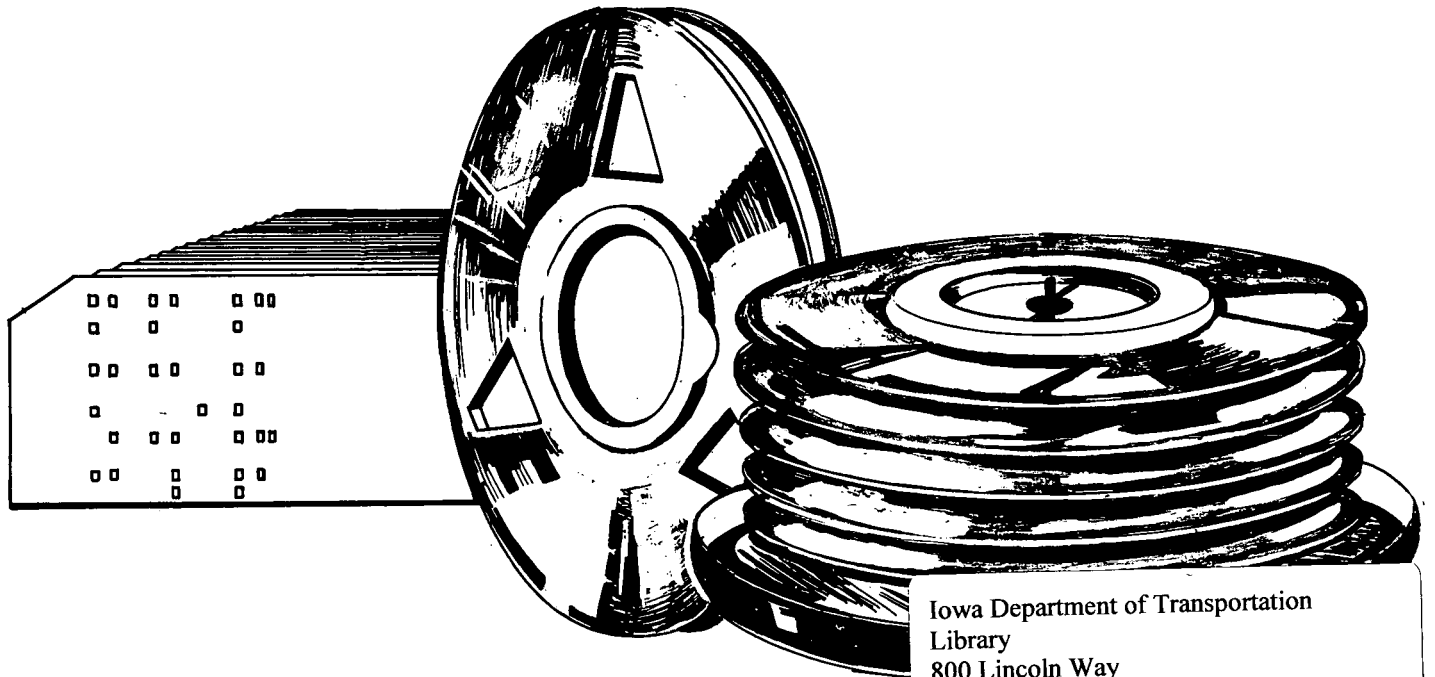


Iowa Highway Research Board

RESEARCH PROJECT HR-143 ROAD PROFILE ADJUSTMENT COMPUTER PROGRAM



Iowa Department of Transportation
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Ames, Iowa 50010

Developed For

IOWA STATE HIGHWAY COMMISSION

by:



HENNINGSON, DURHAM & RICHARDSON

ENGINEERING • ARCHITECTURE • PLANNING

OMAHA • DENVER • PHOENIX • DALLAS • CHARLOTTE • WASHINGTON, D. C.

April 1969

HENNINGSON, DURHAM & RICHARDSON

ENGINEERING • ARCHITECTURE • PLANNING • SYSTEMS • ECONOMICS

3555 Farnam Street
Omaha, Nebraska 68131
March 31, 1969

Iowa State Highway Commission
Ames, Iowa 50010

Attn: Mr. Stephen E. Roberts, Research Engineer

Re: ISHC Research Project HR-143
Computer Program for
Secondary Roads Profile Adjustment

Gentlemen:

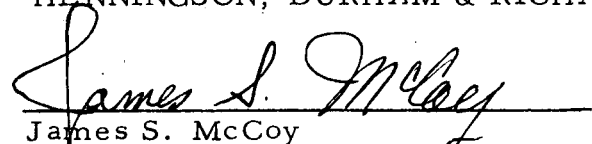
Under the terms of Contract for Services to Conduct Iowa State Highway Commission Research Project HR-143, with signature date October 24, 1968, and supplemental agreement thereto, with signature date October 30, 1968, we are pleased to submit herewith fifty (50) copies of the Final Report for the subject Research Project.

This Research Project covers the mechanics and computer programming approach to Adjustment of Roadway Profiles, primarily as a development to aid county and secondary road engineers. The Adjustment in Profile is normally used as a step in stage construction immediately prior to road hard surface construction.

Properly used, the implementation of this program will result in tremendous time and labor savings to the county and secondary road engineer in readjustment of roadway profiles.

We are sincerely proud to have been of service to the Iowa State Highway Commission in this Research Project and will be available for additional consultation, should the occasion arise.

Respectfully submitted,
HENNINGSON, DURHAM & RICHARDSON


James S. McCoy


Robert A. Rohling, Vice President

rar/mw
enclosures

IOWA HIGHWAY RESEARCH BOARD
RESEARCH PROJECT HR-143

USERS MANUAL

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RESEARCH PROJECT HR-143

INTRODUCTION

// A computer program to adjust roadway profiles has been developed to serve as an aid to the county engineers of the State of Iowa. Many hours are spent reducing field notes and calculating adjusted roadway profiles to prepare an existing roadway for paving that will produce a high quality ride and be as maintenance free as possible. Since the computer is very well adapted to performing long tedious tasks; programming this work for a computer would result in freeing the engineer of these tasks. Freed from manual calculations, the engineer is able to spend more time in solving engineering problems.

The type of roadway that this computer program is designed to adjust is a road that at sometime in its history was graded to a finished subgrade. After a period of time, this road is to receive a finished paved surface. The problem then arises whether to bring the existing roadway up to the designed grade or to make profile adjustments and comprise between the existing and the design profiles. In order to achieve the latter condition using this program, the engineer needs to give the computer only a minimum amount of information. //

Input needed for this program consists of the unreduced field book for the existing roadway and forms containing vertical and horizontal curve data. Data is keypunched directly from the field books and curve data forms.

Output information includes cut and fill values to be marked on the grade stakes by the field crew, original and adjusted profile information to be scrutinized by the project engineer, and plot data enabling the engineer to obtain a computer plot of both the adjusted and design road profile.

Program direction and development was handled by Norman L. Firkins, James S. McCoy and Leon J. Hausman of Henningson, Durham & Richardson. Paul Mahoney, Pottawattomie County **Engineer**, assisted in the development of the methods and approach used in this program. Coordination of work between Henningson, Durham & Richardson and the Iowa State Highway Commission was under the guidance of Mr. Stephen E. Roberts, Research Engineer for the Iowa State Highway Commission and Mr. Robert Rohling of Henningson, Durham & Richardson. Establishment of the program on the Commission's computer was coordinated through the efforts of Mr. James Hoag, Director of Data Processing for the Commission. Bob Swan, Secondary Roads Engineer, assisted in the final approval of this report.

CAPABILITIES AND LIMITATIONS

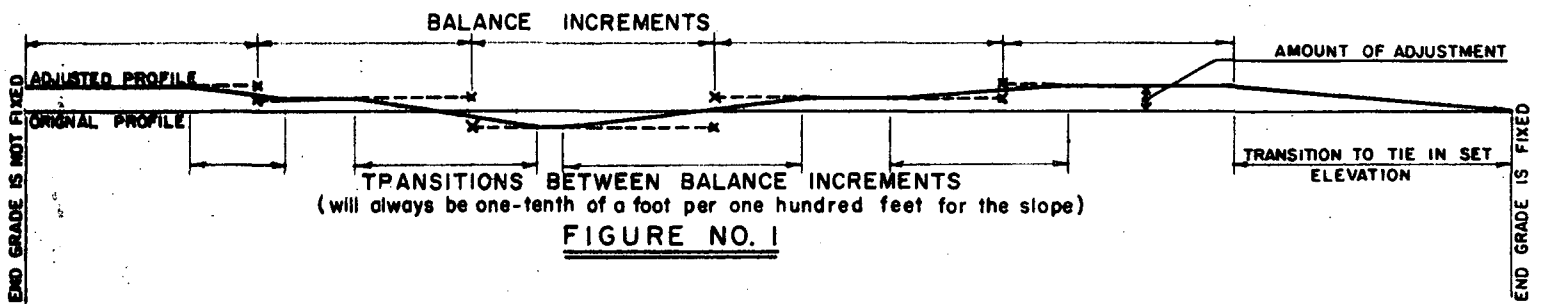
IOWA HIGHWAY RESEARCH BOARD
RESEARCH PROJECT HR-143

CAPABILITIES AND LIMITATIONS

1. Adjustment of roadway profiles using a balanced earthwork approach. Earthwork balancing is achieved between user criteria points. (Maximum and minimum increment sections.)
2. Balancing of the earthwork can be overridden through user specified data. This is accomplished by the raising or lowering of the program adjusted roadway profile.
3. Any number of station equations within a roadway can be inserted.
4. Vertical and horizontal curve information is used to generate the design roadway.
5. The existing roadway profile is generated through the use of field book data.
6. Preset beginning and ending profile elevations can be met. The user also has the ability to leave these ends free so the program will set the end profile elevations.
7. Very short roadway lengths with certain fixed end conditions may result in an impossible roadway profile adjustment.
8. A transition is computed between balanced sections in order to produce a smooth roadway profile. The percent of profile transition used in the program is 0.10%.
9. A minimum of three P.I. control cards is required between the following:
 1. Station equations
 2. Start of the project and a station equation
 3. Start of the project and the end of the project
 4. Station equation and the end of the project
10. No horizontal curve data is required if the horizontal curve control card is left blank.
11. A horizontal curve without any super-elevations should not be coded as a horizontal curve.

