

*W. A. Root.*

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# Field Manual

## Federal and State Aid Road Work

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State Highway Commission

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# Field Manual

## Federal and State Aid Road Work

Iowa State Highway Commission

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1919

Iowa

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## **INSTRUCTIONS TO ENGINEERS.**

### **FEDERAL AND STATE AID ROAD WORK.**

#### **PART I.**

##### **Introductory.**

These instructions are to apply on all federal and state aid work unless special instructions are issued to the contrary.

In handling this work, the district engineer must be the most important link in the organization connecting the general office with the actual engineering work in the field. These instructions are based on this principle, and are designed to outline definitely to each engineer his duties, responsibilities, and authorities with reference to the federal aid work and with reference to other employees engaged in this work.

##### **Conference With County Officers.**

The district engineer shall confer with the county board in the outlining of their project and in other matters pertaining to federal and state aid work. When attending an important conference where the main points to be discussed are previously known, the district engineer should get the views of the proper person at the main office with reference thereto.

When it becomes necessary for a representative of the main office to confer with the board or other county officer, the district engineer will, if possible, be at such conference, or will at least be supplied with a copy of the report of same.

##### **District Engineers' Recommendations.**

The final actions of the office will be governed largely by the recommendations of the district engineer, but the office reserves the right to review such recommendations and to take such action as may appear necessary under the circumstances.

##### **Distribution of Funds.**

Each year the district engineer will be advised of the approximate amount of funds available for his district, and will

be requested to submit recommendations relative to the counties to which this fund should be allotted, give a brief outline of the project, and the nature of the improvement proposed. From these recommendations a tentative list of projects will be made up. After these projects have been reviewed by the Commission, the district engineer will be advised of the final list designated, and he can then proceed to make the necessary reconnaissance survey.

## PART II.

### Reconnaissance Survey.

The district engineer is responsible for making the reconnaissance survey and for getting full and accurate data from which the project statement can be prepared. The reconnaissance survey should in general be made before the board of supervisors passes its final resolution outlining the project. Then after the estimates have been made up, it will be possible to govern the length of the project to suit the funds available. The district engineer should discourage the board from including in the project a mileage largely in excess of what may be built with the funds available.

These instructions refer to Form P. R. 1.1, "Project Statement as required by Federal Aid Road Act." Information is available in the main office from which answers can be made to the following questions: Nos. 2, 6, 7, 8, 9, 10, 12, 13, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28 and 29. The district engineers should secure full data in answer to questions Nos. 1, 3, 4, 5, 11, 14, 15, 16, 17 and 25, as follows:

I. Local name of road. If the road is located on any through route such as the Hawkeye Highway, Lincoln Highway, or Jefferson Highway, the name of the through route should be given; also, if there is any local name such as "Ames-Nevada Road," such local name should be given.

III. Points of beginning and ending. The points of beginning and ending of the project should be stated accurately enough so that we can locate same definitely on the map. Such points should be referred to according to section numbers. Also, if there are any towns on the route along which the proposed project passes, we should have a statement as to whether the improvement is to extend through such towns or whether it stops at the corporation lines, and we should have definite information as to the location of the corporation lines.

IV. Length. We should have a statement of both the gross length and the net length. We understand the gross length of a project to mean the distance from the beginning to the end, including the distance through towns, and also including



the length of any intermediate pieces of road which may have been improved as fully as contemplated under the project under consideration, which pieces of road would therefore not be included in the federal aid project. We understand the net length to mean the gross length minus the distance through any towns on the proposed project into which the federal aid improvement does not extend. Also minus any portions of road on the proposed route which may have been as fully improved as contemplated under the federal aid project. In other words, the net length would include only the exact number of miles of road which it is intended to improve under the federal aid project.

V. Miles of project used as a post route; miles of project not used as post route.

We have maps in this office which were received from the Postoffice Department at Washington in May of 1917 which purport to show the rural routes. These maps are not correct in some instances, and accordingly it is necessary for the district engineer to secure information from which Question No. 5 can be answered. In doing this he should sketch on a map of the county the location of rural routes along the proposed project and for a distance of two or three miles on each side of such project.

In sketching on this information concerning the rural routes, the district engineer should indicate by arrows the direction in which the carrier travels, and should also indicate the number of the route and the town from which it starts. In indicating the towns, some convenient initial should be used, such as "D" for Decorah, "L" for Lawton, etc. This information concerning rural routes probably can be best secured from the postmasters along the routes, or in some instances possibly the rural carriers themselves would have to be interviewed to secure accurate data.

Under the Federal Aid Road Act as amended, any public road that comes within any of the following classes is eligible for federal aid.

- (1) Any public road a major portion of which is used for the transportation of the United States mails at the time the application for Federal Aid is made (the "major portion" may consist of a single stretch of road or several parts); or
- (2) Any public road which can, by reasonable construction or improvement in co-operation with the State authorities, be put into such condition as to permit the use thereof for transporting the United States mails; or
- (3) Any public road no part of which is used for the transportation of the United States mails at the time the application for Federal Aid is made, provided it is not more than ten miles in length and forms a connecting link (cross link) between two roads used for transporting the United States mails at the time such application is made; or

(4) Any public road no part of which is used for transporting the United States mails at the time the application for Federal Aid is made, provided it does not exceed ten miles in length and connects the end of a road with the beginning of another road over both of which the United States mails are being transported at the time of such application.

XI. Improved roads adjacent or contiguous, and type of each. Definite information should be secured from which Question No. 11 can be answered. In some instances we have this information in this office, but in other instances we do not. If, for example, the project extends up to the limits of an incorporated city or town, and such city or town has paved or graveled, or constructed to finished grade the streets or roads leading out to the corporation line, such fact should be noted, giving the type of improvement which the city or town has made.

Also, it will sometimes occur that there will be portions of the route over which this project is supposed to extend that have been improved by constructing to finished grade, or graveled, and if so, such fact should be noted, giving definitely the points of beginning and ending of such improvements, and definite information concerning the same, stating whether such portions should be included in the project for further improvement.

XIV. Description and present condition of traveled way. We understand that the Government wants here a general statement of the condition of the present road.

XV. Proposed width of surfacing; feet between ditches; approximate maximum gradient. State the width of surfacing contemplated, and if more than one width is proposed, give location of portion of project on which each is located. The distance between ditches will usually be the width shown by the standard cross sections. The approximate maximum gradient refers to the maximum grade after construction.

Note: In reference to the width of gravel surfacings it should be noted that the new cross sections provide for surfaces considerably wider than the old. The majority of gravel surfaces on federal aid projects should be 24 ft. wide. The 20 ft. section should be used only on the less important roads.

XVI. Proposed type of construction. State briefly the improvement proposed, such as, "Build to finished grade and surface with a pavement."

XVII. Location, nature, and extent of deposits of local material suitable for use on this project.

If the proposed improvement contemplates surfacing the road with gravel or with a pavement, the district engineer should make an inspection of any local material available, should give the location of gravel pits, a statement of the approximate amount of gravel which can be secured from each pit, and should make a preliminary sieve analysis of a few

samples from each pit, from which an idea can be had as to the grading of the material. If the materials for the proposed surfacing will have to be shipped in, preliminary data as to the cost of such material should be given. If the proposed project contemplates only the permanent grading of the road, we should have a statement as to whether any local material is available for surfacing.

We contemplate that in some instances the federal authorities may question the advisability of doing only permanent grading work without adding any surfacing to the road, and in such instances it will be of material advantage both to us and to the federal authorities to know whether there is any local material available.

XXV. Reconnaissance estimates of cost of project. The district engineer's report shall show his reconnaissance estimate of quantities of each kind of work for each mile or fraction of a mile separately, and shall also show the total estimate of quantities of each kind of work on the whole project. Then estimate the unit price for each kind of work and make up a total estimate of cost for the whole project. No estimate of the cost of bridges and culverts need be made, as our requirements place the construction of all bridges and culverts on the county, and they are consequently not included in the project under consideration.

The question of tile drainage and of the construction of guard rails along fills over 6 ft. in height should be kept in mind. The estimate should show the number of lineal feet of guard rail and the number of lineal feet of each side of tile required. The cost of railroad crossing improvements on the project should be included in the project estimate.

