

HORIZONTAL ALIGNMENT

SCALE

PROFILE

S74° 14' E

PI

R

angle of deflection
MATCHLINE $L(A_1 + A_2)$
2x27

TANGENT

389+50.00

CROSS-SECTION

CUT

DELTA bearing

PLAN BACK stationing

FILL

POC EQUALITY

18

CENTERLINE

GRADE

ELEVATION

vertical alignment

7058-097-107

POT

TERMINI

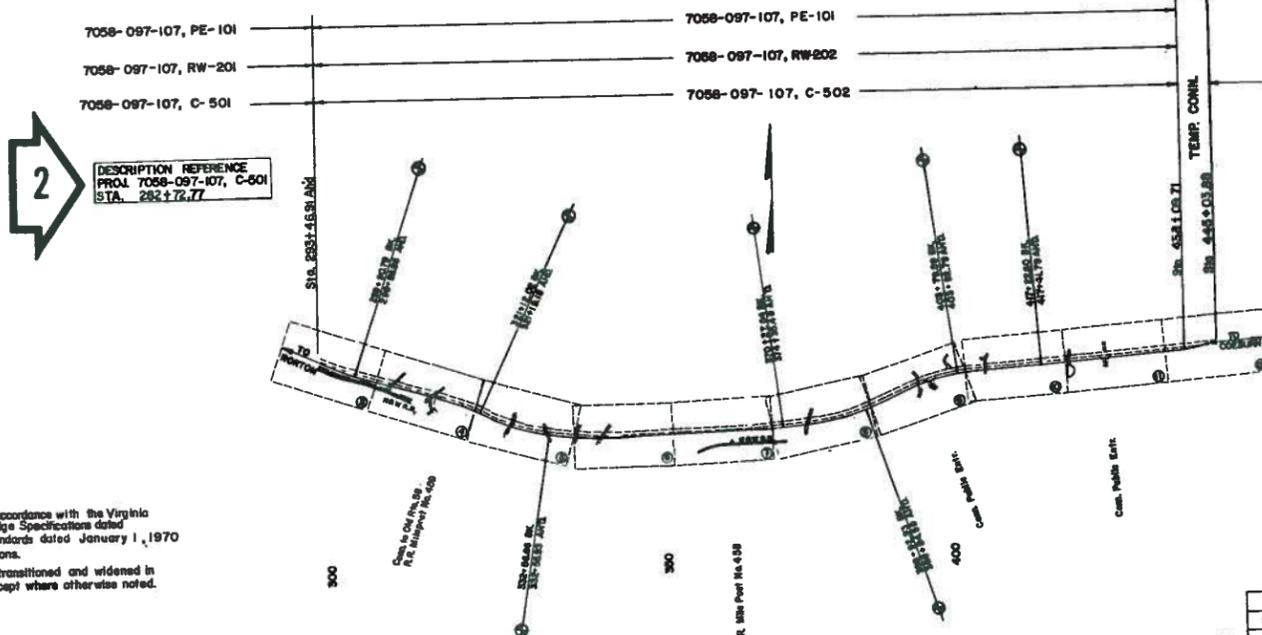
SHEET NO.	DESCRIPTION	STA. TO	STA.
1 & 1A	TITLE & LOCATION SHEETS		
2 THRU 2D	TYPICAL SECTION & SUMMARY SHEETS		
3 THRU 3A	PLAN & PROFILE SHEETS	293 +46.91	306 +00.00
4 " 4A	" " " "	305 +00.00	321 +00.00
5 " 5A	" " " "	321 +00.00	337 +00.00
6 " 6A	" " " "	337 +00.00	353 +00.00
7 " 7A	" " " "	353 +00.00	373 +00.00
8 " 8A	" " " "	373 +00.00	389 +00.00
9 " 9A	" " " "	389 +00.00	405 +00.00
10 " 10A	" " " "	405 +00.00	421 +00.00
11 " 11A	" " " "	421 +00.00	437 +00.00
12 " 12A	" " " "	437 +00.00	445 +05.88


COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HIGHWAYS

PLAN AND PROFILE OF PROPOSED STATE HIGHWAY

WISE COUNTY
FROM: 0.207 MILE INT. RTE 798 (TACOMA)
TO: 0.442 MILE W. W.C.L. COEBURN

EARTH WORK COMPUTATION JOB NO. 709
9 SHEETS CROSS SECTIONS



Note: This project is to be constructed in accordance with the Virginia Department of Highways Road & Bridge Specifications dated July 1, 1966 and Road Designs and Standards dated January 1, 1970 and including all subsequent revisions.
All curves are to be super-elevated, transitioned and widened in accordance with standard TC-2, except where otherwise noted.

STATE LINE	COUNTY LINE	CITY, TOWN OR VILLAGE	RIGHT OF WAY LINE	POWER LINE	UNFENCED PROPERTY LINE	FENCED PROPERTY LINE	TRAVELED WAY	GUARD RAIL	RETAINING WALL	RAILROADS	BASE OR SURVEY LINE
---	---	---	---	---	---	---	---	---	---	---	---

STATE PROJ. NO.	CONTRACT NO.	SECTION	FEDERAL AID PROJECT NO.	QUANTITIES FEET	LENGTH INCL. IN R. BOX DRAIN FEET	LENGTH EXCL. BR. R. BOX DRAIN FEET	TYPE PROJECT	DESCRIPTION
7058-097-107		PE-101	-436.49	14,028.31	2,806	14,028.31	PE	FROM 0.207 MILE INT. RTE. 798 (TACOMA) TO 0.442 MILE W. W.C.L. COEBURN
7058-097-107		C-502	-436.49	14,028.31	2,806	14,028.31	CONSTR.	
7058-097-107		RW-202	-356.49	14,028.31	2,806	14,028.31	RW	

3

F.A.A. DIST. NO.	STATE	FEDERAL AID ROUTE	PROJECT	STATE PROJECT	SHEET NO.	TOTAL SHEETS
2	VA.			ALY. 58 7058-097-107 The Toleration Station For Section Numbers	1	27

DESIGN CLASSIFICATION	
ADT 1968	4,250
ADT 1989	8,100
DHV	885
D	60%
T	13%
V	50

RECOMMENDED FOR APPROVAL FOR RIGHT OF WAY ACQUISITION	
12-3-69	<i>[Signature]</i> DATE LOCATION AND DESIGN ENGINEER
12-9-69	<i>[Signature]</i> DATE DIRECTOR OF ENGINEERING
12-8-69	<i>[Signature]</i> DATE DIRECTOR OF PROGRAMMING & PLANNING
12-9-69	<i>[Signature]</i> DATE DEPT. CHIEF ENGINEER AND C.E.P. ENGINEER

APPROVED FOR RIGHT OF WAY ACQUISITION	
12/16/69	<i>[Signature]</i> DATE

RECOMMENDED FOR APPROVAL FOR CONSTRUCTION	
3-16-70	<i>[Signature]</i> DATE LOCATION AND DESIGN ENGINEER
3-16-70	<i>[Signature]</i> DATE DIRECTOR OF ENGINEERING
3-16-70	<i>[Signature]</i> DATE DIRECTOR OF PROGRAMMING & PLANNING

APPROVED FOR CONSTRUCTION	
3/16/70	<i>[Signature]</i> DATE

APPROVED	

PLANS REVISED			
SHEET NO.	DATE	SHEET NO.	DATE
1	2-6-70		
2	3-9-70		
3	3-30-70		
4	3-11-70		
5	3-27-70		
6	3-27-70		

1

The first sheet in any set of plans is called the TITLE SHEET. It is this sheet that identifies the project and notes the contents of the sheets that follow.

1 On the page opposite you will find a typical TITLE SHEET. In the top center of this sheet you will find the TITLE and DESCRIPTION of the project which looks like this:

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HIGHWAYS

PLAN AND PROFILE OF PROPOSED
STATE HIGHWAY

WISE COUNTY
FROM: 0.207 MI. E. INT. RTE. 798 (TACOMA)
TO: 0.442 MI. W. W. C. L. COEBURN

Thus, the TITLE & DESCRIPTION identifies the road to be built, AND its location with reference to existing roads, intersections, counties, or townships.

In this particular instance the project limits extend 0.207 miles east of the intersection of route 798 in the town of Tacoma to the left, to a point 0.442 miles west of the western corporate limits of the town of Coeburn on the right.

If you will look just below, and to the left of the TITLE & DESCRIPTION you will note a rectangular block which further identifies the location of the intersection of route 798. In other words, what it really says is that this project actually begins 0.207 miles east of station number 282+72.77 AT station number 293+46.91. It extends 2.656 miles to terminate at station number 438+09.71.

Do not concern yourself at this time with computing station numbers. It will be covered thoroughly as you progress further.



In the upper right hand corner of the TITLE SHEET there is a rectangular box which looks like this:

FHWA REG. NO.	STATE	FEDERAL AID		STATE		SHEET NO.	TOTAL SHEETS
		ROUTE	PROJECT	ROUTE	PROJECT		
2	VA.			ALT 58	7058-097-107	1	27

This box contains the following information.....

FHWA REG. NO. 2

→ The Federal Highway Administration Region Number. (The entire country is divided into such regions. Virginia is in region 2.)

INDEX OF SHEETS

SHEET NO.	DESCRIPTION	STA.	TO	STA.
1 & 1A	TITLE & LOCATION SHEETS			
2 THRU 2D	TYPICAL SECTION & SUMMARY SHEETS			
3 THRU 3A	PLAN & PROFILE SHEETS			
4 " 4A	" " " "	293+46.91		305+00.00
5 " 5A	" " " "	305+00.00		321+00.00
6 " 6A	" " " "	321+00.00		337+00.00
7 " 7A	" " " "	337+00.00		353+00.00
8 " 8A	" " " "	353+00.00		373+00.00
9 " 9A	" " " "	373+00.00		389+00.00
10 " 10A	" " " "	389+00.00		405+00.00
11 " 11A	" " " "	405+00.00		421+00.00
12 " 12A	" " " "	421+00.00		437+00.00
		437+00.00		445+03.88

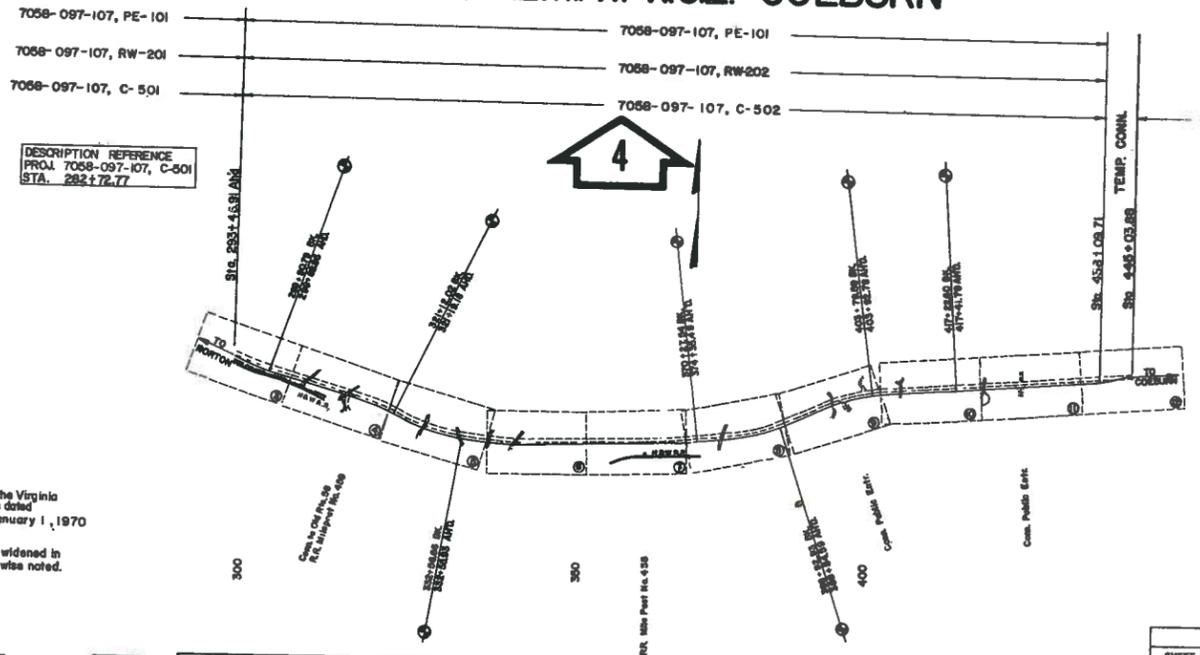


COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HIGHWAYS

PLAN AND PROFILE OF PROPOSED
STATE HIGHWAY

WISE COUNTY
FROM: 0.207 M.I.E. INT. RTE. 798 (TACOMA)
TO: 0.442 M.I. W. WCL. COEBURN

EARTH WORK COMPUTATION JOB NO. 709
9 SHEETS CROSS SECTIONS



Note: This project is to be constructed in accordance with the Virginia Department of Highways Road & Bridge Specifications dated July 1, 1966 and Road Designs and Standards dated January 1, 1970 and including all subsequent revisions.
All curves are to be super-elevated, transitioned and widened in accordance with standard TC-2, except where otherwise noted.

CONVENTIONAL SIGNS

STATE LINE	LEVEL OR EMBANKMENT
COUNTY LINE	CHUTE
CITY, TOWN OR VILLAGE	DROP
RIGHT OF WAY LINE	TRAILWAY POLES
FORCE LINE	POWER POLES
UNFENCED PROPERTY LINE	TELEPHONE OR TELEGRAPH POLES
FENCED PROPERTY LINE	MARKS
TRAVELED WAY	ROCK
GRAVEL ROAD	WOODS
RETAINING WALL	GROUND ELEVATION
RAILROADS	GRADE ELEVATION
RAIL OR SURVEY LINE	POLES WITHIN CONSTRUCTION LIMITS

STATE PROJ. NO.	CONTRACT NO.	SECTION	FEDERAL AID PROJECT NO.	QUANTITIES FEET	LENGTH INCL. BR. & BOX CULV. FEET	LENGTH EXCL. BR. & BOX CULV. FEET	TYPE PROJECT	DESCRIPTION
7058-097-107		PE-101		436.49	14,028.31	2,856	PE	
7058-097-107		C-502		436.49	14,028.31	2,856	CONSTR.	
7058-097-107		RW-202		436.49	14,028.31	2,856	RW	FROM: 0.207 M.I.E. INT. RTE. 798 (TACOMA) TO: 0.442 M.I. W. WCL. COEBURN

F.P.A. DIST. NO.	STATE	FEDERAL AID ROUTE	PROJECT	ROUTE	STATE PROJECT	SHEET NO.	TOTAL SHEETS
2	VA.			ALJ 50	7058-097-107	1	27

DESIGN CLASSIFICATION	
ADT 1968	4,250
ADT 1989	8,100
DHV	885
D	80%
T	13%
V	50

RECOMMENDED FOR APPROVAL FOR RIGHT OF WAY ACQUISITION	
12-3-69	[Signature]
12-9-69	[Signature]
12-9-69	[Signature]
12-9-69	[Signature]

APPROVED FOR RIGHT OF WAY ACQUISITION	
12-9-69	[Signature]

RECOMMENDED FOR APPROVAL FOR CONSTRUCTION	
3-16-70	[Signature]
3-16-70	[Signature]
3-16-70	[Signature]

APPROVED FOR CONSTRUCTION	
3-16-70	[Signature]

APPROVED	
DATE	[Signature]

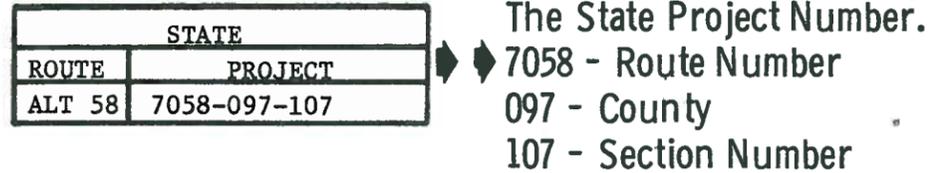
PLANS REVISED			
SHEET NO.	DATE	SHEET NO.	DATE
2	2-6-70		
3	3-9-70		
2	5-22-70		
3	9-22-71		
2	9-22-71		



The state for which the plans are intended.



The Federal Aid Project Number. (Applicable only if Federal funds are used.)



The State Project Number.
7058 - Route Number
097 - County
107 - Section Number



The number of this sheet.



The total number of sheets in this set of plans.

This information is found on each sheet in the same location - upper right hand corner.

Another portion of the State Project Number may include one or more Job Numbers indicated in the following manner:

7058-097-107, C-502, B-601

What this means is that it is a road construction project (C-502) which will include construction of a bridge (B-601).

Job Number classifications are categorized as follows:

- 100 - Preliminary Engineering (Coded PE)
- 200 - Right of Way (Coded RW)
- 300 - Grading & Drainage (Coded G)
- 400 - Paving (Coded P)
- 500 - Construction (Coded C)
- 600 - Bridges (Coded B)
- 700 - Flashing Light Signals (Coded FS)
- 800 - Landscaping (Coded L)
- 900 - Signing (Coded S)

These 3-digit job numbers have been reserved for various phases of work as indicated. This system is designed to enable the different divisions of the Highway Department to identify and record the breakdown of charges.

If you will look directly under the TITLE & DESCRIPTION you will see three phases of the project listed - the preliminary engineering phase, the right of way phase, and the construction phase.

It should be noted that on many plans these job numbers are referred to as section numbers. Do not let this bother you.



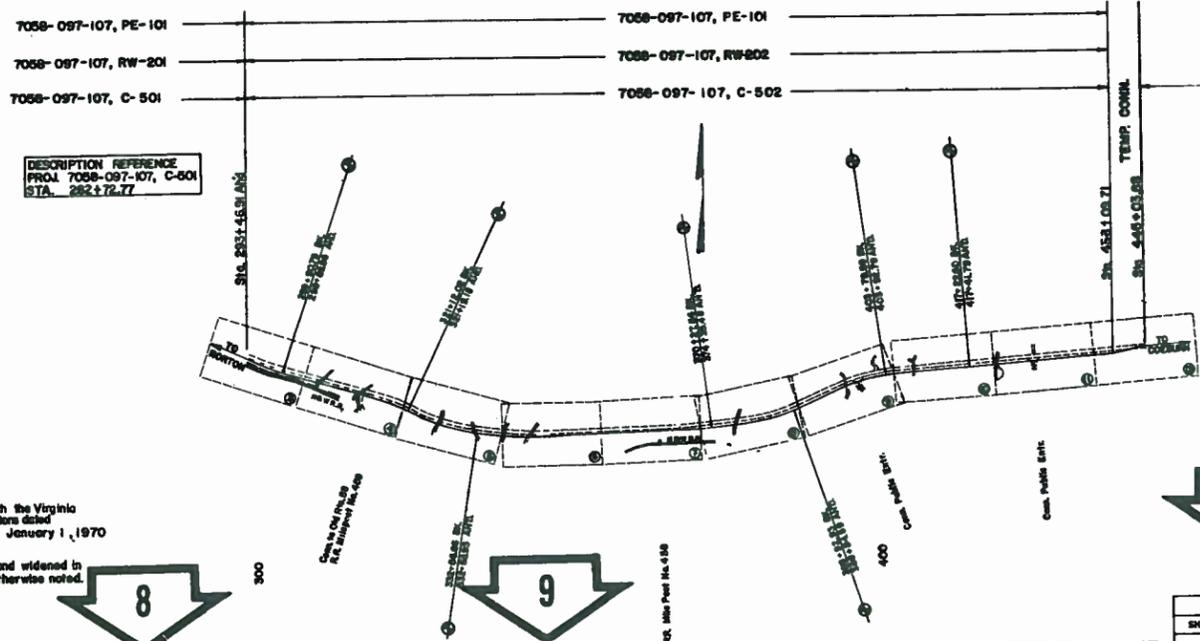
SHEET NO.	DESCRIPTION	STA. TO	STA.
1 & 1A	TITLE & LOCATION SHEETS		
2 THRU 2D	TYPICAL SECTION & SUMMARY SHEETS		
3 THRU 3A	PLAN & PROFILE SHEETS	293+44.91	305+00.00
4 " 4A	" " " "	305+00.00	321+00.00
5 " 5A	" " " "	321+00.00	337+00.00
6 " 6A	" " " "	337+00.00	353+00.00
7 " 7A	" " " "	353+00.00	373+00.00
8 " 8A	" " " "	373+00.00	389+00.00
9 " 9A	" " " "	389+00.00	405+00.00
10 " 10A	" " " "	405+00.00	421+00.00
11 " 11A	" " " "	421+00.00	437+00.00
12 " 12A	" " " "	437+00.00	445+03.68

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HIGHWAYS

PLAN AND PROFILE OF PROPOSED
STATE HIGHWAY

WISE COUNTY
FROM: 0.207 M.I.E. INT. RTE. 798 (TACOMA)
TO: 0.442 M.I.W. WCL. COEBURN

EARTH WORK COMPUTATION JOB NO. 709
9 SHEETS CROSS SECTIONS



Note: This project is to be constructed in accordance with the Virginia Department of Highways Road & Bridge Specifications dated July 1, 1966 and Road Design and Standards dated January 1, 1970 and including all subsequent revisions.
All curves are to be super-elevated, transitioned and widened in accordance with standard TC-2, except where otherwise noted.

STATE LINE	LEVEL OR EMBANKMENT
COUNTY LINE	CITY, TOWN OR VILLAGE
RIGHT OF WAY LINE	FOUR CORNER
FOUR CORNER	DUMP PILE
UNFENCED PROPERTY LINE	TRUCK STOP
FENCED PROPERTY LINE	POWER POLE
TRAVELLED WAY	TELEPHONE OR TELEGRAPH POLE
GUARD RAIL	WATER
RETAINING WALL	GRADE ELEVATION
RAILROAD	POLE WITHIN CONSTRUCTION LIMITS
BAR OR SURVEY LINE	

STATE PROJ. NO.	CONTRACT NO.	SECTION	FEDERAL AID PROJECT NO.	QUALITIES FEET	LENGTH ENCL. BR. & BOX CULV. FEET	LENGTH ENCL. BR. & BOX CULV. FEET	TYPE PROJECT	DESCRIPTION
7058-097-107		PE-101		436.79	1402.31	2.455	PE	FROM 0.207 M.I.E. INT. RTE. 798 (TACOMA)
7058-097-107		C-502		436.79	1402.31	2.455	CONSTR.	TO 0.442 M.I.W. WCL. COEBURN
7058-097-107		RW-202		436.79	1402.31	2.455	RW	

SHEET NO.	DATE	SHEET NO.	DATE
6	2-6-70		
8, 10, 12	3-9-70		
2, 4, 6	3-30-70		
3	9-22-71		
2-20-71	9-27-71		

F.P.A. DIST. NO.	STATE	FEDERAL AID DIST. NO.	PROJECT	ROUTE	STATE PROJECT	SHEET NO.	TOTAL SHEETS
2	VA.			ALX. 88	7058-097-107 See Tabulation Below For Section Numbers	1	27

DESIGN CLASSIFICATION
ADT 1968 4,250
ADT 1969 8,100
DIV 885
D 60%
T 13%
V 50

DATE	BY	LOCATION AND DESIGN ENGINEER
7-9-69		
12-9-69		
12-8-69		
12-9-69		

APPROVED FOR RIGHT OF WAY ACQUISITION
DATE: 1/16/70 BY: [Signature]

DATE	BY	LOCATION AND DESIGN ENGINEER
3-16-70		
3-16-70		
3-16-70		

APPROVED FOR CONSTRUCTION
DATE: 3/16/70 BY: [Signature]

APPROVED
DATE: [Blank] BY: [Blank]

5

Directly beneath the project number box you will find the DESIGN CLASSIFICATION. These are the figures that govern the design and specifications to construct a road to ensure that it will handle the traffic - at least for a few years.

In this instance, through the means of traffic counts, it has been determined that the average daily traffic (ADT) in 1968 was 4,250 vehicles. Average daily traffic for the year 1989 is projected to be 8,100 vehicles.

The designed hourly volume (DHV) is estimated to be 855 vehicles. Direction (D) of traffic at peak hours is anticipated at 60% of vehicular movement in one direction. 13% of all vehicles expected to use this road will be trucks (T), or buses. With these factors considered, a design velocity (V) of 50 MPH is considered appropriate to withstand the volume and usage.

On plans for a secondary system this information is usually contained along the bottom margin of the TITLE SHEET.

6

At the upper left hand corner you will find an INDEX OF SHEETS. Look at this INDEX now and note that Sheet 1 is followed by Sheet 1A; Sheet 2 by 2A, 2B, 2C and 2D. Thus, so far there are 7 sheets. By counting through the remaining figures you can see that there is a total of 27 sheets - exactly as listed in the project number block.

Note also that the Plan & Profile Sheets are broken down by station numbers, enabling ready reference to the sheet desired.

6

7

At the lower left corner of the TITLE SHEET you will find several NOTES. One of the notes located here usually tells which SPECIFICATIONS will be used on this project and such revisions that may be necessary. STANDARDS to be used on specific portions of the project might also be listed here.

IT IS IMPORTANT TO READ THESE AND ANY OTHER NOTES ON ANY SET OF PLANS.

Under these notes you will find a list of conventional signs (map symbols) used on these plans. If you are not familiar with these symbols, it would be to your advantage to look over them now. Do not try to memorize them. After you have familiarized yourself with these symbols, look at some of the PLAN sheets and see if you can locate and identify some of the symbols.

8

The information found in the table at the bottom center of the TITLE SHEET describes the general length of the project and/or projects.

9

In this case, there are three projects. One is for preliminary engineering (PE), one for right of way acquisition (RW), and finally, one for road construction (C).

Look now at the REVISIONS in the bottom right corner of the TITLE SHEET.

10

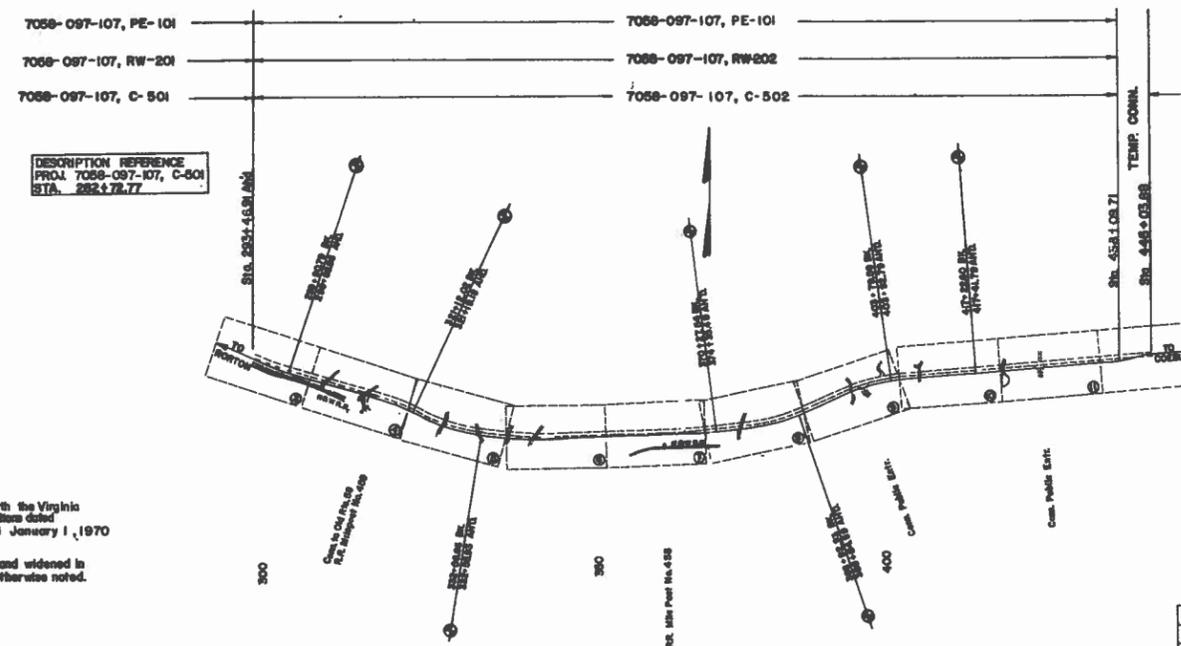
These REVISIONS show which sheets have been revised (changed) or added. You need to read the dates of revision so that you can check to be sure that these revisions have been made on the proper sheets of the plans.

