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

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Regulation
No. 1110-2-1150

31 August 1999

Engineering and Design
ENGINEERING AND DESIGN FOR CIVIL WORKS PROJECTS

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This regulation will supersede ER 1110-2-1150, dated 31 March 1994.

APPENDICES

[Help make this a better guidance document. Submit suggestions for improvements to HQUSACE (CECW-EP), Washington, DC 20413-1000.]

DEPARTMENT OF THE ARMY ER 1110-2-1150
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ENGINEERING AND DESIGN FOR CIVIL WORKS PROJECTS

1. Purpose

This regulation defines engineering responsibilities, requirements, and procedures during the planning, design, construction, and operations phases of civil works projects. The regulation provides guidance for developing and documenting quality engineering analyses and designs for projects and products on time and in accordance with project management policy for civil works activities.

2. Applicability

This regulation is applicable to all HQUSACE elements, major subordinate commands (MSC), districts, laboratories, and field operating activities having civil works engineering and design responsibilities. The guidance included in the regulation is applicable to all civil works engineering products including work to design new projects, work to modify existing projects, and work for others.

3. References

References are listed in Appendix A.

4. Abbreviations and Acronyms

A list of abbreviations and acronyms is included as Appendix B.

5. Distribution

Approved for public release, distribution is unlimited.

6. Policy

The chief of the Engineering organization in a command is responsible for the technical content and engineering sufficiency of all Engineering products produced by the command. This regulation provides policy guidance to be used with professional engineering judgement in the development of engineering products.

6.1. *Policy Structure.* This regulation uses the five phases (reconnaissance, feasibility, preconstruction engineering and design, construction, and operation and maintenance[1]) of a major civil works project requiring specific congressional authorization to present the engineering and design policy and process that applies to all projects and products. This includes projects and products that do not follow the

[1] Operations and Maintenance is used in this regulation to include both “Operations and Maintenance (O&M)” and “Operations, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R)”

normal authorization procedures. When the normal authorization process is not followed, one more of the project phases may be modified or deleted and report titles may change. While the regulation tracks a flood control project, the process is equally applicable to all Civil Works projects and products.

6.2. *Engineer Members of Project Development Team.* The roles and responsibilities of engineer team members and their relationships to team members from other functional elements are provided in the project management regulation (ER 5-1-11).

6.3. *Project Phases.* Projects will be developed as stated in the Management Plan and this regulation. There are five phases in the process for developing a fully authorized project. The phases are listed in paragraph 11 of this regulation and defined in paragraphs 12 through 16. The Engineering activities and products developed in the various phases are also discussed in paragraphs 12 through 16.

6.4. *Major Policy Changes.* The major change in this regulation is in the types of Engineering documents used in the project development process. The old system of General Design Memorandum (GDM) and Design Memorandum (DM) following a Feasibility Report is replaced by a system of Engineering Appendices to the Feasibility Report, Design Documentation Reports (DDR), and Engineering Documentation Reports (EDR). GDM's and DM's are obsolete document types. GDM's will not be prepared for any project. If a project requires reformulation or other sufficient major revisions, then a General Reevaluation Report (GRR) or Limited Reevaluation Report (LRR) with an Engineering Appendix shall be prepared. If a GDM is being prepared on the date of this regulation and the District desires to continue with a GDM in lieu of a GRR or LRR, the District shall submit a written request through the MSC to CECW-E for approval to continue the GDM. An Engineering Appendix shall also be prepared for all Feasibility Reports. In place of formal DM's, the District shall prepare Design Documentation Reports (DDR's) which are implementation documents. When an Engineering document is needed to supplement a Feasibility Report (or GRR or LRR) to support a Project Cooperation Agreement (PCA), an Engineering Documentation Report (EDR), which is also an implementation document, shall be used. The EDR, may contain engineering changes, project descriptions, and cost estimates. Since the EDR is not a decision document, it should not include changes in project formulation or other information requiring a Washington level decision. The annual Programs conference on Congressionally added projects may direct that a EDR with some additional data be used as the sole document to support a project authorized by Congress without a Chief's or other report.

6.5. *Impact of Oversight and Review Comments.* All MSC and Washington-level engineering functional elements will consider the impact their oversight has on design quality, overall project schedule, and project cost when conducting quality assurance activities and policy compliance reviews of decision and implementation documents. Only comments that add value to the product shall be forwarded for resolution.

6.6. *Vertical Communications.* The Management Plan for projects and products shall stress that communications with the MSC and HQUSACE are important during the preparation of decision and implementation documents. Such communications shall be oriented toward insuring the potential comments are resolved at the lowest possible level and as early during the preparation of documents as possible, not after the analytical work and the document are completed. This can be accomplished through starting the Independent Technical Review (ITR) early in the process and including other conferences and reviews in the schedule. Also, every effort shall be made to resolve issues that impact design quality, schedules and costs before requesting schedule and costs changes in accordance with prescribed project management procedures.

7. Project Delivery Team

A Project Delivery Team (PDT) is established for all projects (products) in accordance with ER 5-1-11. The PDT consists of a Project Manager and the technical personnel necessary to develop the project. When more than one individual from the Engineering organization is on the PDT, the technical chief shall designate a "lead engineer". The lead engineer may change as the project moves through the different phases of development. The PDT may include personnel from the local sponsor's staff and from other Federal agencies. Partnering with the local sponsor is a key element during the design of a project and our partners are key members of the PDT. Partnering shall occur in all phases of project development.

8. Engineering Documents

The basic Engineering Documents used in the development of projects are the Engineering Appendix to Feasibility Reports, Design Documentation Reports, Engineering Documentation Reports, and Plans and Specifications. Other Engineering documents are prepared to document construction and provide guidance for project operations.

8.1. *Engineering Appendix to the Feasibility Report.* The engineering and design effort during project formulation is documented in the Engineering Appendix to the Feasibility Report. The length and complexity of the Engineering Appendix shall be appropriate with the size and complexity of the project being formulated. When a project must be reformulated or estimated costs updated, an Engineering Appendix shall be prepared as part of a GRR or LRR. The content and format for the Engineering Appendix to the Feasibility Report is discussed in Appendix C. (For additional information on planning documents see the Guidance for Conducting Civil Works Planning Studies (ER1105-2-100) (also known as the Planning Guidance Notebook)).

8.2. *Design Documentation Report.* The design documentation report (DDR) is a record of final design effort after the feasibility phase. A DDR is required for all engineering design products. The DDR provides the technical basis for the plans and specifications and serves as a summary of the final design. The DDR covers the preconstruction engineering and design phase and the construction phase of the project. It is used by the ITR team and for future reference. The DDR is not totally completed until after the plans and specifications and construction are completed. The approval level for a DDR, which is an engineering implementation document, is at the District command. The content and format for the Design Documentation Report is discussed in Appendix D.

8.3. *Engineering Documentation Report.* An engineering documentation report (EDR) is prepared to support the Project Cooperation Agreement (PCA) when there are minor changes in design and costs from the authorizing reports. The EDR may also be used in lieu of a GRR to document other information not included in a decision document when project reformulation is not required and the changes are only technical changes. An EDR may also be prepared for individual projects, which have been authorized as part of a large system study. In these cases the EDR serves to define the specific design concept and to firmly establish the baseline cost estimate. The EDR can also be used in lieu of a decision document for projects authorized by Congress without a feasibility report when only technical decisions are required. The approval level for an EDR, which is an engineering implementation document, is at the District command. The content and format for an Engineering Documentation Report are discussed in Appendix E. The EDR will generally be included as an enclosure or appendix to the DDR for the project feature described in the EDR.

8.4. *Plans and Specifications*. Plans and Specifications (P&S) shall be prepared in accordance with ER 1110-2-1200 and ER 1110-1-8155. They shall contain all the necessary information required to bid and construct the plan detailed in the engineering appendix or in the DDR.

8.5. *Independent Technical Review.* All engineering documents require an Independent Technical Review (ITR). A copy of the ITR documentation along with a Statement of Independent Technical and Legal Review must be submitted with all documents forwarded to HQUSACE for approval.