12. A minimum length of 200 feet and a maximum length of 1000 feet for a balance section is set by the program.
13. The use of a compound curve indicator will enable the user to insert a curve with different transition lengths.
14. A number of error messages has been incorporated into the program to explain errors due to improper input.
15. The location of the edges of the roadway in relation to the center line is input as data only once per roadway. Therefore, this parameter cannot change within a roadway project. However, to overcome this limitation, the roadway project could be broken down into a number of continuing projects.
16. For accurate results, directions for coding the data and placing the data in proper order should be followed.
17. This program has been primarily designed to make small roadway adjustments. Close review by the project engineer should be made on any deviations of the program parameters.

SUMMARY OF ADJUSTMENT PROCEDURES



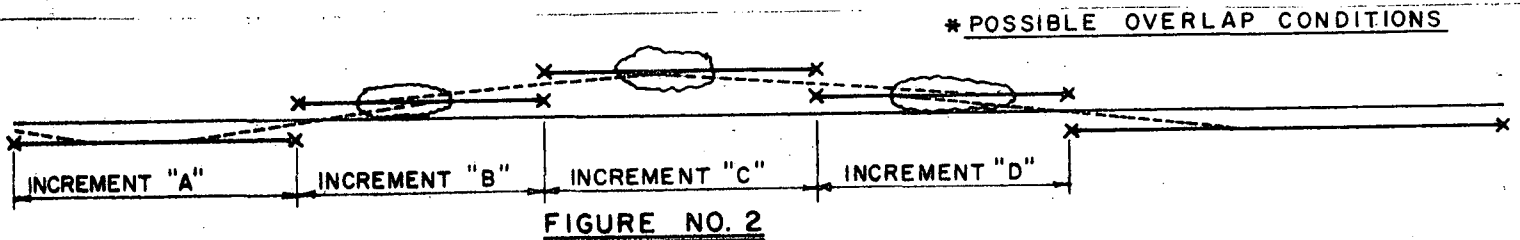
Refer to Figure 1.

Procedure used to adjust the original profile grade:

The program will calculate the amount of earthwork required to bring the roadway to the original profile elevation within a balance increment section. The amount of adjustment which would be required to bring the original profile to an adjusted grade so that the earthwork will balance at the end of an increment section is then calculated. When the starting or ending station has to be tied into a fixed grade, the length required to make the transition to a balance increment section adjustment is calculated without considering the earthwork balance routine. After the balance increment sections are calculated, the program will return and calculate the transitions required to tie the adjusted grades of the increment sections together.

Refer to Figure 2.

Note: If an overlap should occur as in the center of increment "B", the program will readjust so that the condition is corrected.



Method of correction: Increments "A" and "B" are held in storage. After increment "C" is calculated the program checks to see if an overlap will occur, as in the center of increment "B". If an overlap occurs, increment "B" will be extended one station and increment "C" will drop that same station. If increment "C" is shorter than the input value for minimum length of increment, the program will increase increment "C" by reworking the length. The adjustment of increment "B" and increment "C" will be recomputed. The program will then recheck for overlap conditions. This procedure will continue until there is no overlap. When this overlap condition has been eliminated, the program will recheck possible overlap conditions in increment "A", which may have resulted from the readjustment of increment "B". If an overlap should occur in increment "A", the program will extend increments "A" and "B" a required distance to eliminate the overlap conditions of increment "A". This procedure is checked and rechecked on all the balance increments specified.

INPUT

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INPUT DATA

I. GENERAL INFORMATION CARD

1. Seventy-two columns on this card can be used for job identification or other descriptive information. Column one should be left blank.

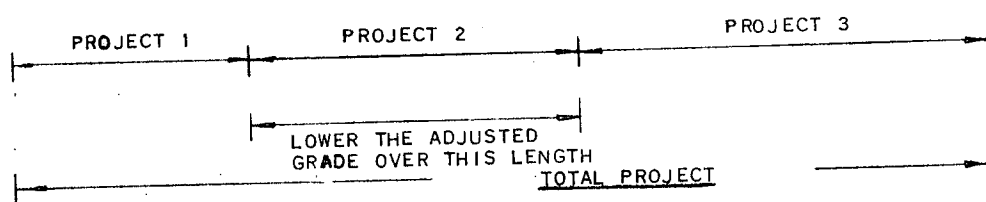
II. ROADWAY SPECIFICATION CARD

1. The distance from the centerline to the left edge of the roadway (in feet).

2. The distance from the centerline to the right edge of the roadway (in feet).

3. The standard slope of the roadway crown (Ft/Ft).

4. Grade adjustment (feet) above (+), or below (-), the new balanced grade established by the program. This adjustment is held constant throughout the roadway project. To make this adjustment along only a portion of the roadway, the overall project should be broken down into a number of small projects.



NOTE: TREAT EACH SMALL PROJECT AS A COMPLETE PROJECT WHEN CODING THE DATA.

5. Total project length in feet to be adjusted.

6. The minimum length of all earthwork balance points (must be at least 200 ft.) along the roadway (in feet). Optional input.

7. The maximum length of all earthwork balance points along the roadway (in feet). Optional input.

Note: Items 6 and 7 are used to control the distance in which the changes in grade adjustment occur.

III. BEGINNING AND ENDING PROJECT EXISTING CONDITIONS CARD

1. Beginning station

2. Design profile elevation at beginning station (subgrade).
3. Profile elevation to be used at beginning station (subgrade).
If a fixed elevation is not required, this item may be left blank.
4. Last station of adjusted roadway.
5. Design profile elevation at last station (subgrade).
6. Profile elevation to be met at last station (subgrade). If a fixed elevation is not required, this item may be left blank.

The above three data cards are entered only once per each run.

IV. VERTICAL CURVE CARD

1. The number of vertical curves from starting point¹ to ending point².

V. VERTICAL CURVE INFORMATION CARDS

1. The station of the vertical P.I.
2. P.I. elevation of the vertical curve.
3. The length of the vertical curve (feet).

Note: The number of vertical curve information cards must equal the total number of vertical curves.

VI. HORIZONTAL CURVE CARD

1. The number of horizontal curves from starting point¹ to ending point².

VII. HORIZONTAL CURVE INFORMATION CARDS

1. The starting transition station, the last stations of normal crown entering a curve.
2. The length of the transition into or out of full super-elevation(feet).
3. The amount of full super-elevation (when the alignment curve is right, this value will be positive and when the alignment curve is left, this value will be negative (feet)).

¹Starting points consist of the beginning project station and beginning station equations.

²Ending points consist of the end of project station and ending station equations.

4. The ending transition station, the first stationing of normal crown exiting from a curve.

5. Identification of horizontal curves. (For a simple curve or the last curve of a compound or reverse system, this value is 0. For the first or interior curve of a compound or reverse system, this value is equal to the length (feet) of transition between the curves.)

Note: (1) The number of horizontal curve information cards equals the number of horizontal curves.

(2) In the case where no horizontal curves occur, insert a blank card for the Item VI Horizontal Curve Card.

VIII STATION EQUATION CARD

1. The first station of the station equation or the ending station of a section of roadway.

2. The second station of the station equation. (This value is 0 when the first station "Item 1" is the end of the project.)

Note: The data following the station equation is the cross section data which is keypunched directly from the field book.

IX. CROSS SECTION CARDS

1. Cross section station.

2. The left hub shot. (If a self reading rod is used, this value will be the left hub elevation.)

3. The left edge of roadway shot or elevation.

4. The centerline shot or elevation.

5. The right edge of roadway shot or elevation.

6. The right hub shot or elevation.

Note: (1) This data is to be punched directly from field books.

(2) When an H.I. Card is to be read, a negative one (-1) is inserted as the value of the station. The value of the H.I. elevation is then placed in Item 2's field. If a self-reading rod is used, no H.I. elevation value is needed.

There are certain rules that must be followed when filling out the data forms:

1. There can be no negative stationing.
2. Elevations cannot be zero or negative.
3. Cross section data must be given for all ending station equations and the last station of the project.

OUTPUT

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OUTPUT

The information available from this program consists of three different parts. The first part is the field data and contains the cut and fill data for the grade stakes. The second part consists of the complete roadway information for both the original and adjusted roadway conditions. The third section is the plot data and is for use by the computer department if a scaled drawing of the roadway is desired.

I. FIELD DATA

1. Station.
2. Cut or fill* in feet at left grade stake.
3. Cut or fill* in feet at right grade stake.

II. COMPLETE ROADWAY INFORMATION

1. Station.
2. Left Grade Stake Information.
 - (1) Elevation of left grade stake.
 - (2) Grade stake cut or fill (feet). Corresponds to field data.
3. Existing Grade Elevation (Reduction of Field Book).
 - (1) Existing grade at left edge of roadway.
 - (2) Existing grade at centerline of roadway.
 - (3) Existing grade at right edge of roadway.
4. Right Grade Stake Information.
 - (1) Elevation of right grade stake.
 - (2) Grade stake cut or fill (feet). Corresponds to field data.

