Bowman

FIELD MANUAL

Instructions for Making Bridge and Culvert Surveys

Iowa Highway Commission
1919

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Outline of Instructions for Making Bridge and Culvert Surveys

Iowa Highway Commission.
January 1, 1919.

General Statement.

I. Location.
   1. Section, township and range.
   2. Civil township.
   3. Road system.
      A. Importance of road.
   4. Local name of structure.
   5. Bridge number.
   6. Name of stream.
   7. Location of materials of construction.
      A. Name of shipping point.
      B. Length of haul to site.
      C. Approximate or known price of materials.

II. Present Structure.
   1. Type.
      A. Superstructure.
         a. Material.
      B. Substructure.
         a. Material.
      C. Arches and culverts.
         a. Material.
   2. Span length and general dimensions.
      A. Main spans.
      B. Approaches.
      C. Size and length of openings.
   3. Width of roadway.
      A. Sidewalks.
      B. Adequacy.
   4. Conditions.
      A. Date when built.
      B. By whom built.
      C. Condition of important members.
   5. Waterway efficiency.
      A. Under flood conditions.
      B. Effects of obstructions.
   6. Portion to be used in new construction.

III. Data Required on Proposed Bridge Site.

1. Reference and record data.
   - A. Bench marks.
     - a. Location.
     - b. Description.
     - c. Elevation.
     - d. Datum plane.
   - B. Reference points.
     - a. Location.
     - b. Description.
     - c. Ties with other surveys.
   - C. Location referred to other road surveys.
     - a. Federal aid surveys.
     - b. City surveys.
2. Alignment.
   - A. Angle of skew.
     - a. On important drainage ditches.
   - B. Future road or street improvements.
3. Plan.
   - A. Course of stream.
     - a. Bank lines.
     - b. Old channels.
     - c. Dykes or spoil banks.
     - d. Direction of flow during flood stage.
     - e. Bank erosion.
   - B. Location of present and proposed structure.
     - a. Wings and retaining walls.
     - b. Topographical features of importance.
   - C. Contours.
     - a. Contour interval.
   - D. Soundings.
     - a. Location.
   - E. General data.
     - a. Bench marks.
     - b. Width of right of way.
     - c. Alignment hubs and reference points.
     - d. Section and township numbers.
     - e. Property owners.
     - f. Directions.
     - g. Scale.
4. Profiles.
   - A. Road grades.
     - a. Present grade.
     - b. Proposed grade.

c. Limits of the profile.

B. Cross section of channel on centerline.
   a. Details of present structure.

C. Cross section on lines parallel to centerline.
   a. Distance from centerline.

D. High water and low water marks.
   a. Date of high water.
   b. Runoff data.
   c. Highest ice marks.

E. Scour.
   a. Depth.
   b. Date of occurrence.

F. Overflow openings.

G. Soundings.
   a. Character of materials.
   b. Method of making soundings.
   c. Elevations.

H. Intersecting road grades.
   a. Modification of grades at intersections.

I. Scales.

5. Additional profiles and cross sections.
   A. Profiles and cross sections to determine waterway openings.
      a. Profile of the stream.
      b. Cross sections of the stream.
      c. Cross sections of other structures over same stream.
   B. Cross sections for computing earthwork quantities.
      a. Cross section on centerline of highway.
      b. Cross sections on channel changes.

IV. Recommendations for Design.
   1. Type of structure.
      A. Material.
   2. Number and length of spans.
   3. Roadway.
      A. Floor surfacing.
   4. Proposed grade elevations.
   5. Special or future loading requirements.
   6. Depth of footings.
   7. Special features of design.
      A. Light posts.
      B. Removable floors for bridges over drainage ditches.

C. Ornamentation.
D. Name plate.
E. Special wing wall lengths.
F. Sidewalks.
G. Catch basins and inlets.
H. Retaining walls.

8. Disposition of plans.
9. Culverts.
   A. Elevation flow line at upper end.
   B. Elevation flow line downstream end.
   C. Elevation of top of drop inlet.

Instructions for Making Bridge and Culvert Surveys.

Iowa Highway Commission.

The fundamental object of a bridge or culvert survey is to secure information from which to determine the type and size of structure to use. The information secured must be complete enough to enable the designer who is unfamiliar with the bridge site to formulate a decision as to the type and details of the structure best suited to meet the conditions and to check recommendations. The refinements of the survey depend largely upon the local conditions encountered and the type of the proposed structure. The engineer securing the notes must be relied upon to obtain complete data even though such information is not specifically mentioned in the outline following. It is necessary that every survey be accompanied by a definite recommendation and vice versa. Standard forms for sending in the information for design will be supplied by the Commission.