9. Budgeting for Engineering and Design

In order for sufficient engineering to be included in a project, the engineering members of the project delivery team (PDT) are responsible for preparing budget estimates for the engineering and design funding required for the project. These estimates shall be based on a realistic schedule for accomplishing the necessary work and show direct labor, other direct costs, private sector contracting costs, and all indirect costs. These estimates are an important part of, and must be incorporated into, the Management Plan. This budget estimating responsibility is most critical for the feasibility and PED phases but is also necessary for the other the phases of the project. Consequently, it is necessary for engineers on the PDT to work with the Project Manager, planning, real estate, and construction team members, along with local interests, to develop a scope of work sufficient to prepare sound budget estimates. In addition to working within the PDT, the engineers must coordinate the scopes and schedules with the engineering functional chiefs.

10. Technical Coordination

The District engineering functional chief is responsible for the technical coordination, execution, and review of all engineering work. Districts shall conduct analyses and investigations in accordance with approved engineering criteria and guidance, coordinate engineering activities, and seek advice on problems encountered during project development from appropriate MSC, HQUSACE, and other engineering staffs. For analysis of special areas, such as hazardous, toxic, and radioactive waste (HTRW), hydropower, and other functions, assigned to centers of expertise, the districts shall coordinate as needed and comply with the regulation of use of centers of expertise. For unprecedented, complex problems, districts shall consider the use of special consultant teams, which may include engineers from the MSC, HQUSACE, other Districts, other agencies, academia, or private industry. The non-Federal sponsor's engineers shall be invited to actively participate in all phases of the design, including attendance at all formal meetings.

10.1. *Mandatory Requirements.* ER's and EM's contain mandatory requirements for engineering procedures and design standards, as discussed in paragraph 19 of this regulation. Districts shall forward requests to deviate from published Corps of Engineers criteria to the MSC for review and approval. Where required by regulations, MSC shall forward requests to deviate from these mandatory requirements to CECW-E for review and approval.

10.2. *Independent Technical Review Team.* All products produced by the District require an ITR. The members of the ITR team may be District personnel, contract personnel, non-Federal sponsor's personnel, or engineers from other sources. The District may use the ITR team in the coordination of special and complex problems as long as such action does not compromise the independence of the ITR team.

11. Phases of a Civil Works Project

Engineering involvement in Civil Works project development is continuous, although the level of intensity varies with progression through the different phases of project development and implementation. The Engineering staff fully supports the Project Manager (PM) in coordinating the engineering and design activities with local interests. Deviations from the process described in paragraph 12 through 16 and in paragraph 18 are possible. Each of the following phases of a project is discussed in more detail in the paragraph on the specific phase. All products have all phases; however, the scope, length, and level of effort can vary from one type project to another. The detail in this regulation discusses the process for large complex projects. In some other cases, such as Continuing Authority projects, some of the phases are combined.

The five phase are the Reconnaissance phase, the Feasibility phase, the Preconstruction engineering and design phase, Construction phase, and Operation and Maintenance phase.

12. Engineering During Reconnaissance Phase

The purpose of the reconnaissance is to identify a problem and potential solutions, or define a project, to address a specific public need. All projects and products have some type of reconnaissance phase where the initial definition of the follow-on work is developed.

12.1. *Formal Reconnaissance Study.* When a formal study has been authorized, the reconnaissance phase commences with the obligation of appropriated reconnaissance funds, and ends with a signing of the Feasibility Cost Sharing Agreement (FCSA) or a decision that no Federal interest exists or the failure to identify a cost sharing partner. During the Reconnaissance Phase, a limited scope WRDA 1986 Section 905(b) Analysis is prepared. Target for completion of the phase (signing of FCSA) is 6-12 months after initial obligation of reconnaissance funds. The formal reconnaissance phase study is 100% Federally funded. The cost of an expedited reconnaissance effort, the preferred process, is typically limited to $100,000. This includes $20,000 to cover all investigation and coordination activities necessary to produce a Section 905(b) Analysis. The remaining $80,000 is intended for completion and negotiation of the Management Plan and the Feasibility Cost Sharing Agreement (FCSA). Some reconnaissance studies may be authorized at a cost greater than $100,000 due to unusual scope or complexity.

12.2. *Scope of Reconnaissance Phase.* The reconnaissance phase is general in scope. However, all functions outlined in this paragraph must be addressed with sufficient engineering involvement as part of the PDT at this early stage to identify the existing conditions, the future without project conditions, the problem to be solved, and the preliminary plans that will ultimately lead to an engineering solution. The team must define the engineering and other efforts required for the feasibility phase, identify potential HTRW, and/or other environmental concerns, develop conceptual designs with reasonable estimates of costs, and support negotiating the FCSA and the Management Plan.

12.3. *Development of Management Plan.* The Management Plan is the blueprint for conducting the following phase of the project. Sufficient detail must be included to define the design criteria to be used for all major components of the project, to identify necessary tests and model studies, and to prepare a preliminary cost estimate. When the detail is lacking problems with funding and timing can arise during the next phase of the project. The format for a Management Plan that is prepared during the reconnaissance is shown in the ER 1105-2-100. The lead engineer on the PDT must insure that sufficient engineering detail is included in the Management Plan.

12.4. *Objectives of a reconnaissance phase.* The four objectives of a reconnaissance phase are:

12.4.1. Determine that the problem(s) warrant Federal participation in feasibility studies,

12.4.2. Define the Federal interest based on a preliminary appraisal consistent with Army policies, costs, benefits, and environmental impacts of identified potential project alternatives,

12.4.3. Prepare a Management Plan, and

12.4.4. Assess the level of interest and support from non-Federal entities in the identified potential solutions and cost sharing of feasibility phase and construction.

12.5. *Engineering assessment of alternatives.* Detailed engineering studies and analyses are generally not required during the reconnaissance phase. The engineers on the PDT must participate in assessing one or more potential alternatives to only determine whether they will function safely, reliably, efficiently, and economically. Effort shall be applied only to alternatives considered to have potential. In addition, PDT members shall jointly assess whether potential alternatives adequately address environmental and HTRW issues to determine if the alternatives are practical. Engineering assessment shall be based on knowledge of standard analyses and operating experience, and on sound engineering judgment. Senior engineering staff must be involved to provide experienced judgment in selection of alternatives. Appropriate outside specialists shall be consulted whenever the in-house engineering staff is not sufficiently trained or lacks experience in the type work being studied. Although only existing informational floodplain hydrology is usually used for reconnaissance phase studies, such data shall be verified. Engineering as well as all members of the PDT must have input in the decision process for the final recommendation.

12.6. *Development of engineering effort required for the feasibility phase.* The engineering effort and its associated costs required for the feasibility phase must be identified in cooperation with the PDT during formulation of the Management Plan and FCSA. This shall include the initial preparation of the quality control plan portion of the Management Plan. The engineering members of the PDT will support, participate, and provide technical assistance in the development and negotiation of FCSA's. The engineering work items, required for a feasibility phase, are listed in paragraph 13. Engineering studies and analyses, including physical and numerical model investigations, shall be scoped to the level needed to establish project features and elements that will form an adequate basis for the project construction schedule and a baseline cost estimate. Non-Federal sponsor requirements, prudent engineering practice, and risk, as reflected in the contingencies, are factors that shall be taken into consideration. Contingencies for engineering costs during the feasibility phase shall be limited to the maximum extent possible; however, good engineering judgement shall be used in developing these contingencies.

12.7. *Cost estimate and schedule.* The cost estimate for the plans that are recommended in the reconnaissance phase shall be developed to the same level as the other data used to support the recommendation. The estimate shall include estimates of total costs for real estate, mitigation, construction, facility and utility relocation, engineering and design, environmental and HTRW concerns, project management, contingencies, and inflation. Historical data, models, or unit prices are acceptable methods for developing costs at this stage, but the method used must establish reasonably supportable costs for determining whether a project is continued into the feasibility phase. Initial design, land acquisition and construction schedules are required to support the development of total project costs.