SHEET NO.	DESCRIPTION	STA. TO	STA.
1 & 1A	TITLE & LOCATION SHEETS		
2 THRU 2D	TYPICAL SECTION & SUMMARY SHEETS		
3 THRU 3A	PLAN & PROFILE SHEETS	293+48.91	305+00.00
4	4A	305+00.00	321+00.00
5	5A	321+00.00	337+00.00
6	6A	337+00.00	353+00.00
7	7A	353+00.00	369+00.00
8	8A	369+00.00	385+00.00
9	9A	385+00.00	401+00.00
10	10A	401+00.00	417+00.00
11	11A	417+00.00	433+00.00
12	12A	433+00.00	449+00.00


COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HIGHWAYS

PLAN AND PROFILE OF PROPOSED
STATE HIGHWAY
WISE COUNTY
FROM: 0.207 MILE INT. RTE. 798 (TACOMA)
TO: 0.442 MILE W. WCL. COEBURN

EARTH WORK COMPUTATION JOB NO. 709
9 SHEETS CROSS SECTIONS



Note: This project is to be constructed in accordance with the Virginia Department of Highways Road & Bridge Specifications dated July 1, 1966 and Road Design and Standards dated January 1, 1970 and including all subsequent revisions.
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CONVENTIONAL SIGNS

ROAD LINE	LEVEL OR EMBANKMENT	
CORRY LINE	DITCHES	
CITY, TOWN OR VILLAGE	CULVERTS	
RIGHT OF WAY LINE	SHOULDER	
FENCE LINE	TROTTLE POLES	
UNFENCED PROPERTY LINE	POWER POLES	
FENCED PROPERTY LINE	TELEPHONE OR TELEGRAPH POLES	
TRAVELLED WAY	MARKS	
GRASS BANK	WOODS	
RETAINING WALL	GROUND ELEVATION	
RAILROADS	GRADE ELEVATION	
NAME ON SURVEY LINE	POLES WITHIN CONSTRUCTION LIMITS	

STATE PROJ. NO.	CONTRACT NO.	SECTION	FEDERAL AID PROJECT NO.	EQUALITIES FEET	LENGTH MCL. IN. & BOX CHAINS	LENGTH ENCL. IN. & BOX CHAINS	TYPE PROJECT	DESCRIPTION
7088-097-107		PE-101		435.49	14,028.31	1,695	PE	
7088-097-107		C-502		435.49	14,028.31	1,695	CONCRETE	FROM 0.207 MILE INT. RTE. 798 (TACOMA) TO 0.442 MILE W. WCL. COEBURN
7088-097-107		RW-202		435.49	14,028.31	1,695	RW	

PLANS REVISED

SHEET NO.	DATE	SHEET NO.	DATE
2	2-6-70		
3	3-9-70		
4	5-30-70		
5	9-27-71		
6	9-27-71		

F.A.A. DIST. NO.	STATE	FEDERAL AID ROUTE	PROJECT	STATE PROJECT	SHEET NO.	TOTAL SHEETS
2	VA.			7088-097-107 See Tabulation Below For Section Numbers	1	27

DESIGN CLASSIFICATION

ADT 1966	4,250
ADT 1989	8,100
DHV	855
D	60%
T	13%
V	90



RECOMMENDED FOR APPROVAL FOR RIGHT OF WAY ACQUISITION

12-3-69	<i>[Signature]</i>	DATE	LOCATION AND SIGNATURE
12-9-69	<i>[Signature]</i>	DATE	DIRECTOR OF ENGINEERING
12-8-69	<i>[Signature]</i>	DATE	DIRECTOR OF PROGRAMMING & PLANNING
12-4-69	<i>[Signature]</i>	DATE	SENIOR COMMISSIONER AND CHIEF ENGINEER

APPROVED FOR RIGHT OF WAY ACQUISITION

12/16/69	<i>[Signature]</i>	DATE	COMMISSIONER
----------	--------------------	------	--------------

RECOMMENDED FOR APPROVAL FOR CONSTRUCTION

3-16-70	<i>[Signature]</i>	DATE	LOCATION AND SIGNATURE
3-16-70	<i>[Signature]</i>	DATE	DIRECTOR OF ENGINEERING
3-16-70	<i>[Signature]</i>	DATE	DIRECTOR OF PROGRAMMING & PLANNING

APPROVED FOR CONSTRUCTION

3/16/70	<i>[Signature]</i>	DATE	SENIOR COMMISSIONER AND CHIEF ENGINEER
---------	--------------------	------	--

APPROVED

DATE	SIGNATURE	SENIOR COMMISSIONER AND CHIEF ENGINEER
------	-----------	--

11

In the extreme right hand corner there is a table containing signatures of authorization. NOTE ESPECIALLY THE SIGNATURE UNDER APPROVED FOR CONSTRUCTION. NO PLANS SHOULD BE USED WITHOUT CHECKING TO MAKE SURE THAT THIS SIGNATURE IS PRESENT. THE ABSENCE OF THIS SIGNATURE MEANS THAT THE PLANS HAVE NOT BEEN AUTHORIZED FOR USE IN CONSTRUCTION.

12

There is one more important item on the TITLE SHEET. It is called a KEY DIAGRAM, and is located pretty much in the center of the sheet. Not only does this diagram give a general plan view of the road to be constructed, but it indicates how the entire project is divided on each of the PLAN and PROFILE sheets.

If you will look at the KEY DIAGRAM you will see a series of rectangular boxes with circled numbers in the lower right of each. These numbers represent the sheet number that shows that portion of the project contained in each of the rectangles.

Also found on this KEY DIAGRAM is the termini of the project. The termini are the stations where the project begins and ends.

1. The TERMINI of the project are station _____ and station _____.

2. On which sheets would you find the Plan & Profile of that portion of the project which lies between station 405+00 and station 421+00? _____

3. What STANDARDS will be used on all curves on this project? _____

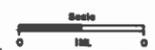
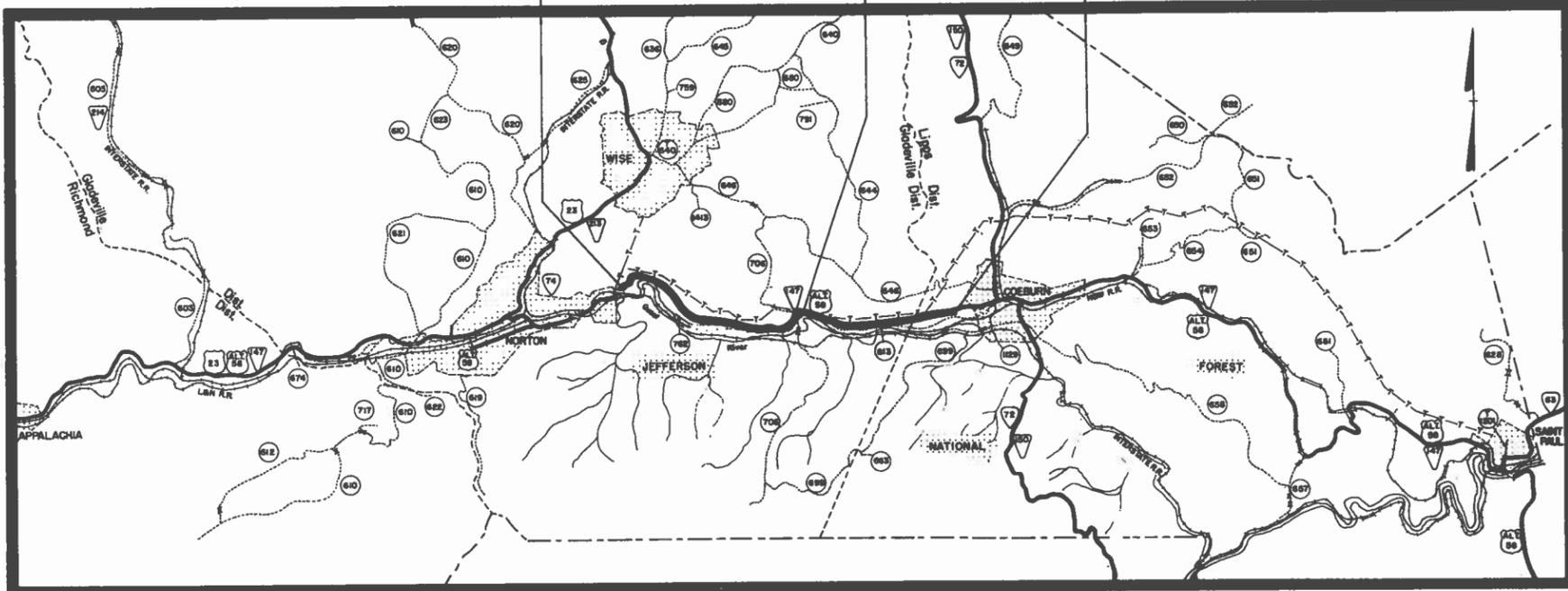
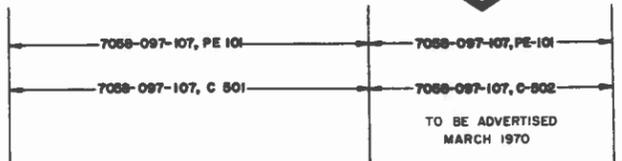
4. What is the total length of the project in feet? _____ and in miles? _____



LOCATION MAP

FED. ROAD DISTRICT	STATE	FEDERAL AID		STATE		SHEET NO.	TOTAL SHEETS
		ROUTE	PROJECT	ROUTE	PROJECT		
2	VA.			ALT. 88	7058-097-107, PE-101 7058-097-107, C-801 7058-097-107, C-802		

DATE: 1-1-70
 PREPARED BY: JAMES
 NECESSARY BY THE DEPARTMENT



Some plans, usually on those projects involving a secondary system, have a PROJECT LOCATION map on the TITLE SHEET. Plans for primary systems contain the LOCATION MAP on Sheet 1A.

13

The purpose of the location map is to orient the project in relation to existing highways or to natural or man-made terrain features in the same area.

As a general rule, LOCATION MAPS are always oriented to the NORTH. However, this will not always be the case. In any event, locate the compass arrow - it will always indicate the northerly direction.

The following symbols are used on highway maps to indicate types of road :



is used to denote U. S. Routes.



is used for State Primary Highways.



is used for State Secondary Roads.



is used for Interstate Highways.

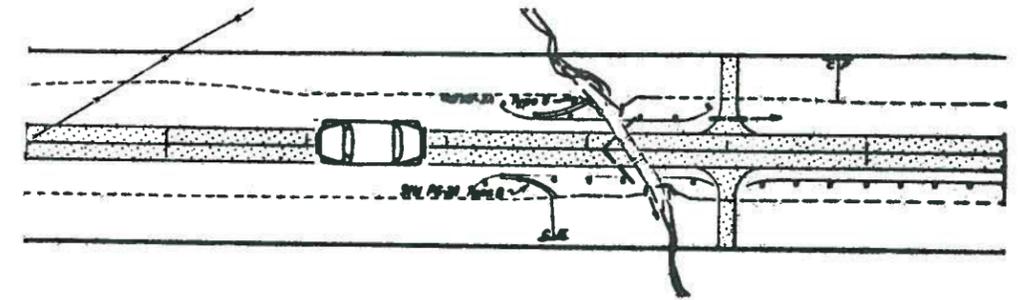


is used for Forestry Roads.

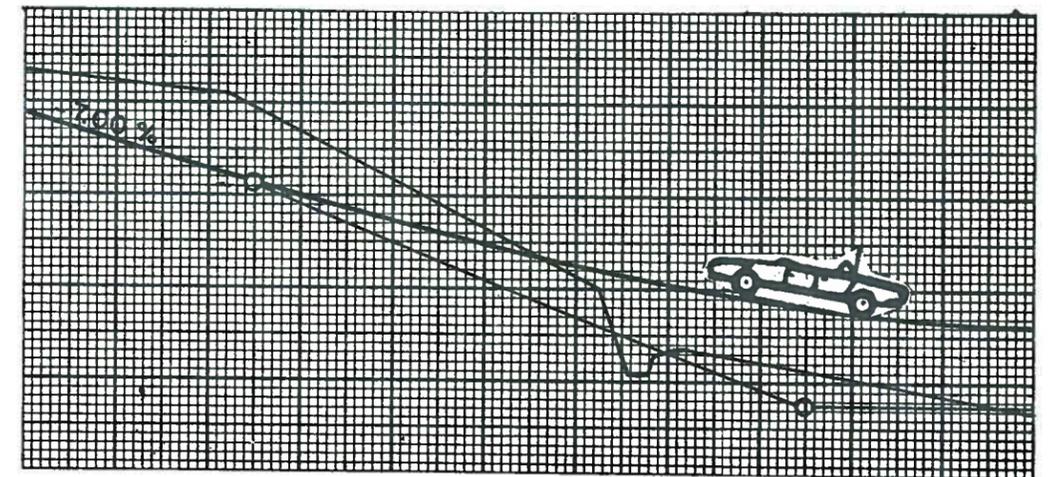
Before we progress any further, it is important that you understand two words ■■■■■■■■■■

PLAN & PROFILE

PLAN (PLAN VIEW). When you speak of the PLAN VIEW imagine yourself looking straight down on it from a point directly above.

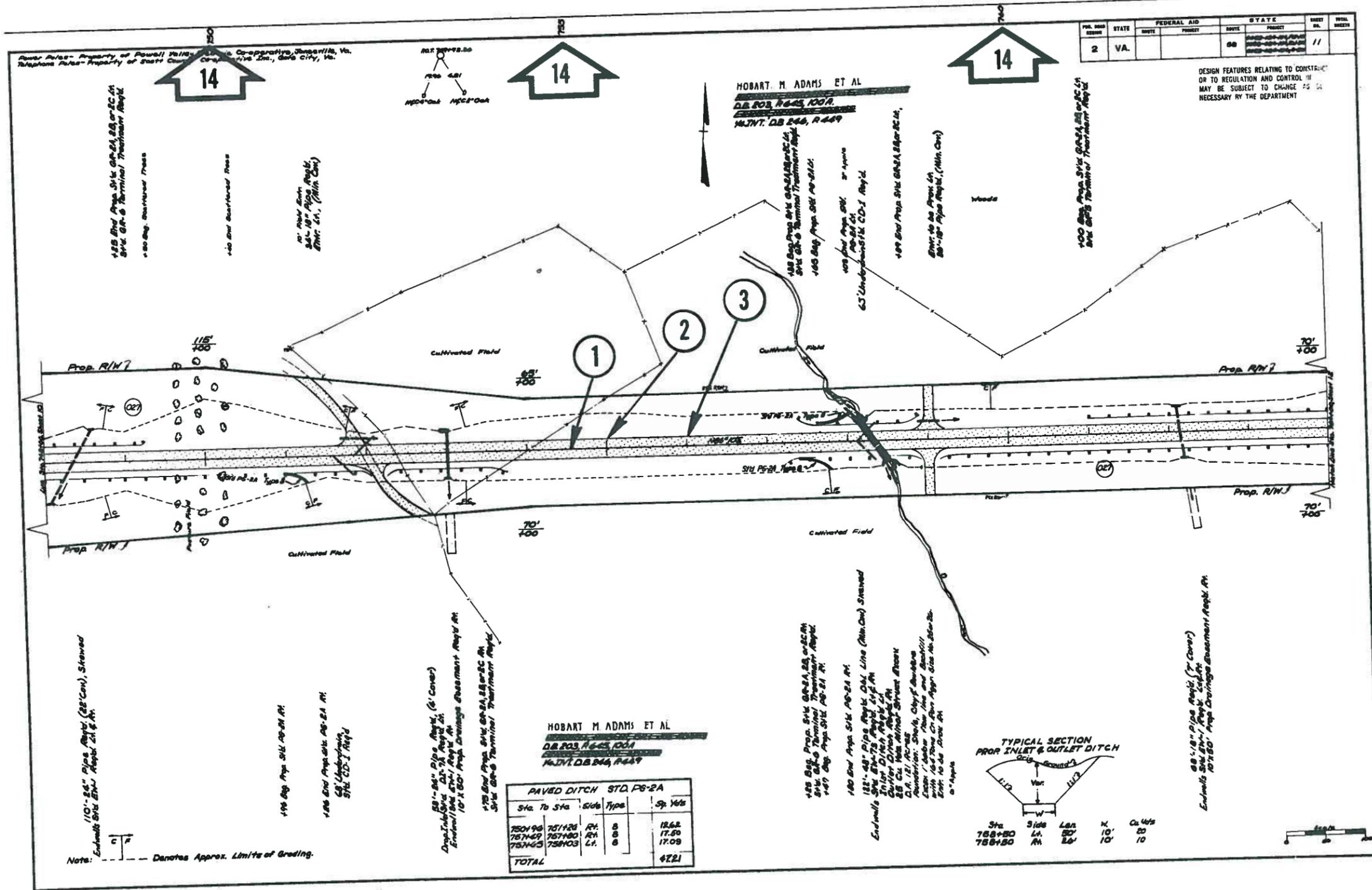


PROFILE (SIDE VIEW). When you speak of the PROFILE you must look at it as if you were standing in a field off to one side of the road and looking back at it.



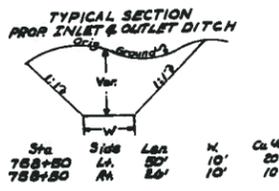
FED. ROAD DISTRICT	STATE	FEDERAL AID	ROUTE	PROJECT	ROUTE	PROJECT	SHEET NO.	TOTAL SHEETS
2	VA.				88		11	

DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL MAY BE SUBJECT TO CHANGE NECESSARY BY THE DEPARTMENT



HOBART M ADAMS ET AL
DB 203, R 645, 100A
M.J.V.T. DB 244, R 444

PAVED DITCH STD PG-2A				
Sta. To	Sta.	Side	Type	Sp. Yds
750+90	751+20	RA	B	12.62
751+20	751+80	RA	B	17.50
751+80	751+83	LA	B	17.08
TOTAL				47.20



Another word you must become familiar with is.....

STATIONING

It is the process of defining locations along the project by station numbers. Highway construction projects are divided into reference points spaced equal distances apart. These points are called STATIONS and are designated by a number such as 755+50.00. In a moment we will see how to translate this number into a practical reference point.

First though, look at the Plan on the opposite page. You will note a line running down the middle of the proposed highway (1). This line represents the CENTERLINE (Q). It is the basic reference point (base line) used for all horizontal measurements.

Follow this CENTERLINE and you will notice

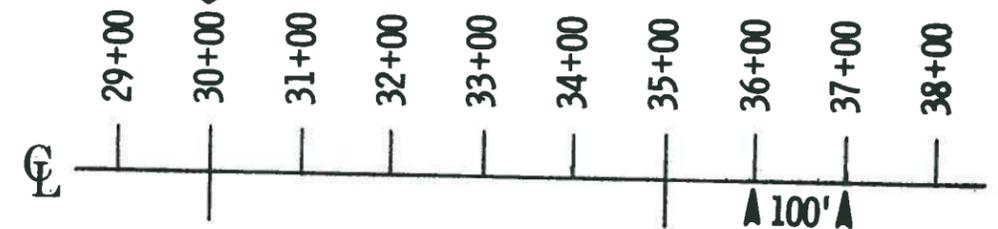
That there are regularly spaced marks on this centerline, and that every fifth (5th) mark goes through the centerline (2), and,

That there are four other marks equally spaced between these marks that do not go through the centerline (3).

These marks indicate STATIONS along the centerline that are based on a reference point which may, or may not, be on the particular project that you are working with. For this reason, it not uncommon to see a project begin with a number that is quite high - not zero as you might expect.

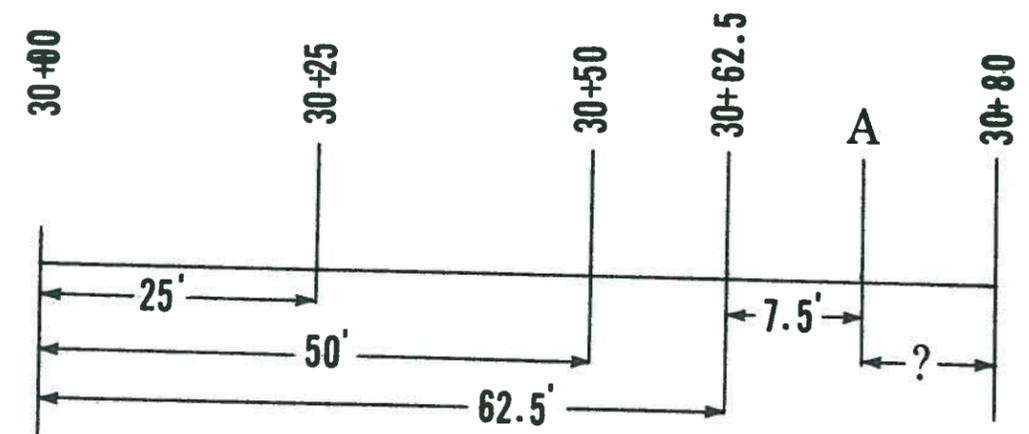
Look at the top edge of your Plan to the areas pinpointed by large arrows. Note that the number 750 is followed by 755 and 760. These numbers are directly above the lines that cross through the centerline and indicate a distance of 500 feet.

Just as there are twelve (12) inches from foot to foot on a ruler - - there are one hundred (100) feet from station to station.



5. How many feet are there between station 30 and station 34? _____

Any point between stations is written as station number plus (+) feet.



6. What is the station number for Point A? _____

7. What is the distance from Point A to station 30+80?

A station number is read as follows

130+02 - Station one thirty plus zero two
(meaning 2 feet AHEAD of station one thirty).

130+00 - Station one thirty plus zero, zero
(meaning exactly at station one thirty).

NOTE: The word NAUGHT is generally used instead of zero, or '0'. Thus, the above station might be read this way:

130+02 - Station 130 + naught, two.

130+00 - Station 130 + naught, naught.

Remember, stations are 100 feet apart. Therefore, when you take the plus (+) sign out of a station number such as 134+50, you have the value of the number in actual feet.

example: $134+50 = 13,450'$

or

$134 \times (100) + 50 = 13,400 + 50 = 13,450'$

To calculate the DISTANCE (on the same project) BETWEEN stations (or points between stations) SUBTRACT the lower station from the higher station.

For example, to calculate the distance from sta. 134+50 to sta. 132+80, you would delete the (+) sign and subtract in this way:

$$\begin{array}{r} 13450 \\ -13280 \\ \hline \text{answer: } 170 \end{array}$$

OR, you may want to do a little mental exercise and figure it this way

from sta. 132+80 to sta. 133+00 is 20'

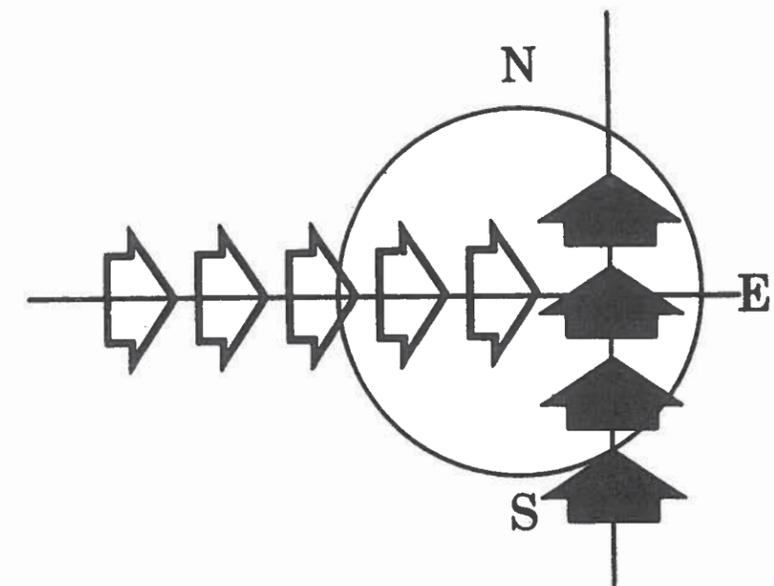
from sta. 133+00 to sta. 134+00 is 100'

from sta. 134+00 to sta. 134+50 is 50'

Thus, we have a total of 170'

Which way do the station numbers increase? Look at the Plan on page 11 and find the compass arrow. Notice that the station numbers increase from WEST to EAST. On highways that are oriented to the north or south, station numbers increase from SOUTH to NORTH.

Remember - WEST to EAST and SOUTH to NORTH.



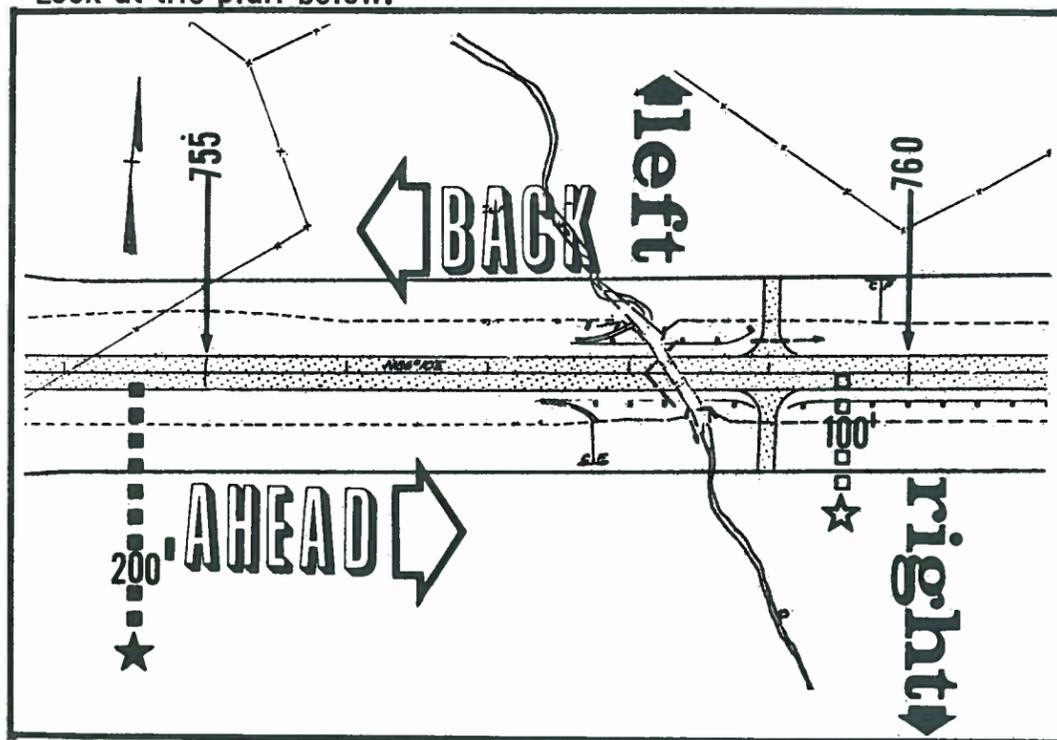
Wooden stakes with these station numbers written on them are put down early in construction. These must be moved later to the side of the roadway as construction progresses. The distance from the centerline will also be written on these stakes.

