Sample Engineering Case Study
Minor Structural Flood Control Projects

Introduction

In an effort to improve the quality of project applications, engineering case studies have been prepared for several common mitigation measures. The engineering cases studies provide focus on the types of information and data needed to ensure completeness of the sections of the project application affecting engineering feasibility. Of particular importance in the engineering review are:

- Scope of Work, including:
  - Problem Description and Proposed Solution;
  - Description of Existing Condition; and,
  - Work Schedule.
- Cost Estimate, including:
  - Conducting the Benefit-Cost Analysis;
  - Anticipated environmental resource remediation or historic property treatment measures;
  - Engineering schematics, detailed engineering drawings, or engineering designs;
  - Other related construction/demolition/relocation costs, such as survey, permitting, site preparation, material disposal; and,
  - Other related acquisition costs, such as appraisals, legal recordation, displacement costs for renters, maintenance.

For each of these sections in the project sub-application, the engineering case studies describe the general type of information that a Sub-applicant should submit. In order to provide additional guidance, the case studies also include sections of a sample project application that present the kind of specific information that the Sub-applicant would need to include in each engineering-related section to support the proposed project. These engineering case studies are not meant to represent complete project applications. Some relevant project information related to historic and environmental impacts, as well as information regarding the project's cost effectiveness may not be included.

Generally, minor structural flood control projects mitigate future flood damages by modifying the runoff characteristics in a specific project area. The projects can include a wide variety of activities including, but not limited to increasing the capacity of a storm sewer system, construction of a new detention facility, alteration of an existing drainage facility, or construction of a floodwall. Although the specific design and relevant project data vary depending on the specifics of the mitigation activity proposed, the general type of information required in a complete grant application is similar. The following sections describe in detail the information required and provides a sample for each application section.

Scope of Work

The proposed mitigation activity should be well defined, with a clear and detailed written description of the entire scope of work. Technical documentation should be provided verifying that the proposed project successfully reduces future flood levels and associated future flood damages. In addition, the anticipated level of project effectiveness should be stated as clearly as

possible. Detailed technical back-up information should be included with the scope of work description, including but not limited to the following:

- Describe in detail the project that is being proposed;
- Include any studies, schematics, or construction plans that will help give details of the proposed project;
- Include a site map clearly showing the location of all proposed project components and their location relative to the areas of historic damage within the contributing watershed;
- Include any hydrologic and/or hydraulic calculations or models that support the proposed mitigation by clearly demonstrating the decrease in future flood levels and associated future flood damage;
- Show that any NFIP requirements have been addressed (i.e. fill in the special flood hazard area (SFHA);
- Describe and quantify any potential downstream effects from the proposed project; and,
- Include any state or local stormwater design codes or standards that need to be followed, including design flows, rainfall frequencies, freeboard, water surface, changes in water surface elevation, allowable velocities, etc.

Sample Scope of Work

The proposed project is to replace the undersized 60-inch corrugated metal pipe (CMP) under Main Street with a 70-foot long double 5-ft x 5-ft concrete box culvert with erosion control protection placed at both the inlet and the outlet of the culvert. ABC Engineers, Inc. has prepared a preliminary design report that includes the hydrologic (USACE HEC-1 model) and hydraulic (Culvert Master) back-up calculations used to size the new structure. The report includes existing and proposed water-surface elevations upstream of the culvert for various storm recurrence intervals. The analyses show that with the existing culvert in place, the 5-year storm overtops the road. The new culvert was designed to pass the ultimate conditions 50-year peak runoff discharge with a headwater elevation of 108.25, allowing 18-inches of freeboard below the road shoulder (109.8). This design is based on the road culvert standards required per the 2002 County Public Facilities Manual (applicable sections are attached to the application). Once construction is complete, the frequent storm events will no longer overtop Main Street.

