INSTRUCTIONAL MEMORANDUMS

To Local Public Agencies

Iowa Department of Transportation

To:	Counties and Cities	Date: October 1, 2013
From:	Office of Local Systems	I.M. No. 3.216
Subject:	Economic Analysis (Benefit-to-Cost Ratio)	

Contents: This Instructional Memorandum (I.M.) includes guidelines and procedures for a Local Public Agency (LPA) to help determine the feasibility of an improvement or analyze various alternatives or countermeasures. Various methods (Cost-Effectiveness, Benefit / Cost Ratio, Rate-of-Return, Time of Return and Net Annual Benefit) are available to determine the economic feasibility of an improvement. This I.M. will present only one method, the Benefit / Cost Ratio.

Benefit / Cost Calculations

The Benefit / Cost Ratio is the ratio of the expected benefits (accrued from a crash reduction factors based on an improvement), to the costs of the improvement (construction, right of way, engineering, etc.). When considering a design exception, the cost of the improvement is only the additional cost to meet the recommended design value as compared to the proposed design. When considering a safety improvement, the cost of the improvement is only the cost of the proposed safety treatments or countermeasures.

In either case, use the Benefit / Cost Spreadsheet provided by the Iowa Department of Transportation (Iowa DOT) Office of Traffic and Safety. This spreadsheet includes separate tabs for evaluating linear improvements along a road segment as well as intersection or spot improvements. The spreadsheet also includes instructions, which are supplemented by the information provided below.

To use the spreadsheet, the following information will be required:

1. Crash Data.

    1. This information can be obtained through the Crash Mapping Analysis Tool (CMAT) computer software that is available through the Iowa DOT Office of Traffic and Safety. For most roads, with no major improvements within the time frame, the crash data should go back 5 years. The crash data on the CMAT printout should be transferred to the appropriate blanks on the spreadsheet, keeping in mind that the number of fatalities or injuries may not be the same number of these types of crashes (two injury crashes could involve five injuries). The actual property damage of all crashes should be totaled and entered in the appropriate blank. The assumed cost per crash is $2,700, if no damage figure is recorded. All crashes within the project termini or at the spot location should be included, regardless of type. If the Crash Modification Factor (CMF) chosen is for all crashes, the Crash Reduction Factor (CRF) is for all crashes. Caution: Sometimes the CMF is just for a specific type of crash on a specific type of road and the CRF would not be appropriate for all crashes.

2. Improvement Information.

    The improvement described and the cost estimate should only be for the work for which the Benefit/Cost Ratio is being determined.

    For example, if as part of a resurfacing project the county is considering widening the shoulders and flattening the foreslopes, the description should be similar to: Widen shoulders from 2' to 6' and flatten slopes from 2:1 to 3:1. The cost estimate might include:
    - Class 10 Excavation, including borrow
    - Culvert Extensions
    - Surfacing or Finishing the Shoulders
    - Seeding and Fertilizing
    - Right of Way (if necessary), including any damages to fences, buildings, etc.
    - Additional Engineering or Surveying
    - Driveway Culverts (remove and relay or replace)

3. Crash Reduction Factors (CRF).

The spreadsheet provides a link to the Crash Modification Factor Clearinghouse. CRF are usually provided for a single countermeasure. However, where multiple countermeasures are being proposed, the CRF will be a combination of the individual CRFs. Since it is not feasible to reduce crashes by more than 100 percent, the formula in the spreadsheet is used to develop an overall CRF for multiple improvements at a location or along a route.

An excerpt from the Clearinghouse website better explains the CMF and CRF:

A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site.

For example, an intersection is experiencing 100 angle crashes and 500 rear-end crashes per year. If you apply a countermeasure that has a CMF of 0.80 for angle crashes, then you can expect to see 80 angle crashes per year following the implementation of the countermeasure (100 x 0.80 = 80). If the same countermeasure also has a CMF of 1.10 for rear-end crashes, then you would also expect to also see 550 rear-end crashes per year following the countermeasure (500 x 1.10 = 550).

The CMF Clearinghouse presents both CMFs and CRFs, or Crash Reduction Factors. The main difference between CRF and CMF is that CRF provides an estimate of the percentage reduction in crashes, while CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given improvement. Both terms are presented in the Clearinghouse because both are widely used in the field of traffic safety.

Mathematically stated, CMF = 1 - (CRF/100). For example, if a particular countermeasure is expected to reduce the number of crashes by 23% (i.e., the CRF is 23), the CMF will be 1 - (23/100) = 0.77. On the other hand, if the treatment is expected to increase the number of crashes by 23% (i.e., the CRF is -23), the CMF will be = 1 - (-23/100) = 1.23.

It is important to note that a CMF represents the long-term expected reduction in crashes and this estimate is based on the crash experience at a limited number of study sites; the actual reduction may vary.

4. Service Life

Tables are provided in the spreadsheet as a guide for approximate service life of typical improvements along roadway segments and at spot locations. However, the service life used for the calculations may be different, based on previous experience and engineering judgment.

Benefit / Cost Evaluation

Most studies indicate that an improvement with a Benefit / Cost Ratio 1.0 or greater is considered beneficial and less than 1.0 is not. However, since the estimated costs and expected benefits cannot be known with precision, use the following guidelines to evaluate the results of the Benefit / Cost calculations:

B/C Ratio less than 0.80: Improvement probably not cost-effective at this time.

B/C Ratio = 0.80 to 1.20: Improvement may be cost effective; however, the following factors should also considered:

1. Crash rate. The crash rate determined in the forms should be reviewed against the statewide average for all roads of a similar type. Statewide average crash rates for different roadway types are available on the Office of Traffic and Safety Crash Comparables web site. Use of average crash rates over a 5 to 10 year time frame is recommended.

2. Types of crashes. Type of crashes should be reviewed against the type of improvement. If the majority of the crashes within the project termini occurred at intersections, then flattening foreslopes may not have much of an effect, although flattening foreslopes is a systemic improvement that may be worthwhile.

3. Severity of crashes. The severity of the crashes should be reviewed with respect to location. If most of the crashes along the route were Property Damage Only (PDO's) and one location had a number of injury or fatality crashes then a review of that particular "spot" location may be in order.

4. Cost of the improvement. The cost of the improvement being considered should be compared with the project cost without the improvement. If a proposed resurfacing project is estimated to cost $200,000 and the estimated cost to widen shoulders or flatten foreslopes is $500,000, it may be desirable to program the improvement at some future time. If the project is estimated at $750,000 and the improvement at $50,000, it may be wise to include the improvement.

5. Environmental and social impacts. The environmental or social effects of the improvement should always be considered. These might include: farmland being taken out of production; relocation of families; adverse effect on wetlands or parks; and disturbance of historical or archaeological areas.

6. Other alternatives. In some cases, other alternatives are available that may result in a similar benefit, or lower cost partial improvements may be used to mitigate the existing condition, if a total improvement is not cost effective or feasible. For example, if the reconstruction of a horizontal curve requires taking a farmstead or relocating a bridge, and is not economically feasible, installing chevrons and advisory speed plates may be used to help mitigate the situation.

B/C Ratio greater than 1.20: Improvement is probably cost effective and should be accomplished as part of project or the work programmed in the near future.

The Benefit/Cost spreadsheet is a tool in deciding whether an improvement is economically feasible. If a design exception is desired, the Benefit/Cost Ratio should not be the only basis. Other reasons that were considered in the decision-making process should be detailed in the design exception justification, as described in I.M. 3.218, Design Exception Process.