OH
SPS-8F
SPS-8R

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February 29, 1996

Mr. Ben Worel, P.E.
Braun Intertec, Inc.
6875 Washington Avenue South
P.O. Box 39108
Minneapolis, MN 55439-0108

Re: Ohio SPS-8 Construction Report
FHWA - LTPP
SME Project No. PP18400

Dear Ben:

Enclosed please find three copies of the construction report for the Ohio SPS-8 project which was built in 1994.

Should you have any questions concerning this report, please contact our office.

Very truly yours,

SOIL AND MATERIALS ENGINEERS, INC.

Cary T. Keller, P.E.
Senior Engineer

Chuck A. Gemayel, P.E.
Senior Associate

Enclosure: Construction Report: Ohio SPS-8 (3 copies)

pc: Erland Lukanen, Braun Intertec
Richard Ingberg, FHWA - LTPP
Monte Symons, FHWA - LTPP

FEDERAL HIGHWAY ADMINISTRATION
Long Term Pavement Performance
Specific Pavement Studies

CONSTRUCTION REPORT ON SPS-8
Ohio Department of Transportation
Control Section DEL-23-17.48
Job No. 380 (94)

Ramp A, Delaware County
Ohio

Report Prepared by:
Soil and Materials Engineers, Inc.
FHWA-LTPP North Central Region
December, 1995

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1.0 INTRODUCTION

The SHRP experimental project SPS-8 studies the environmental effects on pavements in the absence of heavy loads. Four test sections, two rigid pavements and two flexible pavements are constructed for this experiment. The two test sections for each pavement type are constructed with different surface course thicknesses on untreated dense graded aggregate base. The flexible pavement sections are constructed with different base course thickness while the rigid pavement test sections are constructed with the same base course thickness. The design flexural strength for the PCC sections is 550 psi.

1.1 Project Background

An SPS-8 project which contains two flexible and two rigid test sections for the SPS-8 experiment were constructed in Delaware County, Ohio. The general site location is shown in Figure 1. The project was constructed on Ramp A, a north/south on-ramp which carries traffic from SR-229 onto southbound US-23 in Delaware county, Ohio (Fig. 2). The available length of roadway to build the project was 2,850 ft.

1.2 Experimental Cell

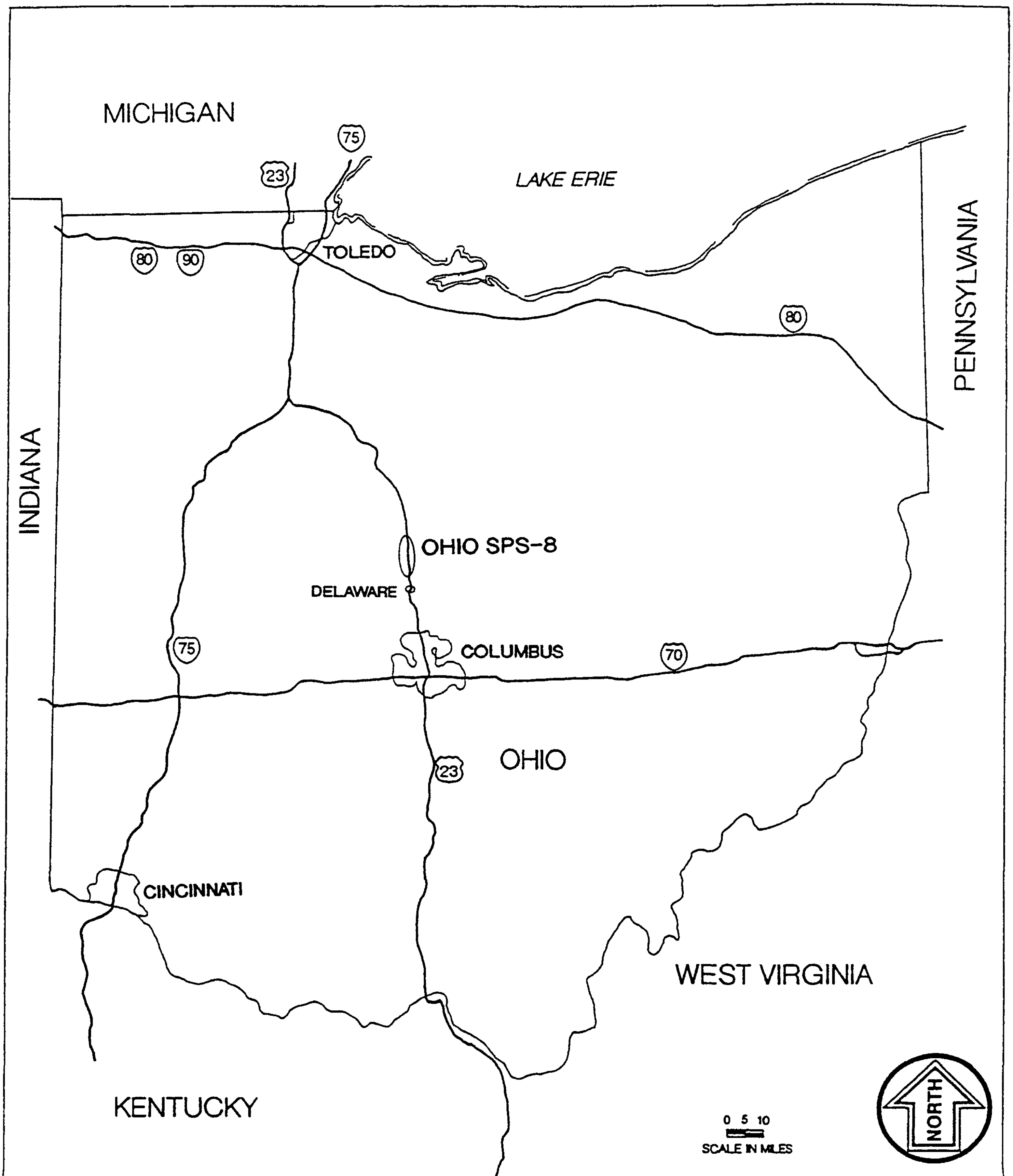
This project falls into the experimental cell for pavements on fine-grained active (frost-susceptible or swelling type relative to the climatic region) soils in the "wet-freeze" environmental zone. Based on Corps of Engineers Design's subgrade soil frost susceptibility criteria, the subgrade soil generally falls into the F4 group which is the most highly frost-susceptible classification.

No supplemental test sections were constructed.

1.3 Construction

The project was advertised for bids in the summer of 1994. The contract, Project 380 (94) was awarded to S.E. Johnson of Findlay, Ohio. Construction of the project began in September, 1994, and ended in November, 1994.

Appendix B contains the project plans, profiles, general notes, and typical sections used for the project. The project was built as a reconstruction of an existing asphalt concrete surfaced pavement. The existing pavement sections at the adjoining sections where the pavement was not reconstructed are shown in Appendix B, Sheet 20. The existing asphalt concrete, brick, subbase and base layers were removed to the subgrade elevation in preparation for construction



Date 2-29-96 Drawn By ARR Scale AS SHOWN Job PP 18400	BAY CITY KALAMAZOO LANSING PLYMOUTH TOLEDO	sme soil and materials engineers, inc.	GENERAL SITE LOCATION DIAGRAM OHIO SPS-8 DELAWARE, OHIO

Figure No. 1

Date 2-29-96 Drawn By ARR Scale AS SHOWN Job PP 18400	BAY CITY KALAMAZOO LANSING PLYMOUTH TOLEDO	sme soil and materials engineers, inc.	SPECIFIC SITE LOCATION DIAGRAM OHIO SPS-8 DELAWARE, OHIO

Figure No. 2

of the new pavement. However, due to poor subgrade conditions, undercuts to a depth of 3 to 4 ft. were required.

1.4 Project Description

Ramp A is a two lane road, having 11 ft. lane widths and 4 ft. wide asphalt concrete shoulders. The test sections are located along the southbound lane. Table 1 provides the SHRP section limits and construction limits while Figure 3 shows the design features of the test sections on a plan view of the project. Typical sections are shown on Sheet 19 in Appendix B.

Table 1
Test Section Layout

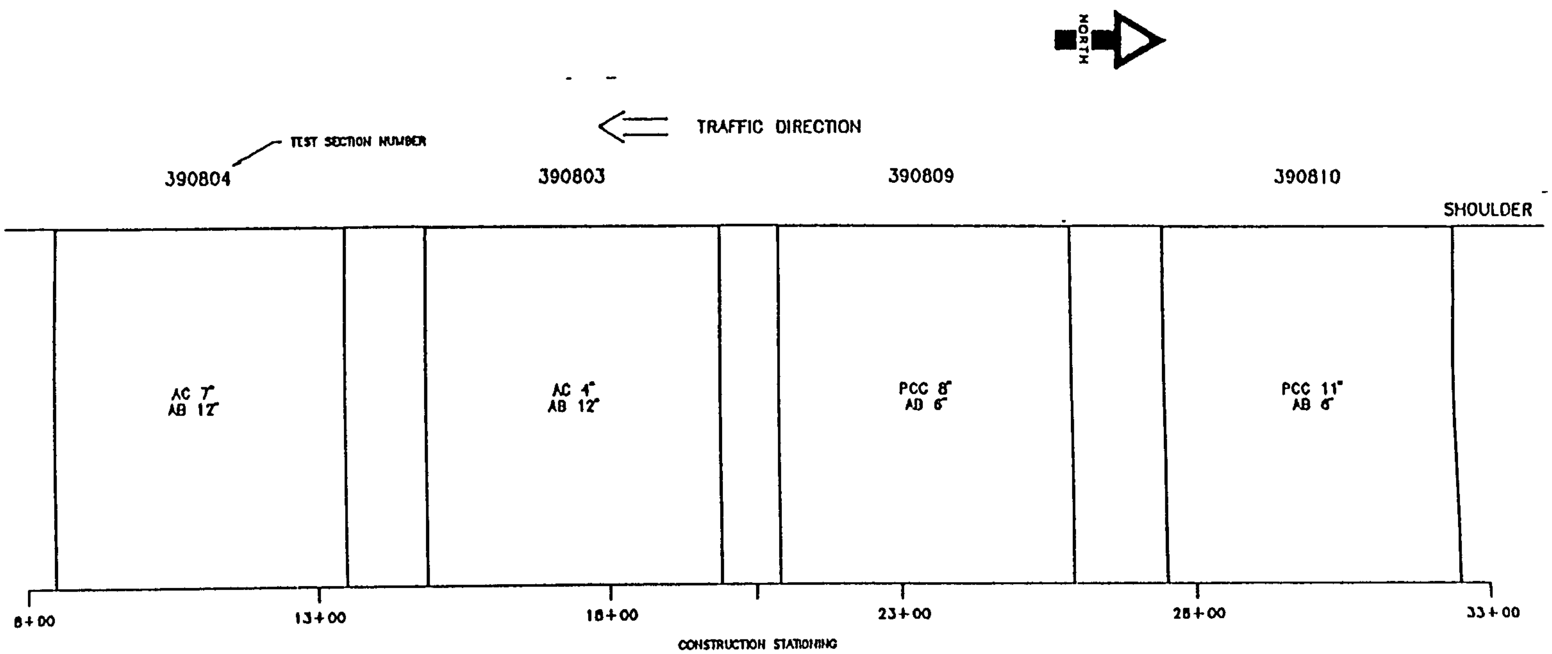
Section No.	Begin Construction	End Construction	Begin 500' Section	End 500' Section
390804	14+40	7+30	13+50	8+50
390803	20+40	14+40	19+90	14+90
390809	26+40	20+40	25+90	20+90
390810	33+50	26+40	32+50	27+50

The terrain in which the project is situated is relatively flat and the alignment is tangent. There are no horizontal curves located in the SHRP areas and the vertical curves range from 200 ft. to 400 ft. in length with grades less than 2%. Sheets 97, 99, 101, and 103 in Appendix B provide the plan and profile of the pavement while Sheets 187 - 193 provide cross sections of the pavement at 50 ft. intervals.

There are several field drives (driveways) which access the road, with traffic generally consisting of automobiles and light trucks. However, the field drives located at Sta 14+00 and 16+00 on the east side of the road are trafficked by heavier farm implements (combines, tractors, etc.). A ditch is present along much of the east side of the road.

1.5 Summary of Known Deviations from Guidelines

The following is a bullet list of known deviations from the site location, construction, and data collection and materials sampling and testing guidelines. The project was designed under the SPS-8 Construction Guidelines dated March, 1992. Construction problems which may impact the performance of the test sections and are not covered by SHRP documents are discussed under



NOTES:

1. EACH TEST SECTION IS 500 FT. LONG

FIGURE 3 DESIGN FEATURES OF TEST SECTIONS project details. The guidelines recommendations regarding construction practices (e. g. placement methods, compaction requirements, etc.) and materials (e. g. design strengths, gradations) were generally followed and will not be discussed unless there was some deviation from the guidelines.

Site Location Deviations:

Underground structures were located within test sections 390804, 390809, and 390810.

Construction Deviations:

DGAB

Compaction of the DGAB was less than 95% of the maximum Modified Proctor density near Sta 5+00 in test section 390809.

Segregation of the DGAB was observed near Sta 5+00 in test section 390809.

Finished elevations varied from the design tolerance of 0.04 ft. based on rod and level surveys. Although the surface was not tested with a 10 ft. straightedge, based on the rod and level surveys, surface irregularities exceeded 1/4 in.

AC

Based on the results of cores taken from 390803, the thickness exceeded the 1/4 in. tolerance.

PCC

Air contents of fresh concrete often exceeded the upper limit of 7-1/2% during paving. Slumps below the 1-1/2 inch recommended for fixed form paving were recorded.

Based on the results of cores taken from 390809, the thickness was below the 1/4 in. tolerance.

Laboratory testing of flexural strength specimens indicated strengths exceeding the 550 psi (+/- 25 psi) requirement.

Data Collection and Materials Sampling and Testing Guidelines Deviations: *Elevations*

Elevation measurements have only a fair correlation with measured pavement thicknesses.

1.5.1 Site Location

Three of the test sections contained underground structures. The placement of test sections over existing underground structures was necessary since this was a reconstruction project which did not allow for regrading and relocating drainage structures and the available project length was only about 1/2 mile. Table 2 provides the location, size, and depth of cover of the underground structures within test sections

Table 2
Underground Structure Locations

Section	Location	Pipe Size	Depth of Cover
390804	0+25	18 in.	5 ft.
390809	1+05	18 in.	5 ft.
390810	4+55	15 in.	4 ft.

Settlement associated with the presence of a drainage structure under 390804 has been observed with about 1 inch of settlement 9 months after construction. Condition surveys performed in 1994 and 1995 did not indicate any distress related to the drainage structures in the other sections.

1.5.2 Construction

DGAB

Compaction of the DGAB was less than 95% of the maximum Modified Proctor density near Sta 5+00 of test section 390809. This was an area where the contractor reduced his compaction efforts to avoid damaging the pavement instrumentation in the base (LVDTs). The lack of compaction was observed when the LVDTs were calibrated with the FWD and most of the deflections occurred in the base.

Segregation of the DGAB was observed near Sta 5+00 in test section 390809. This condition was not corrected prior to paving.

Finished elevations varied from the design tolerance of 0.04 ft. based on rod and level surveys. As a result, the as-built thickness of the layer varied from the design thickness. Although the surface was not tested with a 10 ft. straightedge, based on the rod and level surveys, surface irregularities exceeded 1/4 in. Appendix C contains the results of elevation measurements taken at 50 ft. intervals within the test sections and shows individual thickness differences up to about 3/4 inch within a series of elevation shots taken at the same location. The difference in thickness may be attributable to embankment and DGAB irregularities and to cumulative errors in surveying. Table 3 provides the average as-built thicknesses based on elevation measurements and indicates that on the average the test sections were constructed to the required thickness tolerance.

AC

Table 4 provides the results of cores taken from the asphalt concrete pavements. Based on these results, the thickness of the layer exceeded the 1/4 in. tolerance in section 390803. Based on rod and level surveys, the average as-built thickness of the layer indicated it satisfied the tolerances. The rod and level surveys in test section 390804 indicated the thickness requirement was not met but the results of the coring indicated the thickness satisfied the tolerances. The information contained in Appendix C indicates that individual thickness differences in the test sections of up to about 1 inch within a series of elevation shots taken at the same location occurred. The difference in thickness may be attributable to embankment and DGAB irregularities and to cumulative errors in surveying.

PCC

Table 5 provides the results of slump and air content testing on fresh concrete in the field. The results of materials sampling and testing for the SPS-8 project are provided as are results of state tests on the concrete. The average air content was 7.2% based on 12 tests with a range of 4.9% to 8.7%. Table 6 provides the results of field and laboratory tests on plastic and hardened concrete during placement, at 14 days and at 28 days. A 28 day hardened air content of 6.46% was recorded for a core taken from Sta 5+27 of test section 390810.

Occasional loads of concrete with a slump less than 1-1/2 in. were recorded. The average slump was 1.6 in. based on 10 tests with a range of 1/4 in. to 2-1/2 in.

Table 7 provides the results of cores taken from the PCC pavements. Based on these results, the thickness of the layer in test section 390809 was less than the lower limit based on a 1/4 in. tolerance. This is based on the core thicknesses obtained from 25 ft. before the start of the test section since coring after the test section was performed in a transition area where it is believed the concrete thinned. Based on rod and level surveys, the average as-built thickness of the layer in this section indicated it satisfied the tolerances. The rod and level surveys in test section 390804 also indicated the thickness requirement was met. The information contained in Appendix C indicates that individual thickness differences in the test sections are generally on the order of about 1/2 inch within a series of elevation shots taken at the same location.

TABLE 3
AS-BUILT THICKNESSES BASED ON ELEVATION MEASUREMENTS

TEST SECTION	LAYER	MATERIAL	AVERAGE (IN.)	MINIMUM (IN.)	MAXIMUM (IN.)	STD. DEV. (IN.)
390803	SUBGRADE	SILTY CLAY				
	EMBANKMENT (1)	SILTY CLAY	36.00			
	BASE	DGAB	7.90	7.10	9.00	0.51
	LEVELING	HMAC	2.40	1.80	3.00	0.32
	SURFACE	HMAC	1.50	0.80	2.00	0.26
	AC-COMBINED	HMAC	3.90	3.20	4.70	0.40
390804	SUBGRADE	SILTY CLAY				
	EMBANKMENT (1)	SILTY CLAY	30.00			
	BASE	DGAB	11.90	10.40	13.80	0.64
	LEVELING	HMAC	5.10	4.40	5.80	0.35
	SURFACE	HMAC	1.50	1.20	2.00	0.17
	AC-COMBINED	HMAC	6.60	5.80	7.20	0.35
390809	SUBGRADE	SILTY CLAY				
	EMBANKMENT (2)	SILTY CLAY	24.00			
	BASE	DGAB	6.10	5.40	7.00	0.38
	SURFACE	PCC	7.80	7.10	8.50	0.30
390810	SUBGRADE	SILTY CLAY				
	EMBANKMENT (1)	SILTY CLAY	36.00			
	BASE	DGAB	6.10	5.30	6.60	0.35
	SURFACE	PCC	10.90	10.20	11.60	0.33

NOTES:

1) THE SOILS AT THE ANTICIPATED SUBGRADE ELEVATION WERE UNDERCUT DUE TO POOR SOILS AND EMBANKMENT (BACKFILL) WAS PLACED.

2) THE DEPTH OF UNDERCUT RANGED FROM 4 FT. AT 0+00 TO 0 FT. AT 5+00. THE AVERAGE SHOWN IS BASED ON THE DEPTHS AT 0+00 AND 5+00.

TABLE 4
RESULTS OF ASPHALT CONCRETE CORES

TEST SECTION	CORE NO.	LOCATION	OFFSET (FT.)	THICKNESS (IN.)	COMMENT
390803	C16	0–25	3.7	4.40	
	C15	0–25	5	4.50	
	C14	0–25	6.3	4.50	
	C13	0–25	8	4.50	
			AVG	4.48	
	C12	5+25	3.7	4.25	
	C11	5+25	5	4.25	
	C10	5+25	6.3	4.50	
	C9	5+25	8		CORE THICKNESS RESULTS NOT PROVIDED ON SAMPLING DATA SHEET.
			AVG	4.33	
390804	C8	0–25	3.7	7.00	
	C7	0–25	5	6.88	
	C6	0–25	6.3	7.00	
	C5	0–25	8	7.00	
			AVG	6.97	
	C4	5+25	3.7	6.88	CORE SEPARARATED IN FIELD
	C3	5+25	5	7.00	
	C2	5+25	6.3	6.88	
	C1	5+25	8	7.00	
			AVG	6.94	

TABLE 5
PCC FIELD TEST RESULTS

TEST SECTION	TIME	LOCATION	SLUMP (IN.)	AIR CONTENT (%)	PCC TEMP. (°F)	AIR TEMP (°F)
390809	7:50	4+00	1.5	7.9	69	75
	6:10	1+00	2.5	8.4	70	77
390810	3:20	2+50	1.5	6.4	70	80
	AVERAGE		1.8	7.6	69.7	77.3

NOTES: PAVING STARTED AT NORTH END (390810)

STATE QUALITY CONTROL TESTS

SECTION	TIME	STATION	AIR (%)	SLUMP (IN.)
	12:53		8.70	2.50
		33+50	4.90	0.50
		33+40	6.00	1.50
		33+30	7.50	
		33+15	8.00	
390810	3:20	30+00	6.40	1.50
390809	5:43		5.90	0.25
390809	6:10	24+90	8.40	2.50
390809	7:50	21+90	7.90	1.50
	AVERAGE		7.08	1.50

TABLE 6
PCC FIELD AND LABORATORY TEST RESULTS, 14 AND 28 DAY TESTS

SHRP ID	LOCATION	SAMPLE TYPE	AGE	SLUMP	FIELD AIR	COMPRESSIVE STRENGTH (PSI)	TENSILE STRENGTH (PSI)	FLEXURAL STRENGTH (PSI)	STATIC E MODULUS (PSI) (1)	PCC DENSITY (PCF) (1)	HARDENED AIR CONTENT (%)
390810	B14 (2+50)	CYLINDER	14	1.5	6.4	3140					
	B14 (2+50)	CYLINDER	14	1.5	6.4		395				
	5+27	CORE	14				387				
	0-23	CORE	14			2290				123.5	
	0-25	CORE	14				405				
	B14 (2+50)	CYLINDER	28	1.5	6.4	3790					
	B14 (2+50)	CYLINDER	28	1.5	6.4		470				
	5+27	CORE	28								6 46
	5+25	CORE	28						1450000		
	0-23	CORE	28			1990				122.2	
	0-25	CORE	28								
	0-25	CORE	28				420				
	B14 (2+50)	BEAM	14	1.5	6.4			638			
	B14 (2+50)	BEAM	28	1.5	6.4			808			
390809	B13 (1+00)	CYLINDER	14	2.5	8.4	3130					
	B13 (1+00)	CYLINDER	14	2.5	8.4		376				
	0-25	CORE	14			2810				127.2	
	B13 (1+00)	CYLINDER	28	2.5	8.4	3460					
	B13 (1+00)	CYLINDER	28	2.5	8.4		380				
	0-25	CORE	28			2380				128.5	
	0-27	CORE	28				425				
	0-27	CORE	28						1000000		
	B13 (1+00)	BEAM	14	2.5	8.4			606			
	B13 (1+00)	BEAM	28	2.5	8.4			738			
390809	B12 (4+00)	CYLINDER	14	1.5	7.9	2730					
	B12 (4+00)	CYLINDER	14	1.5	7.9		338				
	5+27	CORE	14			3300				128.3	
	5+25	CORE	14				551				
	B12 (4+00)	CYLINDER	28	1.5	7.9	3350					
	B12 (4+00)	CYLINDER	28	1.5	7.9		365				
	5+27	CORE	28			2870				129.1	
	5+27	CORE	28				650				
	5+25	CORE	28						970000		
	B12 (4+00)	BEAM	14	1.5	7.9			609			
	B12 (4+00)	BEAM	28	1.5	7.9			714			

NOTES: 1) PROCEDURAL MISTAKES ARE BELIEVED TO HAVE BEEN MADE IN PERFORMING THESE TESTS.

TABLE 7
RESULTS OF PORTLAND CEMENT CONCRETE CORES

TEST SECTION	CORE NO.	LOCATION	OFFSET (FT.)	THICKNESS (IN.)	COMMENT
390810	C42	0−25	3	11.25	
	C40	0−25	6	11.25	
	C39	0−25	7.5	11.50	
	C37	0−23	4.5	11.00	
	C36	0−23	6	11.25	
			AVG	11.25	
	C34	5+25	4.5	10.875	
	C31	5+27	4.5	10.875	
	C30	5+27	6	11.00	
			AVG	10.92	
390809	C28	0−27	4.5	7.88	
	C27	0−27	6	7.75	
	C26	0−25	8	7.00	
	C25	0−25	4.5	7.75	
			AVG	7.59	
	C22	5+40	4.5	7.25	
	C21	5+40	6	7.00	CORE LOCATIONS OFFSET TO AVOID INSTRUMENTATION IN PAVEMENT.
	C19	5+42	3	7.38	AS A RESULT THEY WERE TAKEN IN A TRANSITION AREA BETWEEN
	C18	5+42	4.5	7.38	4" AC ON 8" DGAB AND THIS SECTION WHICH HAS 8" PCC ON 6" DGAB
	C17	5+42	6	7.25	
			AVG	7.25	

The difference in thickness may be attributable to embankment and DGAB irregularities and to cumulative errors in surveying.

Laboratory testing of flexural strength specimens indicated strengths exceeding the 14 day 550 psi (+/- 25 psi) requirement. Referring to Table 6, the 14 day flexural strengths of test beams averaged about 620 psi with a range of about 605 to 640 psi.

1.5.3 Data Collection and Sampling and Testing Guidelines Deviations

Elevations

Elevation measurements have only a fair correlation with measured pavement thicknesses. Based on the results of cores, it appears that the thickness determined by the elevations may be slightly lower than the actual thickness. The difference in thickness may be attributable to embankment and DGAB irregularities and to cumulative errors in surveying.

1.6 Traffic Characteristics

The ramp is classified as a rural collector. Ramp A design traffic data is provided in Table 8 below:

Table 8
Ramp A Traffic Data

Current ADT (1994)	500
Design Year ADT (2014)	750
DHV	60
Distribution	50% (See Note)
Trucks	2%
Design Speed	55 mph

Note: A distribution of 50% is shown on the plans, observations of the actual traffic flow suggest that a distribution of 75% is more appropriate. The majority of the traffic (75%) is on the southbound SPS-8 test sections.

Based on an average truck equivalency factor of 1.3 ESAL, and a distribution of 75%, the total ESALs for the 20 year design period would be about 100,000 ESAL. An estimate of about 4,000 ESALs for the year 1994 would be appropriate based on the provided information.

Traffic records from the monitoring equipment installed at the site indicated a total of about 4,500 ESALs for the period from December 15, 1994 through July 31, 1995. Extrapolating this data to a 365 day period results in about 7,200 ESALs. Although this is more than the design traffic, it is below the 10,000 ESAL/year limit for the study. It is believed that once construction of the new mainline pavement is completed this number will be greatly reduced.

1.7 Traffic Monitoring Equipment

A combination weigh-in-motion (WIM) and vehicle classification system was installed between the two concrete test sections. The system was an IRD 1060 with piezoelectric tubes and induction loops to produce a record of the following: wheel load, axle-group load, speed, site identification code, date and time of passage, wheelbase, violation code, axle load, gross-vehicle load, vehicle class, and ESAL. The equipment was installed by International Road Dynamics (IRD) and S.E. Johnson.

1.8 Weather Data Collection

A weather station was installed in 1995 in conjunction with the construction of the SPS projects on the mainline pavement a short distance from the SPS-8 site.

1.9 Pavement Instrumentation

Extensive instrumentation was incorporated into each of the rigid and flexible pavement test sections. The instrumentation on section 390809 (concrete) consisted of measurements of the following seasonal parameters:

1) Temperature
2) Moisture
3) Frost Depth
4) Soil Suction
5) Water Table Elevation

The instrumentation on section 390803 (asphalt concrete) consisted of measurements of the following pavement response parameters:

1) Strain
2) Pressure
3) Displacement

1.10 Project Personnel

The Ohio DOT SHRP coordinator was William Edwards, their LTPP contact for the project was Roger Green, and Brad Young performed the field sampling and testing. The Ohio

DOT project engineer was Lisa Zigmund and the district engineer was Bill Green. The project was constructed in the Ohio Division of Region 5 of the FHWA. FHWA engineers responsible for the coordination of the project construction with ODOT were Andy Garnes and Bob McQuiston. The instrumentation activities were performed by personnel from the Ohio University and other Ohio universities, under the supervision of Dr. Shad Sargand, Ohio University.

A listing of the personnel from the Ohio Department of Transportation, Federal Highway Administration, SHRP North Central Region, and Ohio University who were involved in this project follows.

<u>Ohio Department of Transportation</u>

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Roger Green
Brad Young

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1.11 Contractor Information

The general contractor for the project was S.E. Johnson Company of Findlay, Ohio. Their project engineer was Kevin Hahn. S.E. Johnson's address is:

S.E. Johnson Company
P.O. Box 865
Findlay, OH 45839
(419) 422-8854

They performed the site earthwork, drainage, and asphalt concrete paving.

Hi-Way Paving, Inc. of Columbus, Ohio was the subcontractor for the portland cement concrete paving. Their project engineer was Alan Moore. Hi-Way Paving's address is:

Hi-Way Paving, Inc.
4343 Weaver Court N.
P.O. Box 550
Hillard, OH 43026-0550
(614) 876-1700

1.12 Elevation Measurements

Elevation measurements on all layers were performed by Peterman Associates of Findlay, Ohio, under contract with S.E. Johnson. The elevation measurements were taken at the locations required in the guidelines and also at 50 ft. before and after each section in the area where the cores are taken.

1.13 Field Materials Sampling and Testing

The Ohio D.O.T. conducted all field sampling testing under the supervision of the North Central Region LTPP staff. Falling weight deflectometer testing on all pavement layers, with the exception of the surface layer, was carried out by the Ohio DOT.

1.14 Summary of Construction Equipment and Methods

The following is a summary of key construction equipment and methods used for each layer, construction sequence, and construction methods. Equipment types, plant types, manufacturer's and model numbers are provided where available. Construction was performed according to ODOT's Construction and Materials Specifications (1993), Special Provisions in effect at that time, and the project notes. The Pavement General Notes applicable to the SPS-8 construction project are contained in Appendix B. The construction guidelines for the SPS-8 project were used to draft the project specifications. Section 2.5, Construction Activities, documents construction deviations which may affect the pavement performance and are not covered by the SPS-8 construction guidelines.

Embankment

Excavators, bulldozers, and graders were used to remove the existing pavement. Due to encountering soft, unstable soils at the planned subgrade elevation, deep undercuts were required except in test section 390809 where the undercut depth ranged from about 4 ft. at the beginning of the test section to 0 ft. at the end. This meant that all of the test sections except for 390809 were constructed on an embankment. Since the embankment layer thickness in 390809 varied, it was decided to call the material on which the base was placed the subgrade. End dump trucks were used to place the backfill clay on the subgrade which was then spread into level lifts by a bulldozer and grader. Compaction was performed using a 15 ton self-propelled sheepsfoot roller. The embankment surface was then proofrolled with a tractor drawn pneumatic tired proof roller which consisted of four pneumatic-tired wheels mounted on a rigid steel frame. The proofroller was ballasted with sand and operated at a gross load of 35 tons. The embankment surface was fine graded and trimmed to final elevation by a grader with elevation controls.

DGAB

End dump trucks were used to place the DGAB on the embankment grade which was then spread into level lifts of 4-1/2 to 7 inches (depending on DGAB final thickness) by a bulldozer and grader. Compaction was performed using a 12 ton double drum vibratory roller. The DGAB surface was fine graded and trimmed to final elevation by a grader with elevation controls.