* A plus sign indicates a cut while a minus sign indicates a fill.

5. Adjusted and Original Profile Elevation.

- | | | |
|-----|-----------------------|--|
| (1) | Left edge of highway | (Adjusted elevation)
(Original elevation) |
| (2) | Centerline of highway | (Adjusted elevation)
(Original elevation) |
| (3) | Right edge of highway | (Adjusted elevation)
(Original elevation) |

6. Adjusted and Original Cut or Fill.

- | | | |
|-----|------------------------|--|
| (1) | Left edge of highway | (Adjusted cut or fill(feet))
(Original cut or fill(feet)) |
| (2) | Centerline of highway. | (Adjusted cut or fill(feet))
(Original cut or fill(feet)) |
| (3) | Right edge of highway. | (Adjusted cut or fill(feet))
(Original cut or fill(feet)) |

7. Volume of Material (Cu. Yds.) Accumulated.

8. Vertical Change or Relocation of Highway Profile, in feet, from Original Grade.

Note: (1) When the heading is stated, Adj./Orig., there will be two lines of information. The top line is the adjusted data and the bottom line is the original data.

(2) Plus sign indicates a cut while a minus sign indicates a fill.

III. PLOT DATA

1. Station.
2. Distance from Starting Point to the Station.
3. Original Profile Grade.
4. Adjusted Profile Grade.

Note: The station equation is also included in this data. When this occurs a negative one is used in place of the station followed by the previous and new stationing.

SAMPLE PROBLEM

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	D. LARSON W. TURK	T.	MAY 3, 1967 COLD - SNOWING - 40°	
+ 75				
+ 50				
+ 25				
1400				
+ 74	BEG TRANS.			
+ 50				
+ 25				
0412	BOP.			
BM#1A				1026.36
	9.05	1035.41		

				1.
29.88	29.87	29.84	29.27	29.06
553	554	557	614	635
29.76	29.89	29.83	29.31	29.10
565	562	558	610	631
29.64	29.81	29.93	29.49	29.42
577	560	545	592	599
29.63	29.89	30.20	29.71	29.64
578	552	521	570	577
29.90	30.04	30.57	30.31	30.20
551	537	484	510	521
30.58	30.71	30.90	30.78	30.75
483	470	451	463	466
31.29	31.26	31.22	31.15	31.17
412 422	415	419	426	424
31.17	31.17	31.12	31.11	31.11
424	424	429	430	430
TEL POLE 30' LT STA 0+00				

150					
+25					
5					
+75					
+50					
+25					
4					
TP	7.66	1036.12	6.95	1028.46	HUB PT 3+75
+75					
		1035.41			

					3.
30.68	30.71	30.27	29.40	28.93	
544	541	585	672	719	
30.50	30.56	30.17	29.23	28.80	
562	556	595	689	732	
30.35	30.38	29.96	29.07	28.73	
577	574	616	705	739	
30.22	30.20	29.92	28.91	28.57	
590	592	630	721	755	
30.12	30.03	29.70	28.78	28.50	
600	609	642	734	762	
30.01	30.06	29.63	28.71	28.41	
611	606	649	741	771	
30.09	30.02	29.62	28.76	28.42	
603	610	650	736	770	
30.15	30.05	29.73	28.73	28.46	
526	536	568	668	695	

	P.T. + 47.92	BACK = 9 + 68.93	AHEAD	
	+25			
	7			
	+75			
	+50			
	+25			
	6			
	+75			
		1036.12		

				4.
31.81	31.89	31.56	30.56	30.32
431	423	456	556	580
31.79	31.77	31.50	30.45	30.24
433	435	462	567	588
31.63	31.61	31.35	30.42	30.19
449	451	477	570	593
31.43	31.46	31.23	30.27	30.02
469	466	489	585	610
31.24	31.33	31.08	29.96	29.72
488	479	504	616	640
31.13	31.31	30.89	29.79	29.55
499	491	523	633	657
31.05	31.04	30.60	29.66	29.40
507	508	552	646	672
30.83	30.83	30.42	29.37	29.13
529	529	570	675	699

+33	END TRANS.			
+25				
11				
+75				
+50				
+75				
10				
+75				
		1036.12		

31.74	32.04	32.25	31.72	31.61
438	408	387	440	451
31.73	32.03	32.22	31.70	31.55
437	409	390	442	457
31.72	31.99	32.23	31.64	31.44
440	413	389	448	468
31.82	32.04	32.12	31.47	31.34
430	408	400	465	478
31.90	32.06	32.05	31.41	31.09
422	406	407	471	503
31.82	31.98	31.89	31.06	30.80
430	414	423	506	532
31.91	31.95	31.73	30.83	30.54
421	417	439	529	558
31.82	31.90	31.58	30.65	30.32
430	422	454	547	580

5.

5

+25					
13					
+75					
+50					
+25					
12					
+75					
+50					
TP	7.76	1039.50	4.38	1031.74	HUB LT. 11+33

32.72	32.74	33.25	32.84	32.57
678	656	625	666	693
32.48	32.65	33.06	32.67	32.46
702	685	644	683	704
32.39	32.53	32.87	32.47	32.27
711	697	663	703	723
32.34	32.44	32.81	32.54	32.25
716	706	669	696	725
32.18	32.39	32.75	32.26	32.11
732	711	675	724	739
32.06	32.35	32.60	32.18	31.94
744	715	690	732	756
31.93	32.06	32.40	31.90	31.75
757	744	710	760	775
31.82	32.11	32.25	31.70	31.62
768	739	725	780	788

FIELD BOOK KEY PUNCHED DATA
ROD READINGS

STATION	HUB	LEFT EDGE	CENTERLINE	RIGHT EDGE	HUB
-100	103541	00	00	00	00
1200	424	424	429	430	430
2500	412	415	419	426	424
5000	483	470	451	463	466
7400	551	537	484	510	521
10000	578	552	521	570	577
12500	577	560	548	592	599
15000	565	562	558	610	631
17500	553	554	557	614	635
20000	539	537	548	621	645
22500	521	528	551	636	666
23970	514	525	554	646	680
25000	514	527	558	648	683
27500	529	540	564	655	691
30000	536	538	560	657	689
32500	528	534	562	658	687
35000	522	530	567	652	689
37500	526	536	568	668	695
-100	103612	00	00	00	00
40000	603	610	650	736	770
42500	611	606	649	741	771
45000	600	609	642	734	762
47500	590	592	630	721	755
50000	577	574	616	705	739
52500	562	556	595	689	732
55000	544	541	585	672	719
57500	529	529	570	675	699
60000	507	508	552	646	672
62500	499	491	523	633	657
65000	488	479	504	616	640
67500	469	466	489	585	610
70000	449	451	477	570	593
72500	433	435	462	567	588
74792	431	423	456	556	580
97500	430	422	454	547	580
100000	421	417	439	529	558
102500	430	414	423	506	532
105000	422	406	407	471	503
107500	430	408	400	465	478
110000	440	413	389	448	468
112500	439	409	390	442	457
113300	438	408	387	440	451
-100	103950	00	00	00	00
115000	768	739	725	780	788
117500	757	744	710	760	775
120000	744	715	690	732	756
122500	732	711	675	724	739
125000	716	706	669	696	725
127500	711	697	663	703	723
130000	702	685	644	683	704
132500	678	656	625	666	693
135000	666	637	603	654	678
END OF RUN					

/* NOTE: NEGATIVE STATION CARDS ARE H.I. CARDS.

SHEET 1

TITLE

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
X SAMPLE PROBLEM - IOWA RESEARCH PROJECT HR143 X

DISTANCE FROM C TO LEFT EDGE OF ROADWAY (FT.)	DISTANCE FROM C TO RIGHT EDGE OF ROADWAY (FT.)	STANDARD SLOPE OF ROADWAY CROWN (FT./FT.)	GRADE ADJUSTMENT ABOVE OR BELOW BALANCE GRADE (FT.) (OPTIONAL)	• LENGTH OF ROADWAY SECTIONS TO BE ANALYZED (FT.)	** MINIMUM LENGTH OF EARTH WORK BALANCE INCREMENT SECTION (FT.)	** MAXIMUM LENGTH OF EARTH WORK BALANCE INCREMENT SECTION
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
1 100	1 100	0.15		1 1699		30000

• STATION EQUATIONS MUST BE CONSIDERED.

•• OPTIONAL

STARTING STATION	ORIG. DESIGN PROFILE GRADE AT STARTING STATION	• DESIRED PROFILE GRADE AT STARTING STATION	ENDING STATION	ORIGINAL PROFILE GRADE AT ENDING STATION	** DESIRED PROFILE GRADE AT ENDING STATION
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
1 200	1 03070	1 03062	1 35000	1 03306	1 03313

* IF STARTING GRADE IS NOT FIXED THIS VALUE IS 0.0.

** IF ENDING GRADE IS NOT FIXED THIS VALUE IS 0.0.

NO. OF VERTICAL
CURVE P.I.'S WITHIN
STATION EQUATION LIMITS

NOTE: ALL DECIMAL POINTS ARE ASSUMED AS SHOWN.

1 2 3 4
3

STATION OF VERTICAL P.I.'S	ELEVATION OF VERTICAL CURVE P.I.	LENGTH OF VERTICAL CURVE (FT.)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
1 200	1 03070	
40000	1 02900	40000
74792	1 03094	

NOTE: DECIMALS ARE SHOWN AS ASSUMED BY THE PROGRAM.

