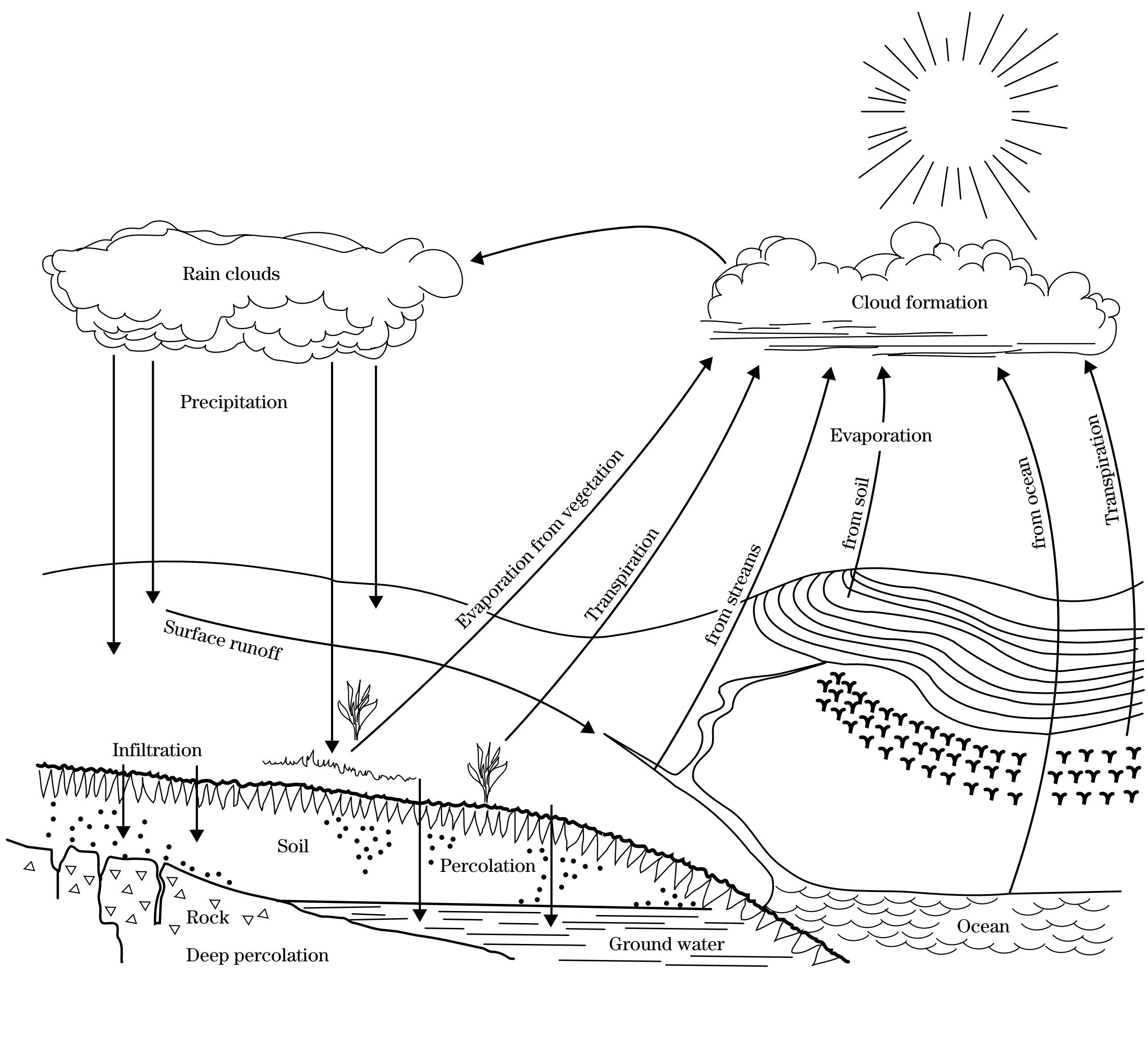
United States Department of Agriculture
Natural Resources Conservation Service

