# CHAPTER 2

# FORMULATION AND PLANNING OF SEDIMENT STUDIES

## Section I. Introduction

2-1. General. This chapter suggests guidelines and concepts to follow to insure the sediment study will identify the significant sediment problems and will produce a satisfactory analysis of alternatives for handling those problems.

2-2. Likelihood of Having Sediment Problems. There is no simple formula that predicts either the likelihood or the severity of sediment problems. However, in applying engineering judgement consider the following concepts:

a. Stable Channel Historically. When the existing channel is stable, the magnitude of the sediment problem for a project channel is generally proportional to the amount of deviation from the existing channel width, depth, slope alignment, vegetation environment, inflowing water discharge hydrographs, inflowing sediment concentrations, particle sizes in the inflowing sediment load, classification of sediment on the surface of the streambed, downstream stage-discharge rating curve, distribution of water between channel and overbanks, and irregularities allowed in the design geometry.

b. Unstable Channel Historically. When the existing channel is unstable, the magnitude of the sediment problem for the design channel will be sufficiently severe to require a detailed sediment study.

2-3. Categories of Sedimentation Problems. It is useful to group sediment problems into two categories:

a. impact of sediment on project performance for which the area of interest is the project reach; and

b. the impact of the project on the behavior of the stream system for which the area of interest extends to the limits of the project's influence on the morphology of the stream system.

2-4. Identification of Potential Problem Area. Sediment problems are not equally likely at all points along a project. In general, the potential is the greatest for the following project features.

a. Increased channel width

b. Bridge crossings

c. Abrupt breaks to steeper channel bottom slope

d. Reaches where the bottom becomes flatter

e. Cutoffs and changes in channel alignment

f. Any feature is braided reaches

g. The upstream approach to the project reach and the transition to the existing channel downstream from the project reach

h. Appurtenant structures in the channel, such as channel training structures

i. Tributaries entering the project

j. Water diversion points

k. Upstream from reservoirs and grade control structures

l. Downstream from dams

m. Lower reaches of tributaries

## Section II. The Sediment Studies Work Plan

2-5. Purpose for the Sediment Studies Work Plan (SSWP). A "Sediment Studies Work Plan" is a document for the district's files which demonstrates that adequate attention has been given toward identifying potential sediment problems. If problems are identified, the SSWP then becomes the instrument for developing and organizing the sediment investigation so:

a. it can be completed in a timely and efficient manner;

b. the level of detail is appropriate to provide information necessary for decision makers at each level of project formulation;

c. the technical procedures and end products are acceptable to reviewing authorities.

2-6. Usage. The SSWP will be drafted and used at the District level. However, projects of unusual scope or complexity may require field meetings between District, Division and Office, Chief of Engineers(OCE) representatives to arrive at acceptable criteria and technical procedures. The SSWP is to be utilized:

a. by the working engineer as the sequence of tasks to follow in performing the investigation and the end products from each task.

b. by the project leader as a basis for contractual negotiations with outside entities such as the Waterways Experiment Station, the Hydrologic Engineering Center or private engineering firms; and

c. by managers as the basis for estimating cost, scheduling work and checking progress.

2-7. Contents of Sediment Studies Work Plan. The SSWP is a planning aid to establish the objectives listed below.

a. Problem Identification. The SSWP should establish in specific terms the nature and scope of the sedimentation investigation necessary for each level of project formulation.

b. Approach. The SSWP should provide a basis for selecting methods that are suitable for timely completion of the study. The selected methods should consider the degree of refinement appropriate for the particular study, the nature, extent and reliability of the available data. The level of detail expected in the end products should insure that major decisions about the overall project design and operation remain sound as more data and study results become available during the project planning and design process.

c. Time and Cost Estimate. The SSWP should establish a basis for providing a reliable time and cost estimate for completion of the study.

d. Schedule. The SSWP should establish the systematic sequence of activities necessary to meet the sedimentation requirements within the allowable time frame.

e. End Products. The SSWP should provide a basis for personnel involved in the project planning and design processes to reach a mutual understandings regarding end products from the proposed sedimentation investigation prior to making major expenditures for sediment studies. The end products should be stated in terms of how results from the sediment investigation will affect decisions to be made about overall project safety, efficiency, reliability, first cost, operational cost, maintenance cost, environmental factors, social factors and mitigation of adverse impacts resulting from the sediment problems.

f. Data Collection. The SSWP should provide a basis for advanced scheduling of data collection where such data is not currently available.

2-8. Level of Detail to be Included in the SSWP. The level of detail to be included in the Sediment Study Work Plan varies depending on the likehood of having sediment problems and by the size of the project. Cite evidence from other, similar, projects operating in the area as well as studies for other projects to justify the degree of detail selected.