The new box culvert will be constructed parallel to the existing CMP, and the existing culvert will be removed once the new box culvert is constructed. All state erosion and sediment control procedures will be followed during construction. A schematic of the proposed culvert is included in the engineers report. Because the Main Street crossing of Swift Creek is in a SFHA, all NFIP requirements will be met. As shown on the attached watershed drainage map, Swift Creek flows through undeveloped county property into the Big River approximately 500 feet downstream of the road crossing; so downstream effects from the new box culvert are expected to be inconsequential. Due to the local terrain, Main Street is not impacted by flood events along the Big River.

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Problem Description and Proposed Solution

A detailed written description of the history of flooding that has occurred at the project location should be provided and should include the following information:

- Describe in detail the source of flooding (e.g. riverine, coastal, local drainage, etc.) and provide any explanation of the cause of flooding. (e.g. pre-FIRM construction, increased upstream development, inadequate drainage capacity of flooding source, etc.);
- List the history of previous flood events including dates, extent and magnitude of impacts, photos of historic flooding, overall cost of damages, and the estimated frequency of each specific event;
- If the facility is in a FEMA SFHA, list the corresponding flood depths and discharges from the Flood Insurance Study (FIS) for the various storm recurrence intervals;
- Briefly state the proposed solution;

Sample Problem Description and Proposed Solution

There have been repetitive flood damages to Main Street due to the undersized 60-inch diameter CMP culvert along Swift Creek. As a result of the increase in development in the upstream watershed over the years, the culvert no longer has the capacity to pass the flow during large storm events causing Swift Creek to overtop Main Street, closing the road to traffic. Main Street is a high-traffic-volume road in the community and is one of the main access routes to the Hospital. If Main Street is shut down, the response time of emergency vehicles to the southern portion of the community is greatly increased. A city street map is attached with the application highlighting the location of the culvert. Also attached are photos of road overtopping that occurred during the June 17, 2002 storm event. That storm was determined to be a 10-year event.

Post-flood maintenance and repair costs, including repavement of the road surface, regrading of the eroded gravel shoulders and road embankment, cleanup of debris washed onto the road surface and within the channel upstream of the culvert and repairs to the CMP culvert have cost the community over $215,000 in the past 20 years. Force-account material and labor records for repairs after 15 different flood events are summarized in a table included with the application.

The proposed project is to replace the undersized 60-inch CMP under Main Street with a double 5-ft x 5-ft concrete box culvert, which will allow the runoff from a 50-year storm event to pass through the culvert without overtopping the road. Swift Creek is included on the County FIRM panel 00135 as a special flood hazard area Zone AE. Selected portions of the 1987 FEMA Flood Insurance Study - including the FIRM panel, stream profile and Summary of Discharges table - are included with the application.

Description of Existing Conditions

The existing conditions within the project area should be described in detail and should include the following:

- Describe existing flow conditions including stream characteristics, system/watershed inlet and outlet locations;

- Provide a detailed description of all infrastructure including, but not limited to size, inverts, materials, conditions, dates of construction, etc.;
- Describe the watershed including current and proposed land use, topography of the area, and areas upstream or downstream that are impacted by the existing facility.

Sample Description of Existing Conditions

Main Street was originally constructed in 1965. When the road was widened in 1983, the length of the 60-inch CMP was increased from 45 to 75 feet. The construction drawings completed for the 1983 widening project are included with the application. The drawings show the as-built details of the culvert. The invert of the culvert was paved during the 1983 construction to increase the flow capacity. The design calculations for the original or the extended culvert could not be located. The culvert and wingwalls have been inspected and maintained over the years. The construction joint between the original and extended culvert has held up fairly well, but frequent maintenance has been required to keep the connection from separating. Current photos of the construction joint, the culvert entrance and exit, the upstream and downstream channel and the general area have been labeled and included in the application.