PCC

The PCC pavement was placed using fixed form paving. Figure 4 provides some photos of the paving operations. The PCC was batched at the on-site batch plant and delivered to the site in end dump trucks. The dump trucks deposited the PCC into the spreader from the haul road located off the mainline pavement. The concrete was consolidated with internal vibrators and vibrating screeds. Finishing was accomplished by hand troweling. The surface was tined and a water based membrane curing compound was used for curing. The initial sawcut for contraction joints were usually performed within 22 hours of placement.

The transverse joints were sealed with low modulus silicone sealant. Some traffic had been allowed on the pavement before sealing, however the joints were air-blasted to remove any debris or compressibles which may have entered the reservoir. The asphalt concrete shoulders were constructed in November and the shoulder joint was not sealed.

Asphalt Concrete

The surface of the DGAB was primed prior to placement of the asphalt concrete. The asphalt concrete was produced in S.E. Johnson's drum mix plant located in Marion, Ohio. The material was brought to the site in covered end dump trucks. The trucks deposited the material directly into the hopper of a Blaw Knox PF-180H paver. The single pass laydown width was 15 ft. to pave the 11 ft. lane and the 4 ft. shoulder. The intermediate course was compacted with a 15 ton pneumatic tired roller with a tire pressure of 100 psi, an 11 ton steel wheeled tandem roller, and an 11 ton steel 3 wheeled roller. The surface course was compacted with a 15 ton pneumatic tired roller with a tire pressure of 100 psi, an 11 ton steel wheeled tandem roller, and a 5 ton steel wheeled tandem roller.

2.0 PROJECT DETAILS

2.1 Layout

The layout of the test sections was shown in Table 1 and Figure 3 (Section 1.4 Project Description). Beginning at the north end of the project, the two PCC test sections were constructed followed by the two asphalt concrete test sections.

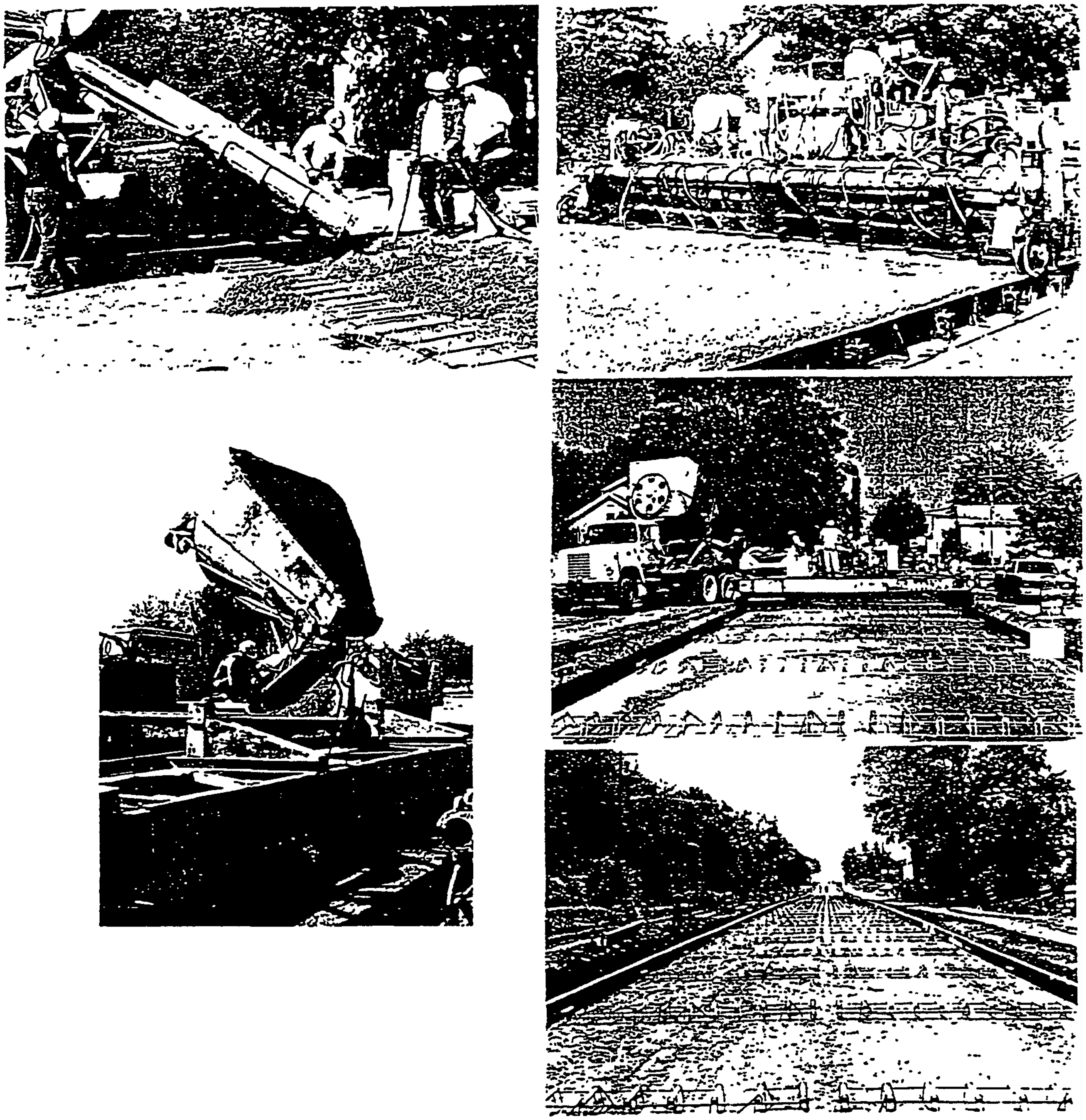


FIGURE 4 PHOTOS OF PCC PAVING OPERATIONS

2.2 As-Built Thicknesses

The average as-built layer thicknesses based on rod and level surveys are provided in Table 3. Tables 4 and 7 (Section 1.5, Summary of Known Deviations from Guidelines) contain the results of the thicknesses of cores obtained from the project.

2.3 PCC Mix Designs

Mix designs for the 550 psi flexural strength PCC were carried out by Bowser Morner Engineers located in Toledo, Ohio, for Hi-Way Construction. Their initial mix design utilized about 34% fly ash (by weight of cement) which exceeds the recommended 15% maximum. This matter was brought to the attention of the LTPP staff and their technical assistance contractor and its use was disallowed. A few days prior to the scheduled placement, two new mix designs were performed, one with 15% fly ash and the other without. The final laboratory mix design is provided in Table 9. Three day beam breaks indicated an average of 450 psi for the fly ash mix and 425 for the mix without fly ash. The decision was made to use the fly ash mix in anticipation of workability and durability problems associated with the lower paste content of the other mix.

On the day of paving, ODOT and SHRP personnel still had some concern about the durability of the mix with such a high water/cement ratio. The first several batches produced that day were used to refine the lab mix design to provide a mix that was workable in the field. The contractor ended up reducing the W/C ratio by reducing the mix water and increased the workability by increasing the amount of air-entraining agent to about twice that used in the lab mix design. With the low amount of paste in the mix, an increase in the amount of air-entraining agent was necessary since the mix air was unstable, but it tended to increase the air content to a level above the 7% allowed by the SPS-8 construction guidelines. Table 10 provides batching information for some of the loads of PCC used on the day of paving. Air content and slumps were noted where they were available.

2.4 AC Mix Design

The asphalt concrete mix designs are provided in Table 11.

2.5 Construction Activities

Table 12 provides the start and end dates for work items on each layer. This section discusses the general timing of the placement of the layers, and provides insight into construction problems not previously covered under the deviations section since they were not specifically requirements set forth by the construction guidelines.

TABLE 9
PCC LABORATORY MIX DESIGN

MATERIAL	PRODUCER	S.G.	ABS.
CEMENT	SOUTHWESTERN CEMENT CO., FAIRBORN, OH	3.15	
TYPE F FLY ASH	APPALACHIAN POWER CO. MOUNTAINEER PLANT #2	2.2	
FINE AGG.	PROSPECT SAND, THORNVILLE, OH	2.58	3.2
COARSE AGG.	NATIONAL LIMESTONE, CAREY, OH	2 62	2.9
WATER	WELL		
AEA, DARAVAIR	W.R. GRACE, CHICAGO, IL		
WRDA, WRDA-82	W.R. GRACE, CHICAGO, IL		

CONCRETE MIX SUMMARY (ONE CUBIC YARD)
MIX NO. HP-01A

MATERIAL			WEIGHT (LBS.)
CEMENT			350
FLY ASH			52
FINE AGG. (SSD)			1358
COARSE AGG. (SSD)			1800
WATER			235
AEA, DARAVAIR	4.02 OZ.		
WRDA, WRDA-82	16.08 OZ.		
		TOTAL	3795

W/C RATIO	0.58
UNIT WEIGHT	140.56
SLUMP	2-1/2"
AIR	7.0

TABLE 10
FIELD PRODUCED BATCH WEIGHTS

TIME 12:53 P.M.
TEST SECTION 390810

MATERIAL	WEIGHT (LBS)	SLUMP (IN)	AIR (%)	W/C	UNIT WT. (PCF)
CEMENT	353	2.5	8.7	0.50	141.3
FLY ASH	56				
FINE AGG. (SSD)	1395				
COARSE AGG. (SSD)	1805				
WATER	205				
AEA, DARAVAIR (0Z)	8.2				
WRDA, WRDA−82 (OZ)	16.0				
TOTAL	3814				

TIME 4:15 P.M.
TEST SECTION 390810

MATERIAL	WEIGHT (LBS)	SLUMP (IN)	AIR (%)	W/C	UNIT WT. (PCF)
CEMENT	348			0.60	142.3
FLY ASH	53				
FINE AGG. (SSD)	1407				
COARSE AGG. (SSD)	1795				
WATER	240				
AEA, DARAVAIR (0Z)	6.7				
WRDA, WRDA−82 (OZ)	16.0				
TOTAL	3843				

TIME 5:43 P.M.
TEST SECTION 390809

MATERIAL	WEIGHT (LBS)	SLUMP (IN)	AIR (%)	W/C	UNIT WT. (PCF)
CEMENT	349	0.25	5.9	0.47	140.7
FLY ASH	52				
FINE AGG. (SSD)	1395				
COARSE AGG. (SSD)	1816				
WATER	187				
AEA, DARAVAIR (0Z)	8.2				
WRDA, WRDA−82 (OZ)	16.0				
TOTAL	3799				

TIME 9:30 P.M.
TEST SECTION 390809

MATERIAL	WEIGHT (LBS)	SLUMP (IN)	AIR (%)	W/C	UNIT WT. (PCF)
CEMENT	351			0.45	140.3
FLY ASH	52				
FINE AGG. (SSD)	1407				
COARSE AGG. (SSD)	1795				
WATER	183				
AEA, DARAVAIR (0Z)	8.1				
WRDA, WRDA−82 (OZ)	16.0				
TOTAL	3788				

TABLE 11
AC MIX DESIGNS

TYPE I SURFACE COURSE

SIEVE	% PASSING
1"	100
3/4"	100
1/2"	96
3/8"	84
#4	45
#8	32
#16	19
#30	12
#50	7
#100	4
#200	3.2

F−T = −2 F/A = 0.48

A.C. CONTENT (%)	6.6
STABILITY	2780
FLOW	10.9
AIR VOIDS (%)	4
VMA	12.7
MAX. THEOR. DENSITY	2.412

MATERIAL	%	SIZE/GRADE	TYPE	SOURCE
CEMENT		AC−20		BITUMINOUS MATERIALS (STONECO), TOLEDO, OHIO
COARSE AGG.	15	7's	LS	NATIONAL LIME & STONE, MARION, OHIO
COARSE AGG.	50	8's	LS	NATIONAL LIME & STONE, MARION, OHIO
FINE AGG.	35	ODOT 703.05	LS	NATIONAL LIME & STONE, MARION, OHIO

TYPE II INTERMEDIATE COURSE

SIEVE	% PASSING
1"	100
3/4"	98
1/2"	81
3/8"	72
#4	59
#8	48
#16	28
#30	17
#50	9
#100	5
#200	3.3

F−T = −3 F/A = 0.53

A.C. CONTENT (%)	6.2
STABILITY	3420
FLOW	9
AIR VOIDS (%)	4
VMA	12.9
MAX. THEOR. DENSITY	2.422

MATERIAL	%	SIZE/GRADE	TYPE	SOURCE
CEMENT		AC−20		BITUMINOUS MATERIALS (STONECO), TOLEDO, OHIO
COARSE AGG.	31	57's	LS	NATIONAL LIME & STONE, MARION, OHIO
COARSE AGG.	13	8's	LS	NATIONAL LIME & STONE, MARION, OHIO
FINE AGG.	56	ODOT 703.05	LS	NATIONAL LIME & STONE, MARION, OHIO

TABLE 12
PLACEMENT DATES FOR LAYERS

TEST SECTION	LAYER	START	END
390803	EMBANKMENT	10/17/94	10/29/94
	BASE	10/31/94	11/04/94
	AC LEVELING	11/12/94	11/12/94
	AC SURFACE	11/14/94	11/14/94
390804	EMBANKMENT	10/25/94	11/04/94
	BASE	11/04/94	11/07/94
	AC LEVELING	11/12/94	11/12/94
	AC SURFACE	11/14/94	11/14/94
390809	EMBANKMENT	9/14/94	9/28/94
	BASE	9/29/94	10/04/94
	PCC	10/07/94	10/07/94
390810	EMBANKMENT	9/14/94	9/28/94
	BASE	9/28/94	10/04/94
	PCC	10/07/94	10/07/94

TABLE 13
FIELD DENSITY TEST RESULTS

TEST SECTION	LAYER	LOCATION	DEPTH (IN.) (1)	DRY DENSITY (PCF) (2)	MOISTURE (%) (3)	COMMENT
390803	SUBGRADE	4+00	48.0	121.6	13.2	
		2+50	48.0	122.2	12.7	
		1+00	48.0	110.1	17.8	
	AVERAGE			118.0	14.6	
	EMBANKMENT	4+00	12.0	114.1	14.7	
		2+50	12.0	115.4	14.0	
		1+00	12.0	114.2	14.7	
	AVERAGE			114.6	14.5	
	DGAB	4+00	4.0	132.3	8.0	
		2+50	4.0	134.0	8.0	
		1+00	4.0	134.8	7.4	
	AVERAGE			133.7	7.8	
390804	SUBGRADE	5+50	40.0	107.3	18.7	BULK SAMPLE LOCATION
		4+00	40.0	121.0	13.7	
		2+50	40.0	105.3	16.9	
		1+00	40.0	117.0	15.5	
		0-50	40.0	117.1	14.0	BULK SAMPLE LOCATION
	AVERAGE			113.5	15.8	
	EMBANKMENT	5+50	19.0	115.9	11.9	BULK SAMPLE LOCATION
		4+00	19.0	115.4	13.7	
		2+50	19.0	110.0	16.6	
		1+00	19.0	113.5	9.2	
		0-50	19.0	114.1	14.7	BULK SAMPLE LOCATION
	AVERAGE			113.8	13.2	
	DGAB	4+00	4.0	132.3	8.0	
		2+50	4.0	134.0	8.0	
		1+00	4.0	134.8	7.4	
	AVERAGE			133.7	7.8	
390809	SUBGRADE	5+35	18.0	109.5	17.0	BULK SAMPLE LOCATION
		3+96	18.0	108.9	17.6	
		2+50	14.0	105.5	15.5	
		1+00	14.5	114.4	15.4	
	AVERAGE			109.6	16.4	
	DGAB	5+15	8.0	120.4	5.8	MOVED FROM PLAN LOCATION DUE TO INSTRUMENTATION AND TEST AREA WAS DRY. AREA ADJACENT HAD DRY DENSITY OF 131 PCF.
		4+00	8.0	134.6	5.3	
		2+50	8.0	134.6	5.9	
		1+00	8.0	130.8	6.5	
	AVERAGE		[illegible]	130.1	5.9	
390810	SUBGRADE	5+48	42.0	110.4	17.3	BULK SAMPLE LOCATION
		2+60	42.0	117.8	14.1	
		0-41	36.0	108.7	18.1	
	AVERAGE			112.3	16.5	
	EMBANKMENT	5+25	17.0	117.8	11.7	BULK SAMPLE LOCATION
		4+00	17.0	115.5	13.2	
		2+50	17.0	118.0	12.9	
		1+00	17.0	117.8	10.5	
		0-50	17.0	117.5	10.2	BULK SAMPLE LOCATION
	AVERAGE			117.3	11.7	
	DGAB	5+50	11.0	137.0	8.9	BULK SAMPLE LOCATION
		4+00	11.0	135.0	5.3	
		2+50	11.0	128.6	4.1	
		1+00	11.0	134.3	4.2	
	AVERAGE			133.7	5.6	

NOTES:
1) DEPTH BELOW FINAL TOP OF PAVEMENT ELEVATION
2) AVERAGE DRY UNIT WEIGHT BASED ON 4 MEASUREMENTS AT TEST LOCATION
3) AVERAGE % MOISTURE BASED ON DRY UNIT WEIGHT AND 4 MEASUREMENTS AT TEST LOCATION

Subgrade

Construction began in September with the removal of the existing asphalt concrete, brick, subbase and base layers at the north end where the PCC sections are located. The removal of the existing pavement at the south end where the AC sections are located began in October.

Poor subgrade conditions (low strength clays at a high moisture content) were encountered after the existing pavement was removed. All of the test sections were undercut up to about 3 to 4 ft. with the exception of 390809 where the undercut depth ranged from 4 ft. at the beginning of the test section to 0 ft. at the end. Work on the embankment backfill was completed by the end of September for the PCC sections and by the first week in November for the AC sections.

DGAB

The construction of the DGAB layer for the PCC pavements began in late September and was completed by the first week of October. The construction of the DGAB layer for the AC pavements began in late October and was completed by the first week of November.

Inadequate compaction was observed in some of the short transition zone areas between sections of different base and surface thicknesses. The transition detail (Appendix B, Sheet 24) indicates that the embankment may be transitioned in a distance of 10 ft. into the thinner of the two adjacent layers. It is believed that there was either inadequate compaction of the embankment or the DGAB in these areas based on the observation of settlements in the flexible pavement sections.

According to observations made by ODOT, the DGAB in the PCC sections was placed in a wet condition (well above optimum moisture). They reported that after a few days of drying, it tightened up and acceptable density test results were obtained.

PCC

The concrete test sections were paved on October 7, 1994. The weather at the time of placement was sunny to partly cloudy with air temperatures generally in the mid 70s to low 80s. The average temperature of the delivered concrete was about 70 degrees. Due to delays associated with a breakdown of the paving train during the placement of the PCC near the transition area between the 8 inch and 11 inch pavements and with delays caused by the finishing operations, paving which began around noon ended at a little after midnight.

There were problems encountered during the production of the mix. Most of them appear to have been related to the low cement content of the mix. Air contents were variable and ranged from 4.9% to 8.7%. Slumps were also inconsistent and ranged from 1/4 inch to 2-1/2 inches.

There were problems encountered in finishing the concrete. Due to the low amount of paste in the mix, excess bleed water was present. The timing of the finishing of the surface may have been too quick, thus trapping excess bleed water below the surface and the surface was refinished several times. Several attempts at tining the surface were necessary to obtain a surface texture that did not sink below the bleed water. Following one winter of service, problems were reported with surface texture abrasion (loss of cement paste at the surface which exposed the fine aggregate) and low severity spalling at transverse joints. An investigation into the matter by the North Central Region LTPP contractor indicated the surface had a thin layer of laitance and was somewhat friable, being easily scratched with a pen knife to a depth of about 3 mm. Some of the paste had worn away, exposing the fine aggregate. Finally, some low severity joint spalling which was believed to be related to the low strength of the surface was noted. Appendix D contains the letter issued by the NC Region and their conclusions regarding the pavement condition and propensity for further deterioration of the surface.

The help of the FHWA was also enlisted to help in determining the cause of the problems (Appendix E, "Report on Examination of Cores: U.S. Route 23 (Columbus, Ohio)"). Cores were taken from both test sections and sent to the Turner-Fairbank Highway Research Center for general visual and microscopic examination and petrographic examination to determine the hardened air content. Testing for the static modulus of elasticity was also requested because there were procedural problems in performing the test by the contractor which ODOT used for the PCC laboratory work.

The results of the FHWA testing are summarized below:

1) The mix proportions used created an unworkable mix which bled excessively and was difficult to finish. A significant number of large, irregular voids and a coarser than usual air void system were noted. The surface problems appeared to stem from improper or poorly timed finishing.

2) The air void system appears to be adequate for paste frost resistance, at least for the limited exposure the pavement had before distress was noted. The high air volume and coarse air void system may be due to a combination of AEA and water reducer, in conjunction with the high W/C ratio.

3) The Modulus of Elasticity results (FHWA's) are more in line with typical values for concrete than those reported by ODOT's contracted testing laboratory.

Observations of the transverse joints indicated that many of the transverse joints appeared to have been sawn with a slight skew on the order of about 1 inch in 11 feet.

AC

The construction of the AC test sections took place during the second week of November. Some problems were encountered achieving compaction of the intermediate (leveling) course. The problem was solved with a reduction in the weight of the steel wheeled roller, although some cracking developed in the shoulders which was probably the result of inadequate compaction of the base or subgrade.

2.6 Materials Sampling and Testing

The materials sampling and testing (MST) requirements for the SPS-8 experiment contained in the document "Specific Pavement Studies Materials Sampling and Testing Requirements for Experiment SPS-8 Study of Environmental Effects in the Absence of Heavy Loads (Operational Memorandum No. SHRP-LTPP-OM-030) dated August, 1992, were used to develop a sampling and testing plan for the project. Plans and soil borings from the original construction were also used. The original MST plan for the project was developed by the North Central Region and was revised in May, 1995, to reflect the as-sampled conditions. A copy of the MST plan can be obtained from the North Central Region office. The locations for field materials sampling and testing for each pavement layer in the test sections are summarized in Appendix F, Figures 3 - 12. A summary of the field and laboratory testing plan is contained in Tables 4 and 5 also in Appendix F.

2.6.1 Field Sampling and Testing

The sampling and testing were conducted in general accordance with the SPS-8 guidelines. The field sampling and testing was conducted by the Ohio Dept. of Transportation.

The results of the field sampling and testing were forwarded to the North Central Region office in Minneapolis, Minnesota. In general, test results which indicated non-compliance with the project specifications have already been discussed. Tables 13 and 14 provide the results of moisture/density testing on soils and density testing on asphalt concrete respectively.

2.6.2 FWD Testing

FWD testing was conducted by ODOT before placement of the surface layers and by the North Central Region FWD after placement of the PCC or AC surface. Testing was conducted on all pavement layers, with the exception of the subgrade, which was usually in a deep cut and inaccessible to the FWD.

Testing was performed along the center of the lane and along the outer wheel path as described in the SHRP Protocol P59. FWD testing on the layers placed before the PCC was performed using a Dynatest Model 8000 Falling Weight Deflectometer. Excessive deflections or variances were encountered at the higher load levels at some locations on the embankment layers and in areas where the DGAB was loose or less compacted such as in transition areas or areas where instrumentation had been placed.

2.6.3 Plate Load Bearing Testing

Plate Load Bearing testing (SHRP Protocol P58) was an optional test and was not conducted for this study.

TABLE 14
ASPHALT CONCRETE FIELD DENSITY TEST RESULTS

TEST SECTION	LAYER	LOCATION	DEPTH (IN.) (1)	WET DENSITY (PCF) (2)	COMPACTION (%) (3)
390803 (4)	INTERMEDIATE	4+00	1.75	139.0	96.6
		2+50	1.75	143.1	99.5
		1+00	1.75	141.7	98.5
	AVERAGE			**141.3**	**98.2**
	SURFACE	4+00	0	135.9	93.6
		2+50	0	135.2	93.1
		1+00	0	133.8	92.2
	AVERAGE			**135.0**	**93.0**
390804 (5)	INTERMEDIATE	4+00	1.75	136.9	95.2
		2+50	1.75	139.3	96.8
		1+00	1.75	137.6	95.7
	AVERAGE			**137.9**	**95.9**
	SURFACE	4+00	0	132.4	91.2
		2+50	0	137.8	94.9
		1+00	0	136.0	93.7
	AVERAGE			**135.4**	**93.3**

NOTES:
1) DEPTH FROM FINAL TOP OF PAVEMENT ELEVATION
2) WET DENSITY BASED ON GAUGE DENSITY + OFFSET VALUE BASED ON CORRELATION WITH CORES.
3) BASED ON MARSHALL BULK DENSITIES FROM SAMPLES COMPACTED IN THE LABORATORY.
4) INTERMEDIATE COURSE = 2-1/4", SURFACE COURSE = 1-3/4"
5) INTERMEDIATE COURSE = 5-1/4", SURFACE COURSE = 1-3/4"

2.6.4 Laboratory Testing

The laboratory test plan for the samples obtained from each pavement layer is summarized in Tables 5 in Appendix F. All soils and bituminous laboratory testing was performed by the Ohio Dept. of Transportation. Testing of hardened concrete was performed by BBC & M Engineers of Columbus, Ohio, under contract with ODOT, except for the following tests:

1. Static modulus of elasticity of PCC cores, air content of hardened PCC, and all tests on 365 day cores. These tests were performed by ODOT and Ohio University.

2. Resilient modulus tests of subgrade, embankment, DGAB, and asphalt concrete. The necessary samples were forwarded to the FHWA-LTPP contractor (Braun Intertec, Inc.)

3. Coefficient of thermal expansion of concrete. Samples were forwarded to the FHWA.

The required samples were shipped to the Materials Reference Library.

2.7 Profile Index

The profile index was determined from California type profilograph traces on the AC test sections only. The profile index for 390803 was 3.2 in./mile and the profile index for 390804 was 3.8 in./mile. The profilograph testing and trace reduction was performed by S.E. Johnson. The sections satisfied the SHRP requirement of a profile index of less than 10 inches per mile.

2.8 Initial Performance

Condition surveys, FWD testing, and profiling were performed on the pavement immediately following opening to traffic in December, 1994. There were no distresses observed in the AC sections and only a small amount of low severity joint spalling was observed in the PCC test section 390809. The results of the condition surveys were forwarded to the North Central Region office in Minneapolis, Minnesota.

The site was visited again in March and July, 1995, to investigate concerns related to the performance of the PCC and AC pavements respectively. FWD testing was also performed on the AC sections in August, 1995 by the State. A summary letter documenting the condition of the PCC test sections was provided in Appendix D and was briefly discussed earlier. A summary letter documenting the condition of the AC test sections can be found in Appendix G. The following sections provides a brief summary of the significant items observed in the condition of the pavement after one year of service:

PCC

The test sections were in excellent condition. However, based on the most recent condition survey, the amount of low severity joint spalling increased on both test sections. The following table contains the results of the December, 1994, survey and the March, 1995, survey.

Table 15
PCC Joint Spalling

SHRP ID	DATE	NO. OF JOINTS SPALLED	LENGTH (m)
390809	12/03/94 3/03/95	6 18	2.1 4.5
390810	12/03/94 3/03/95	0 12	0.0 2.6

A little over 1/2 of the joints on section 390809 were experiencing the low severity joint spalling while almost 1/3 of the joints on section 390810 had some spalling. The spalls were 5 to 25 cm in length and appear to be only about 6 mm deep, about the depth of the surface tining. At all of the spall locations, the silicone joint seal was well adhered to the spalled surface. There was a slight skew to the joints, while the tining appeared to be perpendicular to the lanes. The spalling was generally located adjacent to areas where there was a small sliver of concrete bounded by the tining and the joint.

AC

Wheelpath rutting was reported by the state in both test sections and was most severe in the thinner AC section (390803). In addition, four areas were noted as having settlements.

A pavement condition survey was performed at the site and there was no observable distress in either test section (based on distresses contained in the LTPP Distress Identification Manual). Due to the coarse gradation of the surface course, the pavement had the appearance of low severity raveling/weathering.

Based on stringline measurements, settlements at the four locations tested ranged from 1/4 inch to 1-1/2 inches, were generally across both lanes, and ranged in length from 12 to 20 ft. It appeared that two of the settlements were related to transition areas between two different pavement thicknesses or between the new pavement and the old pavement. Another area of settlement was related to an abandoned 18 inch culvert which was shown on the plans but could not be located in the field.

The outside wheelpath was rutting more than the inside wheelpath on both test sections and section 390803 had deeper ruts than 390804. The average rut depth in test section 390803 was 16.2 mm (0.66 in.) in the outer wheelpath and 8.6 mm (0.33 in.) in the inner wheelpath. The average rut depth in test section 390804 was 4.8 mm (0.19 in.) in the outer wheelpath and 1.8 mm (0.07 in.) in the inner wheelpath.

Preliminary analysis of the FWD deflection data indicated that the subgrade modulus ranged from 2,600 psi to 4,400 psi, with an average value of 3,250 psi. The in-place structural number of the pavement ranged from 1.73 to 2.30 with an average value of 1.96.

APPENDIX A

SPS PROJECT DEVIATION REPORT

LTPP SPS Project Deviation Report Project Summary Sheet	State Code 39 Project Code 0800
Project Classification Information	
SPS Experiment Number: 8	State or Province: OHIO
LTPP Region:	☐ North Atlantic ☒ North Central ☐ Southern ☐ Western
Climate Zone:	☐ Dry-Freeze ☐ Dry-No Freeze ☒ Wet-Freeze ☐ Wet-No Freeze
Subgrade Classification:	☐ Fine Grain ☐ Coarse Grain ☒ Active (SPS-8 Only)
Project Experiment Classification Designation (SPS 1, 2 and 8):	
Construction Start Date: SEPT. 1994	Construction End Date: NOV. 1994
FHWA Incentive Funds Provided to Agency for this Project:	☒ Yes ☐ No
Deviation Summary	
Site Location Deviations:	☐ No Deviations ☒ Minor Deviations ☐ Significant Deviations
Construction Deviations:	☐ No Deviations ☒ Minor Deviations ☐ Significant Deviations
Data Collection and Processing Status Summary	
Inventory Data (SPS 5,6,7,9):	☐ Complete Submission ☐ Incomplete ☐ Data Not Available
Materials Data:	☒ All Scheduled Samples Obtained and Tested ☐ Incomplete/No Test Data
Construction Data:	☒ All Required Data Obtained ☐ Incomplete/Missing Data Elements
Historical Traffic Data:	☐ All Required Historical Estimates Submitted (SPS 5,6,7,9) ☐ Required Estimates Not Submitted
Traffic Monitoring Equipment:	☒ WIM Installed On-Site ☒ AVC Installed On-Site ☐ ATR Installed On-Site ☐ No Equipment Installed
Traffic Monitoring: ☒ Preferred ☐ Continuous ☐ Minimum ☐ Below Minimum ☐ Site Related	
Traffic Monitoring Data:	☒ Monitoring Data Submitted ☐ No Monitoring Data Submitted
FWD Measurements:	☐ Preconstruction Tests Performed ☒ Construction Tests Performed ☒ Post-construction Tests Performed
Profile Measurements:	☐ Preconstruction Tests Performed ☒ Post-construction Tests Performed
Distress Measurements:	☐ Preconstruction Tests Performed ☒ Post-construction Tests Performed
Maint. & Rehab. Data:	☐ Complete Submission ☐ Incomplete ☐ Data Not Available
Friction Data:	☐ Complete Submission ☐ Incomplete ☐ Data Not Available
Report Status	
Materials Sampling and Test Plan:	☒ Document Prepared ☐ Final Submitted to FHWA
Construction Report:	☒ Document Prepared ☐ Final Submitted to FHWA
AWS: (SPS 1, 2, & 8)	☐ AWS Installed ☐ AWS Installation Report Submitted to FHWA

Page 1 of 1 Preparer Cary J. Keller, SME Date 11/12/95

145

APPENDIX B

PLAN, PROFILE, TYPICAL SECTIONS, NOTES

DESIGN DESIGNATION

U.S 23

CURRENT ADT (1994) = 20210
DESIGN YEAR ADT (2014) = 30320
DHV = 2426
D = 55%
T = 12%
DESIGN SPEED = 55 MPH
LEGAL SPEED = 55 MPH
FUNCTIONAL CLASSIFICATION = RURAL ARTERIAL

DESIGN EXCEPTION — APPROVAL DATE
None Required

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
DEL-23-17.48
TROY & MARLBORO TOWNSHIPS
DELAWARE COUNTY

DELAWARE COUNTY | NH-22 (78)

NH-22 (78)
PID 11512

CONVENTIONAL SIGNS

County Line
Township Line
Corporation Line
Fence Line (existing) —x—x— (proposed)
Center Line
Trees, Stumps, (to be removed)
Utility Poles: Telephone, Power, Light
Limited Access (only) —L/A—
Right of Way (only) —R/W—
Limited Access & Right of Way —LA & RW—
Existing Right of Way —R/W—
Property Line (in existing fence)
Railroad
Guardrail (existing) (proposed)

INDEX OF SHEETS

LINE DATA

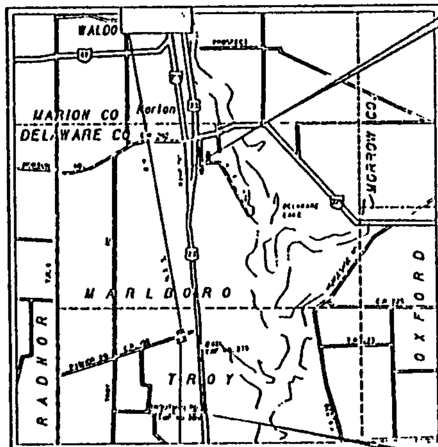
Begin Project = Station 256+08.63
End Project = Station 433+97.27
Station Equation: Sta. 331+37.09 Bk = Sta. 331+37.54 Ah.
Station Equation: Sta. 414+00.04 Bk = Sta. 413+99.62 Ah.
Net Length of Project = 17,788.61 Lin Ft or 3.369 Miles

Begin Work = Station 240+12
End Work = Station 454+95
Station Equation: Sta 256+10.00 Bk. = Sta 256+10.55 Ah.
Station Equation: Sta 331+37.09 Bk = Sta. 331+37.54 Ah.
Station Equation: Sta 414+00.04 Bk. = Sta 413+99.62 Ah.
Total Net Length of Work = 21487.42 Lin Ft. or 4.068 Miles

Plan Prepared By:
OHIO DEPARTMENT OF TRANSPORTATION
BUREAU OF LOCATION AND DESIGN
PLAN PREPARATION SECTION

Projects NH-22 (75)
Date of Letting ,19 , Contract No.

