FORUM ARTICLE

STREAM CORRIDOR RESTORATION: PRINCIPLES, PROCESSES, AND PRACTICES (NEW FEDERAL INTERAGENCY GUIDANCE DOCUMENT)

Introduction

Previous generations of hydraulic engineers were associated with projects that featured major structural interventions in streams and rivers: construction of dams, canals, channelization projects, levees, etc. In recent years, a growing national and global awareness of environmental issues, in general, and of the importance of streams, in particular, has resulted in numerous projects intended to restore or rehabilitate environmental resources degraded by earlier engineering projects or other factors. For example, Fig. 1 shows a stream corridor damaged by fluvial response to channelization, where rehabilitation measures constructed around 1991 have resulted in partial recovery of riparian zone vegetation. The growing importance of stream restoration to the profession is illustrated by the growth in the literature dealing with stream and river restoration over the last 20 years (Fig. 2). A recent ASCE specialty conference on river and wetland restoration is a noteworthy example of the growth in this area (Hayes 1998).

Document Production

In conjunction with the growing interest in stream restoration, an interdisciplinary group of technical leaders representing several federal agencies met initially to explore possibilities for a stream corridor restoration guideline in late 1994. Early in 1995, a series of meetings were held to develop an ambitious list of expectations for the document and an outline, and extended to 15 federal agencies that agreed to produce a single reference to be used to guide, educate, and assist people in restoring stream corridor functions and values. The following expectations were developed for the utility of the document:

1. Breadth sufficient for ''one-stop shopping''
2. Based on sound scientific principles
3. Approach sensitive to social, political, and economic considerations
4. Layout and vocabulary appropriate for use as a technical reference by field office professionals and technicians, as well as a diverse group of private landowners, consultants, and others
5. Scope applicable to all ecoregions in the United States
6. Format to allow inclusion of local and regional supplements to maximize the utility to diverse field offices
7. Useful in evaluation of landscape and watershed characteristics contributing to satisfactory or unsatisfactory stream corridor conditions

The expectations for the document's content ranged from specific to general, and included

1. A process to formulate reasonable alternatives and logically arrive at optimal solutions
2. An array of practical techniques and systems to restore stream corridor structure, function, and values
3. An ecological approach to stream corridor restoration and management
4. Intended to be policy neutral; however, the document would provide a basis for making policy
5. Information allowing optimization of non-point-source pollution prevention using streamside buffers
6. A compilation of native plant species that were suitable candidates for stream corridor restoration
7. Insights filling information gaps for abatement of sediment and nutrient loading
8. A compilation of references and general descriptions of techniques for monitoring and field testing

In the opinion of this writer, most of these expectations were ultimately met.

As the outline was developed, workers were organized into two teams: the steering team, composed of about 30 agency executives and technical leaders; and the production team, which was composed of a similar number of persons representing disciplines including hydraulics, biology, ecology, landscape architecture, geomorphology, soil science, and forestry. From the outset, several issues arose as engineers and scientists from diverse educational and agency viewpoints began to work together:

- What level of detail should be provided?
- How much space should be devoted to fundamentals?
- How specific (''cookbook'') should the document be? For example, should techniques for measuring stream discharge be described, or should standard guidelines be referenced without comment?
- What approaches to channel design should be recommended?
- What balance should be struck between descriptive material and prescriptive?
- How much emphasis should be provided to passive (remove disturbance) restoration approaches relative to active intervention (modify landscape)?
- How should classification systems be presented?
- What order of presentation and document organization is best?
- How should key terms be defined?

Issues were gradually resolved through often spirited discussion among members of the two teams. A key factor leading to resolution of many issues was the definition of the intended audience. The target audience was defined as interdisciplinary teams responsible for planning, design, and implementation of stream corridor restoration efforts. A secondary audience composed of landowners, contractors, conservation groups, and agency executives was also identified. The document was intended primarily for national application to streams smaller than rivers that support commercial navigation.

Production of drafts proceeded after the initial outline was finalized. A subset of the production team wrote chapter sections and identified experts within and without federal service to write other sections. Some writing was done by contractors. Production team members and leaders then attempted to merge contributions into a coherent document which was subjected to several rounds of review, including review by a panel of about 19 independent experts with experience in stream restoration. The expert panel represented all major regions of the United States and a wide range of disciplinary backgrounds.