12.8. *Independent Technical Review for Reconnaissance Phase.* The independent technical review shall concentrate on evaluation of the overall project plans, on the initial cost estimates and on the Management Plan. Because the plans are largely based on experience and on extrapolation of limited data, it is essential that expert technical reviewers verify that the plan represents a reasonable solution. The review shall be consistent with the level of the reconnaissance phase and shall verify that the plan will be safe and functional, will comply with engineering criteria, and will be able to satisfy requirements for project authorization. Reviewers shall also evaluate the schedule, budget, and work plan proposed in the Management Plan for the feasibility phase. A Statement of Independent Technical and Legal Review will be prepared as described in Appendix F and accompany any reconnaissance report submitted to CECW-AR for policy compliance review. These statements are not necessary for Section 905(b) analyses under the expedited reconnaissance study process.

12.9. *Technical Review Conference (TRC).* At the determination of the district, a TRC may be held prior to the end of the reconnaissance phase, with appropriate senior district staff, and if required, MSC and HQUSACE staff. The purpose of the TRC is to resolve any outstanding technical issues on the scope and detail of the engineering development of alternative plans to be accomplished during the feasibility phase, as documented in the Management Plan, which have not been resolved by the ITR process.

13. Engineering During Feasibility Phase

The purpose of the feasibility phase is to formulate a solution to address a specific public need. The work includes studying potential solutions, evaluating costs and benefits, preparing initial designs, and recommending a plan to solve the problem. All projects and products have some type of feasibility phase where a decision is made concerning the product to be designed and constructed.

13.1. *Formal Feasibility Studies.* A formal feasibility study investigates and identifies solutions to water resources problems and recommends either for or against Federal authorization or implementation of a project. Feasibility studies, except for some navigation studies, are cost-shared 50/50 with a non-Federal sponsor and are the basis for congressional authorization. Typical studies are completed in three to four years. The feasibility phase begins with the allocation of feasibility funds for fully Federal-funded projects or the execution of a Feasibility Cost Sharing Agreement (FCSA) for cost-shared projects. At least 50 percent of a non-Federal sponsor's share (25 percent of the total feasibility phase) will be in cash. The remainder of the non-Federal sponsor's share (up to 25 percent of the feasibility cost) may be in-kind products and services. In addition to the preparation of the feasibility report with an engineering appendix, a Preconstruction Engineering and Design (PED) cost-sharing agreement is prepared during the feasibility phase.

13.2. *Engineer Elements of a Feasibility Study.* The engineering effort during feasibility shall include, but not be limited to,

13.2.1. Hydrology and hydraulic studies,

13.2.2. Development of data for the environmental assessment,

13.2.3. Establishment of the preliminary design,

13.2.4. Development of surveying and mapping information in conjunction with the real estate division,

13.2.5. Identification and design of utilities and facilities proposed for relocation,

13.2.6. Determination and design of the improvements required on lands to enable the proper disposal of dredged or excavated material,

13.2.7. Development of geotechnical information,

13.2.8. Development of HTRW information,

13.2.9. Design of project alternatives,

13.2.10. Structural, electrical, and mechanical design analysis,

13.2.11. Development of construction procedures

13.2.12. Identification of construction materials including borrow and spoil areas, and

13.2.13. Identification of O&M (OMRR&R) requirements and costs.

13.3. *Plan formulation Support.* To support the plan formulation during the Feasibility Phase, engineering shall establish project features, elements, induced flooding impacts, environmental concerns and opportunities, and real estate requirements. Engineering will also develop conceptual designs, assess available data, and collect necessary new data. The engineering aspects of feasibility studies must be developed to the level that will result in a baseline cost estimate within which the project can be designed and constructed. The engineering effort during the early feasibility study stage consists of evaluating plan alternatives, including the existing and future without-project condition. The engineering members of the PDT will also identify other alternative solutions and verify the amount and level of detail of the engineering studies and field investigations to be accomplished as previously established in the Management Plan. Sufficient engineering and design are performed to enable refinement of the project features, prepare the baseline cost estimate, develop a design and construction schedule, and allow detailed design on the selected plan to begin immediately following receipt of PED funds. The objective is to allow the project to proceed through the PED phase without need for reformulation, or post-authorization changes. Engineering must also provide support to the PM in developing the Management Plan for the selected plan.

13.4. *Evaluation of Alternatives.* Engineering staff shall assist in the evaluation of alternatives to identify those that are constructible and the degree to which safety, reliability, and functional requirements and objectives are met including operations and maintenance. The type and extent of HTRW contamination shall be determined and alternatives and costs for remedial action developed. Proposed alternatives that do not satisfy the constructibility, reliability, safety, or functional requirements shall be recommended for withdrawn from further consideration. This recommendation shall be discussed and agreed upon by the full PDT.

13.5. *Engineering objectives.* The engineering objectives during the feasibility phase are:

13.5.1. Provide engineering data and analyses sufficient to develop the complete project schedule and cost estimate. This is the primary engineering objective during the feasibility phase.

13.5.2. Assist the PM in the development of a complete project schedule for the Management Plan. Identify and schedule funds needed for final design and construction.

13.5.3. Develop conceptual plans and costs for an evaluation and comparison of alternatives and selection of a recommended plan.

13.5.4. Develop the design of the recommended plan to the level required to ensure that it can be implemented without the need for major revisions, and that the baseline cost estimate is adequate.

13.5.5. Determine the relative engineering performance and costs for the various structural and non-structural alternatives for providing a decisive comparison of characteristics between alternatives.

13.5.6. Develop design studies and operations plan requirements.

13.5.7. Determine the value and acceptability of any subsequent in-kind engineering and design services that the non-Federal sponsor may provide in accordance with the Feasibility Cost Sharing Agreement.

13.5.8. Evaluate the functional benefits, acceptability, and the value of any existing features which the non-Federal sponsor proposes to incorporate into and function as part of the project; e.g., highway embankment, storm sewer system, channel, and levee.

13.5.9. Assess risk and uncertainty for safety and functional objectives clearly estimating and displaying the probable performance of the selected plan in accordance with current risk and uncertainty analysis policy and criteria.

13.5.10. Provide preliminary design drawings to establish real estate requirements. Identify other property requirements necessary to protect project features, such as high ground between floodwall segments.

13.5.11. Identify facilities and utilities proposed for relocation.

13.5.12. identify borrow and disposal sites and determine the improvements required including lands, easements and rights-of-way for the proper disposal of dredged or excavated material.

13.5.13. Develop a baseline project performance for project authorization and subsequent design efforts. Adequate engineering analysis must be undertaken in the feasibility phase to assess and document the intended project performance. This information is needed to coordinate the safety and the functional aspects of the project with the non-Federal sponsor and with the district operational staff. The baseline project performance becomes a standard to monitor changes during detailed design affecting the intended performance of project features.

13.5.14. Identify and assess potential areas of HTRW contamination including the effects on project lands, worker health and safety, and material disposal; develop alternatives for addressing HTRW contaminated materials; and develop regulatory compliance strategies.

13.5.15. Develop the baseline cost estimate to be used for project authorization and setting the amount of allowable cost increases without reauthorization.

13.6. *Engineering studies and investigations.* Engineering data and analyses in the feasibility phase shall be sufficient to develop the complete project schedule and baseline cost estimate with reasonable contingency factors for each cost item or group of cost items. Results of engineering evaluations of planning alternatives will be documented in an engineering appendix to the feasibility report. An outline of

the engineering appendix is given in Appendix C. Engineering analysis shall integrate sound environmental engineering principles and procedures into all phases and features of the project. The feasibility level engineering data and analyses shall include, but are not limited to:

13.6.1. Hydrology and Hydraulics. Hydrologic and hydraulic studies facilitate the evaluation of economic and environmental impacts of alternatives. These studies are required to determine the functional design and requirements of water resource projects and to establish channel capacities, structure configurations, levels of protection, interior flood-control requirements, residual or induced flooding, etc. Engineering assumptions shall be consistent with plan formulation assumptions, the without project conditions, and the project economic analyses. For flood reduction projects, it is equally important to address internal flood-control requirements and residual flooding when evaluating alternatives. Physical and numerical modeling may be required in the feasibility phase to demonstrate that the proposed alternative(s) can be designed to satisfy project objectives and to determine project costs within the required level of accuracy. For navigation projects, ship-simulation investigations shall be completed in accordance with established guidance, unless a waiver is obtained. Modeling not required for project formulation, such as modeling that provides only information required for preparation of plans and specifications may be deferred to PED. However, all such modeling shall be identified in the Management Plan and scheduled for the PED phase.