Part 630 Hydrology
National Engineering Handbook

Chapter 3 Preliminary Investigations



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Chapter 3 Preliminary Investigations

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630.0300 Introduction

A preliminary investigation (PI) is a brief study of a potential project to estimate whether a detailed investigation is justified. For a watershed protection and flood prevention project, the PI is mainly concerned with flood problems and their solutions. A planning team makes a PI by examining available reports and data for a watershed, making a field reconnaissance, briefly evaluating their findings, and writing a concise report. U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) policy assigns the responsibility for selecting the degree of intensity of a PI to the State Conservationist. Once this degree is selected, the planning team modifies its procedures accordingly and makes the study. The hydraulic engineer can make a valuable contribution to the study by supplying appropriate reports and data, using suitable techniques on the problems, and developing new techniques as the need arises.

630.0301 Making the preliminary investigation

During a PI, the hydraulic engineer may be required to work in fields other than hydrology. Because of this, chapter 3 covers the general concepts of a PI without undue emphasis on the hydrologic analysis.

(a) Examination of available reports and data

Any earlier reports made for the area in which the watershed is located should be examined. Such reports may include material useful in evaluating a potential project or in preparing the PI report. U.S. Department of Interior's Bureau of Reclamation, U.S. Army Corps of Engineers, USDA Agricultural Research Service, USDA Forest Service, and State engineer reports may give applicable information or data. U.S. National Weather Service, U.S. Geological Survey (USGS), NRCS National Water and Climate Center, and State university publications may provide appropriate data on rainfall and runoff. NRCS soil survey reports provide soils and generalized cover information. The local NRCS conservationist can readily evaluate a wide range of information regarding a specific watershed in the area.

(b) Reconnaissance

A field reconnaissance gives the watershed staff an opportunity to become familiar with the physical characteristics of the watershed. This familiarity is necessary to avoid making gross mistakes in evaluating the available information or in writing the report. Before conducting reconnaissance, the staff obtains aerial photographs and other available maps of the watershed. Sources of detailed maps include those prepared by the NRCS National Cartography and Geospatial Center, NRCS soil survey maps, and USGS topographic or other similar maps.

In addition to their use as direction finders, the photographs or maps are used in the field for recording possible sites of project measures, designating areas of major floodwater or sediment damages, and indicating areas requiring intensive study in a detailed investigation.

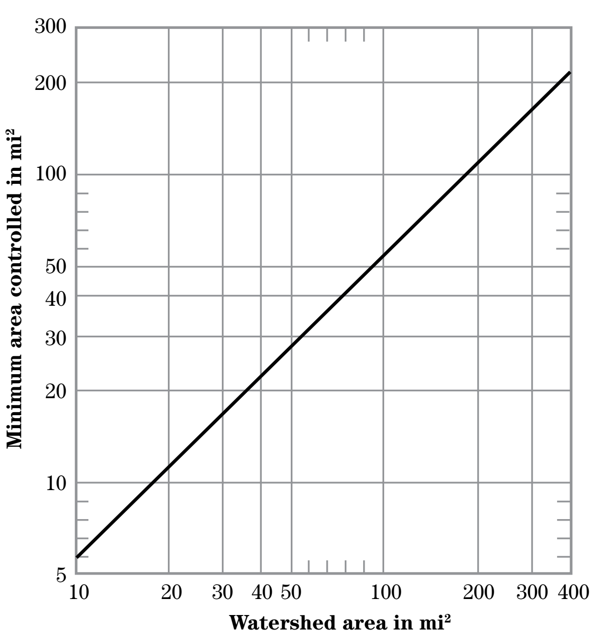
During the reconnaissance, the hydraulic engineer obtains estimates of Manning's n (NEH 630.14), natural storage areas (lakes, large wetlands), and hydrologic soil cover complexes (NEH 630.07, 630.08, and 630.09) if such estimates are needed in the evaluation or report.