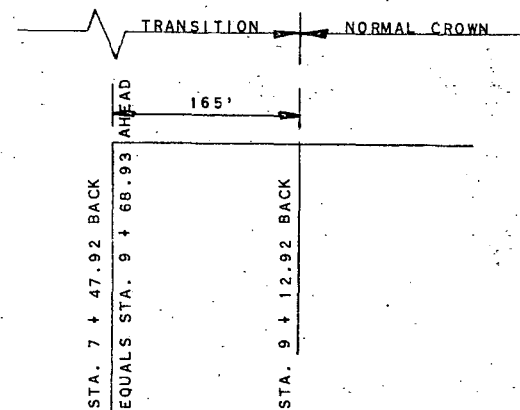
IOWA HIGHWAY RESEARCH BOARD RESEARCH PROJECT HR-143
DATA FORM

SHEET 2

NO. OF HORIZONTAL CURVES WITHIN STATION EQUATION LIMITS			
1	2	3	4

STARTING TRANSITION STATION INTO CURVE										LENGTH OF TRANSITION INTO FULL SUPERELEVATION										AMOUNT OF FULL SUPERELEVATION										ENDING TRANSITION STATION OUT OF CURVE										IDENTIFICATION OF HORIZONTAL CURVES									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
7470										16500										063										91292																			

NOTE: THIS IS A FICTITIOUS STATION OBTAINED BY ADDING THE DISTANCE FROM THE STATION EQUATION TO THE ENDING TRANSITION POINT.



NOTE: ALL DECIMAL POINTS ARE ASSUMED AS SHOWN.

STATION EQUATION																			
FIRST STATION										SECOND STATION									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
74792										96893									

SHEET 1

TITLE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

DISTANCE FROM C TO LEFT EDGE OF ROADWAY (FT.)	DISTANCE FROM C TO RIGHT EDGE OF ROADWAY (FT.)	STANDARD SLOPE OF ROADWAY CROWN (FT./FT.)	GRADE ADJUSTMENT ABOVE OR BELOW BALANCE GRADE (FT.) (OPTIONAL)	• LENGTH OF ROADWAY SECTIONS TO BE ANALYZED (FT.) †	** MINIMUM LENGTH OF EARTH WORK BALANCE INCREMENT SECTION (FT.)	** MAXIMUM LENGTH OF EARTH WORK BALANCE INCREMENT SECTION																																																																									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

• STATION EQUATIONS MUST BE CONSIDERED. ** OPTIONAL

STARTING STATION	ORIG. DESIGN PROFILE GRADE AT STARTING STATION	• DESIRED PROFILE GRADE AT STARTING STATION	ENDING STATION	ORIGINAL PROFILE GRADE AT ENDING STATION	** DESIRED PROFILE GRADE AT ENDING STATION																																																																									
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

* IF STARTING GRADE IS NOT FIXED THIS VALUE IS 0.0. ** IF ENDING GRADE IS NOT FIXED THIS VALUE IS 0.0.

NO. OF VERTICAL
CURVE P.I.'S WITHIN
STATION EQUATION LIMITS

NOTE: ALL DECIMAL POINTS ARE ASSUMED AS SHOWN.

1	2	3	4
		3	

STATION OF VERTICAL P.I.'S	ELEVATION OF VERTICAL CURVE P.I.	LENGTH OF VERTICAL CURVE (FT.)
9	103094	
26	104000	60000
36	103600	

NOTE: DECIMALS ARE SHOWN AS ASSUMED BY THE PROGRAM.

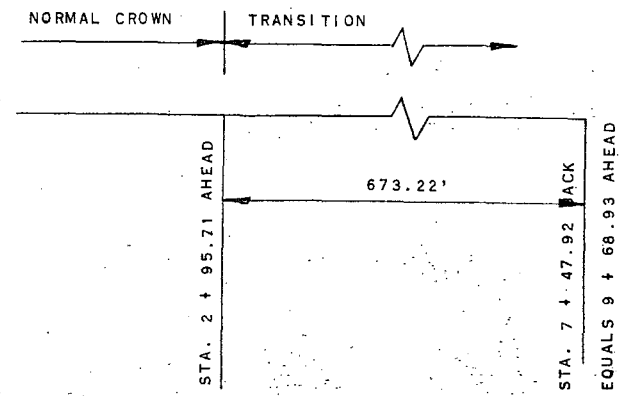
IOWA HIGHWAY RESEARCH BOARD RESEARCH PROJECT HR-143
DATA FORM

SHEET 2

NO. OF HORIZONTAL CURVES WITHIN STATION EQUATION LIMITS			
1	2	3	4
			1

STARTING TRANSITION STATION INTO CURVE										LENGTH OF TRANSITION INTO FULL SUPERELEVATION										AMOUNT OF FULL SUPERELEVATION										ENDING TRANSITION STATION OUT OF CURVE										IDENTIFICATION OF HORIZONTAL CURVES										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40		41	42	43	44	45	46	47	48	49	50
					2	9	5	7	1																																									
29571										16500										063										113393																				

SEE NOTE →



NOTE: THIS IS A FICTITIOUS STATION OBTAINED BY SUBTRACTING THE DISTANCE FROM THE STATION EQUATION TO THE STARTING TRANSITION POINT.

NOTE: ALL DECIMAL POINTS ARE ASSUMED AS SHOWN.

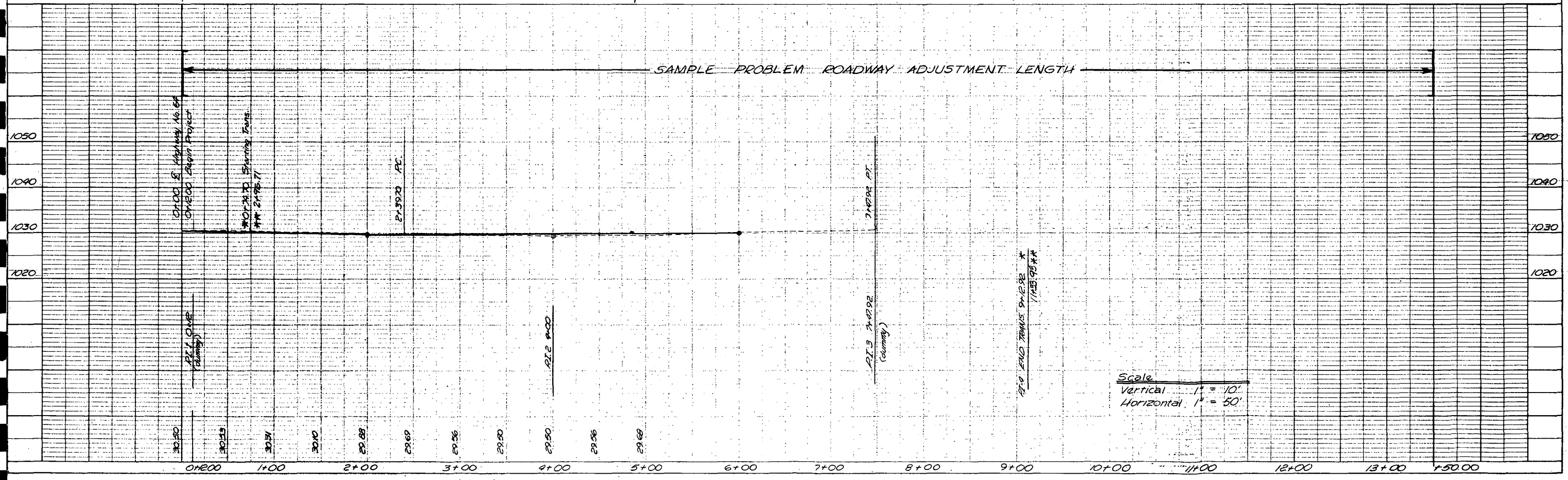
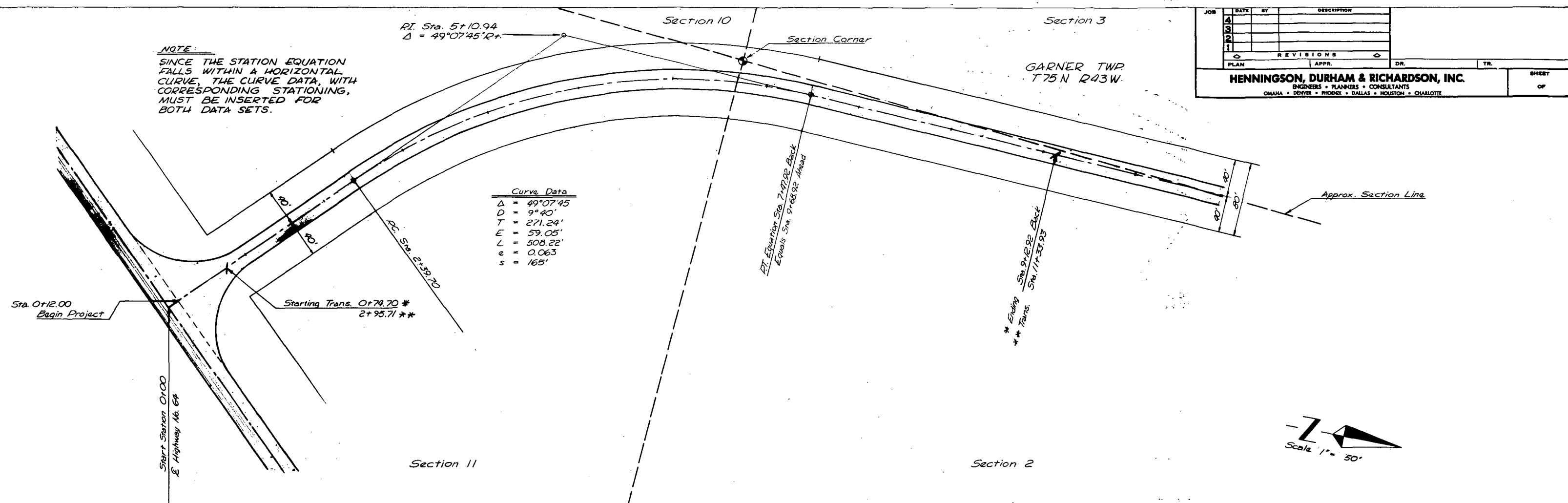
STATION EQUATION	
FIRST STATION	SECOND STATION
135000	

NOTE: SINCE LAST STATION IS THE END OF THE PROJECT, THIS FIELD IS LEFT BLANK.