#### Bridges and Culverts.

At the time of making the reconnaissance survey, the district engineer shall make a separate report on the bridge problems. This report shall include all structures 16 ft. span or more, except that where the present structure is 16 ft. span or more and is of temporary construction, and it is apparent that the new structure will be less than 16 ft. span, such structure need not be reported.

In reporting bridge problems, the following data shall be secured regarding each structure:

- I. Location.
- II. Name of stream.
- III. Span (or length and number of spans).
- IV. Roadway.
- V. Type.
- VI. General conditions.
  - a. General statement as to conditions.
  - b. Is the old structure safe?
  - c. If the old structure is, in your judgment, not safe, should it be replaced with a new one?

- d. If the old structure is, in your judgment, not safe, should it be repaired? State briefly the repairs required.

Note: The answers to (c) and (d) will be based on the assumption that the old structure will conform to the required grade and line. If it is apparent that the old structure will not conform to the required grade and line, a note should be added to that effect.

### **Railroad Crossings.**

At the time of making the reconnaissance survey, the district engineer shall make a careful study and report on all railroad crossings on the subject, or located so near to the project as to be affected by the project improvement. This report shall contain the following information relative to each crossing:

- I. Type of crossing (grade, overhead, or subway).
- II. If overhead or subway, state,
  - a. Type and condition of structure.
  - b. Clear width of roadway.
- III. General notes relative to clean view of approaching trains or vehicles.
- IV. Outline in detail (using sketches where possible) all the various methods of improving or eliminating the crossings, such as,
  - c. Elimination by relocating the road.
  - d. Separating the grade by building overhead or subway on old road.
  - e. Relocating road and constructing overhead or subway.
  - f. Improving grade crossing on old location.
  - g. Relocating road to improve grade crossing.

Each method of improvement that presents itself should be investigated and reported fully, giving recommendations as to which methods of improvement should be surveyed. In recommending the construction of a subway or overhead it must be remembered that a subway requires eighteen feet, and an overhead requires twenty-four feet, from top of rail to roadway grade.

Note: If more than one method of improvement presents itself, and appears feasible, the district engineer should recommend that each be surveyed.

### **PART III.**

#### **Traffic Count.**

A count will be made of the traffic on each project. The number and locations of the counting stations will be determined by the district engineer. Traffic counting parties of two men each will be used on this work. These men will be under the supervision of the district engineer. They shall keep the

district engineer advised of the progress of the work, shall file their reports with him, and shall look to him for instructions regarding the work, the locations of new counting stations, etc.

Before a counting party is started in a district, the district engineer will be advised of the projects ready for traffic counts and of the general order in which it appears that the counts should be made. After that, the district engineer will attend to transferring the party from one project to another and to all supervising details of the traffic counting in his district.

When the last count in his district is nearing completion the district engineer shall notify the road engineer of the fact, and the road engineer will give such instructions as may be necessary regarding the traffic counting party.

#### **Instructions to Traffic Enumerators.**

In addition to the detailed instructions given the enumerators by the district engineer who selects the location of the traffic station and makes other arrangements, the following instructions should be followed closely in the taking of traffic counts:

- I. A record of the traffic count will be kept on Form No. 229 of which a number of copies will be supplied before the count is started.
- II. In starting a new sheet the enumerator should always fill in the blanks at the top of the page, giving his name and address, the name of the county, the station number, the location stating the section number, township and range, the date, the number of sheet, and the weather conditions.
- III. The number of the station will be given by the engineer who selects the location of the station.  
Note: The counting stations should be numbered consecutively for each county. Thus, if there have previously been three counting stations in a county, then in starting a new count the first station should be numbered "four."
- IV. The number of the sheet will be determined by the enumerator. The sheets used at one counting station will be numbered consecutively from the first sheet used the first day to the last sheet used the last day. When the count is finished at any station the total number of sheets used for that station should be noted on each sheet.
- V. "Hours A. M.—P. M." The hour during which the data was collected must be shown. It will be noted that there is a blank line at the top of the form immediately under the words "Hours A. M.—P. M." Suppose the count starts at 7:00 A. M. The enumerator should note

for its return in good condition except for the ordinary wear occasioned by the service required.

The chief of party shall be responsible for keeping all instruments in adjustment. Before starting a survey, and at frequent intervals during its progress he shall test the adjustment of the instrument and make sure that no work is done with instruments out of adjustment.

#### **District Engineer in General Charge of Survey.**

Before a survey party is started in his district, the district engineer will be advised of the projects in his district ready for surveys, and of the general order in which these projects shall be surveyed.

The party, whether furnished by the county or by the Commission, shall be under the district engineer's supervision. The chief of party shall receive instructions from the district engineer. The chief of party shall file duplicate copies of his daily report (Form No. 307) with the district engineer, and shall take up with the district engineer all questions concerning the surveys. The district engineer shall visit the county frequently during the survey so as to keep closely in touch with the work of the party.

#### **Relocations.**

Before the survey is started, or as soon as possible thereafter, the district engineer and the chief of party shall go carefully over the whole length of the project and carefully inspect all features of the road.

The district engineer shall at this time investigate fully all relocations that may appear feasible and shall instruct the chief of party to make such relocation surveys. If in doubt as to the feasibility of any relocation that presents itself, a survey should be made. It is much better to survey a number of relocations that are later abandoned than to fail to survey one which later proves desirable.

The district engineer is responsible for outlining all relocations and having surveys made. This does not relieve the chief of party from his obligations to at all times look for opportunities to take advantage of conditions and improve the general quality of the surveys. If at any time it should become apparent that the district engineer has overlooked any feasible relocations or other features of the project, the chief of party should call this fact to the district engineer's attention.

The district engineer shall report fully to the general office relative to all relocations which are to be surveyed. These reports should contain sketches of all such relocations.

#### General Plan of Survey.

The district engineer shall go over the general plan of the survey with the chief of party and agree as to,

- I. Datum to be used.
- II. Point at which survey should start.
- III. Points governing alignment, such as important bridges, cemeteries, streams, etc.

In regard to starting point of survey, it should be noted that there should be only one zero station on a project, and that on east and west roads it is preferable to start the survey at the west end of the project.

If the project connects with a corporation line, or if it extends inside the corporation line, the elevation of established street and sidewalk grades, elevation and location of sewers, manholes, etc., elevation and location of water and gas mains, and the elevation and location of conduits shall be secured. The city or town datum shall be tied to the road survey datum.

#### Instructions for Making Survey.

##### General.

The chief of party should constantly bear in mind that the office man who works up the notes may have no first-hand knowledge of field conditions; he must necessarily base the design on the information contained in the notes, and the value of the completed plans will depend entirely upon the care with which the survey is made and recorded.

In the instructions which follow, a great many points have been covered, but it is impossible to anticipate all conditions. The chief of party will doubtless encounter many situations not mentioned here. To make sure that nothing important is omitted, get **everything** that will have any bearing on any phase of the improvement. Unnecessary information does not harm, but lack of information will mean delay in completing the plans and another trip into the field to secure the missing data.

To fully appreciate the needs of the designers, the field man should familiarize himself with the details of completed plans. The fullest co-operation between field and office force is necessary. Under no other conditions can the best results be obtained.

## Keeping the Notes.

In keeping the notes of the transit survey the arrangement shown on Plate A shall be followed. Here the sketch appears on the right hand page plotted from the bottom of the page up. The station numbers with additional notes appear on the left hand page. It is not necessary that any fixed length of road be covered on a double page; sufficient space should be allowed that the notes will not be crowded.

The form for keeping the level notes is shown on Plate B. These also are carried up from the bottom of the page, which leaves no doubt as to which side of the road the notes refer to. Always leave a line between the stations so that when the notes are reduced there will be ample room to write in the elevations.

The notes shall show (preferably in the first alignment book) a sketch map of the entire project, drawn approximately to scale with the line or lines as surveyed plainly marked. All relocations or alternate lines shall be indicated by a system of lettering. If the chief of party so desires, he may use a print of the project diagram instead of drawing a sketch map.