Final revisions involved addressing comments by the expert panel, late agency reviews, and editorial revisions. A draft (preprint manuscript) version was released via the World Wide Web at ⟨http://www.usda.gov/stream_restoration⟩ in the fall of 1998. The initial press run and shipping of hard copies was completed in December 1998. An official ceremony marking the release of the handbook in concert with the first anniversary of the federal Clean Water Action Plan was planned for February 1999.

(a)

(b)

FIG. 1. Goodwin Creek, Miss.: (a) Facing Upstream in 1986, Prior to Stream Corridor Rehabilitation; (b) Same Location Facing Downstream in 1996

Content

Leaders of the project defined a key constraint early in the process: the content was to be policy neutral and science based. With so many agencies and individuals involved in the production process, reaching consensus on purely scientific grounds was difficult. If policy matters had been included, the process would have become much more difficult—perhaps impossible. Although no direct policy statements are included, the document contains a strong bias in favor of nonstructural restoration strategies, reflecting the philosophy and values of many of the federal land-management agencies. Structural approaches are included throughout the document, but generally follow presentation of nonstructural approaches intended to restore a natural hydrologic regime and plant communities. The document was produced as a loose-leaf binder to allow for easy insertion of supplementary materials. A table of contents is reproduced in Fig. 3. The document is divided into three major parts and nine chapters, each marked with colorful dividers. Readers are aided by a detailed table of contents, a brief index, and numerous photographs and illustrations. Color is used throughout the document to mark highlights and contrasts. Marginal notes, text boxes containing case studies or in-depth discussion of special topics, and cross-references are used to create linkages. Many readers may feel that the figures represent the strength of the document and make it useful for self-guided instruction or as a source of visual aids for classroom instruction.

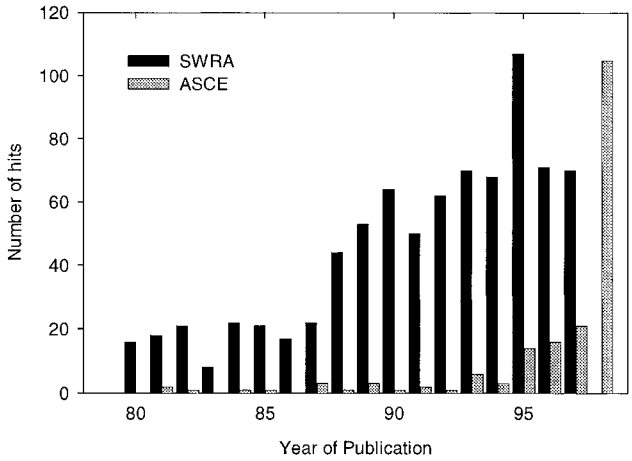

FIG. 2. Number of Citations Obtained from Water Resources Abstracts Database (November 1998) and ASCE Web Site Database (⟨http://www.pubs.asce.org/cedbsrch.html⟩, February 1998) When Searched with Keywords "{(Stream or River) and Restoration}" versus Publication Year

Part I: Background

1. Introduction
2. Stream Corridor Processes and Characteristics
3. Disturbances to Stream Corridors

Part II: Developing a Restoration Plan

4. Getting Organized, Identifying Problems and Opportunities
5. Developing Goals and Objectives and Selecting Alternatives
6. Implement, Monitor, Evaluate, and Adapt

Part III: Applying Restoration Principles

7. Stream Corridor Condition Analysis
8. Restoration Design
9. Managing and Monitoring Stream Corridor Restoration

Appendix: Techniques for Restoration

Index

FIG. 3. Table of Contents, *Stream Corridor Restoration: Principles, Processes, and Practices*

Many members of the production team argued that the content should emphasize functions and processes common to unimpaired stream corridors rather than design guidelines. Accordingly, the first three chapters and much of the seventh chapter, comprising almost half of the document, deal with descriptions of stream corridor systems and how they respond to perturbations. Content includes fundamentals of watershed hydrology, stream ecology, water quality, and fluvial geomorphology. Much of the fundamental knowledge as well as applied science contained in the document does not represent the current state of the art, but lags behind recent developments by several years.

