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	Engineering and Design  HYDROLOGIC ENGINEERING MANAGEMENT	
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CECW-EH

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

ER 1110-2-1460

Regulation  
No. 1110-2-1460

7 July 1989

Engineering and Design  
HYDROLOGIC ENGINEERING MANAGEMENT

1. Purpose. This regulation defines the scope, authorities, and management requirements for hydrologic engineering activities within the Corps of Engineers.
2. Applicability. This regulation applies to all HQUSACE/OCE elements, and field operating activities having civil works engineering and design responsibilities.
3. References. References are listed in Appendix A.
4. Scope of Hydrologic Engineering Activities.

a. General. Hydrologic engineering is a part of civil engineering practice in which applications of professional knowledge of hydrologic and hydraulic principles are key elements in water resources development and management decisions. The scope includes the natural and management processes affecting the water cycle from initial precipitation on the land surface through ultimate return of water to the sea or inland sink. Technical methods of analysis include field measurement and observation, mathematical and statistical analyses, and models. Outputs of hydrologic engineering studies include: water availability as expressed by surface and subsurface yield; water surface elevations and water surface profiles; sediment processes; modeling of watershed catchment processes, flood hydrograph development, and surface infiltration; probability analysis of frequency of flooding, risk of project failure, and reliability of supply; reservoir regulation requirements for water supply, power generation, and flood control; water quality effects of natural phenomena and project operations; and groundwater level changes due to recharge and withdrawal. The hydrologic engineer must also be knowledgeable of and able to communicate in related legal, social, economic, plan formulation, administration and management areas.

(1) Hydrologic engineering is a key element in many programs of the Corps of Engineers. Hydrologic engineering studies are an integral part of planning, design, construction, operations, and maintenance of civil works projects and other special studies.

7 Jul 89

(2) Hydrologic engineering studies are performed in the federal interest in the areas defined in EP 1165-2-1. Those include navigation, flood damage reduction, shore protection, stream bank erosion control, hydroelectric power, recreation, water supply and quality management, fish and wildlife, wetlands conservation, regulatory program, and special programs.

(3) Activities of a programmatic nature managed by CECW-EH include water control, elements of the dam safety program, reservoir sedimentation, hydrometeorology studies, hydrologic data collection, hydrologic studies, and the cooperative stream gaging program.

b. Hydrologic Engineering During Planning. Hydrologic engineering studies develop fundamental technical flood and drought information for reconnaissance and feasibility phases of survey investigations and continuing authority programs, floodplain management, and special and national studies.

c. Hydrologic Engineering During Design. Hydrologic engineering studies develop technical material for preconstruction engineering and design studies, post authorization changes, and general and feature design memoranda. They also provide information for preparation of plans and specifications and handling of water during construction.

d. Water Control Management. Hydrologic engineering studies provide the basis for real-time water control decisions, undertaking emergency management actions, preparation of water control manuals, monitoring reservoir sedimentation, and other water control studies.

e. Regulatory. Hydrologic engineering studies are performed in support of Section 404 permitting activities, Federal Energy Regulatory Agency license actions, water quality certification, and flood plain management actions.

f. Other. Inter-agency committees and other federal, state, and local agency programs frequently request Corps hydrologic engineering studies. Negotiated agreements establish the basis for these studies.

5. Hydrologic Engineering Studies. Studies use technical methods selected to achieve the objectives of the investigation. The studies are planned and managed to achieve the objectives in the most efficient and cost-effective manner.

7 Jul 89

a. Study Design and Management. The scope of technical studies is determined through consultations and negotiations between the hydrologic engineer and other affected parties. The study scope will be responsive to the nature and type of investigation and the needs of other study participants. A formal study plan will be developed that documents the study objectives, scope, level of detail, budget, schedule, milestones, and form of the final product. The study plan will be negotiated between the responsible parties. Conferences, meetings and other appropriate means of communication will be utilized as necessary to involve other district, division, and HQUSACE staff in the resolution of critical issues.

b. Study Team and Coordination. The hydrologic engineer has two roles when he serves as a participant in an interdisciplinary investigation team. The hydrologic engineer shares in the accomplishment of overall responsibilities of the team. The hydrologic engineer also contributes as the technical specialist in hydrologic engineering matters. Coordination with other affected parties, in and outside of the Corps, will be a continuous process. Consultations with and supervision of hydrologic engineers participating in the team effort is the responsibility of hydrologic engineering supervisors and managers.