(c) Evaluation

The PI report is concerned with a potential project and its economic justification. Magnitudes of rains or floods and similar data are introductory material of minor interest, but the quantities of measures, damages, benefits, and costs are of major interest. The required quantities can generally be estimated by use of relations developed from workplans or other studies already completed for the physiographic region in which the watershed lies.

Some typical relations are shown in figures 3–1 through 3–7. Relations of this kind are used because the PI evaluation must be made in a relatively short time. Figures 3–1 through 3–7 are not for general application to all watersheds because they were developed for particular areas and are valid only for those areas.

Figure 3–1 Estimating the minimum amount of area necessary to control by floodwater retarding structures



The figures illustrate principles that can be applied in developing relations for other areas. All such relations are empirical, which means that the lines of relation should not be extended very far beyond the range of data used in their construction. An example of the use of some of the relations is given later in this chapter.

Figure 3–1 shows a relation developed from data in workplans for projects containing floodwater retarding structures, but few channel improvements. The line of relation shows the minimum amount of watershed area that must be controlled by the structures for a project to be economically justified. For other areas, the line of relation may be curved or have a different slope.

Figure 3–2 shows the average annual cost of a system of floodwater retarding structures in relation to watershed area and percent of control for projects having few channel improvements. In this and other figures that show costs, the costs are valid only for the economic period for which they were originally applicable. An adjustment must be made for later periods.

Figure 3–3 shows the cost relation for total cost of individual structures. The cost is related to the drainage area above a structure and to the land resource area in which it lies.

Figure 3–4 shows the amount of flood plain area in a watershed in relation to the product of total watershed area and average annual rainfall. Such a relation is most effective for regions where the annual rainfall does not vary abruptly over the region.

Figure 3–5 shows the average annual direct damage for present conditions in relation to flood plain area size and percent of cultivation. This figure was developed by means of a multiple regression analysis (NEH 630.18). Similar relations for other areas may be developed either by such an analysis or by a graphical method in which the data are plotted on log paper and a family of curves or straight lines is fitted by eye.

Parameters other than percent cultivated may also be suitable. In relations using damages in dollars, the damage estimates are valid only for the economic period in which they were originally applicable. An adjustment must be made for later periods.

Figure 3–2 Estimating average annual cost of a system of floodwater retarding structures