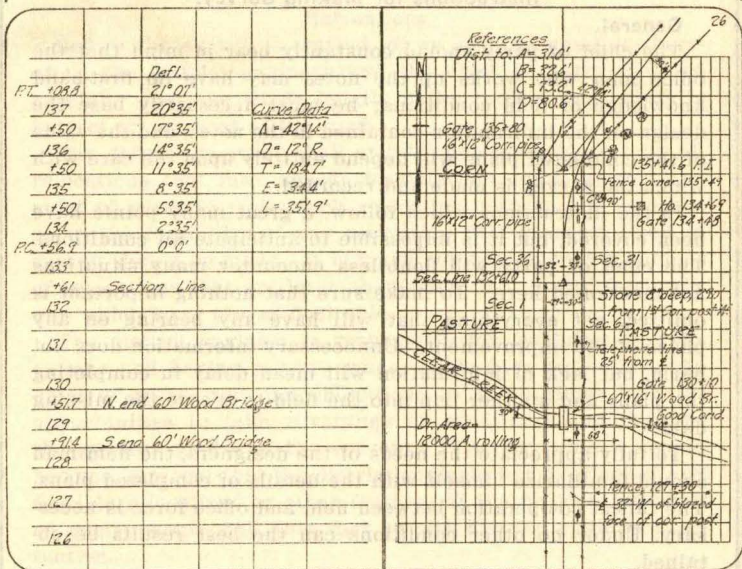


Plate A—Standard Form for Transit Notes.



Sta.	B.S.	I.I.	F.S.	Elev.																
133																				
132																				
131																				
130																				
+62	Ends of wings																			
T.P.	8.34	97.40	2.21	89.06	B.M. 8 Elev.															
+517	End of bridge																			
+25	Stream bed																			
129	Stream bed																			
+91.4	End of bridge																			
+80	Ends of wings																			
128																				
127																				
126																				
		91.27																		

Plate B—Standard Form for Level Notes.

If this is done the print should be pasted in the first alignment book.

#### Indexing Notes.

The notes in each book shall be completely indexed. In the case of alternate lines or relocations the same system of lettering used on the sketch map shall be followed in the index.

#### Staking the Line.

The following method should be followed in staking the line:

- I. Set all hubs on the center line in their true position.
- II. Set adjacent hubs at such stations that each can readily be seen from the other. This will usually be on the top of hills or ridges.
- III. In no case should hubs be more than one-half mile apart even though it may be possible to see further than that distance.
- IV. For all hubs use 2"x2"x18" hard wood stakes.
- V. Drive all hubs down until the top is three inches below the ground surface.
- VI. All hubs shall be referenced to four points so located that a line drawn between the diagonally opposite reference points will intersect at the hub. Give the distance from each reference point to the hub. (Plate A.)

## II. Relocations:

The matter of relocations has been partly covered in the above instructions. In sections of the state where the topography is flat or gently rolling the profiles readily lend themselves to satisfactory grades at a moderate cost, and relocations of any extent are seldom necessary. But in the rougher portions of the state relocations will frequently be necessary and the field man must constantly watch for opportunities to better the alignment, avoid steep hills, or improve stream crossings by relocations. The necessity for or advisability of relocating must always be balanced against the cost, and in general it is true that a proposed change of any magnitude only when it can be shown that such change will be economical or will produce a decidedly better road. It is therefore important that the cost of relocations be thoroughly investigated. In this connection the field man must remember to take into consideration the various improvements along the existing road, such as farm buildings, orchards, permanent bridges and culverts, heavy cuts and fills, etc.

The following instructions should be followed:

- a. In all cases where it appears that an excessive amount of earthwork will be required to reduce the present road to six per cent grades, the possibility of relocations to reduce grades to six per cent or less shall be fully investigated.
- b. In cases where there is a succession of grades which may be reduced to five or six per cent, but which cannot be reduced below that figure without considerable work, the question of relocation should be fully investigated.
- c. In case of doubt as to the feasibility of any relocation, a survey should always be made.
- d. In all cases where relocations are surveyed a survey shall be made on the old road also.
- e. In the case of minor relocations the margins of the old roadway should always be shown by a sketch indicating the old roadway by dotted lines, and by data in the cross section notes. In such cases the survey of the old road may consist only of extending the cross sections over the same.
- f. The notes shall show which location is to be used or shall state that the determination of which route to follow cannot be made until the notes are worked up in the office. The chief of party shall enter this notation in the field notes after consultation with the district engineer.

## III. Intersection Angles:

Intersection angles, however small, shall be measured and

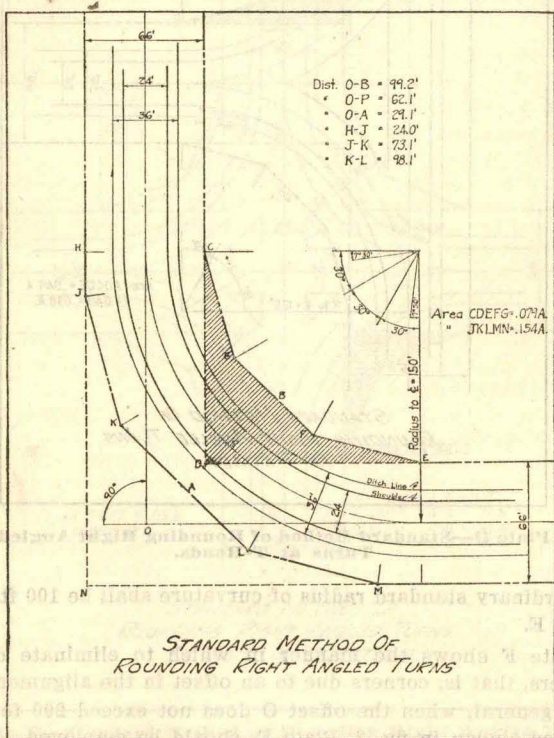
recorded. All intersection angles shall be measured by the repetition method.

#### IV. Horizontal Curves:

At all points of intersection where the intersection angle is greater than 10 degrees, horizontal curves shall be run in, and the stationing shall be carried continuously around such curves. In running in curves the data given in the HARGER & BONNEY HIGHWAY ENGINEER'S HANDBOOK shall be followed.

Curves having a radius less than 382 feet (the radius for a 15 degree curve) shall not be used except as right angle turns, and in other special cases such as sharp turns at railroad crossings, alignment between buildings, or other improvements which may necessitate the use of the sharper curve.

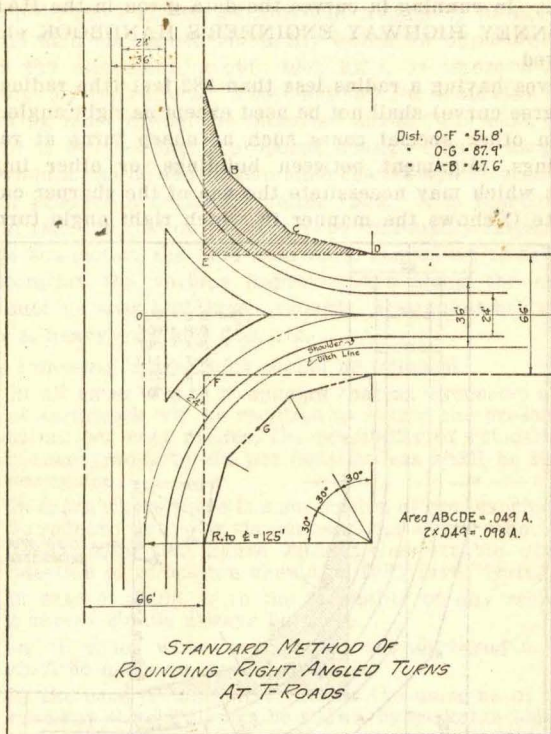
Plate C shows the manner in which right angle turns are



STANDARD METHOD OF  
 ROUNDING RIGHT ANGLED TURNS

Plate C—Standard Method of Rounding Right Angled Turns.

to be rounded off. At all such turns which are not road intersections the ordinary standard radius of curvature shall be 150 feet. At all such turns which are "T" road intersections, the ordinary standard radius of curvature shall be 125 ft. See Plate D. At all such turns which are cross road intersections,



**Plate D—Standard Method of Rounding Right Angled Turns at T-Roads.**

the ordinary standard radius of curvature shall be 100 ft. See Plate E.

Plate F shows the manner in which to eliminate double corners, that is, corners due to an offset in the alignment.