c. Technical Procedures. Technical procedures are selected commensurate with the nature and type of investigation and the needs of other study participants. Choice of technical methods will be made in a decision process that includes consultations with division and HQUSACE staff, and coordination as appropriate, with others. These include federal, state, and local agencies and cost-sharing partners. The decision process supporting selection of the technical methods will be thoroughly documented.

d. Quality Control, Review. The review process provides quality control for technical studies and the resulting reports. It ensures that studies are complete and performed to an appropriate level of confidence consistent with the study objectives. Technical review is conducted within the district on a regular basis throughout the study. Division staff provide final, detailed technical review. Review by HQUSACE is performed primarily to confirm conformance with existing policy, identify the need for new or revised policy, and to ensure the safety, function, and performance of project proposals. Table 1 summarizes the review levels for hydrologic engineering components of Corps studies. Requirements for coordination with and review by agencies outside the Corps that is mandated by law is documented in other regulations.

7 Jul 89

e. Cost-Shared Studies. Many Corps studies are cost-shared with local sponsors. These include the feasibility phase of survey studies, most design studies, and other special studies. The studies may involve joint financing with the Corps performing all technical work, or joint analysis in which the local cost sharing partner contributes to the hydrologic engineering work. The study scope, technical methods, schedules, and budgets are negotiated with the cost sharing partners. Negotiations involving hydrologic engineering components of studies require hydrologic engineering representation. Performance of studies will be in an open, cooperative partnership manner including local cost-share partner representatives in study activities.

6. Level-of-Detail and Completeness.

a. General Requirements. The level-of-detail and completeness of hydrologic engineering studies will be established at the time of study plan development. The study plan will reflect a conscious decision to develop a specific technical product. It will be phased to provide increasing refinement of completeness and detail as the study progresses. The technical product will be scoped to support the decisions and recommendations for the specific investigation being performed.

b. Planning Studies.

(1) Feasibility Studies. Reconnaissance phase studies provide the basis for a decision as to whether to proceed with more detailed feasibility studies and scope the full feasibility study. The study must demonstrate that there is a federal interest as well as likelihood that a feasible, implementable project would result from further studies. Feasibility phase studies provide the bases for NED plans, impacts on environmental quality, safety and risk determinations, and baseline costs for selecting project recommendations by the Corps for congressional authorization. Hydrologic engineering investigations for such items as frequency analysis, storm studies, reservoir yield, and stream water surface profiles are therefore considered final for supporting economic analysis, basic plan formulation and evaluation.

(2) Flood Plain Management. Studies are performed for flood plain information, flood insurance, and other special studies. The technical scope and detail for these studies are consistent with existing conditions analysis for feasibility studies. A major exception is that flood insurance studies do not use expected probability frequency estimates and are based on existing conditions.

(3) Special Studies. The technical scope and detail for special studies, such as regional and national studies, are often consistent with the reconnaissance phase of feasibility studies.

c. Design Studies. The preconstruction engineering and design (PED) begins after the division engineer issues his public notice for the feasibility report and PED funds are allocated to the district. During the PED phase, engineering effort consists of those activities necessary to ready the project for the first construction contract. Results of these studies are documented in design memoranda, plans and specifications, and other special reports. Engineering during construction includes preparation of plans and specifications for subsequent contracts (where appropriate), review and approval of selected shop drawings, site visits, support for claims and modifications, development of operation and maintenance manuals, and preparation of as-built drawings.

(1) As a project moves from the feasibility phase to design, the emphasis will normally shift from hydrologic engineering analysis in support of plan formulation to hydraulic design. Design studies determine final sizes, configurations, and structural details of features of projects. Studies for structure geometry, stable channel design, and erosion protection works predominate. Additional hydrologic engineering studies to refine features such as real estate requirements, spillway dimensions, water control plans, and pumping plant and control structure operation will usually be required.

(2) Post authorization change studies are the result of significant changes in the economics, engineering, local conditions, or other pertinent aspects of the project. Revision of feasibility-level hydrologic engineering analysis as well as design studies may be needed.

d. Water Control Management. Hydrologic engineering studies to support water control management are described in ER 1110-2-240 and ETL 1110-2-251. Studies are needed to develop technical elements of water control manuals and to support real-time water control decisions for flood control and conservation operations at Corps projects. The scope and technical detail for these studies will be consistent with the operation decisions to be made.

e. Regulatory. Studies needed for regulatory decisions are diverse. The usual analysis involves impact assessments similar to the feasibility phase of survey investigations. The nature of the regulatory action under study will determine the needed technical product.

