

## Appendix I

# BUSINESS INTERRUPTION BENEFITS – ELECTRICITY AND WATER UTILITIES

Following are the steps undertaken to estimate Business Interruption (BI) losses resulting from damage to water and electric utility systems. The benefit is the reduction in loss resulting from increased resilience of the utility due to execution of a mitigation grant activity.

### 1. Calculate the Partial Business Interruption Loss in Dollar Terms.

Begin with the HAZUS physical unit downtime loss estimate for the utility in question for one recurrence interval. The dollar loss can be calculated in one of two ways:

- a. Obtain a gross income or net income figure for the utility system component to which the mitigation applies. If provided, this is usually expressed in terms of an annual number. Multiply this annual figure by the ratio of HAZUS-computed downtime and annual operating time (e.g., 4 weeks of downtime yields a ratio of 4/52). Multiply this ratio by the income loss of the utility component to obtain an estimate of the lost income to the utility from failure of this component.
  - (1) If an income figure is not available, one can estimate it by using physical component capacity multiplied by unit revenue (e.g., cents/kwh)
  - (2) If neither component income nor component physical size are available, the following proxy is used: the ratio of component parts to the total system parts. For example, if the mitigation grant applies to 2 electricity sub-stations of a total of 20 in the system, we assume it applies to 10% of the system. This ratio can be applied to gross or net income estimates or total physical service estimates from Step 1a.
- b. For the calculations below it is necessary to be especially mindful of the distinction between gross income (total revenue or gross output) and net income (total revenue minus total non- primary factor cost, or value added). The desired total BI estimate is expressed in net terms, but some HAZUS calculations require the use of gross income. Translation of one income definition to the other can be accomplished by the use of the following conversion factors: The ratio of net income to gross income for electric utilities is: .646; for water utilities, it is .684.

### 2. Calculate Direct Customer BI Losses.

Adapt a base vector of gross output changes due to utility outages for each of the 10 sectors of the Indirect Economic Loss Model (IELM) per million dollars of utility income change (actually only 9 sectors, since the Misc Sector is just a placeholder for special computations). The elements of the vector are the reciprocal of the utility input per unit of gross output for each sector weighted according to the sectoral mix of a standard HAZUS model input-output table (i.e., the elements represent the gross output change per unit of utility input change for each sector). One need only multiply each element of the vector by the total gross income loss to the utility from Step 1 (say \$40 million) to determine the full *direct* BI loss for each

customer sector. Actually, there are 2 separate vectors to choose from because of differences in input intensities and relative use for electricity and for water

	<u>Electricity</u>	<u>Water</u>
Agriculture	2.1	192.8
Mining	6.4	1638.8
Construction	72.3	3760.0
Manufacturing	11.1	1084.3
Transportation/Communication/Utility	41.9	2588.3
Trade	17.3	1706.9
Finance/Insurance/Real Estate	55.3	2214.3
Services	70.0	3911.8
Government	38.8	468.1

**3. Set Up the IELM Simulation and Compute Preliminary Estimates of Total BI Losses.**

Insert the 9-element vector of sectoral income losses from step 2 into the IELM Module in order to simulate an initial estimate of *total* BI losses to the regional economy. The insertion is to the user option called “Stimulus” as a vector of negative numbers.

- a. Be sure to set some of the user options as follows for the utility sector in question (the "Transportation" sector in HAZUS is actually the Transportation/Communication/Utility or, TCU, sector);
  - (1) set inventories for the TCU sector to zero for the case of electricity outages (electricity cannot be stored); set inventories to default value for water outages
  - (2) set imports and exports for the TCU sector to zero for both electricity and water
- b. Input other parameter specifications from the "Supplementary Economic Data Sheet" supplied for each stratum:
  - o economy-type
  - o unemployment rate
- c. set the “outside aid” option to the desired level (for this project equal to zero)

**4. Calculate a “Resilience-Adjusted” Estimate of Total Income Losses.**

The IELM will compute a preliminary set of total *net* income losses from the utility disruption. Then:

- a. Multiply each element (sector) of the 9-element "(net) income change" vector by that sector's recapture factor from the list below. (Recapture factors in HAZUS are provided in terms of occupancy categories, so it is necessary to assign them to economic sectors externally according to the following values, see also Rose and Lim, 2002):

Manufacturing, Mining, and Construction	95%
Trade and Finance/Insurance/Real Estate	90%
Government	80%
Agriculture	75%

Services	80%
Transportation	30%

Actually multiply each element of the "net income change" vector by unity minus that sector's recapture factor expressed as a decimal fraction, e.g., for services it would be  $(1 - 0.8) = .2$ .

- b. Sum the 9-sector computation in 4a to obtain the adjusted total BI (net income) impact on the economy.

**5. Compute a “Multiplier” to Apply to Other Recurrence Intervals**

(Other Levels of Direct Utility Damage and Downtime). Take the result of Step 4b and the partial BI estimate from Step 1 and compute a ratio, or "multiplier" of total *net* income change/partial *net* income change (say 10.65). The analysis reasonably assumes linearity, so one can apply the same "multiplier" to all the partial net income change results all of HAZUS runs for this mitigation grant (each recurrence interval run for the basic property damage estimate, where each yields a partial BI estimate). Also, this same multiplier should apply to both "with mitigation" and "without mitigation" HAZUS simulations.