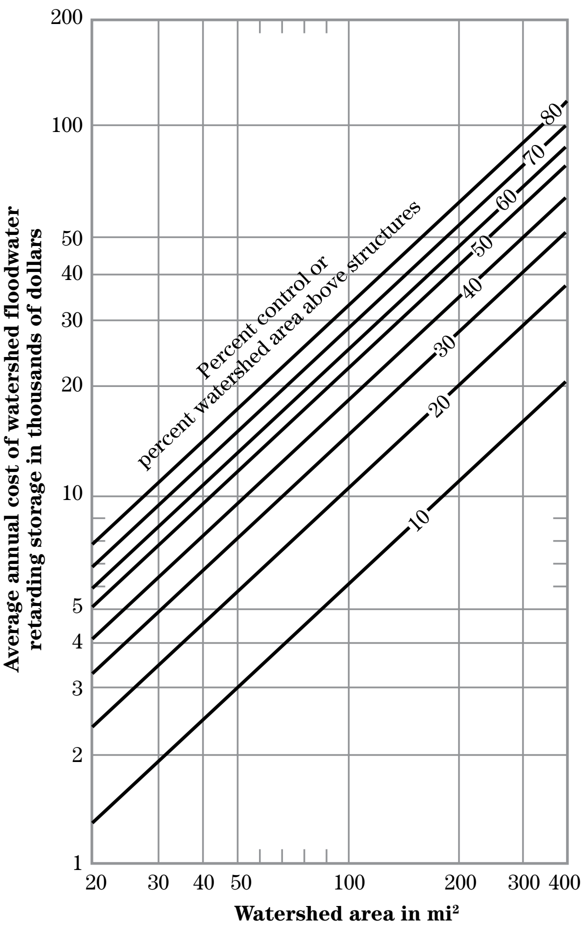


Figure 3–4 Estimating amount of flood plain area in a watershed

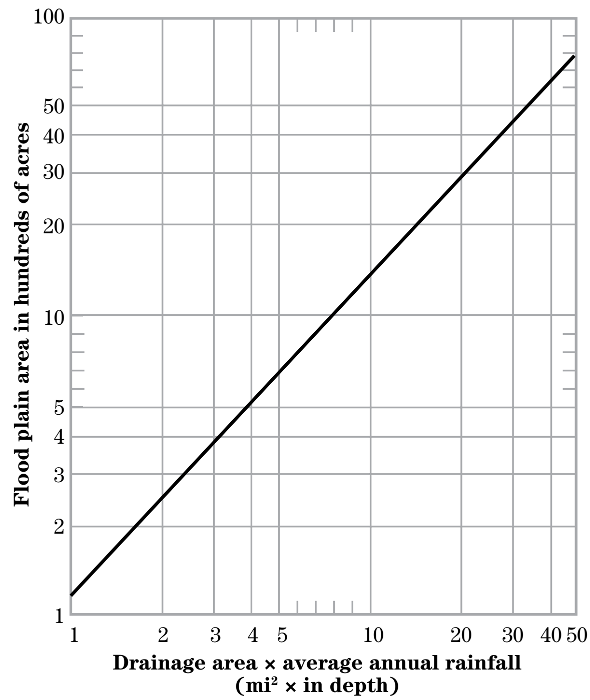


Figure 3–3 Estimating total cost of a system of floodwater retarding structures

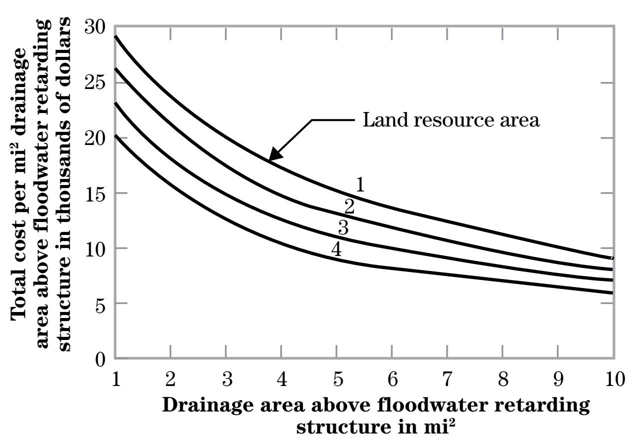


Figure 3–5 Estimating average annual direct damage

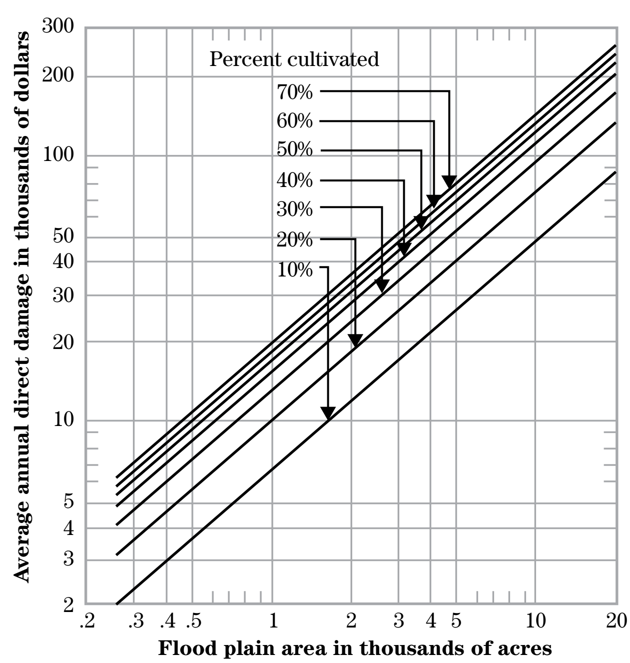


Figure 3–6 shows another damage relation for present conditions. This relation applies within a region for which flood frequency lines of the watersheds will have about the same slope when plotted on lognormal probability paper. For other regions, the line of relation may have a different curvature. Figure 3–6 is used with a historical flood for which the frequency and total damage are known. For example, if a watershed in this region has had a flood