CECW-EH-Y Regulation No. 1110-2-8153	Department of the Army U.S. Army Corps of Engineers Washington, DC 20314-1000	ER 1110-2-8153 30 September 1995
	Engineering and Design SEDIMENTATION INVESTIGATIONS	
	Distribution Restriction Statement Approved for public release; distribution is unlimited.	

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000

ER 1110-2-8153

CECW-EH-Y

Regulation
No. 1110-2-8153

30 September 1995

Engineering and Design
SEDIMENTATION INVESTIGATIONS

1. Purpose

This regulation prescribes the procedure and rationale for conducting sedimentation investigations in support of the hydrologic analysis, hydraulic design of civil works projects, and environmental impact analyses. Guidance for performing sedimentation investigations is contained in references listed in paragraph 3 and in recognized engineering texts.

2. Applicability

This regulation applies to all HQUSACE elements and USACE commands, districts, and laboratories having civil works responsibilities.

3. References

a. 33 F.R. 208.10.

b. ER 1110-2-401, Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual for Projects and Separable Elements Managed by Project Sponsors.

c. ER 1110-2-1403, Studies by Corps Hydraulic and Hydrologic Facilities and Others.

d. ER 1110-2-1405, Hydraulic Design for Local Flood Protection Projects.

e. ER 1110-2-1460, Hydrologic Engineering Management.

f. ER 1110-2-4001, Notes on Sedimentation Activities.

g. EM 1110-2-1601, Hydraulic Design of Flood Control Channels.

h. EM 1110-2-1607, Tidal Hydraulics.

i. EM 1110-2-4000, Sedimentation Investigations of Rivers and Reservoirs.

4. Definitions

As used in this document, the term “sedimentation” has broad definition and embodies the processes of erosion, entrainment, transportation, deposition, and compaction of sediment. The principal external dynamic agents are water, wind- and vessel-generated waves, gravity, salinity, and ice.

5. Design Rationale

The formulation of a civil works project must provide a safe, efficient, reliable, and cost-effective design in the most feasible environmentally sustainable manner. The appropriate degree of effort given to each of these design elements will vary from one stage of project formulation to the next. The following factors need to be considered in each design element:

a. *Safety*. Safety covers the potential hazards to humans and property; creation of a false sense of security; and consequences of inflows of water and/or sediment that exceed the project design capacities.

b. *Efficiency*. Efficiency covers the project dimensions and features that optimize the performance, operation, and maintenance of the project.

c. Reliability. Reliability includes the ability to achieve the project's purposes throughout its project life, and proper functioning of facilities, e.g., pumps, gates, and trash fenders.

d. Cost effectiveness. This covers initial, operational, maintenance, and replacement costs optimized on an annual cost basis over the estimated life of the project.

e. Environmental and social aspects. These aspects include the identification of significant resources such as fish and wildlife, wetlands, cultural resources, aesthetics, and recreation and access needs; and design opportunities to enhance these resources and/or to avoid or mitigate adverse impacts to these resources. Also included is assessing potential impacts from contaminated sediment.

6. Estimating Project Costs

Guidelines contained in the Water Resources Development Act of 1986 (WRDA) limit the amount that project costs can escalate after the project cost-sharing agreement (PCA) has been signed. Costs from sedimentation impacts to the project during formulation, construction, operation, and maintenance should be estimated. Early in project formulation there may not be adequate data to allow estimates within the tolerance specified in the guidelines; therefore, a "staged sediment studies" approach should be followed in which contingency factors are assigned and revised as more data and analysis are available to decision-makers. Three stages are recommended: sediment impact assessment, detailed sedimentation study, and feature design sedimentation study.

a. Contingency. The contingency factors should be established based on the potential for sedimentation problems in the region, the impact of sedimentation problems on the five design elements listed in paragraph 5, the level of confidence in the data and analysis, and the extent to which the project features deviate from the historical river regime. If this impact does not affect basic go/no-go decisions about project feasibility, the sedimentation study can be staged and refined as the project moves through planning and design stages.

b. Stage 1 (reconnaissance level). Sediment impact assessment. A sediment impact assessment will be prepared for all projects. When this assessment indicates that sediment problems will substantially affect project design and project economics or will result in significant environmental impacts, collect the necessary data, and perform investigations as required to comply with the water resources guidelines for project cost. The subsequent stages will normally provide increasing levels of information for decision-makers as project formulation progresses.

(1) Purpose. The purpose of the sediment impact assessment report is to convey to reviewing authorities the amount of effort expended to date in investigating sedimentation problems; the amount and type of field data available for the assessment; the anticipated impact of sedimentation on project performance and maintenance; and the anticipated impact of the project on stream system morphology. This assessment is expected in the initial planning document with amplification as necessary in subsequent reports. An assessment that identifies "no sediment problems" is as important as one identifying problems. It will establish contingency factors based on the level of uncertainty in predicting the cost of resolving sediment problems revealed in this assessment.

(2) Scope. This report will discuss, at a minimum, the reservoir or river sedimentation problems identified in EM 1110-2-4000 and estuarine problems identified in EM 1110-2-1607. In addition, any problems unique to this site will be included.

c. Stage 2 (feasibility level). Detailed sedimentation study.