Table 1  
Technical Review Process  
Hydraulics and Hydrology Elements of Studies

<u>Study Type</u>	<u>District</u>	<u>Division</u>	<u>HQUSACE</u> a	<u>BERH</u> a
Survey				
Reconnaissance	X	X	**	
Feasibility	X	X	**	X
Continuing Authority	X	X		
Flood Plain Mgmt.	X	X		
Special/National	X	X	X	
Design Memoranda				
General Design	X	X	*	
Feature Design	X	X	*	
Post Authorization Change	X	X	*	
Water Control	X	X		
<u>Regulatory</u>	X	X		

a Staff review for HQUSACE elements and BERH is provided by the Washington Level Review Group (WLRG), a division of the Water Resources Support Center, Ft. Belvoir.

\* Selected project types and features require review/approval by HQUSACE (ER 1110-2-1150).

\*\* HQUSACE participates in issue resolution conferences and may provide consulting services to the BERH.

## 7. Documentation and Reporting

a. General. The results of hydrologic engineering studies are documented in technical reports. The technical material may be published separately or incorporated in other documents. The documentation will present technical information on a professional engineering level. The objective is to document the data, study methods, assumptions, and results for use by the originating office, reviewers within the Corps, and other interested professionals. The documentation will permit an independent analyst to follow and understand the analysis and decision process presented in the document.

b. Content. The documentation will include a complete and accurate description of the total functional project (not just what is proposed for construction), project features, function, and setting for the study. A description of the source and reliability of data, alternative methods of analysis considered, analysis methods selected, and calibration procedures utilized will be included. Relevant assumptions will be documented and the results presented. Conclusions will be explained as they relate to project formulation, feature selection, design, operation, and the function of the project. Analysis and design items to be incorporated into operations manuals and local cost sharing agreements will be identified. Project performance in physical terms as well as economic and social terms will be explained. Also included will be a description of project performance when design is exceeded and any associated operations and actions by the Corps as well as local agreements needed to assure proper operation for events exceeding the design event.

c. Format. The format will be that of a professional technical report including logical text construction, liberal use of graphs, charts, maps and tables, and proper use of references and bibliography. Format guidance is contained in ETL 1110-2-230, Appendix A of ER 1110-2-1150, and ETL 1110-2-251.

d. Reporting Documents. The reporting documents include reconnaissance- and feasibility-phase reports for survey studies, detailed project reports for continuing authority investigations, flood plain information and flood insurance reports, design memoranda, water control manuals, and special reports. Specific guidance for these documents is contained in the appropriate regulations.



7 Jul 89

8. Professional Development. Professional development and maintenance of the hydrologic engineering workforce is critical to accomplishment of the Corps Civil Works mission. It is an important responsibility of supervisors and commanders at the district, division, and HQUSACE levels. Improving skills at the entry level and skills of experienced engineers can be accomplished through on-the-job experience and training, formal short course and long term training assignments, and through participation in activities of professional societies. Skills development should involve technical hydrologic engineering skills, and other important skills of written and verbal communications, familiarity with other technical elements of the Corps, and supervision and management skills. Supervisors and employees should cooperate to formulate a systematic development program as part of the annual performance appraisal process.

a. On-the-Job. Regular work assignments performed under the supervision of experienced engineers is a proven method of engineer development. Assignments should be diversified and encompass the full scope of hydrologic engineering studies, avoiding where possible, repeated piece-meal work. Periodic informal technical sessions involving colleagues and supervisors are encouraged.

b. Formal Training. Short-term training courses specifically tailored to Corps hydrologic engineers are available through the PROSPECT program. Registration for these courses occurs annually and is managed by training officers within districts and divisions. Short courses are available through local universities and occasionally on a special-case basis locally within a Corps office. Long-term training (up to one year) at selected universities is available for advanced education. Applications for long-term training are made on an annual basis.

c. Professional Society Activities. Professional societies provide the opportunity to participate with peers in sharing of technical information and exchange of views on items of mutual professional interest. Hydrologic engineers are encouraged to belong to professional societies and consider participating in society activities through committee work and preparation and presentation of professional papers. Commanders and supervisors are encouraged to foster a sense of professionalism among the hydrologic engineering staff.