NOTE:
 SINCE THE STATION EQUATION FALLS WITHIN A HORIZONTAL CURVE, THE CURVE DATA, WITH CORRESPONDING STATIONING, MUST BE INSERTED FOR BOTH DATA SETS.

PI Sta. 5+10.94
 $\Delta = 49^{\circ}07'45''R$

Curve Data	
Δ	$49^{\circ}07'45''$
D	$9^{\circ}40'$
T	$271.24'$
L	$508.22'$
e	0.063
s	$165'$



Scale
 Vertical 1" = 10'
 Horizontal 1" = 50'

SAMPLE PROBLEM - IOWA RESEARCH PROJECT HR143

30000

1100 1100 .015 00 111699
 1200 103070 103062 135000 103306 103313

3

1200 103070 00
 40000 102900 40000
 74792 103094 00

VERTICAL CURVE DATA

1

7470 16500 .063 91292 00

HORIZONTAL CURVE DATA

STATION EQUATION CARD

74792	96893				
-100	103541	00	00	00	00
1200	424	424	429	430	430
2500	412	415	419	426	424
5000	483	470	451	463	466
7400	551	537	484	510	521
10000	578	552	521	570	577
12500	577	560	548	592	599
15000	565	562	558	610	631
17500	553	554	557	614	635
20000	539	537	548	621	645
22500	521	528	551	636	666
23970	514	525	554	646	680
25000	514	527	558	648	683
27500	529	540	564	655	691
30000	536	538	560	657	689
32500	528	534	562	658	687
35000	522	530	567	652	689
37500	526	536	568	668	695
-100	103612	00	00	00	00
40000	603	610	650	736	770
42500	611	606	649	741	771
45000	600	609	642	734	762
47500	590	592	630	721	755
50000	577	574	616	705	739
52500	562	556	595	689	732
55000	544	541	585	672	719
57500	529	529	570	675	699
60000	507	508	552	646	672
62500	499	491	523	633	657
65000	488	479	504	616	640
67500	469	466	489	585	610
70000	449	451	477	570	593
72500	433	435	462	567	588
74792	431	423	456	556	580

DATA SET 1

STATION EQUATION

3

96893 103094 00
 260000 104000 60000
 360000 103600 00

VERTICAL CURVE DATA

1

29571 16500 .063 113393 00

HORZ. CURVE DATA (SAME CURVE USED IN DATA SET 1)

STATION EQUATION CARD

135000	00				
97500	430	422	454	547	580
100000	421	417	439	529	558
102500	430	414	423	506	532
105000	422	406	407	471	503
107500	430	408	400	465	478
110000	440	413	389	448	468
112500	439	409	390	442	457
113300	438	408	387	440	451
-100	103950	00	00	00	00
115000	768	739	725	780	788
117500	757	744	710	760	775
120000	744	715	690	732	756

DATA SET 2

FIELD BOOK DATA

122500	732	711	675	724	739
125000	716	706	669	696	725
127500	711	697	663	703	723
130000	702	685	644	683	704
132500	678	656	625	666	693
135000	666	637	603	654	678

END OF RUN

/*

NOTE: HORIZONTAL CURVE COMMON TO BOTH DATA SETS!

SAMPLE PROBLEM - IOWA RESEARCH PROJECT HR143

STATION	*	LEFT HUB	*	RIGHT HUB
12.00	*	CUT	0.72	* CUT 0.66
25.00	*	CUT	0.91	* CUT 0.79
50.00	*	CUT	0.31	* CUT 0.48
74.00	*	FILL	0.27	* CUT 0.03
100.00	*	FILL	0.56	* FILL 0.41
125.00	*	FILL	0.57	* FILL 0.52
150.00	*	FILL	0.48	* FILL 0.68
175.00	*	FILL	0.38	* FILL 0.48
200.00	*	FILL	0.26	* FILL 0.34
225.00	*	FILL	0.13	* FILL 0.34
239.70	*	FILL	0.09	* FILL 0.37
250.00	*	FILL	0.07	* FILL 0.38
275.00	*	FILL	0.18	* FILL 0.42
300.00	*	FILL	0.21	* FILL 0.36
325.00	*	FILL	0.12	* FILL 0.33
350.00	*	FILL	0.06	* FILL 0.35
375.00	*	FILL	0.12	* FILL 0.43
400.00	*	FILL	0.21	* FILL 0.50
425.00	*	FILL	0.34	* FILL 0.56
450.00	*	FILL	0.29	* FILL 0.53
475.00	*	FILL	0.27	* FILL 0.54
500.00	*	FILL	0.23	* FILL 0.47
525.00	*	FILL	0.17	* FILL 0.49
550.00	*	FILL	0.09	* FILL 0.46
575.00	*	FILL	0.05	* FILL 0.37
600.00	*	CUT	0.04	* FILL 0.23
625.00	*	FILL	0.02	* FILL 0.22
650.00	*	FILL	0.05	* FILL 0.19
675.00	*	FILL	0.0	* FILL 0.03
700.00	*	CUT	0.06	* FILL 0.0
725.00	*	CUT	0.08	* FILL 0.09
747.92	*	FILL	0.03	* FILL 0.14
975.00	*	FILL	0.02	* FILL 0.20
1000.00	*	CUT	0.06	* FILL 0.25
1025.00	*	FILL	0.04	* FILL 0.26
1050.00	*	CUT	0.03	* FILL 0.24
1075.00	*	FILL	0.06	* FILL 0.23
1100.00	*	FILL	0.17	* FILL 0.27
1125.00	*	FILL	0.17	* FILL 0.30
1133.00	*	FILL	0.16	* FILL 0.28
1150.00	*	FILL	0.17	* FILL 0.37
1175.00	*	FILL	0.19	* FILL 0.37
1200.00	*	FILL	0.20	* FILL 0.32
1225.00	*	FILL	0.21	* FILL 0.28
1250.00	*	FILL	0.16	* FILL 0.25
1275.00	*	FILL	0.23	* FILL 0.35
1300.00	*	FILL	0.25	* FILL 0.27
1325.00	*	FILL	0.13	* FILL 0.28
1350.00	*	FILL	0.12	* FILL 0.24

SAMPLE PROBLEM - IOWA RESEARCH PROJECT HR143

STATION	HUB *	EXISTING GRADE			HUB *	ADJ./ORIG. PROFILE			ADJ./ORIG.		
	ELEV *	ELEV			ELEV *	ELEV			CUT/+/ OR FILL/-/		
	LEFT *	LT	CL	RT	RIGHT *	LT	CL	RT	LT	CL	RT
	CUT 0.72				CUT 0.66	1030.45	1030.62	1030.45	0.72	0.50	0.66
12.00	1031.17	1031.17	1031.12	1031.11	1031.11	1030.53	1030.70	1030.53	0.64	0.42	0.58
VOLUME #	0.0 CU. YD.		ADJUSTMENT #			-0.08 FEET					
	CUT 0.91				CUT 0.79	1030.38	1030.55	1030.38	0.88	0.67	0.77
25.00	1031.29	1031.26	1031.22	1031.15	1031.17	1030.47	1030.64	1030.47	0.79	0.58	0.68
VOLUME #	7.11 CU. YD.		ADJUSTMENT #			-0.09 FEET					
	CUT 0.31				CUT 0.48	1030.27	1030.44	1030.27	0.44	0.46	0.51
50.00	1030.58	1030.71	1030.90	1030.78	1030.75	1030.36	1030.53	1030.36	0.35	0.37	0.42
VOLUME #	19.49 CU. YD.		ADJUSTMENT #			-0.09 FEET					
	FILL 0.27				CUT 0.03	1030.17	1030.34	1030.17	-0.13	0.23	0.14
74.00	1029.90	1030.04	1030.57	1030.31	1030.20	1030.26	1030.43	1030.26	-0.22	0.14	0.05
VOLUME #	25.21 CU. YD.		ADJUSTMENT #			-0.09 FEET					
	FILL 0.56				FILL 0.41	1030.19	1030.22	1030.05	-0.30	-0.02	-0.34
100.00	1029.63	1029.89	1030.20	1029.71	1029.64	1030.28	1030.31	1030.14	-0.39	-0.11	-0.43
VOLUME #	24.66 CU. YD.		ADJUSTMENT #			-0.09 FEET					
	FILL 0.57				FILL 0.52	1030.21	1030.11	1029.94	-0.40	-0.18	-0.45
125.00	1029.64	1029.81	1029.93	1029.49	1029.42	1030.30	1030.20	1030.03	-0.49	-0.27	-0.54
VOLUME #	19.85 CU. YD.		ADJUSTMENT #			-0.09 FEET					
	FILL 0.48				FILL 0.68	1030.24	1030.01	1029.78	-0.45	-0.18	-0.47
150.00	1029.76	1029.79	1029.83	1029.31	1029.10	1030.33	1030.10	1029.87	-0.54	-0.27	-0.56
VOLUME #	13.51 CU. YD.		ADJUSTMENT #			-0.09 FEET					
	FILL 0.38				FILL 0.48	1030.26	1029.90	1029.54	-0.39	-0.06	-0.27
175.00	1029.88	1029.87	1029.84	1029.27	1029.06	1030.35	1029.99	1029.63	-0.48	-0.15	-0.36
VOLUME #	8.26 CU. YD.		ADJUSTMENT #			-0.09 FEET					
	FILL 0.26				FILL 0.34	1030.28	1029.79	1029.30	-0.24	0.14	-0.10
200.00	1030.02	1030.04	1029.93	1029.20	1028.96	1030.37	1029.88	1029.39	-0.33	0.05	-0.19
VOLUME #	6.13 CU. YD.		ADJUSTMENT #			-0.09 FEET					
	FILL 0.13				FILL 0.34	1030.33	1029.71	1029.09	-0.20	0.19	-0.04
225.00	1030.20	1030.13	1029.90	1029.05	1028.75	1030.39	1029.77	1029.15	-0.26	0.13	-0.10
VOLUME #	6.33 CU. YD.		ADJUSTMENT #			-0.06 FEET					