End Project
Sta. 433+97.27
S.L.M. 20.85



Begin Project
Sta. 256+08.63
S.L.M. 17.48

LOCATION MAP
SCALE IN MILES
0 2 4 6

Portion to be Improved
State & Federal Routes
Other Roads

SCALES

Plan: 0 50 100
Profiles: Horizontal 0 50 100, Vertical 0 5 10
Cross Sections: Horizontal 0 10 20, Vertical 0 10 20

UNDERGROUND UTILITIES
TWO WORKING DAYS
BEFORE YOU DIG
Call 800-362-2764 (Toll free)
OHIO UTILITIES PROTECTION SERVICE
NON-MEMBERS MUST BE CALLED DIRECTLY

1993 SPECIFICATIONS

The standard specifications of the State of Ohio Department of Transportation, including changes and supplemental specifications listed in the proposal shall govern this improvement.

I hereby approve these plans and declare that the making of this improvement will not require the closing to traffic of the highway except for the side roads described on sheet 39 , and that provisions for the maintenance of traffic and safety of traffic will be set forth in the plans and estimates.

LIMITED ACCESS

This improvement is especially designed for through traffic and has been declared a limited access highway or freeway by action of the Director in accordance with the provisions of Section 5511.02 of the Ohio Revised Code.

Approved ______
Date 2/22/94 District Deputy Director of Transportation

Approved ______
Date 3-1-94 Engineer, Bureau of Bridges and Structural Design

Approved ______
Date 3-16-94 Deputy Director, Design

Approved ______
Date 3-16-94 Director, Department of Transportation

SUPPLEMENTAL SPECIFICATIONS			
801	1/22/90	944	3/18/92
802	4/13/90	948	2/1/93
820	3/18/92	962	1/23/90
841	5/16/84	910	6-10 81
843	7/29/88		
862	12/16/88		
931	3/18/92		
942	3/18/92		

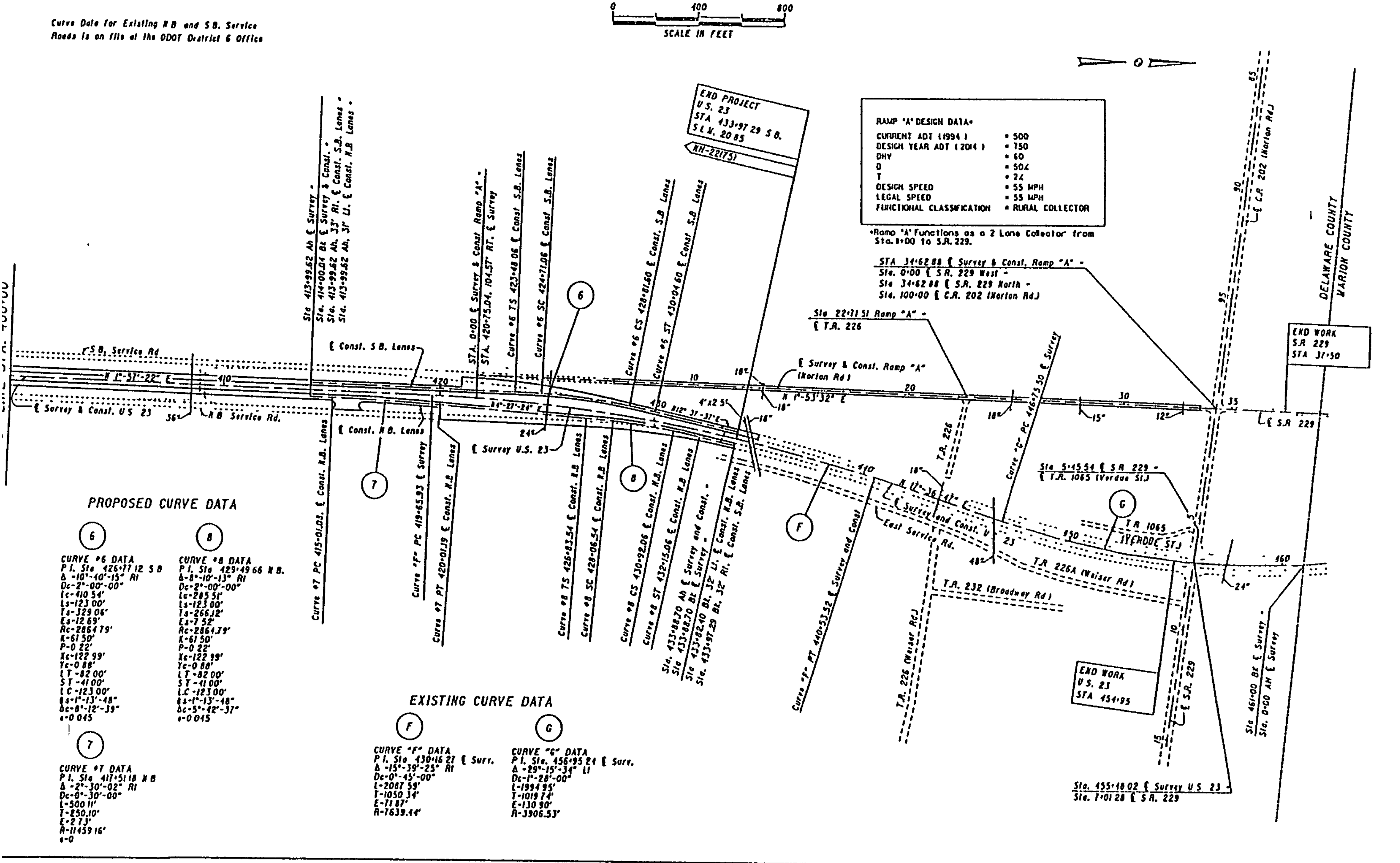
SUPPLEMENTAL PRINTS OF STANDARD CONSTRUCTION DRAWINGS

BP-1J	2/21/92	F-1	1/10/83	HW-4A	4/1/80	HL-10.1	5/1/87	MT-102.10	8/25/89	TC-51.10	1/20/84
BP-2J	2/21/92	F-2	5/1/76	HW-4B	4/1/80	HL-10.13	5/1/87	MT 102 20	8/25/89	TC-51.11	1/20/84
BP-2.2	2/21/92	F-4	1/10/83	I-1	12/18/84	HL-20.11	5/1/87	MT-105.10	7/1/92	TC-52.10	4/3/79
BP-3J	2/21/92	GR-1J	5/6/91	I-3A & B	4/1/80	HL-30.11	5/1/87	MT-105.11	7/1/92	TC-52 20	4/3/79
BP-4J	2/21/92	GR-1.2	10/30/92	MC-1	6/13/69	HL-30 22	5/1/87			TC-61.10	4/5/82
		GR 1.3	2/21/92	MC-4	7/26/76	HL-40.10	5/1/87	TC-22 20	9/1/92	TC-65.10	2/1/90
CB-2-2 A & B	5/1/79	GR-2J	5/6/91	MC-9 2	5/6/91	HL-60.11	5/1/87			TC-65.11	2/1/90
CB-2-3 & 2-4	5/1/79	GR-3J	5/6/91	MC-9 3	10/30/92	HL-60.31	5/1/87	TC-31 21	9/1/92	TC-71.10	9/10/91
CB-2 5 & 2-6	5/1/79	GR 3 4	5/6/91	MC-10	5/1/76	MT-95 30	10/10/28	TC-41.10	8/29/84	TC-72 20	2/26/82
CB-458A	5/1/79	GR-3 5	1/31/94	MC-11	8/1/78	MT-95 40	10/1/92	TC-41 20	3/26/79	TC-82.10	8/29/84
CB-5	1/10/83					MT-99.10	8/14/86	TC-41 50	3/26/79	TC 85 20	1/20/84
CB C	5/1/79	HW 1	6/1/65	MH 1	12/18/84	MT-99 20	4/29/88	TC-42.10	8/19/77	DOA-2-73	4/10/73
		HW-2	6/1/65	MH 3	12/18/84	MT KH 60	7/1/92	TC 42 20	3/26/79	PCB-91	4/24/72

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
APPROVED
DIVISION ADMINISTRATOR — DATE

SCHEMATIC PLAN

Curve Data for Existing N.B. and S.B. Service Roads is on file at the ODOT District 6 Office



PROPOSED CURVE DATA

6

CURVE #6 DATA
P.I. Sta 426+77.12 S.B.
Δ -10°-40'-15" Rt
Dc-2°-00'-00"
Lc-410.54'
Ls-123.00'
Ts-329.06'
Es-12.69'
Rc-2864.79'
K-61.50'
P-0.22'
Xc-122.99'
Yc-0.88'
LT -82.00'
ST -41.00'
LC -123.00'
θs-1°-13'-48"
Δc-8°-12'-39"
e-0.045

8

CURVE #8 DATA
P.I. Sta 429+49.66 N.B.
Δ-8°-10'-13" Rt
Dc-2°-00'-00"
Lc-285.51'
Ls-123.00'
Ts-266.12'
Es-7.52'
Rc-2864.79'
K-61.50'
P-0.22'
Xc-122.99'
Yc-0.88'
LT -82.00'
ST -41.00'
LC -123.00'
θs-1°-13'-48"
Δc-5°-42'-37"
e-0.045

7

CURVE #7 DATA
P.I. Sta 417+51.18 N.B.
Δ -2°-30'-02" Rt
Dc-0°-30'-00"
L-500.11'
T-250.10'
E-2.73'
R-11459.16'
e-0

EXISTING CURVE DATA

F

CURVE "F" DATA
P.I. Sta 430+16.27 ℄ Surv.
Δ -15°-39'-25" Rt
Dc-0°-45'-00"
L-2087.59'
T-1050.34'
E-71.87'
R-7639.44'

G

CURVE "G" DATA
P.I. Sta. 456+95.24 ℄ Surv.
Δ -29°-15'-34" Lt
Dc-1°-28'-00"
L-1994.95'
T-1019.74'
E-130.90'
R-3906.53'

RAMP "A" DESIGN DATA*

CURRENT ADT (1994)	= 500
DESIGN YEAR ADT (2014)	= 750
DHV	= 60
D	= 50%
T	= 2%
DESIGN SPEED	= 55 MPH
LEGAL SPEED	= 55 MPH
FUNCTIONAL CLASSIFICATION	= RURAL COLLECTOR

*Ramp "A" Functions as a 2 Lane Collector from Sta. 1+00 to S.R. 229.

TYPICAL SECTIONS

PAVEMENT LEGENDS

LOCATION OF TYPICAL SECTIONS			
	BEGIN STATION	END STATION	PAGE *
US 23 NORTHBOUND	256+08.63 AH	268+05.62	6
	268+05.62	286+85	7
	286+85	293+25	9
	293+25	302+30	14
	302+30	309+30.13	10
	309+30.13	318+00	16
	318+00	349+25	11
	349+25	365+30	10
	365+30	368+50	363
	368+50	372+75	10
	372+75	377+38	9
	377+38	382+77	10
	382+77	382+93	16
	382+93	404+25	11
	404+25	412+00	10
	412+00	421+64.42	17
	421+64.42	433+82.40 BK	18
US 23 SOUTHBOUND	256+09.34 AH	263+95.05	6
	263+95.05	280+72.96	8
	280+72.96	294+00	7
	294+00	314+00	14
	314+00	334+50	10
	334+50	342+00	13
	342+00	349+00	12
	349+00	356+00	11
	356+00	365+30	10
	365+30	368+50	363
	368+50	376+00	15
	376+00	382+77	13
	382+77	382+93	16
	382+93	385+25	13
	385+25	393+25	10
	393+25	407+25	15
	407+25	414+25	12
	414+25	420+07.17	15
	420+07.17	421+60.14	11
	421+60.14	424+23.16	17
	424+23.16	433+97.29 BK	18
SOUTHBOUND SERVICE RD.	579+10.25	583+50	8
RAMP "A"	7+30	33+50	19
TROUTMAN RD.	198+50	199+17.62	318

No Prime Coat Shall be Placed Directly Above the Underdrain Trench.

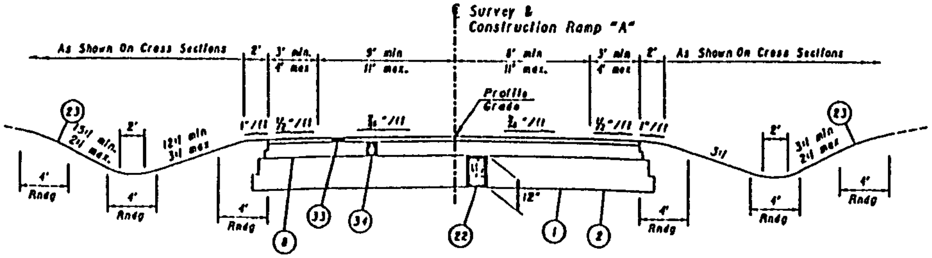
EXISTING LEGEND

- (A) 5" Asphalt Resurfacing
- (B) 9" Reinforced Concrete Pavement
- (C) Asphalt Pavement Depth Unknown
- (D) 8" Aggregate Base
- (E) 2" Asphalt Concrete
- (F) 3¼" Asphalt Resurfacing
- (G) 1¼" Asphalt Concrete
- (H) 2" Bituminous Material
- (I) 2½" Asphalt Concrete
- (J) 3½" Brick
- (K) 1" Sand Cushion
- (L) 8" Waterbound Macadam
- (M) 6" Asphalt Concrete Base
- (N) 1¼" Subbase
- (P) 10" Bituminous Aggregate Base
- (Q) 3" Asphalt Concrete
- (R) Subbase, Thickness as Shown
- (S) Aggregate Base - Depth Unknown

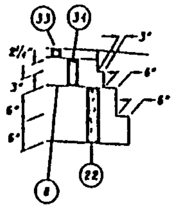
PROPOSED LEGEND

- (1) Item 203 - Subgrade Compaction
- (2) Item 203 - Proof Rolling, as Per Plan (See Sheet 22)
- (3) Item Special - Bituminous Aggregate Base, Depth as Shown (See Sheet 23)
- (4) Item Special - Bituminous Aggregate Base (See chart Sheet 10 for Depth and Sheet 23 for Composition)
- (5) Item 452 - See Chart Sheet 9-11 for description
- (6) Item 446- 2¼" Asphalt Concrete Intermediate Course Type 2 PG 58-30, As Per Plan (See Sheet 24)
- (7) Item 452 - 8" Plain Concrete Pavement, As Per Plan "A" (See Sheet 25)
- (8) Item 408 - Bituminous Prime Coat (Applied at a Rate of 0.40 Gal./Sq. Yd.) *
- (9) Item 446 - 1¼" Asphalt Concrete Surface Course, Type 1, AC-20, As Per Plan (See Sheet 24)
- (10) Item 446 - 1¾" Asphalt Concrete Intermediate Course, Type 2, AC-20, As Per Plan (See Sheet 24)
- (11) Item 446 - 2¼" Asphalt Concrete Intermediate Course, Type 2, AC-20, As Per Plan (See Sheet 24)
- (12) Item 605 - 4" Pipe Underdrain (See Chart Sheets 301-309 for Type, Depth and As Per Plan Notes)
- (14) Item 606 - Guardrail, Barrier Design, Type 5
- (15) Item 622 - Concrete Barrier, Type B, or Type B Reinforced
- (16) Item Special and Item 304 - See Chart Sheet 11 for Description
- (17) Item 408 - Bituminous Prime Coat (Applied at a rate of 0.40 Gal./Sq. Yd.*) See Chart Sheets 11, 12 and 15
- (18) Item 451 - 11" Reinforced Concrete Pavement, As Per Plan "C" (See Sheet 25)
- (19) Item Special and Item 304 - See Chart Sheets 10, 12 and 15 for Description.
- (20) Item Special and Item 304 - See Chart Sheets 10, 12 and 15 for Description.
- (21) Item Special - 4" Asphalt Treated Free Draining Base (See Sheet 26)
- (22) Item 304 - Aggregate Base, as Per Plan, Depth as Shown (See Sheet 24)
- (23) Item 659 - Seeding and Mulching
- (24) Item 452 - 11" Plain Concrete Pavement, as Per Plan "A" (See Sheet 25)
- (25) Item 452 - 11" Plain Concrete Pavement, as Per Plan "B" (See Sheet 25)
- (26) Item 446 - 1¾" Asphalt Concrete Surface Course, Type 1, PG 58-30, as Per Plan (See Sheet 24)
- (27) Item 301 - Bituminous Aggregate Base, AC-20, Depth as Shown
- (28) Item 452 - 11" Plain Concrete Pavement, as Per Plan "C" (See Sheet 25)
- (29) Item Special - 12" Bituminous Aggregate Base (See Sheet 23)
- (30) Item Special - 6" Lean Concrete Base (See Sheet 23)
- (31) Item Special - 4" Cement Treated Free Draining Base (See Sheet 27)
- (32) Item Special - 4" Base (See Chart Sheet 10)
- (33) Item 446 1¾" Asphalt Concrete Surface Course Type 1, AC-20, As Per Plan (See Sheet 24)
- (34) Item 446 5¼" Asphalt Concrete Intermediate Course Type 2, AC-20, As Per Plan (See Sheet 24)

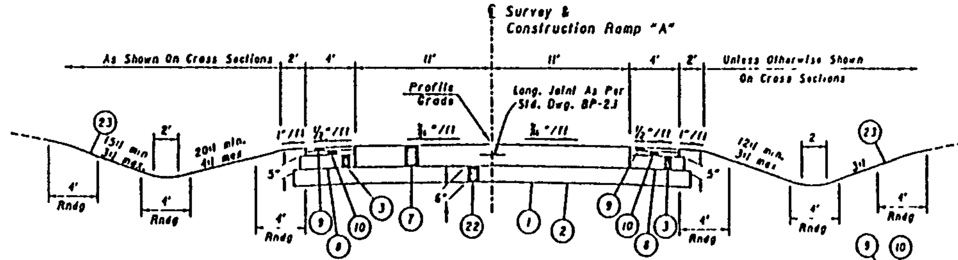
TYPICAL SECTIONS
VARIOUS PAVEMENT TYPES



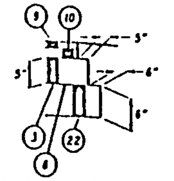
NORMAL CROWN SECTION
SECTION APPLIES :
Sta 7+30 to Sta 14+40 - 710.00 Lin. Ft (S.H.R.P. #390804)



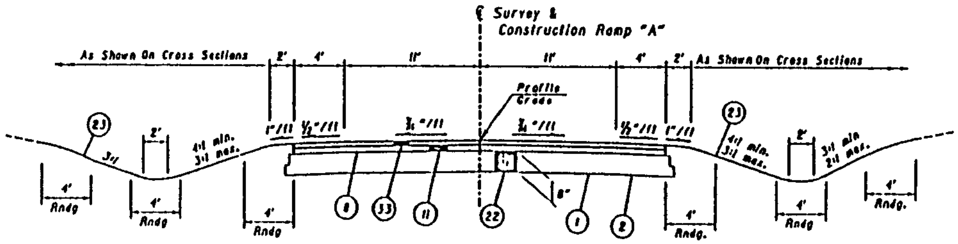
EDGE DETAIL "A"
(Applies Sta. 7+30 to Sta. 14+40)



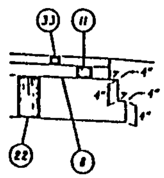
NORMAL CROWN SECTION
SECTION APPLIES :
Sta 20+40 to Sta. 26+40 - 600.00 Lin Ft (S.H.R.P. #390809)



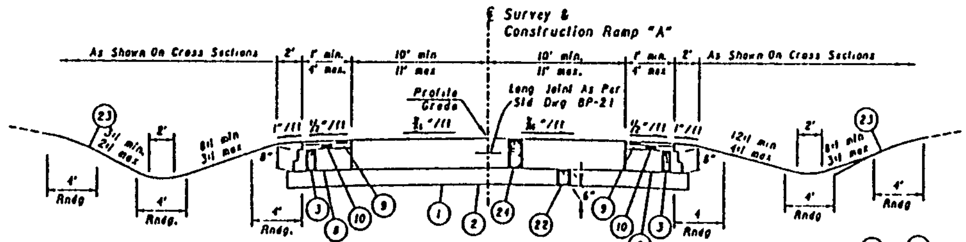
EDGE DETAIL "C"
(Applies Sta 20+40 to Sta 26+40)



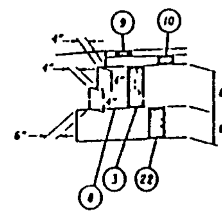
NORMAL CROWN SECTION
SECTION APPLIES :
Sta 14+40 to Sta. 20+40 - 600.00 Lin. Ft (S.H.R.P. #390803)



EDGE DETAIL "B"
(Applies Sta. 14+40 to Sta 20+40)



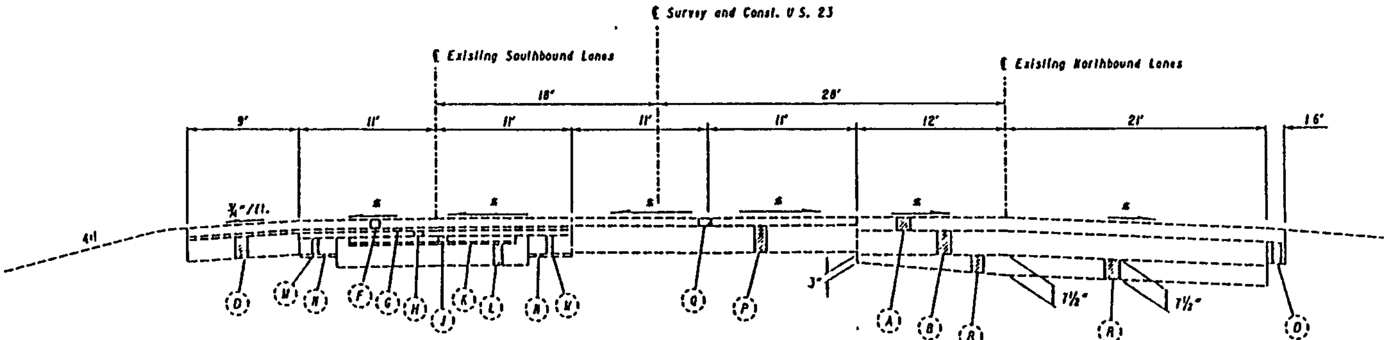
NORMAL CROWN SECTION
SECTION APPLIES :
Sta 26+40 to Sta. 33+50 - 710.00 Lin. Ft.(S.H.R.P. #390810)



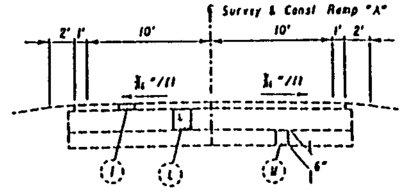
EDGE DETAIL "D"
(Applies Sta 26+40 to Sta 33+50)

For Proposed Legend See Sheet 5.

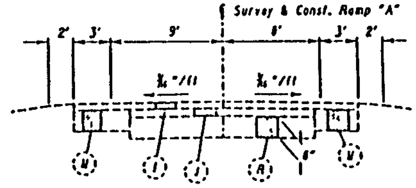
ADJOINING TYPICAL SECTIONS



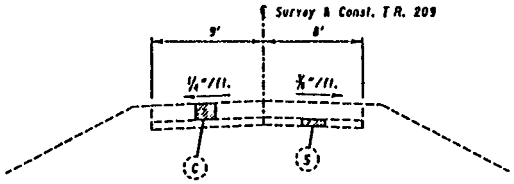
ADJOINING SECTION
SECTION APPLIES :
Sta. 255+61.15 ℄ Survey and Const. (Southbound Lanes Only)
Sta. 256+10.00 BK ℄ Survey and Const. (Northbound Lanes Only)



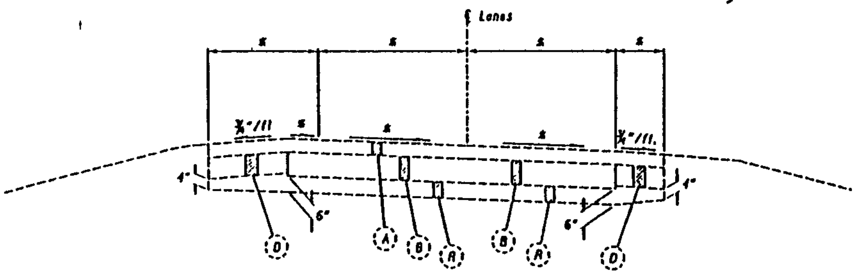
ADJOINING SECTION
SECTION APPLIES :
Sta. 33+50 RAMP "A"



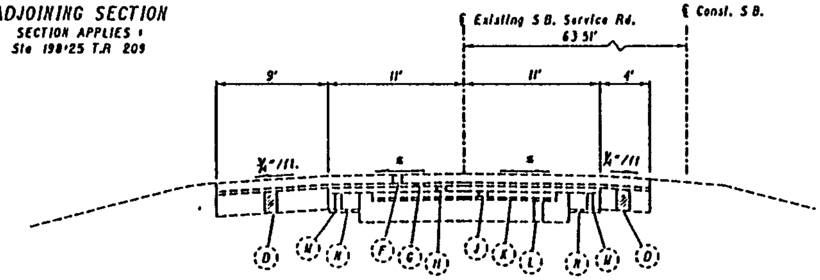
ADJOINING SECTION
SECTION APPLIES :
Sta. 6+30 RAMP "A"



ADJOINING SECTION
SECTION APPLIES :
Sta. 198+25 T.R. 209



ADJOINING SECTION
SECTION APPLIES :
Sta. 268+05.62 ℄ Const. N.B. (Northbound Service Rd. Only)
Sta. 120+08.36 ℄ Const. N.B. (Northbound Service Rd. Only)
Sta. 421+60.14 ℄ Const. N.B. (Southbound Service Rd. Only)
Sta. 433+88.70 AH ℄ Survey and Const. (Northbound Lanes Only)
Sta. 434+88.70 AH ℄ Survey and Const. (Southbound Lanes Only)



ADJOINING SECTION
SECTION APPLIES :
Sta. 284+50.00 ℄ Const. S.B. Service Rd.

* See Pavement Detail Sheets for Varying Dimensions and Slopes

For Existing Legend See Sheet 5

GENERAL NOTES

PROJECT DESCRIPTION
THE PURPOSE OF THIS PROJECT IS TO CONSTRUCT AND INSTRUMENT FOUR EXPERIMENTS FOR THE STRATEGIC HIGHWAY RESEARCH PROGRAM (SHRP). SPS-1, THE STUDY OF STRUCTURAL FACTORS FOR FLEXIBLE PAVEMENTS CONSISTS OF FIFTEEN SECTIONS IN THE SOUTHBOUND LANES. SPS-2, THE STUDY OF STRUCTURAL FACTORS FOR RIGID PAVEMENTS CONSISTS OF EIGHTEEN SECTIONS IN THE NORTHBOUND LANES. SPS-8, THE STUDY OF ENVIRONMENTAL FACTORS ON FLEXIBLE AND RIGID PAVEMENTS CONSISTS OF FOUR SECTIONS CONSTRUCTED ON RAMP A. SPS-9, THE STUDY TO VALIDATE THE SHRP MIX DESIGN PROCEDURES, CONSISTS OF TWO SECTIONS CONSTRUCTED IN THE SOUTHBOUND LANES.

DUE TO THE EXPERIMENTAL NATURE OF THIS PROJECT, STRICT TOLERANCE REQUIREMENTS ON THICKNESS AND ELEVATION WITHIN THE SHRP TEST SECTIONS HAVE BEEN SPECIFIED AND WILL BE ENFORCED. THE CONTRACTOR IS REQUIRED TO ALLOW ACCESS AND TIME FOR SHRP RELATED MATERIALS SAMPLING AND PAVEMENT INSTRUMENTATION INSTALLATION TO BE PERFORMED BY OTHERS BEFORE PROCEEDING WITH CONSTRUCTION OF OVERLAYING PAVEMENT LAYERS. A COPY OF THE MATERIALS SAMPLING AND TESTING PLAN, AND A COPY OF THE PAVEMENT INSTRUMENTATION PLAN WILL BE AVAILABLE IN CONTRACT SALES FOR REVIEW PRIOR TO BIDDING. THE CONTRACTOR WILL BE RESPONSIBLE FOR PATCHING OF SHRP RELATED MATERIAL SAMPLING CORE HOLES AND BACKFILLING BULK SAMPLING EXCAVATIONS WITH LIKE MATERIAL. A MINIMUM 48 HOURS NOTICE WILL BE GIVEN THE ENGINEER WHEN THE SHRP TEST SECTIONS ARE PREPARED FOR MATERIALS SAMPLING.

WITH THE EXCEPTION OF GRADING, DRAINAGE (NOT INCLUDING UNDERDRAINS), AND SUBGRADE PREPARATION, CONSTRUCTION OF ALL SECTIONS IN A S.H.R.P. EXPERIMENT (SPS-1, SPS-2 SPS-8 OR SPS-9) SHALL BE COMPLETED IN THE SAME CALENDAR YEAR. UNDERDRAINS SHALL BE INSTALLED IN THE SAME CALENDAR YEAR AS THE PAVEMENT. SEE SHEET 358 FOR EXPERIMENT LIMITS.

ANY PAVEMENT LAYER PLACED WITHIN A 600' SHRP SECTION WILL BE COMPLETED IN THE SAME DAY. NO TRANSVERSE CONSTRUCTION JOINTS WILL BE PERMITTED WITHIN A SHRP SECTION. SEE SHEET 358 FOR SHRP TEST SECTION LOCATIONS.