9. Technical Committees. Technical committees have been established to assist the Corps in maintaining competency in selected technical areas. The four committees that are established and operate as defined in ER 15-2-14 are: Committee on Tidal Hydraulics, Committee on Channel Stabilization, Committee on Water Quality, and Committee on Hydrology.

a. Objectives. These four committees provide technical focal points identifying problems and recommending investigations, monitoring the technical developments, and disseminating information.

b. Other Committees. Corps representatives serve on many inter-agency and professional society committees. These contacts serve as a source of current technical activities in areas additional to the existing Corps committees.

#### 10. Hydrologic Engineering Research

a. Objectives and Products. Hydrologic engineering research is accomplished to develop information, analysis methods, and technical guidance to ensure efficient accomplishment of the Corps civil works mission. The scope of research is the full range of hydrologic engineering as defined in paragraph 4, Scope of Hydrologic Engineering Activities. Output products are improved information and improved analysis methods, new and revised computer programs, and technical literature.

b. Management. Civil works research needs are identified through the research needs system (ER 70-2-6). The program is managed by the Directorate of Research and Development (ER 70-1-5). Research may also be undertaken for specific projects.

c. Performing Organizations. Corps research and development laboratories and performing elements and occasionally Corps field offices perform the research and can provide technical assistance. Corps agencies that perform hydrologic engineering related research are:

(1) Hydrologic Engineering Center, 609 Second Street, Davis, CA. 95616, phone (916) 551-1748.

(2) Cold Regions Research and Engineering Laboratory, 72 Lyme Road, Hanover, NH, 03755-1290, phone (603) 646-4100.

(3) Waterways Experiment Station, Halls Ferry Road, Vicksburg, MS, 39180-0631, (601) 634-2485.

11. Hydrologic Engineering Guidance.


a. General. Hydrologic engineering guidance is provided in engineer regulations (ER's), engineer manuals (EM's), engineer technical letters (ETL's), engineer pamphlets (EP's), engineer circulars (EC'S), and occasionally by other communications such as engineer multiple letters. Some guidance documents are devoted only to hydrologic engineering topics while others address broader issues.

b. Guidance Definitions. ER's prescribe policy and are directive in nature; EM's document technical aspects of broader hydrologic engineering topics; ETL's document a restricted technical subject; EC's are an interim document with a 1-year expiration date; and EP's provide information about a particular subject.

c. Status. Hydrologic engineering guidance is revised and updated on a continuing basis. EP 25-1-1, Index of publications, documents the official status of HQUSACE/OCE documents. Information on the status of hydrologic engineering guidance will be provided through EC's issued periodically.

FOR THE COMMANDER:

1 Appendix  
APP A - References



ALBERT J. GENETTI, JR.  
Colonel, Corps of Engineers  
Chief of Staff

Appendix A  
References

- a. ER 10-1-3, Divisions and Districts
- b. ER 15-2-14, Committees on Tidal Hydraulics, Channel Stabilization, Water Quality, and Hydrology
- c. ER 70-1-5, Corps of Engineers Research and Development Program
- d. ER 70-2-6, Identification of Civil Works Research Needs
- e. ER 1105-2-10, Planning Programs
- f. ER 1105-2-20, Project Purpose Planning Guidance
- g. ER 1105-2-30, General Planning Principles
- h. ER 1105-2-60, Planning Reports
- i. ER 1110-2-100, Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures
- j. ER 1110-2-240, Water Control Management
- k. ER 1110-2-1150, Engineering After Feasibility Studies
- l. ER 1110-2-1400, Reservoir Control Centers
- m. ER 1110-2-1403, Hydraulic and Hydrologic Studies by Corps Separate Field Operating Activities and Others
- n. ER 1110-2-1455, Cooperative Stream Gauging Program
- o. ER 1130-2-339, Inspection of Local Flood Protection Projects
- p. ER 1165-2-1, The Federal Responsibility in Water Resources Development
- q. EM 1110-2-4000, Reservoir Sedimentation Investigations Program
- r. EP 25-1-1, Index of Publications
- s. EP 1165-2-1, Digest of Water Resources Policies and Authorities

ER 1110-2-1460  
7 Jul 89

- t. ETL 1110-2-230, Hydrologic & Hydraulic Engineering for Survey Investigations
- u. ETL 1110-2-251, Preparation of Water Control Manuals