FEMA'S BENEFIT COST-ANALYSIS TOOL FOR SEISMIC INFRASTRUCTURE MITIGATION PROJECTS

General Guidance

The purpose of this document is to provide potential subapplicants with general guidance on FEMA's Hazard Mitigation Assistance (HMA) benefit-cost analysis (BCA) tool. The BCA is a required subapplication component. This guidance is not intended to provide complete information, but rather to outline basic requirements and considerations as subapplicants begin the analysis process. Cal OES is available to answer technical questions about BCAs and can be contacted by e-mailing HMA@caloes.ca.gov.

Seismic Infrastructure Mitigation Projects Benefit-Cost Analysis

Seismic retrofits for water utilities commonly include water treatment plants and reservoirs (treated water or raw water). Retrofits may also be for transmission or distribution pipes when they are in soft soil areas subject to liquefaction and/or slope failures in earthquakes. Seismic retrofits for wastewater utilities include treatment plants. Retrofits may also include conveyance and discharge piping in soft soil areas subject to liquefaction and/or slope failures in earthquakes.

Seismic retrofits for electric utilities are much less common but may include essential infrastructure in areas soft soil areas subject to liquefaction and/or slope failures. Another example is replacing an important cable that crosses a river on a bridge with major seismic vulnerabilities with an underground cable.

For all three utilities, seismic retrofits may include buildings that are essential for operations and recovery after earthquakes or other natural hazard events result in damage. This includes control center buildings, administration buildings, and shop or warehouses that contain parts and equipment necessary for post-earthquake response and recovery.

For all three utilities there may also be seismic non-structural projects to brace and anchor equipment. These types of BCAs are best done using the seismic non-structural BCA module.

BCA Software and Methodology

FEMA requires the use of its BCA software (version 6 for all BCAs). Subapplicants can get the software by visiting FEMA's Benefit-Cost Analysis Guidance and Tools website: https://www.fema.gov/media-library/assets/documents/179903.

The FEMA BCA software includes only very limited information that can be used in an analysis of a proposed seismic infrastructure retrofit, so the analysis must be conducted using the *expected damages* path, not the full seismic module. Analysts should select *Seismic* as the hazard type, and *Non-Structural* as the mitigation action type. The software includes three approaches, only two of which generally apply to seismic projects. The first is *modeled damages,* in which the analyst selects various input parameters and enters data related to loss of function and occupancy, and the software calculates the benefits of the project. The second is *expected damages,* in which the analyst must establish a series of relationships between earthquake frequencies and likely damages. The third is *historic damages,* which seldom applies to earthquake projects, but is based on the same approach as *expected damages.* It is very rare that any seismic project is based on historic damages, so analysts will nearly always use the expected damages approach, which in all cases requires input from a qualified structural or civil engineer, or another professional with technical knowledge of the material.

Data used in the Analysis

This subsection is intended as a general summary of data requirements for seismic structural BCAs. Note that many of these inputs require expert understanding of the underlying data, such as seismicity and the performance of systems when they are under seismic loads. In order to complete a non-structural seismic retrofit BCA, you must have the following information (this is not intended as a comprehensive list):

1. Address or latitude and longitude.
2. Project scope and description.
3. Project useful life. Refer to the Help menu in FEMA's BCA software that provides additional information on project useful life values. The information may also be found in the 2009 FEMA BCA Reference Guide.
4. Project cost and annual maintenance cost.
5. Frequency/damage relationships for at least two potential earthquake events. Frequencies are usually determined using USGS or similar data sources, and are site-specific. Calculating damages is a complex and technically demanding process. Analysts must have access to expert

inputs on likely facility *damage states* in order to calculate the value of direct damages and lost function. Lost function often predominates BCAs for seismic infrastructure projects, and calculating this requires specific expertise. FEMA provides some baseline values for critical functions such as water/wastewater, electricity and community functions like fire, police and EMS services.

6. Project performance, the degree to which damages and lost function are reduced due to the implementation of the mitigation project (post-project frequency-damage relationships).

Benefits

As discussed above, the benefits of seismic infrastructure mitigation projects are predominated by avoided direct physical damages, and avoided loss of function.

Project Effectiveness

Project effectiveness is the extent to which a mitigation activity reduces future damages. As noted above, project effectiveness for seismic infrastructure mitigation projects must be determined by a qualified engineer with experience in the design performance of such measures.

Documentation

Cal OES and FEMA require subapplicants to provide documentation for all data that is used in a BCA. This must be included with the materials that are submitted as part of the application package.

Best Practices

Cal OES strongly recommends that each subapplicant BCA be supplemented by a brief technical report that summarizes the approach to the analysis, the data that was used, the sources of the data, and the results of the analysis.

Ideally, every data point entered into the software will be explained in a technical report and backed up with written documentation.