A PREBID CONFERENCE WILL BE CONDUCTED AT LEAST TWO WEEKS PRIOR TO THE SALE OF THIS PROJECT. CONTRACT SALES WILL NOTIFY PLAN HOLDERS OF THE CONFERENCE. MINUTES FROM THE CONFERENCE WILL BE CONSIDERED AN ADDENDUM TO THIS PROJECT.

COMPLETION DATES
THE INTERIM COMPLETION DATE FOR PHASE 2B (SEE SHEET 33 FOR DETAILS) SHALL NOT BE EXTENDED FOR DELAYS EXCEEDING THOSE SPECIFIED IN THE SCHEDULE IN CMS 108.06.

THE INTENT OF THIS PLAN IS TO CONSTRUCT THE WORK IN PHASE 2A BEFORE THAT OF PHASE 2B. IN THE EVENT THAT PHASE 2B IS COMPLETED BEFORE PHASE 2A THE INTERIM COMPLETION DATE FOR PHASE 2A SHALL BE THE SAME AS THAT FOR PHASE 2B.

TEMPORARY SOIL EROSION AND SEDIMENT CONTROL
THE FOLLOWING ESTIMATED QUANTITIES ARE TO BE USED AS DIRECTED BY THE ENGINEER FOR TEMPORARY EROSION AND CONTROL MEASURES:

ITEM 207 - TEMPORARY SEEDING AND MULCHING	299,000 SQ. YD.
ITEM 207 - STRAW OR HAY BALES	350 EACH
ITEM 207 - TEMPORARY DITCH PROTECTION	6000 SQ. YD.
ITEM 207 - TEMPORARY BENCHES, DAMS, AND SEDIMENT BASINS	500 CU. YD.
ITEM 207 - FILTER FABRIC FENCE	7500 LIN. FT.
ITEM 601 ROCK CHANNEL PROTECTION, TYPE C, WITHOUT FILTER	45 CU. YD.
ITEM 659 - MOWING	074 M SQ. FT.
ITEM 659 - COMMERCIAL FERTILIZER	29 TON
ITEM 659 - REPAIR SEEDING AND MULCHING	16,000 SQ. YD.
ITEM 659 - WATER	.646 M GAL.

TEMPORARY SEEDING IS PROVIDED FOR THE ENTIRE EXISTING UNPAVED MEDIAN. THIS ADDITIONAL SEEDING IS REQUIRED BECAUSE THE MEDIAN WILL BE LEFT EXPOSED AFTER THE FIRST CONSTRUCTION SEASON. SEE THE MAINTENANCE OF TRAFFIC SEQUENCE OF OPERATIONS FOR DETAILS.

EROSION CONTROL
ITEM 601 IS PROVIDED IN THE PLANS FOR EROSION CONTROL. THE ENGINEER SHALL CHECK AND NON-PERFORM QUANTITIES OR ADJUST LOCATIONS AND QUANTITIES OF THIS ITEM WHERE INDICATED BY FIELD CONDITIONS DURING CONSTRUCTION. IN ADDITION, THIS ITEM SHALL MEET THE REQUIREMENTS OF CMS 108.04.

ITEM 201 CLEARING AND GRUBBING
ALTHOUGH THERE ARE NO TREES AND/OR STUMPS SPECIFICALLY MARKED FOR REMOVAL WITHIN THE LIMITS OF THIS PROJECT, A LUMP SUM QUANTITY HAS BEEN INCLUDED IN THE GENERAL SUMMARY FOR ITEM 201, CLEARING AND GRUBBING. ALL PROVISIONS AS SET FORTH IN THE SPECIFICATIONS UNDER THIS ITEM SHALL BE FOLLOWED AND ALL COSTS SHALL BE INCLUDED IN THE LUMP SUM PRICE BID FOR ITEM 201 CLEARING AND GRUBBING.

CONSTRUCTION INITIATION
THE CONTRACTOR WILL ADVISE THE DISTRICT COMMUNICATIONS OFFICE AT (614) 363-1251, EXTENSION 261, OR BY FAX (614) 469-0235 SEVEN DAYS PRIOR TO THE START OF CONSTRUCTION ACTIVITES. THE PROJECT ENGINEER WILL PROVIDE ASSISTANCE/CLARIFICATION FOR ANY QUESTIONS.

UNSUITABLE MATERIAL
ANY UNSUITABLE MATERIAL ENCOUNTERED BENEATH PROPOSED PAVEMENT AREAS SHALL BE REMOVED TO A DEPTH OF 18 INCHES BELOW THE PROPOSED TOP OF SUBGRADE. THE UNDERCUT AREA SHALL EXTEND TO ONE FOOT OUTSIDE THE SHOULDER EDGE. THE UNDERCUT AREA SHALL BE REPLACED WITH SUITABLE ITEM 203 EMBANKMENT MATERIAL.

UNSUITABLE MATERIAL SHALL BE DEFINED AS MATERIAL IN WHICH, DUE TO NO FAULT OR NEGLECT OF THE CONTRACTOR, SATISFACTORY STABILITY CANNOT BE OBTAINED BY MOISTURE CONTROL AND COMPACTION AS PROVIDED FOR UNDER 203.11 AND 203.13(e).

THE FOLLOWING CONTINGENCY QUANTITIES ARE PROVIDED FOR THE REPLACEMENT OF UNSUITABLE MATERIAL TO BE USED AS DIRECTED BY THE ENGINEER.

ITEM 203 - EMBANKMENT	1,000 CU YD
ITEM 203 - EXCAVATION NOT INCLUDING EMBANKMENT CONSTRUCTION	1,000 CU YD.

GENERAL NOTES

ITEM SPECIAL IMPACT ATTENUATOR, TYPE I, BIDIRECTIONAL
THIS WORK SHALL CONSIST OF FURNISHING AND INSTALLING AN IMPACT ATTENUATOR SYSTEM.

THE IMPACT ATTENUATOR SYSTEM SHALL BE ONE OF THE FOLLOWING:

1. THE BREAKMASTER IMPACT ATTENUATING SYSTEM MANUFACTURED BY ENERGY ABSORPTION SYSTEMS, INC. ONE EAST WACKER DRIVE, CHICAGO ILLINOIS 60601 (TELEPHONE 312-467-6750).

2. THE C.A.T. IMPACT ATTENUATING SYSTEM MANUFACTURED BY SYRO STEEL COMPANY, 1170 N. STATE STREET, GIRARD, OHIO 44420 (TELEPHONE 216-545-4373).

THE ATTENUATOR SHALL BE DESIGNED FOR BIDIRECTIONAL IMPACTS AND SHALL BE PLACED IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS AND AT THE LOCATIONS SHOWN ON THE PLANS.

THE NOSE OF THE ATTENUATOR SHALL BE MARKED WITH THREE EVENLY SPACED, FOUR (4) INCH WIDE HORIZONTAL STRIPES OF WHITE REFLECTIVE MATERIAL MEETING THE REQUIREMENTS OF CMS 730.19.

PAYMENT FOR THE ABOVE WORK SHALL BE MADE AT THE UNIT PRICE BID FOR ITEM SPECIAL, EACH, IMPACT ATTENUATOR, TYPE I. THIS PRICE SHALL INCLUDE FULL PAYMENT FOR ALL LABOR, TOOLS, EQUIPMENT AND MATERIALS NECESSARY TO COMPLETE THIS ITEM IN PLACE, INCLUDING ALL RELATED HARDWARE, NOT SEPERATELY SPECIFIED, AS REQUIRED BY THE MANUFACTURER TO CONSTRUCT A COMPLETE AND FUNCTIONAL IMPACT ATTENUATOR SYSTEM

ITEM 606 ANCHOR ASSEMBLY, TYPE E
THIS ITEM SHALL CONSIST OF FURNISHING AND INSTALLING AN ET-2000, OPTION "B", GUARDRAIL END TERMINAL AS MANUFACTURED BY SYRO STEEL COMPANY, 1170 N STATE STREET GIRARD, OHIO 44420 (TELEPHONE 216-545-4373).

THE LENGTH OF THE ET-2000 SYSTEM IS CONSIDERED TO BE 50', INCLUSIVE OF TWO 25' LONG RAIL ELEMENTS. INSTALLATION SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS AND AT THE LOCATIONS SHOWN IN THE PLANS

PAYMENT FOR THE ABOVE WORK SHALL BE MADE AT THE UNIT BID PRICE FOR ITEM 606, EACH ANCHOR ASSEMBLY, TYPE E AND SHALL INCLUDE ALL LABOR, TOOLS, EQUIPMENT AND MATERIALS NECESSARY TO CONSTRUCT A COMPLETE AND FUNCTIONAL ANCHOR ASSEMBLY SYSTEM, INCLUDING ALL RELATED HARDWARE, NOT SEPARATELY SPECIFIED, AS REQUIRED BY THE MANUFACTURER.

ELEVATIONS
ALL ELEVATIONS ARE BASED ON USGS DATUM SEE SHEET 359.

BRIDGE RAILING REMOVED, AS PER PLAN
BRIDGE RAILING REMOVED, AS PER PLAN SHALL CONSIST OF REMOVAL OF DEEP BEAM RAIL AND TUBULAR BACKUP. POSTS AND THEIR ANCHORINGS ARE TO REMAIN IN PLACE.

ROUNDING OF CORNERS SHOWN ON CROSS SECTIONS
THE ROUNDED CORNERS SHOWN ON THE TYPICAL SECTIONS, APPLY TO ALL CROSS SECTIONS EVEN THOUGH OTHERWISE SHOWN ON THESE PLANS.

CONTINGENCY QUANTITIES
THE CONTRACTOR SHALL NOT ORDER MATERIALS OR PERFORM WORK LISTED IN THE GENERAL SUMMARY FOR ITEMS DESIGNATED BY PLAN NOTE TO BE USED "AS DIRECTED BY THE ENGINEER" UNLESS AUTHORIZED BY THE ENGINEER. THE ACTUAL WORK LOCATIONS AND QUANTITIES USED AT THE ENGINEER'S DISCRETION SHALL BE MADE A MATTER OF RECORD BY INCORPORATION INTO THE FINAL CHANGE ORDER GOVERNING COMPLETION OF THIS PROJECT.

UNDERGROUND UTILITIES
THE LOCATION OF THE UNDERGROUND UTILITIES SHOWN ON THE PLANS ARE AS OBTAINED FROM THE OWNERS OF THE UTILITY AS REQUIRED BY SECTION 153.64 ORC.

UTILITY OWNERSHIP
THE FOLLOWING UTILITIES ARE LOCATED WITHIN THE WORK LIMITS OF THIS PROJECT:

1) COLUMBUS SOUTHERN POWER/OHIO POWER COMPANY.
215 N. FRONT STREET
COLUMBUS, OHIO 43215
614-464-7911

2) GTE NORTH INC.
550 LEADER STREET
MARION, OHIO 43302
614-383-0509

WORK LIMITS
THE WORK LIMITS SHOWN ON THESE PLANS ARE FOR PHYSICAL CONSTRUCTION ONLY. THE INSTALLATION AND OPERATION OF ALL TEMPORARY TRAFFIC CONTROL DEVICES REQUIRED BY THESE PLANS SHALL BE PROVIDED BY THE CONTRACTOR WHETHER INSIDE OR OUTSIDE THESE WORK LIMITS.

WORK LIMITS
MONUMENTS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE DETAILS AS SHOWN ON THE STANDARD CONSTRUCTION DRAWINGS AND AT THE LOCATIONS SHOWN ON SHEET NOS. 355 AND 356.

REFERENCE MONUMENTS INSTALLED OUTSIDE NORMAL WORK LIMITS
ALTHOUGH NOT INCLUDED IN THE WORK LIMITS SHOWN ON THE PLAN AND PROFILE SHEETS, SOME ITEM 604 REFERENCE MONUMENTS ARE TO BE INSTALLED ALONG THE RIGHT-OF-WAY LINE AS PER SHEET 355.

ITEM 203, PROOF ROLLING, AS PER PLAN
THE REQUIREMENTS OF ITEM 203, PROOF ROLLING, SHALL APPLY EXCEPT:

THE FINISHED SURFACE SHALL NOT VARY MORE THAN 1/4 INCH IN 10 FEET.

MOISTURE CONTENT OF THE COMPACTED SUBGRADE OR EMBANKMENT SOIL SHALL BE BETWEEN 85% AND 120% OF THE OPTIMAL MOISTURE CONTENT. THE CONTRACTOR WILL MAINTAIN THE SUBGRADE AT THE SPECIFIED MOISTURE CONTENT AND DENSITY UNTIL THE NEXT PAVEMENT LAYER IS PLACED.

THE CONTRACTOR SHALL USE COMPETENT PERSONNEL AND SUITABLE EQUIPMENT TO DETERMINE THE ELEVATION OF THE SUBGRADE AT THE LOCATIONS SHOWN ON SHEET 354. THE FINISHED SUBGRADE ELEVATIONS SHALL NOT VARY BY MORE THAN 1/2" FROM THOSE SHOWN ON THE PLANS. THIS WORK SHALL BE DONE UNDER THE SUPERVISION OF A REGISTERED PROFESSIONAL ENGINEER OR A REGISTERED SURVEYOR. THE ELEVATIONS WILL BE RECORDED AND MADE AVAILABLE TO THE ENGINEER FOR SHRP'S RECORDS.

AN ESTIMATED QUANTITY FOR THIS ITEM HAS BEEN PROVIDED IN THE GENERAL SUMMARY FOR USE AS DIRECTED BY THE ENGINEER.

ITEM 203 PROOF ROLLING:
(184924 SQ YD ÷ 2704 SQ. YD.) (1 HR/3000 SQ. YD) = 62.5 HR
(USE 63 HR)

S.H.R.P. SECTION NUMBERS
THROUGHOUT THE PLAN REFERENCE IS MADE TO S.H.R.P. NUMBERS THESE NUMBERS ARE TEST SECTION IDENTIFICATION NUMBERS USED BY THE STRATEGIC HIGHWAY RESEARCH PROGRAM. THEY ARE PROVIDED FOR REFERENCE ONLY.

GUARDRAIL REPLACEMENT
NO HAZARD SHALL BE LEFT UNPROTECTED EXCEPT FOR THE ACTUAL TIME NECESSARY TO REMOVE, GRADE AND REINSTALL GUARDRAIL IN A CONTINUOUS OPERATION THE REMOVAL OF ALL GUARDRAIL SHALL AT ALL TIMES BE AS DIRECTED BY THE ENGINEER. NO GUARDRAIL SHALL BE REMOVED UNTIL THE REPLACEMENT MATERIAL IS ON THE SITE, READY FOR INSTALLATION. FAILURE TO COMPLY WITH THIS REQUIREMENT SHALL BE DEEMED SUFFICIENT CAUSE TO ORDER WORK SUSPENDED ON THIS PROJECT UNTIL SUCH TIME THAT THE ENGINEER IS ASSURED OF SAID COMPLIANCE.

ITEM 659, SEEDING AND MULCHING
SEEDING AND MULCHING SHALL BE APPLIED TO ALL EXPOSED SOIL AREAS BETWEEN TEN FEET OUTSIDE THE WORK LIMITS OR TO THE RIGHT-OF-WAY LINE, WHICHEVER IS LESS.

ITEM SPECIAL - MAILBOX SUPPORT
THIS WORK SHALL CONSIST OF FURNISHING AND ERECTING MAILBOX SUPPORTS AND ANY ASSOCIATED MOUNTING HARDWARE IN ACCORDANCE WITH PLAN DETAILS, AND ATTACHING AN OWNER-SUPPLIED MAILBOX AT LOCATIONS SPECIFIED IN THE PLAN, OR OTHERWISE ESTABLISHED BY THE ENGINEER.

WOOD POSTS SHALL BE NOMINAL 4" X 4" SQUARE OR 4-½" DIAMETER ROUND, AND CONFORM TO 710.14.

STEEL POSTS SHALL BE NOMINAL PIPE SIZE 2" I.D., AND CONFORM TO AASHTO M 181.

HARDWARE (PLATES, SCREWS, BOLTS, ETC) SHALL BE COMMERCIAL-GRADE GALVANIZED STEEL.

POSTS SHALL BE SET PER THE FIRST PARAGRAPH OF 606.03, AND SHALL IN NO INSTANCE BE ENCASED IN CONCRETE.

SUPPORT HARDWARE SHALL ACCOMODATE EITHER A SINGLE OR A DOUBLE MAILBOX INSTALLATION, AND NO MORE THAN TWO BOXES MAY BE MOUNTED ON A SINGLE POST.

THE MAILBOX SHALL BE SECURELY AND NEATLY ATTACHED BY THE CONTRACTOR TO THE NEW SUPPORT. THE CONTRACTOR SHALL FURNISH ALL NECESSARY ATTACHMENT HARDWARE (NUTS, BOLTS, PLATES, SPACERS, AND WASHERS) AS NECESSARY TO ACCOMODATE THE COMPLETE INSTALLATION.

IN THE ABSENCE OF A NEW BOX SUPPLIED BY THE OWNER THE CONTRACTOR SHALL SALVAGE THE EXISTING BOX AND PLACE IT ON THE NEW SUPPORT. DUE CARE SHALL BE EXERCISED IN SUCH AN OPERATION, AND THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRING OR REPLACING ANY BOX DAMAGED BY IMPROPER HANDLING ON HIS PART, AS JUDGED BY THE ENGINEER

THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING WITH THE LOCAL POST MASTER REGARDING THE TIMING OF THE MOVEMENT OF ANY MAILBOX TO A NEW LOCATION.

PAYMENT UNDER THIS ITEM SHALL BE LIMITED TO FINAL PERMANENT INSTALLATIONS. TEMPORARY INSTALLATIONS SHALL BE IN ACCORDANCE WITH 107.12 HOWEVER, THE SAME MATERIAL AND SIZE LIMITATIONS AS FOR PERMANENT INSTALLATIONS SHALL APPLY.

MAILBOX SUPPORTS, COMPLETE IN PLACE WILL BE PAID FOR AT THE CONTRACT UNIT PRICE BID EACH, FOR ITEM SPECIAL MAILBOX SUPPORT, (SINGLE) (DOUBLE). SEE DETAILS SHEET 351.

PART-WIDTH CONSTRUCTION
BECAUSE OF THE NECESSITY TO BUILD PORTIONS OF THIS PROJECT UNDER TRAFFIC, AND CONSTRUCTING THE FULL PAVEMENT WIDTH IN STAGES, EXTREME CARE SHALL BE TAKEN TO PREVENT THE CONSTRUCTION OF A BUTT JOINT IN THE BASE COURCES. LONGITUDINAL JOINTS SHALL BE LAPPED AS SHOWN ON STANDARD CONSTRUCTION DRAWING BP-3.1.

PAVEMENT GENERAL NOTES

ITEM 304, AGGREGATE BASE, AS PER PLAN
THE REQUIREMENTS OF ITEM 304, AGGREGATE BASE, SHALL APPLY EXCEPT:

AGGREGATE SHALL BE CRUSHED STONE, CRUSHED GRAVEL. A MINIMUM OF 75% OF THE AGGREGATE RETAINED ON THE ¾ INCH SIEVE SHALL HAVE 2 OR MORE FRACTURED FACES AS DETERMINED BY ASTM DD 2940. THE FOLLOWING GRADATION SHALL APPLY:

SIEVE	TOTAL PERCENT PASSING
1½ INCH	100
1 INCH	70-100
¾ INCH	50-90
NO 4	30-50
NO. 30	7-30
NO 200	0-10

THE FRACTION PASSING THE NO. 200 SIEVE SHALL BE LESS THAN 60% OF THE FRACTION PASSING THE NO. 30 SIEVE. THE FRACTION PASSING THE NO. 40 SIEVE SHALL HAVE A LIQUID LIMIT NOT GREATER THAN 25 (AASHTO T89) AND PLASTICITY INDEX NOT GREATER THAN 4 (AASHTO T90).

MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT SHALL BE DETERMINED BY AASHTO T180, METHOD D. THE AGGREGATE BASE SHALL BE COMPACTED TO A MINIMUM 95% RELATIVE DENSITY.

THE FINISHED SURFACE OF THE AGGREGATE BASE SHALL NOT VARY MORE THAN ¼ INCH IN 10 FEET.

THE CONTRACTOR SHALL USE COMPETENT PERSONNEL AND SUITABLE EQUIPMENT TO DETERMINE THE ELEVATION OF THE AGGREGATE BASE AT THE LOCATIONS SHOWN ON SHEET 354 THE FINISHED BASE ELEVATIONS SHALL NOT VARY BY MORE THAN ½" FROM THOSE SHOWN ON THE PLANS. THIS WORK SHALL BE DONE UNDER THE SUPERVISION OF A REGISTERED PROFESSIONAL ENGINEER OR A REGISTERED SURVEYOR THE ELEVATIONS WILL BE RECORDED AND MADE AVAILABLE TO THE ENGINEER FOR SHRP'S RECORDS.

ITEM 446, ASPHALT CONCRETE SURFACE COURSE, TYPE 1, AC-20, AS PER PLAN
ITEM 446, ASPHALT CONCRETE, TYPE 1 SHALL APPLY WITH FOLLOWING EXCEPTIONS:

RECLAIMED MATERIAL WILL NOT BE PERMITTED FOR THIS ITEM.

A MINIMUM OF 60% OF THE AGGREGATE RETAINED ON THE #4 SIEVE SHALL HAVE 2 OR MORE FRACTURED FACES AS DETERMINED BY ASTM D 2940. AGGREGATE SHALL HAVE MINIMUM SAND EQUIVALENT TEST OF 45 AS DETERMINED BY AASHTO T176.

THE FINISHED THICKNESS SHALL BE WITHIN ± ¼ INCH OF THE THICKNESS SPECIFIED ON THE TYPICAL SECIONS.

THE CONTRACTOR SHALL USE COMPETENT PERSONNEL AND SUITABLE EQUIPMENT TO DETERMINE THE ELEVATION OF THE SURFACE COURSE AT THE LOCATIONS SHOWN ON SHEET 354. THE FINISHED SURFACE COURSE ELEVATIONS SHALL NOT VARY BY MORE THAN ½" FROM THOSE SHOWN ON THE PLANS. THIS WORK SHALL BE DONE UNDER THE SUPERVISION OF A REGISTERED PROFESSIONAL ENGINEER OR A REGISTERED SURVEYOR. THE ELEVATIONS WILL BE RECORDED AND MADE AVAILABLE TO THE ENGINEER FOR S.H.R.P.'S RECORDS.

PAYMENT FOR ACCEPTED QUANTITIES, COMPLETED IN PLACE, WILL BE MADE AT THE CONTRACT PRICE FOR:

ITEM	UNIT	DESCRIPTION
446	CUBIC YARDS	ASPHALT CONCRETE SURFACE COURSE, TYPE 1, AC-20, AS PER PLAN

ITEM 446, ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE 2, AC-20, AS PER PLAN
ITEM 446, ASPHALT CONCRETE, TYPE 2 SHALL APPLY WITH FOLLOWING EXCEPTIONS:

RECLAIMED MATERIAL WILL NOT BE PERMITTED FOR THIS ITEM.

A MINIMUM OF 60% OF THE AGGREGATE RETAINED ON THE #4 SIEVE SHALL HAVE 2 OR MORE FRACTURED FACES AS DETERMINED BY ASTM D 2940. AGGREGATE SHALL HAVE MINIMUM SAND EQUIVALENT TEST OF 45 AS DETERMINED BY AASHTO T176.

THE FINISHED THICKNESS SHALL BE WITHIN +/-¼ INCH OF THE THICKNESS SPECIFIED ON THE TYPICAL SECIONS. THE MAXIMUM COMPACTED LIFT THICKNESS SHALL BE 3 INCHES.

THE CONTRACTOR SHALL USE COMPETENT PERSONNEL AND SUITABLE EQUIPMENT TO DETERMINE THE ELEVATION OF THE INTERMEDIATE COURSE AT THE LOCATIONS SHOWN ON SHEET 354. THE FINISHED INTERMEDIATE COURSE ELEVATIONS SHALL NOT VARY BY MORE THAN ½" FROM THOSE SHOWN ON THE PLANS. THIS WORK SHALL BE DONE UNDER THE SUPERVISION OF A REGISTERED PROFESSIONAL ENGINEER OR A REGISTERED SURVEYOR. THE ELEVATIONS WILL BE RECORDED AND MADE AVAILABLE TO THE ENGINEER FOR S.H.R.P.'S RECORDS.

PAYMENT FOR ACCEPTED QUANTITIES, COMPLETED IN PLACE, WILL BE MADE AT THE CONTRACT PRICE FOR:

ITEM	UNIT	DESCRIPTION
446	CUBIC YARDS	ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE 2, AC-20, AS PER PLAN

ITEM 446, ASPHALT CONCRETE SURFACE COURSE, TYPE 1, PG 58-30, AS PER PLAN
ITEM 446, ASPHALT CONCRETE, SHALL APPLY WITH FOLLOWING EXCEPTIONS:

IN LIEU OF THE REQUIREMENTS OF 702.01, THE BITUMINOUS MATERIAL SHALL MEET THE REQUIREMENTS OF THE STRATEGIC HIGHWAY RESEARCH PROGRAM (SHRP) BINDER SPECIFICATION FOR PERFORMANCE GRADE PG 58-30. THE MATERIAL SHALL BE PRIOR APPROVED.

THE ASPHALT CONCRETE MIX WILL BE DESIGNED BY THE LAB IN ACCORDANCE WITH THE SHRP "SUPERPAVE" PROCEDURE. THE CONTRACTOR WILL COOPERATE WITH THE LAB BY SUPPLYING THE NECESSARY MATERIALS AND A TRIAL MIX DESIGN.

IN ADDITION TO THE REQUIREMENTS OF 703.05, AGGREGATE SHALL MEET THE REQUIREMENTS SPECIFIED IN THE PROPOSAL. CONTRACTOR WILL ALLOW TWO MONTHS AFTER DELIVERY OF MATERIALS FOR THE MIX DESIGN.

RECLAIMED MATERIAL WILL NOT BE PERMITTED FOR THIS ITEM.

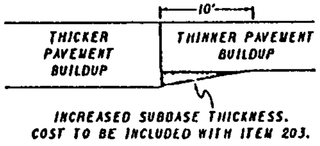
THE FINISHED THICKNESS SHALL BE WITHIN +/- 1/4 INCH OF THE THICKNESS SPECIFIED ON THE TYPICAL SECTIONS.

THE CONTRACTOR SHALL USE COMPETENT PERSONNEL AND SUITABLE EQUIPMENT TO DETERMINE THE ELEVATION OF THE SURFACE COURSE AT THE LOCATIONS SHOWN ON SHEET 354. THE FINISHED SURFACE COURSE ELEVATIONS SHALL NOT VARY BY MORE THAN ½" FROM THOSE SHOWN ON THE PLANS. THIS WORK SHALL BE DONE UNDER THE SUPERVISION OF A REGISTERED PROFESSIONAL ENGINEER OR A REGISTERED SURVEYOR THE ELEVATIONS WILL BE RECORDED AND MADE AVAILABLE TO THE ENGINEER FOR S.H.R.P.'S RECORDS.

PAYMENT FOR ACCEPTED QUANTITIES, COMPLETED IN PLACE, WILL BE MADE AT THE CONTRACT PRICE FOR:

ITEM	UNIT	DESCRIPTION
446	CUBIC YARDS	ASPHALT CONCRETE SURFACE COURSE, TYPE 1, PG 58-30, AS PER PLAN

PAVEMENT BUILDUP TRANSITIONS
THE TYPICAL SECTIONS SHOW ABRUPT CHANGES IN THE PAVEMENT THICKNESS AT GIVEN LIMITING STATIONS HOWEVER, THE EMBANKMENT MAY BE TRANSITIONED A DISTANCE OF 10' INTO THE THINNER OF THE TWO LAYERS THE THICKNESS OF THE SUBBASE LAYER SHALL BE INCREASED TO ACCOUNT FOR THIS TRANSITION. ALL COSTS ASSOCIATED WITH THIS WORK SHALL BE INCLUDED WITH ITEM 203.



ITEM 407 TACK COAT
THE RATE OF APPLICATION OF THE ITEM 407 TACK COAT SHALL BE SUBJECT TO ADJUSTMENT, AS DIRECTED BY THE ENGINEER PLAN QUANTITIES INDICATE AN AVERAGE APPLICATION OF 0.075 GALLONS OF TACK PER SQUARE YARD OF PAVEMENT FOR ESTIMATING PURPOSES ONLY.

ITEM 446, ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE 2, PG 58-30, AS PER PLAN
ITEM 446, ASPHALT CONCRETE, SHALL APPLY WITH FOLLOWING EXCEPTIONS:

IN LIEU OF THE REQUIREMENTS OF 702.01, THE BITUMINOUS MATERIAL SHALL MEET THE REQUIREMENTS OF THE STRATEGIC HIGHWAY RESEARCH PROGRAM (SHRP) BINDER SPECIFICATION FOR PERFORMANCE GRADE PG 58-30. THE MATERIAL SHALL BE PRIOR APPROVED.

THE ASPHALT CONCRETE MIX WILL BE DESIGNED BY THE LAB IN ACCORDANCE WITH THE SHRP "SUPERPAVE" PROCEDURE THE CONTRACTOR WILL COOPERATE WITH THE LAB BY SUPPLYING THE NECESSARY MATERIALS AND A TRIAL MIX DESIGN.

IN ADDITION TO THE REQUIREMENTS OF 703.05, AGGREGATE SHALL MEET THE REQUIREMENTS SPECIFIED IN THE PROPOSAL. CONTRACTOR WILL ALLOW TWO MONTHS AFTER DELIVERY OF MATERIALS FOR THE MIX DESIGN.

RECLAIMED MATERIAL WILL NOT BE PERMITTED FOR THIS ITEM.

THE FINISHED THICKNESS SHALL BE WITHIN +/- 1/4 INCH OF THE THICKNESS SPECIFIED ON THE TYPICAL SECTIONS. THE MAXIMUM COMPACTED LIFT THICKNESS SHALL BE 3 INCHES.

THE CONTRACTOR SHALL USE COMPETENT PERSONNEL AND SUITABLE EQUIPMENT TO DETERMINE THE ELEVATION OF THE SURFACE COURSE AT THE LOCATIONS SHOWN ON SHEET 354 THE FINISHED SURFACE COURSE ELEVATIONS SHALL NOT VARY BY MORE THAN ½" FROM THOSE SHOWN ON THE PLANS. THIS WORK SHALL BE DONE UNDER THE SUPERVISION OF A REGISTERED PROFESSIONAL ENGINEER OR A REGISTERED SURVEYOR THE ELEVATIONS WILL BE RECORDED AND MADE AVAILABLE TO THE ENGINEER FOR S.H.R.P.'S RECORDS.
PAYMENT FOR ACCEPTED QUANTITIES COMPLETED IN PLACE, WILL BE MADE AT THE CONTRACT PRICE FOR:

ITEM	UNIT	DESCRIPTION
446	CUBIC YARDS	ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE 2, PG 58-30, AS PER PLAN

PAVEMENT GENERAL NOTES

ITEM 451, REINFORCED CONCRETE PAVEMENT, AS PER PLAN "C"

THIS WORK SHALL CONSIST OF CONSTRUCTING A REINFORCED CONCRETE PAVEMENT ON A PREPARED BASE. THE PORTLAND CEMENT CONCRETE PAVEMENT SHALL MEET THE REQUIREMENTS OF ITEM 451 OF THE CONSTRUCTION AND MATERIALS SPECIFICATION, STANDARD DRAWING BP-2.2 AND STANDARD DRAWING BP-2.1 EXCEPT AS MODIFIED HEREIN.

CEMENT SHALL BE 701.08

THE FINE AGGREGATE SHALL HAVE A FINENESS MODULUS NO LESS THAN 2.3 AND NO GREATER THAN 3.1. FINE AGGREGATE SHALL CONTAIN NOT LESS THAN 25 PERCENT OF SILICEOUS PARTICLES AS DETERMINED BY THE INSOLUBLE RESIDUE TEST ON FILE AT THE LABORATORY.