In general, when the offset O does not exceed 200 feet the method shown in fig. 2, Plate F, should be employed. When

O=200 feet it is necessary to fix the P I for each curve a distance  $X=109.4$  feet from the corner in order to get in a 15 degree reverse curve. When O is less than 200 feet the distance X might be shortened accordingly for the same degree of curve, but O=200 feet is assumed to be the maximum condition which this method is designed to eliminate, and since a 15 degree curve is considered the ordinary maximum, it is better when O is less than 200 feet to hold  $X=109.4$  or say 110 feet and use a flatter curve of such degree that it will reverse at the mid point on the offset. In general, when O is greater than 200 feet the corners should be rounded off in the manner shown on Plate C.

Radii less than 150 feet, 125 feet, or 100 feet, as the case may

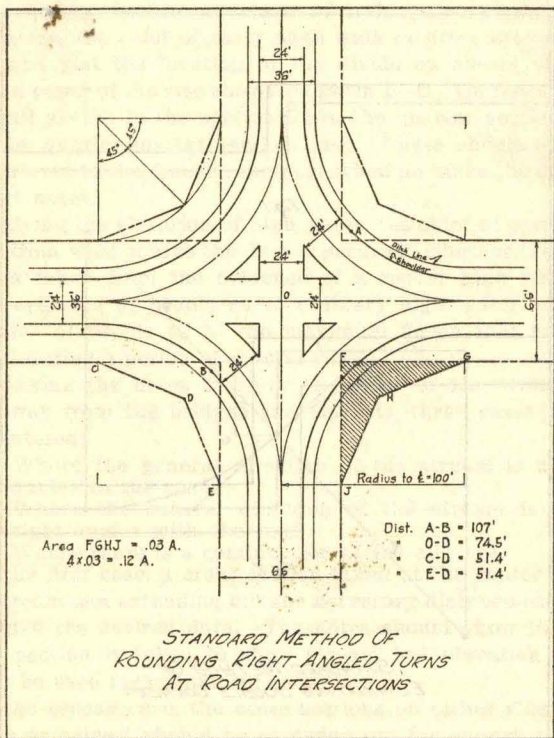


Plate E—Standard Method of Rounding Right Angled Turns at Road Intersections.

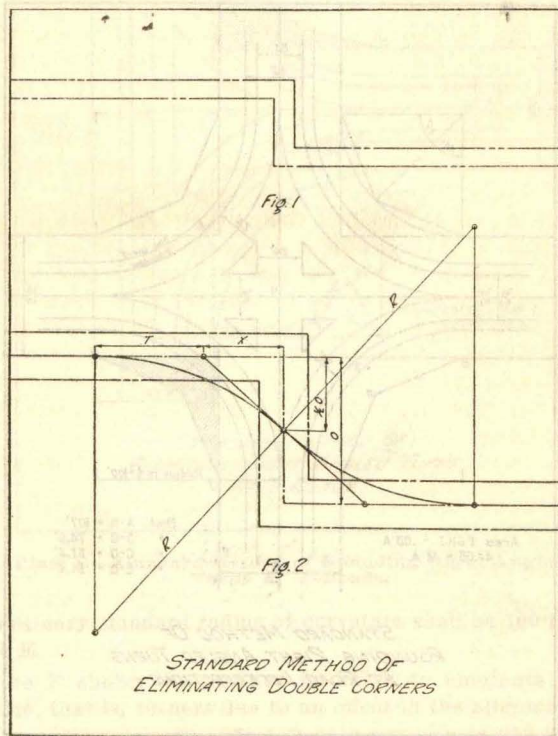
be shall not be used except in cases where improvements such as buildings, orchards, etc., may require it, or where the topography is such as to make the standard radii undesirable. In such exceptionable cases the radii used shall be the maximum which the conditions will permit.

**Drainage.**

**I. Bridges and Culverts.**

The chief of party is required to secure the following data for each bridge and culvert:

- a. Size (length and roadway).
- b. Type.
- c. Number of spans.
- d. Drainage area (up to about 1300 acres).
- e. Elevation of high water.



**Plate F—Standard Method of Eliminating Double Corners.**

- f. Elevation of present grade over culverts.
- g. Elevation of present grade at both ends of bridges.
- h. Elevation of flow lines of culverts.
- i. Elevation of stream bed under bridges.
- j. Profile of stream bed 100 ft. each way from each culvert.
- k. Elevation and location of headwalls on culverts.
- l. Profile of stream bed 500 ft. each way from each bridge.

The chief of party is not required to make recommendations regarding the size and type of new bridges and culverts to be built.

In giving the roadway for bridges and culverts, always give the clear roadway between handrails or parapet walls. This measurement should be carefully taken and the chief of party should make sure that the width of roadway given in the cross section checks with the roadway given in the transit notes.

In securing the data as to size of drainage area up to about 1300 acres, the chief of party shall walk or drive around such area and plat the location of the divide on sheets of cross section paper of the size shown on Form 1—C. On these sheets he shall sketch in the section lines, the quarter section lines and the quarter-quarter section lines. These sheets shall be turned over to the district engineer when he takes the detailed culvert notes.

In giving the elevation of high water, the chief of party shall state from what source the data is secured; whether the elevation is taken from the evidence of a recent high water, or from evidence of people as to ordinary high water, or from evidence of people as to the maximum floods that have occurred during a period of several years.

In taking the notes to show the slope of the stream bed each way from the bridges and culverts, three cases will be encountered:

- a. Where the general direction of the stream is at right angles to the road.
- b. Where the general direction of the stream is not at right angles with the road.
- c. Where there is a combination of (a) and (b).

In the first case, a cross section taken at the center line of the stream and extending out the necessary distance each way will give the desired data. The notes should show that this cross section is taken to show stream bed elevation and is not to be used for computing quantities.

In the second case, the cross sections on either side of the bridge or culvert should be extended out far enough to show an elevation on the stream bed the necessary distance both

above and below the road. These cross sections will be taken at right angles to the road in all cases. The elevations on the stream bank and stream bed should be indicated in the notes by suitable letters. It should be noted here that on a skew culvert the elevation of headwall and flow line at both ends cannot be shown on the same cross section. Two cross sections will be required.

In the third case the elevations on stream bed will be secured by a combination of the methods used in the other two cases. It should always be remembered that elevations on stream bed should always be taken the same way as any cross section; i. e., in a practically straight line and at right angles to the road.

When a stream or ditch is not at right angles with the road, the cross section notes shall show accurately the location of such stream so long as it remains within 100 feet the center line of the road.

The district engineer, the county engineer, and an engineer from the bridge department will complete the bridge and culvert survey, determine the size and type of structure required, and make recommendations relative to the elevation at which the new grade should be located.

## II. Tiling:

Prior to the completion of the survey, the district engineer and the county engineer will go over the project and determine where new tile drains shall be put in. This data shall be recorded in the survey notes. These notes on new tile lines shall show:

- a. Between what stations tile are to be laid.
- b. On which side or sides of the road tile are to be located.
- c. The location of the outlet.
- d. Elevation of the outlet.
- e. Size of tile to be used.
- f. Area to be drained.

The notes on old lines shall show:

- a. Between what stations tile are now in place.
- b. On which side of the road they are located.
- c. All data in the county engineer's or auditor's office showing the elevation and grade of the tile.
- d. Size of the tile.
- e. Area drained.

If the instructions regarding where to use tile were to be limited to a single sentence, it would be this: "In case of doubt, specify tile." As a general proposition it is considered



that grades flatter than 0.5%, if extending any considerable distance, will not give satisfactory surface drainage. Accordingly, it is necessary in the case of such flat grades, if tile are not specified, that the notes show how satisfactory drainage is to be secured, whether by tile already in place, natural subdrainage through porous soil, or surface drainage both ways from the road. In considering the necessity for tile, much can often be learned by consulting the residents along the road in regard to conditions during wet weather. It is also possible in this manner to ascertain what has already been done in the way of tile subdrainage. It is the practice in many counties to handle small drainage areas at points where the tile cross the road, by installing intakes. In general, this is a very satisfactory means of disposing of surface water, but care should be taken not to specify such intakes where additional surface water would overtax the capacity of the tile.

It often happens, particularly in northern counties, that tile are necessary in certain places but have not been put in because of lack of outlet. In such cases it is not expected that the field party will always make an extended topographical survey in working out the necessary drainage system, but sufficient data should be taken to insure that definite plans for the completion of the road drainage system can be made.

