A STUDY OF THE SHAPE OF CHANNELS FORMED BY NATURAL STREAMS FLOWING IN ERODIBLE MATERIAL

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INTRODUCTION

For many centuries man has been concerned with the action of rivers. In most cases, the highest forms of the earliest civilizations developed in the fertile river valleys, such as the Nile, Euphrates and Indus, and the life of the people was greatly influenced by the action of these streams. The importance of streams in the life of the human race has remained a major factor down to the present. In the past few centuries rivers have been studied and to a minor extent controlled, but in the past half century the idea of developing the total resources of our streams has evolved, which will result in material change in the conditions under which the streams flow. Considerable development work has already been completed, and important changes are becoming evident in the forms of some of the controlled streams, which were largely unanticipated when the works were first planned. Interest in the total development of the streams has spread to the less developed countries, and if the present rate of progress is continued, the next half century will see the streams largely developed in the more fortunate countries, and a very large degree of progress in development reached in many of the less fortunate ones. As a result in the near future the number of cases of changed stream forms will be greatly increased. Moreover, there is ample reason to believe that the magnitude of these effects will increase with time, so that they will be even more important in the future. Some of these changes will be beneficial and some, detrimental. It is very important that, so far as possible, in planning future water resource development projects, these changes be anticipated and advantage be taken of the favorable changes, and the unfavorable

ones, so far as possible, be guarded against. For best results this must be done during the period when the works are designed, so that the necessary steps can be made during the original construction, when they usually can be built most economically. These changes may be of the nature of a raising or lowering of the stream bed, or may be a change of stream width. They may also involve a change in the stream alignment, in a straightening of the stream or a change in the direction of more crooked alignment. Considerable study has been given to the changes involving raising or lowering of the stream bed, (1,2) and some study to changes in river width (3) but except for studies of meandering streams, little attention has been paid to changes in alignment. This is probably because the latter changes go on more slowly, and the effects of past construction has not yet become evident. It is therefore not practicable to predict the nature of the future changes from a study of changes that have occurred in the past. The only approach available therefore seems to be a study of the forms of natural streams and of the conditions which give rise to these forms. The changes which will occur can then be inferred from the nature of the changes in conditions that have been or will be made by the engineering works.

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(1) E. W. Lane. 1955. The Importance of Fluvial Morphology in Hydraulic Engineering. A.S.C.E. Proceedings Separate 745.

(2) Retrogression of Levels in Riverbeds below Dams. Engineering News-Record Vol. 112, June 28, 1934, pp 836-838.

(3) Leopold, L. B. and Maddock, Thomas Jr. 1953. The Hydraulic Geometry of Stream Channels and Some Physiographic Implications - U. S. Geological Survey Professional Paper 252.

As is so often the case when an advance is made in knowledge in a given field, the new information is useful in ways which were not anticipated when the study leading to the advance was made. Therefore, in the case of this study, it is believed that the increased knowledge of streams will be beneficial in ways that cannot now be foreseen, in a number of fields. One of these is in geology, where the study of morphology or physiography is an important subject. The forms of streams is an important part of this field of knowledge, and it is hoped that this study will be useful in that field also.

Scope of the Study

Because of the great variety of conditions affecting stream forms, to have a study of reasonable extent, it was necessary to limit considerably the scope of this investigation. In investigating any complex phenomenon, it is necessary to start first with the simpler aspects, for until one can understand these, there is no hope of understanding the more complex cases. The work will therefore be confined largely to the forms which streams carve for themselves in erodible material. In order that the ideas developed may be useful to a wide range of persons, it will be presented in as simple terms as possible, with the mathematics reduced to a minimum, since so many engineers and geologists have lost, through disuse, their ability to handle readily explanations in mathematical terms.

The channel of a stream may be considered to be an irregular, three dimensional solid. It can be adequately represented by a topographic map, but few maps giving the configuration of the stream bottom are available. The material usually available consists of maps, cross sections, and profiles. In this study, generally only the plans and profiles have been used, as the form of