I. Location.

1. Section, township and range.

The number of the section, township and range of the proposed structure should always be given. This is essential as it is often necessary to check the information given with data secured from other sources and confusion is likely to occur where only the name of the civil township is given and there are two or more sections of the same number in that township. Whenever there may be any question as to whether the bridge is located east or west of the Fifth Principal Meridian this fact should be indicated in the notes.

If the bridge or culvert is located on a section line road, indicate the location thus—Between sections 33 and 34, or, on south line section 12. If the structure is wholly within the section, indicate it thus—Near center section 3, or, in northeast one-fourth section 5.

2. Civil township.

The name of the civil township is important since it enables a ready reference to the county map. It

with wood floor. Steel I-beam superstructure with wood floor.

B. Substructure.

The substructure is considered to include that portion of the bridge which serves as a foundation or support and includes the piers, abutments and all of the structure below the span or superstructure. In reporting the type of substructure the material of which it is principally composed should be indicated thus—Steel tubular piers and wood pile approaches, or concrete abutments and stone masonry pier

C. Arches and culverts.

Arches and culverts should be listed under this heading. This includes arch bridges and culverts as well as box and other types of culverts. The material of which the structure is composed should be indicated.

2. Span length and general dimensions.

The clear span lengths between supports of the main and approach spans should be given and such other general dimensions as will be of any value in the preparation of the new design. Where the existing structure is a culvert the general dimensions of the waterway opening together with the length of the culvert from headwall to headwall should be given. In reporting the waterway opening of culverts the span length should be given first and the height of opening given last as (8'x4' box culvert). The dimension 8 indicating the span length in feet. For truss spans on piers or abutments, the span length should indicate the clear opening between faces of supports although the length of truss may conveniently be indicated under this heading in the notes thus—Span length 137' (140' truss). The clear span length of arch openings as well as the rise above springing line should always be given.

3. Width of roadway.

The width of roadway desired is the clear width of roadway between curbs or railings. If the present structure is provided with sidewalks a sectional view of the structure should be given on the profile sheets which will indicate the position of the side-

walks, their width and relation to the roadway proper.

Any general observations as to the adequacy of the present roadway should be noted under this heading. If the present structure is a culvert which is provided with headwalls extending up to the height of road grade, the clear width of roadway would be the distance between such headwalls. If the culvert headwalls do not extend up to the height of the grade the width of roadway should be omitted and the length of the culvert barrel given.

4. Condition.

The condition of the existing structure at the time the survey is made should be recorded and indicated on the notes sent in for design.

The reasons for replacing the present structure with new construction should also be given in the notes as well as general information in regard to the cause of failure if any of the old bridge. On small structures general terms indicating the present condition will be sufficient but on all structures involving spans of 50 ft. or more in length the report should be more in detail. Such a report should cover the present condition of the important members carrying stress and general conditions which may cause failure. If the existing structure has failed the important facts causing the failure should be given.

On all important bridges and culverts the date should be given when the present structure was built and by whom constructed. This can often be obtained from existing name plates on the structure itself or by consulting some of the older inhabitants in the vicinity of the bridge site.

5. Waterway efficiency.

Undue emphasis cannot be placed upon the importance of observing and reporting the actual discharge efficiency of the present structure under flood conditions. If the present structure has proved to be inadequate in times of extreme flood the reasons for such failure should be given in detail. Very often it will be found that the present structure would have been adequate if obstructions impeding the free flow of the flood had been removed.

2. Alignment.

Accompanying the printed sheet for sending in field notes is a profile sheet upon which should be indicated the correct alignment of the proposed structure with its relation to the centerline of the road and stream.

A. Angle of skew.

Whenever the centerline of the proposed waterway opening makes an angle with the centerline of the road this angle should be given and should be indicated on the accompanying plan or sketch sent in. When the bridge is located within cities or towns or over important drainage ditches the angle of skew should be determined very accurately with an instrument in order that the new improvement may fit the location exactly.

B. Future road or street improvement.

The alignment of the proposed bridge should be so chosen that it will fit in with the eventual road or street improvement. This is a point of considerable importance and whenever doubt exists as to the proper location the proposed alignment should be gone over carefully with the county or city authorities and an agreement reached as to the proper location. On important structures some time and thought should be put on the possible future developments of the road and street and the effect of such development upon the alignment of the bridge.