Hydraulic engineers will find the basic information on biology and water quality in Chapters 2 and 3 enlightening and easy to read. Engineers charged with project management may find valuable insights in Chapters 4, 5, 6, and 9. Representatives of some agencies objected to the generic guidance provided in chapters dealing with planning stream corridor restoration projects, fearing interference with standard agency policies and practices for project planning. However, others noted the lack of a sufficiently broad perspective and clear-cut

goals in many existing restoration projects, and stressed that these guidelines would be valuable to some users.

Most information dealing with aspects of water resources engineering is found in Chapters 7 and 8. These chapters include basic information on hydrologic analyses (e.g., determining an appropriate design discharge), geomorphic analyses (assessment of channel stability), and channel design (determination of average width, depth, and slope for reconstructed channels). Sections describing data collection and analysis are at an introductory level. Rudimentary descriptions are provided of the instruments needed, the types of information collected, and the kinds of analyses that may be performed, but reading the handbook will not enable people to perform as if they had received formal technical training—coursework in an accredited academic program and experience under the direction of licensed professionals. However, the intent of the authors and editors was not to make engineers of biologists or biologists of engineers, but to foster communication among the broad array of disciplines required for successful stream corridor restoration planning, design, implementation, and management. That is why the intended audience was described as ''interdisciplinary teams'' rather than individuals, as noted above.

Chapter 7 includes discussion of stream classification systems and channel evolution models, including the highly controversial Rosgen classification system. However, the discussion includes caveats regarding limitations of classification systems. No direct linkage between classification of degraded stream corridors and appropriate design approaches is presented. Literature dealing with stream classification is reviewed. Classification systems are presented as tools useful for describing stream corridors and understanding the dominant fluvial processes shaping them.

Stable channel design for stream corridor restoration is presented in Chapter 8. Although three approaches for determining channel dimensions (average width, depth, and slope) are presented, the treatment of state-of-the-art engineering tools is light. Only two paragraphs are devoted to physical modeling, and a broad review of computer models occupies little more than two pages. Older tools such as empirical regime or hydraulic geometry formulas, allowable velocity, and allowable shear stress are covered in greater detail. Sediment transport fundamentals are presented in earlier sections, and a short review of sediment transport relationships and analyses is included, along with a review of channel design approaches based on extremal hypotheses.

The text concludes with a brief but very practical chapter on project implementation, monitoring, and management that parallels a more philosophical treatment of the same topics in Chapter 6. Although many construction agencies have their own detailed guidance for inspection and management of construction contracts, others will find the concepts presented in Chapter 9 useful, particularly the sections on handling living plant materials and minimizing disturbance.

Material describing structures and management practices is located in Appendix A, which contains brief fact sheets about each measure. Of the 36 measures presented, 28 are either simple hydraulic structures or require some type of hydraulic engineering analyses in their design. Material presented in the appendix is limited to a simple schematic drawing of each measure, a bulleted list of constraints, and a list of references to various types of literature. Clearly, this document is not a hydraulic design standard or guideline, but will likely be used (and misused) as one on occasion.

Conclusions

Partnering within the federal government is a popular concept, but hard to implement. A process of partnering among 15 federal agencies and many colleagues outside the federal government has produced a large and complex guidance document on stream corridor restoration. Although the final product is far from perfect, those who have labored to bring it to press hope that it will lead to wiser stewardship of our nation's stream corridors.

Stream Corridor Restoration: Principles, Processes, and Practices by the Federal Interagency Stream Restoration Working Group is available from the National Technical Information Service (NTIS), Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. The NTIS may also be contacted at 1-800-553-NTIS, 703-605-6000, or via e-mail at ⟨orders@ntis.fedworld.gov⟩. Its Website is ⟨http://www.ntis.gov⟩. Cost is $71 ($142 outside the United States, Canada, and Mexico) for a hard copy (PB98-158348LUW), or $60 ($90 outside the United States, Canada, and Mexico) for a CD-ROM version (PB98-502487LUW) with search engine plus a $5 handling fee per order.

APPENDIX. REFERENCE

Hayes, D. F., ed. (1998). ''Engineering approaches to ecosystem restoration.'' *Proc., 1998 Wetlands Engrg. and River Restoration Conf.*, ASCE, Reston, Va. (available on CD-ROM).

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