ANY point pertaining to a project may be located on an actual spot on the ground or on the plans by station number and the number of feet left or right of the CENTERLINE (Symbol - CL).

The word **AHEAD** is used to denote the direction in which the project is going. This is indicated by increasing station numbers; it is not found on the plans.

The word **BACK** is used to denote the opposite direction and is indicated by decreasing station numbers; it is not found on the plans, either.

Look at the plan below.



LEFT or RIGHT relates to facing AHEAD on a project.

Locate point \star on the plan. You will find it 200' to the right of the centerline at station 754+50.

Its "highway address" is: Station 754+50, 200' RT. of CL .

8. From the plan in the opposite column, give the "highway address" (location) of point \star _____.

9. Is this point AHEAD or BACK of sta. 761.42? _____.

A CURVE is defined as any section of roadway in which the points along the centerline do not fall on a straight line.

On a horizontal curve, the roadway bends to the right or left.

On a vertical curve, the road bends up or down.

There are essentially two kinds of curves:

circular & spiral

For learning purposes REMEMBER that:



would make a complete circle if it kept going around.



would keep getting smaller and smaller if it kept going around.

There are combinations of these curves which will be covered later on.

Look at the diagram on the right. Here you have an example of two horizontal curves. Trace the centerline from the small circle back of sta. 188+00 where it appears to bend and follow it through to the small circle ahead of sta. 195+00 where the centerline begins to straighten out again. The junction of this double curve is the point of reverse curve (PRC) at sta. 192+40.16.

Direct your attention to curve A. Directly above it you will note a series of numbers and symbols which together make up the CURVE DATA.

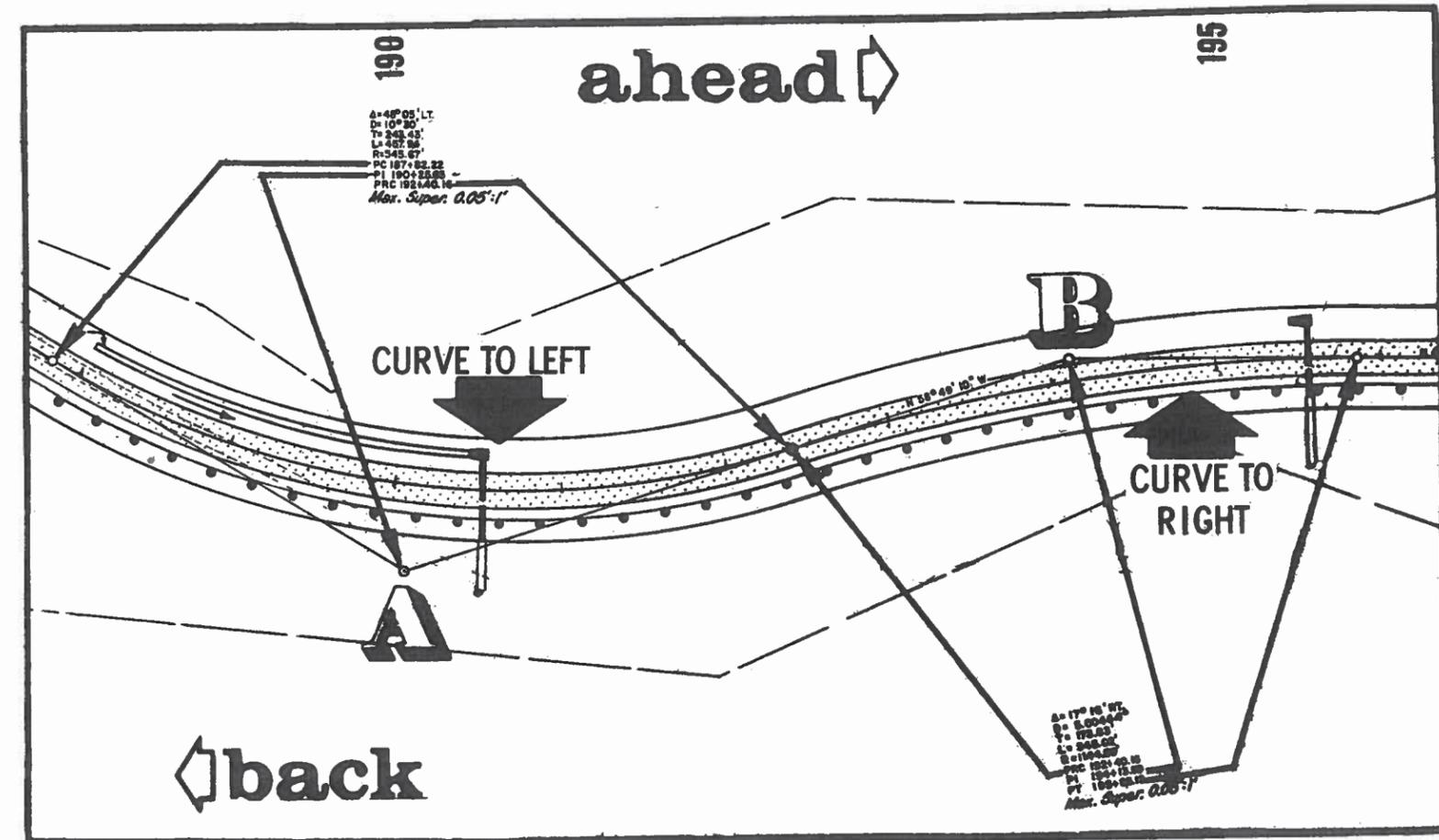
Now for an explanation of each symbol:

The POINT OF CURVATURE (PC). This is where the centerline leaves the tangent and begins to form a curve.

The intersection of the tangents just above the letter A is the POINT OF INTERSECTION (PI). This is much like a corner on a city street system. It is obvious that such corners are impractical on high speed highways; therefore, we construct curves.

Whether a highway is curving LEFT or RIGHT depends on which side of the centerline the PI is located.

If the centerline is located on the right side of the PI, the CURVE is to the RIGHT.



If the centerline is to the left of the PI, the CURVE is to the LEFT.

Trace the centerline on the plan above and note the location of the PI on both curves.

The centerline of the road is controlled by the terrain features around it. The highway curves around such terrain features as hills and lakes, and stretches out in straight lines (tangents) through the level valleys.

Such a series of straight lines and curves is called the HORIZONTAL ALIGNMENT. This alignment can be recognized by looking at the plan view of the highway.

On the Curve Data for curve B you will see a designation PT which means POINT OF TANGENT. This is where the curve ends and the tangent (straight line) begins.

In addition to designations PRC, PC, PI & PT, you will often find the designation POC. This refers to a POINT ON THE CURVE. This point can be any point on the curve where some information is necessary.

Usually it is a point where two centerlines intersect, therefore serving as a reference to the tie-in point for connecting roads.

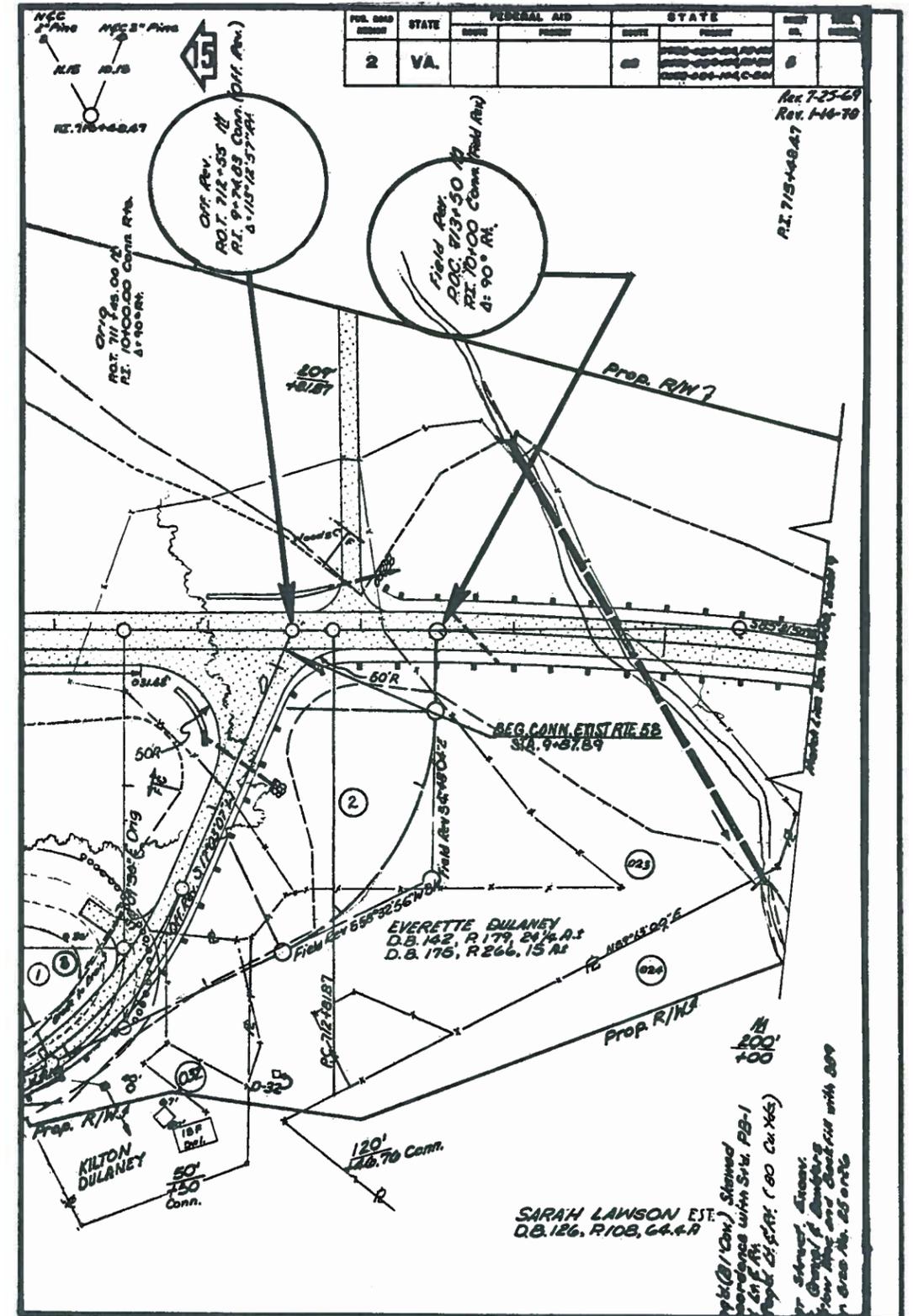
The designation POT (POINT ON THE TANGENT) will frequently be found, and again, as with POC, it has no relative position in regards to anything other than itself, but serves only to pinpoint some special information.

Check the circled notations on the plan to your right and note that the original centerline for the connection at sta. 713+50 was a POC (Point on the Curve); however, subsequent revisions placed the actual connection to a POT (Point on the Tangent) at sta. 712+55.

In the upper left hand corner of the plan you will find a diagram of survey data used to relocate particular points along the roadway in the event marking stakes are moved. This particular reference pinpoints the Point of Intersection (PI) at sta. 715+48.47 located on the extreme right edge of the plan.

An explanation of this survey data will be covered later on in this course.

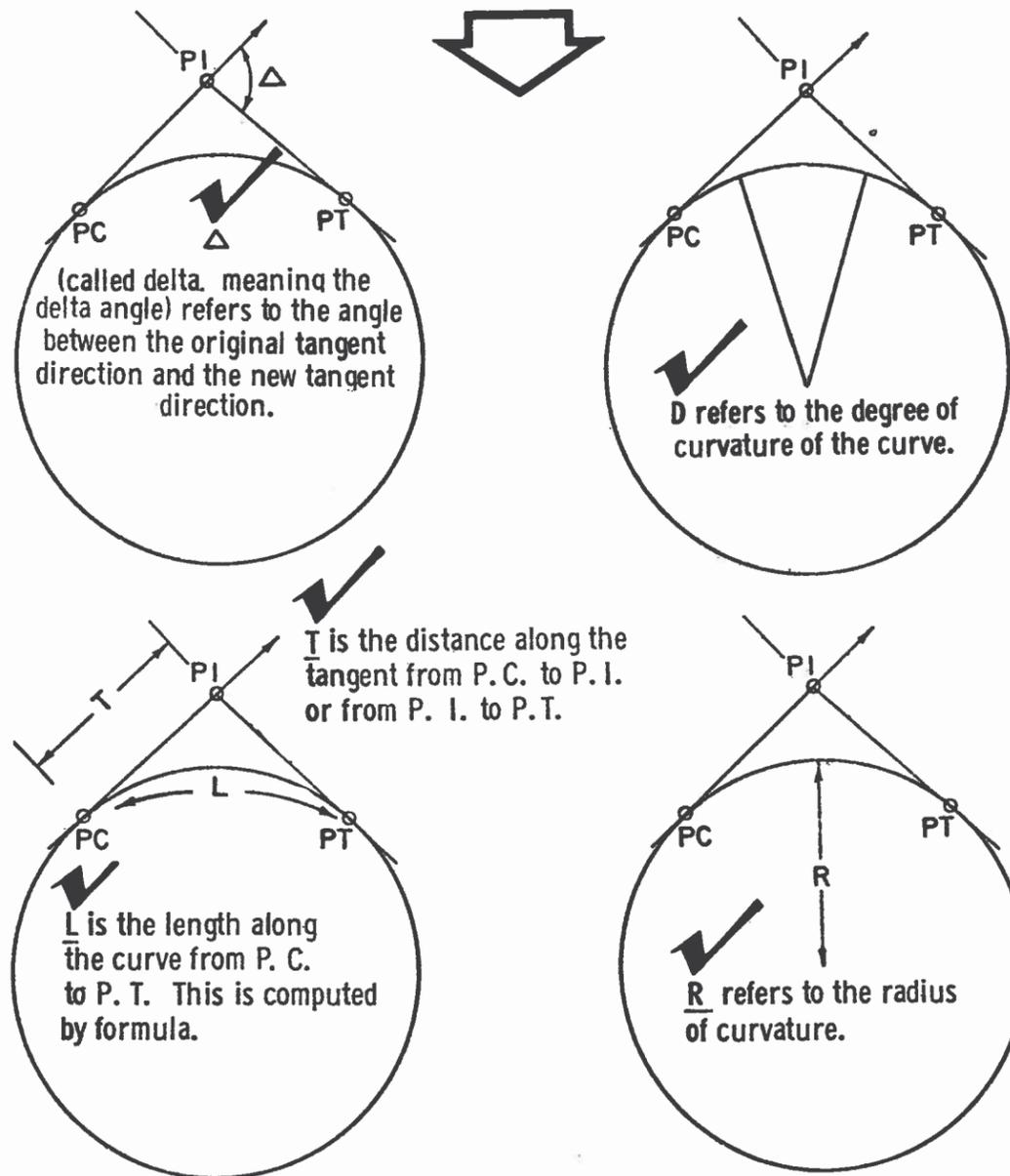
10. Using this same plan, (a) locate and give the station number of the PC _____, and (b) indicate which way the curve bends _____.



Other elements of the Curve Data with which you should be familiar are:

△
D
T
L
R

Study the diagrams closely for the meaning of these symbols.



Now that we have determined what the symbols represent, let's find out how to use them.

On any set of plans you will see figures arranged in this manner: $S 74^{\circ} 14' E$ This is known as a bearing (or direction).

It is read SOUTH SEVENTY-FOUR DEGREES, FOURTEEN MINUTES EAST.

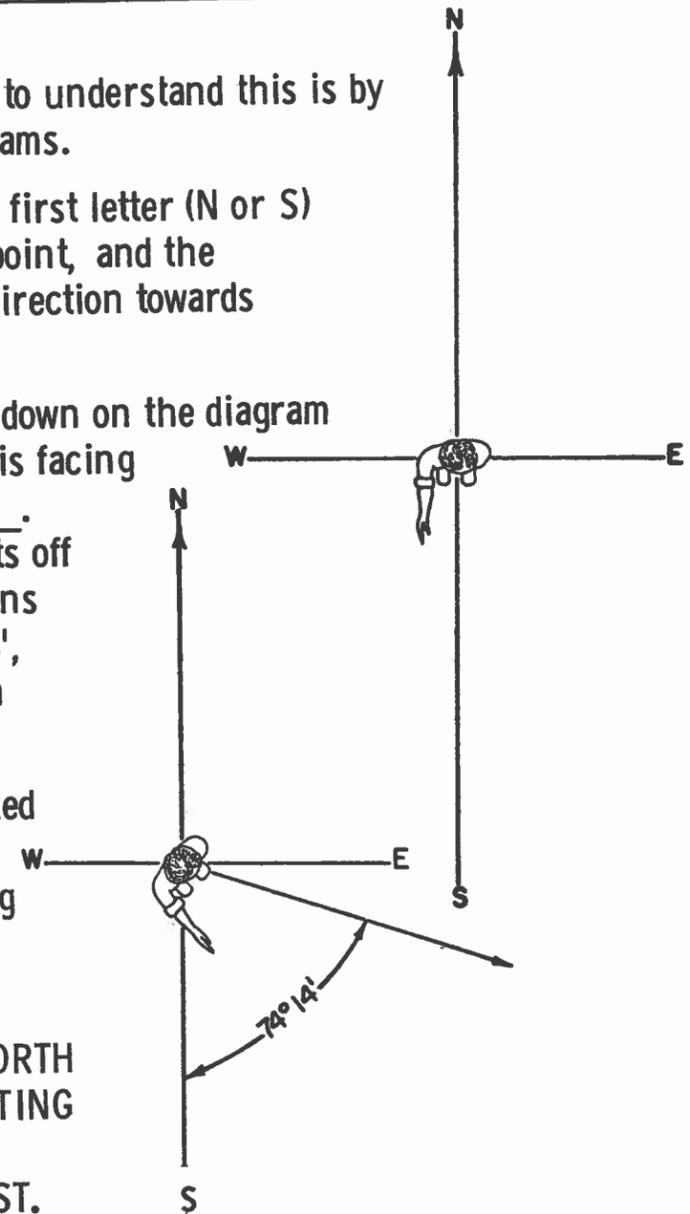
Perhaps the best way to understand this is by the use of a few diagrams.

NOTE: Always use the first letter (N or S) as Zero, or starting point, and the second letter as the direction towards which you turn.

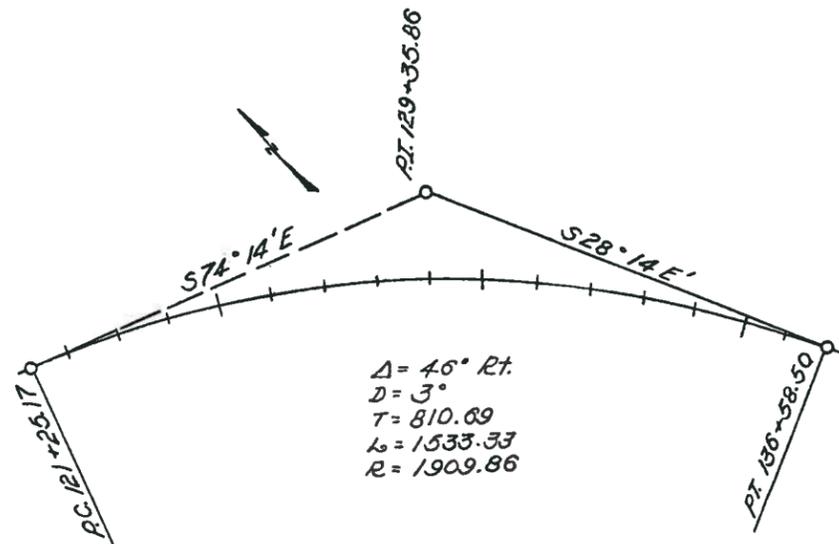
11. Looking straight down on the diagram to the right the man is facing due _____.
Therefore, if he starts off facing South and turns toward the East $74^{\circ} 14'$, he would be facing in this direction.

12. Thus, if he walked in this direction, he would be on a bearing of _____.

All bearings used in highway work use NORTH or SOUTH as a STARTING POINT and PROCEED EITHER EAST OR WEST.



Check the diagram below and note that the bearing of the tangent as it enters the curve (back tangent) is $S 74^{\circ} 14' E$. On the tangent between the PI and the PT (ahead tangent) a bearing of $S 28^{\circ} 14' E$ is given.

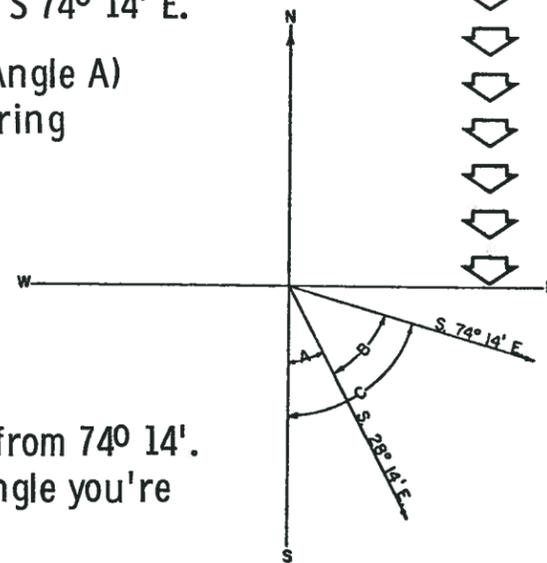


If we plot both these bearings in the same manner as on the previous page, we find that angle A, formed between SOUTH and bearing $S 28^{\circ} 14' E$, is smaller than angle C, formed between SOUTH and bearing $S 74^{\circ} 14' E$.

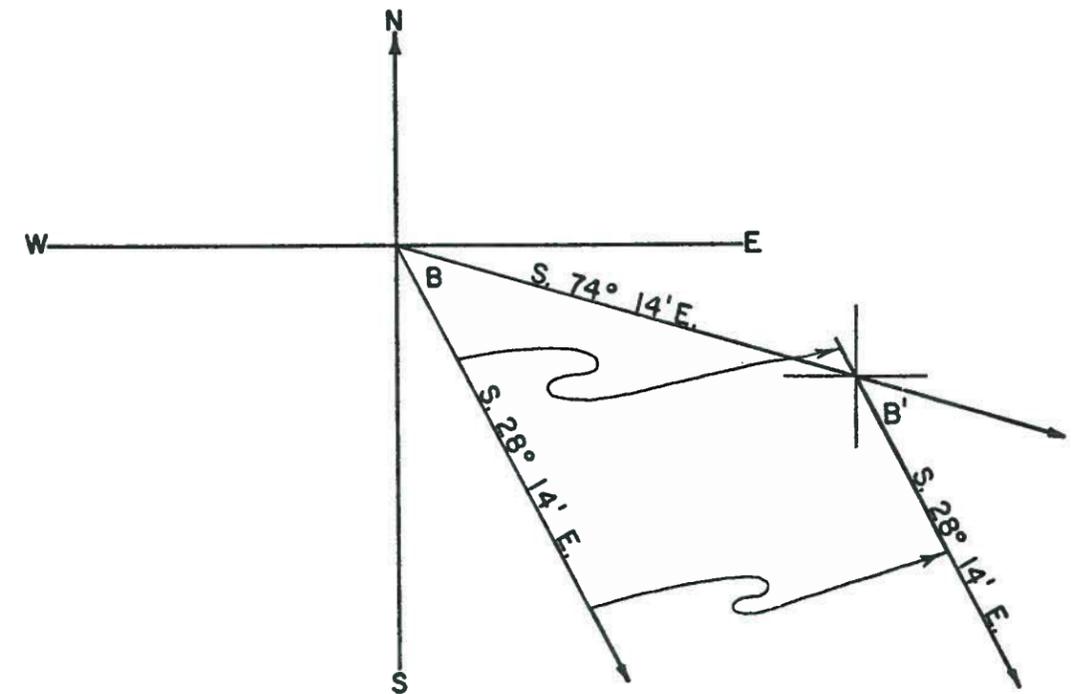
Thus, bearing $S 28^{\circ} 14' E$ (Angle A) is closer to SOUTH than bearing $S 74^{\circ} 14' E$ (Angle C).

But, how much closer (Angle B) is what we have to know in order to figure the delta angle.

So, simply subtract $28^{\circ} 14'$ from $74^{\circ} 14'$. The difference is 46° , the angle you're looking for.



If we rearrange our diagram by moving bearing $S 28^{\circ} 14' E$ over to a point along bearing $S 74^{\circ} 14' E$ your tangents are formed and intersect.

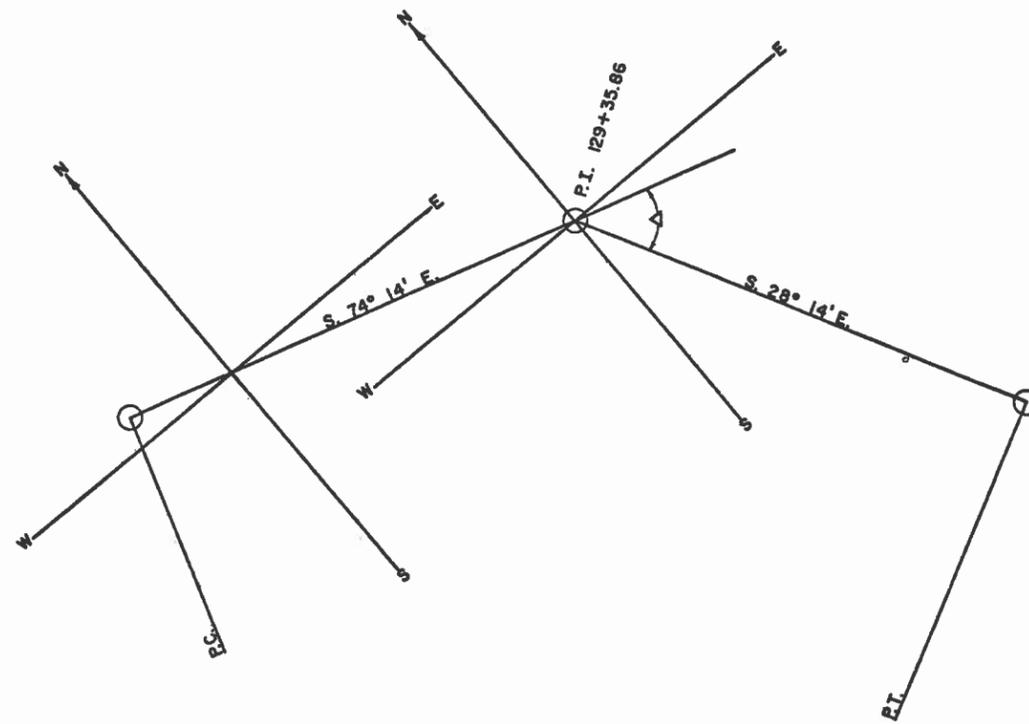


We know from elementary geometry that angle B and angle B^1 are identical. If you don't, take our word for it!