13.6.2. Surveying, Mapping, and other Geospatial Data. Surveying, mapping, and other geospatial data information should be obtained to support all feasibility phase requirements. At this level, existing surveying, mapping, and other geospatial data available through in-house sources or through other federal, county, local, commercial, or private sources may be adequate. Additional information on finding these sources is available in EM 1110-1-2909. The data source, i.e., compilation scale, contour interval, control data and datum, etc., should be verified to assure it meets accuracy requirements to support the level of detail required. Otherwise, new surveying, mapping, and other geospatial data may need to be developed. If sufficiently scaled topography is not available to support the level of detail required, then it shall be developed during the feasibility phase to eliminate the possibility of large quantity errors (e.g., real estate, reservoir volumes, etc.). Detailed guidance on photogrammetric mapping surveys is provided in EM 1110-1-1000. Survey control methods and if possible the actual control points shall be established in the field at this phase of study to avoid rework and errors and to maintain continuity during subsequent phases of the project. Detailed site-specific mapping may be deferred and developed during the PED phase unless it is required to develop an accurate baseline cost estimate. The Geographic Information System (GIS) for the project should be established during this phase in accordance with EM 1110-1-2909 and ER 1110-1-8156.

13.6.3. Preliminary Project Layout. Preliminary design drawings, as defined in paragraph 13.6.6 below, shall be furnished to the Real Estate Division to establish real estate requirements (estates, rights-of-way, etc.) and to prepare the Real Estate Appendix or Real Estate Plan for the feasibility report. These drawings shall also be furnished to the environmental planning team members for use in impact analysis and mitigation planning.

13.6.4. Data and Document Management. Data and document management is as important as project management and must be a “cradle to grave” activity on each project. It is important to maintain continuity and effective resource and time management on the project. One element of the data management on a project is the GIS. The GIS starts being developed (at least a plan or outline of what kinds of data sets are likely to be developed and what the GIS will look like) in the reconnaissance phase and shall be used to maintain data in the feasibility phase. This is required to insure that all data used is maintained and available for use in the later phases of the project. In order to achieve maximum cost savings and system

flexibility, it is important that the GIS is developed in accordance with the District's Geospatial Data and Systems Implementation Plan.

13.6.5. Subsurface Exploration. Sufficient geologic and soils information shall be obtained, analyzed, and presented to support the site selection, type of foundations, and selection of structures. Subsurface investigations necessary to support the project design and baseline cost estimate, are to be performed. Additional foundation exploration and testing required during the PED and construction phases shall be identified. Subsurface investigations shall also include investigations of potential borrow and spoil areas.

13.6.6. Project design. Engineering must establish all design criteria for the project, including functional requirements, non-Federal sponsor requirements, technical and procedural design criteria, and environmental engineering considerations. Engineering must also present technical results of alternative studies leading to selection of project site, configuration and features, including main structures, major appurtenances, and major electrical and mechanical features. To establish a realistic comparison of costs, these studies shall include field tests, evaluations of HTRW, stability analyses, structural material tests, and initial seismic, thermal and conventional stress evaluations. Adequate coordination is required to obtain and process survey, hydrologic, hydraulic, structural, geotechnical, and operations and maintenance information for these studies. Studies shall address site restrictions, cofferdams and dewatering, diversion plans, and environmental restrictions or enhancements, In addition to the planned testing program for the project, special testing may be required to assess unique situations such as unusual sites, materials, structural configurations, operational plans, or extreme loadings. Because of the costs, field tests during feasibility shall be described in the Management Plan and should be limited to the alternatives most likely to be selected as the recommended plan. Any additional studies or tests planned for later phases of the design, including potential impacts on project costs must also be described and included in the Management Plan. To address the requirements of PL 89-670 with respect to authority for structure clearances over navigable waters, the U.S. Coast Guard shall be contacted to determine requirements for permits for any structures to be constructed or relocated over a river, embayment, or tributary thereto of navigable waters of the United States in connection with development of the project.

13.6.7. HTRW. Projects shall be designed to avoid HTRW contamination. Where HTRW cannot be avoided, investigations must be conducted to establish the nature and extent of HTRW contamination, if any, and the impact and cost of needed remedial action. The HTRW investigations shall address the impacts of any suspected HTRW contamination identified in the Preliminary Assessment, including development of Data Quality Objectives, Remedial Action alternatives and all associated costs of characterization and remediation. On cost-shared projects, the investigations to determine the extent and nature of contamination are cost shared the same as the cost sharing for the current of the project. The non-Federal sponsor is responsible for 100% of the cost to develop the clean-up procedures (remedial action plan) and to treat the contaminate in place or relocate the material. If the sponsor requests assistance developing the remedial action plan, the PDT shall discuss using an approved HTRW design district for the work. An engineer member of the PDT shall coordinate the studies and monitor the analysis when a HTRW design district provides assistance. The clean-up procedures must comply with the appropriate HTRW Laws and Regulations governing the site and must be approved by the appropriate Regulatory Agencies.

13.6.8. Environmental Engineering. Project design shall seek to avoid adverse environmental impacts. When avoidance is not possible, projects shall be designed as much as practical to minimize adverse environmental impacts and when possible be in concert with the surrounding environment. Mitigation shall be considered only after all practical environmental design alternatives have been considered. The non-Federal sponsor shall be a partner in the decision to mitigate in lieu of preserving or enhancing the

existing environment. When environmental restoration or enhancement is the primary project purpose, the design standards used shall acknowledge this purpose. Temporary mitigation measures required during construction must also be considered when developing the project design.

13.6.9. Construction Materials and Procedures. Potential sources and suitability of concrete materials, earth and rock borrow materials, and stone slope protection material as well as potential disposal sites shall be identified. Preliminary construction procedure, construction sequence and duration, and control of water for each step of the proposed plan shall be developed. The control of water plan shall address dewatering and surface water bypass during construction to confirm that the plan is feasible. Construction equipment and production rates that are used as the basis for the estimate shall be identified for major items. When developing the construction procedures, efforts shall be coordinated with the construction member of the PDT.

13.6.10. Consideration of Human Factors. Human judgement and reactions are equally important to physical design criteria in the performance of many civil works features, most notably deep-draft navigation channels and floodgate closure structures. Coordination with potential users and/or operators of facilities, such as ship pilots or local emergency response authorities, is required to insure that human factors are accounted for in the overall workability of civil works projects. For those features of a project where human interaction or intervention is needed, a validation of the workability of the design must be obtained from operators or users of these features during the feasibility phase.

13.6.11. Design of Non-Life Safety Critical Structures. For the purposes of this regulation, non-life safety critical structures are those small features whose failure would not result in loss of life, or significant economic loss or liability. For design of these structures (e.g., those related to environmental restoration projects), cost efficiency will be considered as a primary factor when determining appropriate design criteria.

13.7. *Engineering Review Conferences.* Not later than 18 months into the feasibility study the lead engineer on the PDT shall assess the status of the engineering portion of the study. This assessment shall include a review of the independent technical review comments, if available, and the adequacy of the field investigations and design studies identified in the Management Plan. If necessary, the engineer may request an Engineering Review Conference (ERC). The PM will coordinate with the non-Federal sponsor and encourage their participation in the ERC. If additional field investigations or design studies, beyond those identified in the Management Plan for accomplishment during the feasibility study, are required a request shall be submitted to the PM in accordance with project management guidance. The engineering appendix to the feasibility report may present the major items of discussion from an ERC, and describe the results on project formulation and design. In addition, the engineers on the PDT may participate in Issue Resolution Conferences (IRC) to resolve technical or policy issues between the independent technical review team, the non-Federal sponsor, the MSC, and/or HQUSACE.