In some sections of the state and on certain soils it will possibly be unnecessary to put in tile even on level grades, but this is not to be considered as a general rule. Each portion of the road must be studied separately and the information turned in by field parties must show proper drainage for every foot of the road. It often happens that the profiles show slight depressions in the center line which are not apparent to the eye. Each dip in the profile means a collection of side ditch water at the low point and the notes must show how such water is disposed of, either by a culvert, tile drainage, natural subdrainage through sandy or gravelly soil, drainage along the road through deep side ditches, or surface drainage each way from the road.

### III. On Hill Sides:

Some of the worst places on the roads are on steep hill-sides where the water seeps out on the road surface. These spots should be located and tile lines laid to collect the water and conduct it away before it breaks out on the surface. The

experience of the county engineer and of people living along the road will be valuable in locating such springy places.

In certain types of soil which erode easily, the side ditch water often washes deep holes dangerously near to the traveled way. To prevent such occurrences, it is desirable to keep to a minimum the amount of water which the side ditches must carry. In many cases where steep hills occur at the foot of more gentle inclines, it has been found possible to place culverts across the road at the brow of the hill, and by leaving the side ditches filled just below the culverts, force all of the side ditch water from above the hill to leave the road, thus limiting the amount of drainage carried through the cut to the water which falls in the cut itself. The possibility of such a procedure should always be investigated and all instances of badly washed side ditches should be reported in the notes.

Where such side ditches wash badly and where it is not possible to prevent such wash by diverting the water from the road the use of baffle walls shall be recommended by the district engineer and shown in the notes by the chief of party.

#### IV. Drainage at Intersecting Roads and Driveways:

The surface drainage at intersecting roads is indicated on the plans by arrows showing the direction of flow. Field notes should show this in every instance and should show also the size of the area which drains into such intersection. When culverts are necessary at intersections, it must be remembered in recommending sizes that our standard cross section will not admit a size larger than 18" in diameter unless the outlet is low enough to permit the flow line being lowered below the regular ditch grade.

It very often happens that farm and field entrances are located at high points, and when so located do not need culverts. This is usually self-evident on the plan but should also be covered in the notes. The size, type, and length of all existing entrance culverts should always be shown with notes on their value for future use.

#### Miscellaneous Data.

##### I. Pluses:

As the transit party proceeds they should take plus measurements to the following:

- a. Corner stones.
- b. Section and quarter section lines.
- c. Division fences.

- d. Buildings, giving exact distance from center line if within or immediately adjacent to the right of way lines.
- e. Rows of trees—kind, usefulness, and distance from center line.
- f. Existing tile lines, size and outlet.
- g. Field and yard driveways.
- h. Sidewalks.
- i. All culverts and bridges. Pluses to center line of culverts is sufficient, but for bridges give plus to both ends.
- j. Telephone and transmission lines, distance from center line.
- k. Guard rails and retaining walls.
- l. Gravel pits.

## II. Property Owners:

A separate sketch or skeleton map to a small scale should be prepared, showing the names of the various land owners along the road. This information may be secured from residents, but perhaps may be obtained easier and quicker by referring to the county auditor's records.

## III. Source of Borrow:

It is often found necessary in establishing grades on low, flat stretches of road to keep the grade line high, which results in considerable excess of fill quantities over the cut quantities. The field man will not always be able to foresee such conditions, but it is well when on such low stretches to observe if there is any source from which material may be borrowed other than at the roadside. It is highly undesirable to make deep borrow pits within the right of way and this can often be avoided by getting material from waste banks of drainage ditches, stripping from gravel pits, hills on intersecting roads, stream channel changes, etc.

## IV. Nature of Soil:

The notes should show the nature of the available road building material, that is, the character of the soil with special attention to the location of sandy or gravelly places, springs on or adjacent to the roads, rock outcrops, etc. In case of the latter, soundings should be made to determine the elevation of the rock in order that the approximate quantity of rock excavation may be computed and included in the estimate:

## V. Railroad Crossings:

On federal and state aid projects all railroad grade crossings will be eliminated if possible. If it is not possible to eliminate a grade crossing, such crossing will be improved in

the best manner possible. The district engineer will outline to the chief of party the surveys that shall be made at each crossing. In case of existing railroad subways or overhead crossings the notes shall show:

- a. Type of structure.
- b. Horizontal clearance of subways.
- c. Vertical clearance and roadway of overheads.
- d. Intersection angle between center line of highway and railway.
- e. Elevation of low steel, or clearance elevation of subway.
- f. Elevation of top and base of rail.

#### VI. Railroad Bridges and Culverts, and Location:

When a railroad comes within 500 ft. of the highway the following data on such railroad shall be secured:

- a. Location of center line of railroad with respect to the center line of the highway.
- b. Elevation of base of rail at intervals not exceeding 500 ft.
- c. Location, size and type of all bridges and culverts on the railroad, the waterway, and the elevation of flow lines of waterway structures.

#### Bench Marks.

##### I. Selection of Datum:

Sea level datum is to be used wherever the same can be obtained. If this is not available, the county datum should be used. If no county datum has been adopted, it will be necessary to assume an arbitrary datum, but care should be taken to assume the elevation of the original bench mark at such height that all elevations will be plus.

##### II. Establishing Bench Marks:

Bench marks should be established at least every 1500 feet and at closer intervals in rough country, particularly at high and low points. A bench mark should be established at each bridge and culvert that will probably be rebuilt. They should not be established on objects which are likely to be disturbed previous to or during construction, but rather on such points as bridge seats, wingwalls, headwalls of culverts, stone or concrete steps, etc. If such points are not available, use pieces of gas pipe or bar iron about four feet in length, driven nearly flush. Such bench marks should be so placed as to be visible in both directions along the road, in all cases they should be carefully and accurately described so that they may be readily found for future use.

All bench marks shall be numbered consecutively beginning at One.

## II. Running and Checking Bench Mark Levels:

Bench levels on any portion of the road shall be checked prior to running the cross section levels on that portion. In running check levels each bench mark must be taken as a turning point in order to get a true check. The maximum allowable variation in the difference of elevation between any two bench marks is  $0.05\sqrt{\text{distance}}$  in miles.

Should the variation in the difference of elevation between two adjacent benches exceed this amount, the check levels shall be re-run between these benches until two differences of elevation between these benches check within the above limits. The chief of party shall then make up a bench mark adjustment sheet (See Plate G) on which the benches are listed. In the first column show the bench mark numbers. In the second column show the station of the bench mark. In the third column show the book and page numbers where description of the bench will be found. In the fourth column show the elevation of each bench and the difference in eleva-

B.M. No.	Sta.	Descrip- tion Book Page	Original B.M. Elev and Diff	1st Check Elev and Diff	2nd Check Elev and Diff	3rd Check	4th Check	5th Check	6th Check	Adjusted Diff. Corrected in Elev.	Corrected Elev.
1	0+38	2-4	841.25	841.25							841.25
				+18.90	+18.88					+18.89	
2	28+15	2-14	860.15	860.13						+12.04	860.14
				+12.04	+12.02					+12.03	
3	51+99	2-22	872.19	872.15	872.15					-1.98	872.17
				-1.98	-1.14	-1.17				-1.16	
4	80+00	2-23	870.21	871.01	870.98					+3.14	871.01
				+3.14	+3.17					-13.15	
5	105+89	2-34	883.35	884.18						+8.05	884.16
				+8.05	+8.04					+8.05	
6	131+74	2-38	891.40	892.22						-10.38	892.21
				-10.38	-10.35					-10.36	
7	158+82	2-46	880.82	881.27						-7.83	881.25
				-7.83	-7.86					-7.85	
8	185+00	2-50	872.57	873.41	873.41					-10.79	873.40
				-10.79	-10.68	-10.76				-10.77	
9	209+34	2-56	861.80	862.73	862.65					+6.21	862.63
				+6.21	+6.18					+6.19	
10	234+91	2-60	868.01	868.91							868.88
										Total Plus	+58.31
										" Minus	-30.76
										Net Diff.	+27.57
										841.25 + 27.57 =	868.82

Plate G—Standard Form for Bench Mark Adjustment Sheet.

tion between each two adjacent benches as obtained by the first bench levels. In the succeeding columns show the corresponding elevations and differences of elevations as obtained by succeeding check levels. In the column next to the last show the adjusted difference in elevation between each two benches, and in the last column show the corrected or adjusted elevation for each bench. This corrected elevation shall be used in running cross section levels.