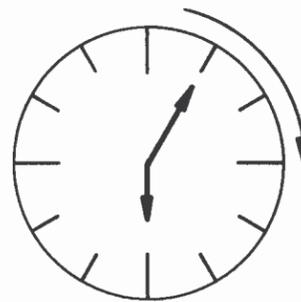
Thus, angle B^1 is the same as the delta angle. This is also called the angle of deflection. This is the angle that you would have to turn in order to leave a bearing of $S 74^{\circ} 14' E$ and begin a bearing of $S 28^{\circ} 14' E$.

13. In this case, the delta angle, or angle of _____ is _____ degrees.

By adding a few more lines (below) you can see how it fits a curve.



WHEN THE INITIAL BEARING TO THE NEW BEARING IS CLOCKWISE, THE ANGLE OF DEFLECTION (DELTA) IS TO THE RIGHT.



WHEN THE INITIAL BEARING TO THE NEW BEARING IS COUNTER-CLOCKWISE, THE ANGLE OF DEFLECTION (DELTA) IS TO THE LEFT.

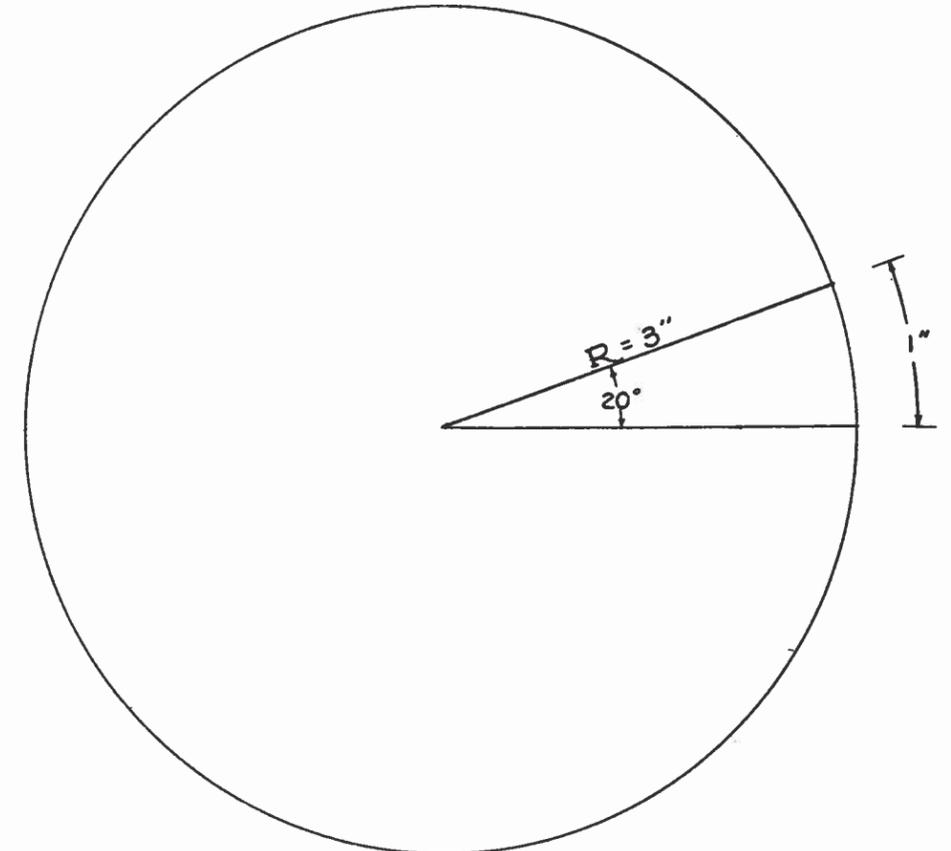
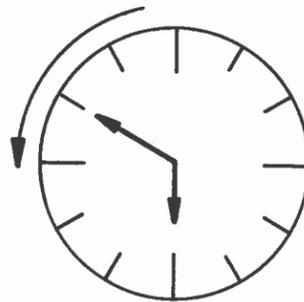


Figure 1

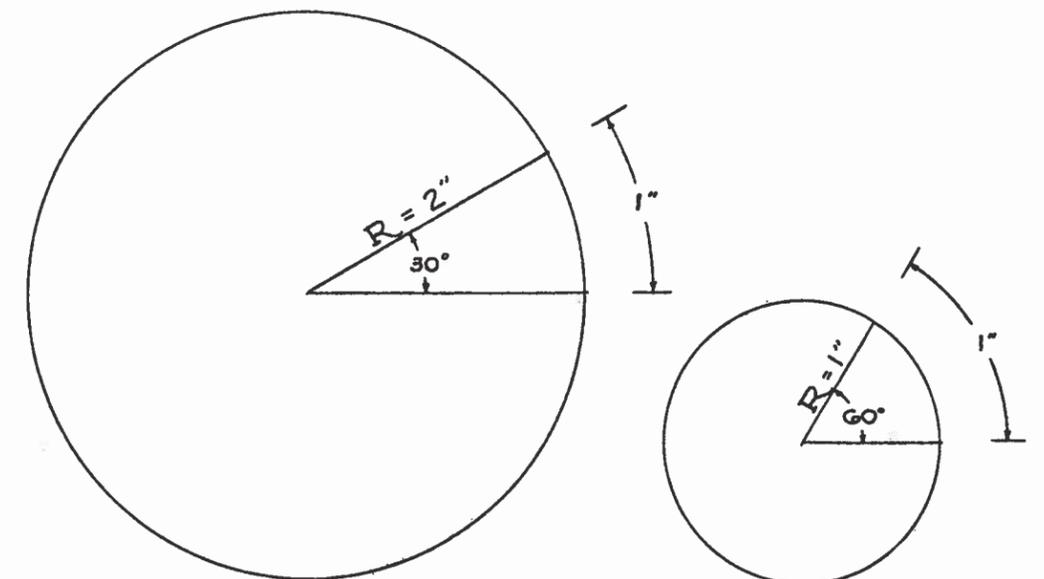


Figure 2

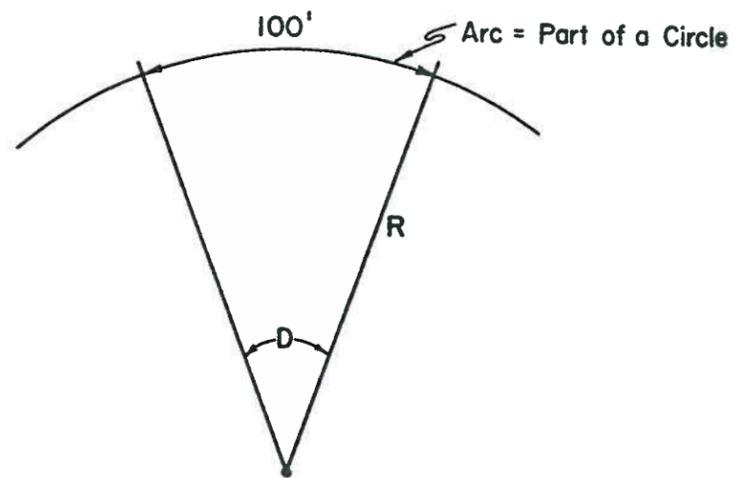
Figure 3

16

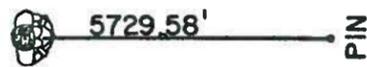
The curvature of a circular arc is perfectly defined by its radius.

Study figures 1, 2 & 3 on the opposite page. Notice that as the radius decreases in figures 2 and 3, the angle of curvature increases substantially while maintaining the same arc length. However, because of the shorter radius, the arc must bend more sharply. This bending is termed DEGREE OF CURVATURE.

The degree of curve is the central angle subtended by a 100 foot arc, as illustrated below.

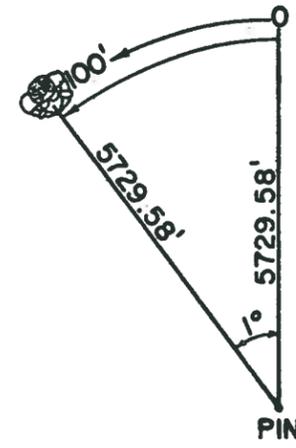


For a 1° curve, the radius R is 5729.58'. In other words, if you stuck a pin in the ground and attached a tape that was 5729.58' long by one end, thusly

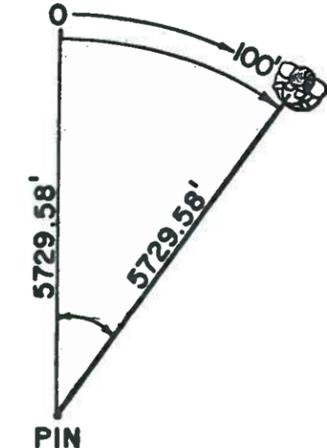


and started moving either way (left or right) for a distance of 100 feet ■■■■■■■■■■

RIGHT

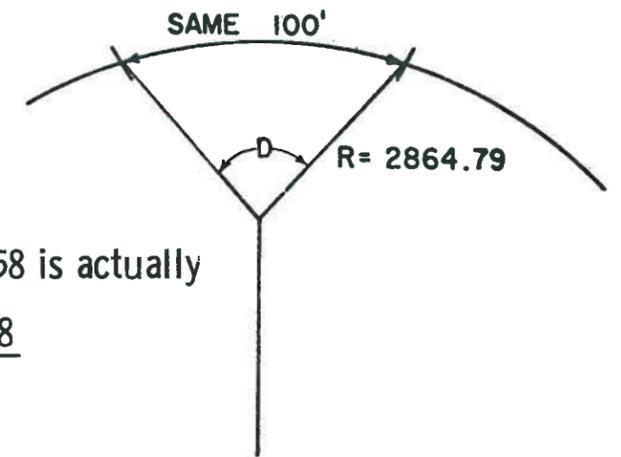


LEFT



the angle would be 1°.

For a 2° curve you would use the same rule, EXCEPT THE RADIUS WOULD BE SHORTER.



Note that 2864.58 is actually

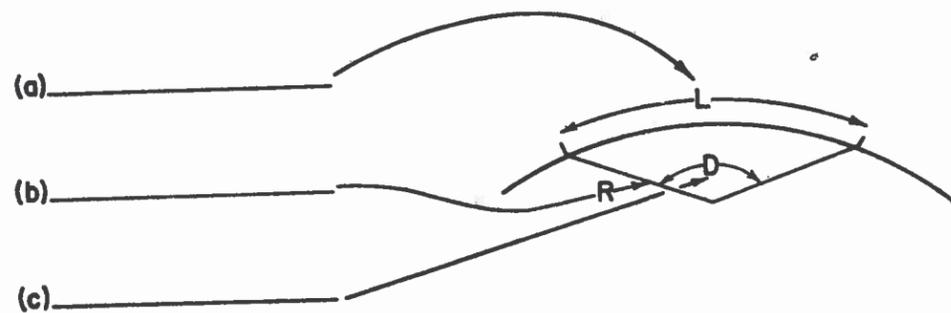
$$\frac{5729.58}{2}$$

And note also that D is twice as large as it was for a 1° curve.

14. Now divide 3 into 5729.58 and you get _____.

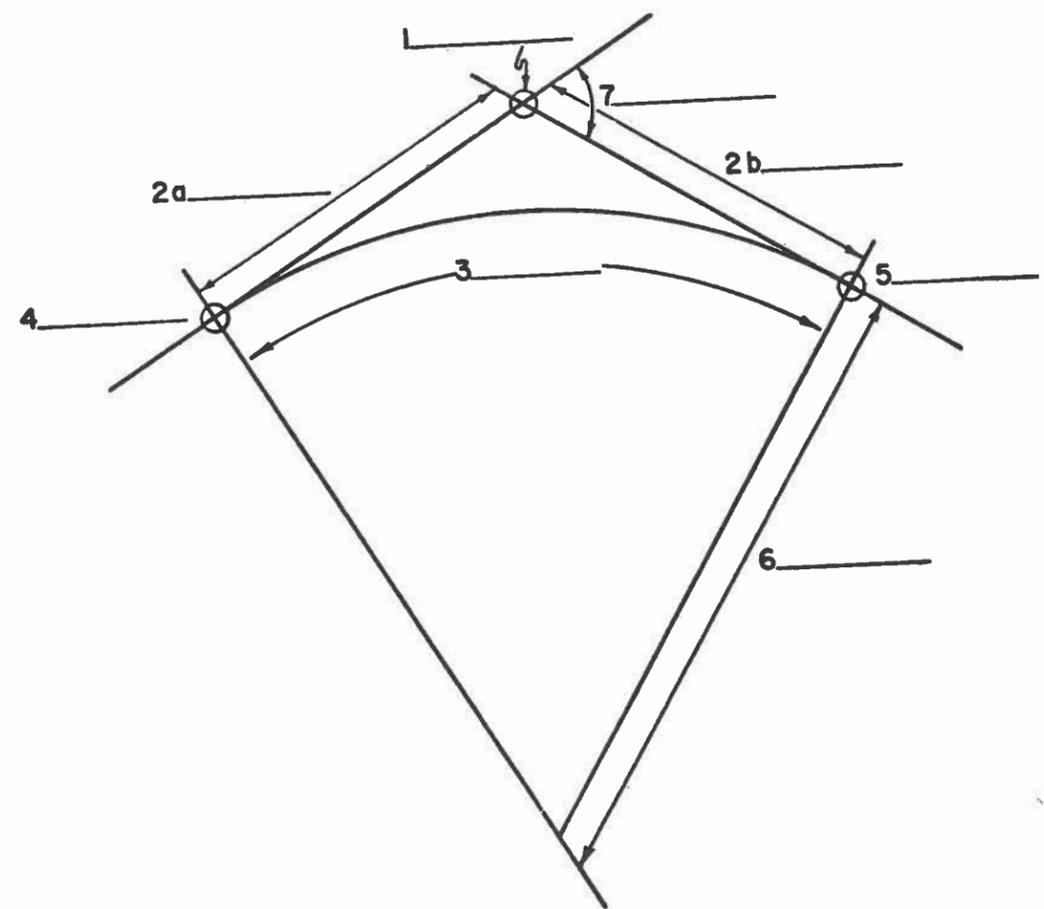
Check this R for the curve shown on Page 18. The answer to the division above should check with the R of this data.

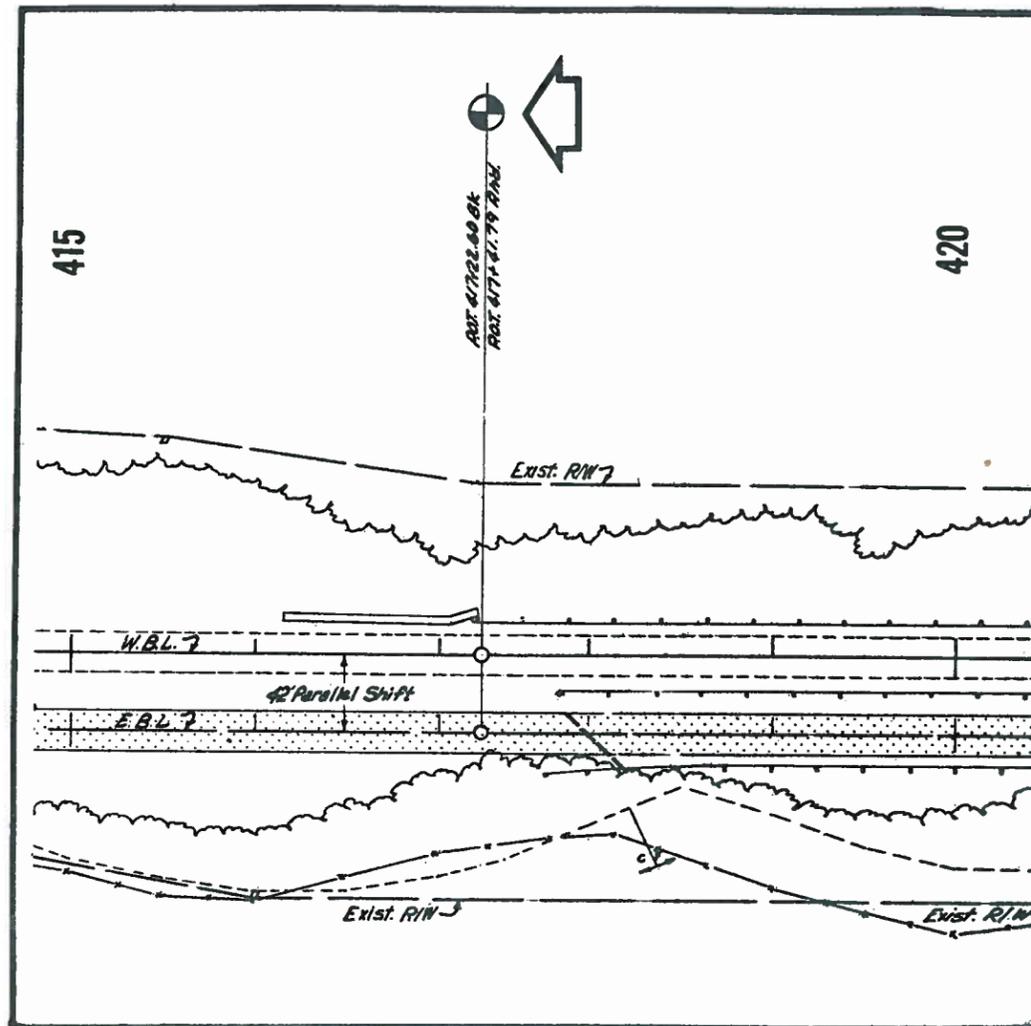
15. Using this information fill in the values on the diagram below for a 3° curve.



The point to be remembered is the degree of curvature is inversely proportional to the length of the radius. In other words, as the length of the radius increases, the degree of curvature decreases, and as the radius decreases, the degree of curvature increases.

16. Correctly label the diagram opposite for the R, T, L, PC, PT, and DELTA.





In the center of the above plan you will note a vertical line topped by a black and white checkered circle.

This is called an **EQUALITY**.

What this means is that this particular point along the centerline has TWO station numbers. The one that is used depends on the direction in which you're going.

There are numerous reasons for establishing an EQUALITY and they will be covered later. Right now all we're concerned with is how to compute measurements across equalities.

As an example: To determine the distance along the centerline from sta. 415+00 to sta. 420+00, proceed as follows:

Start at one end and measure up to the equality using the value on the same side of the line as your starting point -
from sta. 415+00 to sta. 417+22.60 = 222.60'.

Now start with the value on the other side of the line and measure to your destination -
from sta. 417+41.79 to sta. 420+00 = 258.21'.
for a total of 480.81'.

So the total distance from station 415+00 to sta. 420+00 is not 500' as you might expect at first glance.

In other words, you have a negative equality, and the length of that equality is minus 19.19 feet.

Take another look at the equality. Notice that one side of the equality says POT 417+22.60 B'K (BACK) and the other, 417+41.79 A'HD (AHEAD).

Always subtract your AHEAD station from your BACK station. This is true even if your AHEAD station is larger. For example:

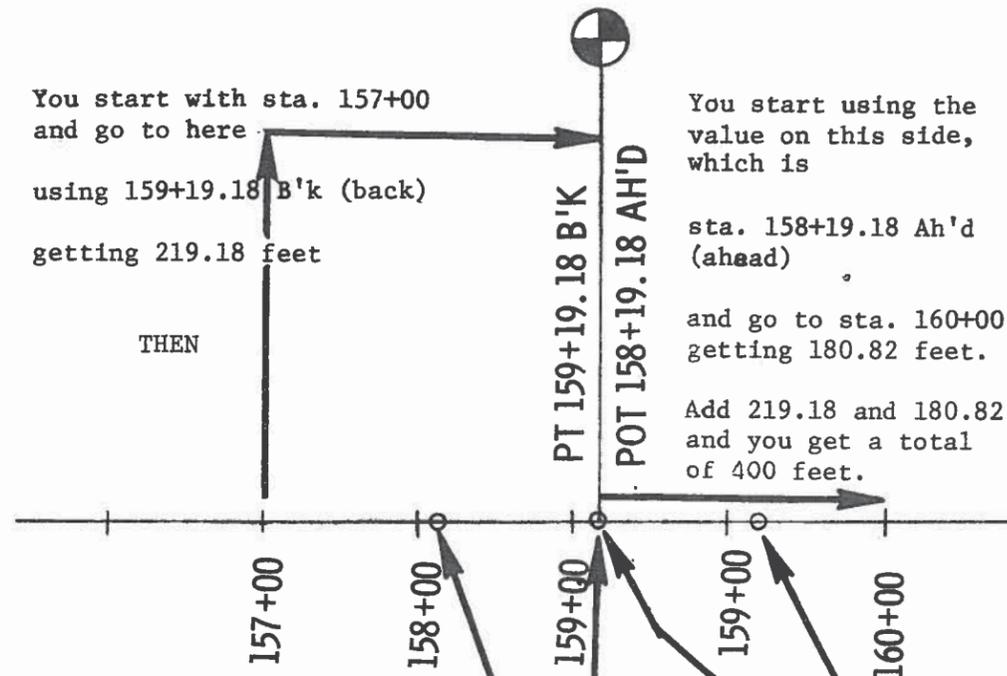
You can't really subtract this way, SO merely reverse the figures and note a minus answer (a negative equality).

417+22.60 B'K	↔
417+41.79 AH'D	
417+22.60 B'K	
-19.19 feet	

Now, if your AHEAD station is smaller than your BACK station, simply subtract and you will arrive with a plus figure. You now have a PLUS EQUALITY, and an important thing to remember in cases like this is that you will have more than one station with identical numbers.

That is why we use the words BACK (B'K) and AHEAD (AH'D). It prevents confusion.

Let's see how it works. Using the procedure we learned earlier, let's measure the distance from sta. 157+00 to sta. 160+00 on the following diagram together.



Now then, did you notice that there are two stations 159+19.18? And, two stations 158+19.18?

THAT IS WHY YOU TALK ABOUT STA. 159+19.18 B'K AND STA. 159+19.18 AH'D!

Pay particular attention to this when measuring distances involving plus equalities. It is a common cause of error.

Now let's see if you really understand this business about stations ahead and stations back.

17. Determine the distance from station 157+50 to station 158+19.18 B'K in feet. _____

18. Determine the distance from station 159+19.18 B'K to station 158+19.18 AH'D in feet. _____

We mentioned earlier that there are many reasons for using EQUALITIES. Perhaps the following illustration will help explain one of them.

After the centerlines are laid out by the survey party, the alignment of some portions sometimes have to be changed. This requires an increasing or a shortening of distances between certain stations. Where the new line converges with the old line, the station numbers will not agree. This is due to the differences in the distances of the old and new line. To re-survey the entire route to conform to the new length would be a tremendous task, and would require revision of many records.

Instead, it is customary to use what we call EQUALITIES. This requires no changes in the stationing of the undisturbed portions of the highway.

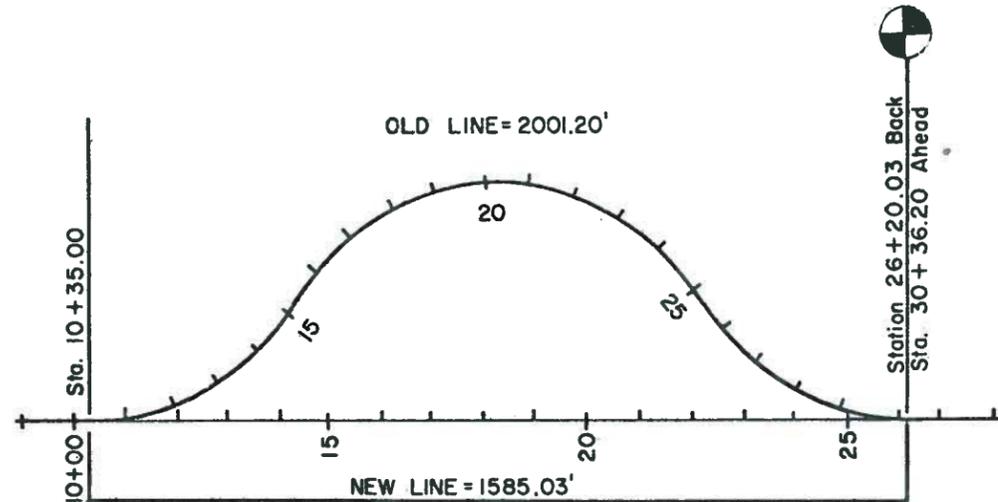
For example: Let's take a curve where the PC is sta. 10+35.00 and which runs 2001.20 feet to the PT at sta. 30+36.20.

It is decided to straighten the highway by projecting a tangent between these two points. The length of this new tangent is 1585.03 feet.

Thus, the station at the point of tie-in of the new line and the old line will become 26+20.03.

This point then is designated as sta. 30+36.20 AH'D and sta. 26+20.03 B'K. Notice that by retaining the old station at 30+36.20 we can continue along the centerline without changing station numbers beyond the point of tie-in.

What we have actually done is taken 416.17 feet out of the centerline. This is illustrated by the sketch below.



Think you've got it now? Well, let's do a little checking to see.

The old line was 2001.20 feet.
 The new line is 1585.03 feet.
 The difference is 416.17 feet.

The PC is sta. 10+35.00. Drop the (+) and we get a distance of 1035.00 feet. By adding the length of the old line which is 2001.20', you end up with 3036.20. Divide by 100, slip your (+) back in and you get sta. 30+36.20.

Do the same thing with the new line length and you end up with sta. 26+20.03.

Now, by subtracting your AH'D sta. from your B'K sta. as previously covered, you'll find the length of your equality is minus 416.17 feet. Simple, isn't it?

Thus far we have examined only the centerline, Let's check out a few other features found on a Plan Sheet.

On some plans you will note the words "proposed easement" with the following symbol: $\begin{matrix} 80' \\ +50 \end{matrix}$

These easement break points are read the same as Right of Way break points which will be covered in a short while.

In the upper left hand corner of each Plan Sheet you will find information as to the ownership of power and telephone poles which may have to be moved in the course of construction. Check the Title Sheet on Page 1 for the appropriate symbol for both power and telephone poles. An arrow attached to either symbol indicates it must be moved to another location.

The following page graphically illustrates other features such as Construction Limits, Right of Way lines, R/W Break Points, Property Lines, Property Owners, and Parcel Numbers. 

Along R/W boundaries you'll note numbers looking like $\frac{40'}{+50}$. These are RIGHT OF WAY BREAK POINTS and are located at each place in the right of way where there is a break (a change in direction or interruption of the R/W line). The top number indicates how far from the centerline the R/W boundary is, plotted at right angles to the centerline; the bottom number indicates the nearest whole back station PLUS additional feet, where that measurement took place. For instance, if a break occurred at sta. 691+50, the figure shown would be +50.