(1) Purpose. The purpose of the detailed sedimentation study is to further address problems reported in the sediment impact assessment, recommend corrective measures, and assess the effectiveness of these measures. A detailed study will be required if the sediment impact assessment predicts a sedimentation problem, if a similar, existing project is experiencing sedimentation problems, or if significant adverse environmental impacts are predicted.

(2) Scope. The scope and depth of study in this stage is controlled by the level of technical details required to resolve the problems. The contingency will reflect the reduction in uncertainty as a result of this additional data and study effort. The end product is a plan showing design features needed to resolve the general sedimentation problems.

d. Stage 3 (preconstruction engineering and design). Feature design sedimentation study. The purpose of the feature design sedimentation study is to develop and present a detailed plan to protect the project against failure from sedimentation and to establish special operational procedures as necessary.

7. Sediment Study Work Plan

a. General. A study plan will be developed to document the type and scope of sedimentation studies identified for funding. An uncomplicated small project may require only the sediment impact assessment while a complex project may require progression to more sophisticated studies as project formulation proceeds. This will involve data collection and analysis, sediment investigations, and the incorporation of results into the design of project features as well as into operation and maintenance requirements. The study plan will:

(1) Coordinate sediment activities with the needs and the results of other disciplines involved in project formulation (Appendix A).

(2) Establish the sediment-related information that will be needed for decisions in each stage of project formulation.

(3) Estimate the data requirement.

(4) Schedule the data collection activities.

(5) Specify the results from laboratory analysis.

(6) Outline the sedimentation studies to be performed.

(7) Present the project features that will be needed for operation and maintenance.

Decisions as to portions, if any, of the sedimentation investigation requiring physical or mathematical modeling by others will be highlighted in the plan. The plan will indicate by schedule, or other means, the timing of studies, required input from others, and interfacing of outputs with the formulation process to allow for coordination with other disciplines. Additional guidance is available in ER 1110-2-1460, ER 1110-2-4001, EM 1110-2-1601, and EM 1110-2-1607.

b. Influence of project features. If extensive modifications are proposed to the channel cross section, alignment, or bank-full discharge, or if water diversions or reservoirs are proposed, the possibility of sediment problems increases significantly. Such influence should be reflected in the scope of sediment studies work plan.

c. Study time and costs. Problems and the means of further study should be forecast. Since these results are used to develop the project cost-sharing agreement, a firm estimate of the total time and cost for conducting future sediment studies is required.

d. Modification of study plan. There will be occasions when the study plan is sufficiently complex or when sediment problems are sufficiently large that the study plan should be modified as needed during project formulation. More detail can be found in ER 1110-2-1403.

8. Reporting Requirements

a. General. Basically, the sedimentation portion of all reports, forwarded either for approval or for information, should contain sufficient detail to allow an independent assessment to be made as to the soundness of conclusions and recommendations. When sedimentation impacts are different for different alternative plans, then the same level of detail should be included for each alternative. The following specific topics form the basis for reporting studies. The list is not exhaustive. Topics to report are suggested in EM 1110-2-4000.

b. Study area boundaries. Streams function as systems. Therefore, it is essential to include a sufficient area in the study to identify the impact of the project on the stream or waterway system as well as the impact of sedimentation on project performance. The reasons the study area boundaries were selected should be documented, and the selection should be presented in sufficient detail so reviewing authorities can arrive at an independent evaluation of their appropriateness.

c. Model geometry and hydraulic roughness. The report should include evidence that the selected geometry (cross-section layout and spacing) and hydraulic roughness coefficients produce computed results that properly represent the phenomena being evaluated. How the cross sections were selected should be discussed. Particularly, in sediment computations, the distribution of water, between channel and overbanks, should be justified. This refers to the percentage of total flow conveyed on the left overbank, in the channel, and on the right overbank. Possible changes in channel

bed roughness with water discharge in mobile boundary streams should be addressed.

d. Boundary conditions. Each investigation will justify the selection of the water discharge entering the project reach, the sediment concentration and particle size in that water discharge, and the water surface elevation at the downstream end of the model. These will be reported as "boundary conditions."

e. Sediment data. The rationale for selecting the water and sediment inflow points should be described. The type and source of sediment data for inflows as well as for the boundary geometry along the reach of study should be reported.

f. Side drainage. The presentation will specifically address the rates of water discharge and sediment inflow at significant side drainages, such as tributaries and overland flow. The rationale for such determination should be documented.

g. Care of water during construction. The care of water and sediment during construction will be covered for all projects. If river conditions during construction are forecast to be more hazardous than have existed historically, the fact should be stated. For projects extending over several construction seasons, the care of water and sediment during construction will include contingency measures to ensure the efficacy of constructed portions and to obviate project-induced damages upstream, downstream, and within the constructed project reach.

h. Real estate requirements. Analyses for real estate requirements will be explicitly presented. Access, dredging, disposal areas, preclusion of obstructions in flow way, maintenance measures, pondage, erosion easements, etc., are examples of conditions to present. This is not an exhaustive list.

i. Alternative designs. Alternative designs are to be studied and presented in sufficient detail so reviewers can ascertain, from an independent study using the reporting document, the soundness of conclusions and recommendations.

j. Postconstruction needs. The presentation will include an operations and maintenance section. This section will report sedimentation issues that affect project operation as required by provisions of Federal Code 208.10, Title 33, as approved by the Secretary of the Army. It will form the basis for more detailed information to be included in the Operations and Maintenance Manual that will accompany the project when it is turned over to local interests as provided for in the Federal Code (ER 1110-2-401 and ER 1110-2-1405). Additionally, if not presented in detail elsewhere, such matters will be covered as:

(1) The measurements required to determine the impact of sedimentation on project performance during the life of the project.