### Cross Sections.

#### I. Cross Sections on the Main Road:

Cross sections are to be taken at every 100-foot station, and at plus stations where breaks occur in the center line profile. Sections are also to be taken at points where the cross section breaks even though the center line profile may continue on a uniform grade. This refers particularly to existing 0.0 points where changing from cut to fill. Sections are always to be extended at least 33 ft. on each side of the center line, and in rough country where there is any reason to suppose that the proposed improvement will extend beyond the right of way limits, the sections must be extended accordingly. In the case of level cross sections a 66 ft. right of way will permit a center cut of 7 ft. and a center fill of 14 ft., using the standard county road cross sections with  $1\frac{1}{2}$ :1 side slopes. (See Plate H.)

Knowing this and taking into consideration the existing grades on the road, the field chief can roughly determine if it will be necessary to extend the cross sections beyond the 33 ft. limit. Additional sections should always be taken at both ends of bridges and at the ends of the wingwalls. Center line elevations should be taken at the end and at all intermediate supports. Similar sections should be taken at culverts. In the case of permanent culverts the distance back to back and elevations of headwalls must always be taken. Without this information it is impossible to determine the height of grade that the culvert will carry. Each cross section shall show the distance to the fence line on each side of the road.

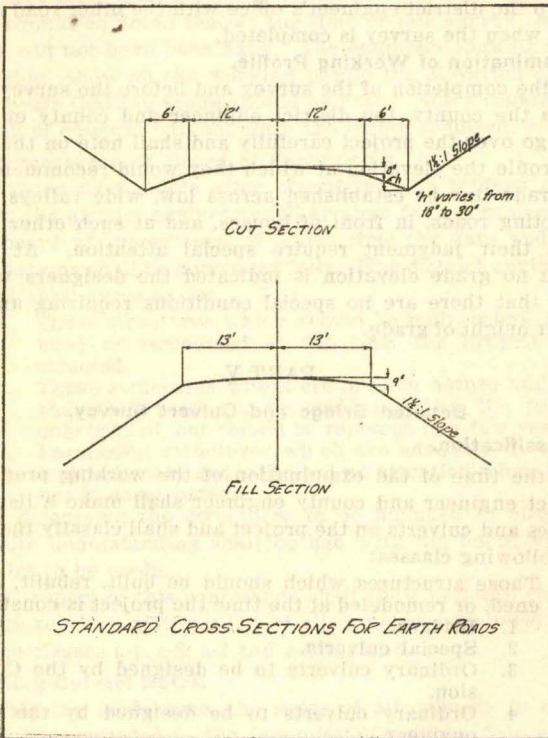
Any abbreviations appearing in the cross section notes shall be explained by suitable notations or a key on the page where such abbreviations first occur. This key will be construed to apply to any further use of the same abbreviations on that project survey.

#### II. Levels on Branch Roads:

The center line profile of branch roads should always be

taken and continued a sufficient distance to enable the designers to establish the grade lines to fit both roads. In level or gently rolling country, the profiles for branch roads shall be continued a minimum distance of 300 ft. from the intersection point. Where there is a hill on the side road near the main road, the profile of the side road shall be continued far enough to enable the designer to establish a grade on the side road to fit the grade on the main road, and to balance the cut and fill on said side road.

Whenever it seems possible that the proposed improvement will necessitate the grading of branch roads for a short distance in order to make proper connections with the main roads, the branch roads must be cross sectioned far enough to permit the computation of the necessary earthwork.



**Plate H—Standard Cross Sections for Earth Roads.**

### III. Levels on Driveways:

When passing farm or field entrances, side shots are to be taken out in the driveway about 100 ft. from the center line, or at some other distance as will show how the existing grade of the driveway will be affected by the proposed improvement.

#### Plotting Working Profile.

As the work of taking cross sections progresses, the chief of party shall each night plot up a center line profile of the road cross sectioned that day. This profile will be plotted on a roll of cross section paper eleven inches wide, using the scale of 1"=100 ft. horizontally, and 1"=10 ft. vertically. Supplies of this cross section paper will be furnished on request.

The working profile shall be available for the use of the engineers making the bridge and culvert survey. It shall be sent to the district engineer's office with the other road survey notes when the survey is completed.

#### Examination of Working Profile.

At the completion of the survey and before the survey party leaves the county, the district engineer and county engineer shall go over the project carefully and shall note on the working profile the elevation at which they would recommend that the grade line be established across low, wide valleys, at intersecting roads, in front of houses, and at such other points as in their judgment require special attention. At points where no grade elevation is indicated the designers will assume that there are no special conditions requiring any particular height of grade.

## PART V.

### Detailed Bridge and Culvert Survey.

#### Classification.

At the time of the examination of the working profile, the district engineer and county engineer shall make a list of all bridges and culverts on the project and shall classify them into the following classes:

- a. Those structures which should be built, rebuilt, lengthened, or remodeled at the time the project is constructed.
  1. Bridges.
  2. Special culverts.
  3. Ordinary culverts to be designed by the Commission.
  4. Ordinary culverts to be designed by the county engineer.
- b. Those structures which are of such nature and quality



that they need not be replaced when the project is constructed but should be replaced in a few years.

- c. Permanent structures which are adequate as to traffic and waterway and will need no attention when the project is constructed.

#### **Notes on Classes a-3, a-4, b and c.**

The district engineer and county engineer shall secure complete designing notes for all structures placed in classes a-3 and a-4.

The notes on structures in class "b" shall show the drainage area, the size and type of present structure, the repairs (if any) which should be made when the project is built, and the size and type of new structures to be built when the present one is reconstructed. The notes on structures in class "c" shall show drainage area, size, type, and condition of present structure.

It should be noted that at the time of this survey the grade lines will not have been fixed. The engineers making the survey shall show on the working profile the elevation at which it appears that the grade should be fixed. Notes regarding the length of culverts will not show the length required.

#### **Conference with Board of Supervisors.**

As soon as possible after classifying the bridges and culverts, the district engineer shall arrange for a conference with the board of supervisors, at which time the data and recommendations shall be gone over fully. The district engineer and board shall agree as to:

- I. Those structures which should be built, rebuilt, lengthened or remodeled at the time the project is constructed.
- II. Those structures which are of such nature and quality that they need not be replaced when the project is constructed, but should be replaced in a few years.
- III. Permanent structures which are adequate as to traffic and waterway and will need no attention when the project is constructed.

In discussing the structures to be included in class "b" a definite understanding shall be had with the board as to the repairs to be made.

The report of this conference shall show in detail the agreements reached, giving a list of all structures included in each of the classes a-1, a-2, a-3 and a-4, b and c.

#### **Filing Culvert Notes.**

After the conference, the notes of all culverts in class a-3 shall be forwarded to the Commission's office. The notes for all culverts in class a-4 shall be filed with the county engineer.

As soon as the grade lines are fixed, the elevation of grade at the site of each culvert in class a-4 will be sent to the county engineer.

#### **Bridge and Special Culvert Surveys (Classes a-1 and a-2).**

The district engineer and an engineer from the bridge department are jointly responsible for securing the designing notes for bridges and special culverts, for the accuracy of the data, and for the correctness of the designs recommended. This survey should preferably be made immediately following the culvert survey.

Notes of bridges and special culverts will be filed in the office by the engineer of the bridge department.

#### **Survey Party.**

It is intended that the survey party will be available for making surveys at bridge sites of an unusual nature where extensive surveys are necessary. At all other bridge sites and at all culvert sites it is intended that all notes and surveys other than those required of the survey party in Part IV hereof shall be secured or made by the district engineer, the county engineer and the engineer of the bridge department as herein outlined.

### **PART VI.**

#### **Preparation of Plans.**

##### **Preparation of Road Plans.**

In general, all road plans for Federal Aid projects will be prepared by the Commission. Any deviation from this policy will be by special agreement.

##### **Field Examination of Road Plans.**

As soon as possible after the grades have been designed on the working profile, these grades and the general features of the improvement will be checked against the field conditions. This inspection will be made by the engineer of the road plans and the district engineer, representing the Commission, and in so far as possible by an engineer from the office of the district engineer of the Bureau of Public Roads. Any special local conditions will be noted, and any modifications in the plans will be agreed upon.