3. Plan.

A complete situation map showing the principal topographical features in the vicinity of the bridge site is essential. The importance of such a map increases with the size of the proposed structure, but it is of such importance that at least a sketch plan showing the principal controlling features is necessary for even the smallest culvert. The value of the map increases directly as its completeness so there is little danger of overloading the plan with information. The scale to be used for the plan should be selected so that all of the information can be given conveniently. A scale of 1 inch=10 ft. has been found to be quite satisfactory for this

purpose. If necessary use a large sheet of cross section paper for this purpose. The following are the essential features which should be shown on the average bridge plan sent in.

A. Course of stream.

The bridge survey plan should accurately show the course of the stream for a distance above or below the stream sufficient to include all possible future channel changes. The top and bottom bank lines should be given.

Old channels which serve as overflow channels in time of flood should be shown in their true position as well as any spoil banks or dykes which in any way divert or control flood flow. All data pertaining to the direction of flow of the flood waters and drift should be given. Small arrows in color on the bridge plan indicating the general direction of flood flow will be very serviceable in determining wing angles and lengths and other features of the design. If the stream has a tendency to change its course causing excessive bank erosion these facts should be indicated in the notes.

B. Location of present and proposed structure.

Show on the bridge plan the exact location of the present and the approximate location of the proposed structure with all of their wings or retaining walls correctly placed. Two different colors of pencil or ink used to show the present and proposed structure will usually make the drawing or sketch more legible. In addition to showing the present and proposed structure on the plan all other topographical features of importance near the proposed bridge site should be shown and fully described either on the plan or in the notes. This will include all structures which might influence flood flow such as spoil banks, dykes, dams, intersecting streams, old piers or abutments, buildings, trees, etc., or topographical features which might affect the design of the structure itself such as buildings, sidewalks, intersecting streets, light, telephone or telegraph lines or

conduits, interurban or railroad structures and all other features of a like nature.

C. Contours.

The value of an accurate contour map of the bridge site to the designer can hardly be overestimated. It serves as a check to other elevations given in the notes, gives him a general idea of the condition at the bridge site, provides a means for estimating excavation quantities and determining wing lengths and enables him to consider the practicability of making slight adjustments in the alignment of the proposed structure. Contours should always be sketched in on the plan whenever possible and should always be shown on the location surveys of all important structures. The contour interval to be used must be left to the judgment of the engineer securing the notes but in general a two foot interval will provide all of the information required. Special cases may require the use of a much greater contour interval especially where the topography is rough and the survey extensive.

D. Soundings.

The location of the sounding pits or holes should be shown on the plan view of the bridge site. Proper reference numbers should be shown on the plan so that there may be no difficulty in identifying the soundings taken.

E. General data to be shown.

In addition to the specific data mentioned above there is some additional data which has no bearing on the proposed design but which should be indicated on the plan for reference and record purposes. Much of this data will be transferred to the completed plan when it is prepared. The following data will need to be given in practically every case.

a. Bench marks.

The location and a brief description of all bench marks should be shown on the plan.

b. Width of right of way.

The width of right of way owned by the county or city should be given in every case since it often has a bearing on wing lengths or length of barrel on culverts.

c. Alignment hubs and reference points.

These should be shown on the plan to indicate their position and in order that these data may be transferred to the completed plan for future reference.

d. Section and township numbers.

If a section or township line comes within the limits of the bridge plan the number of the section, township and range should be correctly indicated. The location of section corners should be shown in all cases.

e. Property owners.

The names of property owners is not of great importance on culvert or small bridge surveys, but large bridges or particularly on those located within cities or towns these names should always be given and the property lines carefully determined. Ornamental grounds or orchards contiguous to buildings should be shown whenever a bridge relocation is contemplated which will involve the purchase or condemnation of such grounds or orchards.

f. Directions.

The north point should be shown as well as the direction of flow of all water courses and drainage.

g. Scale.

The scale to which the plan is drawn should be indicated on the plan view. This scale will need to be varied to suit local conditions. A scale of 1 inch=10 ft. is commonly used and is ordinarily quite satisfactory.

h. Highwater marks.

The location of readings taken to show highwater mark elevations should be shown on the plan together with the source of the information and date of the high water.

4. Profile.

An accurate profile of the bridge site is of equal value with the plan. From it the designer must secure most of the data necessary to determine the height of structure, approach grades, waterway openings required and economical span length. The following are the general requirements of a workable profile of the bridge site and this information should be supplied in detail on all bridges of importance.