On either side of the centerline you'll notice a series of broken lines which indicate the CONSTRUCTION LIMITS of the project. These will be represented in this manner:

This means that the short dashes indicates a CUT in that particular area; the long dashes indicates a FILL. Together they explain on what portions of the project earth is to be removed, or added, to bring the road up to planned grade.

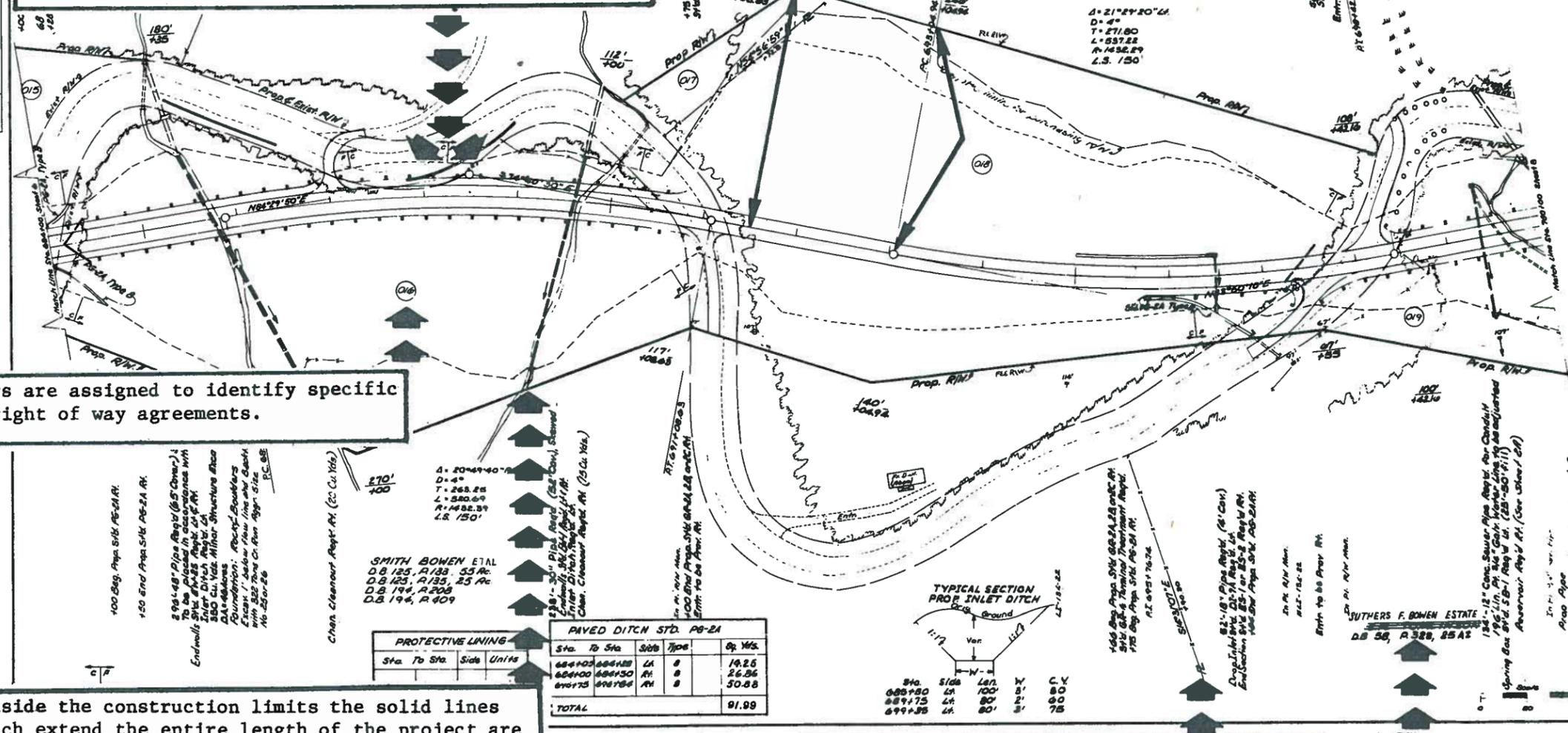
Parcel numbers are assigned to identify specific property in right of way agreements.

Outside the construction limits the solid lines which extend the entire length of the project are called RIGHT OF WAY lines (Symbol - R/W). These lines separate property owned by the Highway Department and that of the adjoining property owners.

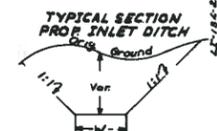
The symbol \mathbb{R} represents a property line. In this case, the property line is a fence. A property line that is not a fence is a dashed line without the "x" marks.

25 The names of the property owners are shown on the plans in large capital letters.

DATE	NOV 19 1966
BY	J. J. ...
CHECKED	...
NOTED	...
REVISIONS	...



Sta.	To Sta.	Side	Type	Sp. Yds.
684+00	684+100	L	A	10.25
684+100	684+150	R	B	26.26
684+150	684+200	R	B	50.88
TOTAL				91.99



SMITH BOWEN ETAL
D.B. 125, R. 133, S. 34 R.
D.B. 123, R. 135, S. 34 R.
D.B. 194, R. 208
D.B. 194, R. 409

SUTHERS F. BOWEN ESTATE
D.B. 58, R. 328, S. 5 A 2

Thus far, in our study of plan reading, we have been concerned only with the PLAN view. From a Plan view, it can be determined whether the road is curving to the right or to the left, or going straight. This is referred to as the horizontal alignment.

Just as roads curve left and right in their horizontal alignment, they sometimes curve up and down. This is known as the vertical alignment.

To study vertical curves we must look at the PROFILE. Remember that we said that we had to look at the highway from one side or the other in order to get a PROFILE (side) view. Turn back to page 10 and take another look at the diagrams for Plan and Profile.

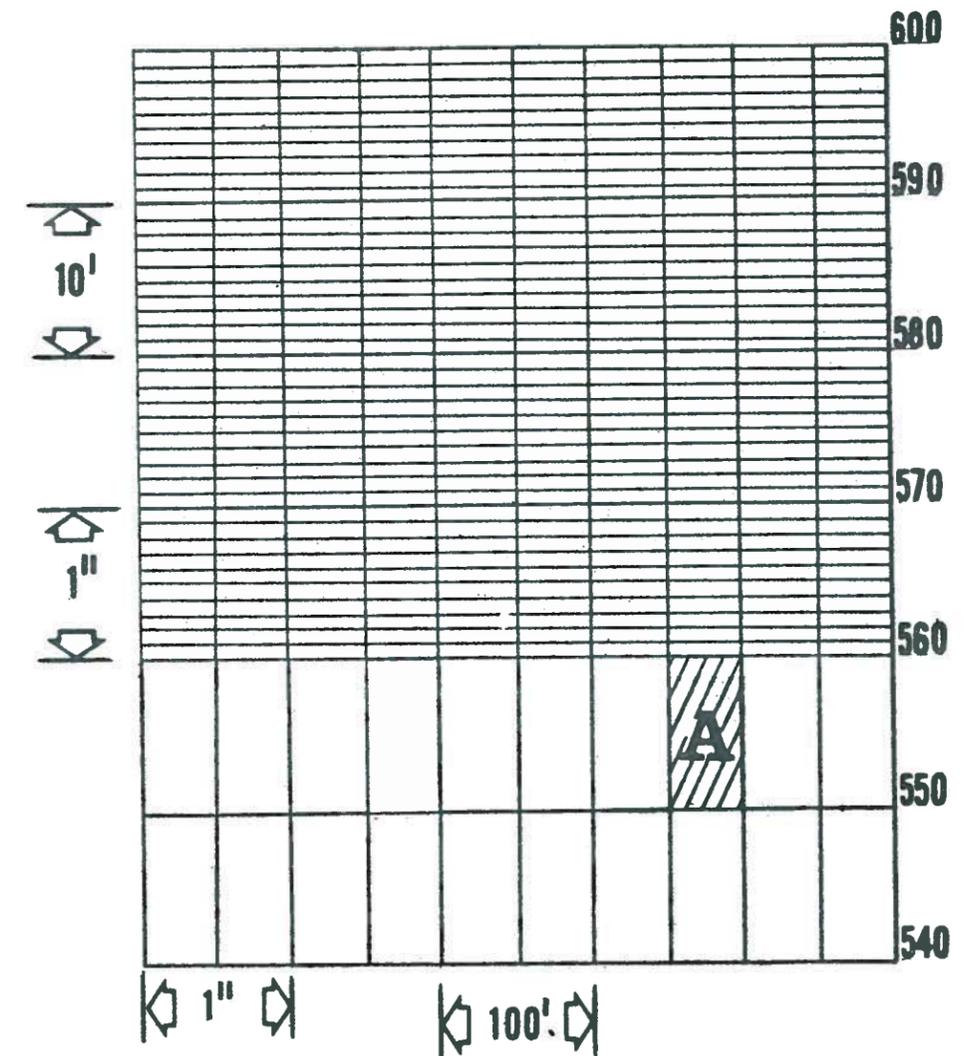
Now turn to page 11 and note the scale drawn in the lower right hand corner. This is commonly called a Horizontal Scale, and is used to compute horizontal distances. Normally full size plans are scaled to 1" equalling 100 feet. Note that on the Title Sheet, page 2, the scale used is 1" equals 2000 feet. The smaller scale in this instance is necessary in order to depict the entire project on one sheet.

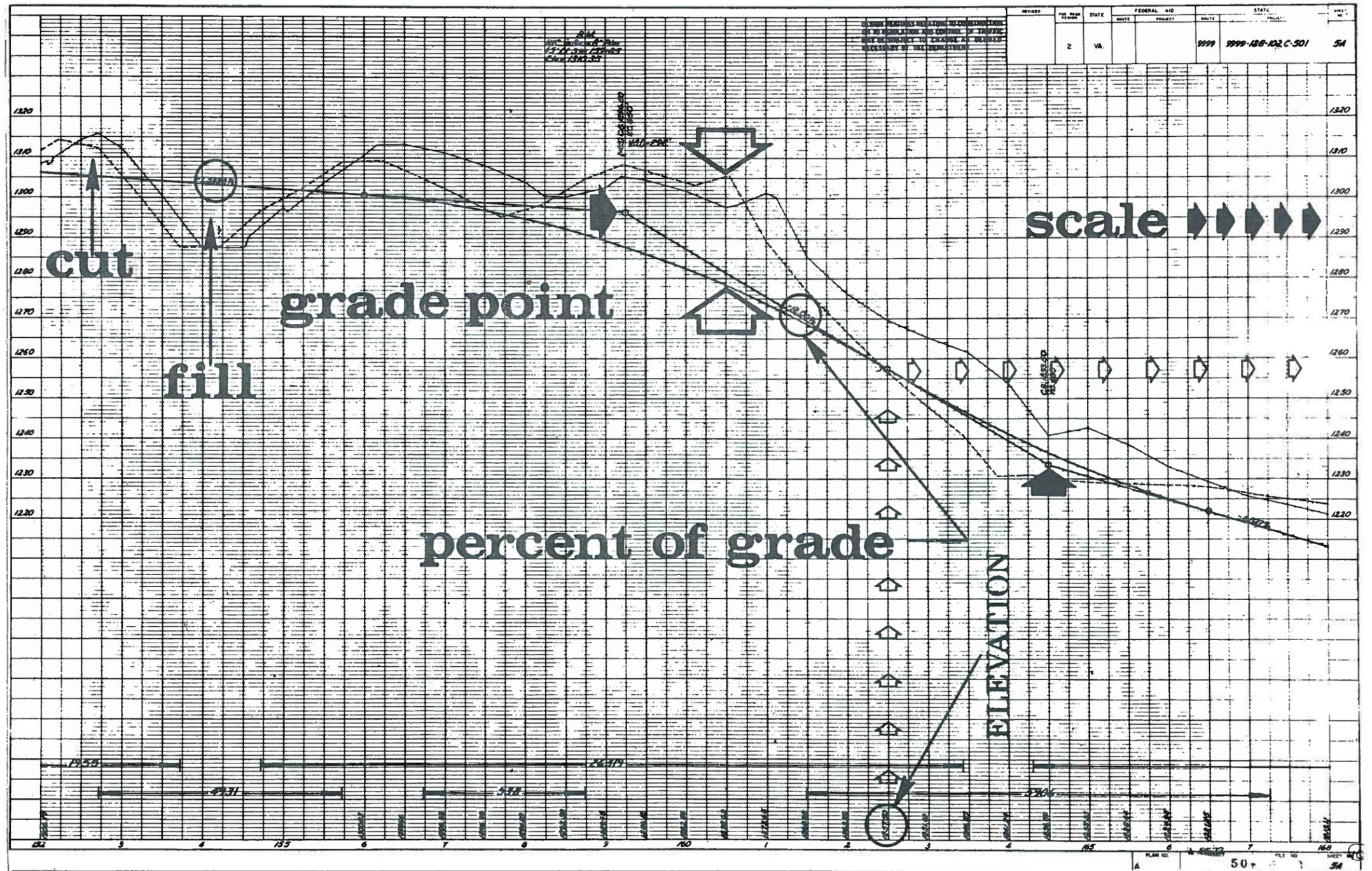
There are times when you will be using reduced size (usually half-size) plans in the field. It is important that you realize that the scale will also be half-size. In other words 1/2" would equal 100 feet.

The horizontal scale is the same for both the Plan and the Profile sheets. In addition, the Profile Sheet has a numerically graduated vertical scale along the left and right margins to measure elevation. This scale is usually 1" equalling 10 feet; however, this is not always so. But a quick glance at the Profile Sheet will tell you just what the scale is for that particular profile.

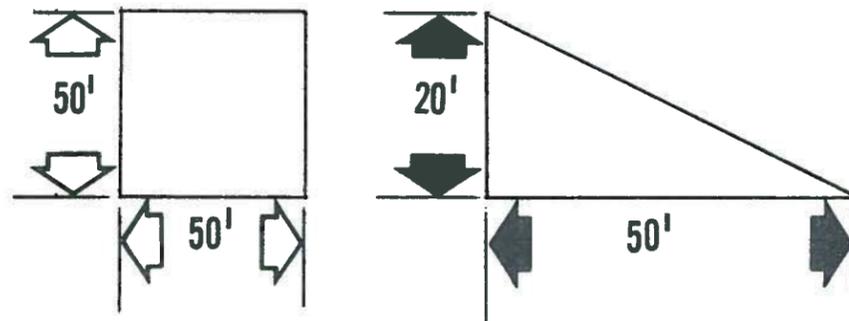
Study the following diagram and determine the horizontal and vertical dimensions of block "A".

If you came up with a 50' horizontal distance and a 10' vertical distance you're catching on. BUT, notice that the height exceeds the width considerably. This exaggeration is necessary in order to amplify existing grade to a point where it is discernible, thus facilitating grading operations.





19. To emphasize this exaggeration, shade in the areas depicted below on the diagram on Page 26.



By now you should understand the exaggeration of dimension (measurement) found on the vertical (up and down) part of the Profile. Because of bumps and curves along the grade which may be extremely small and hard to see, it is necessary to enlarge these by "blowing them up" so they can be readily seen.

Refer now to the Profile Sheet on the opposite page.

In the right and left hand margins locate the numbers 1220, 1230, 1240, 1250, and so on. This is the vertical scale and it indicates the elevation of the existing and proposed grade as determined by some reference point, usually sea level.

At the bottom of the sheet you'll notice a circled figure titled "elevation". Follow the arrows up and over to the vertical scale and you'll see that the point indicated on the grade is at 1257.50 feet.

Beneath this circle are figures across the sheet indicating station numbers. Every station on the profile corresponds to that same station on the plan sheets.

On the left vertical scale at an elevation of 1306' you'll notice a heavy dark line. Trace this line across the profile until it leaves the right side of the profile at an elevation of 1213.11'. This heavy line  represents the centerline (planned elevation) of the road upon completion of the project.

The thin lines entering above the proposed grade line  represent the existing grade. Where these lines are above the proposed grade a CUT is necessary; where these lines are below the proposed grade a FILL is required.

When both the existing and proposed elevations are the same as they are at Sta. 155+20 you have what is known as a GRADE POINT.

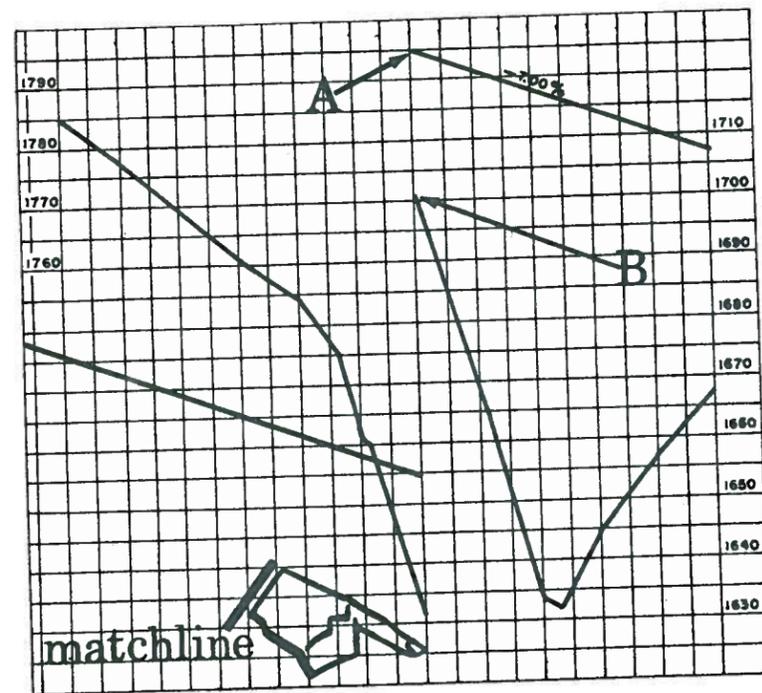
Directly above Sta. 154+25 you'll see a circle with the figures -1.333%. This refers to the percent of grade. All grades that are going downhill are designated negative (-) grades. All grades going uphill are designated positive (+) grades. In this particular instance, the grade is downhill.

The figures indicate that the grade drops 1.333' vertically for each 100' of horizontal plane. This method of calculation is true for all straight grades whether uphill or downhill.

Above Sta. 161+50 you'll notice another circle with the figures -12.00%. Instead of a straight grade, here we have a vertical curve formed by a parabola. The -12.00% indicates a drop of 12' for each 100' of horizontal plane from the point of intersection (PI)  to the point of reverse curve (PRC) .

You'll notice that elevations of 50' intervals are listed for this curve at the bottom of the sheet. Check your vertical scale and you'll find that at Sta. 159+50 the PI is at an elevation of 1296.50'; at Sta. 160+50 the tangent elevation is 1284.50' - a drop of 12 feet.

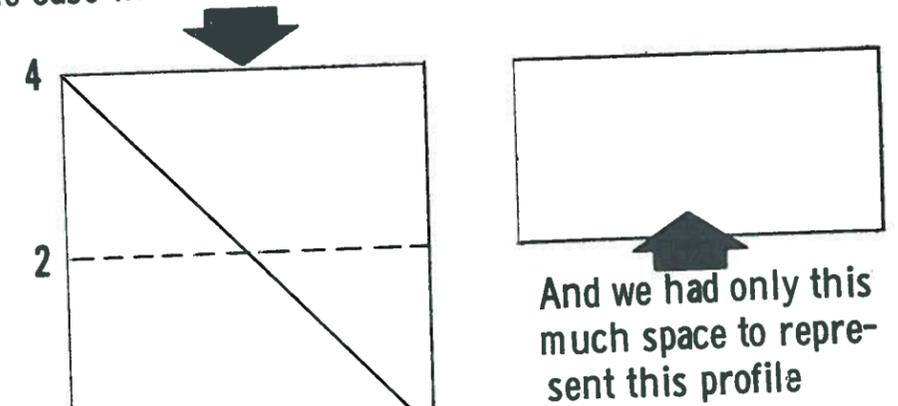
The partial profile below illustrates a break in both the existing grade line and the proposed grade line. Notice that the vertical scales differ from side to side. The reason for this break is that the profile is too steep to illustrate it on our profile sheet. Therefore, we must raise the lower portion to fit within our limits. But to do this we must still have a scale by which to determine the elevation, thus we raise the lower scale also.



If we lowered the righthand profile lines A & B would match the lefthand profile. The matchline merely represents a linear reference point for realignment of the two profiles.

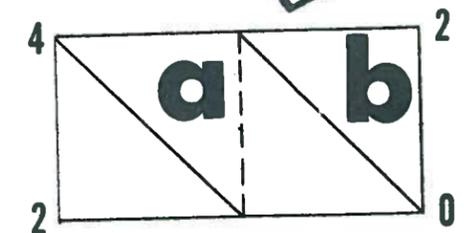
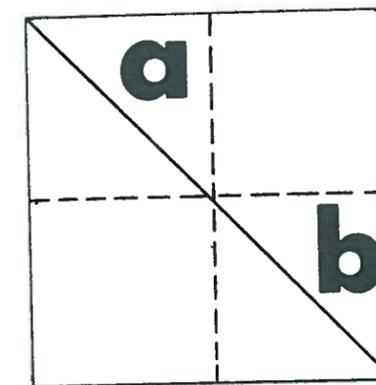
The following diagrams should help you understand this break and the reason for it.

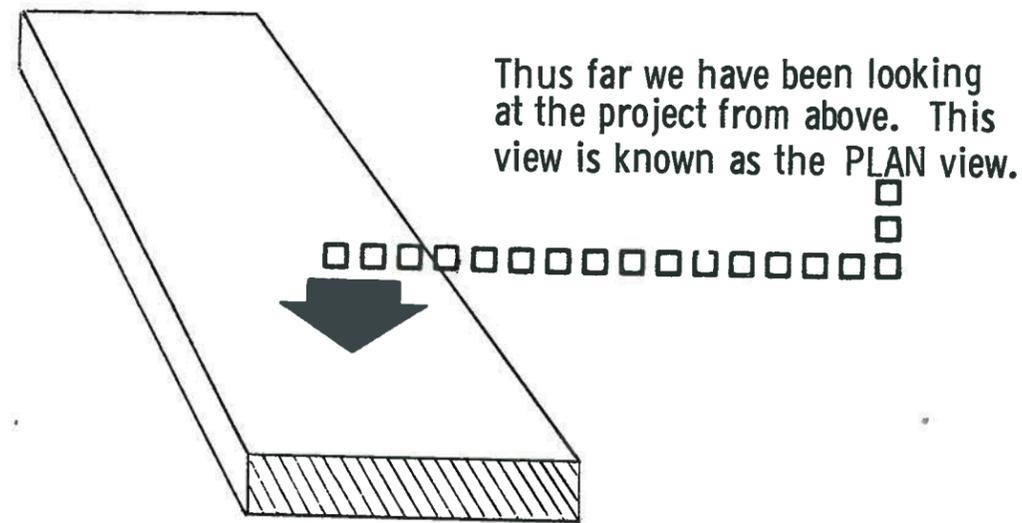
Suppose we had a profile that was extremely steep that necessitated the use of a large area to represent it as is the case in this drawing.



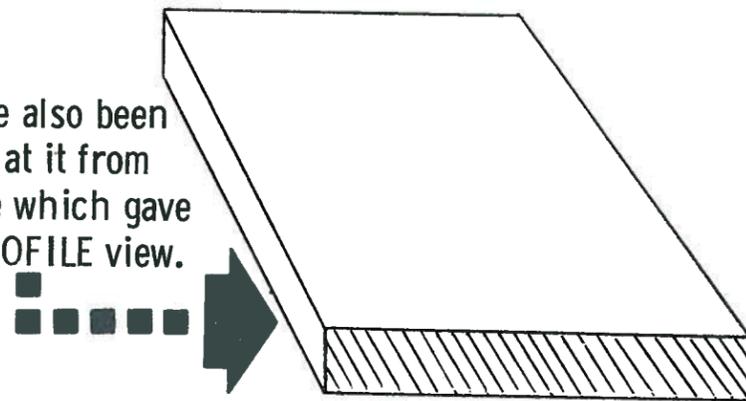
The first thing to do is to find out how much of the line will fit onto the smaller sheet.

By dividing the larger sheet we find that the line is contained in two of the blocks - A and B. The other two are blank. So we place B in the blank space alongside of A. Now we have the entire profile on one sheet, but note that the left scale is from 4' to 2' - the right scale from 2' to 0'.

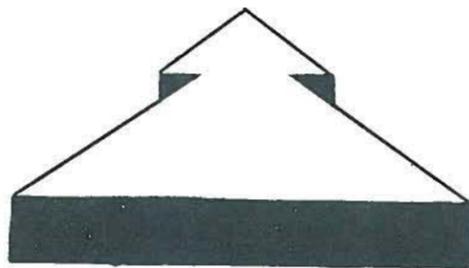




We have also been looking at it from the side which gave us a **PROFILE** view.

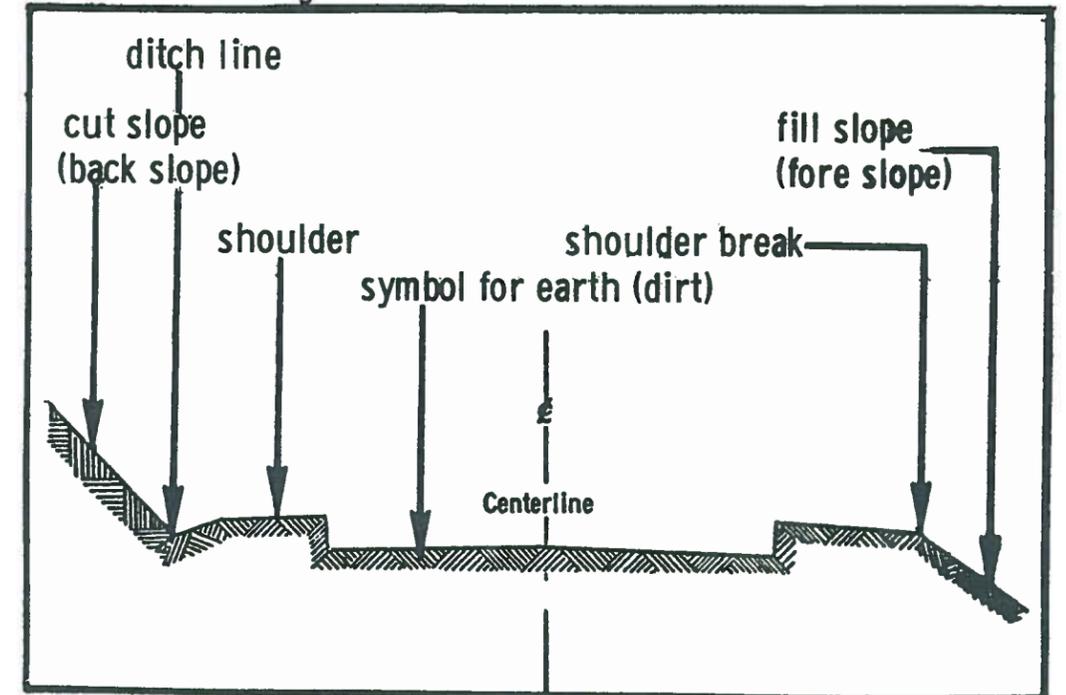


Now, let's look at highway construction from another view. This view is known as the **END VIEW** or **CROSS SECTION**.