THE COARSE AGGREGATE SHALL BE NO 57 AS SHOWN IN TABLE 703-1. THE COARSE AGGREGATE INCORPORATED INTO CONCRETE SHALL MEET 703.02 AND BE TESTED IN ACCORDANCE WITH ASTM C-666, PROCEDURE B. THE AREA GENERATED UNDER THE CURVE OBTAINED BY PLOTTING THE EXPANSIONS OF THE TEST SPECIMENS VERSUS THE NUMBER OF TEST CYCLES SHALL NOT EXCEED 2.05 AT 350 OR LESS CYCLES.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN OF THE CONCRETE MIXTURE. THE WATER TO CEMENT RATIO SHALL BE 0.50 MAXIMUM THE CONTRACTOR SHALL SUBMIT A SINGLE MIX DESIGN FOR EACH CONCRETE MIX WITH DATA FROM AT LEAST 3 TEST BATCHES OF LABORATORY PRODUCED CONCRETE. CALCIUM CHLORIDE WILL NOT BE PERMITTED IN THE MIX. ADMIXTURES SHALL BE APPROVED BY THE CEMENT MANUFACTURER. A MINIMUM OF THREE FLEXURAL TEST SPECIMENS WILL BE TESTED FROM EACH BATCH. THE TEST RESULTS SHALL CONFORM TO THE FOLLOWING REQUIREMENTS:

	AS PER PLAN "C"
14 DAY FLEXURAL STRENGTH (PSI) AVERAGE OF BATCH AVERAGES:	860 to 940
14 DAY FLEXURAL STRENGTH (PSI), RANGE OF BATCH AVERAGES:	
FOR 3 BATCHES TESTED	250
FOR 4 BATCHES TESTED	270
FOR 5 BATCHES TESTED	290
FOR 6 BATCHES TESTED	300

MODULUS OF RUPTURE WILL BE MEASURED IN ACCORDANCE WITH ASTM C78. THE CONTRACTOR SHALL SUBMIT CERTIFIED TEST DATA FROM A RECOGNIZED TESTING LABORATORY SHOWING THE PROPOSED PROPORTIONING WILL MEET THE STRENGTH REQUIREMENTS. A RECOGNIZED TESTING LABORATORY IS ANY LABORATORY REGULARLY INSPECTED BY THE CEMENT AND CONCRETE REFERENCE LABORATORY. THE ENGINEER WILL REVIEW THE CONCRETE MIX DESIGN ON THE BASIS OF THE FOREGOING INFORMATION.

THE MAXIMUM AMBIENT TEMPERATURE FOR PLACEMENT SHALL BE 80 DEGREES F.

JOINT SPACING SHALL BE A MAXIMUM OF 80 FEET. JOINT SPACING SHALL BE AS DETAILED ON SHEETS 336 AND 337.

REINFORCING SHALL CONSIST OF #4 DEFORMED LONGITUDINAL REINFORCING BARS SPACED 6 INCHES CENTER-TO-CENTER AND #4 DEFORMED TRANSVERSE REINFORCING BARS SPACED 12 INCHES CENTER-TO-CENTER. THE DISTANCE FROM THE TOP OF THE PAVEMENT SHALL BE NO LESS THAN 2½" AND NO MORE THAN 4 INCHES. CHAIRS SHALL BE USED TO HOLD THE REINFORCEMENT IN PLACE DURING PAVING. REINFORCING BARS SHALL BE EPOXY-COATED IN ACCORDANCE WITH 709.00. STEEL CHAIRS SHALL BE EPOXY-COATED IN ACCORDANCE WITH 709.14.

LONGITUDINAL JOINTS SHALL BE TIED WITH 30-INCH LONG #5 DEFORMED BARS SPACED AS SHOWN ON BP-2.1. TIE BARS SHALL BE EPOXY-COATED AS PER 709.00.

CURING COMPOUND SHALL BE APPLIED WITHIN 15 MINUTES AFTER THE SURFACE TEXTURING OPERATION AND NO LATER THAN 45 MINUTES AFTER CONCRETE PLACEMENT.

LONGITUDINAL AND TRANSVERSE JOINTS SHALL BE CONSTRUCTED BY SAWING. THE INITIAL SAW CUT SHALL BE ⅛" WIDE TO A DEPTH ONE-THIRD THE SPECIFIED PAVEMENT THICKNESS. JOINTS SHALL BE SEALED WIT A SILICONE SEALANT MEETING THE REQUIREMENTS OF SUPPLEMENTAL SPECIFICATION 801 EXCEPT THE JOINT SEALANT RESERVOIR SHALL BE ⅜" WIDE BY 1 INCH DEEP.

THE CONTRACTOR SHALL USE COMPETENT PERSONNEL AND SUITABLE EQUIPMENT TO DETERMINE THE ELEVATION OF THE CONCRETE PAVEMENT AT THE LOCATIONS SHOWN ON SHEET 354. THE FINISHED SURFACE ELEVATION SHALL NOT VARY BY MORE THAN ½" FROM THOSE SHOWN ON THE PLANS. THIS WORK SHALL BE DONE UNDER THE SUPERVISION OF A REGISTERED PROFESSIONAL ENGINEER OR A REGISTERED SURVEYOR. THE ELEVATIONS WILL BE RECORDED AND MADE AVAILABLE TO THE ENGINEER FOR SHRP'S RECORDS. PAYMENT FOR ACCEPTED QUANTITIES, COMPLETED IN PLACE, WILL BE MADE AT THE CONTRACT PRICE FOR :

ITEM	UNIT	DESCRIPTION
451	SQUARE YARDS	REINFORCED CONCRETE PAVEMENT, AS PER PLAN "C"

ITEM 452, PLAIN CONCRETE PAVEMENT, AS PER PLAN "A"
ITEM 452, PLAIN CONCRETE PAVEMENT, AS PER PLAN "B"

ALL REQUIREMENTS OF ITEM 452, PLAIN CONCRETE PAVEMENT AS PER PLAN "C" SHALL APPLY EXCEPT :

CEMENT SHALL BE 701.01, 701.02 OR 701.04.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN OF THE CONCRETE MIXTURE. THE CONTRACTOR SHALL SUBMIT A SINGLE MIX DESIGN FOR EACH CONCRETE MIX WITH DATA FROM AT LEAST 3 TEST BATCHES OF LABORATORY PRODUCED CONCRETE. A MINIMUM OF THREE FLEXURAL TEST SPECIMENS WILL BE TESTED FROM EACH BATCH. THE TEST RESULTS SHALL CONFORM TO THE FOLLOWING REQUIREMENTS:

	AS PER PLAN "A"	AS PER PLAN "B"
14 DAY FLEXURAL STRENGTH (PSI) AVERAGE OF BATCH AVERAGES:	525 to 575	860 to 940
14 DAY FLEXURAL STRENGTH (PSI) RANGE OF BATCH AVERAGES:		
FOR 3 BATCHES TESTED	165	250
FOR 4 BATCHES TESTED	180	270
FOR 5 BATCHES TESTED	195	290
FOR 6 BATCHES TESTED	200	300

MODULUS OF RUPTURE WILL BE MEASURED IN ACCORDANCE WITH ASTM C78. THE CONTRACTOR SHALL SUBMIT CERTIFIED TEST DATA FROM A RECOGNIZED TESTING LABORATORY SHOWING THE PROPOSED PROPORTIONING WILL MEET THE STRENGTH REQUIREMENTS. A RECOGNIZED TESTING LABORATORY IS ANY LABORATORY REGULARLY INSPECTED BY THE CEMENT AND CONCRETE REFERENCE LABORATORY. THE ENGINEER WILL REVIEW THE CONCRETE MIX DESIGN ON THE BASIS OF THE FOREGOING INFORMATION.

THE PLAIN CONCRETE PAVEMENT SHALL BE PLACED WITH A SLIP FORM PAVER. THE SLUMP OF THE CONCRETE SHALL NOT EXCEED 2½". CONCRETE SHALL CONTAIN 6½ ± 1½ PERCENT OF TOTAL AIR.

PAYMENT FOR ACCEPTED QUANTITIES, COMPLETED IN PLACE, WILL BE MADE AT THE CONTRACT PRICE FOR :

ITEM	UNIT	DESCRIPTION
452	SQUARE YARDS	PLAIN CONCRETE PAVEMENT, AS PER PLAN "A"

ITEM	UNIT	DESCRIPTION
452	SQUARE YARDS	PLAIN CONCRETE PAVEMENT, AS PER PLAN "B"

ITEM 452, PLAIN CONCRETE PAVEMENT, AS PER PLAN "C"

THIS WORK SHALL CONSIST OF CONSTRUCTING A PLAIN CONCRETE PAVEMENT ON A PREPARED BASE. THE CONCRETE PAVEMENT SHALL MEET THE REQUIREMENTS OF ITEM 452 OF THE CONSTRUCTION AND MATERIAL SPECIFICATIONS, STANDARD DRAWING BP-2.2, AND STANDARD DRAWING BP-2.1 EXCEPT AS MODIFIED HEREIN.

THE FINE AGGREGATE SHALL HAVE A FINENESS MODULUS NO LESS THAN 2.3 AND NO GREATER THAN 3.1 FINE AGGREGATE SHALL CONTAIN NOT LESS THAN 25 PERCENT OF SILICEOUS PARTICLES AS DETERMINED BY THE INSOLUBLE RESIDUE TEST ON FILE AT THE LABORATORY.

COARSE AGGREGATE SHALL BE CRUSHED STONE, CRUSHED GRAVEL OR CRUSHED SLAG. A MINIMUM OF 75% BY COUNT OF THE AGGREGATE RETAINED ON THE ⅜ INCH SIEVE SHALL HAVE 2 OR MORE FRACTURED FACES . MAXIMUM LOSS, SODIUM SULFATE SOUNDNESS TEST, SHALL BE 12%.

THE COARSE AGGREGATE SHALL BE NO 57 AS SHOWN IN TABLE 703-1. THE COARSE AGGREGATE INCORPORATED INTO CONCRETE SHALL MEET 703.02 AND BE TESTED IN ACCORDANCE WITH ASTM C-666, PROCEDURE B. THE AREA GENERATED UNDER THE CURVE OBTAINED BY PLOTTING THE EXPANSIONS OF THE TEST SPECIMENS VERSUS THE NUMBER OF TEST CYCLES SHALL NOT EXCEED 2.05 AT 350 OR LESS CYCLES. MAXIMUM LOSS, SODIUM SULFATE SOUNDNESS TEST, SHALL BE 12%.

TRANSVERSE JOINT SPACING WITHIN THE 500' TEST SECTIONS SHALL BE 15' AS DETAILED ON TRANSVERSE JOINT DETAIL SHEET 344. JOINT SPACING OUTSIDE TEST SECTIONS SHALL BE 15' UNLESS OTHERWISE SHOWN ON JOINT DETAIL SHEETS 335, 338 TO 344. IN NO CASE SHALL THE JOINT SPACING BE LESS THAN 10'.

TRANSVERSE JOINTS SHALL BE DOWELLED IN ACCORDANCE WITH 451.08 (B) AND BP-2.2 IN LIEU OF THE DOWEL DIAMETER REQUIREMENTS OF BP-2.2, DOWEL DIAMETER SHALL BE 1¼" FOR 8" THICK PAVEMENT AND 1½" FOR 11" THICK PAVEMENT.

LONGITUDINAL JOINTS SHALL BE TIED WITH 30-INCH LONG #5 DEFORMED BARS SPACED AS SHOWN ON BP-2.1. TIE BARS WILL BE EPOXY-COATED AS PER 709.00. BENT TIE BARS WILL NOT BE PERMITTED.

CURING COMPOUND SHALL BE APPLIED WITHIN 15 MINUTES AFTER THE SURFACE TEXTURING OPERATION AND NO LATER THAN 45 MINUTES AFTER CONCRETE PLACEMENT.

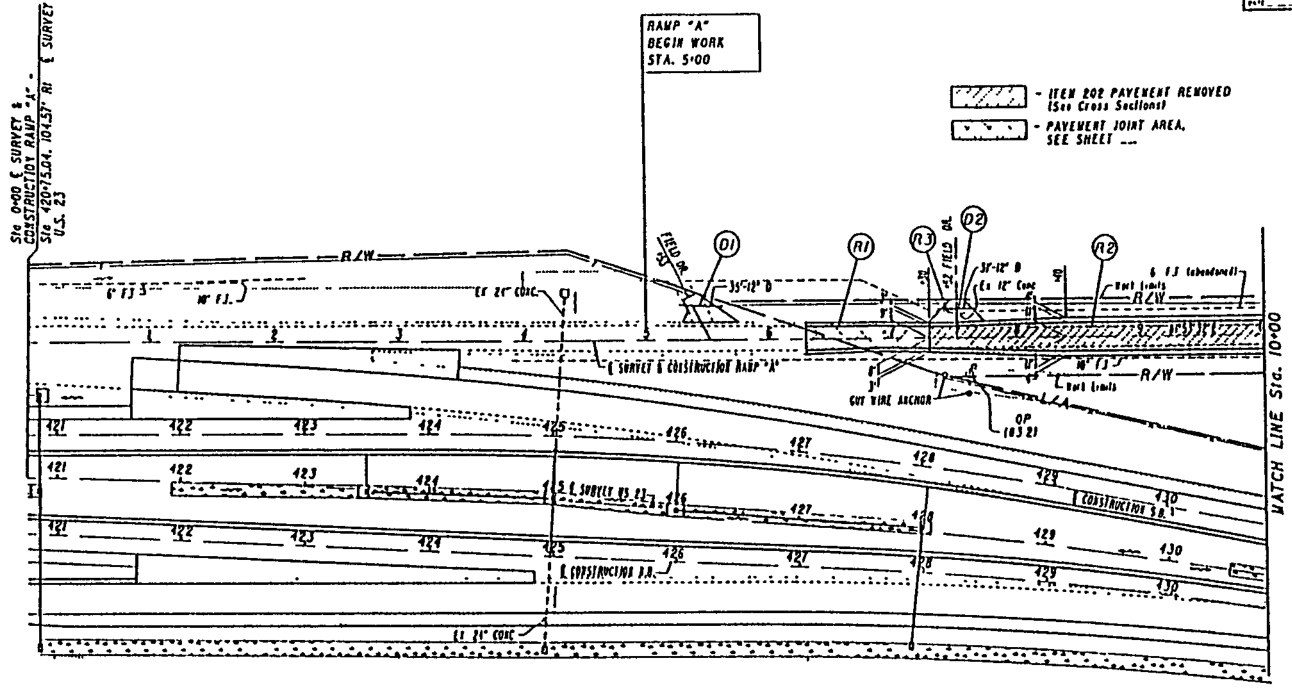
LONGITUDINAL AND TRANSVERSE JOINTS SHALL BE CONSTRUCTED BY SAWING. THE SAW CUT SHALL BE ⅛" WIDE TO A DEPTH OF ONE-THIRD THE SPECIFIED PAVEMENT THICKNESS. JOINTS SHALL BE SEALED WITH A SILICONE SEALANT MEETING THE REQUIREMENTS OF SUPPLEMENTAL SPECIFICATION 801 EXCEPT THE LONGITUDINAL JOINT SEALANT RESERVOIR SHALL BE ⅜" WIDE BY 1 INCH DEEP.

THE CONTRACTOR SHALL USE COMPETENT PERSONNEL AND SUITABLE EQUIPMENT TO DETERMINE THE ELEVATION OF THE CONCRETE PAVEMENT AT THE LOCATIONS SHOWN ON SHEET 354 THE FINISHED SURFACE ELEVATION SHALL NOT VARY BY MORE THAN ¼" FROM THOSE SHOWN ON THE PLANS.

THIS WORK SHALL BE DONE UNDER THE SUPERVISION OF A REGISTERED PROFESSIONAL ENGINEER OR A REGISTERED SURVEYOR THE ELEVATIONS WILL BE RECORDED AND MADE AVAILABLE TO THE ENGINEER FOR SHRP'S RECORDS.

PAYMENT FOR ACCEPTED QUANTITIES, COMPLETED IN PLACE, WILL BE MADE AT THE CONTRACT PRICE FOR :

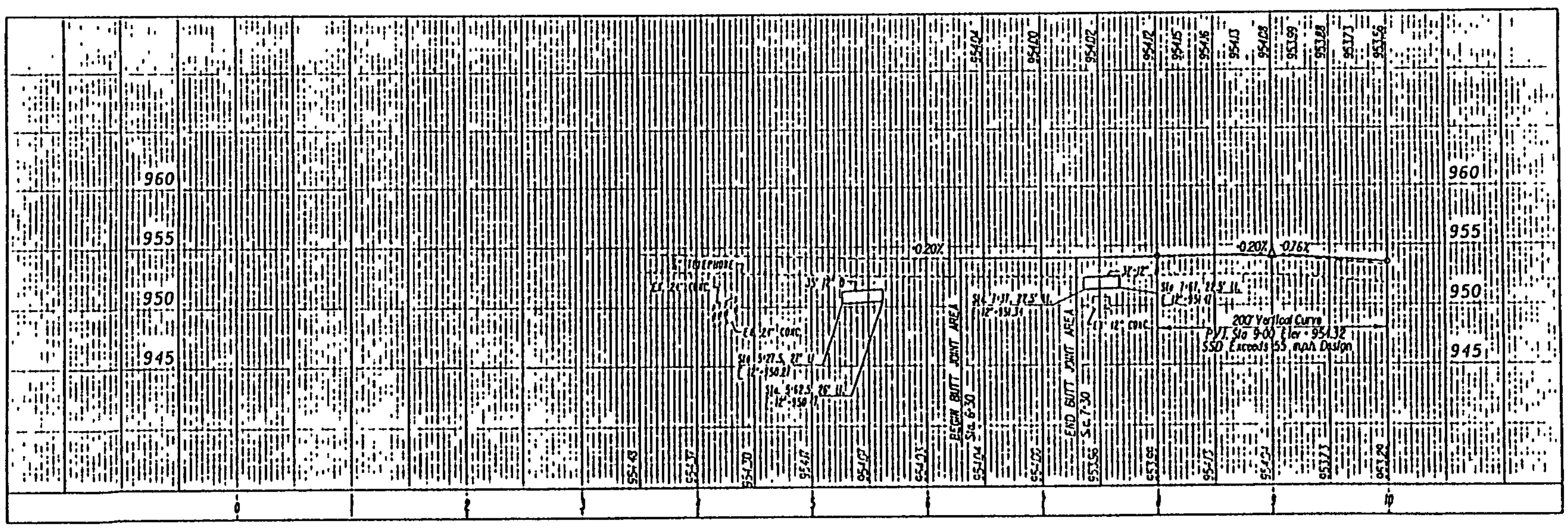
ITEM	UNIT	DESCRIPTION
452	SQUARE YARDS	PLAIN CONCRETE PAVEMENT, AS PER PLAN "C"



CROSS REFERENCES

SHEET No	DESCRIPTION
234 236	PAVEMENT DETAILS
265	DRIVE DETAILS

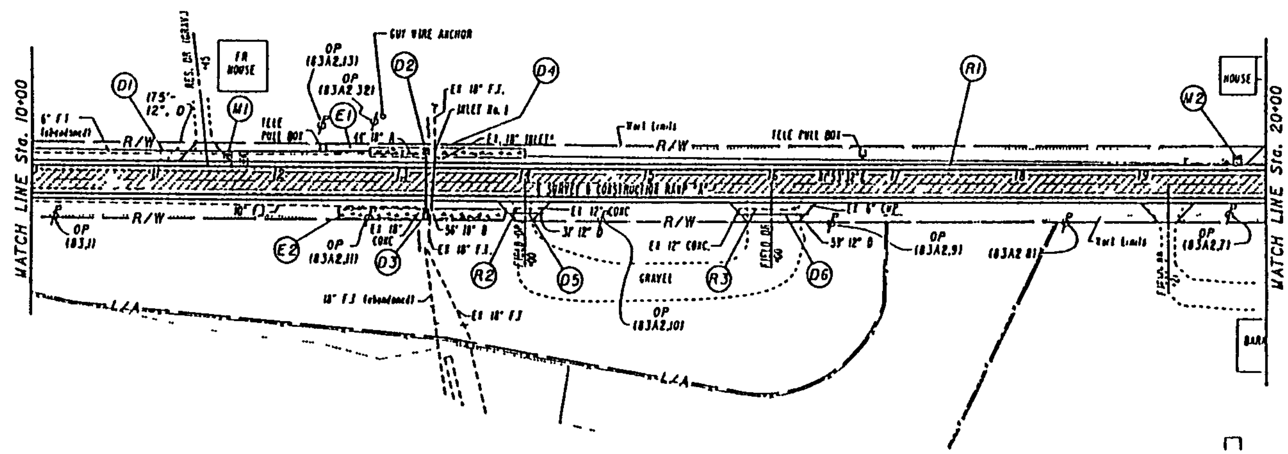
Station 0+00 to Station 10+00	
203 Excavation not including Embankment Construction	463 c.y
203 Embankment	99 c.y
659 Seeding and Mulching	1350 s.y



PLAN AND PROFILE RAMP "A" Sta 0+00 to Sta. 10+00

DEL-23-17.48 DELAWARE COUNTY	0110	5

- ITEM 202 PAVEMENT REMOVED (See Cross Sections)

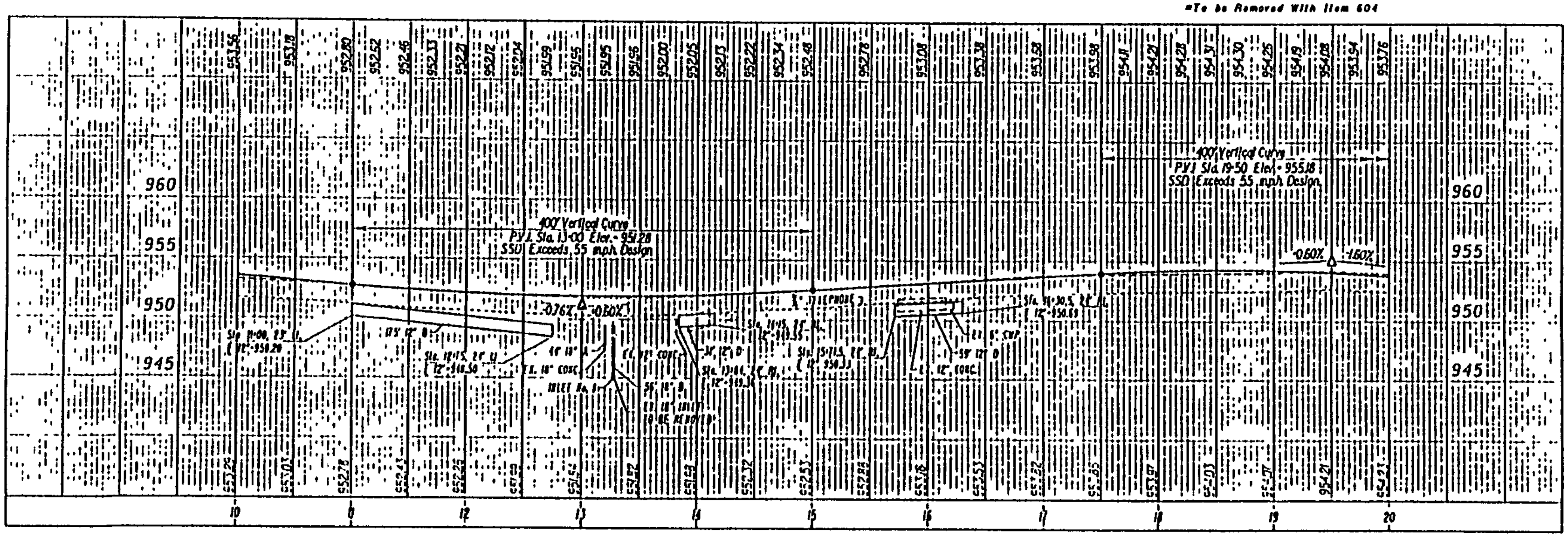


CROSS REFERENCES	
SHEET No.	DESCRIPTION
265-266	DRIVE DETAILS

Station 10+00 to Station 20+00	
203 Excavation not Including Embankment Construction	1395 c.y.
203 Embankment	174 c.y.
659 Seeding and Mulching	2992 s.y.

Existing mailbox supports to be removed with Item 202

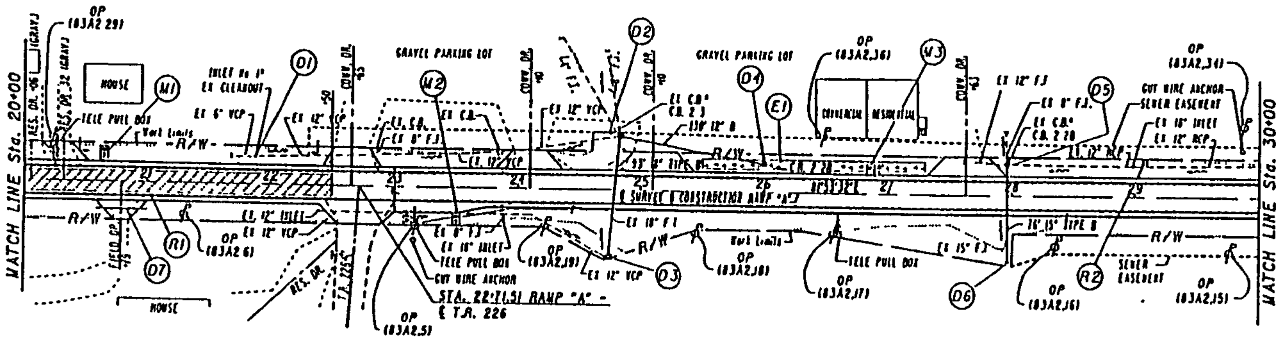
*To be Removed With Item 604



PLAN AND PROFILE RAMP "A" Sta 10+00 to Sta 20

DEL-23-17.48 DELAWARE COUNTY	OHIO	101/104

(Legend) – ITEM 202 PAVEMENT REMOVED (See Cross Sections)



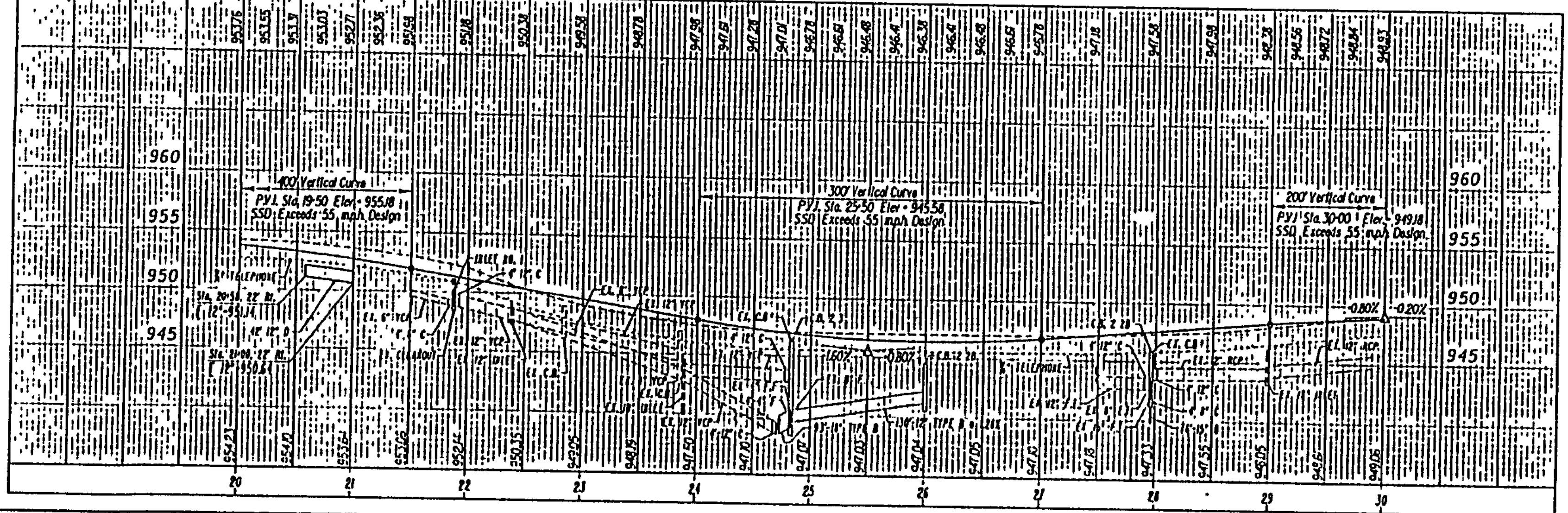
CROSS REFERENCES

SHEET No.	DESCRIPTION
206 267	DRIVE DETAILS
250	T.R. 226 INTERSECTION DETAIL

Station 20+00 to Station 30+00	
203 Excavation not including Embankment Construction	2164 c.y.
203 Embankment	55 c.y.
659 Seeding and Mulching	3263 s.y.