13.8. *Operation and Maintenance Considerations.* An operations, maintenance, repair, replacement, and rehabilitation (OMRR&R) plan for the project, including detailed estimates of the Federal and non-Federal costs, shall be developed during the feasibility phase. Budgets and schedules for the preparation of the necessary O&M or OMRR&R manuals must be included in the Management Plan. The specific requirements for the O&M or OMRR&R plan are stated in regulations and pamphlets dealing with specific types of projects. Some of the regulations dealing with O&M and OMRR&R plans are 33 CFR 208.10, ER 1110-2-401, ER 1110-2-1404, ER 1110-2-1405, ER 1110-2-1407, ER 1110-2-2902 ER 1130-2-500, and EP 1130-2-500.

13.9. *Baseline Cost Estimate.* The baseline cost estimate, based on the project schedule and the design developed for the recommended plan, becomes a major product upon which the project is authorized, developed, and completed. Adequate engineering data must be obtained and analyzed. Sufficient design must be performed to define the level of risk with associated contingencies and to ensure that reasonable costs can be developed for the identified project features based on the baseline design and construction schedule.

13.9.1. MCACES is the required software for the preparation of the final feasibility cost estimate. Specific details and guidance are covered in ER 1110-2-1302. Flexibility is provided to permit development of comparative cost estimates to be developed outside the MCACES software for the evaluation and elimination of project alternatives. The final cost estimate supporting the National Economic Development (NED) or recommended plan within the feasibility report must be prepared using the MCACES software and the established Work Breakdown Structure (WBS). The baseline estimate is the fully funded project cost estimate developed for the recommended scope and schedule established in the feasibility report. It includes all Federal and non-Federal costs for lands and damages, all construction features, planning, engineering and design, and supervision and administration, along with the appropriate contingencies and escalation associated with each of these activities through project completion. The level of cost detail may vary according to the design information/detail established to support the feasibility report. Contingencies shall be developed based upon the risks related to the uncertainties or unanticipated conditions identified by the investigation data and design detail available at the time the estimate is prepared. Contingencies will vary throughout the cost estimate and could have a significant impact on overall costs being high when lack of design data is associated with critical cost items. Part of the PDT overall project evaluation shall be whether to perform additional investigations or studies in order to reduce the uncertainties and refine the cost estimate or to proceed with the higher estimate and contingencies.

13.9.2. The final product must be a reliable, accurate cost estimate that defines the non-Federal sponsor's obligations and supports project authorization within the established WRDA86, Section 902 limits.

13.10. *Project Design and Construction Schedule.* As part of the PDT, the engineers shall provide schedules for design, performance of utility/facility relocations, provision of disposal area improvements, and construction for preparation of the Management Plan in accordance with project management guidance. These schedules shall be based on engineering judgement and indicate the optimum schedule for completing design and construction. The PM shall coordinate schedule adjustments based on funding availability and local sponsor requirements. The adjusted schedules will be used in the development of the baseline cost estimate.

13.11. *Engineering Support for Project Cooperation Agreement and PED Agreement.* During the feasibility study the PM reviews the provisions of the PCA and cost-sharing requirements with the sponsor, using the model PCA. The PM and the non-Federal sponsor negotiate their differences and agree on a final draft PCA to be included in the feasibility report. The engineering members of the PDT participate and provide technical support to the PM in defining the project scope, preparing the project description, developing the cost estimate, and providing critical considerations affecting project performance in the PCA. The engineering members of the PDT also work with the PM and the non-Federal sponsor to develop and negotiate the PED agreement. The PED agreement includes scopes of work for the final design and the plans and specifications for the first contract. It also outlines the division of design responsibilities between the Government and the non-Federal sponsor.

13.12. *Independent Technical Review for Feasibility Phase.*

13.12.1. An independent technical review for the feasibility phase must, as a minimum,

13.12.1.1. Verify that the recommended plan satisfies engineering and functional criteria,

13.12.1.2. Verify that the plan meets the customers needs consistent with law and existing public policy,

13.12.1.3. Verify that design assumptions and calculations are correct, and

13.12.1.4. Verify that the level of engineering is sufficient to substantiate both the screening level comparative cost estimates and the baseline cost estimate with contingencies to support selection of the recommended plan and to establish the baseline cost estimate with contingencies.

13.12.2. The district should include a technical review certification, as described in Appendix F, and findings with the final feasibility report documentation. The findings will summarize any changes made to the draft report made as a result of the review. Appendix F also provides guidelines for objectives and procedures appropriate for technical review of project decision documents.

13.13. *Engineering policy review and assessment of feasibility reports.* The Washington-level Policy Compliance review, combined with the feasibility phase conference report(s), is intended to produce one objective and comprehensive review of feasibility reports that can be used as a basis for forming recommendations by the Chief of Engineers and Assistant Secretary of the Army (Civil Works) for project authorization. The policy compliance review considerations are available from the Policy Review Branch (CECW-AR).

13.14. *Value Engineering.* A value engineering study shall be performed on the earliest document available that satisfies the functional requirements of the project and includes a MCACES cost estimate. The PDT shall determine if the initial value engineering study shall occur during the feasibility phase or be delayed until the PED phase. The study shall follow the guidance in paragraph 14.7.

13.15. *Engineering by the Non-Federal Sponsor.* Current policies and cost sharing agreements allow the non-Federal sponsor to perform work in-kind. When the non-Federal sponsor proposes work in-kind, an engineer from the sponsor's staff shall be on the PDT. The sponsor's work shall be reviewed as part of the ITR process. The District engineering organization shall provide the same level of oversight on the sponsor's work, as is provided on other contract engineering work. If a non-Federal entity submits a complete feasibility report for authorization, the District engineering element shall review the report for compliance with Corps of Engineers guidance. Engineering judgement shall be applied when the report varies from Corps standards and waivers shall be granted where appropriate.

14. Engineering During Preconstruction Engineering and Design Phase (PED)

The Preconstruction Engineering and Design Phase (PED) is the phase during which the design is finalized, the plans and specifications (P&S) are prepared, and the construction contract is prepared for advertising. Under current appropriations the budget definition of PED includes only the first set of P&S; however, the activities discussed in this paragraph occur for each set of P&S prepared for a project.

14.1. *Forma/ PED Phase.* On a project following the full normal project authorization process, the PED phase begins when the MSC Commander issues the public notice for the feasibility report and PED funds

are allocated to the district. On projects, which require cost sharing, PED new starts require the execution of the PED cost-sharing agreement prior to the start of PED. The non-Federal sponsor must provide 25 percent of the cost of PED during this phase. The actual cost-sharing for PED shall be the same percentage as project construction costs with adjustments, if necessary, being made after the start of the construction phase. PED generally requires a period of up to two years, depending on the complexity of the project, and ends with completion of the P&S for the first construction contract or as otherwise defined in the PED cost-sharing agreement. Engineering functions shall be prepared to begin an intensive effort immediately upon notification from the Project Manager that PED funds are available.

14.2. *Project Reformulation.* If circumstances require project reformulation, a GRR shall be prepared. For minor design changes an EDR may be prepared to support the PCA. The EDR may, also, be prepared for individual projects authorized as part of a large system study or authorized by Congress without a feasibility report, However, in these cases the EDR will only be use when engineering technical decisions only are required (see paragraph 8.3. for the EDR). DDR's will be required to properly document the engineering and design work performed during the PED and construction phases. The requirement for DDR's can not be waived; however, the content of the DDR may be reduced if the project is not complex, sufficient engineering detail is contained in the feasibility report engineering appendix, and no further detailed documentation is necessary. When a minimum DDR is used, the content of the engineering appendix must be more comprehensive, and shall contain full documentation of the completed design. When the design is an adaptation of a similar design from a previous project, a justification for adaptation shall be included in the DDR and the previous design document referenced.

14.3. *Documentation of Design.* The requirement for DDR's and their related ITR's can not be waived; complete design documentation must always be produced. However, the DDR where appropriate to avoid duplication, may refer to a detailed Engineering Appendix if that appendix contains full documentation of the completed design.

14.3.1. For a large or complex project, which may have multiple construction contracts, after the feasibility phase it may be appropriate to prepare an initial DDR for the overall project, including initial design of all major features of the project. This initial DDR could then be referenced by separate DDR's for the features in each contract. Production of the DDR and related P&S shall proceed concurrently as one unified design phase. The design should shall be completed and documented in the DDR, in accordance with Appendix D, Content and Format of Design Documentation Report.