with a 10-year frequency, then the curve gives a multiplier of 0.41. If the total damage for that flood was $80,000, then the estimated average annual damage for the watershed is $32,800 (0.41 × $80,000).

Figure 3–7 shows the average annual damage reduction resulting from use of a system of floodwater retarding structures in relation to the percent of the watershed controlled by the system. Lines of relation for different land resource areas in a particular region are given. The reason for the variations by area is not specified in the original source of the figure, but it may be a result of one or more influences such as topography, soils, rainfall, or type of economy.

Figure 3–6 Estimating percent average annual flood damages

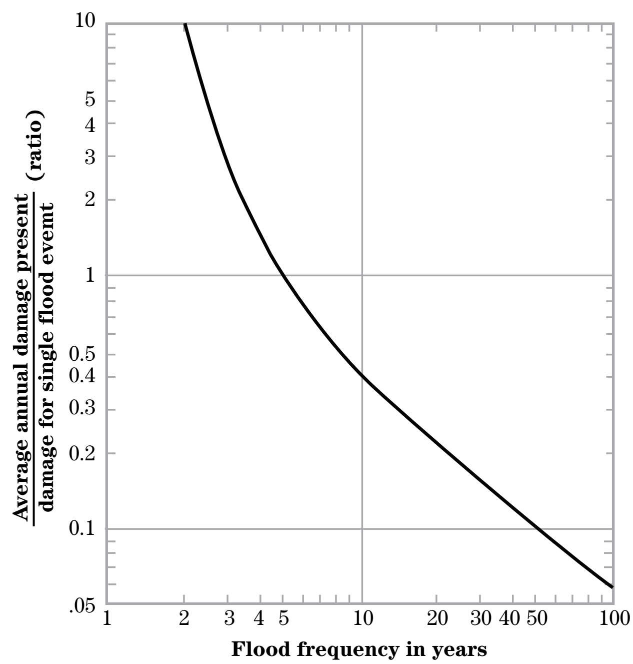
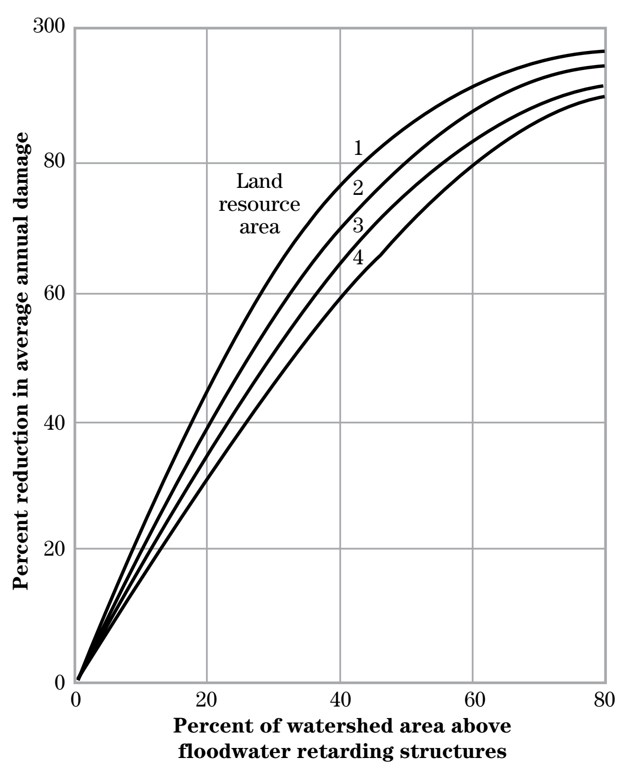