##### **Preparation of Bridge and Culvert Plans.**

In general, all plans for bridges and for special culverts will be prepared by the Commission. Any deviation from this policy will be by special agreement with the county engineer.

In general, all plans for culverts other than special culverts,

will be prepared by the county engineer. Any deviation from this policy will be by agreement between the district engineer and the county engineer.

#### **Form and Arrangement of Bridge and Culvert Plans.**

The Commission has adopted standards governing the form, size, and arrangements of bridge and culvert plans for Federal Aid projects. The district engineer should make sure that the county engineer prepares his plans in accordance with these standards, so that the plans prepared by the Commission and those prepared by the county engineer will harmonize into a neat, orderly set of bridge and culvert plans for the whole project.

#### **Specifications.**

The specifications for all Federal Aid road work will be prepared by the Commission. Standard specifications are being prepared for all the various classes of roads included in Federal Aid projects. Special provisions will be added to these standards to suit individual projects.

These standard specifications include in addition to the detailed specifications, the notice to contractors, instructions to bidders, form of tender, contract form, and contractor's bond.

### **PART VII.**

#### **Letting Contracts.**

##### **General.**

All contracts for federal and state aid road work will be let by the Board of Supervisors in the same manner as contracts for ordinary county road construction work. All such contracts are subject to the approval of the Commission before becoming effective as contracts.

##### **Date of Lettings.**

District engineers should advise county officials to communicate with the Commission before fixing a date for letting on federal or state aid work. The board should indicate a tentative date. The Commission will meet this date as nearly as possible.

##### **Notice to Contractors.**

The Commission will furnish the county engineer with copies of the standard "notice to contractors," which shall be used in advertising the letting.

##### **Advertising Letting.**

The county shall advertise the letting in local official pa-

pers, and shall call the same to the attention of all contractors whom they may know. The Commission will send notices to all contractors on the mailing lists.

In the case of important projects where it appears that publication in engineering journals would be desirable, the Commission will attend to publishing such notices.

#### **District Engineer to Report Letting.**

The district engineer shall attend all federal and state aid road lettings and make full report of same.

### **PART VIII.**

#### **Construction.**

##### **Organization.**

The construction work on each project will be under the direct charge of a resident engineer. The resident engineer will be under the supervision of and shall report to the district engineer in whose district the project is located. The district engineer is under the supervision of and shall report to the road construction engineer, whose headquarters are at Ames.

In some cases the resident engineer will be a man assigned to the project by the Commission. In other cases the county engineer will act as a resident engineer. This point will be determined for each individual project. Where the county engineer is designated as resident engineer, he will be under the supervision of the district engineer as fully as though he were employed by the Commission. This is the only basis on which the Commission will approve of the county engineer's acting as resident engineer.

The road construction engineer will have full supervisory charge of federal and state aid construction work. District engineers will report to him, and will take up with him all construction questions concerning which the district engineer may be in doubt.

##### **Duties of Resident Engineer.**

The resident engineer is responsible for carrying on the work in strict accordance with the plans, specifications and instructions of the district engineer. He shall,

- I. Make sure that the road is staked out at the proper time and in a proper manner, and right of way provided.
- II. See that the specifications and plans are fully complied with.
- III. Recommend to the district engineer any change in

plans or deviation from the specification that may seem necessary.

- IV. Inspect all materials and work, or make sure that such materials and work are being properly inspected.
- V. Report fully and promptly to the district engineer any faulty work or any failure of the contractor to comply with any plans, specifications, or instructions.
- VI. Make such progress reports and other reports as are hereinafter required.
- VII. Make up the estimates of work performed.
- VIII. Have full supervision of all inspectors, instrumentmen, or assistants placed on the work.
- IX. Make no acceptance of the work.

The resident engineer will have no authority to change, alter, or modify the plans or specifications except where it appears that such plans or specifications are obviously in error, and where such changes and corrections must be made at once, in which event he will immediately notify the district engineer regarding such changes or corrections.

Where changes, alterations or modifications might be made for the benefit of the work, the resident engineer will call this to the attention of the district engineer, who will instruct the resident engineer regarding such changes.

All instructions will be given to the contractor by or through the resident engineer.

The Federal Aid Law places all federal aid road work under the direct supervision of the Commission. The resident engineer must at all times be courteous toward county road officials, but he is under no obligation to obey orders of county officials. County officials have no authority to make any change in the plans or specifications, or to give any instructions to the contractor. If the county officials should request a change in the plans or specifications, and the resident engineer should deem such request meritorious, such request should be referred to the district engineer.

The resident engineer must always remember that he is the man on the job and that he is primarily responsible for the proper execution of the work. He must be the eyes and ears of the Commission and its various employees. He must make friends with the local officials and local people with whom he comes in contact. His value to the Commission depends on his ability to get good work and leave no sore spots.

#### **Duties of the District Engineer.**

The district engineer will have full supervision over the resident engineer. He shall,

- I. Give the resident engineer such instructions as are necessary to secure the completion of the work in accordance with the plans and specifications.
- II. Inspect the work at frequent intervals, and make sure that the work is being done in accordance with plans, specifications and instructions.
- III. Confer with and adjust matters with the board of supervisors relative to the progress and method of prosecution of the work.
- IV. Approve or disapprove minor changes of the plans promptly, where such changes require prompt action, and report such approval immediately to the road construction engineer.
- V. Refer important changes of plans or specifications to the construction engineer.
- VI. Check and approve estimates.
- VII. Make such reports as are hereinafter required.
- VIII. Comply with all instructions of the construction engineer.

#### **Duties of Construction Engineer.**

The construction engineer shall,

- I. Have general supervision of all road construction work on federal aid projects.
- II. Make decisions on construction questions submitted by the district engineer.
- III. Inspect the work occasionally and instruct the district engineer as to any corrections or modifications which should be made in the methods, equipment, materials, or manner of prosecuting the work.
- IV. Approve all major changes in the plans.

#### **Construction Reports and Records.**

##### **I. Daily Progress Report, IHC Form No. 238:**

The resident engineer will be supplied with a pocket field book (IHC Form 238) in which he shall daily record the number of men on each contract separately, their time distributed over the various items of work, and the amount of each kind of work accomplished.

This data is kept for the purpose of supplying an accurate record from which the weekly progress reports can be compiled, and to provide an accurate daily record of the forces employed and the work accomplished.

##### **II. Weekly Progress Report, IHC Form 239:**

The resident engineer is required each week to make a weekly progress report to the district engineer. This weekly report shall be made up for each contract separately, and mailed in such time that it will reach the district engineer's office not later than Saturday morning.

First Part: In making up the weekly progress report, the

resident engineer will total up each item shown on the daily progress reports for that week. Each week's totals shall be added to the totals of the previous weekly report, and the amounts thus obtained shall be entered in the proper space on Form No. 239, so as to show the total number of hours to date spent on each item of work by the various classes of labor comprising the contractor's force; also the amount of each kind of work performed to date. At the right of the form are two columns with a common heading, "Work Accomplished". In the first, show only the amount for the week. In the second, show totals to date. When the job is completed, the last reports will show total labor and total quantities for the whole contract.

**Second Part:** This part of the form is ruled so as to provide for work being carried on in various locations. Note that under each heading "Work Finished" and "Work in Progress" provision is made for six entries which should take care of the average contracts. From the information contained in this part of the report, a progress chart will be made and kept in the Highway Commission's office at Ames. The chart is to be built up weekly showing condition of work in the field.

**Third Part:** On the back of this form are spaces in which are to be shown the engineering features of the work as indicated, merely recording stations between which the various items of engineering work have been completed.

I. H. C. Form 239 is to be made out for each separate contract on the project. For instance, a contractor with ten miles of pavement would no doubt run two paving crews, and one or more grading crews, in which case one report would be required, but with two different contractors on this same project, two separate reports are required.

The report is to be made out in duplicate, the original sent to the district engineer, the carbon copy to be retained in its binder by the resident engineer. The district engineer will make two typewritten copies, sending both to the Highway Commission at Ames.

**III. Daily Inspection Reports:** (I. H. C. Forms No. 224, 225A, etc.)

Where the contract includes paving, the inspector shall make out in triplicate a daily inspection report. This report shall be filed with the resident engineer each evening.