14.3.2. Engineering efforts must be in accordance with the current Management Plan with respect to schedule, cost of design, and, more importantly, estimated construction cost. The engineering members of the PDT shall analyze the current design efforts and the estimated construction costs for conformance with the design parameters, assumptions, and costs in the baseline cost estimate. Any proposed revisions in the estimated cost or schedule of design work for this and subsequent phases of engineering must be submitted to the PM in accordance with project management guidance.

14.4. *Technical Review Conference.*

14.4.1. Early in PED, before substantial work is accomplished, technical review conference (TRC) may be held to insure that all PDT members understand the scope of work to be completed during the PED phase in accordance with the PED cost-sharing agreement. A site visit will normally be included as part of the first conference. Complex projects may require several TRC's. The PM may conduct the TRC or designate an engineering member of the PDT to conduct the meeting.

14.4.2. The purpose of the initial TRC is to discuss the current project plan, project background, objectives, schedules, costs, design options, major issues, problem areas, and the type of documents which must be prepared and the level of detail in those documents. The objective of the initial TRC will be oriented toward the design of the current project plan.

14.4.3. The lead engineer on the PDT will document the proceedings and results of the initial TRC as part of their Quality Control programs. Appropriate MSC staff may attend as part of the MSC Quality Assurance responsibilities.

14.5. *Design Documentation Reports.* A DDR shall contain but is not limited to the applicable items outlined in Appendix D. Format of a DDR shall follow that also shown in Appendix D.

14.6. *Permit applications for structures over navigable waters.* Application shall be made to the U.S. Coast Guard for any permits determined during the feasibility phase to be required for structures to be constructed or relocated over navigable waters in connection with the project. The engineer member of the PDT shall coordinate this action with the PM.

14.7. *Value Engineering.*

14.7.1. Public law and Office of Management and Budget directive require value Engineering (VE). It application has been the subject of a number of Corps of Engineers wide audits. As such, the Corps current VE Policy is to provide VE studies on Construction General projects with estimated cost of $2,000,000 and greater, and Operations and Maintenance projects with estimated cost of $1,000,000 and greater. In unusual cases where the district determines a VE study is not cost effective, the district shall prepare a formal waiver request for approval by the division engineer, with a copy of the approved waiver forwarded to CEMP-EV.

14.7.2. The PM, acting for the commander of the district, shall establish a multi-disciplinary team for each VE study on a project. This team may be made up of in-house staff, A-E contractors, or a group consisting of Corps employees outside of the immediate field office, such as the Office of the Chief of Engineers Value Engineering Study Team. Project studies will incorporate the following guidance:

14.7.2.1. A VE study shall be performed on the earliest document available that establishes the functional requirements of the project and includes a MCACES cost estimate.

14.7.2.2. If, for some reason as discussed in paragraph 8.3 above, a future project requires an EDR (or similar concept document) and final design is proceeding concurrently with the EDR review, the VE study may be started prior to its approval.

14.7.2.3. Standard criteria and designs normally incorporated into the project may be studied prior to the receipt of the approved EDR or similar document.

14.7.2.4. A representative of the sponsor will be invited and encouraged to participate on this VE review team.

14.7.2.5. The cost and schedule for VE will be included in all cost estimates and the Management Plan.

14.7.3. Each district commander will certify, based on the recommendations of the project VE team, that the design achieved is the most cost effective found by the VE study. The cost analysis shall address life cycle and deferred risk costs as well as first costs, in accordance with ER 1110-2-8159. The certification statement will accompany the document that was the basis for the VE study, or if the document has already been submitted, the certification statement will be included in a separate letter and submitted to

HQUSACE (CECW-E). Any cost savings resulting from the cost effectiveness review will be identified in the certification statement.

14.8. *HTRW.* For non-cost-shared water resource projects where HTRW cannot be avoided, the design of a plan for remediation of the HTRW is required. This effort shall be undertaken by a Geographic HTRW design district, but technical assistance will be needed to coordinate and incorporate the response work with the project plan and construction. Where the remediation action levels cannot be reached before scheduled construction, a risk assessment shall be conducted to determine what actions are warranted to allow construction to start. For cost-shared water resource projects, the sponsor is responsible for the design and implementation of the remediation, but that work effort must be coordinated with the design and construction schedule of the civil works project.

14.9. *Relocations.* Relocations are a local responsibility and cost, and in many cases are a major consideration in Civil Works projects. They need to be emphasized, and given proper consideration. The local sponsor shall be part of the PDT when relocations are being considered. During PED decisions must be made on who will accomplish relocation designs and how relocations will be coordinated with the other elements of the PDT.

14.10. *Physical model studies.* Any physical model studies or ship simulation studies required, but not previously performed during feasibility, shall be conducted during the PED phase. The need for these studies must be determined during the feasibility phase and the schedule and cost for conducting such studies must be incorporated into the Management Plan.

14.11. *Approval authority and distribution of documentation reports.* The procedures for distribution and approval of a DDR's and EDR's are as follows:

14.11.1. Design documentation reports (DDR's) are implementation documents, which undergo independent technical review and approval at the district level. A statement of the independent technical review, Appendix F, will be completed for all DDR's, and placed in the project file. DDR's are not to be submitted for a Washington-level approval. DDR's shall not be used to support the PCA. If the project has changed since approval of the decision document (feasibility report) then an EDR shall be prepared to describe the changes.

14.11.2. Engineering Documentation Reports (EDR's) are implementation documents, which undergo an independent technical review and approval at the district level. EDR's are, also, supplements to decision documents. Districts shall provide 12 copies of a final EDR to Policy Review Branch (CECW-AR), to support the PCA. One copy of the EDR shall be sent to Engineering and Construction Division (CECW-EP). The MSC will receive a copy of EDR's for information and/or quality assurance activities.

14.11.3. Design centers or other districts performing work on a project shall perform an independent technical review and approval of their work. The geographic district shall be on the review team.

14.11.4. Districts will send one copy each of DDR's to the MSC and HQUSACE, respectively, for informational purposes and project file. There will be no review or reply by higher headquarters.

14.11.5. The originating district shall furnish one complete copy of each approved DDR on a major feature of a project to the Waterways Experiment Station, ATTN: Research Library. Copies of DDR's filed at the Research Library shall be used as a source of data for model and prototype tests and investigations conducted by the Waterways Experiment Station and will be available for loan to other USACE installations. The library shall periodically announce to other USACE offices what DDR's are available for loan.

14.12. *Engineering Support for Preparation of the Project Cooperation Agreement.* The draft PCA is refined during PED. This refinement is based on continual communication between the PDT members, the PM, and project sponsor concerning project requirements. Engineering shall update the project description and cost estimate prepared during the feasibility phase. The project report to support the PCA shall be a Feasibility Report with Engineering Appendix, a general reevaluation report (GRR), or a document that updates the changes since approval of the feasibility report. An EDR may serve as to supplement the supporting decision document. The engineer team members of the PDT will work with the PM to determine the appropriate report to support the PCA. In any case, the report must document that the project to be built under the PCA is the same as that presented in the document previously approved by the Administration. If the project has been changed, the report must document the changes and reasons therefor. Engineering shall assist the PM during negotiations, as needed.

14.13. *Preparation of plans and specifications (P&S).* P&S shall be prepared in accordance with ER 1110-2-1200. P&S shall also be prepared in accordance with the Architect/Engineer/Construction CADD Standards and the Tri-Service Spatial Data Standards. They shall contain all the necessary information required to bid and construct the plan detailed in the engineering appendix and documented in the DDR. Reviews shall be made for biddability, constructibility, operability and environment (ER 415-1-11). Contract duration and liquidated damage amounts shall be estimated in coordination with the construction organization. The submittal register (ENG Form 4288), which forms a part of the specifications package, shall be prepared, and the contractor submittals to be reviewed by engineering shall be indicated on this form (ER 415-1-10 prescribes Form 4288). P&S shall be reviewed and approved by the district commander or his designated representative. Either contract or Government personnel can accomplish the review of P&S prepared by a contractor.