A. Road grades.

The profile on the centerline of the highway should show the existing and proposed future road grades for a sufficient distance either side of the bridge to include all of the road within the limits of the highwater marks and for a distance sufficient to enable intersecting grades on the highway to be determined. The maximum distance to which the profile should extend beyond the bridge site will depend upon local conditions but in any event it should be carried a distance back from the bridge which will enable earthwork quantities necessary for the approach fills to be roughly computed. It is important that the proposed grade be indicated on the profile.

B. Cross section of channel on centerline.

The cross section taken on the center line of the proposed bridge should be accurate and complete and readings should be taken often often enough to give such a section. This section on important bridges should be platted to a much larger scale than the general profile itself. In addition to the ground elevations on the centerline this section should show the floor elevation and details of the existing structure if any.

C. Cross sections on lines parallel to the centerline.

On surveys where contours are not located or shown on the plan a cross section of the stream channel and a profile of the natural ground a short distance on either side should be taken on lines parallel to the centerline and equidis-

tant from it. These cross sections are needed for the purpose of checking the wing lengths and for determining the height of short abutments supporting approach spans. Such cross sections drawn to the same scale as the cross section on the centerline should be furnished in all cases where accurate contours are not given. These cross sections should be taken at such a distance from the centerline as to indicate the true ground elevation at the end of the proposed wings or toe of fill. They should be so identified on the profile that they will not be confused with the centerline cross section and will indicate on which side of the centerline they are taken.

D. High water and low water marks.

The elevation of all high water marks as well as the year in which such high water occurred are to be shown on the profile. Identification of the location of the readings and source of information will be made on the plan view. Complete data regarding runoff and extreme floods should accompany the profile. High ice marks should also be given whenever such information can be authentically determined. A reading should be taken which will indicate the normal stage of water during the winter months.

E. Scour.

The normal stream bed should be shown and below it should be dotted in on the cross section any local deepening of the stream bed due to scour. This scour may be due to obstructions in the stream near the bridge site or from insufficient provision for waterway. The cause of such scour should be noted as well as the date of its occurrence and source of information.

F. Overflow openings.

All overflow openings in the grade which carry flood water should be shown on the profile and if of importance a separate cross section should be included, drawn to an enlarged scale. Scour occurring at these openings

should be indicated in the manner above described.

G. Soundings.

The soundings taken at the bridge site should be complete enough to determine the character of materials to be encountered at all points where important parts of the structure are to be located. The depth to which the soundings will be taken must depend on the facilities for making such soundings but in any event accurate data concerning the foundations of importat bridges is essential and must be secured in order to prepare an intelligent design. On the profile should be indicated graphically the soundings taken and the character of material encountered at the various elevations. All data of a general nature of known value concerning foundation conditions should be given. The method by which the soundings were made and the source of such general information as is given should be stated.

H. Intersecting road grades.

A profile of the grades of all intersecting roads or streets which may have any bearing on the grade of the proposed bridge should be given. These profiles should be shown for some distance back of their intersection that a study may be made if necessary of the effect of any modification of the grades at the intersection.

I. Scales.

A natural scale should always be used for the large scale profile of the cross sections of the stream and overflow bridges. The general profile of the road grade for some distance either side of the bridge may if necessary be shown to a smaller scale. The scale adopted for showing the profile and section is not as important as complete data on the site and surrounding conditions which may affect the design. Any scale which shows the conditions at the bridge site in a legible manner will be acceptable.

5. Additional profiles and cross sections.

There are certain profiles and cross sections needed in special cases to assist in the determination of the waterway opening which should be provided in the new structure. In some cases it is necessary to consider the cost of an approach grade in connection with the improvement. These profiles and cross sections frequently are taken some distance from the bridge site, consequently they bear little relation to it and have been classified under a special heading. These additional profiles and cross sections needed may be classified under the following general headings:

A. Profiles and cross sections to determine waterway openings.

a. Profile of stream.

Sufficient readings should be taken in the stream bed or at the water surface on important bridges to give accurately the fall of the stream per 100 ft. or per mile above and below the bridge site. This information is of great importance in determining the hydraulic properties of the proposed structure and the readings should be very carefully taken in order that correct results may obtain. For the smaller streams having areas less than five square miles it will be sufficient to have readings in the stream bed at intervals of 100 ft. for a distance of 500 ft. either side of the site. For larger streams these reading should extend for a distance of at least 1,000 ft. on either side of the bridge site. For culverts the profile of the stream should be very accurately determined for some distance beyond the ends of the proposed culvert. Special cases of culvert designs requiring drop box inlets and sloping barrels will require profiles of a special nature.

b. Cross sections of the stream.