-17-

SAMPLE PROBLEM - IOWA RESEARCH PROJECT HR143

STATION	HUB *	EXISTING GRADE				HUB *	ADJ./ORIG. PROFILE			ADJ./ORIG.		
	ELEV *	ELEV				ELEV *	ELEV			CUT/+/ OR FILL/-/		
	LEFT *	LT	CL	RT	* RIGHT *	LT	CL	RT	* LT	CL	RT	
	FILL 0.09				FILL 0.37	1030.36	1029.67	1028.98	-0.20	0.20	-0.03	
239.70	1030.27	1030.16	1029.87	1028.95	1028.61	1030.41	1029.72	1029.03	-0.25	0.15	-0.08	
VOLUME #	6.80 CU. YD.		ADJUSTMENT #		-0.05 FEET							
	FILL 0.07				FILL 0.38	1030.34	1029.65	1028.96	-0.20	0.18	-0.03	
250.00	1030.27	1030.14	1029.83	1028.93	1028.58	1030.38	1029.69	1029.00	-0.24	0.14	-0.07	
VOLUME #	7.11 CU. YD.		ADJUSTMENT #		-0.04 FEET							
	FILL 0.18				FILL 0.42	1030.30	1029.61	1028.92	-0.29	0.16	-0.06	
275.00	1030.12	1030.01	1029.77	1028.86	1028.50	1030.31	1029.62	1028.93	-0.30	0.15	-0.07	
VOLUME #	7.37 CU. YD.		ADJUSTMENT #		-0.01 FEET							
	FILL 0.21				FILL 0.36	1030.26	1029.57	1028.88	-0.23	0.24	-0.04	
300.00	1030.05	1030.03	1029.81	1028.84	1028.52	1030.25	1029.56	1028.87	-0.22	0.25	-0.03	
VOLUME #	7.83 CU. YD.		ADJUSTMENT #		0.01 FEET							
	FILL 0.12				FILL 0.33	1030.25	1029.56	1028.87	-0.18	0.23	-0.04	
325.00	1030.13	1030.07	1029.79	1028.83	1028.54	1030.21	1029.52	1028.83	-0.14	0.27	0.0	
VOLUME #	8.97 CU. YD.		ADJUSTMENT #		0.04 FEET							
	FILL 0.06				FILL 0.35	1030.25	1029.56	1028.87	-0.14	0.18	0.02	
350.00	1030.19	1030.11	1029.74	1028.89	1028.52	1030.19	1029.50	1028.81	-0.08	0.24	0.08	
VOLUME #	10.20 CU. YD.		ADJUSTMENT #		0.06 FEET							
	FILL 0.12				FILL 0.43	1030.27	1029.58	1028.89	-0.22	0.15	-0.16	
375.00	1030.15	1030.05	1029.73	1028.73	1028.46	1030.18	1029.49	1028.80	-0.13	0.24	-0.07	
VOLUME #	10.61 CU. YD.		ADJUSTMENT #		0.09 FEET							
	FILL 0.21				FILL 0.50	1030.30	1029.61	1028.92	-0.28	0.01	-0.16	
400.00	1030.09	1030.02	1029.62	1028.76	1028.42	1030.19	1029.50	1028.81	-0.17	0.12	-0.05	
VOLUME #	9.34 CU. YD.		ADJUSTMENT #		0.11 FEET							
	FILL 0.34				FILL 0.56	1030.35	1029.66	1028.97	-0.29	-0.03	-0.26	
425.00	1030.01	1030.06	1029.63	1028.71	1028.41	1030.21	1029.52	1028.83	-0.15	0.11	-0.12	
VOLUME #	6.72 CU. YD.		ADJUSTMENT #		0.14 FEET							
	FILL 0.29				FILL 0.53	1030.41	1029.72	1029.03	-0.38	-0.02	-0.25	
450.00	1030.12	1030.03	1029.70	1028.78	1028.50	1030.25	1029.55	1028.87	-0.22	0.14	-0.09	
VOLUME #	3.46 CU. YD.		ADJUSTMENT #		0.16 FEET							

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SAMPLE PROBLEM - IOWA RESEARCH PROJECT HR143

STATION	HUB *	EXISTING GRADE			* HUB *	ADJ./ORIG. PROFILE			ADJ./ORIG.		
	ELEV *	ELEV			* ELEV *	ELEV			CUT/+/	OR	FILL/-/
	LEFT *	LT	CL	RT	* RIGHT *	LT	CL	RT	* LT	CL	RT
	FILL 0.27				FILL 0.54	1030.49	1029.80	1029.11	-0.29	0.02	-0.20
475.00	1030.22	1030.20	1029.82	1028.91	1028.57	1030.30	1029.61	1028.92	-0.10	0.21	-0.01
	VOLUME #	0.61 CU. YD.			ADJUSTMENT #	0.19 FEET					
	FILL 0.23				FILL 0.47	1030.58	1029.89	1029.20	-0.20	0.07	-0.13
500.00	1030.35	1030.38	1029.96	1029.07	1028.73	1030.37	1029.68	1028.99	0.01	0.28	0.08
	VOLUME #	-1.02 CU. YD.			ADJUSTMENT #	0.21 FEET					
	FILL 0.17				FILL 0.49	1030.67	1029.98	1029.29	-0.11	0.19	-0.06
525.00	1030.50	1030.56	1030.17	1029.23	1028.80	1030.46	1029.77	1029.08	0.10	0.40	0.15
	VOLUME #	-0.96 CU. YD.			ADJUSTMENT #	0.21 FEET					
	FILL 0.09				FILL 0.46	1030.77	1030.08	1029.39	-0.06	0.19	0.01
550.00	1030.68	1030.71	1030.27	1029.40	1028.93	1030.56	1029.87	1029.18	0.15	0.40	0.22
	VOLUME #	0.41 CU. YD.			ADJUSTMENT #	0.21 FEET					
	FILL 0.05				FILL 0.37	1030.88	1030.19	1029.50	-0.05	0.23	-0.13
575.00	1030.83	1030.83	1030.42	1029.37	1029.13	1030.67	1029.98	1029.29	0.16	0.44	0.08
	VOLUME #	1.97 CU. YD.			ADJUSTMENT #	0.21 FEET					
	CUT 0.04				FILL 0.23	1031.01	1030.32	1029.63	0.03	0.28	0.03
600.00	1031.05	1031.04	1030.60	1029.66	1029.40	1030.80	1030.11	1029.42	0.24	0.49	0.24
	VOLUME #	4.26 CU. YD.			ADJUSTMENT #	0.21 FEET					
	FILL 0.02				FILL 0.22	1031.15	1030.46	1029.77	0.06	0.43	0.02
625.00	1031.13	1031.21	1030.89	1029.79	1029.55	1030.94	1030.25	1029.56	0.27	0.64	0.23
	VOLUME #	8.23 CU. YD.			ADJUSTMENT #	0.21 FEET					
	FILL 0.05				FILL 0.19	1031.29	1030.60	1029.91	0.04	0.48	0.05
650.00	1031.24	1031.33	1031.08	1029.96	1029.72	1031.08	1030.39	1029.70	0.25	0.69	0.26
	VOLUME #	13.30 CU. YD.			ADJUSTMENT #	0.21 FEET					
	FILL 0.0				FILL 0.03	1031.43	1030.74	1030.05	0.03	0.49	0.22
675.00	1031.43	1031.46	1031.23	1030.27	1030.02	1031.22	1030.53	1029.84	0.24	0.70	0.43
	VOLUME #	19.10 CU. YD.			ADJUSTMENT #	0.21 FEET					
	CUT 0.06				FILL 0.0	1031.57	1030.88	1030.19	0.04	0.47	0.23
700.00	1031.63	1031.61	1031.35	1030.42	1030.19	1031.36	1030.67	1029.96	0.25	0.68	0.44
	VOLUME #	25.32 CU. YD.			ADJUSTMENT #	0.21 FEET					

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SAMPLE PROBLEM - IOWA RESEARCH PROJECT HR143