(2) Surveillance requirements and permanent features in support thereof such as benchmarks and staff gages.

(3) Estimates of monitoring and reporting requirements for sedimentation investigations and the cost for the sediment monitoring program (drawings and photographs should be included, as required, to convey to those responsible for operations and maintenance activities what the design assumptions were for each project feature).

(4) Estimates of operation, maintenance, and reporting costs to continue the sedimentation investigation, as required, for the life of the project.

If preconstruction studies indicate periodic postconstruction maintenance dredging requirements, a sediment removal plan shall be included in the report. The plan shall include the proposed postconstruction methods of dredging, equipment access, material handling, stockpiling and drying locations, access roads, and disposal site locations. The sedimentation study should indicate the potential Hazardous Toxic Radiological Waste (HTRW) contamination of channel bottom sediments during the life of the project.

k. Approach and exit channels. The presentation will include an analysis of the approach channel to the project and the exit channel from the project. When the project includes the mouth of the river, the analysis of exit conditions will cover an area sufficiently far away to avoid contaminating the analysis by the prescribed boundary conditions. The confluence with each tributary and the upper end of each distributary channel is to be presented similarly. The range of tailwater conditions for each exit channel (main and distributary) will be presented.

9. Sedimentation Investigation Program

This program refers to monitoring, evaluating, and reporting sedimentation during the life of a project.

a. Reports. Project formulation reports will forecast the requirements for conducting sediment investigations. The cost will be included in the overall project cost.

b. Reservoir sedimentation investigation program. Details for this program are contained in Appendix K of EM 1110-2-4000.

c. Channel sedimentation investigation program. Channel projects will include an investigation program similar in structure to that for reservoirs; that is, range lines will be established and monitored. It will be designed to provide information as required for the operation and maintenance of the channel project. It will follow the same concepts for permanent range layout as shown for reservoirs.

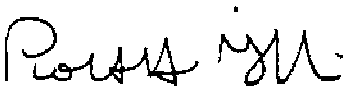
d. Sedimentation investigation program for navigation projects. The sedimentation investigation program for navigation projects will provide the necessary information to operate and maintain the project. Dredging will be recorded annually showing the date, location, amount, disposal area, and a sufficient number of particle-size gradation curves to describe the characteristics of the material dredged.

e. Follow-on sedimentation investigation programs for other projects. At other projects, such as creation or restoration of wetlands or cleanup of hazardous and toxic wastes, a sediment investigation program will only be required if justified for that specific project.

10. Continuing Authority Requirements

The entire series of continuing authority reports (PL 99, Section 201, Section 14, etc.) involve sediment analysis. Most of these studies are applicable only to limited, site-specific modifications, however, and a simple sediment-impact analysis will convey sufficient information. The Section 205 Small Flood Control Continuing Authority Report is a possible exception. Since construction can follow the completion of a favorable Section 205 study, the level of detail would be similar to that in a combined survey report-design memorandum.

FOR THE COMMANDER:



ROBERT H. GRIFFIN
Colonel, Corps of Engineers
Chief of Staff

1 Appendix
APP A - Typical Factors Affecting the Sedimentation Investigation

APPENDIX A
TYPICAL FACTORS AFFECTING THE SEDIMENTATION INVESTIGATION

1. Hydrologic

a. Climate: weather (precipitation, wind, and temperature)

b. Discharge (hydrographs, frequency, stage, and duration—annual and single event)

c. Trash and ice

d. Sediment (suspended and bed)

e. Morphology (aggradation, degradation, meandering, etc.)

f. Tidal effects on downstream boundary condition

2. Hydraulic

a. Velocity

b. Slope

c. Energy losses (roughness, transitions, obstructions, etc.)

d. Configuration (channel)

e. Water surface profile-stage (or tides)

f. Waves (wind, standing, and vessel)

g. Stability (channel)

h. Spatial and temporal variation in salinity

3. Physical

a. Geology

b. Topography—hydrography—channel bed forms

c. Vegetation

d. Sediment (sizes, physical characteristics, areal distribution, sources, and yields)

e. Potential for catastrophic events (mud and debris flow, volcanic activities)

4. Environmental

a. Significant natural resources

b. Ecological processes

c. Aesthetics

d. Cultural resources

e. Water quality

f. Threatened and endangered species

g. Permits

h. Contamination (anticipated and potential)

5. Social

a. Recreation

b. Access-egress

c. Safety-welfare

d. Displacement