14.14. *Independent Government estimates (/GE).* A formal, approved construction cost estimate is prepared to support the award of each construction contract. This estimate is required for all contracts of $100,000 or more (FAR). It often represents the first detailed cost estimate based upon specific contract documents (P&S) and conditions (schedule, phasing, and constraints). This estimate serves as the document for evaluating contractor bids as a fair and reasonable cost to the Government. It further provides a mechanism through the cost item related bid abstract to collect costs for historical purposes and to compare costs with the baseline cost estimate for the project. This estimate covers the contract construction features only and does not include contingencies or profit on civil works projects. All estimates shall be prepared in accordance with ER 1110-2-1302.

14.15. *Engineering considerations and instructions for field personnel.* In preparation for the beginning of each major construction contract, engineering shall prepare a report outlining the engineering considerations and providing instructions for field personnel to aid them in the supervision and inspection of the contract. This effort must be included in the Management Plan. The report will summarize data presented in the engineering document and include informal discussions on why specific designs, material sources, construction plant locations, etc. were selected. This information shall assist field personnel by providing the insight and background needed to review contractor proposals and resolve construction problems without compromising the design intent. The discussions must not conflict with the P&S. In all

cases, the P&S will govern. The report shall be reasonably short and organized for quick reference in field situations. An outline to aid in preparing the engineering considerations and instructions for field personnel is presented in Appendix G.

14.16. *Review of A/EPA document.* In accordance with ER 200-2-2, the PDT shall review the NEPA document during PED to determine if changes to the project will require preparation of a revised or supplemental NEPA document.

14.17. *Independent Technical Review.* The products produced during the PED phase (DDR's and P&S's) are subject to an independent technical review, which is a continuing process from the start to the completed of the PED phase. The ITR team will issue periodic reports in coordination for the engineer member of the PDT.

14.17.1. The district independent review team or contractors ITR team shall verify or ensure the following:

14.17.1.1. That the design conforms to proper criteria,

14.17.1.2. That the design conforms to the plan recommended in the feasibility report,

14.17.1.3. That any deviations from criteria or the recommended plan are properly justified,

14.17.1.4. That appropriate design methods have been followed,

14.17.1.5. That the design office has completed an internal check of the design and has so indicated on drawings and computation sheets, and

14.17.1.6. That the completed project design is adequately documented in the DDR

14.17.2. The ITR team may be in-house personnel, personnel from another district, or contractor personnel. The review effort should concentrate primarily on issues related to safety and function of the project. All critical portions of the design shall be addressed in the original DDR. A statement of independent technical and legal review, Appendix F, will be completed for all DDR's and P&S's.

15. Engineering During Construction Phase

Engineering effort during construction includes completion of DDR's, modification of P&S (where appropriate), and preparation of engineering considerations and instructions to field personnel. Additional effort is needed to review selected contractor submittals, conduct site visits, and prepare construction foundation reports and concrete reports. Other plans and reports prepared during construction are the initial reservoir filling plan, the embankment surveillance plan, and the HTRW documentation report. The engineers must also provide support for contract claims and modifications, development of operation and maintenance (O&M or OMRR&R) manuals, emergency action plans (including inundation maps), and review of as-built drawings.

15.1. *Engineering funding for Construction Phase.* Engineering shall review the budget established in the baseline cost estimate for engineering work during the construction phase to ensure it is current. Any revisions needed shall be provided to the PM in accordance with project management guidance. Engineering must monitor and account for its staff expenditures during this phase to ensure adherence to

the Management Plan. The following engineering support shall be provided and included in the budgets of the Management Plan.

15.2. *Complex projects.* For complex projects with multiple contracts, the work under the first contract will be in the Engineering During Construction phase while work on other future contracts will be in the PED phase as described in paragraph 14. Preparation of DDR's and P&S's for additional contracts is handled using the PED phase guidance.

15.3. *Preconstruction conference attendance.* Appropriate engineering personnel shall attend preconstruction conferences to develop an awareness of any contractor construction concerns and assist with any technical questions that may arise.

15.4. *Review of selected contractor submittals.* The shop drawings, samples, letters of certification, tests, and/or other engineering information identified for review by engineering on ENG Form 4288 shall be processed in a timely manner (ER 415-1-10).

15.5. *Site visits.* Site visits shall verify that conditions match the assumptions used in designing the project features. Site visits may also be necessary to brief construction division personnel on any issues affecting the construction, including aesthetic considerations, which cannot be conveyed via the report on engineering considerations and instructions for field personnel. All field visits shall be well documented and scheduled.

15.6. *Engineering support for c/aims and modifications.* Engineering shall provide design and cost-estimating assistance for claims and modifications when requested and be knowledgeable of all claims and modifications arising on a project as they relate to the designs produced in the P&S. Engineering input into this process is essential to ensure continuity of the design process through construction, to help improve the viability of future designs, and to provide feedback and advice to the cost engineer and the PM.

15.7. *Development of O&M or OMRR&R manual and Water Control manual.* The O&M (or OMRR&R) and water control manuals are the responsibility of the engineering element and shall be completed and fully coordinated with the PM, the Operations element, and the non-Federal sponsor (if any) during this phase of the project. These manuals can be prepared either by in-house personnel or by a contractor.

15.8. *As-built drawings.* Final as-built drawings will be reviewed and approved by the engineering organization. The construction contractor as a contract requirement shall generally perform the preparation of as-built drawings. In certain special cases engineering division may prepare as-built drawings from marked up drawings prepared by the construction contractor. The District office shall maintain the original as-built drawings in electronic format. Copies of final as-built drawings to be maintained at the site will be presented to operations personnel or the local sponsor upon turn over of the project or functional element for operations.

15.9. *HTRW.* Engineering shall assist the construction field office in the preparation of an HTRW documentation report, which shall serve as a permanent record of all HTRW-related activities at the project during construction. The local sponsor shall furnish a section for this report documenting the HTRW actions taken on their behalf prior to construction. This HTRW documentation report does not remove the requirement to preserve all Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) environmental restoration actions performed for civil works funded components and non-DOD agencies.

15.10. *Post Construction Reports.* To fully document the project, the post construction reports, which are required by other regulations shall be completed and referenced in the Design Documentation Report. Examples of post construction reports include (but are not limited to) the Project Geotechnical and Concrete Materials Completion Report for Major USACE Projects.

16. Engineering During Operations Phase

Operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of a completed project shall be accomplished by either the non-Federal sponsor or by the Federal government. Responsibilities shall be as set forth in the project authorization(s) and as described in a Project Cooperation Agreement (PCA) for cost-shared projects. The Corps shall periodically inspect the project, and shall review and approve owner-proposed structural or operational modifications, and recommend repair, rehabilitation, and/or replacement of components. Under the Federal Guidelines for Dam Safety, the Corps continues to have a liability for all dams it designed and/or constructed as long as the structure is in service. For other local protection projects, the Corps liability is more limited.

16.1. *Support of Operations Activities.* Engineering support shall be provided for those maintenance activities that require P&S and for major rehabilitation projects. For new construction, engineering shall provide support during the project turnover phase. Depending on the project purpose and subject to the terms of the PCA, engineering support shall be provided to modify as-built drawings, review operational deviations, identify and address project deficiencies, and evaluate replacement plans.

16.2. *Periodic inspections.* Periodic inspections shall be conducted to assess and evaluate the performance and safety of the project during its operating life in accordance with ER 1110-2-100, ER 1110-2-111, ER 1110-2-1156, and ER 1130-2-530. For projects operated by local sponsors, the Corps shall conduct the first and second periodic inspections, and the first filling inspection. After these inspections are completed, the Corps may participate in the periodic inspections that are conducted by the sponsor in accordance with the OMRR&R manual.

16.3. *As-built drawings.* Modifications to the features of a project, which occur during the operating life of a project, shall be reflected in the as-built drawings. The status of as-built drawings shall be a subject of each periodic inspection. For projects operated by local sponsors, the OMRR&R manual shall require an electronic file copy of modified as-built drawings to be furnished to the District office.

16.4. *Operational deviations from the p/an.* Any deviations from the use or function of any portion of a project shall be reviewed and approved by engineering. Changes to the O&M manual shall be made as required.

16.5. *Existing project deficiencies.* Noted deficiencies of a project or evidence of distress exhibiting potential failure shall be identified and reported in accordance with ER 1165-2-119 and ER 1110-2-101, respectively. A plan for correcting such deficiencies shall be developed as required.