2-9. Sequence of Tasks in Developing the SSWP.

a. Boundary of Study Area. Establish the size of the study area which, in turn, will determine the amount of work that needs to be addressed with the SSWP. (The potential for the impact of the project on the stream system extends beyond the project boundary.) See chapters 4 and 5 for a more complete discussion of size of study area.

b. Objective. Write an objective statement for the sedimentation investigation. Identify and quantify existing constraints - such as: funding, time available for the study, manpower availability and data availability. Recommend a course of action that will remove constraints to the maximum extent possible.

c. Problem Identification. By studying quadrangle maps of the project area, pertinent project features, soil classification maps, and aerial photographs, and by field reconnaissance, potential problem areas can be identified and noted on the maps. Use the location, number and type of problems as an aid for selecting methods for analysis, for assessing the adequacy of available data, and for preparing time and cost estimates.

d. Data Inventory. Prepare an inventory of available data by type: geometric, hydrologic, hydraulic, sedimentary, and land use data. Use the boundary of the study area as a guide for selecting gages and displaying spatial distributions. Use historical stability and project life in selecting time periods. Use specific project features to justify data requirements.

e. Recommended Approaches. Chapter 1 gives general guidance and the technical chapters give more detailed guidance on "Staging Sedimentation Studies." Perform a Sediment Impact Assessment for the project to determine the probable severity of sediment problems. Based on that result itemize the necessary tasks for completing the staged sedimentation investigations.

f. Time and Cost Estimate. Estimate the time and cost for each task in the itemized list. Beware of the subtle activities which are required to manage large quantities of data. i.e. Sediment studies require spatial and time dependent data sets describing geometry, hydrology, hydraulics, sediment and land use parameters. For example, the cost for assemblying such data is always considered; however, there are additional costs for converting, manipulating and displaying data that are often omitted. Another example, the analysis of historical boundary conditions is obviously needed for each inflow and outflow point around the project boundary to confirm the model by reconstituting historical events, but project performance depends on extrapolating boundary conditions into the future. This is often a more complicated analysis than is required for the historical calculations and is often omitted from estimates. A final example regards the analyses of proposed project designs, an obvious need; however, the analyses of the existing stream conditions during recent floods or droughts as well as the predicting of a future "do-nothing case" are sometimes neglected when estimating time and cost. Any one of these examples can be a formidable task because of the large quantity of data involved. In addition to these, there may be other tasks that are specific to your investigation. Estimate the number of man-days, by grade, for each category and sum to provide the time and cost estimate for the sediment investigation.

g. Review. The above should be developed and reviewed at the District level. However, division and OCE representatives may also be included, depending on the scope and complexity of the proposed project.

2-10. Data Sources.

a. General. The data that will be needed to develop the SSWP should come from office files, from other federal agencies, from state or local agencies, and from the team making the field reconnaissance of the project site.

b. U. S. Geological Survey (USGS). USGS topographic maps and mean daily discharges are used routinely in hydraulics and hydrology studies and are common data sources for sediment studies, also. However, mean daily flows are often not adequate for sediment studies, and data for intervals less than one day or stage-hydrographs for specific events can be obtained, through strip-chart stage recordings, by special request. It may be preferable to use USGS discharge-duration tables rather developing such in house, and these are available through the state office for each long-record gage. Water quality data includes suspended sediment concentrations and grain size distributions. Published daily maximum and minimum sediment discharges for the year and for the period of record are available as are periodic measurements of particle size gradations for bed sediments.

c. National Weather Service (NWS). There are cases where mean daily runoff can be calculated directly from rainfall records and expressed as a flow-duration curve without detailed hydrologic routing. In those cases use the rainfall data published monthly by the National Weather Service for each state. Hourly and one-day interval rainfall data, depending on the station, are readily accessible. Shorter interval or period-of-record rainfall data would require contact with the NWS National Climatic Center at Asheville, North Carolina.

d. Soil Conservation Service (SCS). The local SCS office is a good point of contact for historic and future estimates of land use, land surface erosion, and sediment yield. They often have soil maps, ground cover maps and aerial photos from periodic overflights of watersheds which can be acquired and used to site specific estimates of sediment yield. Input data for the Universal Soil Loss Equation is often available for much of the United States. The SCS also updates reservoir deposition studies for hundreds of reservoirs throughout the country every 5 years, providing a valuable source of measured sediment data.

e. Agricultural Stabilization & Conservation Service (ASCS). This agency of the Department of Agriculture accumulates aerial photography of crop lands for allotment purposes. However, those photographs will include the streams crossing those lands and are extremely valuable for establishing historical channel behavior because overflights are made periodically.

f. Corps of Engineers. Since the Corps gathers discharge data for operating projects and for those being studied for possible construction, considerable data from the study area may already exist. The Corps has acquired considerable survey data, aerial and ground photography, and channel cross sections in connection with flood plain information studies. Corps laboratories have expertise and methods to assist in both the preparation of the SSWP and the implementation of it.

g. State Agencies. A number of states have ongoing climatologic, hydrologic, and sediment data collection programs. Topographic data drainage areas, stream lengths, slopes, ground covers, travel times, etc are often available.

h. Local Agencies, Businesses and Residents. Land use planning data are normally obtained through local planning agencies. Cross section and topographic mapping data are often available. Local agencies and local residents have some of the most valuable information to the engineer in their verbal and photographic descriptions of changes in the area over time, of channel changes from large flood events, of caving banks,of significant land use changes and when these changes occurred, of channel clearing/dredging operations, and other information. Newspapers and those who use the rivers and streams for their livelyhood are valuable sources of data.