Cross sections at right angles to the stream and extending above high water mark should be taken above and below the bridge site at suitable locations. These

sections furnish valuable evidence to be used in determining the waterway opening required. Their location should be so chosen that they will represent average conditions of the stream channel and they should be shown on the bridge plan or referenced in to the situation survey in some manner.

c. Cross sections of other structures over the same stream.

Detailed measurements should always be secured of other railroad or highway structures above or below the proposed bridge site. If possible the high water mark at these structures should be determined and full information given concerning the efficiency of the openings which will aid in determining the waterway opening in the proposed structure. Much valuable information has been overlooked in the past in this respect and consequently structures have been designed for a given stream which are not consistent in size with other structures nearby. These things can and should be avoided by giving more complete data on other drainage structures over the same stream.

B. Cross sections for computing earthwork quantities.

a. Cross sections on centerline of highway.

Whenever it is necessary to consider the cost of constructing approaches to the bridge, cross sections taken at 100 ft. or less intervals along the centerline of the highway should be taken and should accompany the notes sent in. If the bridge or culvert is located on a road which is being surveyed for improvement the cross sections taken in connection with the road survey will be sufficient.

b. Cross sections on channel changes.

If the cost of a proposed channel change is to be considered in connection with the improvement, complete data giving the lo-

cation of the proposed channel change, the character of material to be excavated, the disposition of the excavated material and cross sections must be furnished.

IV. Recommendations for Design.

Your recommendations concerning the proposed structure should be complete and consistent with the data reported as indicated in the foregoing outline. They will be followed in all cases unless it appears that more economical or satisfactory construction can be used or that they are not consistent with the data supplied. In either case you will be given opportunity to discuss the proposed changes before they are finally incorporated in the design. The following are the specific items upon which we must have your recommendations before we can complete the design.

1. Type of structure.

   Under this heading should be given the recommended type of structure including the material of which the superstructure and substructure are composed and the Commission's standard series of design. A typical recommendation would be as follows—X-series low truss on concrete abutment, or; skewed concrete box culvert.

2. Number and length of spans.

   Give the number of spans in the bridge and the length of each span. For box culverts the size of opening should be given as well as the length of culvert back to back of parapet. The length of the culvert opening should be given first. For arch spans the span length and the approximate rise from the springing line should be given. Typical recommendations would be given as follows:

   3-90′ low riveted truss spans with 2-32′ I-beam approach spans.

   8′x6′x38′ skew box culvert.

   50′ arch 15′ rise (approximately).

3. Roadway.

   The recommended clear width of roadway and the floor surfacing material should be given. If a special floor surfacing material is to be laid over the concrete floor this fact should be noted.

4. Proposed grade elevation.

   The elevation of the proposed grade of the new bridge should be given together with any recommendations regarding camber which you may have. This information is also indicated on the profile which accompanies the field notes.

5. Special or future loading requirements.

   If the bridge is to be designed for any special loading such as street cars or heavy machinery full data giving the wheel concentration, width of gauge, etc., should accompany the notes. Some of the bridges located within cities will need to be designed for future street car loading. These facts should be taken into consideration and recommendation governing the possible future traffic given.

6. Depth of footings.

   The data on soundings and scour will if complete indicate in a measure to what depth the footings on the foundations should be carried. However, local conditions sometimes govern in matters of this kind and it will be necessary in every case to have your recommendations as to foundation depths. Piling should always be used whenever it is possible to drive them and if it is clearly evident that piilng cannot be driven, this information should be supplied.

7. Special features of design.

   It would be quite impossible to enumerate all of the special features of the design which will in all cases need your recommendation, but the following list will indicate some of the special features of the design upon which your recommendation will be required before the design can be completed.

   A. Light posts.
   B. Removable floors for bridges over drainage ditches.
   C. Ornamentation.
   D. Name plate.
   E. Special wing wall length.
   F. Sidewalks.
   G. Catch basins and inlets.
   H. Retaining walls.

8. Disposition of plans.

   The name and address of those to whom copies of the plans should be sent should be given.

9. Culverts.

   Whenever special designs for culverts are to be prepared the following recommendations should be made. These recommendations should preferably accompanied with a sketch of the design desired.

   A. Elevation of flow line at upper end.
   B. Elevation of flow line down stream end.
   C. Elevation of top of drop inlet.