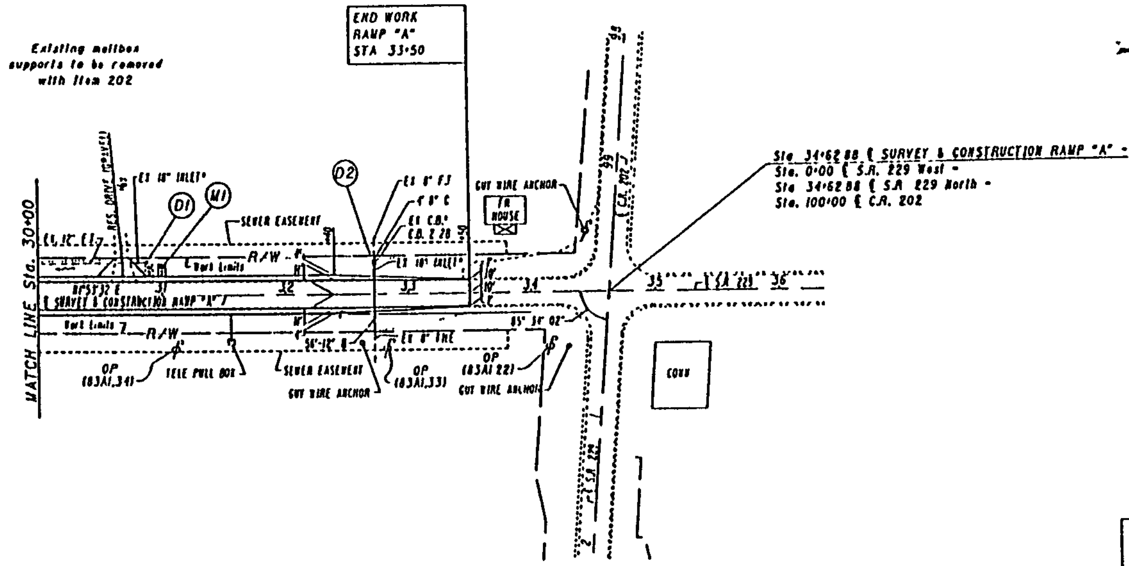
Existing mailbox supports to be removed with Item 202

*To be Removed With Item 604



PLAN AND PROFILE RAMP "A" Sta. 20+00 to Sta. 30+00

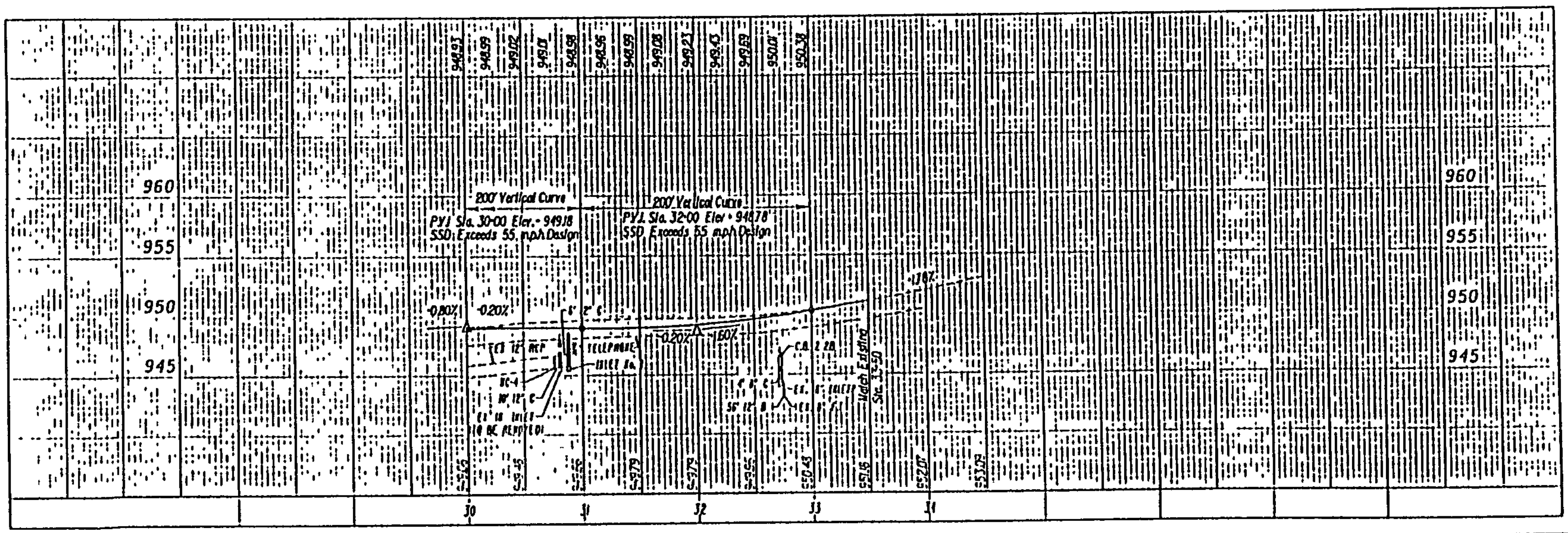
DELAWARE COUNTY



CROSS REFERENCES	
SHEET No.	DESCRIPTION
267	DRIVE DETAILS

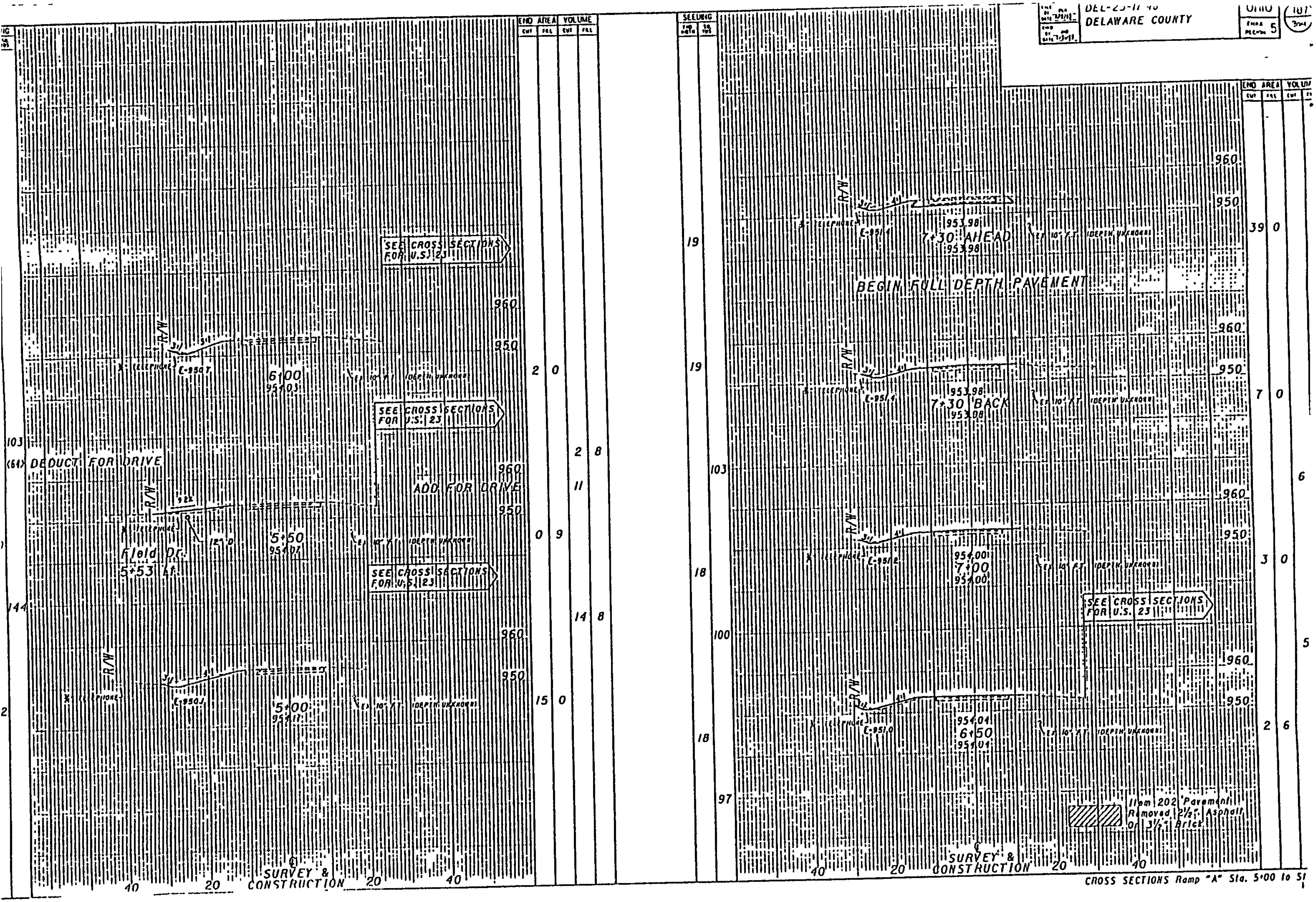
Station 30+00 to Station 33+50	
203 Excavation not Including Embankment Construction	915 c.y.
203 Embankment	9 c.y.
659 Seeding and Mulching	1178 s.y.

*The Removal of the Existing Inlets will be Included with the Cost of Item 603



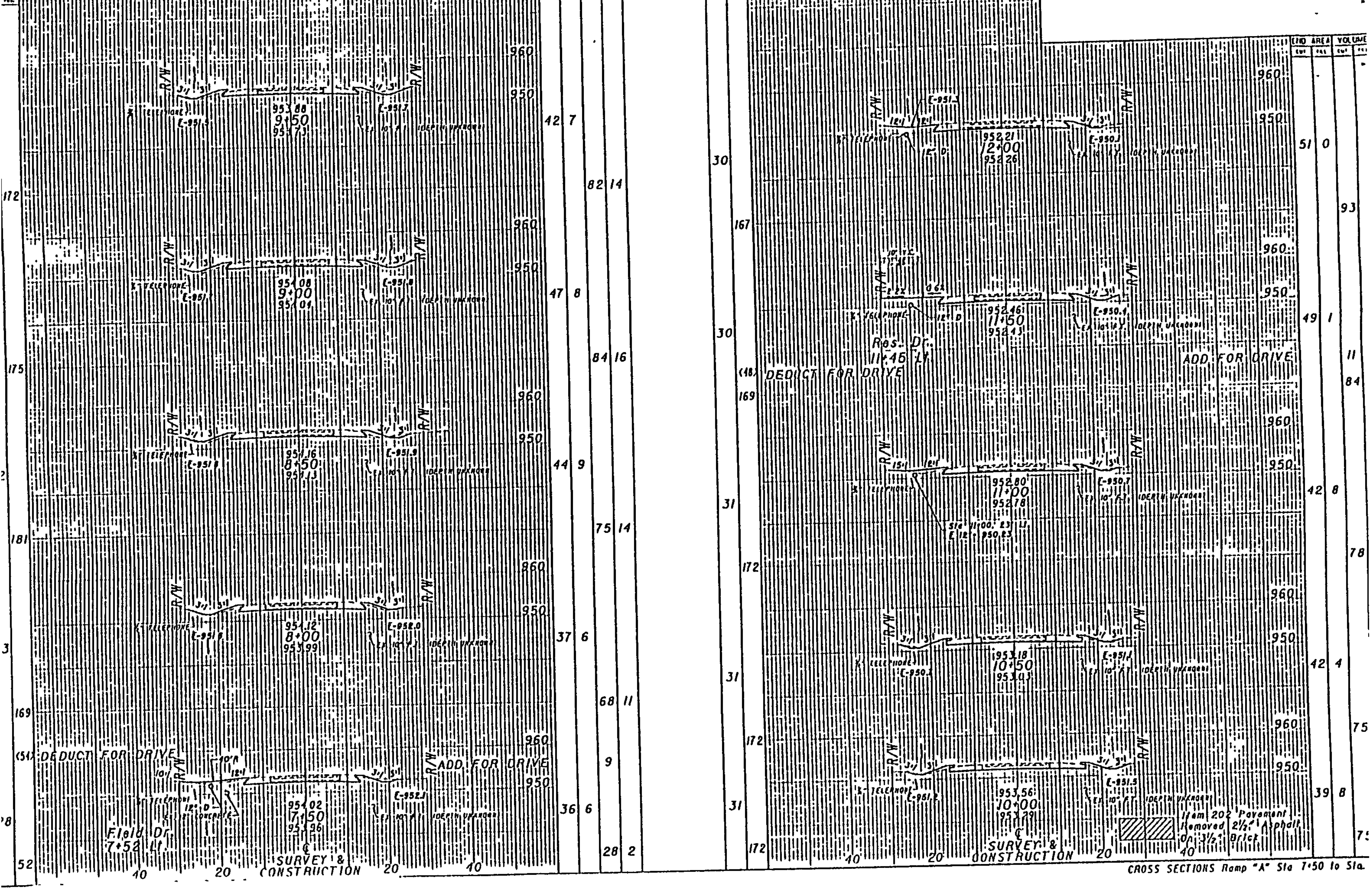
PLAN AND PROFILE RAMP "A" Sta. 30+00 to Sta. 34+

DEL-23-17.46
DELAWARE COUNTY
OHIO

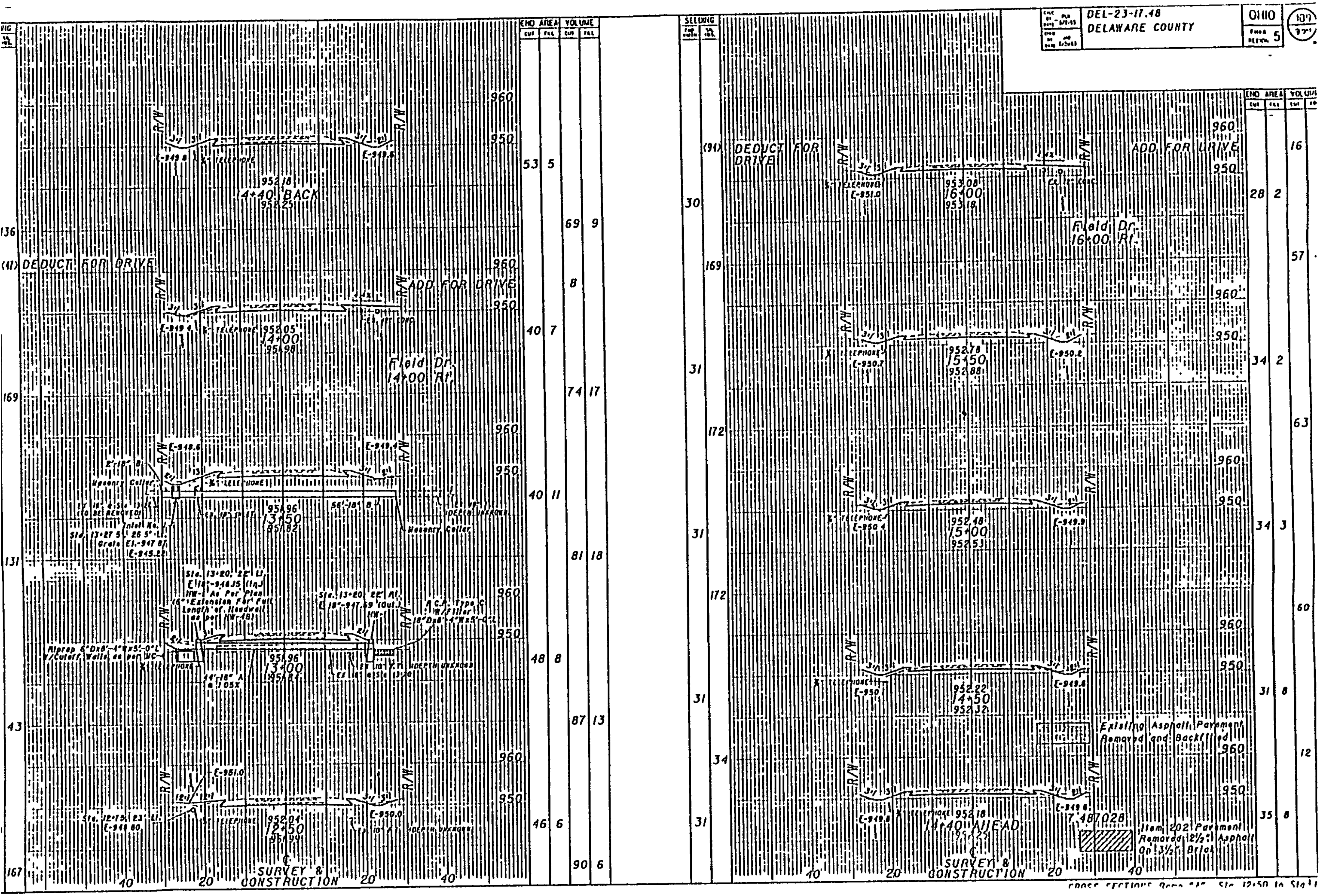


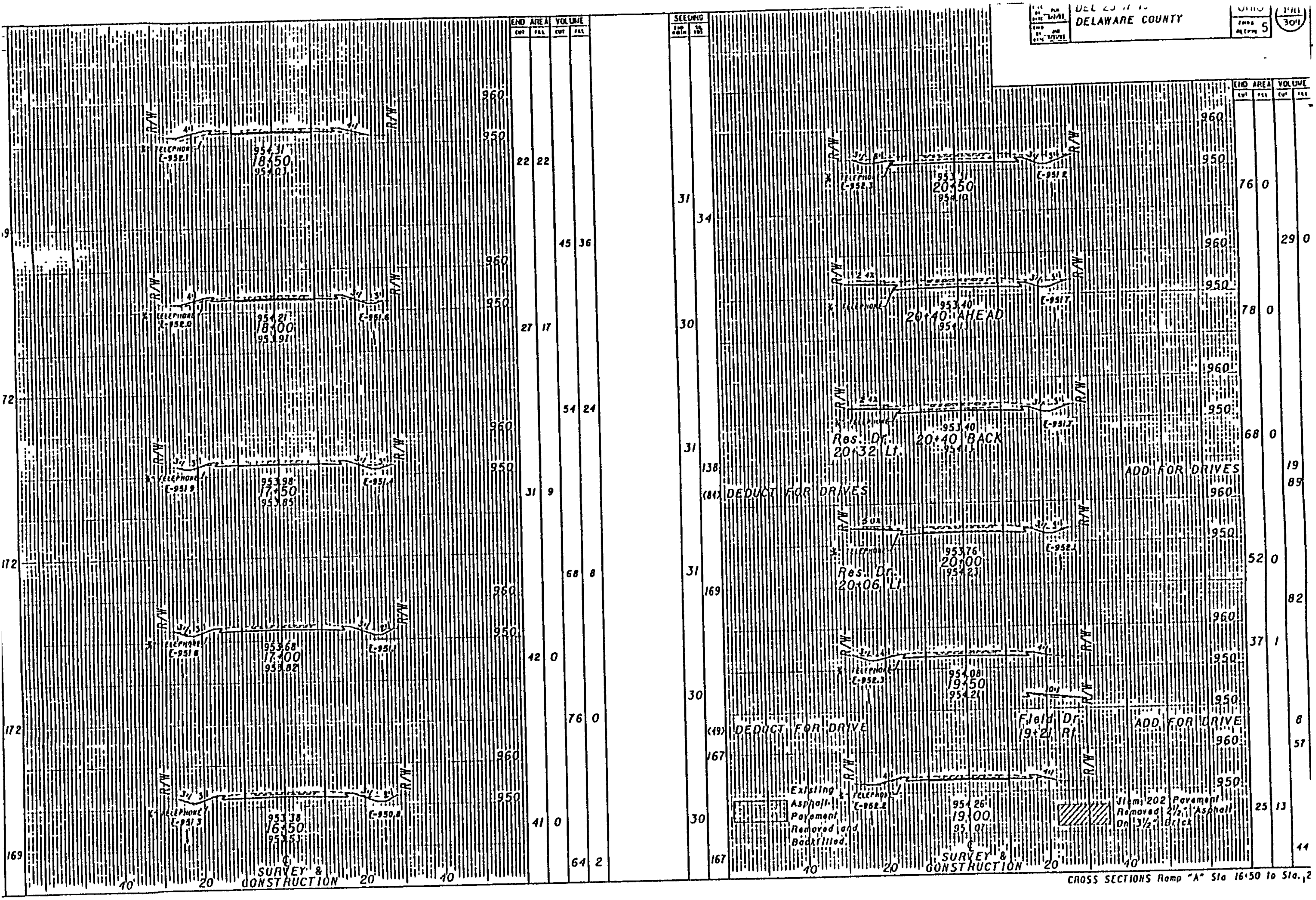
DEL-23-11.45
DELAWARE COUNTY

OHIO 5

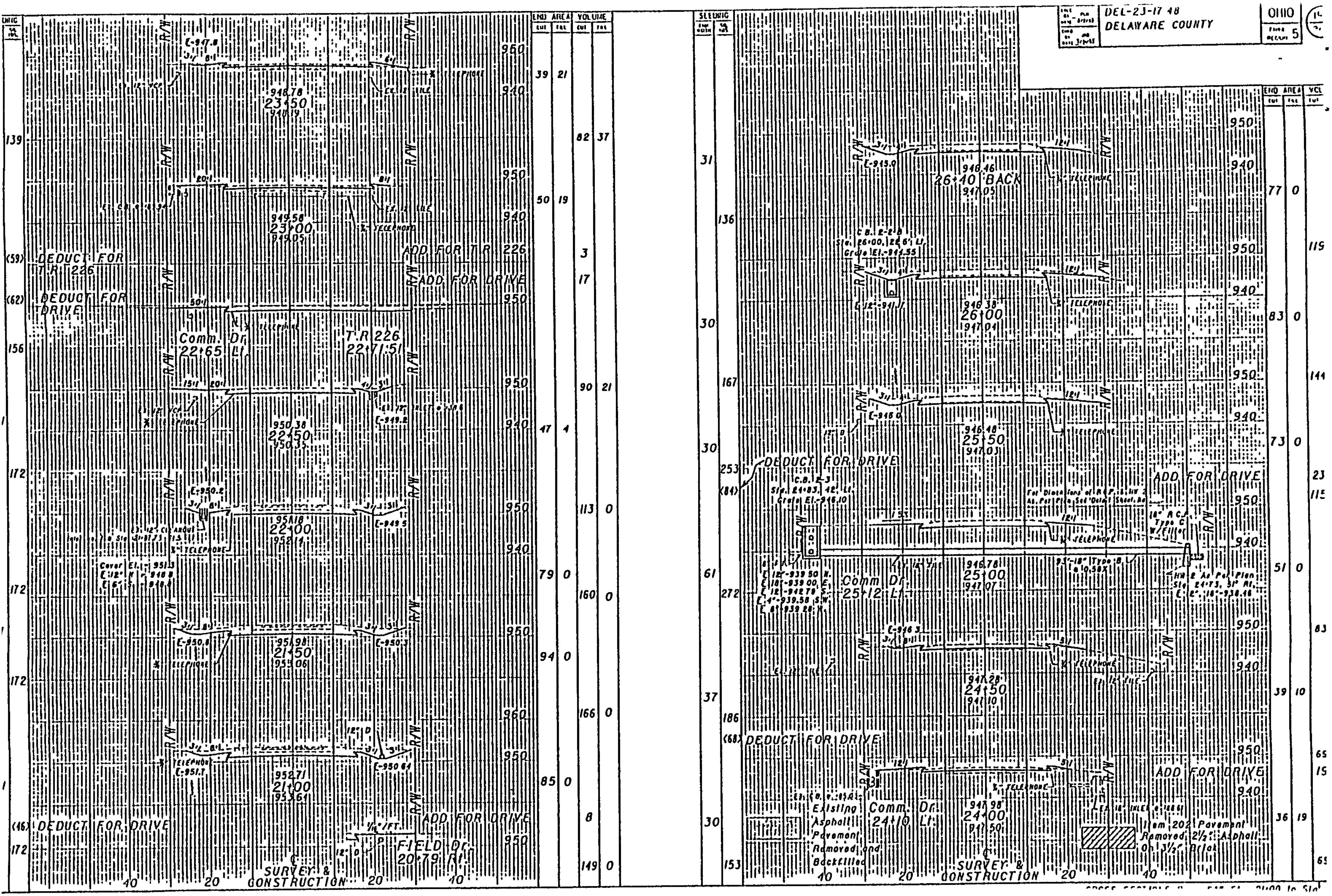


CROSS SECTIONS Ramp "A" Sta 7+50 to Sta.

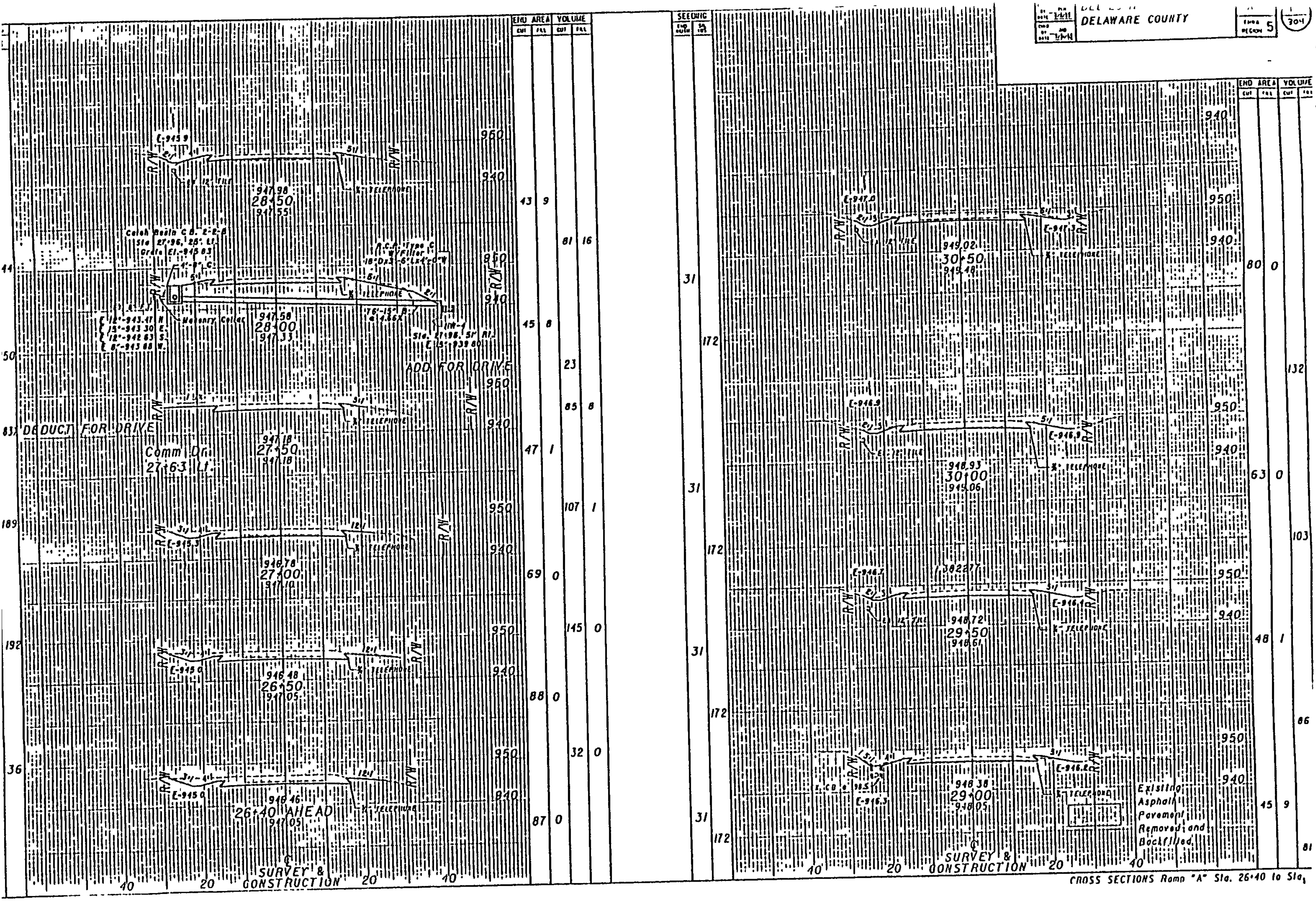

DEL-23-17.48
DELAWARE COUNTY
OHIO
5
END AREA
VOLUME
CUT
FILL
4+40 BACK
14+00
13+50
13+00
12+50
16+00
15+50
15+00
14+50
14+40 AHEAD
DEDUCT FOR DRIVE
ADD FOR DRIVE
Field Dr. 14+00 Rt.
Field Dr. 16+00 Rt.
Existing Asphalt Pavement Removed and Backfilled
Item 202 Pavement Removed 12½" Asphalt On 3½" Brick
SURVEY & CONSTRUCTION
960
950
R/W



DELAWARE COUNTY
END AREA
VOLUME
SEEDING
18+50
18+00
17+50
17+00
16+50
20+50
20+40 AHEAD
20+40 BACK
Res. Dr. 20+32 Lt.
ADD FOR DRIVES
DEDUCT FOR DRIVES
20+00
Res. Dr. 20+06 Lt.
19+50
Field Dr. 19+21 Rt.
ADD FOR DRIVE
DEDUCT FOR DRIVE
19+00
Existing Asphalt Pavement Removed and Backfilled.
Item 202 Pavement Removed 2½" Asphalt On 3½" Brick
SURVEY & CONSTRUCTION
TELEPHONE
R/W
CROSS SECTIONS Ramp "A" Sta 16+50 to Sta. 2



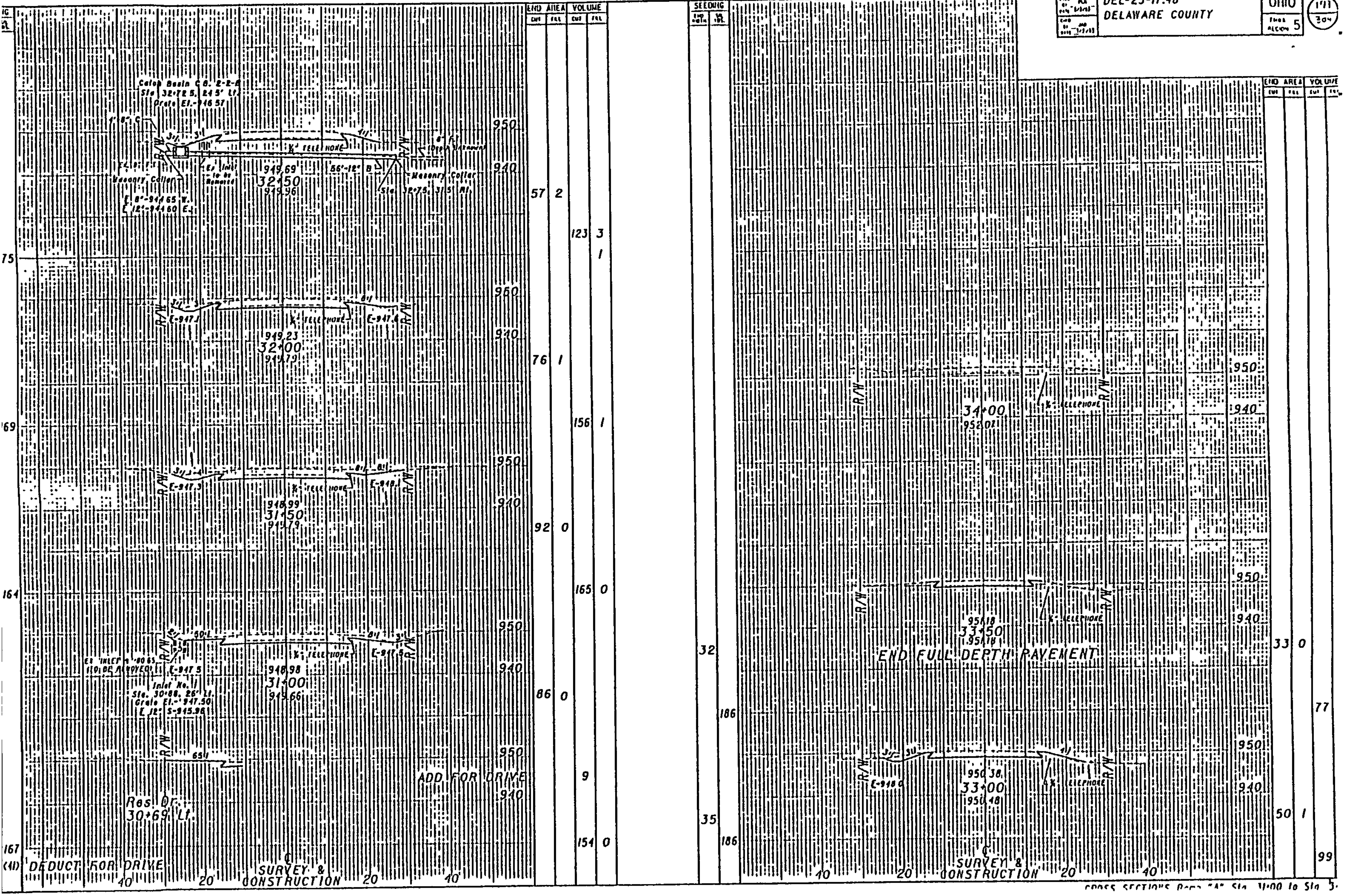
DEL-23-17.48
DELAWARE COUNTY
END AREA
VOLUME
23+50
23+00
22+50
22+00
21+50
21+00
26+40 BACK
26+00
25+50
25+00
24+50
24+00
DEDUCT FOR T.R. 226
ADD FOR T.R. 226
DEDUCT FOR DRIVE
ADD FOR DRIVE
Comm. Dr. 22+65 Lt.
T.R. 226 22+71.51
FIELD Dr. 20+79 Rt.
Comm. Dr. 25+12 Lt.
Comm. Dr. 24+10 Lt.
Existing Asphalt Pavement Removed and Backfilled
Item 202 Pavement Removed 2½" Asphalt On 3½" Br.
SURVEY & CONSTRUCTION
TELEPHONE
R/W


DELAWARE COUNTY
DISTRICT 5
304
END AREA
VOLUME
CUT
FILL
SEEDING
940
950
R/W
28+50
947.98
947.55
Catch Basin C.B. 2-2-B
Sta. 27+96, 25' Lt.
Grate El.-945.83
28+00
947.58
947.33
Masonry Collar
ADD FOR DRIVE
DEDUCT FOR DRIVE
Comm Dr.
27+63 Lt.
27+50
947.18
947.18
27+00
946.78
947.10
26+50
946.48
947.05
26+40 AHEAD
946.46
947.05
TELEPHONE
SURVEY & CONSTRUCTION
40
20
43 9
81 16
45 8
23
85 8
47 1
107 1
69 0
145 0
88 0
32 0
87 0
31
172
30+50
949.02
949.48
80 0
132
30+00
948.93
949.06
63 0
103
29+50
948.72
948.61
48 1
86
29+00
948.38
948.05
45 9
81
Existing Asphalt Pavement Removed and Backfilled
CROSS SECTIONS Ramp "A" Sta. 26+40 to Sta.