Figure 3–7 Estimating reduction in average annual flood damages



600.0302 Summary

The chief requirement for relations is that they be conservatively developed. The lines of relation should be drawn in such a way that the estimates are conservative; that is, the lines should tend to overestimate costs and underestimate benefits. If this is done, these types of relations will be valuable working tools not only for PIs, but also for river basin studies. Example 3–1 illustrates the relations used to determine the benefit-to-cost ratio of a potential system of floodwater retarding structures.

Example 3–1 Preliminary investigation process

Assume: Figures 3–1, 3–2, 3–4, 3–5, and 3–7 apply to the land resource area in which the problem watershed lies.

Determine: The benefit-to-cost ratio of a potential system of floodwater retarding structures so that a statement can be made in the preliminary report whether further investigation of the project is worthwhile. The required data are as follows:

- The watershed is in land-resource area 4.
- The drainage area is 150 square miles.
- The average annual rainfall 24 inches.
- The flood plain is 60 percent cultivated.

Solution: (All numerical estimates will be carried with as many digits as can be read from the figures, and the rounding will be in the last step.)

Step 1 Estimate the minimum area that must be controlled to have an economically justified project. Enter figure 3–1 with the drainage area of 150 square miles and read an area controlled of 80 square miles. In practice, the reconnaissance may show that more control can be obtained; if so, use the higher degree of control in the remaining steps.

Step 2 Compute the percent controlled:

$$100\left(\frac{80}{50}\right) = 53\%$$

Step 3 Estimate the average annual cost of the system. Enter figure 3–2 with the drainage area of 150 square miles and for 53 percent control; read by interpolation an average annual cost of $36,000.

Step 4 Estimate the amount of flood plain area. First, compute the product of drainage area and average annual rainfall:

$$150(24) = 3,600$$

Next, enter figure 3–4 with this product and read a flood plain area of 5,200 acres.

Example 3–1 Preliminary investigation process—Continued

Step 5 Estimate the average annual direct damages. Enter figure 3–5 with the flood plain area of 5,200 acres. At the line for 60 percent cultivated, read damages of $75,000.

Step 6 Estimate the reduction in average annual direct damages. Enter figure 3–7 with the percent controlled from step 2. At the line for land resource area 4, read a reduction of 73 percent.

Step 7 Compute the estimated benefits. Use the average annual direct damages in step 5 and the percent reduction in step 6:

$$\left(\frac{73}{100}\right)(\$75,000) = \$54,750$$

Step 8 Compute the estimated benefit-to-cost ratio. Use the benefit in step 7 and the cost in step 3. The ratio is:

$$\left(\frac{\$54,750}{36,000}\right) = 1.52$$

Round to 1.5, which is the required estimate for this example.

Conclusion: In this example, the benefit-to-cost ratio is favorable, and a recommendation can be made in the PI report that further investigation is justified. If the ratio happens to turn out slightly unfavorable, it may still be desirable to recommend further investigation. The shortcut procedure is conservative, and a detailed investigation may show that the project is economically feasible. If the ratio is very unfavorable, however, it is not likely that a detailed investigation can improve it. An alternative project measure needs to be considered instead.

630.0303 Report

The general format of a PI report will not be given here because each State establishes its own pattern. Generally, the hydrology in the report is merely descriptive. However, if hydrographs of present and future (with project) flows must be in the report, the hydrologist can find shortcut methods of estimating runoff amounts in chapter 10 and of constructing hydrographs in NEH 630.16 and 630.17.