included. Project proponents, especially those without technical expertise in river systems, should always seek the advice of an experienced, interdisciplinary team before deciding on any course of action. These guidelines should not be used in place of the interdisciplinary team.

Because integrated soil-plant-rock systems encompass many scientific areas, no single design reference will cover all aspects of the project elements in detail. Throughout the document, additional reading sources have been referenced that should be utilized for design criteria. After thoroughly reading this document, the reader will have a basic understanding of the complexity of natural stream systems and utility of the bank stabilization techniques.

This is a practical guide for assessing erosion problems, evaluating alternative solutions, and designing and constructing a bank stabilization project. Careful pre-project planning, on-site construction supervision and post-project maintenance are all important elements of successful stabilization projects. Integrating a well-planned and constructed stabilization project with the unique characteristics of a river and stream will have long-lasting benefits.

Readers are encouraged to share their successes and failures with other practioners. In this way, the successful application of these techniques will be advanced in King County and throughout western Washington.

CHAPTER 1

INTRODUCTION

Six major rivers and a large network of tributary streams flow through King County. Most of these drainages originate in the upper elevations or foothills of the Cascade Mountains in the eastern part of the County and flow westward to Lake Washington, Lake Sammamish, and Puget Sound. These rivers and streams are a highly valued natural resource in the County, providing important ecological, economic, recreational and aesthetic benefits to its residents.

As the County's population has grown, an ever-increasing number of residents has chosen to live, farm, or do business along its rivers and streams. Because most river and stream channels naturally move horizontally and vertically over time, many developments along these waterways may be threatened by erosion that causes streambank failures.

Streambank failure is one of two major problems associated with living near these waterways—the other is flooding. Both these problems cause serious property damage in King County every year and tend to occur coincidentally; that is the high flows that cause flooding also tend to cause episodes of accelerated bank erosion. In 1990 alone, flooding and bank erosion caused over $15 million to public and private property damage along King County's rivers and streams (King County 1993).

1.1 THE NEED FOR A NEW APPROACH

In the past, the solution chosen to protect public and private properties from serious bank erosion typically was to cover the eroding bank with a blanket of riprap (i.e. large, angular rock). Riprap was dumped from the ends of trucks onto the bank to create a revetment.

Most of the riprap revetments built in King County in the past were funded under the County's River Management Program (previously, the River Improvement Program). At present, that program is not funded to build any new capital improvement projects. The program's bank stabilization efforts are limited to maintaining projects built in previous years. However, even this basic level of service can be quite expensive. For example, the cost of repairing damages to County-maintained revetments after the 1990 floods was estimated to exceed $4.5 million.

In recent years, numerous scientists and public works managers responsible for river management have examined the traditional approach to bank stabilization projects. These professionals have debated if and when bank stabilization should occur and how stabilization projects should be built and maintained. As a result of their efforts, new approaches are emerging.

Bank stabilization methods that use a combination of rock, soil and plant materials create a complex grid, or matrix, of different materials in the bank. As the vegetation in the project site becomes established, the bank becomes naturally stronger and resistant to erosion, reducing the need for maintenance. At the same time, the vegetation improves fish and wildlife habitat and reduces local stream velocities. These projects thus provide an environmentally sensitive, low-maintenance solution with lower long-term costs.

Bank stabilization techniques that use soil, vegetation, and rock, have been successful in various places across the United States and Europe. Most significant, however, is that a number of recent projects have proven these methods to be highly effective method of erosion control along major rivers and streams in King County. The County has constructed these types of projects on the Cedar, Green, and Raging Rivers and Issaquah Creek. Two projects on the Raging River and Issaquah Creek were installed only shortly before the record-setting November 1990 flows, leaving no time for vegetation to become established. The projects, however, survived remarkably well. Although minor damage was evident, these projects

prevented further erosion of the immediate area during unprecedented flooding. Today, these projects provide both effective erosion control and environmental enhancement.

In recognition of these new approaches to bank stabilization, the 1993 *King County Flood Hazard Reduction Plan* recommended these techniques for numerous bank stabilization projects throughout the County. To fulfill this recommendation and satisfy an increasing demand for information about these methods, King County initiated efforts in 1990 to prepare bank stabilization guidelines.

1.2 SCOPE AND INTENDED AUDIENCE OF THE GUIDELINES

This document provides scientists, engineers and other technical specialists guidelines for planning, designing, building, and maintaining bank stabilization projects along major rivers and streams in King County. These guidelines are intended both for proposed bank stabilization projects along rivers and streams and for the repair of existing levees and revetments. The focus is on medium to larger stream and river systems (systems with mean annual flows of 20 cubic feet per second or more). These systems are regulated as "shorelines of the state" under the King County Shoreline Master Program. The concepts included in this document, however, could be use in conjunction with other natural resource information when considering revegetation projects on smaller sized streams.

Fish habitat considerations are integral in bank stabilization projects and are discussed in that context within this document. Detailed discussion of fish habitat modifications not associated with the specific goal of bank stabilization were considered beyond the scope of this document. Information of channel modifications for the purpose of benefitting fish habitat is available through many other resources, and so, was not included in this document.

These guidelines are not intended as a "design manual" prescribing precise standards and formulas for bank stabilization projects. Nor is it intended to set regulatory thresholds. Rather, these guidelines provide information and parameters while leaving a fair amount of discretion to the engineer and other technical specialists developing the project within existing regulatory requirements.

The application of bank stabilization methods is evolving, and the body of empirical data is too limited to provide the kind of precision found in traditional design manuals. Moreover, intuition as much as practical science is needed when applying these techniques. Professional and field experience with problem-solving along rivers and streams, and a thorough understanding of the riverine site under investigation are all essential for developing bank stabilization solutions. None of these qualifications can be provided by any set of written guidelines.

For these reasons, these guidelines are intended for a very specific and well-qualified audience. Users of this document should have a comprehensive background in river systems and specific training in one or more of the following: open channel hydraulics, sediment transport, geomorphology, riparian ecology, or aquatic and terrestrial habitats. Because these guidelines rely heavily on the designer's ability to integrate engineering expertise with the soil, plant, and biological sciences, it is strongly recommended that a multidisciplinary team approach be used when developing or reviewing possible bank stabilization projects.

These guidelines are a first step in a long-term effort to study, improve, and promote bank stabilization methods that enhance the natural resources of King County and western Washington. Refinement of procedures in this document is expected and encouraged so that others may learn from the creativity of innovative designers.

1.3 OVERVIEW OF THE GUIDELINES

The guidelines consist of nine chapters covering the following topics:

- Chapter 1 - this *Introduction*;
- Chapter 2 - *The Riverine Environment*, a description of the geology and ecology of rivers and streams in Western Washington, specifically King County;
- Chapter 3 - *Modes and Causes of Bank Failures*, a discussion of different erosion and bank failure processes and how to identify which process is at work;
- Chapter 4 - *Project Planning*, an overview of what questions to ask, and what data to gather, when planning a project;
- Chapter 5 - *Permits and Policies*, a discussion of government regulations, permit requirements, and policy issues that project planners need to understand;
- Chapter 6 - *Role and Use of Vegetation*, a description of how vegetation can be used in bank stabilization, and the benefits it can provide;
- Chapter 7 - *Design Guidelines*, a discussion of various design options for different circumstances, and guidelines for how to select the best alternative;
- Chapter 8 - *Construction Procedures*, a step-by-step description of how to install bank stabilization projects;
- Chapter 9 - *Long-Term Site Management*, guidelines for how to monitor projects after construction and maintain them to ensure effectiveness.

These chapters are followed by a glossary of important terms, a list of references for those seeking additional information, and four appendices.