STATION	HUB *	EXISTING GRADE			HUB *	-ADJ./ORIG. PROFILE			ADJ./ORIG.		
	ELEV *	ELEV			ELEV *	ELEV			CUT/+/ OR FILL/-/		
	LEFT *	LT	CL	RT	* RIGHT *	LT	CL	RT	* LT	CL	RT
	CUT 0.08				FILL 0.09	1031.71	1031.02	1030.33	0.06	0.48	0.12
725.00	1031.79	1031.77	1031.50	1030.45	1030.24	1031.50	1030.81	1030.12	0.27	0.69	0.33
	VOLUME #	31.30 CU. YD.			ADJUSTMENT #	0.21 FEET					
	FILL 0.03				FILL 0.14	1031.84	1031.15	1030.46	0.05	0.41	0.10
747.92	1031.81	1031.89	1031.56	1030.56	1030.32	1031.63	1030.94	1030.25	0.26	0.62	0.31
	VOLUME #	36.23 CU. YD.			ADJUSTMENT #	0.21 FEET					
STATION EQUATION		747.92 #		968.93							
	FILL 0.02				FILL 0.20	1031.84	1031.18	1030.52	0.06	0.40	0.13
975.00	1031.82	1031.90	1031.58	1030.65	1030.32	1031.63	1030.97	1030.31	0.27	0.61	0.34
	VOLUME #	37.44 CU. YD.			ADJUSTMENT #	0.21 FEET					
	CUT 0.06				FILL 0.25	1031.85	1031.32	1030.79	0.10	0.41	0.04
1000.00	1031.91	1031.95	1031.73	1030.83	1030.54	1031.64	1031.11	1030.58	0.31	0.62	0.25
	VOLUME #	42.41 CU. YD.			ADJUSTMENT #	0.21 FEET					
	FILL 0.04				FILL 0.26	1031.86	1031.46	1031.06	0.12	0.43	0.0
1025.00	1031.82	1031.98	1031.89	1031.06	1030.80	1031.65	1031.25	1030.85	0.33	0.64	0.21
	VOLUME #	47.35 CU. YD.			ADJUSTMENT #	0.21 FEET					
	CUT 0.03				FILL 0.24	1031.87	1031.60	1031.33	0.19	0.45	0.08
1050.00	1031.90	1032.06	1032.05	1031.41	1031.09	1031.66	1031.39	1031.12	0.40	0.66	0.29
	VOLUME #	52.82 CU. YD.			ADJUSTMENT #	0.21 FEET					
	FILL 0.06				FILL 0.23	1031.88	1031.74	1031.57	0.16	0.38	-0.10
1075.00	1031.82	1032.04	1032.12	1031.47	1031.34	1031.67	1031.53	1031.36	0.37	0.59	0.11
	VOLUME #	57.89 CU. YD.			ADJUSTMENT #	0.21 FEET					
	FILL 0.17				FILL 0.27	1031.89	1031.88	1031.71	0.10	0.35	-0.07
1100.00	1031.72	1031.99	1032.23	1031.64	1031.44	1031.68	1031.67	1031.50	0.31	0.56	0.14
	VOLUME #	61.84 CU. YD.			ADJUSTMENT #	0.21 FEET					
	FILL 0.17				FILL 0.30	1031.90	1032.02	1031.85	0.13	0.20	-0.15
1125.00	1031.73	1032.03	1032.22	1031.70	1031.55	1031.69	1031.81	1031.64	0.34	0.41	0.06
	VOLUME #	64.67 CU. YD.			ADJUSTMENT #	0.21 FEET					

SAMPLE PROBLEM - IOWA RESEARCH PROJECT HR143

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STATION	HUB * EXISTING GRADE * HUB *			ADJ./ORIG. PROFILE *			ADJ./ORIG.			
	ELEV *			ELEV *			CUT/+ / OR FILL/- /			
	LEFT *	LT	CL RT	* RIGHT *	LT	CL RT	* LT	CL	RT	
FILL 0.16				FILL 0.28	1031.90	1032.06	1031.89	0.14	0.19	-0.17
1133.00	1031.74	1032.04	1032.25 1031.72	1031.61	1031.69	1031.85	1031.68	0.35	0.40	0.04
VOLUME #		65.26 CU. YD.		ADJUSTMENT #		0.21 FEET				
FILL 0.17				FILL 0.37	1031.99	1032.16	1031.99	0.12	0.09	-0.29
1150.00	1031.82	1032.11	1032.25 1031.70	1031.62	1031.78	1031.95	1031.78	0.33	0.30	-0.08
VOLUME #		65.89 CU. YD.		ADJUSTMENT #		0.21 FEET				
FILL 0.19				FILL 0.37	1032.12	1032.29	1032.12	-0.06	0.11	-0.22
1175.00	1031.93	1032.06	1032.40 1031.90	1031.75	1031.91	1032.08	1031.91	0.15	0.32	-0.01
VOLUME #		65.76 CU. YD.		ADJUSTMENT #		0.21 FEET				
FILL 0.20				FILL 0.32	1032.26	1032.43	1032.26	0.09	0.17	-0.08
1200.00	1032.06	1032.35	1032.60 1032.18	1031.94	1032.05	1032.22	1032.05	0.30	0.38	0.13
VOLUME #		66.50 CU. YD.		ADJUSTMENT #		0.21 FEET				
FILL 0.21				FILL 0.28	1032.39	1032.56	1032.39	0.0	0.19	-0.13
1225.00	1032.18	1032.39	1032.75 1032.26	1032.11	1032.19	1032.36	1032.19	0.20	0.39	0.07
VOLUME #		68.03 CU. YD.		ADJUSTMENT #		0.20 FEET				
FILL 0.16				FILL 0.25	1032.50	1032.67	1032.50	-0.06	0.14	0.04
1250.00	1032.34	1032.44	1032.81 1032.54	1032.25	1032.33	1032.50	1032.33	0.11	0.31	0.21
VOLUME #		69.33 CU. YD.		ADJUSTMENT #		0.17 FEET				
FILL 0.23				FILL 0.35	1032.62	1032.79	1032.62	-0.09	0.08	-0.15
1275.00	1032.39	1032.53	1032.87 1032.47	1032.27	1032.47	1032.64	1032.47	0.06	0.23	0.0
VOLUME #		69.79 CU. YD.		ADJUSTMENT #		0.15 FEET				
FILL 0.25				FILL 0.27	1032.73	1032.90	1032.73	-0.08	0.16	-0.06
1300.00	1032.48	1032.65	1033.06 1032.67	1032.46	1032.61	1032.78	1032.61	0.04	0.28	0.06
VOLUME #		70.04 CU. YD.		ADJUSTMENT #		0.12 FEET				
FILL 0.13				FILL 0.28	1032.85	1033.02	1032.85	0.09	0.23	-0.01
1325.00	1032.72	1032.94	1033.25 1032.84	1032.57	1032.75	1032.92	1032.75	0.19	0.33	0.09
VOLUME #		71.88 CU. YD.		ADJUSTMENT #		0.10 FEET				
FILL 0.12				FILL 0.24	1032.96	1033.13	1032.96	0.17	0.34	0.00
1350.00	1032.84	1033.13	1033.47 1032.96	1032.72	1032.89	1033.06	1032.89	0.24	0.41	0.07
VOLUME #		75.42 CU. YD.		ADJUSTMENT #		0.07 FEET				

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IOWA RESEARCH PROJECT HRI43

12.00	0.0	1030.70	1030.62
25.00	13.00	1030.64	1030.55
50.00	38.00	1030.53	1030.44
74.00	62.00	1030.43	1030.34
100.00	88.00	1030.31	1030.22
125.00	113.00	1030.20	1030.11
150.00	138.00	1030.10	1030.01
175.00	163.00	1029.99	1029.90
200.00	188.00	1029.88	1029.79
225.00	213.00	1029.77	1029.71
239.70	227.70	1029.72	1029.67
250.00	238.00	1029.69	1029.65
275.00	263.00	1029.62	1029.61
300.00	288.00	1029.56	1029.57
325.00	313.00	1029.52	1029.56
350.00	338.00	1029.50	1029.56
375.00	363.00	1029.49	1029.58
400.00	388.00	1029.50	1029.61
425.00	413.00	1029.52	1029.66
450.00	438.00	1029.56	1029.72
475.00	463.00	1029.61	1029.80
500.00	488.00	1029.68	1029.89
525.00	513.00	1029.77	1029.98
550.00	538.00	1029.87	1030.08
575.00	563.00	1029.98	1030.19
600.00	588.00	1030.11	1030.32
625.00	613.00	1030.25	1030.46
650.00	638.00	1030.39	1030.60
675.00	663.00	1030.53	1030.74
700.00	688.00	1030.67	1030.88
725.00	713.00	1030.81	1031.02
747.92	735.92	1030.94	1031.15
-1.00	747.92	968.93	
975.00	741.99	1030.97	1031.18
1000.00	766.99	1031.11	1031.32
1025.00	791.99	1031.25	1031.46
1050.00	816.99	1031.39	1031.60
1075.00	841.99	1031.53	1031.74
1100.00	866.99	1031.67	1031.88
1125.00	891.99	1031.81	1032.02
1133.00	899.99	1031.85	1032.06
1150.00	916.99	1031.95	1032.16
1175.00	941.99	1032.08	1032.29
1200.00	966.99	1032.22	1032.43
1225.00	991.99	1032.36	1032.56
1250.00	1016.99	1032.50	1032.67
1275.00	1041.99	1032.64	1032.79
1300.00	1066.99	1032.78	1032.90
1325.00	1091.99	1032.92	1033.02
1350.00	1116.99	1033.06	1033.13

PLOT DATA TAPE

Subgrades For Paving

Project No. S-1277(6)