16.6. *Evaluation and design of scheduled replacement features.* Support for evaluation and design of scheduled replacement features may be provided as required.

16.7. *Design and Construction of Project Maintenance and Other Contract Work.* When maintenance or other work requires the design, preparation of plans and specifications, and engineering during construction, the applicable portions of paragraphs 14 and 15 shall apply. The non-Federal sponsor may request the Corps to perform this work on a reimbursable basis.

16.8. *Emergency Action Plans.* Engineering shall assist the project operators in the preparation, maintenance, and testing of Emergency Action Plans.

17. Design Quality

Product quality is the responsibility of everyone on the PDT. Execution of design and technical quality is the responsibility of engineering. Technical quality must be achieved while conforming to schedules, budgets, and customer expectations. To ensure these goals are met simultaneously, it is essential that coordinating and planning the work effort occur at the earliest stage of project development, through preparation and execution of the Management Plan. Engineering must provide input for development of the plan. Engineering in conjunction with project management must ensure that the work is properly defined and schedules are attainable. Technical quality shall be achieved mainly through the a process that includes development of realistic comprehensive work plans, definition of functional and technical criteria, adequate coordination among the project team and technical disciplines, and continuous coordination with the PM and non-Federal sponsor. In addition proper oversight by senior design experts, and full participation in constructibility and other feedback sessions is required. Quality is further achieved by participation in value engineering studies and thorough internal checking and review by qualified engineers. Application of lessons learned during current planning and design work can enhance quality of future work. To take advantage of an opportunity for improvement, designers shall document any problems experienced and effective solutions developed during the design and other processes. These may occur in any aspect of design, such as coordination, scheduling, criteria, design methods, regulations, or other areas. Written lessons learned reports shall be forwarded through the command so the entire Corps can benefit from experiences with each project. Specific guidance on design and technical quality is contained in ER 1110-1-12.

18. Continuing Authorities Program.

District staff will use judgment to perform the appropriate level of detail of analyses to produce a quality project and meet Continuing Authorities Program time and cost targets. The level of detail should be minimized to that which is necessary to determine the recommended plan. This does not authorize commanders to deviate from legislative or regulatory requirements. However, districts and divisions are encouraged to be innovative and develop their own time and cost saving measures. Issues that arise over appropriate level of detail should be elevated to the MSC for resolution.

Specific instructions for level of detail are not possible due to the variation in type, scope and extent of problems and the issues surrounding recommended solutions, The Continuing Authorities Program procedures allow the Corps of Engineers to bring expertise and experience to bear to solve identified water resource problems of a more limited scope than those projects, which are pursued under congressional authorization. This mission works best when the program is used to solve the problems for which it was designed, leaving complex projects to the specifically authorized program and very small projects to non-Federal entities. Successful performance on the Continuing Authorities Program's limited funding and time targets requires significant reliance on professional judgment and prudent engineering practices. The Continuing Authorities Program process requires staff skilled in the principles and practices of engineering, economic and environmental evaluation, real estate, and contracting procedures.

19. Published Criteria Mandatory Requirements.

Engineering policy for civil works projects is issued in the form of official publications, primarily engineer regulations (ER's) and engineer manuals (EM's). Engineer circulars (EC's); engineer pamphlets (EP's);

and engineer technical letters (ETL's) are also used. Generally, ER's have been viewed as conveying mandatory policy requirements for management of the engineering function. However, the engineering requirements contained in EM's and other publications have been considered as mandatory standards by some offices, while being treated as mere suggested methods by other offices. This difference has resulted in inconsistent application of engineering requirements throughout USACE, sometimes not in accordance with HQUSACE intent. This intent has not always been clearly stated in the publications; however, many specific provisions have been intended as mandatory. For example, minimum safety factors and minimum clearances to ensure functional adequacy are intended to be mandatory requirements. These mandatory engineering standards ensure reasonable uniformity throughout USACE, and are intended to ensure project safety and functional adequacy.

19.1. *Publications*

19.1.1. Engineer Regulations. ER's contain policy requirements for engineering management. All ER requirements will be considered mandatory unless otherwise indicated within the regulation or as clarified by official correspondence from CECW-E.

19.1.2. Engineer Manuals. EM's contain policy standards for uniform engineering practice related to civil works projects. Existing EM's contain some mandatory requirements to ensure project safety and function. These requirements shall be identified annually in an ETL. These interim annual lists of mandatory requirements will be in effect until individual EM's are updated. In all new EM's and future revisions of each EM, the HQUSACE proponent shall ensure that the mandatory engineering requirements are specifically identified.

19.1.3. Engineer Technical Letters. ETL's contain information similar to EM's, and the above policies for EM's are also applicable to ETL's. However, ETL's are intended for temporary use. Their content should be incorporated into appropriate EM's as soon as practical.

19.1.4. Engineer Circulars. EC's are used for temporary publication of draft content of ER's or EM's, All EC's will clearly state which provisions are mandatory.

19.1.5. Engineer Pamphlets, EP's are used to distribute general information within USACE or to the public. EP's never establish requirements; this is done other publications. EP's may include discussion of specific mandatory standards.

19.1.6. Guide Specifications. Each design district is responsible for producing contract specifications for each project. The project specifications must conform to engineering policies established in any of the above types of publications. Guide specifications are useful tools for producing these project specifications, but do not, by themselves, set any mandatory requirements for civil works projects. Where there is a conflict between a guide specification and another publication (ER, EM, EC or ETL), the other publication will govern.

19.2. *Proponent Office Symbol.* Each official publication identifies the HQUSACE proponent by including an office symbol in the heading. This symbol is primarily for administrative purposes. It shall not be interpreted to limit the applicability of the publication. The scope and applicability of the publication are described within the body of the publication.

19.3. *Exceptions.*

19.3.1. Mandatory Standards. No standard can be considered universally applicable, but published USACE engineering standards are appropriate for most civil works projects. When a mandatory standard is not appropriate for a project, the district shall request a waiver of that requirement from CECW-E. This request shall be submitted through the MSC and shall explain the reasons for the request, and the consequences if it is not granted. Such waivers should be initiated early in the design or evaluation process to minimize possible impacts on execution. The MSC shall forward the waiver request to CECW-E where it shall be approved or rejected within 30 days of receipt.

19.3.2. Non-mandatory Standards. Decisions to deviate from the non-mandatory provisions of official publications can be made by the districts as part of the design or evaluation process, subject to normal quality control and independent technical review. Deviations are subject to approval by the Engineering chief and shall be clearly identified in the engineering documentation. Since our official publications ensure reasonable uniformity by establishing the general standard for engineering practice within USACE, deviations should be infrequent and subject to a disciplined decision process. Use of stricter standards to increase safety or reliability is usually not justifiable because of the higher costs. When more conservative standards are proposed for use, the project cost-sharing partner should be consulted.

19.4. *New Technology.* USACE engineering standards are based on our traditional projects and practices. When new technologies are utilized, appropriate standards for design might not be contained within our publications. In such circumstances, the district shall determine appropriate design standards by consulting with appropriate experts within USACE, experts in the broader engineering community, and CECW-E proponents. These proposed standards shall be subject to final approval by CECW-E.

19.5. *Architect-Engineers.* The above requirements apply to all projects, whether the engineering is performed by in-house personnel or by architect-engineers.

19.6. *Design-Build.* The above requirements also apply to design-build contracts. The contract documents must clearly identify the engineering standards, which govern the design, and the procedures for obtaining approval of changes to those standards.

20. Internal Management Control of Engineering and Design

Each engineering organization shall establish sufficient internal management controls to ensure that all engineering functions are conducted in a cost-efficient manner in accordance with the requirements of this regulation. The internal management control review checklist for engineering and design of civil works projects is included as Appendix H to this regulation. This checklist shall be used as a guide in establishing local internal management control programs. Completion of the checklist is mandatory on a five-year cycle as published in the annual Army Management Control Plan.

FOR THE COMMANDER:

RUSSELL L. FUHRMAN
Major General, USA
Chief of Staff

8 Appendices
(See Table of Contents)