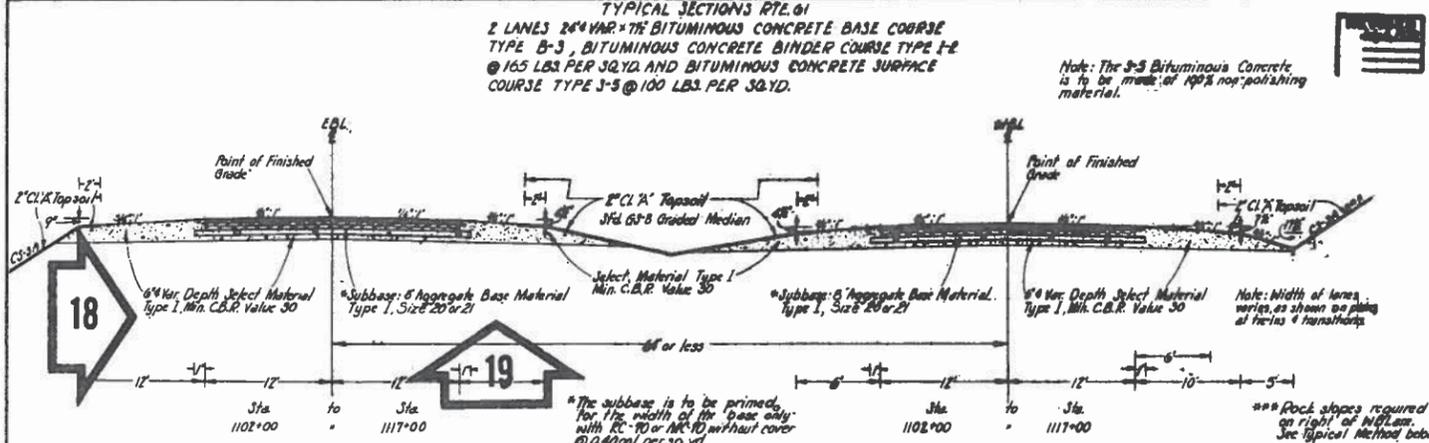
It is necessary at this time to familiarize you with the nomenclature of the highway. The diagram below pinpoints areas that will be of concern to you as you progress through this course.

We will cover plotted cross sections later on to determine and measure the number of cubic yards of cut or fill required to attain a desired grade.



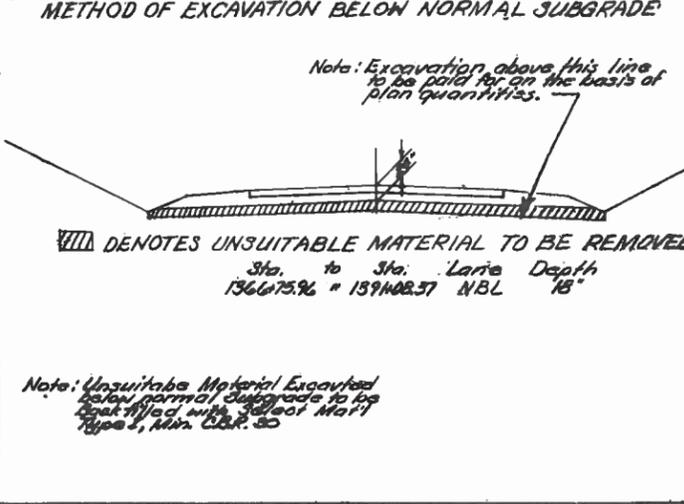
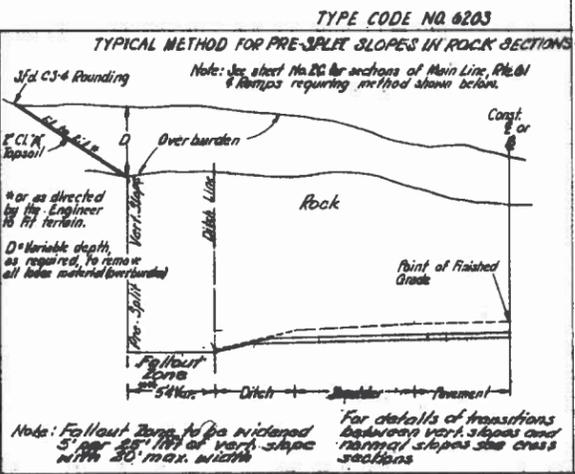
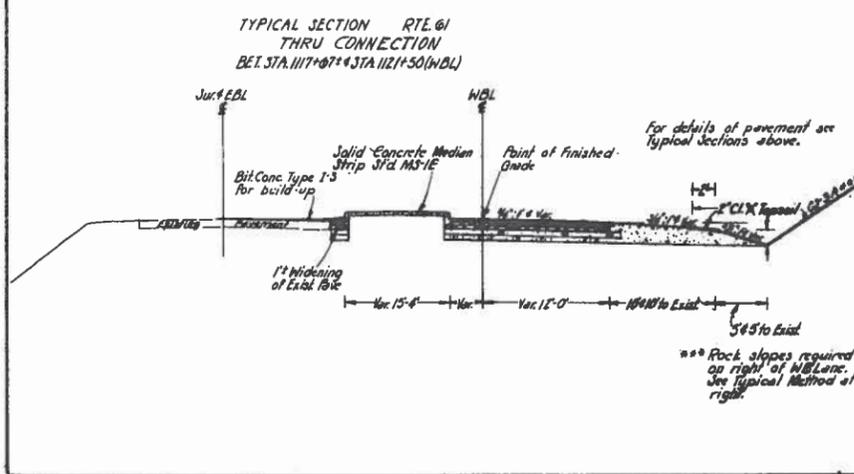
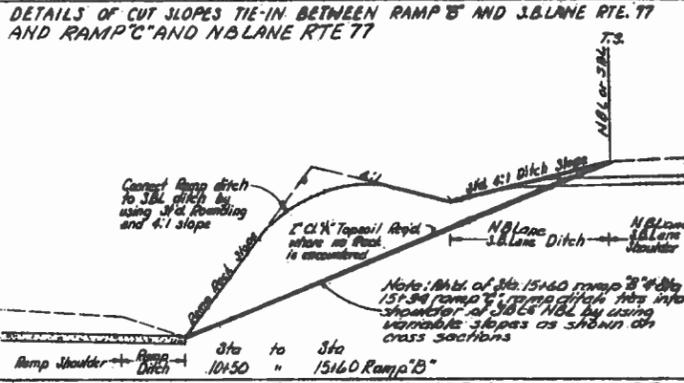
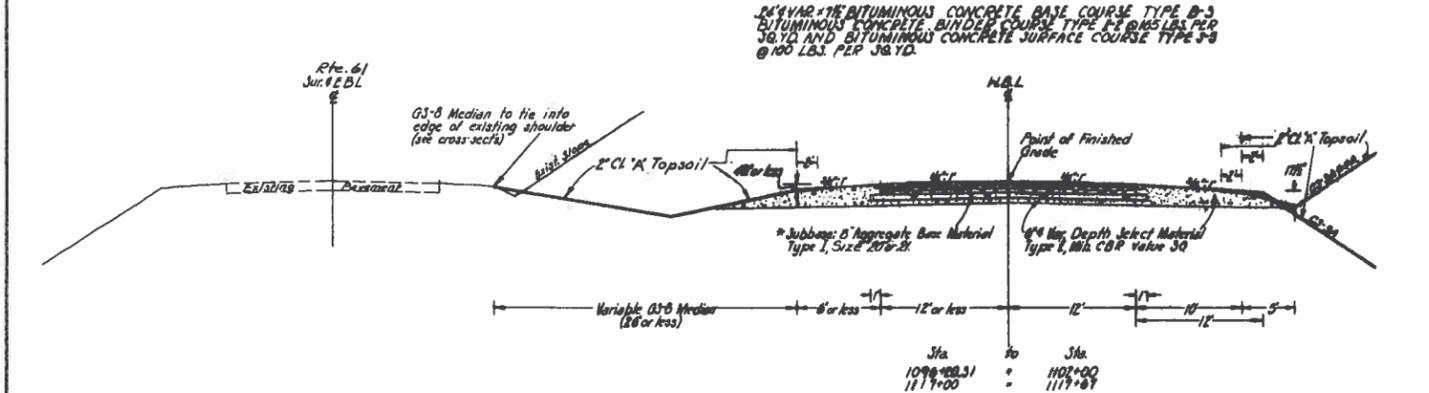
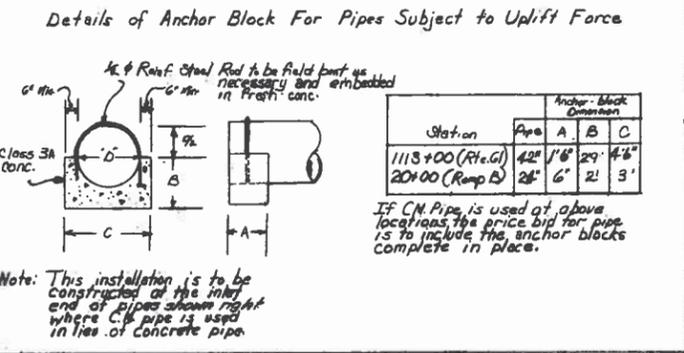
The trench (empty space) between shoulders above is where the **PAVEMENT** will be placed.

You will recall in our study of the Title Sheet that the Index of Sheets listed Typical Section & Summary Sheets. Let's take a good look at a Typical Section now.



DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT.

I-77-11153 77 SUPER-SURFACE C-302 20
 I-77-87754



The TYPICAL SECTION represents the dimensions and details required for the greater portion of the project.

There are several drawings on the TYPICAL SECTION Sheet on the opposite page. For the moment we will be concerned with the drawing in the upper left hand side titled:

TYPICAL SECTIONS RTE 61

2 LANES 24' & VAR. 7 1/2" BITUMINOUS CONCRETE BASE COURSE TYPE B-3, BITUMINOUS CONCRETE BINDER COURSE I-2 @ 165 LBS. PER SQ. YD. AND BITUMINOUS CONCRETE SURFACE COURSE TYPE S-5 @ 100 LBS. PER SQ. YD.

In a moment we'll discuss the meaning of all this. But right now look just below the east bound lane (EBL) to the left and you'll find:

6' & VAR. DEPTH SELECT MATERIAL TYPE I, MIN C.B.R. VALUE 30

This means that you're going to apply or place a six-inch layer of capping material that complies with the requirements of Type I (one) minimum California Bearing Ration of 30. (The full meaning of this is covered in the course on earthwork). VAR (variable) indicates that the thickness will vary in depth in order to raise the shoulders to desired grade.

Just to the right of the centerline you'll see the specification for an 8" Aggregate Base Material, Type I, Size 20 or 21 for the Subbase. The asterisk (*) is a signal that additional information is given regarding the subbase. Look below and to the right where it indicates that the subbase is to be primed for the width of the base only with RC-70 or MC-70 without cover @ 0.40 gal. per sq. yd.

Now we're ready for the paving, so let's go back now to the information listed at the top of the drawing.

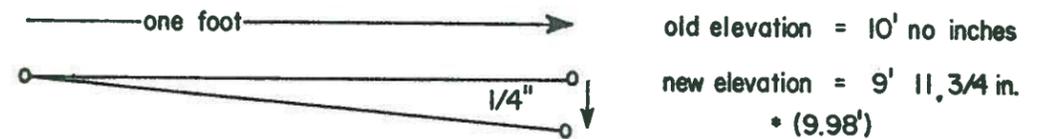
This outlines the requirement that a 7 1/2" Bituminous concrete base course, Type B-3 be placed on top of the subbase. An intermediate layer of Bituminous concrete binder course, Type I-2 will be applied next at a rate of 165 lbs. per sq. yd. Finally, the Bituminous concrete surface course, Type S-5 will be applied at a rate of 100 lbs. per sq. yd.

In the types mentioned, B refers to base course; I refers to intermediate course; S refers to a surface course. Further information concerning the make-up of these courses is contained in the book of specifications which govern the construction of highways in Virginia.

At this point, examine the drawing closely and you'll note that the elevation of the POINT OF FINISHED GRADE is higher than the edge of the pavement. You will also note that the shoulder break is lower than the edge of the pavement.

Just above the pavement, locate the following: 1/4":1'

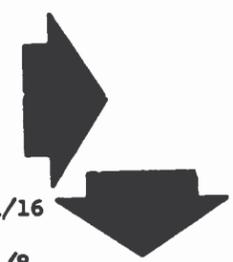
This means that for every one (1) foot along the horizontal you drop 1/4 inch lower than you were on the previous foot. For instance:



Thus, if you were four feet horizontally from the POINT OF FINISHED GRADE at CENTERLINE where the elevation was 10', the elevation of where you are now would be 9 feet, 11 inches.



INCHES AND FRACTIONS OF AN INCH IN DECIMALS OF A FOOT



	0	1	2	3	4	5	6	7	8	9	10	11	
1/16	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9219	1/16
1/8	.0104	.0938	.1771	.2604	.3438	.4271	.5104	.5938	.6771	.7604	.8438	.9271	1/8
3/16	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	.9323	3/16
1/4	.0208	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.6875	.7708	.8542	.9375	1/4
5/16	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	.9427	5/16
3/8	.0313	.1146	.1979	.2813	.3646	.4479	.5313	.6146	.6979	.7813	.8646	.9479	3/8
7/16	.0365	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8698	.9531	7/16
1/2	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583	1/2
9/16	.0469	.1302	.2135	.2969	.3803	.4635	.5469	.6302	.7135	.7969	.8802	.9635	9/16
5/8	.0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7188	.8021	.8854	.9688	5/8
11/16	.0573	.1406	.2240	.3073	.3906	.4740	.5573	.6406	.7240	.8073	.8906	.9740	11/16
3/4	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792	3/4
13/16	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844	13/16
7/8	.0729	.1563	.2396	.3229	.4063	.4896	.5729	.6563	.7396	.8229	.9063	.9896	7/8
15/16	.0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948	15/16
1	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167	1.000	1



BUT, we do not use inches in elevation - we use decimals of feet. Correctly written, the elevation would be. 9.92'.

Let's take a close look into the conversion of inches and fractions of inches to decimals of feet. This is extremely important and must be mastered in order to successfully complete this phase of the plan reading course.

← On the opposite page you will find a table of conversion units. We will use this method of conversion for this course. You will learn to convert mathematically in your math course.

Look at this table and you will see the numbers 0 through 11 running across the top of the table. These numbers represent whole inches.

Now look down the right and left hand sides of this table and you will find a series of fractions which represent fractions of inches.

Place your finger on the 0 and move it down the column. You will notice that you are starting with 1/16 of an inch and increasing until you reach the bottom which is a whole inch. When you come back to the top of the column and place your finger on 1 you are reading 1 and 1/16th of an inch. This column increases until you get to 1 at the bottom. At this time you have 1 inch plus 1 inch, or 2 inches. When you come back to the top and start with 2, you are reading 2 and 1/16th inches. This goes on right across the chart.

The best way to understand this conversion table is to use it.

On page 32 we showed a new elevation to be 9 feet 11 3/4 inches and said that this was equivalent to 9.98'.

Let's see how this value was obtained.

Using the table of conversions, look across the top until you come to 11. Now move your finger down the column until you come to the fraction 3/4. You are reading 11 3/4 inches. Where these two intersect, you will find the value .9792. In other words, 11 3/4 inches = .9792 feet.

Therefore, the 9 feet of the answer, plus the .98 (we only use two places and have thus rounded off) is 9.98 feet.

Now test yourself to see how well you can handle this table.

20. Convert the following fractions to decimal feet. DO NOT LOOK AT THE ANSWERS UNTIL YOU HAVE COMPLETED THIS EXERCISE.

- (a) 6 13/16 inches = _____
- (b) 9 3/8 inches = _____
- (c) 2 inches exactly = _____

NOW CHECK YOUR ANSWERS.

Look at the typical section diagram on page 30. In this diagram, the pavement, base, and select material is left out, and you are looking at the TOP OF EARTHWORK.

At this time we will concern ourselves with the establishment of the POINT OF FINISHED GRADE and of the TOP OF EARTHWORK (also called the subgrade elevation).

The POINT OF FINISHED GRADE elevation may be read from the profile on the PLAN AND PROFILE SHEETS when the particular section under consideration is on a VERTICAL CURVE.

Look at the profile of sta. 162+50 on page 27. This particular portion of the road is in a vertical curve. Along the bottom of the profile you will find numbers every fifty feet which represent the elevation of that particular station. The elevation of sta. 162+50 is 1257.50'.

This means that the POINT OF FINISHED GRADE at the centerline is 1257.50 feet above some reference point. Keep in mind that this elevation refers only to the centerline.

In order to establish the elevation of the subgrade (top of earthwork) we will have to subtract the total thickness of the pavement, base and select material from the elevation of POINT OF FINISHED GRADE.

1" of S-5	1257.50'
1 5/8" of I-2	
7 1/2" of B-3	
8" of Aggregate Base Type I	
6" of select material	
1255.49'	

24 1/8" total pavement, base and select mat'l.

NOTE: The bituminous concrete courses applied at the rates specified for S-5, I-2 & B-3 are of approximate thicknesses shown on the diagram above.

On page 34 we stated that the elevation of the POINT OF FINISHED GRADE of a vertical curve could be read from the profile which indicates the actual elevation at 50-foot intervals.

However, this is true only in the case of a vertical curve. On straight grades (tangents) you must learn to calculate the elevation in a different manner.

Turn back to page 27. There is no elevation given for sta. 154+00 on the bottom of the profile. We can estimate it by looking at the profile scale, BUT, you can't estimate to hundredths of a foot. SO WE MUST CALCULATE THIS ELEVATION.

The elevation of the centerline profile is determined by multiplying the PERCENT OF GRADE by the distance in linear feet from the last KNOWN elevation (written along the bottom of the profile) and subtracting or adding the result obtained from the previous elevation.

Here's what we know:

The last known elevation is 1306.17' at sta. 152+00.

From sta. 152+00 to sta. 154+00 is 200 feet.

The grade is -1.3333%.

Now then, what is the elevation at sta. 154+00?

First, let's convert -1.3333% to decimals - .013333. Remember that for every 100 feet of distance, you'll drop (minus) 1.3333 feet. So, multiply 200 feet by 1.3333 and you'll get 2.6666'. Round this figure out to 2.67' and subtract it from our last known elevation of 1306.17' at sta. 152+00, and you have the elevation of sta. 154+00 --- 1303.50 feet.

You can verify this by checking your scale. In this particular case, it is easily read; however, had the figure been 1303.58, you could never have read the other .08 accurately - that is why we figure it mathematically.

There are several things to be remembered here to prevent error in your computations in the future.

1. When calculating distance make sure that you don't overlook an EQUALITY. This could obviously make quite an error.
2. Make sure that you remember that minus (-) grades are going down and thus you must subtract the vertical drop when on the downhill side of the previously known elevation.
3. Likewise, you must remember that plus (+) grades are going up and thus you must add the vertical rise when on the uphill side of the previous known elevation.

21. Let's see if you've really gotten the knack of computing elevations:

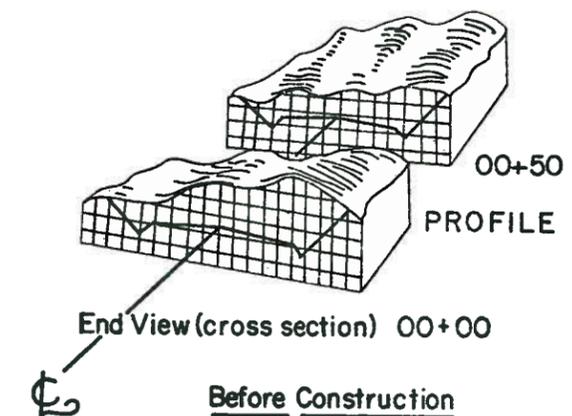
- (a) At sta. 167+50, on page 27, what is the elevation of the centerline? _____.
- (b) What is the elevation of the Point of Grade at sta. 155+18? _____.
- (c) Using the courses listed on page 35, what is the subgrade elevation at the centerline at sta. 160+00? _____.

With some sets of plans you will get a set of PLOTTED (drawn) CROSS SECTIONS.

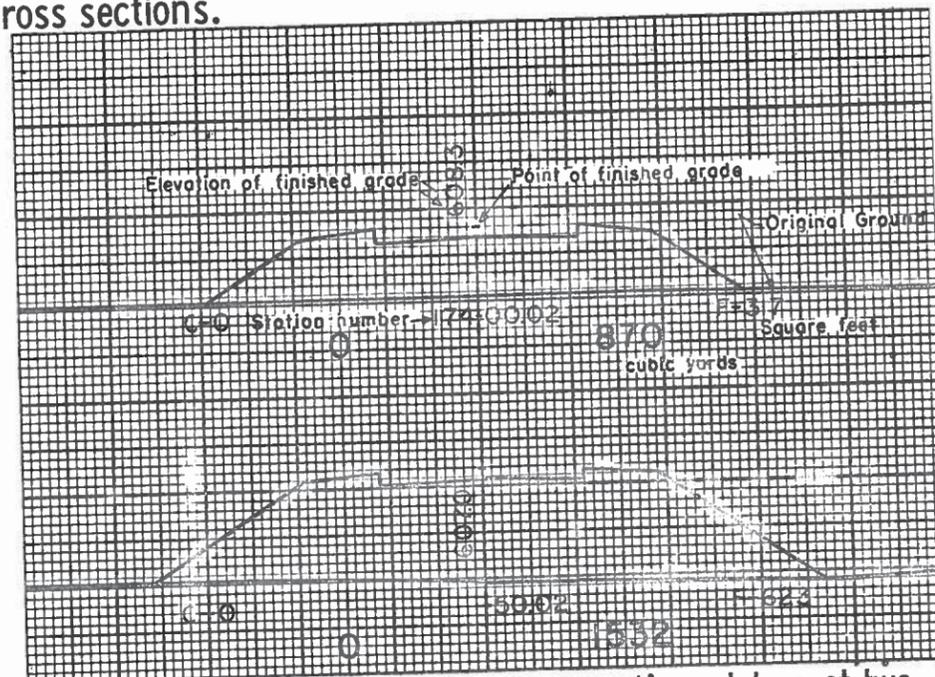
Imagine the road under construction to be like a loaf of bread. Looking at the "heel" of the loaf will give you an end view. Remove the heel and you will get a cross section of the loaf of bread at this point. Imagine each slice of the loaf as occupying fifty (50) feet; one side of the slice will be an even station such as 00+00 and the other side will be 00+50.

So as you remove the slices one at a time you get a cross section view of the highway at fifty-foot intervals.

The following sketch is similar to chunks of earth sliced at 50-foot intervals, along a proposed roadbed. This portrayal is called the cross section. Cross section paper is lined with grid lines so that the road pattern may be drawn thereon according to the typical section dimensions. These cross sections are required in order to determine and measure the number of cubic yards of cut or fill within the limits of the proposed roadway as indicated between the existing ground and the typical section.



The following drawings will help us to understand the use of cross sections.



These two drawings represent cross sections taken at two stations fifty feet apart. The lower drawing is taken at sta. 173+50.02. The Point of Finished Grade is at an elevation of 607.0'. The elevation of the old ground is represented by the line that the typical section is resting on.

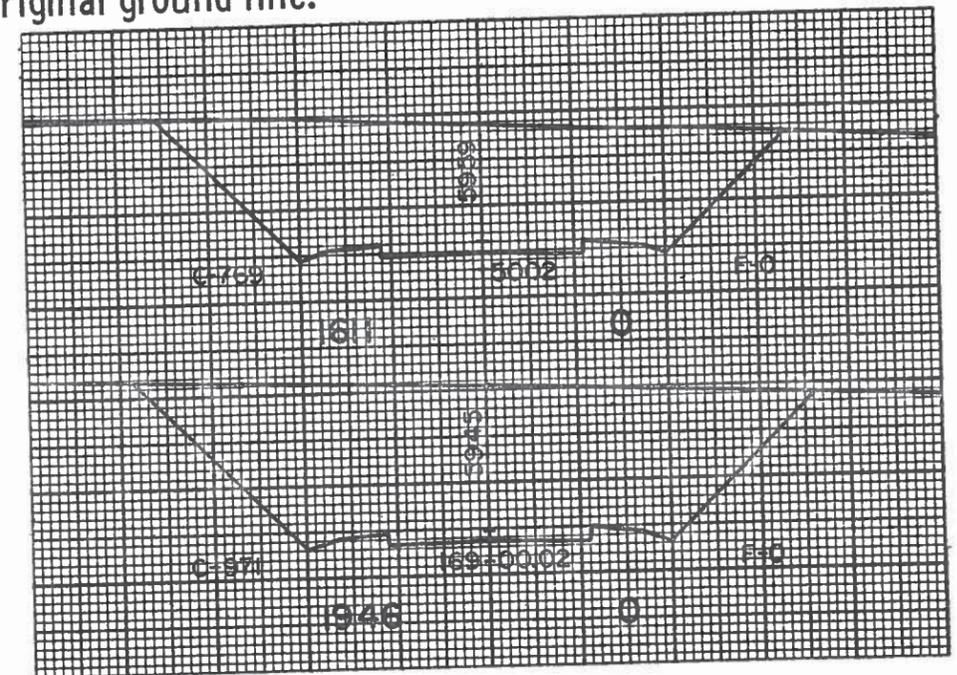
These drawings represent FILL sections along the project.

The cross sections of sta. 174+00.02 show four numbers:

C - 0 (Cut)	F - 317 (Fill)
0	870

C - 0 means that there is no CUT here. F - 317 means that there is a 317 square foot area of FILL at this station. 870 represents the amount of cubic yards of material that is needed for the fill between station 173+50.02 and station 174+00.02.

The diagrams below represent CUT sections of the project. Compare these drawings with the ones for the FILL and you will notice that they are similar except for the location of the original ground line.



22. Answer the following questions from the cross section drawings on this page:

(a) The POINT OF FINISHED GRADE has an elevation of _____ at sta. 169+00.02.

(b) What is the cut area at sta. 169+00.02? _____

(c) What is the fill area at sta. 174+00.02? _____

(d) How many cubic yards of material are there between sta. 169+00.02 and sta. 169+50.02? _____

Suppose we take a look at how we figure the amount of cut or fill required.

First, you must realize that AREA is measured in square feet.

We know the cut area of sta. 169+00.02 is 971 square feet, and the area of sta. 169+50.02 is 769 square feet. To find the average area of the two, we would add the two and divide by two.

$$\text{Thus, } \frac{971 + 769}{2} = \frac{1740}{2} = 870 \text{ Sq. Ft. (average)}$$

Now we must find the volume of the area between the two stations. Our cross section has an average of 870 square feet and there is 50 feet between stations. Therefore, 870 multiplied by 50 = 43,500 cubic feet to be removed from between these stations.

In order to arrive at 1611 cubic yards (this is the unit used as a basis of payment in earthwork) we divide the 43,500 cubic feet by 27, since there are twenty-seven cubic feet in one cubic yard.

There is a formula used to determine the volume of earthwork called the AVERAGE END AREA METHOD. Examine it closely.

$$\text{Volume} = \frac{L}{27} \left(\frac{A' + A''}{2} \right)$$

where L = distance between stations.
A' = area of one station.
A'' = area of second station.
2 gets average of A' & A''.
and 27 converts cubic feet to cubic yards.