The 110-acre watershed drainage to the culvert has become urbanized over the years, causing significant increases in runoff during storm events. The channel grade of Swift Creek varies from steep in the upper portions to moderate around the Main Street crossing. In response to the rapid growth in County development in the mid 1990s a watershed study was prepared by ABC Engineers, Inc. for the county in 1997. The study determined the existing and ultimate hydrologic conditions of selected watersheds and calculated water-surface elevations for various recurrence intervals for the major streams. The study showed that the existing conditions headwater elevation for the 5-year storm is 110.5, which is one-half foot overtop of the low point of the road (elevation 110). A copy of this report has been attached to this application.

As stated in the Problem Description, flood-related damages to Main Street at the crossing of Swift Creek are becoming more frequent with the new upstream development. In addition, a townhouse development on the upstream side of the road experienced high water levels and basement flooding during the June 2002 storm.

Work Schedule

Additional supporting documentation for the project should include a work schedule to:

- Describe the anticipated project schedule;
- Include all phases of the task including survey, design/specifications, construction, permitting, site preparation, etc.;
- Include a description of any potential changes or obstacles that may be encountered during project implementation.

Sample Work Schedule

	Calendar days from Award		
Task	*Start*	*Complete*	*Total Days*
Engineering and Secure Final Design Plan Approval	*0*	*90*	*90*
Permitting	*90*	*120*	*30*
Prepare Bid Documents and Advertise for Bids	*90*	*150*	*30*
Award Construction Contract	*150*	*170*	*20*
Construct Project	*170*	*230*	*60*
Project Closeout	*230*	*260*	*20*
		Total to Complete Project	*260*

This schedule is based on the assumption that the project construction phase will fall within the normal construction season. Should this phase occur between the months of November and March, construction may be delayed accordingly.

Cost Estimate

All anticipated project costs should be detailed, including maintenance costs over the useful life of the project. Avoid the use of lump sum costs. Whenever possible, quantify or provide additional breakdown of large lump sum costs items. The Cost Estimate should include the following:

- Provide the source of the estimate (e.g. documented local cost, bids from qualified professionals, published national or local cost estimating guides, etc.) and provide documentation supporting each source;
- Reference the base year of all cost estimates provided, and consider any potential deviations due to the anticipated date of construction;
- Make sure costs include the likely date of construction.

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Sample Cost Estimate
CULVERT REPLACEMENT

ITEM DESCRIPTION	*UNIT*	*QUANTITY*	*UNIT PRICE*	*AMOUNT*	*SOURCE*
Mobilization	*LS*	*1*	*$5,000*	*$5,000.00*	*Engineer*
Remove Ex. Asphalt	*SY*	*125*	*$4*	*$500.00*	*Means*
Remove Ex. 60" Rcp	*LF*	*75*	*$10*	*$750.00*	*Means*
Remove Ex. Wingwall And Headwalls	*EA*	*2*	*$1,000*	*$2,000.00*	*Means*
Load, Haul And Dump Removals, 5mi Rt	*CY*	*10*	*$325*	*$3,250.00*	*Means*
Relocate Existing Utilities	*LF*	*100*	*$60*	*$6,000.00*	*Engineer*
Excavation	*CY*	*500*	*$5*	*$2,500.00*	*Means*
Headwall And Wingwall	*EA*	*2*	*$2,000*	*$4,000.00*	*Means*
Double 5'x5' Box Culvert	*LF*	*70*	*$560*	*$39,200.00*	*Means*
Erosion Control Stone	*TON*	*150*	*$15*	*$2,250.00*	*Engineer*
Road Reconstruction	*LF*	*20*	*$1,000*	*$20,000.00*	*Engineer*
Erosion And Sediment Control	*SF*	*500*	*$10*	*$5,000.00*	*Engineer*
Subtotal				*$90,450.00*	
Engineering Design and Construction Inspection @ 10.0%				*$9,045.00*	
TOTAL				*$99,495.00*	
TOTAL FEDERAL SHARE				*$74,621.00*	

Means = RS Means Site Work and Landscape Cost Data, 2003 Engineer = Mr. John Smith of ABC Construction Company