DEL-23-17.48
DELAWARE COUNTY

OHIO 5

171/304



CROSS SECTIONS Ramp "A" Sta. 31+00 to Sta. 3

APPENDIX C

LAYER THICKNESS AS DETERMINED BY ELEVATION MEASUREMENTS

SPS-8 CONSTRUCTION DATA SHEET 12 LAYER THICKNESS MEASUREMENTS	* STATE CODE [3 9] * SPS PROJECT CODE [0 8] * TEST SECTION NO. [0 3]

SHEET 1 OF 2

STATION NUMBER	OFFSET (Inches)	LAYER THICKNESS MEASUREMENTS (Inches): DENSE GRADED AGGREGATE BASE	PORTLAND CEMENT CONCRETE SURFACE	ASPHALT SURFACE AND BINDER	Asphalt SURFACE [redacted] LAYER	Asphalt Binder layer
0-10 0 - 10	0	8.6		4.1	1.9	2.2
	36	8.2		4.2	1.7	2.5
	72	7.9		4.0	1.8	2.2
	108	7.9		4.1	1.8	2.3
	132	7.4		4.0	1.8	2.2
0+40	0	8.3		3.4	1.0	2.4
	36	8.5		3.4	1.1	2.3
	72	8.4		3.6	1.3	2.3
	108	8.0		3.8	1.6	2.2
	132	7.6		4.4	1.7	2.7
0+90	0	8.2		3.4	1.2	2.2
	36	8.4		3.2	1.2	2.0
	72	8.3		3.5	1.3	2.2
	108	8.5		3.8	1.7	2.1
	132	7.3		4.6	2.0	2.6
1+40	0	8.3		3.4	0.8	2.6
	36	8.5		3.5	1.1	2.4
	72	8.6		3.4	1.3	2.1
	108	8.5		3.6	1.7	1.9
	132	8.3		4.3	2.0	2.3
1+90	0	8.4		3.5	1.1	2.4
	36	8.2		3.7	1.2	2.5
	72	8.0		4.1	1.6	2.5
	108	8.2		4.2	1.8	2.4
	132	7.6		4.7	1.9	2.8
2+40	0	7.4		3.7	1.3	2.4
	36	7.2		3.8	1.3	2.5
	72	7.3		3.8	1.4	2.4
	108	7.2		4.1	1.6	2.5
	132	7.3		4.6	1.8	2.8
2+90	0	7.7		4.1	1.3	2.8
	36	7.4		4.3	1.4	2.9
	72	7.4		4.3	1.6	2.7
	108	7.4		4.4	1.7	2.7
	132	7.9		4.0	1.7	2.3
LAYER NUMBER		3	— —	04 and 05	0 5	04

SPS-8 CONSTRUCTION DATA SHEET 12 LAYER THICKNESS MEASUREMENTS	* STATE CODE [3 9] * SPS PROJECT CODE [0 8] * TEST SECTION NO. [0 3]

SHEET 2 OF 2

STATION NUMBER	OFFSET (Inches)	LAYER THICKNESS MEASUREMENTS (Inches): DENSE GRADED AGGREGATE BASE	PORTLAND CEMENT CONCRETE SURFACE	ASPHALT SURFACE AND BINDER	Asphalt SURFACE LAYER	Asphalt Binder layer
3+40	0	7.4	.	4.4	1.4	3.0
	36	7.6	.	4.1	1.4	2.7
	72	7.3	.	4.4	1.7	2.7
	108	7.2	.	4.6	1.7	2.9
	132	7.3	.	4.6	1.7	2.9
3+90	0	7.4	.	4.0	1.3	2.7
	36	7.4	.	4.0	1.3	2.7
	72	7.6	.	4.1	1.4	2.7
	108	7.3	.	4.1	1.4	2.7
	132	8.0	.	3.5	1.7	1.8
4+40	0	7.7	.	3.8	1.3	2.5
	36	7.6	.	3.6	1.4	2.2
	72	7.6	.	4.0	1.4	2.6
	108	8.0	.	3.6	1.6	2.0
	132	7.7	.	4.0	1.8	2.2
4+90	0	7.4	.	4.1	1.4	2.7
	36	7.4	.	4.2	1.4	2.8
	72	7.2	.	4.2	1.4	2.8
	108	7.1	.	4.2	1.3	2.9
	132	7.6	.	4.4	1.6	2.8
5+40	0	8.9	.	3.4	1.4	2.0
	36	9.0	.	3.4	1.6	1.8
	72	8.6	.	3.4	1.3	2.1
	108	8.5	.	3.4	1.4	2.0
	132	8.2	.	3.4	1.6	1.8
__+__ __	0	.	.	.	.	
	36	.	.	.	.	
	72	.	.	.	.	
	108	.	.	.	.	
	132	.	.	.	.	
__+__ __	0	.	.	.	.	
	36	.	.	.	.	
	72	.	.	.	.	
	108	.	.	.	.	
	132	.	.	.	.	
LAYER NUMBER		03	__ __	04 + 05	05	04

C.T. Kelton

SPS-8 CONSTRUCTION DATA SHEET 12 LAYER THICKNESS MEASUREMENTS	* STATE CODE [3 9] * SPS PROJECT CODE [0 8] * TEST SECTION NO. [0 4]

SHEET 1 OF 2

STATION NUMBER	OFFSET (Inches)	LAYER THICKNESS MEASUREMENTS (Inches)				
		DENSE GRADED AGGREGATE BASE	PORTLAND CEMENT CONCRETE SURFACE	ASPHALT SURFACE AND BINDER	Asphalt SURFACE [redacted] LAYER	Asphalt Binder Layer
0-50	0	12.0	__.__	6.4	1.8	4.6
	36	12.1	__.__	6.5	1.8	4.7
	72	11.8	__.__	6.4	1.7	4.7
	108	11.4	__.__	6.8	1.8	5.0
	132	10.9	__.__	7.1	2.0	5.1
0+00	0	11.9	__.__	6.6	1.7	4.9
	36	11.4	__.__	6.7	1.6	5.1
	72	11.2	__.__	7.1	1.7	5.4
	108	11.0	__.__	7.1	1.4	5.7
	132	12.0	__.__	7.2	1.8	5.4
0+50	0	12.2	__.__	6.5	1.4	5.1
	36	11.5	__.__	6.7	1.4	5.3
	72	11.6	__.__	6.8	1.3	5.5
	108	11.8	__.__	7.1	1.3	5.8
	132	11.6	__.__	7.2	1.6	5.6
1+00	0	12.6	__.__	6.5	1.6	4.9
	36	12.6	__.__	6.7	1.6	5.1
	72	12.7	__.__	6.7	1.4	5.3
	108	12.8	__.__	6.8	1.4	5.4
	132	12.5	__.__	7.2	1.7	5.5
1+50	0	11.8	__.__	6.7	1.6	5.1
	36	11.4	__.__	7.0	1.4	5.6
	72	11.2	__.__	7.2	1.4	5.8
	108	11.6	__.__	7.0	1.4	5.6
	132	11.9	__.__	7.0	1.4	5.6
2+00	0	12.0	__.__	6.6	1.3	5.3
	36	11.9	__.__	6.7	1.3	5.4
	72	11.9	__.__	6.7	1.4	5.3
	108	11.9	__.__	6.7	1.3	5.4
	132	12.7	__.__	6.6	1.6	5.0
2+50	0	12.2	__.__	6.7	1.4	5.3
	36	11.9	__.__	6.8	1.4	5.4
	72	11.8	__.__	6.6	1.4	5.2
	108	12.0	__.__	6.5	1.6	4.9
	132	11.8	__.__	6.7	1.6	5.1
LAYER NUMBER		0 3	__ __	04 and 05	0 5	04

SPS-8 CONSTRUCTION DATA SHEET 12 LAYER THICKNESS MEASUREMENTS	* STATE CODE [3 9] * SPS PROJECT CODE [0 8] * TEST SECTION NO. [0 4]

SHEET 2 OF 2

STATION NUMBER	OFFSET (Inches)	LAYER THICKNESS MEASUREMENTS (Inches): DENSE GRADED AGGREGATE BASE	PORTLAND CEMENT CONCRETE SURFACE	ASPHALT SURFACE AND BINDER	Asphalt SURFACE [redacted] LAYER	Asphalt Binder Layer
3+00	0	12.4	__ . __	6.4	1.4	5.0
	36	11.8	__ . __	6.6	1.6	5.0
	72	11.8	__ . __	6.4	1.7	4.7
	108	11.8	__ . __	6.1	1.4	4.7
	132	11.9	__ . __	6.2	1.7	4.5
3+50	0	10.4	__ . __	7.2	1.6	5.6
	36	10.9	__ . __	7.2	1.6	5.6
	72	10.7	__ . __	7.2	1.7	5.5
	108	10.7	__ . __	7.1	1.7	5.4
	132	11.6	__ . __	6.8	1.6	5.2
4+00	0	13.4	__ . __	5.8	1.3	4.5
	36	13.1	__ . __	6.5	1.4	5.1
	72	13.0	__ . __	6.2	1.4	4.8
	108	13.0	__ . __	6.1	1.4	4.7
	132	13.8	__ . __	5.8	1.4	4.4
4+50	0	12.1	__ . __	6.2	1.3	4.9
	36	11.9	__ . __	6.5	1.4	5.1
	72	11.8	__ . __	6.4	1.4	5.0
	108	12.2	__ . __	6.5	1.4	5.1
	132	12.2	__ . __	6.4	1.4	5.0
5+00	0	11.9	__ . __	6.1	1.3	4.8
	36	11.4	__ . __	6.4	1.4	5.0
	72	11.2	__ . __	6.2	1.7	4.5
	108	11.3	__ . __	6.2	1.6	4.6
	132	12.2	__ . __	6.4	1.6	4.8
5+50	0	12.1	__ . __	6.7	1.2	5.5
	36	11.5	__ . __	6.7	1.2	5.5
	72	11.3	__ . __	6.7	1.4	5.3
	108	11.5	__ . __	7.0	1.7	5.3
	132	11.6	__ . __	6.8	1.7	5.1
__+__ __	0	__ . __	__ . __	__ . __	__ . __	
	36	__ . __	__ . __	__ . __	__ . __	
	72	__ . __	__ . __	__ . __	__ . __	C.T.K
	108	__ . __	__ . __	__ . __	__ . __	
	132	__ . __	__ . __	__ . __	__ . __	
LAYER NUMBER		03	__ __	04 and 05	05	04

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SPS-8 CONSTRUCTION DATA SHEET 12 LAYER THICKNESS MEASUREMENTS	* STATE CODE [3 9] * SPS PROJECT CODE [0 8] * TEST SECTION NO. [0 9]

SHEET 1 OF 2

STATION NUMBER	OFFSET (Inches)	LAYER THICKNESS MEASUREMENTS (Inches)			
		DENSE GRADED AGGREGATE BASE	PORTLAND CEMENT CONCRETE SURFACE	ASPHALT SURFACE AND BINDER	SURFACE FRICTION LAYER
0-10	0	6.0	8.3	.	.
	36	6.1	7.9	.	.
	72	6.1	7.7	.	.
	108	5.9	7.6	.	.
	132	5.8	7.3	.	.
0+40	0	6.3	8.0	.	.
	36	6.4	7.8	.	.
	72	6.3	7.3	.	.
	108	6.1	7.4	.	.
	132	5.8	7.4	.	.
0+90	0	6.0	8.2	.	.
	36	6.1	7.9	.	.
	72	6.3	7.7	.	.
	108	6.0	7.6	.	.
	132	6.3	7.8	.	.
1+40	0	6.1	7.8	.	.
	36	6.4	7.7	.	.
	72	6.8	7.2	.	.
	108	6.4	7.1	.	.
	132	6.0	7.3	.	.
1+90	0	6.6	8.0	.	.
	36	6.6	7.8	.	.
	72	6.8	7.6	.	.
	108	6.3	7.7	.	.
	132	5.9	7.8	.	.
2+40	0	6.4	8.5	.	.
	36	6.4	8.4	.	.
	72	6.4	8.0	.	.
	108	5.9	8.2	.	.
	132	5.8	8.3	.	.
2+90	0	6.3	8.0	.	.
	36	6.5	7.7	.	.
	72	5.6	8.0	.	.
	108	5.8	7.8	.	.
	132	5.6	7.9	.	.
LAYER NUMBER		03	04		

PREPARED ... EMPLOYER ... DATE

SPS-8 CONSTRUCTION DATA SHEET 12 LAYER THICKNESS MEASUREMENTS	* STATE CODE [3 9] * SPS PROJECT CODE [0 8] * TEST SECTION NO. [0 9]

SHEET 2 OF 2

STATION NUMBER	OFFSET (Inches)	LAYER THICKNESS MEASUREMENTS (Inches)			
		DENSE GRADED AGGREGATE BASE	PORTLAND CEMENT CONCRETE SURFACE	ASPHALT SURFACE AND BINDER	SURFACE FRICTION LAYER
3+40	0	6.1	8.2		
	36	6.8	7.7		
	72	6.3	7.4		
	108	5.5	7.8		
	132	5.5	7.9		
3+90	0	5.9	8.0		
	36	5.8	8.0		
	72	6.1	7.9		
	108	5.8	7.9		
	132	5.8	7.8		
4+40	0	5.6	8.4		
	36	6.0	8.2		
	72	6.6	7.8		
	108	6.1	7.9		
	132	6.0	8.0		
4+90	0	7.0	7.9		
	36	6.6	8.3		
	72	7.0	7.7		
	108	6.5	7.7		
	132	6.1	8.4		
5+40	0	6.0	8.0		
	36	6.4	7.9		
	72	6.4	7.7		
	108	6.1	7.7		
	132	6.0	7.7		
5+50	0	5.4	8.3		
	36	5.6	8.0		
	72	5.6	7.6		
	108	5.4	7.8		
	132	5.5	7.8		
+	0				
	36				
	72				
	108				
	132				
LAYER NUMBER		03	04		

PREPARER ______ EMPLOYER ______ DATE ______

SPS-8 CONSTRUCTION DATA SHEET 12 LAYER THICKNESS MEASUREMENTS	* STATE CODE [3 9] * SPS PROJECT CODE [0 8] * TEST SECTION NO. [1 0]

SHEET 1 OF 2

STATION NUMBER	OFFSET (Inches)	LAYER THICKNESS MEASUREMENTS (Inches)			
		DENSE GRADED AGGREGATE BASE	PORTLAND CEMENT CONCRETE SURFACE	ASPHALT SURFACE AND BINDER	SURFACE FRICTION LAYER
0-50	0	6.1	10.9	__._	__._
	36	6.1	10.9	__._	__._
	72	6.1	10.8	__._	__._
	108	5.6	11.4	__._	__._
	132	5.4	11.6	__._	__._
0+00	0	6.3	11.4	__._	__._
	36	6.0	11.4	__._	__._
	72	5.8	11.3	__._	__._
	108	5.8	11.4	__._	__._
	132	6.4	10.9	__._	__._
0+50	0	6.1	11.2	__._	__._
	36	5.9	11.3	__._	__._
	72	5.8	11.3	__._	__._
	108	6.3	11.3	__._	__._
	132	5.6	10.9	__._	__._
1+00	0	6.0	10.9	__._	__._
	36	6.3	10.7	__._	__._
	72	5.8	10.9	__._	__._
	108	5.3	11.3	__._	__._
	132	5.9	10.9	__._	__._
1+50	0	6.3	11.4	__._	__._
	36	6.5	10.3	__._	__._
	72	6.3	10.3	__._	__._
	108	5.9	10.4	__._	__._
	132	5.8	10.3	__._	__._
2+00	0	6.4	11.2	__._	__._
	36	5.9	11.3	__._	__._
	72	5.8	11.0	__._	__._
	108	5.9	11.0	__._	__._
	132	6.1	10.8	__._	__._
2+50	0	6.1	11.2	__._	__._
	36	6.5	10.7	__._	__._
	72	6.5	10.7	__._	__._
	108	5.8	10.9	__._	__._
	132	5.8	10.9	__._	__._
LAYER NUMBER		03	04	__ __	__ __

PREPARER ______ EMPLOYER ______ DATE ______

September 1992

SPS-8 CONSTRUCTION DATA SHEET 12 LAYER THICKNESS MEASUREMENTS	* STATE CODE [3 9] * SPS PROJECT CODE [0 8] * TEST SECTION NO. [1 0]

SHEET 2 OF 2

STATION NUMBER	OFFSET (Inches)	LAYER THICKNESS MEASUREMENTS (Inches)			
		DENSE GRADED AGGREGATE BASE	PORTLAND CEMENT CONCRETE SURFACE	ASPHALT SURFACE AND BINDER	SURFACE FRICTION LAYER
3+00	0	5.9	11.4	.	.
	36	6.0	10.9	.	.
	72	6.3	10.6	.	.
	108	5.8	10.9	.	.
	132	5.9	10.8	.	.
3+50	0	5.9	11.2	.	.
	36	5.6	11.2	.	.
	72	5.8	10.8	.	.
	108	6.3	10.6	.	.
	132	6.4	10.2	.	.
4+00	0	5.9	11.2	.	.
	36	6.3	10.7	.	.
	72	6.1	10.6	.	.
	108	5.8	10.6	.	.
	132	6.1	10.3	.	.
4+50	0	6.3	10.9	.	.
	36	6.2	10.9	.	.
	72	6.3	10.9	.	.
	108	5.6	10.8	.	.
	132	5.8	10.3	.	.
5+00	0	6.1	11.2	.	.
	36	6.3	10.9	.	.
	72	6.5	10.6	.	.
	108	6.1	10.7	.	.
	132	6.6	10.4	.	.
5+50	0	6.6	11.0	.	.
	36	6.4	11.2	.	.
	72	5.9	11.2	.	.
	108	5.9	11.0	.	.
	132	6.4	10.6	.	.
6+00	0	6.5	11.2	.	.
	36	6.6	10.8	.	.
	72	6.6	10.7	.	.
	108	6.1	10.6	.	.
	132	5.9	10.8	.	.
LAYER NUMBER		03	04		

C. Tibbe

APPENDIX D

LETTER REPORTING ON PCC PROBLEMS

soil and materials engineers, inc.
43980 Plymouth Oaks Blvd. Plymouth, MI 48170-2584 (313) 454-9900 FAX (313) 454-0629

March 9, 1995

Mr. Richard E. Ingberg, Regional Engineer
North Central FHWA - LTPP
6875 Washington Avenue South
P.O. Box 39108
Minneapolis, MN 55439-0108

Re: Ohio SPS-8 PCC Test Sections
FHWA - LTPP
SME Project No. PP18400

Dear Mr. Ingberg:

Following our meeting of March 8, 1995, at the Ohio SPS-8 site, I surveyed the condition of the two concrete test sections. An earlier survey had been performed by Eric Huff on December 3, 1994. The condition surveys were performed according to the guidelines contained in the Distress Identification Manual for the Long-Term Pavement Performance Project (SHRP-0-338), however there were no faulting measurements made during my survey. The results of the December, 1994 survey is provided in Appendix A while the March, 1995, survey is provided in Appendix B.

The test sections are in excellent condition. However, based on the most recent condition survey, the amount of low severity joint spalling has increased on both test sections. The following table contains the results of the December, 1994, survey and the March, 1995, survey.

SHRP ID	DATE	NO. OF JOINTS SPALLED	LENGTH (m)
390809	12/03/94 3/03/95	6 18	2.1 4.5
390810	12/03/94 3/03/95	0 12	0.0 2.6

Presently, a little over 1/2 of the joints on section 390809 are experiencing the low severity joint spalling while almost 1/3 of the joints on section 390810 now have some spalling. The spalls are 5 to 25 cm in length and appear to be only about 6 mm deep, about the depth of the surface tining. At all of the spall locations, the silicone joint seal was well adhered to the spalled surface. It should be noted that there is a slight skew to the joints, while the tining appears to be perpendicular to the lanes. The spalling was generally located adjacent to areas where there was a small sliver of concrete bounded by the tining and the joint.

The upper surface of the concrete has a thin layer of laitance and is somewhat friable, easily scratched with a knife to a depth of about 3 mm. It also appears that the some of the paste has worn away, exposing the fine aggregate. The surface condition has not changed significantly from that observed during our first visit to the site about 2 weeks after construction.

We believe the reason for the joint spalling is due to slight thermal movement of the joint which induces a fracture in the weak surface of the concrete. The silicone sealant appears to have a higher adhesive bond strength to the joint faces than the tensile strength of the upper surface of the concrete. This situation is especially critical when there is only a short distance between the joint face and the adjacent tining as described above. We expect that the amount of joint spalling will increase after this winter, when there will be increased movement of the joints due to daily temperature fluctuations.

The friable nature of the surface may be due to excess bleed water at the surface and due to the extended finishing operations. As was discussed at the meeting, several attempts at tining the surface were necessary to obtain a surface texture. Although the amount of deterioration of the surface does not appear to have increased since construction, this has been a relatively mild winter. There may be some increased surface deterioration in the form of spalling and surface abrasion which can result from additional freeze/thaw cycles and traffic on the pavement.

Should you need further information, please contact our office.

Very truly yours,

SOIL AND MATERIALS ENGINEERS, INC.

Cary T. Keller

Cary T. Keller, P.E.
Senior Engineer

pc: Monte Symons, FHWA - LTPP
John Miller, PCS-Law
Gene Skok, Braun Intertec
Bill Edwards, ODOT

APPENDIX E

FHWA REPORT ON PCC CORES

REPORT ON EXAMINATION OF CORES
U.S. Route 23 (Columbus, Ohio)

Marcia J. Simon, P.E.
Stephen W. Forster, Ph.D., P.G.

Federal Highway Administration
Turner-Fairbank Highway Research Center
McLean, Virginia

INTRODUCTION

Six 100 mm (nominal) diameter cores and two 150 mm (nominal) diameter cores from U.S. 23 in Ohio were submitted for examination by the Ohio DOT through Bob McQuiston of the Ohio Division office. The concrete was placed as part of the LTPP SPS-8 experiments in Ohio. Reports indicated that the pavements are exhibiting "surface scaling, surface texture abrasion and degradation and indications of poor surface durability". The DOT requested a petrographic examination of the concrete to determine possible problems, and specifically were looking for information on the air void system, unit weight, and w/c ratio. Testing for modulus of elasticity was also requested.

TEST RESULTS

1.a. General Visual and Microscopic Examination

Two of the 100 mm diameter cores (designated STA3 and STA5) were selected for visual and microscopic examination. The core STA3 was chosen as representative of the group and given a general examination with the unaided eye and the stereomicroscope at magnifications of 50 to 200X. At the time of examination the core had already been sawed vertically and one of the sawed surfaces polished for later evaluation of the air void system. The portion of the core examined was the upper approximate 150 mm (6 in) of the core, and included the pavement riding surface. It was noted that the upper surface was tined, and that there seemed to be some loss of surface material, although the tining was certainly still easily visible.

Examination of the sawed and polished surface revealed the coarse aggregate to be a crushed limestone with a maximum size of approximately 19 mm (3/4 in). The fine aggregate used in the concrete is a natural sand. The overall aggregate gradation appears to be somewhat lacking in the smaller coarse aggregate sizes (10 mm (3/8 in) to No. 4 sieve). The coarse aggregate appears very porous, indicating a likely high absorption and potential batch water control problems.

The concrete is air entrained, with a total air content that appears high. The air voids appear to be uniformly distributed over the depth of the core (further details on the air void system are given below in 1.b.). A number of large (greater than 13 mm (1/2 in)), irregularly shaped voids were noted on the polished surface. These may be entrapped air voids or voids formed by entrapped bleed water. The locations of some of these voids beneath coarse aggregate particles would indicate that at least some are most likely water voids. There was no evidence of cracking in the concrete or segregation or coarse aggregate settling.

1.b. Air Void System Analysis

The air void system analysis consisted of air void system evaluation using visual observation and ASTM C457 [1]. The cores labeled "STA3" and "STA5" were cut into cylindrical sections approximately 150 mm (6 in) long (measured from the top surface of the core), cut in half lengthwise, and cut again parallel (or nearly so) to the first lengthwise cut to obtain one slice approximately 25 mm (1 inch) thick from each core. The larger flat surface (representing the first lengthwise cut) was ground and polished using a series of silicon carbide grits to achieve a satisfactory plane surface for microscopical analysis. The air void system measurements were performed in accordance with ASTM C457, Procedure B, Modified Point Count. The test parameters used for both samples are shown in Table 1.

Table 1. ASTM C457 Test Information

Test Parameter	Value
Traverse length, cm (in)	241.3 (95)
Traverse area, cm^2 (in^2)	96.8 (15)
Traverse lines	32
Number of points	1425

The estimated air void system parameters based on modified point count measurements are shown in Table 2. The equations for calculating the air void parameters are found in ASTM C457.

Table 2. Modified Point Count Results

	Parameter	STA 3	STA 5
Volume Fractions	Air (%)	8.7	8.7
	Paste (%)	21.8	24.4
	Fine (%)	24.3	22.6
	Coarse (%)	45.3	44.3
ASTM C457 Parameters	Mean chord length, mm (in)	.216 (.009)	.312 (.012)
	Voids per inch	10.2	7.1
	Specific surface, mm^{-1} (in^{-1})	18.5 (471)	12.8 (326)
	Spacing factor, mm (in)	.127 (.005)	.229 (.009)

2. Modulus of Elasticity

The static modulus of elasticity of each of the 150 mm (6 in) cores (40125-A and 40125-B) was measured in accordance with ASTM C469 [1], except as noted below. The specimen lengths (capped) were 240 mm (9.46 in) for Sample 40125-A and 230 mm (9.05 in) for Sample 40125-B. The actual diameters of both samples were 143 mm (5.63 in). The L/D ratios are 1.68 for Sample 40125-A and 1.61 for Sample 40125-B (both are greater than 1.5, as required by ASTM C469).

Three test cycles were performed (the data for the first test is ignored as specified in ASTM C469). The specimens were tested first in a dry condition, which is not the standard practice of ASTM C469. However, the modulus of elasticity is lower for dry samples than for samples soaked immediately prior to testing (as specified in ASTM C469). Therefore, the test values for dry samples should be conservative. Test results (average of two tests) are shown in Table 3.

Table 3. Modulus of Elasticity test results (tested dry)

Specimen	Modulus of Elasticity, MPa (psi)
40125-A	18,340 (2,660,000)
40125-B	18,200 (2,640,000)

The specimens were then soaked for 72 hours and tested in the wet condition (in accordance with ASTM C469). The modulus for Specimen 40125-A (wet) was 20,550 MPa (2,980,000 psi). The cap on Specimen 40125-B cracked resulting in an invalid test.

DISCUSSION OF RESULTS

1.a. General Visual and Microscopic Examination

Considering the nature of the problems apparently noted in this pavement, there are a number of possible indicators from the general examination which may have some bearing on the pavement performance. Since the air void system appeared to be uniformly distributed throughout the concrete, the reported scaling or loss of some surface material was probably not due to a lack of air near the surface (see section 1.b below). It was reported that during construction the mix was "boney" and hard to finish, and excessive bleeding was noted. The poor workability of the mix could be attributed to several causes, including the low cementitious content (and hence low paste volume) and the gradation of the aggregate. Apparent gap-grading of the aggregate was noted during visual examination of the polished surface. This type of grading will often create a mix which is difficult to work and which has higher water requirements. The apparent porosity and high absorption of the coarse aggregate could additionally have contributed to water demand and control problems if the aggregate was not kept at a consistent, known water content prior to mixing. Placement, workability or finishing problems could have led to the addition of water at the job site. Excessive bleeding is not uncommon in mixes with low cement content and high w/c ratio. If finishing operations were started prior to evaporation of all the bleed water, surface durability problems could result.

1.b. Air Void System Analysis

The air contents of both specimens are high (8.7 %) but appear to be consistent with fresh air tests. The specific surface values, 18.5 and 12.8 mm^{-1} (471 and 326 in^{-1}), are lower than would be expected, especially for STA5 (see discussion below). The spacing factor value for STA3 is .127 mm (.005 in), which would generally be considered a sign of durable concrete. The spacing factor for STA5 is .229 mm (.009 in), which would generally be considered marginal (a widely quoted recommendation for durable concrete is for spacing factor to be less than.200 mm (.008 in)). There was no evidence (from visual observation) of differences in the air void system with depth from the pavement surface.

Based on the estimated air void system parameters, we would not have expected this concrete to fail due to freezing and thawing deterioration in the paste in one winter of freeze-thaw cycles (we assume that the aggregate used in these sections has previously been tested for D-cracking susceptibility).

A low specific surface is an indicator of a relatively coarse air void system. Visual observation of the specimen surface during testing revealed few void sections in the smallest size ranges (less than .050 to .075 millimeters). This finding is consistent with the low specific surface. Also, on each specimen there were 15-25 large, irregular voids of several millimeters or more in size. These large voids would also tend to reduce the specific surface. Since the spacing factor is a function of, and inversely proportional to, specific surface, spacing factor increases as specific surface decreases.

Possible factors which could have contributed to development of a coarser air void system:

1. Combinations of AEA and water reducers can sometimes lead to coarser air void systems.

2. High w/c means a very fluid paste, which makes bubble coalescence easier.

3. Low workability may lead to incomplete consolidation, which can result in the formation of many large, irregular voids.

Inferences about whether deicer scaling would have caused the deterioration cannot be made without inspecting the surface and possibly running scaling tests. However, some points to be aware of are (1) fly ash in a mix has been found, in some cases, to reduce resistance to scaling, and (2) the adequacy of curing at the surface is critical, especially with a relatively low strength mix such as this one. Inadequate curing will lead to a weak surface with more potential not only for scaling loss but abrasion loss as well.

Finally, the paste volume fractions for the two samples were 21.8 and 24.4 percent (samples STA3 and STA5, respectively). These values are low, suggesting a low cement content and the potential for a harsh mix.

2. Modulus of elasticity

The values obtained in these tests are markedly different than those reported in the copies of data sheets sent to us (test date 11-04-94). One would expect the modulus of elasticity to increase with age, but not by over 100 percent. It is possible that a mathematical error was made in the original tests -- a common mistake is to use the change in dial gage reading instead of the change in specimen length, which (depending on how the compressometer is designed) is usually half the change in dial gage reading. Using the actual dial gage reading would result in a value for the modulus which is one-half the actual test result.

Although it is based on 28-day cylinder tests, the ACI 318 equation for modulus of elasticity as a function of compressive strength,

$$E = 57{,}000\sqrt{f'_c} \qquad (1)$$

can be used to see if the modulus values obtained in the tests are at least "in the ballpark." If the values obtained in the tests are substituted into the ACI 318 equation for estimating modulus of elasticity, and the equation is solved for compressive strength, values of approximately 14.5 to 15 MPa (2100 to 2200 psi) are obtained. These appear to be reasonable "ballpark" values for core compressive strengths. Typical values of the modulus of elasticity for normal weight concrete with compressive strength (28 day cylinders) of 20 to 35 MPa (3,000 to 5,000 psi) are 13,800 to 41,400 MPa (2,000,000 to 6,000,000 psi). The modulus value depends on factors such as the concrete compressive strength and the aggregate type [2].

3. Unit Weight

One of the measures requested by the Ohio DOT was the unit weight of the concrete. The usefulness of this measure in evaluating the problem at hand was not apparent. The porosity of the coarse aggregate and an air content of 8.7 percent (a few percentage points higher than typical specifications) might lead to a slightly lower unit weight than would otherwise be expected, but the difference would, in our opinion, be insignificant in terms of hardened concrete properties. Therefore, the unit weight was not estimated.

If desired, the DOT could measure the unit weight of the hardened concrete by weighing a sample of concrete in air, then weighing it in water and calculating the unit weight. This number cannot be compared to the unit weight of the plastic concrete since there are a number of factors which can affect the unit weight of the hardened concrete.

The unit weight could also be estimated from the volume fractions of the concrete constituents and their specific gravities. However, this would involve several assumptions about the cement paste such as the degree of hydration, and the porosity. These assumptions would be complicated for this mix due to the presence of fly ash.