Here's what it would look like:

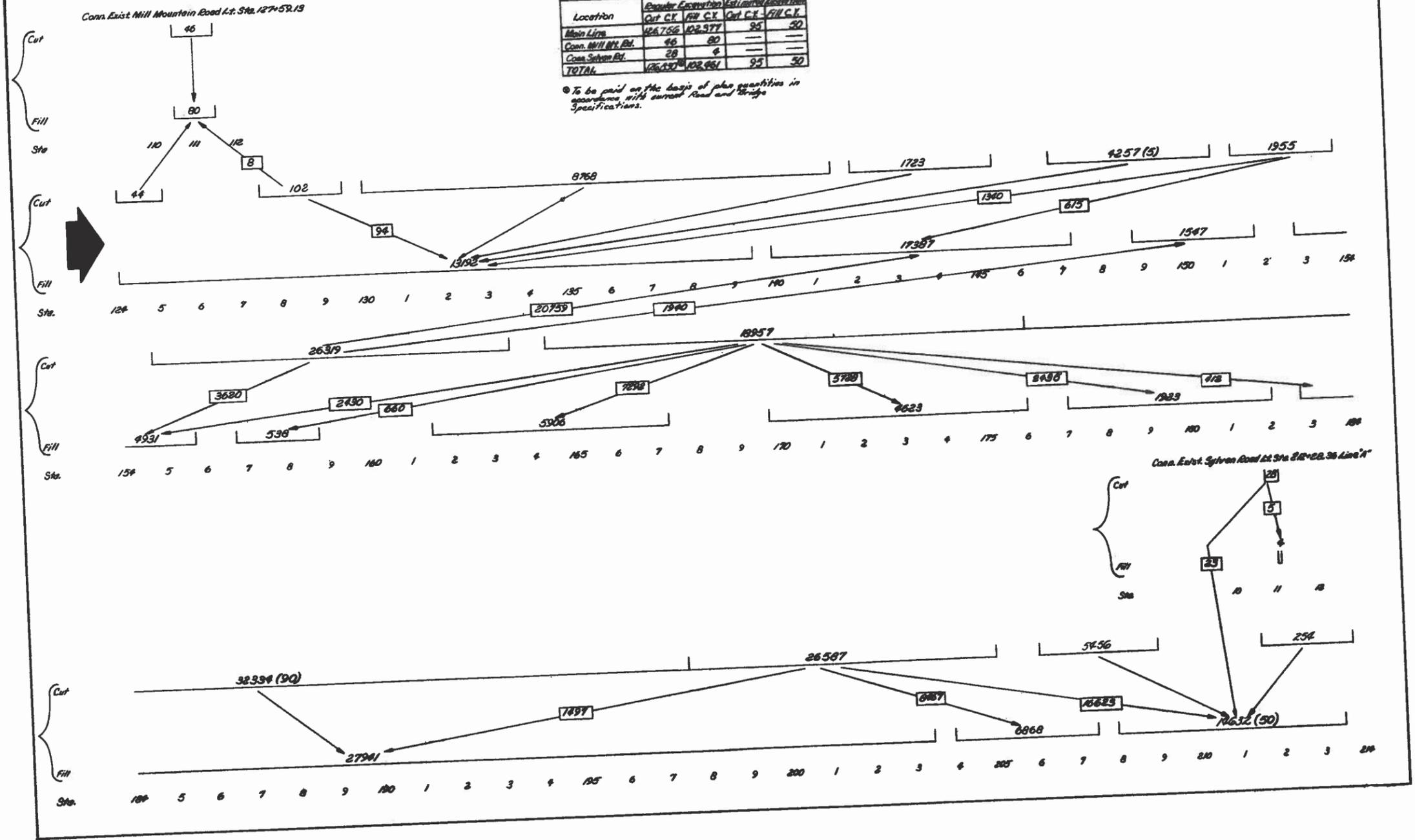
$$\text{Volume (in cubic yds.)} = \frac{50 (971 + 769)}{2 \times 27} = 1611$$

For practice, check the volume of the fill diagram. If you get the correct answer on the first try, consider yourself well on your way to being a success as a young highway employee.



Location	Proposed Excavation		Estimated Filling	
	Cut C.Y.	Fill C.Y.	Cut C.Y.	Fill C.Y.
Main Line	124,756	102,577	95	50
Conn. Mill Mt. Rd.	46	80		
Conn. Sylvan Rd.	28	4		
TOTAL	125,030	102,661	95	50

to be paid on the basis of plus quantities in accordance with current Road and Bridge Specifications.



Plans sometimes have a GRADING SUMMARY which is a breakdown, by location, of excavation required to establish a uniform grade line. This is accomplished by removing high points (CUT) and building up low areas (FILL). In a large number of cases the Grading Summary is supplemented by a Grading Diagram which is schematically illustrated to denote this movement of earth from one point to another. Grading diagrams are not always illustrated in the same manner; in fact, some may bear little resemblance to the diagram shown on the opposite page. However, careful study of variations will show that basically they serve the same purpose.

Not all plans include a grading diagram. In such cases a more comprehensive grading summary is outlined.

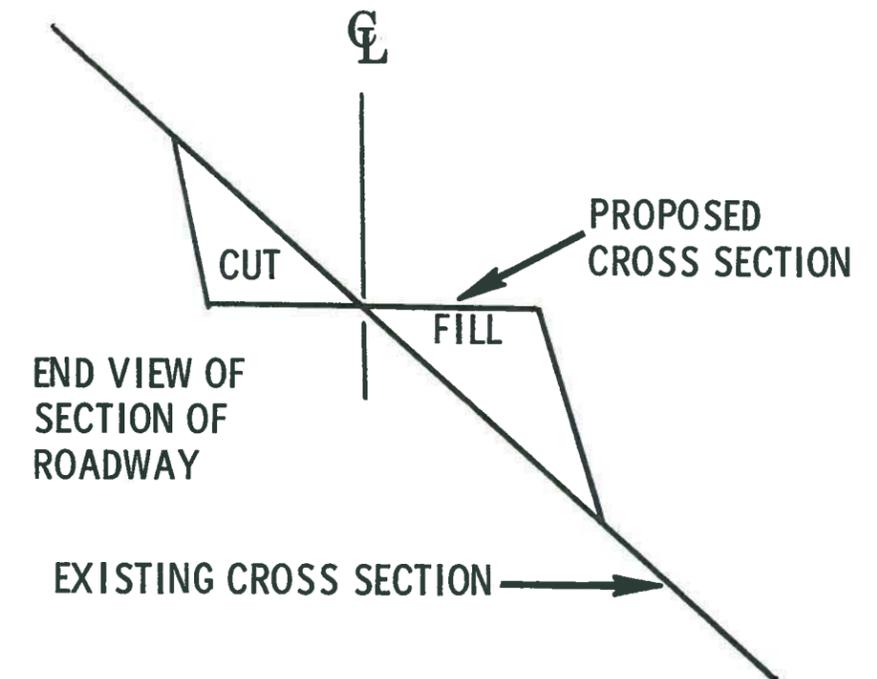
Now for an interpretation of our grading diagram.

On the extreme left you will note the symbol . The horizontal lines to the right of this symbol represent the length along the entire project by station numbers. As the line nears the edge of the page, it is again picked up on the left and continues with succeeding station numbers.

The top line above Sta. #124 indicates CUT required and is represented as 44. This means that 44 cubic yards of a CUT are required between stations #124 and #125. At Sta. #127+50 another cut of 102 cubic yards (102) is indicated extending to Sta. #129+50.

The space between these two cuts requires FILL which is denoted by the lower line. This line, however, also begins at Sta. #124, and we have already said a CUT is required at Sta. #124. This is not meant to be a contradiction. It simply

means that across the width of the right-of-way at Sta. #214 a cut is required at some point while the remaining area requires fill, thus converting existing right-of-way into a relatively level surface for the roadway. For instance, note the following diagram:



At Sta. #127+50 cut 102 has two arrows pointing in different directions. This indicates movement of specified quantities of cut to fill areas. In this case 8 cubic yards is being transferred to one point, while 94 cubic yards are transferred to a different area. In other words, it shows exactly how to make immediate use of the material you have excavated by moving it to an area requiring fill.

The fill required between Sta. #124 and 139+50 is rather extensive. Therefore, excavation material from several points is need to complete the grade. The total fill required is 13,192

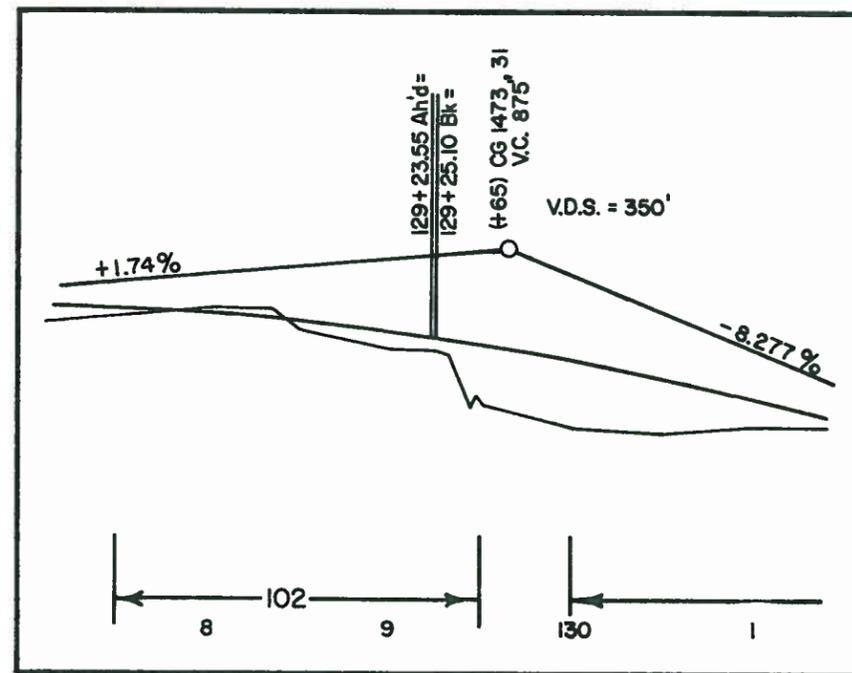
VIRGINIA DEPARTMENT OF HIGHWAYS
LOCATION AND DESIGN DIVISION
VIRGINIA DIGITAL ROADWAY DESIGN

PROJ.
PROJ.

LANE	JOB NO.	REVISION	SEQUENCE NO.	TYPE	CARD NO.	STATION	DATE:		ROADWAY DESIGN (7)												LIST NO.		DRD-1					
							GM=GRADED MEDIAN TS=TEMPLATE SEPARATOR D=AHEAD DESIGN		CHECKED GROUND CROSS SECTIONS (1)												SHEET NO.			1-CHECKED X-SECT.				
							BOB READING XX.XX	GROUND ELEVATION XXXX.XX	POINT NO.	ELEV. XXX.X	DIST. XXX.X	POINT NO.	ELEV. XXX.X	DIST. XXX.X	POINT NO.	ELEV. XXX.X	DIST. XXX.X	POINT NO.	ELEV. XXX.X	DIST. XXX.X	POINT NO.	ELEV. XXX.X			DIST. XXX.X	POINT NO.	ELEV. XXX.X	DIST. XXX.X
4	127	A	1132	1	1	170+00.02		61030		6117	0500		6113	0340		6106	0170		6103	0000		6097	0170		6089	0340		2-A
4	127	A	1132	1	2	170+00.02		61030		6082	0500																	3-O
4	127	A	1132	P	1	170+00.02			32	6114	0386	34	5928	0200	37	5938	0170	38	5943	0110	40	5945	0000	42	5943	0110		4-C
4	127	A	1132	P	2	170+00.02			43	5938	0170	46	5928	0200	48	6088	0360											5-C
4	127	A	1132	X	1	170+00.02			32	6114	0386	34	5928	0200	37	5938	0170	38	5943	0110	39	5931	0110	40	5933	0000		6-GR
4	127	A	1132	X	2	170+00.02			41	5931	0110	42	5943	0110	43	5938	0170	46	5928	0200	48	6088	0360					7-DES
4	127	A	1133	1	1	170+50.02		60880		6104	0500		6100	0340		6095	0170		6088	0000		6080	0170		6074	0340		8-
4	127	A	1133	1	2	170+50.02		60880		6066	0500																	9A-D
4	127	A	1133	P	1	170+50.02			32	6100	0358	34	5942	0200	37	5952	0170	38	5957	0110	40	5959	0000	42	5957	0110		9B-S
4	127	A	1133	P	2	170+50.02			43	5952	0170	46	5942	0200	48	6074	0332											9C-L
4	127	A	1133	X	1	170+50.02			32	6100	0358	34	5942	0200	37	5952	0170	38	5957	0110	39	5945	0110	40	5947	0000		9D-B
4	127	A	1133	X	2	170+50.02			41	5945	0110	42	5957	0110	43	5952	0170	46	5942	0200	48	6074	0332					9E-E
4	127	A	1134	1	1	171+00.02		60510		6071	0500		6066	0340		6060	0170		6051	0000		6042	0170		6030	0340		9F-G
4	127	A	1134	1	2	171+00.02		60510		6024	0500																	9G-R
4	127	A	1134	P	1	171+00.02			32	6065	0309	34	5956	0200	37	5966	0170	38	5971	0110	40	5973	0000	42	5971	0110		9H-T
4	127	A	1134	P	2	171+00.02			43	5966	0170	46	5956	0200	48	6034	0278											9I-U
4	127	A	1134	X	1	171+00.02			32	6065	0309	34	5956	0200	37	5966	0170	38	5971	0110	39	5959	0110	40	5961	0000		9J-V
4	127	A	1134	X	2	171+00.02			41	5959	0110	42	5971	0110	43	5966	0170	46	5956	0200	48	6034	0278					9K-W
4	127	A	1135	1	1	171+50.02		59770		5985	0500		5988	0340		5991	0170		5977	0000		5967	0170		5952	0340		9L-X
4	127	A	1135	1	2	171+50.02		59770		5937	0500																	9M-Y
4	127	A	1135	P	1	171+50.02			32	5990	0220	34	5970	0200	37	5980	0170	38	5985	0110	40	5987	0000	42	5985	0110		9N-Z
4	127	A	1135	P	2	171+50.02			44	5978	0190	49	5963	0212														9O-AA
4	127	A	1135	X	1	171+50.02			32	5990	0220	34	5970	0200	37	5980	0170	38	5985	0110	39	5973	0110	40	5975	0000		9P-AB
4	127	A	1135	X	2	171+50.02			41	5973	0110	42	5985	0110	44	5978	0190	49	5963	0212								9Q-AC
4	127	A	1136	1	1	172+00.02		58340		5736	0680		5753	0510		5770	0450		5809	0340		5840	0210		5838	0170		9R-AD
4	127	A	1136	1	2	172+00.02		58340		5834	0000		5827	0170		5810	0340		5794	0500		5780	0670					9S-AE
4	127	A	1136	P	1	172+00.02			31	5748	0556	36	5992	0190	38	5999	0110	40	6001	0000	42	5999	0110	44	5992	0190		9T-AF
4	127	A	1136	P	2	172+00.02			49	5796	0484																	9U-AG
4	127	A	1136	X	1	172+00.02			31	5748	0556	36	5992	0190	38	5999	0110	39	5987	0110	40	5989	0000	41	5987	0110		9V-AH
4	127	A	1136	X	2	172+00.02			42	5999	0110	44	5992	0190	49	5796	0484											9W-AI
4	127	A	1137	1	1	172+50.02		57290		5744	0670		5738	0500		5735	0470		5722	0420		5728	0250		5724	0240		9X-AJ
4	127	A	1137	1	2	172+50.02		57290		5725	0210		5725	0170		5729	0000		5723	0170		5715	0340		5712	0500		9Y-AK
4	127	A	1137	1	3	172+50.02		57290		5702	0650		5647	0780		5642	0840											9Z-AL
4	127	A	1137	P	1	172+50.02			31	5741	0587	36	6005	0190	38	6012	0110	40	6014	0000	42	6012	0110	44	6005	0190		9A-AM
4	127	A	1137	P	2	172+50.02			49	5702	0643																	9B-AN
4	127	A	1137	X	1	172+50.02			31	5741	0587	36	6005	0190	38	6012	0110	39	6009	0110	40	6002	0000	41	6000	0110		9C-AO
4	127	A	1137	X	2	172+50.02			42	6012	0110	44	6005	0190	49	5702	0643											9D-AP

cubic yards; however, by adding all transferred quantities we find out that it equals in excess of 16,000 cubic yards. This is not an error; the excess is required to make up for a loss which results from compaction of the fill, where in most cases, compaction is greater than that of the cut in the original solid state.

The diagram below is a profile of existing and planned grades between stations #127+50 and #130. By matching this with your grading diagram you can see another view of what is happening. One point you must remember though; the planned profile is that expected at the centerline of the roadway. High or low spots to either side of centerline must be expected - your grading diagram takes this into consideration.



Many times on construction projects, you will be furnished with a set of computer "print-outs" (Such as the one opposite this page) instead of drawn cross sections and road design templates. Once understood, these print-outs can be a great time saving convenience.

Follow the directions in the following exercise very carefully. Check your answers only when told to do so.



23. The line above contains (1) _____ units each of which is one inch long. The \odot symbol is (2) _____ inches from zero or the starting point and is to the (3) _____ of the starting point.
(left, right)



24. The line above contains (1) _____ units each of which is one inch long. The \odot symbol is (2) _____ inches from the origin (zero) and is to the (3) _____ of it.

25. The line to the right is (1) _____ units long and each unit is (2) _____ inch. The symbol \odot is (3) _____ (4) _____ the origin.
(above, below)



26. Draw a \odot symbol 3 inches below zero on the line to the right.

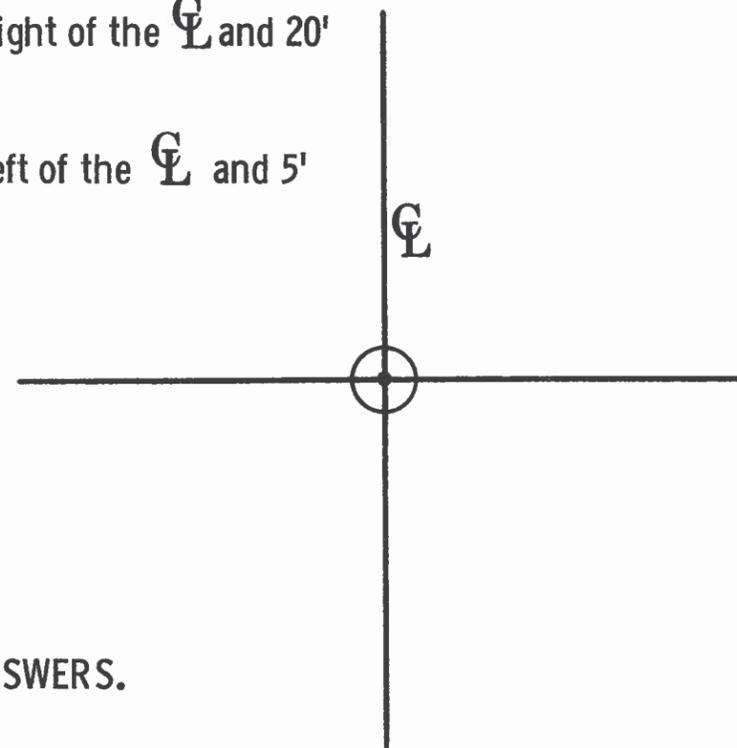
27. Substituting the \mathbb{C} for 0 (zero) and using a scale of 1 inch = 10 feet, place a \odot symbol 15' to the right and 10' to the left of the \mathbb{C} on the line below.



28. Again, on the lines below, using a scale of 1 inch = 10 feet, place a \odot symbol

(a) 10' to the right of the \mathbb{C} and 20' above it.

(b) 15' to the left of the \mathbb{C} and 5' below it.

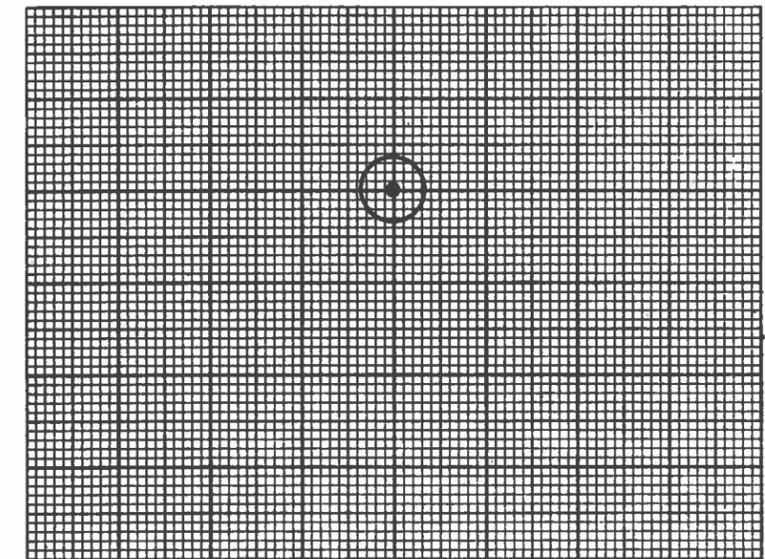


CHECK YOUR ANSWERS.



29. On the graph below, there are (a) _____ large blocks across the top and (b) _____ how many large blocks from top to bottom. There are (c) _____ small blocks inside ONE large block.

Assuming that each large block is one inch by one inch, and a scale of 1 inch = 10 feet, each of the small blocks would be (d) _____ ft. long and (e) _____ ft. high.

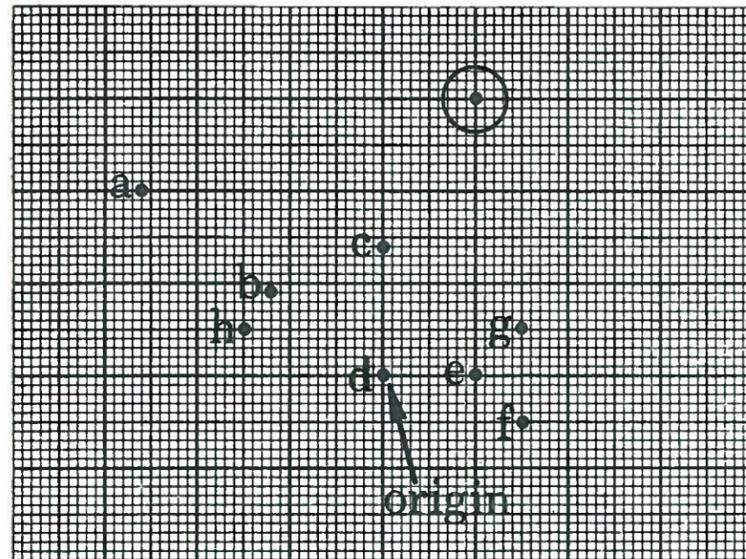


30. Using the \odot on the graph above as a starting point, plot the following points and connect these points with a straight line between each two points.

- (a) 30'L, 10' above
- (b) 20'L, 3' below
- (c) 15'L, 0' above or below
- (d) 10'L, 0' above
- (e) 2' above origin
- (f) 10'R, 1' above
- (g) 15'R, 0' above or below
- (h) 20'R, 0' above or below
- (i) 30'R, 0' above

CHECK YOUR ANSWERS

The drawing that you just completed by connecting the points should look familiar to you as a cross section of a roadway. If you follow these fundamental rules about drawing cross sections, you will have no trouble reading Computer cross sections and road designs.



31. On the graph above, there are several points labeled (a), (b), etc. In the space provided below, give the values of these points. (Again, assume each block is 1 inch x 1 inch.

Example:  = ELEV. 30' DIST. 10'R

POINT NO.	ELEV.	DIST.															
XXX.X	XXX.X	XXX.X															
A			B			C			D			E			F		
G			H														

32. From the preceding table that you have just completed, there are two points which are the same distance from the centerline and on the same side. These are points (a) _____ and (b) _____.

There are two points which are the same elevation and the same distance from the centerline but on opposite sides. These are points (c) _____ and (d) _____. There are two points with the same numerical value for the elevation but one elevation is plus and the other is minus. Also these two points are the same distance from the centerline. These two points are (e) _____ and (f) _____.

From the table that you completed, you should now be able to realize that the vertical lines of the graph represent distances to the left and right of a specific point. DISTANCES ARE MEASURED HORIZONTALLY FROM THE VERTICAL LINE THAT GOES THROUGH THE ORIGIN. IN HIGHWAY WORK THIS VERTICAL LINE REPRESENTS THE CENTERLINE (C) AND ALL DISTANCES ARE MEASURED TO THE LEFT AND RIGHT OF THIS CENTERLINE.

The horizontal line that passes through the origin represents a specific elevation. ELEVATIONS ARE MEASURED VERTICALLY FROM THIS HORIZONTAL LINE THAT GOES THROUGH THE ORIGIN. IN HIGHWAY WORK THIS HORIZONTAL LINE REPRESENTS A SPECIFIC ELEVATION AND ALL ELEVATIONS ARE MEASURED ABOVE AND BELOW IT, IN FEET.

At this point, let's take another look at the computer print-out sheet on the following page. 

Move across the columns at the top of the sheet until you get to the column marked STATION.

LINE	JOB NO.	REVISION	SEQUENCE NO.	TYPE	CARD NO.	STATION
4	127	A	1132	1	1	170+00.02
4	127	A	1132	1	2	170+00.02

Then, move down the column until you locate 170+00.02.

Now, move two columns to the right under

GROUND ELEVATION
XXXX.XX (Shows position of the decimal point in the numbers in this column.)

VIRGINIA DEPARTMENT OF HIGHWAYS
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STATION	DATE:	ROADWAY DESIGN (7)												LIST NO.	
		CHECKED GROUND CROSS SECTIONS (I)												SHEET NO.	
ROAD READING	GROUND ELEVATION	ELEV.	DIST.	ELEV.	DIST.	ELEV.	DIST.	ELEV.	DIST.	ELEV.	DIST.	ELEV.	DIST.	ELEV.	DIST.
170+00.02	61030	6117	0500	6113	0340	6106	0170	6105	0000	6097	0170	6089	0340		
170+00.02	61030	6082	0500												

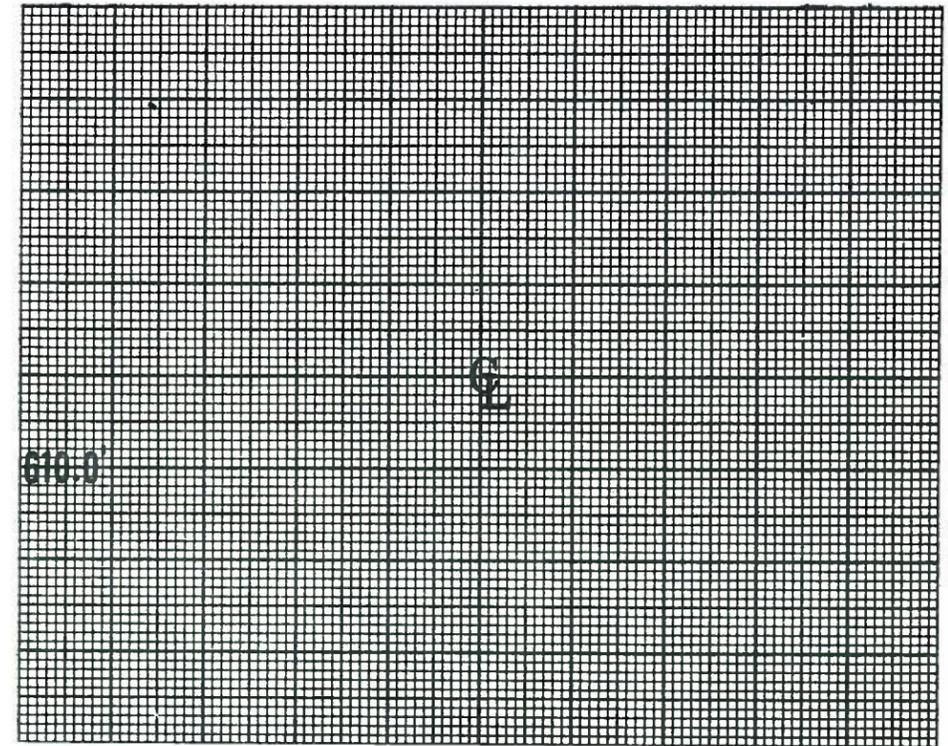
Locate 61030. All numbers in this column are 5 digits and represent the elevation of the original ground at the centerline to the nearest 0.01 (hundredth) of a foot.