For daily reports on monolithic brick pavement construction, use Form No. 225A; for concrete pavement, or concrete base construction, use Form No. 224. Other forms will be prepared for the daily reports on other classes of pavement construction.

One copy of the daily inspection report shall be retained by the resident engineer; the other two copies being forwarded to the district engineer with the weekly progress report. The district engineer shall keep one copy and forward the original to the Commission at Ames.

#### IV. Order for Extra Work—I. H. C. Form 240:

Whenever it is necessary for extra work to be performed by the contractor, the resident engineer will issue a written order using Form I. C. H. No. 240. If the extra work is of a minor nature and needs attention promptly, the resident engineer may issue the order for same promptly. If the extra work is of some importance, or involves the expenditure of any considerable sum of money, or does not require immediate attention, the resident engineer shall issue no order therefor until he has consulted with and secured the approval of the district engineer. The work may be an extra paid on an agreed unit price basis, or it may be force account work paid on a cost plus basis. In neither case, specify the basis of payment as indicated on the blank form.

This form is to be made out in triplicate, the original given to the contractor, one duplicate forwarded to the district engineer, and the remaining duplicate retained in its binder by the resident engineer.

#### V. Daily Force Account Records: (I. H. C. Forms 317 and 318.)

A daily record of material and labor on each force account job shall be kept on Forms No. 317 and No. 318. More detailed instructions regarding these reports will be found in Part IX—Payments.

#### VI. Engineer's Approval of Completed Work: (I. H. C. Form 241.)

When some well defined portion of a project is completed, ready to be opened for traffic, the resident engineer may approve of this part of the road, using I. H. C. Form 241.

In the event of several parts or sections being approved in this manner, then on the last section the engineer should write on the blank lines provided, "This approval together with the approval of sections previously given will constitute the engineers's approval of the entire project, pending acceptance by the Board and Commission."

The original copy is to be given to the contractor, the carbon retained in its binder by the resident engineer. Before making



such approval, the resident engineer shall consult with and secure the approval of the district engineer.

## PART IX.

### Payments.

#### General.

All bills, estimates, and force account statements for Federal Aid road work shall be prepared on forms furnished by the Commission and in accordance with these instructions and such special instructions as may be issued in connection with individual projects. These instructions shall apply only to contracts let on a unit price basis. Care in the keeping of records and rendering of estimates will facilitate payments.

#### Forms Used.

The following named forms shall be used:

- No. 308 Voucher or Bill.
- No. 309 Cost of Engineering—Monthly Time Report.
- No. 314 Estimate Sheet.
- No. 315 Force Account Statement, Material, etc.
- No. 316 Force Account Statement, Pay Roll.
- No. 317 Daily Material Report, Force Account Work.
- No. 318 Daily Time Report, Force Account Work.

#### Classification of Work.

With reference to manner of payment, all work shall be divided into two classes, namely, "Contract Work" and "Extra Work".

I. **Contract Work.** Contract work shall be reported on Form No. 314, as directed hereinafter under the heading "MONTHLY ESTIMATES".

II. **Extra Work.** Extra work shall be recorded and reported in accordance with the instructions directly following.

Extra work will consist of two classes,

- a. Extra work which is being done on the basis of unit prices or a lump sum.
- b. Extra work which is being done on the force account basis.

#### Daily Force Account Records.

Force account work is one of the most fruitful sources of difficulty and disagreement between engineers and contractors. This disagreement can be largely avoided by keeping the records each day complete for that day's work. For this purpose Form No. 318, Daily Time Report, and No. 317, Daily Material Report, have been prepared. Each day the resident engineer or inspector should make out in duplicate the material and time reports for each force account job separately. These

sheets should be signed by both the resident engineer or inspector, and by the representative of the contractor, one copy being retained by each.

All of the information required by the blanks should be given. Under "employment" should be listed the class of employment which a man is performing; that is, "laborer", "hoisting engineer", "foreman", "teamster", etc. The attention of the engineer is directed to the specifications which outline the items that may be included and the division of time which is to be made for foremen, timekeepers, or superintendent on the work. Should the engineer's representative be unable to agree with the contractor on any point, notes stating the difference shall be added on the reverse side of the sheet.

#### **Statement of Force Account.**

At the end of each two weeks, the daily time record shall be transferred to Form No. 315, Statement of Force Account—Materials, Supplies, etc., and to Form No. 316, Statement of Force Account—Pay Roll. Six copies of these statements of force account shall be prepared and are to be certified by the resident engineer and checked and approved by the district engineer.

#### **Monthly Estimates.**

The monthly estimates are to be prepared on Form No. 314. All data required by this form shall be added thereto. The data required by the various columns is as follows:

"Item No." The numbers entered in this column should be the same as those shown in the proposal form, for the item of work being listed.

"Items." State briefly in this column the nature of the work such as "earth excavation", "Monolithic brick pavement", "guard rail", etc.

"Rates." List the unit prices for which work is being constructed.

"Sum of previous estimates." Show the quantity and amount of estimates which have been allowed for each individual item.

"This estimate." Show the quantity and amount of each item included in this estimate.

"Totals to date." In this column show the sum of the "previous estimates" plus "This estimate".

"Totals this estimate." In this column it is intended to show the totals of this estimate for contract work and for extra work on each individual extra job.

In making up the estimate sheet, all of the contract items shall be grouped under the general heading of "Contract Work" and all of the extra work shall be grouped under the general

heading "Extra Work". Extra work shall be further divided so as to show each individual job and the job name should be shown. It will be noted that there are blanks for the estimate number and the sheet number. Separate estimates should be made for each separate contract. The estimates for each contract should be numbered consecutively beginning at "One". Should more than one sheet be required in making up any estimate, the sheets should also be numbered.

At least five copies of the estimate shall be made, one for the Commission, one for the district engineer, one for the resident engineer, one for the contractor, and one for the county auditor. Each copy of the estimate shall have attached the "statements of force account", (Forms No. 315 and No. 316) referring to all force account included in that particular estimate. The estimate shall be certified to by the resident engineer and checked and approved by the district engineer.

#### **Payments.**

1. By the County: No payments shall be made by the county until the estimate and force account statements, if any, have been approved by the district engineer. All vouchers or bills shall be prepared for payment on Form No. 308 and shall be fully itemized. In preparing vouchers from the engineer's estimates, only the items in the column headed "this estimate" need be copied. Form No. 308 shall be made out by the resident engineer.

In all other respects the vouchers may be handled in the same manner as provided for audit and payment of county bills, but one copy of each voucher with approval of the Board of Supervisors endorsed thereon, and a copy of the engineer's estimate and force account statements attached, shall be forwarded to the State Highway Commission by the district engineer.

II. By the State: Vouchers to be paid by the state shall be prepared in the same manner as directed above, but two copies of the approved voucher, the estimate and the force account statements shall be forwarded to the State Highway Commission. When approved by the said Commission, one copy will be forwarded to the Auditor of State for payment. Warrants issued by the Auditor of State will be forwarded by the State Highway Commission to the contractor.

#### **Funds.**

On projects where the county's allotment from the Federal-County-Co-operative Road Fund is insufficient to cover the

cost of construction, a portion of the bills must be paid from county funds. The division of the bill between the county and the state as the work progresses shall be on approximately the same ratio as the total amount which the county must pay, bears to the total amount of the federal and state aid funds allotted to that county.

#### **Cost of Engineering.**

The cost of all engineering supervision, including salaries, mileage, meals, supplies, and all miscellaneous items of expense incident to the engineering supervision on Federal Aid projects shall be reported to the district engineer by the resident engineer at the end of each month on Form No. 309 furnished by the Commission. The district engineer will forward these reports to the Commission. It is essential that these records be correct in order that an accurate report on the cost of engineering may be prepared when the project is completed.

Where the total cost of the project, including engineering, is to be paid from the Federal-County-Co-operative Road Fund, payments will be made by the state.

Where the total cost of the project, including engineering, is to be paid partly by the county, the district engineer shall arrange with the county board to pay such engineering costs from the county funds in order that payments may be made as promptly as possible. If the board should object to paying such engineering costs from county funds, payments will be made by the state as above.

Whether payments are made from the county funds or from the Federal-County-Co-operative Road Fund, the bills shall be made up on Form 308 and checked and approved by the district engineer the same as provided for bills on construction work.

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