Sta.	Hub	11' Lt.	€	11' Rt.	Hub	11' Lt.	€	11' Rt.	11' Lt.	€	11' Rt.
+25	(C.02)				(F.16)	31.11	30.42	29.71	C.20	C.47	C.06
	31.13	31.31	30.89	29.79	29.55	30.94	30.26	29.56	C.37	C.64	C.23
6+00	(C.10)				(F.17)	30.95	30.26	29.57	C.09	C.34	C.09
	31.05	31.04	30.60	29.66	29.40	30.80	30.11	29.42	C.24	C.49	C.24
+75	(C.03)				(F.29)	30.80	30.11	29.42	C.03	C.31	F.05
	30.83	30.83	30.42	29.37	29.13	30.68	29.99	29.50	C.15	C.43	C.09
+50	(C.03)				(F.34)	30.65	29.96	29.27	C.06	C.31	C.13
	30.68	30.71	30.27	29.40	28.93	30.55	29.86	29.17	C.16	C.41	C.23
+25	(F.03)				(F.35)	30.53	29.84	29.15	C.03	C.33	C.08
	30.50	30.56	30.17	29.23	28.80	30.46	29.77	29.08	C.10	C.40	C.15
5+00	(F.07)				(F.31)	30.42	29.73	29.04	F.04	C.23	C.03
	30.35	30.38	29.96	29.07	28.73	30.37	29.68	28.99	C.01	C.28	C.08
+75	(F.19)				(F.37)	30.32	29.63	28.94	F.12	C.29	F.03
	30.22	30.20	29.92	28.91	28.57	30.30	29.61	28.92	F.10	C.31	F.01
+50	(F.13)				(F.37)						
	30.12	30.03	29.70	28.78	28.80	30.25	29.56	28.87	F.22	C.14	F.09
+25	(F.18)				(F.40)	30.19	29.50	28.81	F.13	C.13	F.06
	30.01	30.06	29.63	28.71	28.41	30.21	29.52	28.85	F.15	C.11	F.08
4+00	(F.05)				(F.34)	30.14	29.45	28.76	F.12	C.17	C.00
	30.09	30.02	29.62	28.76	28.42	30.19	29.50	28.81	F.17	C.12	C.05
+75	(C.04)				(F.27)	30.11	29.42	28.73	F.06	C.31	C.00
	30.15	30.05	29.73	28.73	28.46	30.18	29.49	28.80	F.13	C.24	C.07
+50	(C.10)				(F.19)	30.09	29.40	28.71	C.02	C.34	C.18
	30.19	30.11	29.74	28.89	28.52	30.19	29.50	28.81	F.08	C.24	C.08
+25	(C.04)				(F.17)	30.09	29.40	28.71	F.02	C.39	C.12
	30.13	30.07	29.79	28.83	28.54	30.21	29.52	28.83	F.14	C.27	C.00
3+00	(F.05)				(F.20)	30.10	29.41	28.72	F.07	C.40	C.12
	30.05	30.03	29.81	28.84	28.52	30.25	29.56	28.87	F.22	C.25	F.03
+75	(F.02)				(F.26)	30.14	29.45	28.76	F.13	C.32	C.10
	30.12	30.01	29.77	28.86	28.50	30.31	29.62	28.93	F.30	C.15	F.07
+50	(C.09)				(F.22)	30.18	29.49	28.80	F.04	C.34	C.13
	30.27	30.14	29.83	28.93	28.28	30.38	29.69	29.00	F.24	C.14	F.07
P.C. +39	(F.04)				(F.24)	30.23	29.54	28.85	F.07	F.10	C.33
	30.21	30.20	29.87	28.95	28.67	30.23	29.52	28.85	F.05	C.29	C.06
+25	(F.03)				(F.29)	30.23	29.54	28.85	F.07	F.10	C.33
	30.20	30.13	29.90	29.05	28.75	30.23	29.54	28.85	F.05	C.29	C.06
2+00	(F.20)				(F.28)	30.22	29.73	29.24	F.18	C.20	F.04
	30.02	30.04	29.93	29.20	28.96	30.37	29.80	29.39	F.33	C.05	F.19
+75	(F.35)				(F.45)	30.23	29.87	29.51	F.36	F.03	F.29
	29.88	29.87	29.84	29.27	29.06	30.35	29.99	29.63	F.48	F.15	F.36
+50	(F.47)				(F.67)	30.23	30.00	29.77	F.34	F.17	F.46
	29.76	29.89	29.83	29.31	29.10	30.33	30.10	29.87	F.44	F.27	F.56
+39	(F.60)				(F.55)	30.24	30.14	29.97	F.43	F.21	F.48
	29.64	29.81	29.93	29.49	29.42	30.31	30.21	30.04	F.50	F.28	F.55
+35	(F.60)				(F.45)	30.23	30.26	30.09	F.34	F.06	F.38
	29.63	29.89	30.20	29.71	29.64	30.28	30.21	30.14	F.39	F.11	F.43
1+00	(F.34)				(F.04)	30.24	30.41	30.24	F.20	C.16	C.07
	29.90	30.04	30.57	30.31	30.20	30.26	30.43	30.26	F.22	C.14	C.05
+50	(C.16)				(C.36)	30.42	30.50	30.39	C.29	C.40	C.39
	30.58	30.71	30.90	30.78	30.75	30.36	30.53	30.36	C.35	C.37	C.42
+25	(C.80)				(C.64)	30.59	30.58	30.53	C.67	C.64	C.62
	31.39	31.26	31.22	31.15	31.17	30.47	30.64	30.47	C.79	C.58	C.65
+12	(C.50)				(C.50)	30.67	30.62	30.61	C.50	C.50	C.50
	31.17	31.17	31.12	30.11	31.11	30.53	30.70	30.53	C.64	C.42	C.50

Subgrades For Paving

Project No. S-1277(6)

Sta	Hub	11' Lt.	€	11' Rt.	Hub	11' Lt.	€	11' Rt.	11' Lt.	€	11' Rt.
	(F09)				(E27)	33.13 x10	33.30	33.13	C16	C34	C04
+75	33.04	33.29	33.64	33.17	32.86	33.03	33.20	33.03	C26	C44	C14
	(F12)				(E24)	32.96 x07	33.13	32.96	C17	C34	C00
+50	32.84	33.13	33.47	32.96	32.72	32.89	33.06	32.89	C24	C41	C07
	(F08)				(E23)	32.80 x05	32.97	32.80	C14	C28	C04
+25	32.72	32.94	33.25	32.84	32.57	32.71	32.92	32.75	C19	C33	C09
	(F15)				(F17)	32.63 x02	32.80	32.63	C02	C26	C04
13+00	32.48	32.65	33.06	32.67	32.46	32.61	32.78	32.61	C04	C28	C06
	(F08)				(F20)						
+75	32.39	32.53	32.87	32.47	32.27	32.47	32.64	32.47	C06	C23	C100
	(F01)				(F10)	32.35 x02	32.52	32.35	C09	C29	C19
+50	32.34	32.44	32.81	32.54	32.25	32.53	32.50	32.53	C11	C31	C21
	(F06)				(F13)	32.24 x05	32.41	32.24	C15	C34	C02
+25	32.18	32.39	32.75	32.26	32.11	32.19	32.36	32.19	C20	C39	C07
	(F06)				(F18)	32.12 x01	32.29	32.12	C23	C31	C06
12+00	32.06	32.35	32.60	32.18	32.94	32.05	32.22	32.05	C30	C38	C13
	(F09)				(E27)	32.02 x10	32.19	32.02	C04	C21	F12
+75	31.98	32.06	32.40	31.90	31.71	31.92	32.09	31.92	C14	C31	F02
	(F08)				(E28)	31.90 x12	32.07	31.90	C21	C18	F20
+50	31.82	32.11	32.25	31.70	31.62	31.78	31.85	31.78	C33	C30	F08
	(F08)				(F21)	31.82 x15	31.99	31.82	C22	C36	C10
+33	31.74	32.04	32.25	31.72	31.61	31.88	31.85	31.88	C22	C40	C24
	(F10)				(F28)	31.83 x15	31.96	31.83	C20	C26	F13
+25	31.73	32.03	32.22	31.70	31.55	31.68	31.81	31.68	C25	C41	C02
	(F12)				(E23)	31.84 x17	31.84	31.67	C15	C39	F03
11+00	31.72	31.99	32.23	31.64	31.44	31.67	31.67	31.50	C32	C56	C14
	(F04)				(E22)	31.86 x20	31.73	31.56	C18	C39	F09
+75	31.82	32.04	32.12	31.47	31.34	31.66	31.53	31.36	C38	C59	C11
	(F03)				(F26)	31.87 x12	31.61	31.35	C19	C44	C06
+50	31.90	32.06	32.05	31.41	31.09	31.65	31.39	31.13	C41	C66	C28
	(F07)				(E31)	31.89 x12	31.50	31.11	C09	C39	F05
+25	31.82	31.98	31.89	31.06	30.80	31.64	31.25	30.86	C34	C64	C20
	(C00)				(F29)	31.91 x12	31.38	30.83	C04	C35	F02
10+00	31.91	31.95	31.73	30.83	30.54	31.64	31.11	30.58	C31	C62	C25
	(F12)				(E23)	31.93 x12	31.24	30.55	F04	C32	C01
9+68.9	31.81	31.89	31.56	30.56	30.32	31.63	30.94	30.25	C26	C62	C31
	(F12)				(E23)	31.93	31.24	30.55	F04	C32	C01
7+47	31.81	31.89	31.56	30.56	30.32	31.63	30.94	30.25	C26	C62	C31
	(C02)				(F15)	31.77 x27	31.08	30.39	C00	C42	C06
+25	31.79	31.77	31.50	30.45	30.24	31.60	30.81	30.12	C27	C69	C33
	(C02)				(F04)	31.61 x25	30.92	30.23	C00	C43	C19
7+00	31.63	31.61	31.35	30.42	30.19	31.36	30.67	29.98	C25	C68	C44
	(F01)				(F04)	31.44 x22	30.75	30.06	C02	C48	C21
+75	31.43	31.46	31.23	30.27	30.02	31.22	30.53	29.84	C24	C70	C43
	(F04)				(F18)	31.28 x24	30.59	29.90	C05	C49	C06
+50	31.24	31.33	31.08	29.96	29.72	31.08	30.37	29.70	C25	C69	C26

END
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