Therefore, 61030 is really 610.30 feet.

For the purpose of explanation in the following exercise, we are going to use this elevation of 610.30' as the elevation of our horizontal reference line, which is called the ELEVATION.

33. On the graph opposite, place a \odot at the place on the graph which represents the elevation of the GROUND CENTERLINE OF STATION 170+00.02.

(Assume that each large block is 1" x 1" and the scale is 1" = 10'.)



(a) Move over to the next major column on the right:

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LOCATION AND DESIGN DIVISION
VIRGINIA DIGITAL ROADWAY DESIGN

STATION	DATE:	ROADWAY DESIGN (7)												LIST NO.	
		CHECKED GROUND CROSS SECTIONS (I)												SHEET NO.	
ROAD READING	GROUND ELEVATION	ELEV.	DIST.	ELEV.	DIST.	ELEV.	DIST.	ELEV.	DIST.	ELEV.	DIST.	ELEV.	DIST.	ELEV.	DIST.
170+00.02	61030	6117	0500	6113	0340	6106	0170	6105	0000	6097	0170	6089	0340		
170+00.02	61030	6082	0500												

Locate the ELEV. and the DIST. again noting the position of the decimal point as indicated by the XXX.X.

XXX.X
6117

XXX.X
0500

These 4 digit numbers are read to the nearest 0.1, thus:

ELEV. 6117 = 611.7', and,

DIST. 0500 = 50.0' (Assume this distance to be left of the centerline, for the time being.) Plot this point on the graph above.

- (b) Move over to the next ELEV - DIST column.
 The Elev. is (1) _____ and the Dist. is (2) _____.
 Plot this point on the same graph (again assuming the distance to be left of the centerline).
- (c) Plot the Elev-Dist of the next column on the graph as you did in the previous step.
- (d) In plotting the next column you'll notice the Point No. is 40 and the Dist. is 0000. THIS IS YOUR CENTERLINE.
 Normally, on all single lane highways, point 40 is the dividing line between left and right of centerline. On double lane highways the dividing point is usually 60. However, the zero distance (0000) is the determinate in all cases.
- (e) Plot the next column to the right.
- (f) Plot the last column to the right.
- (g) Drop down one line on the computer print-out and start in the left hand ELEV. DIST. column and plot that point.

CONNECT THESE POINTS. The line that results is the cross section of the original ground line.

CHECK YOUR ANSWERS.

34. Drop down to the third line on your print-out sheet and give the elevation of the centerline _____.

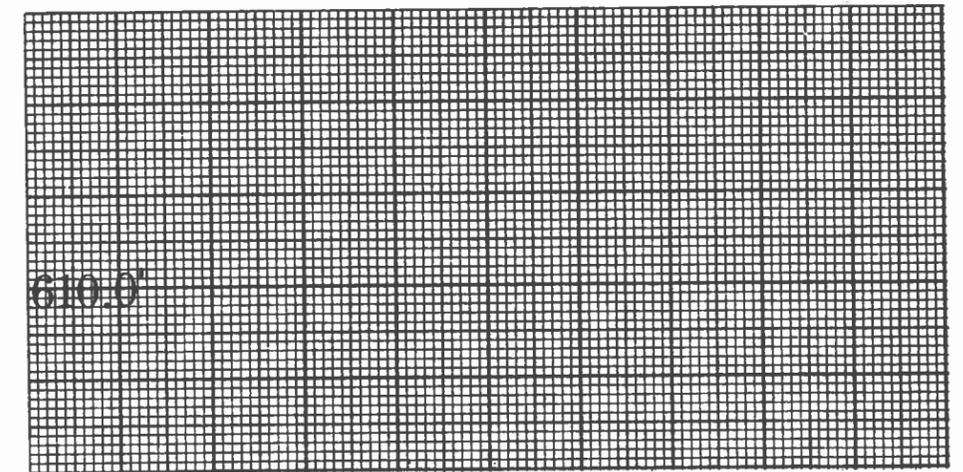
TYPE	CARD NO.	STATION	DATE:		ROADWAY DESIGN (7)												LIST NO.						
			TS-TEMPLATE SCHEMATIC		CHECKED GROUND CROSS SECTIONS (1)												SHEET NO.						
			ROAD READING	DATE	ELEV	DIST	POINT NO	ELEV	DIST	POINT NO	ELEV	DIST	POINT NO	ELEV	DIST	POINT NO	ELEV	DIST					
P 1		170+00.02			32	6114	0386	34	5928	0200	37	5938	0170	38	5943	0110	40	5943	0000	42	5943	0110	
P 2		170+00.02			43	5938	0170	46	5928	0200	48	6088	0360										

Remembering this particular column as the dividing line between the left and right sides, plot the points (ELEVATIONS AND DISTANCES) as shown. Plot on the graph provided on page 46.

When you have completed the plotting, connect the points with straight lines.

CHECK YOUR DRAWING, POINT BY POINT, WITH THE ANSWERS.

35. At this point, drop down to lines 5 and 6 of your print-out and plot the points on the graph provided below. Label each point with the point number that just precedes the column being plotted. CHECK YOUR ANSWER.



CONGRATULATIONS! You have just completed the first level of basic HIGHWAY PLAN READING. You have had much material presented to you in a very short time. If you have mastered this much, however, you will be better equipped to proceed to the next level.



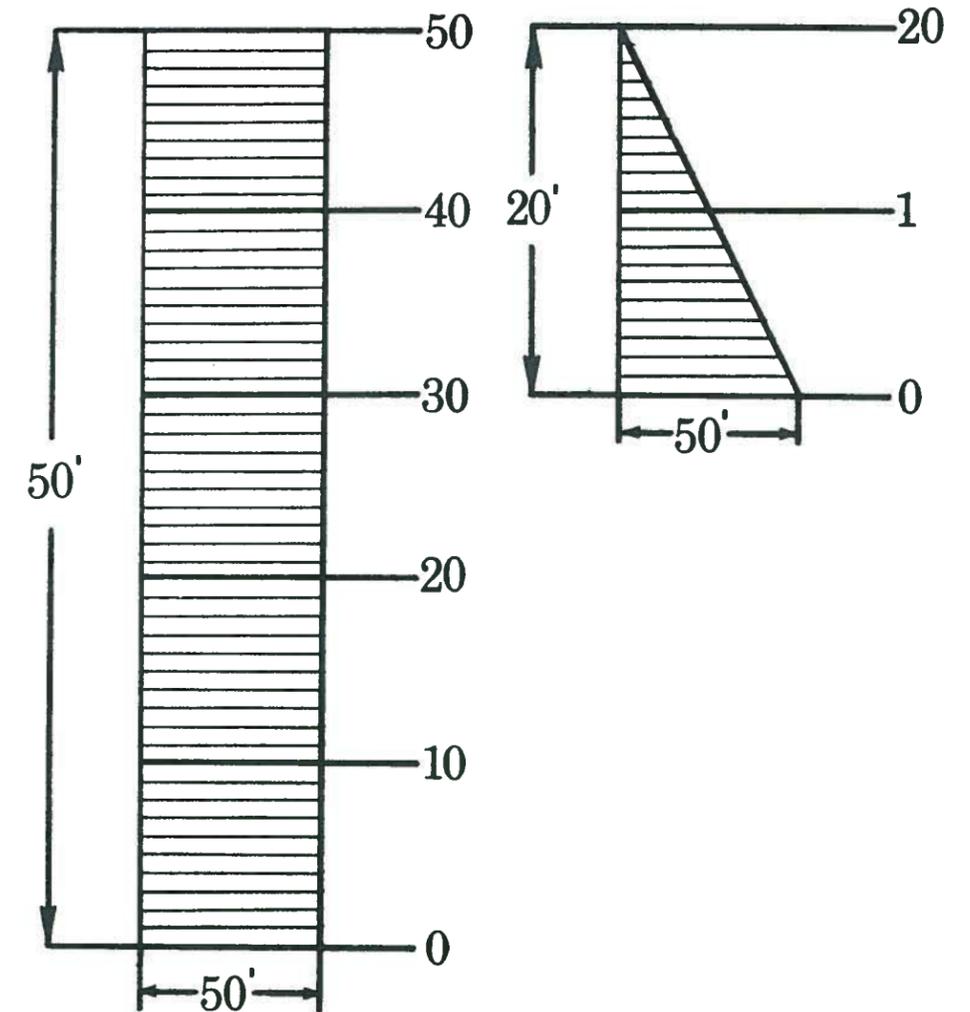
ANSWERS

1. 293+46.91 Ah'd and 438+09.71.
2. 10 - 10A
3. TC-2
4. 14,026.31 feet, 2.656 miles
5. 400 feet
6. 30+70
7. 10 feet
8. 759+50, 100' RT of \underline{CL}
9. BACK
10. 187+82.22
11. SOUTH
12. S $74^{\circ} 14'$ E
13. DEFLECTION, 46°
14. 1909.86
15. (a) 1533.33
(b) 1909.86
(c) 46°
16. 1. PI, 2a. T, 2b. T, 3. L, 4. PC, 5. PT, 6. R,
7. 

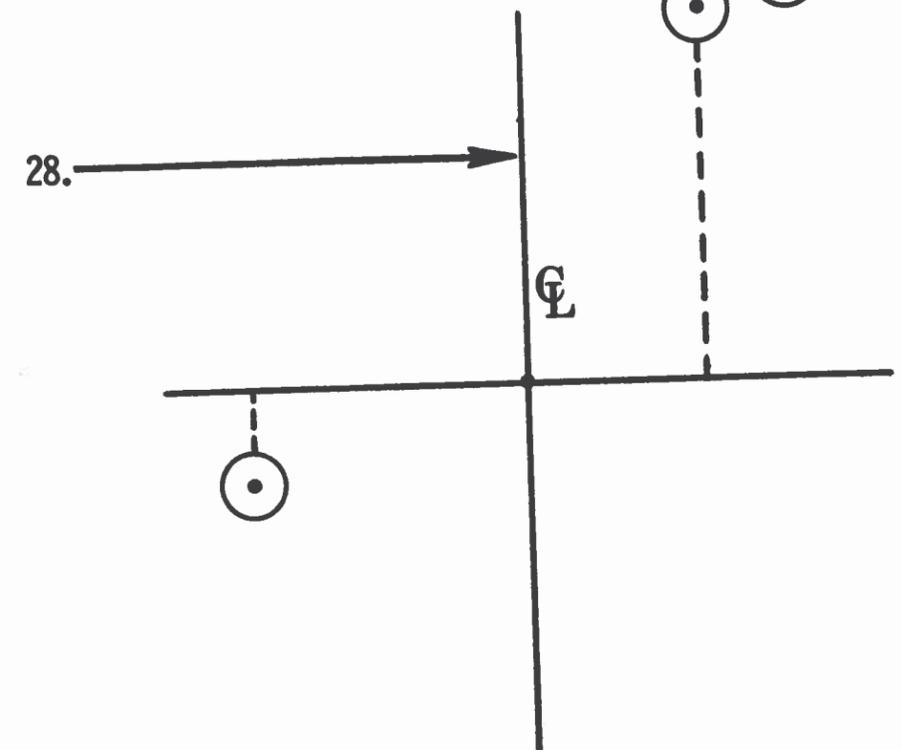
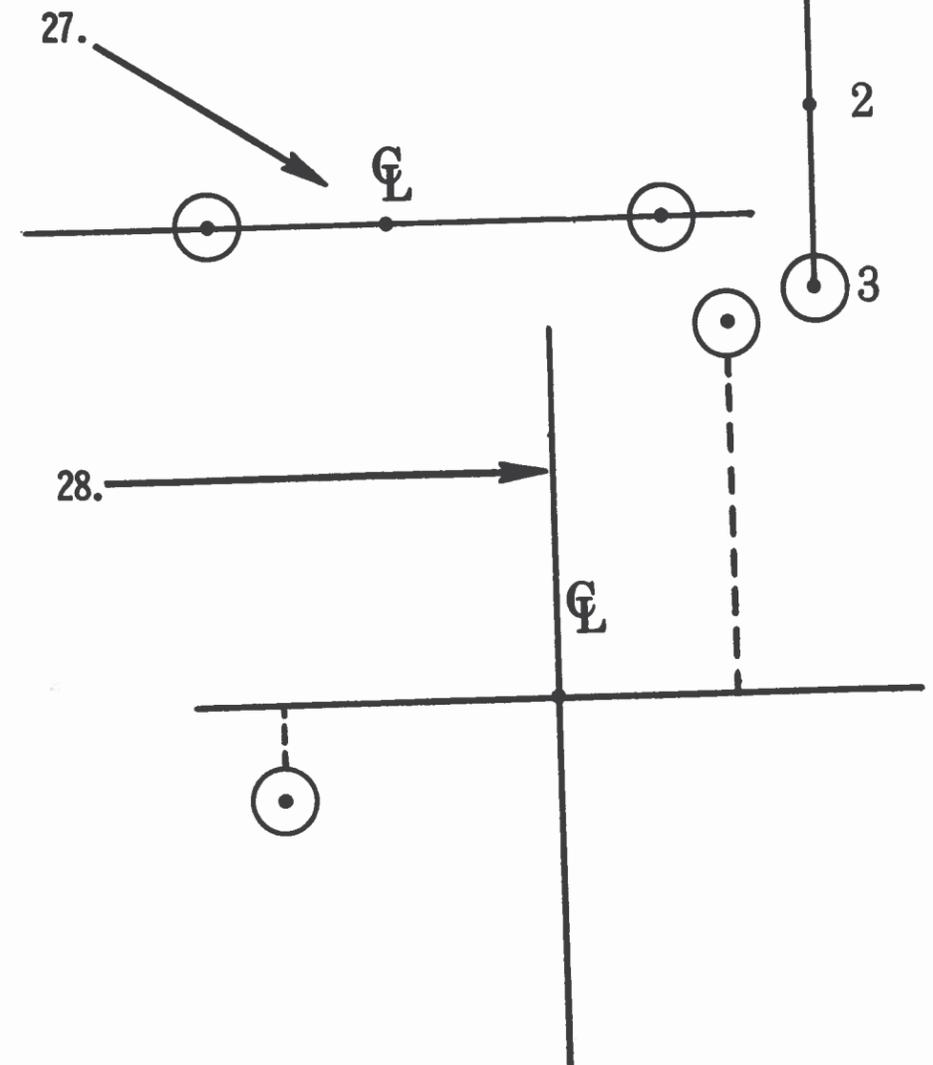
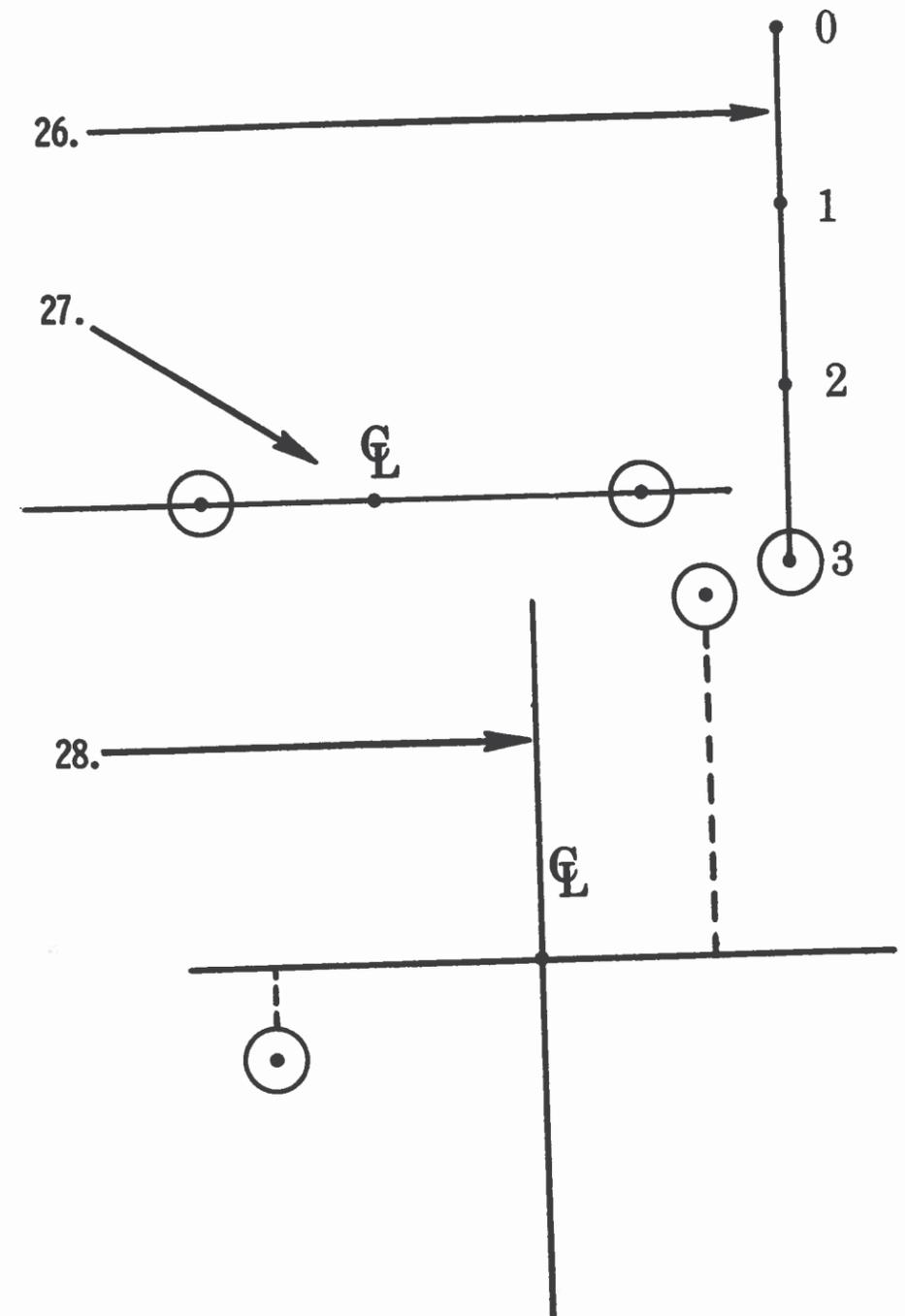
17. 69.18 feet

18. 0 feet

19.

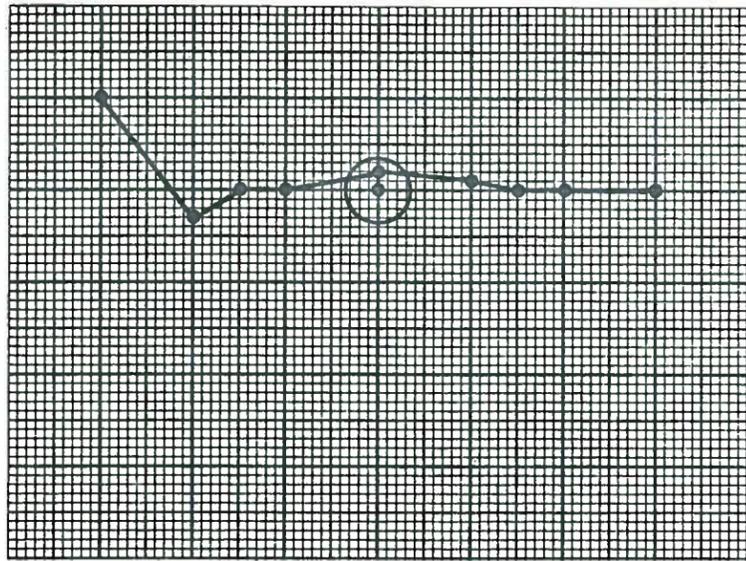


20. (a) .5677
(b) .7813
(c) .1667
21. (a) 1216 feet
(b) 1302 feet
(c) 1258.37 feet
22. (a) 594.5 feet
(b) 971 square feet
(c) 317 square feet
(d) 1611 cubic yards
23. (1) 3
(2) 2
(3) RIGHT
24. (1) 3
(2) 3
(3) LEFT
25. (1) 3
(2) 1
(3) 1
(4) ABOVE



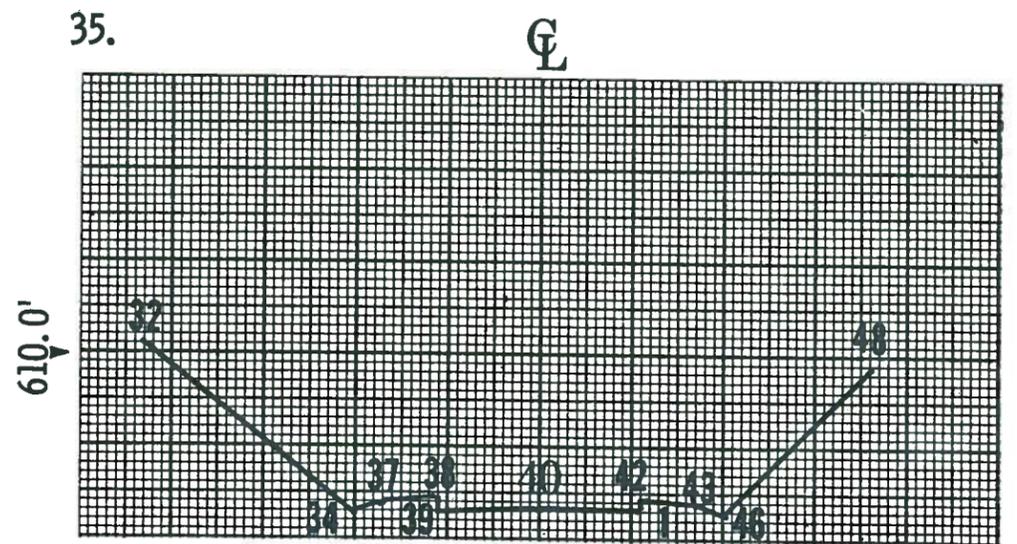
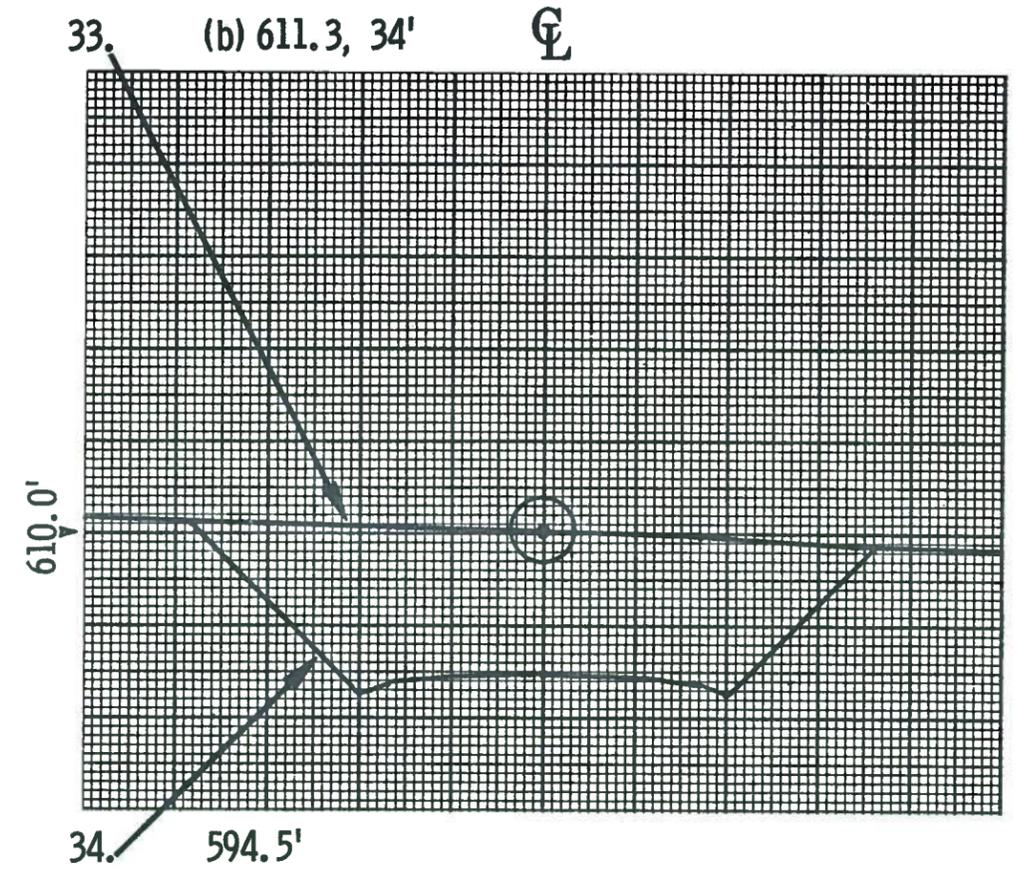
29. (a) 8
 (b) 6
 (c) 100
 (d) 1 foot
 (e) 1 foot

30.



31. A 20' 26'L B 9' 12'L C 14' 0' D 0' 0'
 E 0' 10'R F 5' 15'R G 5' 15'R H 5' 15'L

32. (a) g
 (b) g
 (c) g
 (d) h
 (e) f
 (f) g



ERRATA SHEET

Errata to Basic Highway Plan Reading Course

Page 10, lower right hand corner. Drawing is not technically correct in that the forward tangent does not intersect with centerline. Drawing exaggerated for purpose of illustration only.

Page 20, lower right hand corner. Change note: Note that 2864.58 is actually . . . should read "Note that 2864.79 is actually . . ."

Page 28, last paragraph, right hand column. Change Sta. 159+50 to 159+25 and Sta. 160+50 to 160+25.

Page 37. Figures on graphs representing elevation of finished grade should be depicted to the right of centerline as shown under "Conventional Signs" of Title page.

Page 37, first line, last paragraph, left hand column. Change F-137 to F-317.

Page 40, right hand column, first line. Change Sta. 214 to Sta. 124.

Page 49, answer 21(c). Change to 1268.37.

Page 50, answer 32(a). Change to "f".

Page 48, answer 10. Change to 712+81.87, Right.