4. W/C Ratio

The Ohio DOT also requested an evaluation of the water cement ratio of the hardened concrete. According to the mix design sent to us, the w/c ratio was 0.58, which is quite high. Use of such a high w/c ratio was necessary to meet the low flexural strength requirements of the mix. Direct measurement of the w/c in the hardened concrete is not possible, but some of the observations noted above signal a high w/c ratio. For instance, mixtures with high w/c ratio have a tendency to generate a higher air volume for a given dosage of air entraining agent (AEA), and since the water tends to dilute the AEA, smaller individual air voids are less stable resulting in a greater proportion of larger and sometimes more irregular voids. Both these characteristics were noted during the examination of the air void system. The field observations reported to us (excessive bleeding, unworkable mix, hard to finish) are also signs of a high w/c ratio.

SUMMARY AND RECOMMENDATIONS

Summary of Findings

1. The difficulty in obtaining the desired 14-day flexural strength of 550 ± 25 psi probably stems primarily from the use of crushed limestone aggregate, with secondary factors could including the cement fineness and/or chemical composition. The mix proportions used, with w/c of 0.58 (an extreme measure) created an unworkable concrete mix which bled excessively and was difficult to finish. Several items noted in the visual and microscopic observations (e.g., significant number of large, irregular voids and coarser than usual air void system) corroborate the field observations. It is most likely that the surface problems which are appearing stem from improper or poorly timed finishing. Inadequate curing would have made the problem worse.

2. The air void system appears to be adequate for paste frost resistance, at least for the limited exposure the pavement had before distress was noted. The high air volume and coarse air void system may be due to the combination of AEA and water reducer, in conjunction with the high w/c ratio.

3. The modulus of elasticity results seem reasonable when compared to typical published values for concrete and estimates of compressive strength using the ACI 318 equation for normal weight concrete. The test results obtained from these two cores are substantially higher than the values obtained in previous testing (November 1994), even when age at testing is accounted for. The previous test results should be checked.

4. Measurements of unit weight and water cement ratio of the hardened concrete were not performed, because the usefulness of the former in evaluating the condition of the concrete was not apparent, and the latter cannot be measured.

Recommendations

1. The DOT should consider using a different aggregate if additional placements of the low strength mix are required. Concretes made with crushed stone typically exhibit higher strengths than those made with rounded aggregates, due to the effects of aggregate interlock. Limestone aggregates also provide especially good paste-aggregate bond, since some chemical interaction can take place. Therefore, crushed limestone aggregate makes it more difficult to produce the low strength required.

2. If the crushed limestone is the only possible aggregate, a cement with low fineness (i.e, coarsely ground), low C_3S content, and low C_3A content would help reduce short-term strength.

3. The use of fly ash as a cement replacement (as done in this case) is another method of reducing short-term strength. Perhaps a higher total cementitious material content with a greater replacement percentage is required (i.e., add more fly ash while keeping the cement content the same). A greater percentage of fly ash might also help to reduce bleeding and to improve workability. A higher total cementitious material content (e.g., higher paste content) would probably help the workability as well.

4. Construction should be monitored closely. Care should be taken to prevent water additions at the site. Finishing and curing procedures should be given careful attention to avoid construction-related surface distress.

REFERENCES

1. 1994 Annual Book of ASTM Standards, Volume 4.02 (Concrete and Aggregates). ASTM: Philadelphia, 1994.

2. Kosmatka, S.H. and W.C. Panarese, Design and Control of Concrete Mixtures, 13th Edition. Portland Cement Association: Skokie, Illinois, 1990, p. 157.

APPENDIX F

SUMMARY MATERIALS SAMPLING AND TESTING PLAN

FIGURE 3 - LEGEND FOR FIGURES 4 - 7 - SPS8

B1-B5	Bulk Samples and Moisture Samples - Subgrade
B15,16,18,19	Bulk Samples and Moisture Samples - Embankment
A1-A9	Shelby Tube Samples from Subgrade
S1-S2	Continuous Subgrade Sampling (20 ft) Locations
T1-T13,T15,T17	Nuclear Density and Moisture Tests - Subgrade
T39-46, T51-55	Nuclear Density and Moisture Tests - Embankment
T18-T32	Nuclear Density and Moisture Tests - Aggregate Base
T33-T38	In-Place Density Tests on Asphalt Concrete (Tests Performed on the intermediate and surface course)
C1-C39	4 inch diameter cores

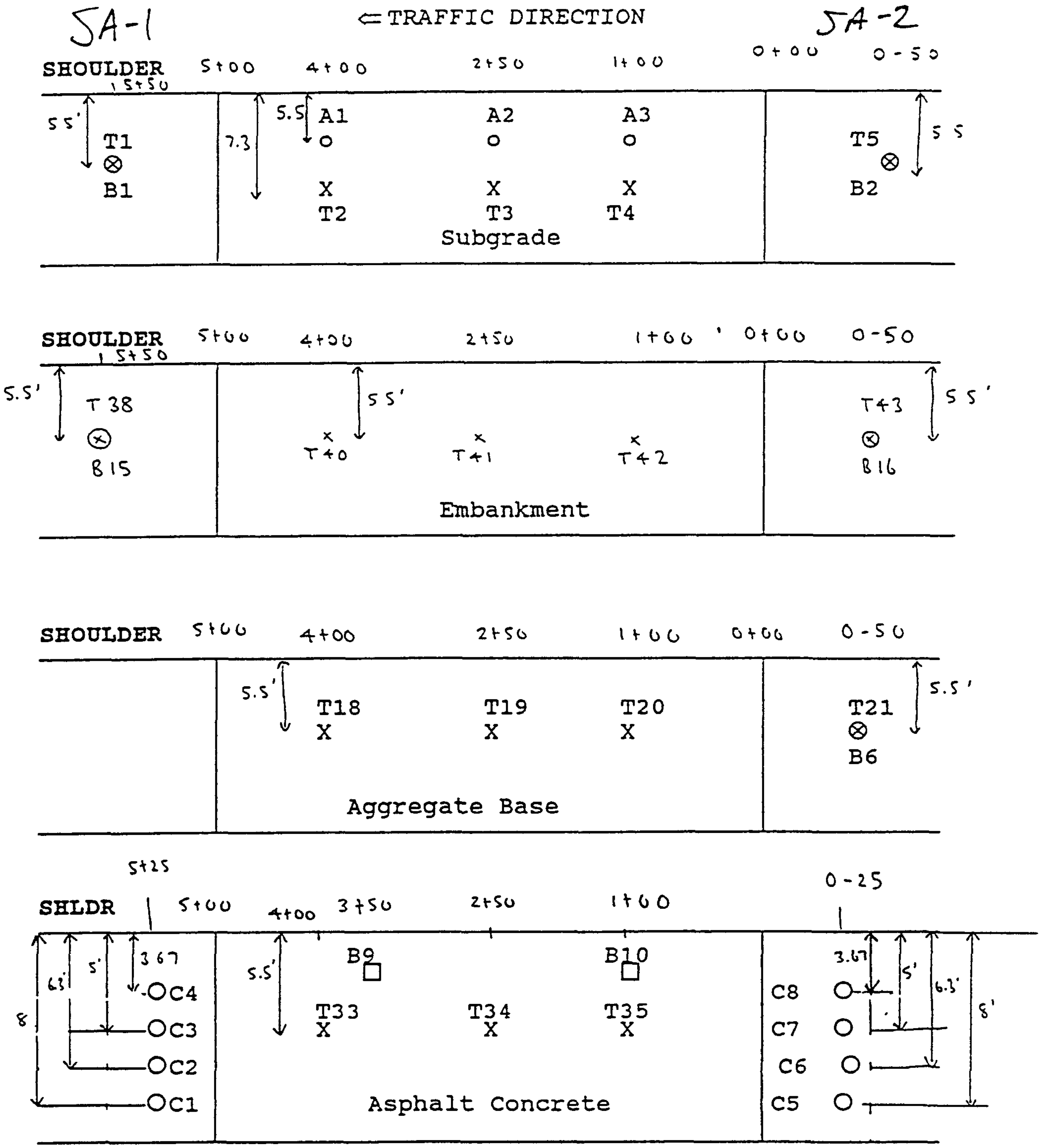


FIG. 4 SAMPLING AND TESTING FOR SECTION 390804

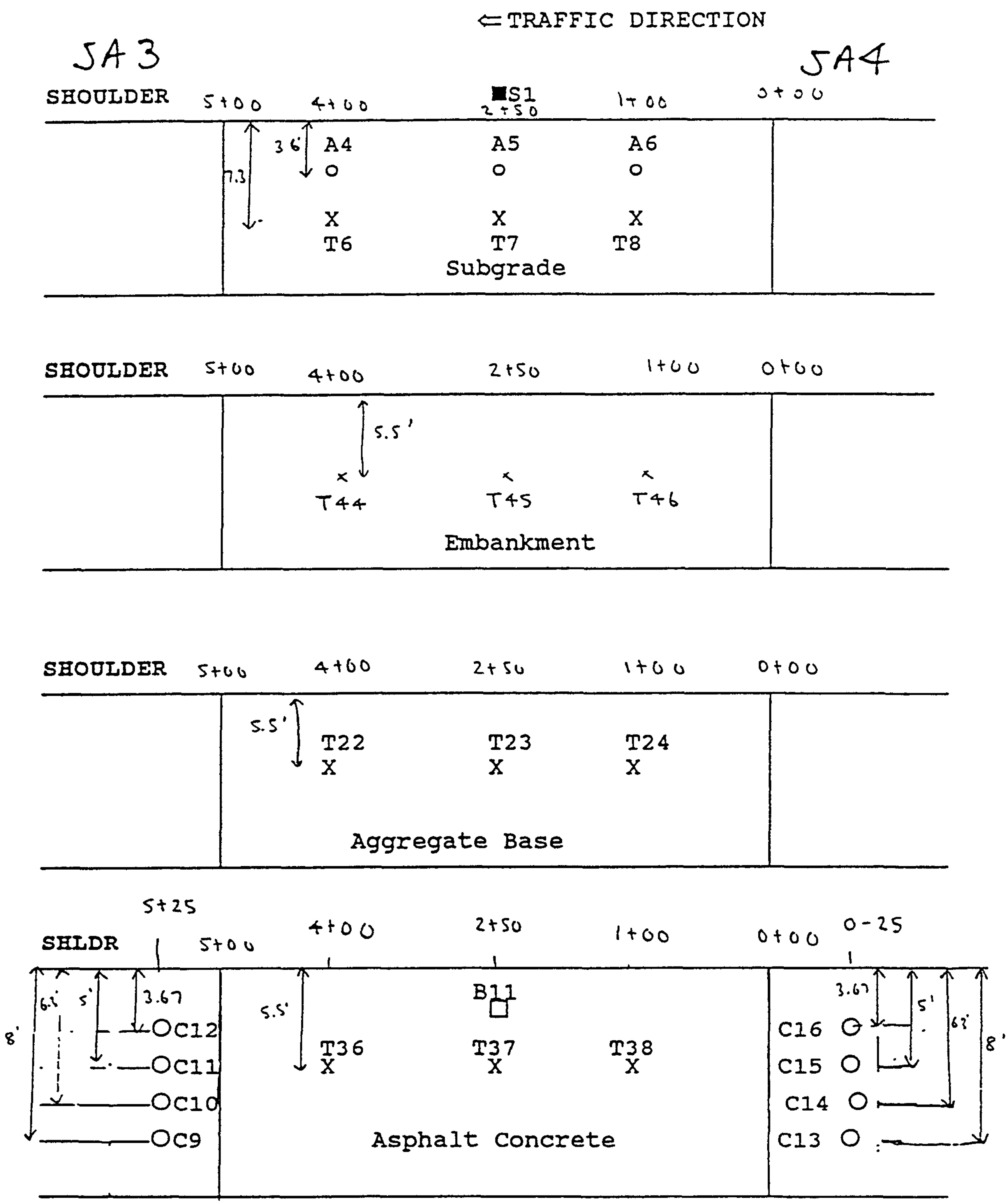


FIG. 5 SAMPLING AND TESTING FOR SECTION 390803

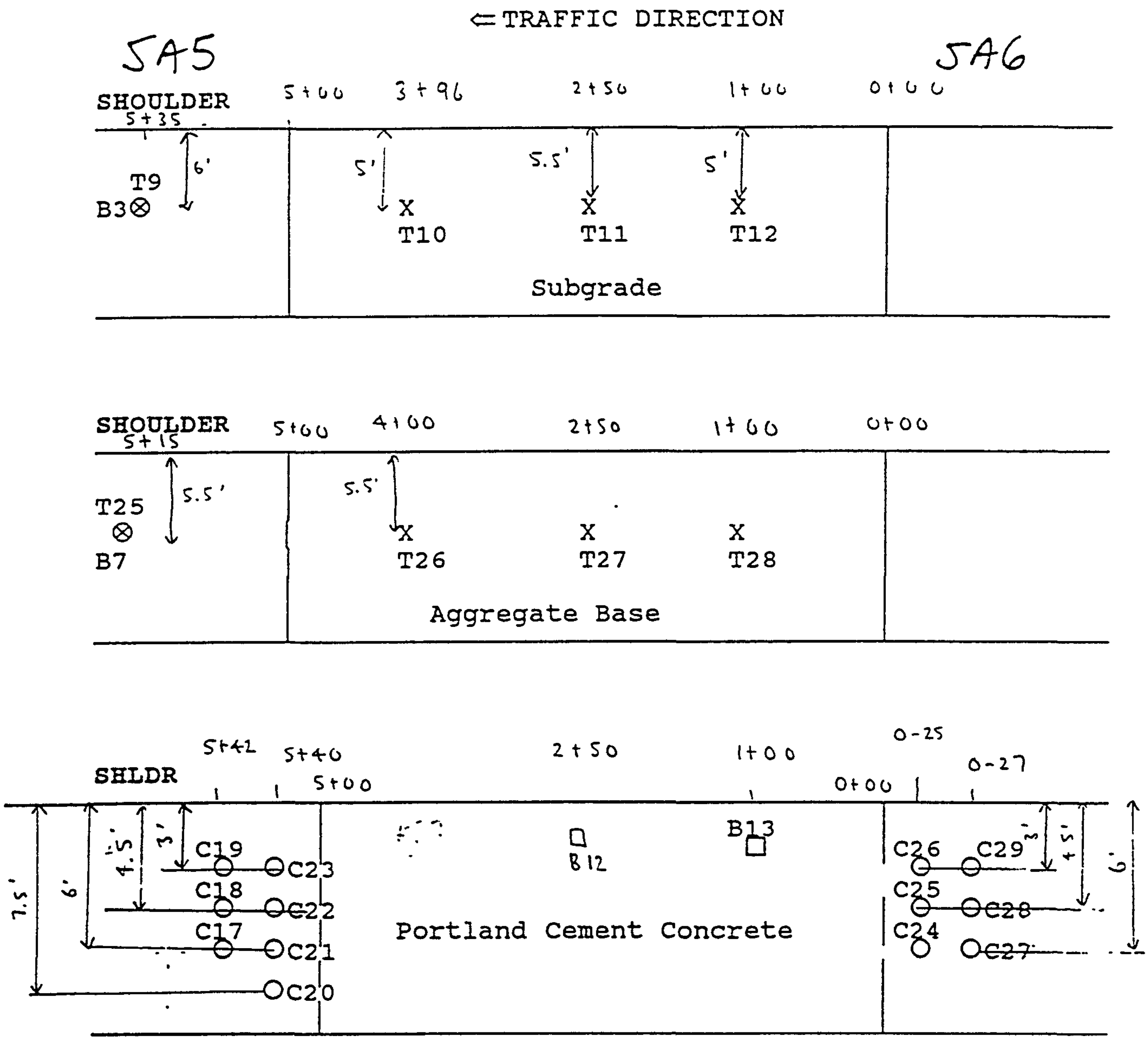


FIG. 6 SAMPLING AND TESTING FOR SECTION 390809

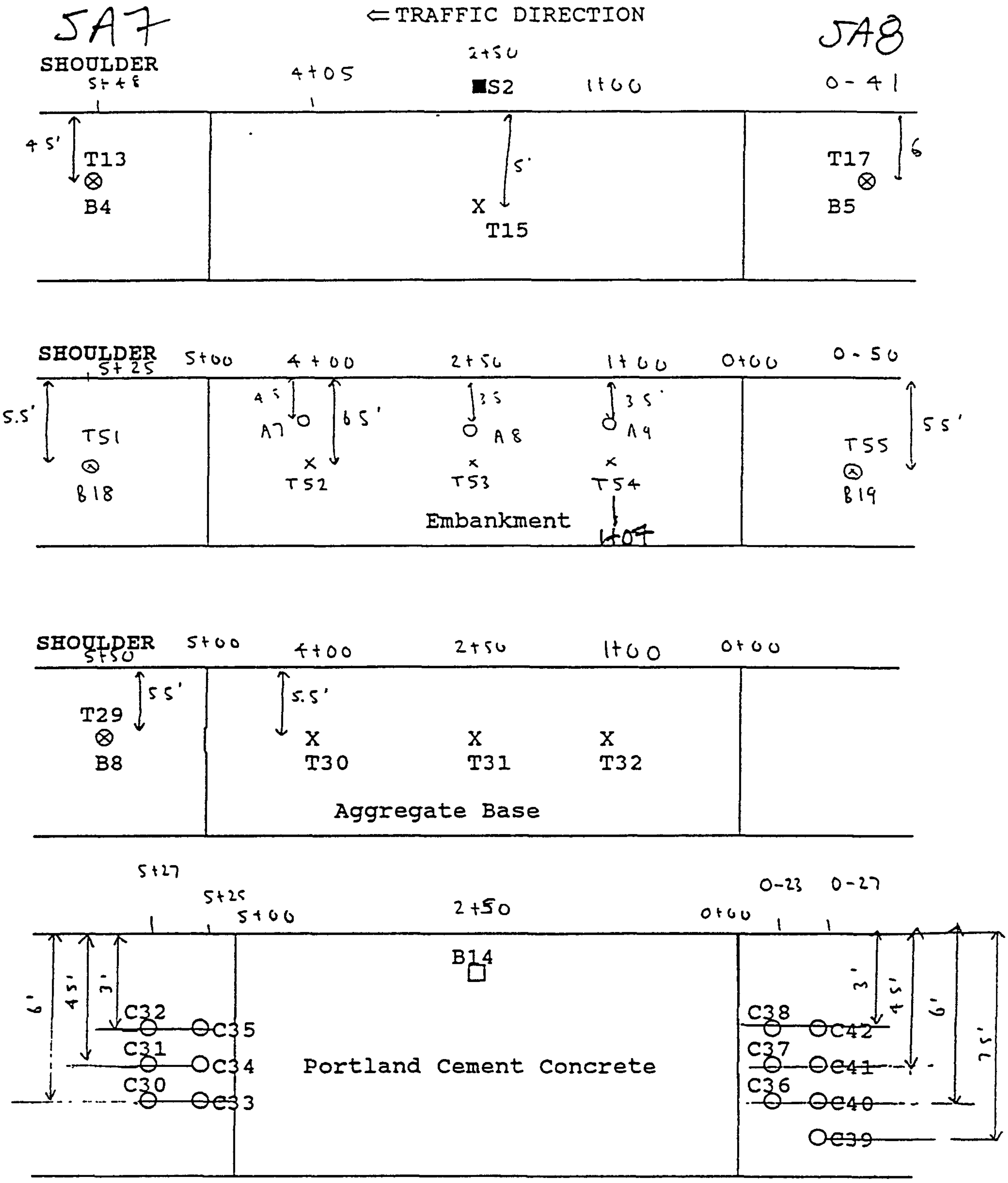
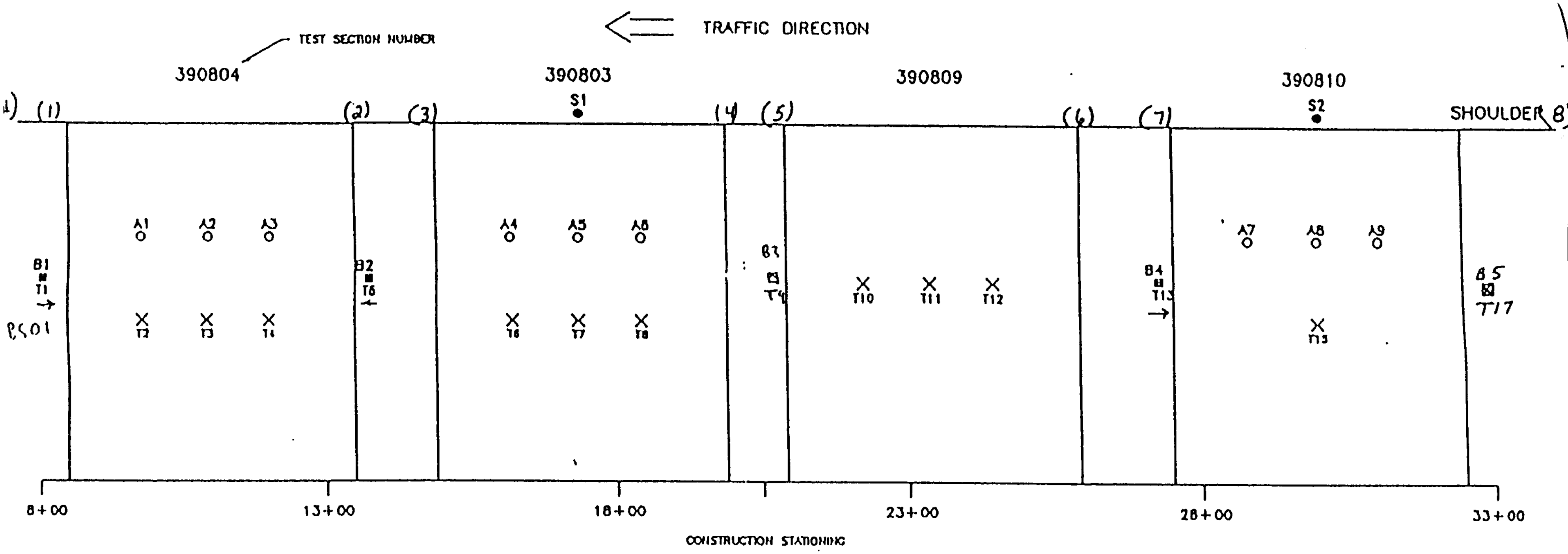


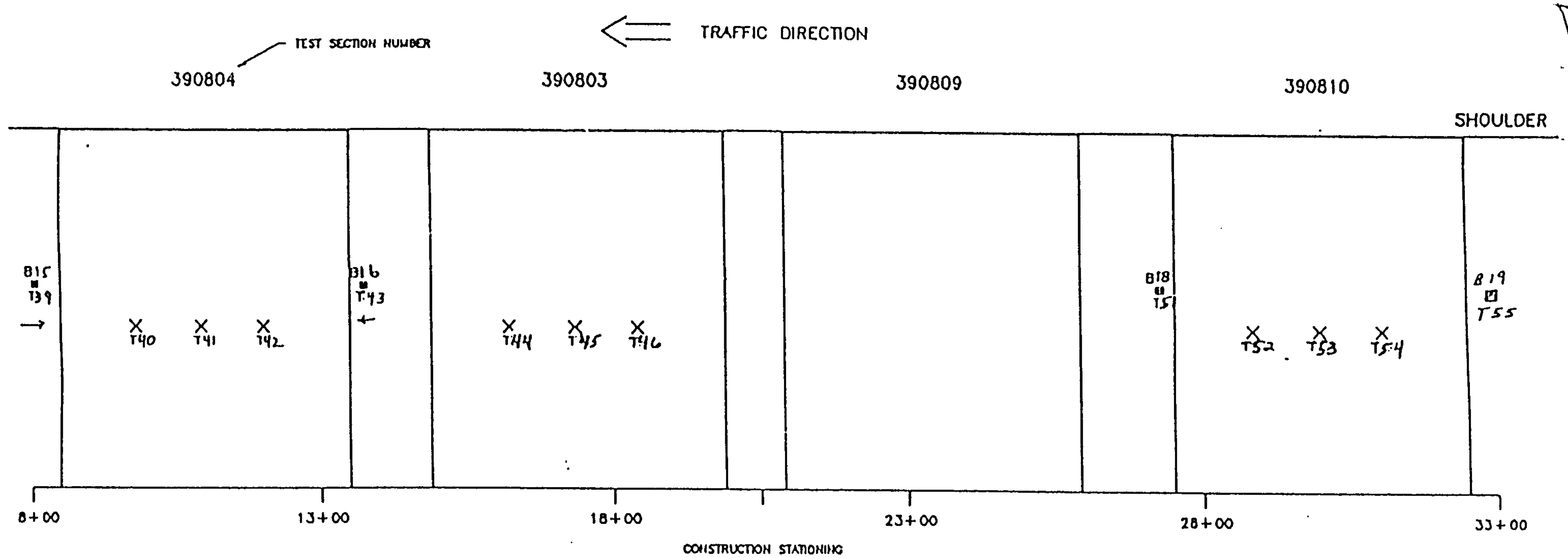
FIG. 7 SAMPLING AND TESTING FOR SECTION 390810



NOTES:

1. T – NUCLEAR DENSITY/MOISTURE TESTS, B – BULK AND MOISTURE SAMPLES, S – SHOULDER PROBE, P – PLATE LOAD TEST
2. CONDUCT ELEVATION MEASUREMENTS AND FWD TESTING ON ALL SECTIONS
3. CONDUCT NUCLEAR DENSITY TESTS ON BULK SAMPLING LOCATIONS BEFORE SAMPLING

FIG. 8 – OVERVIEW OF SAMPLING AND FIELD TESTING ON SUBGRADE

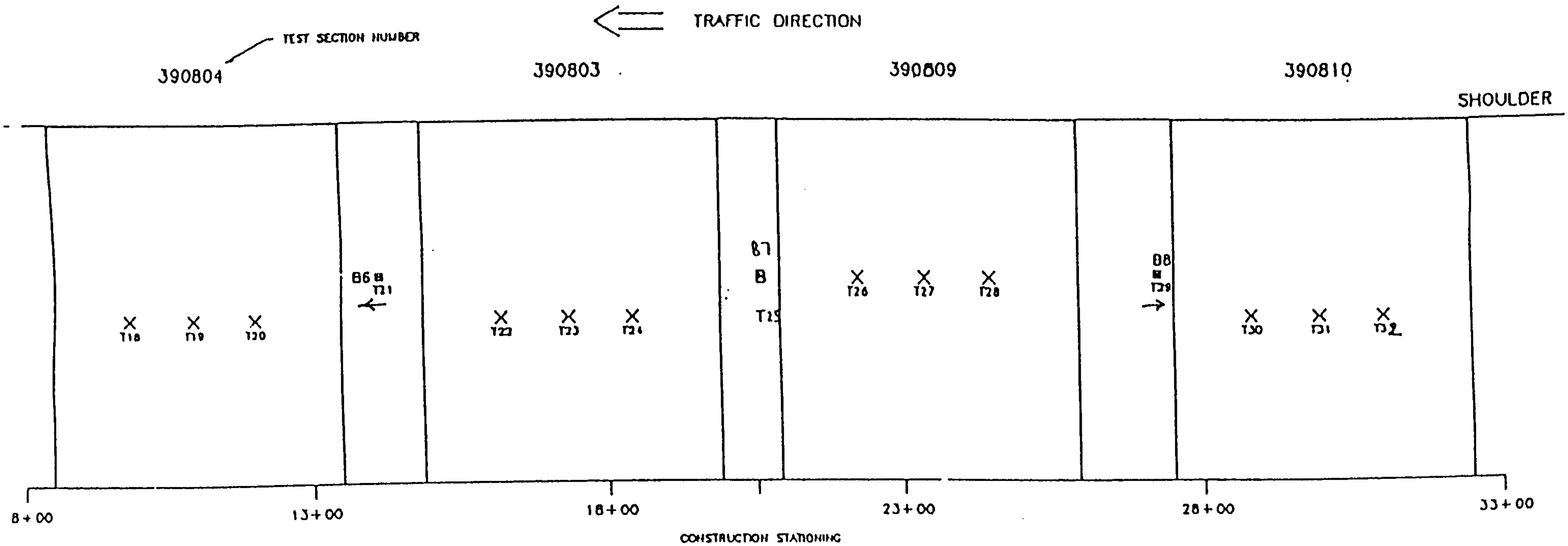


Note: Section 390809 had a transition from 4' of fill to no fill located near the end - sta 21+00 - 22+00? No embankment sampling was done as a result.

NOTES:

1. T – NUCLEAR DENSITY/MOISTURE TESTS, B – BULK AND MOISTURE SAMPLES, S – SHOULDER PROBE, P – PLATE LOAD TEST
2. CONDUCT ELEVATION MEASUREMENTS AND FWD TESTING ON ALL SECTIONS
3. CONDUCT NUCLEAR DENSITY TESTS ON BULK SAMPLING LOCATIONS BEFORE SAMPLING

FIG.9 – OVERVIEW OF SAMPLING AND FIELD TESTING ON Embankment



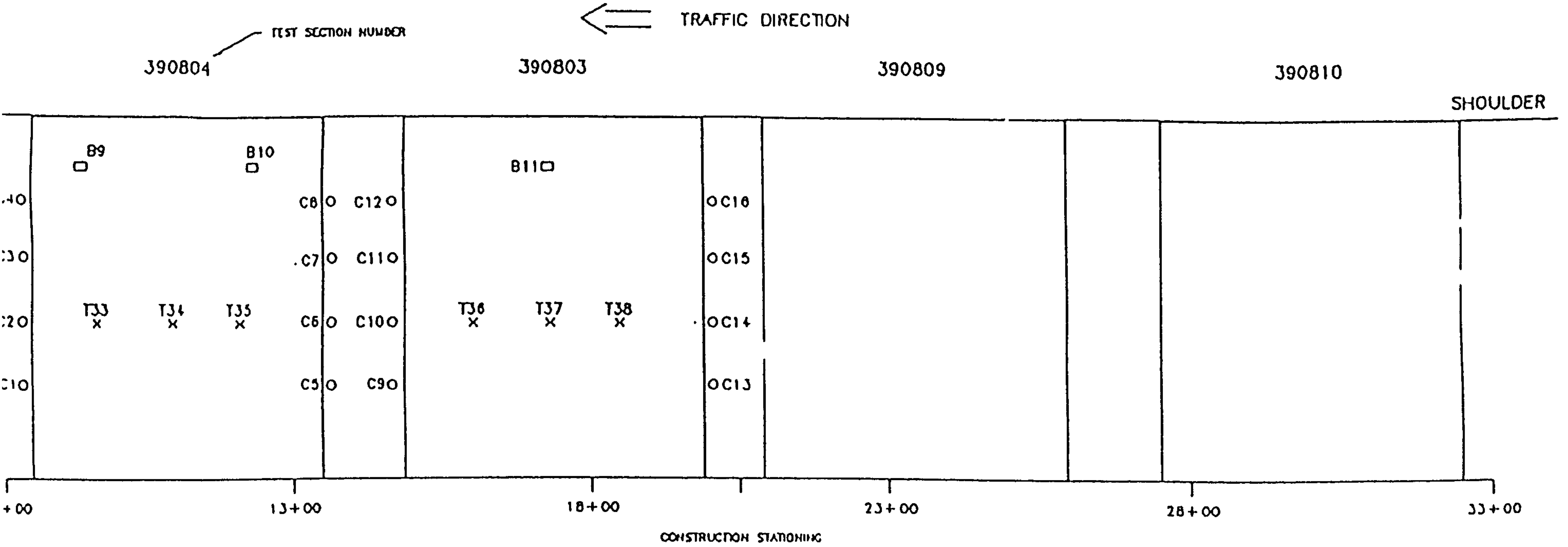
NOTES:

1. T – NUCLEAR DENSITY/MOISTURE TESTS,
   B – BULK AND MOISTURE SAMPLES,

2. CONDUCT ELEVATION MEASUREMENTS AND FWD TESTING ON ALL SECTIONS

3. CONDUCT NUCLEAR DENSITY TESTS ON BULK SAMPLING LOCATIONS BEFORE SAMPLING

FIG. 10 – OVERVIEW OF SAMPLING AND FIELD TESTING ON AGGREGATE BASE

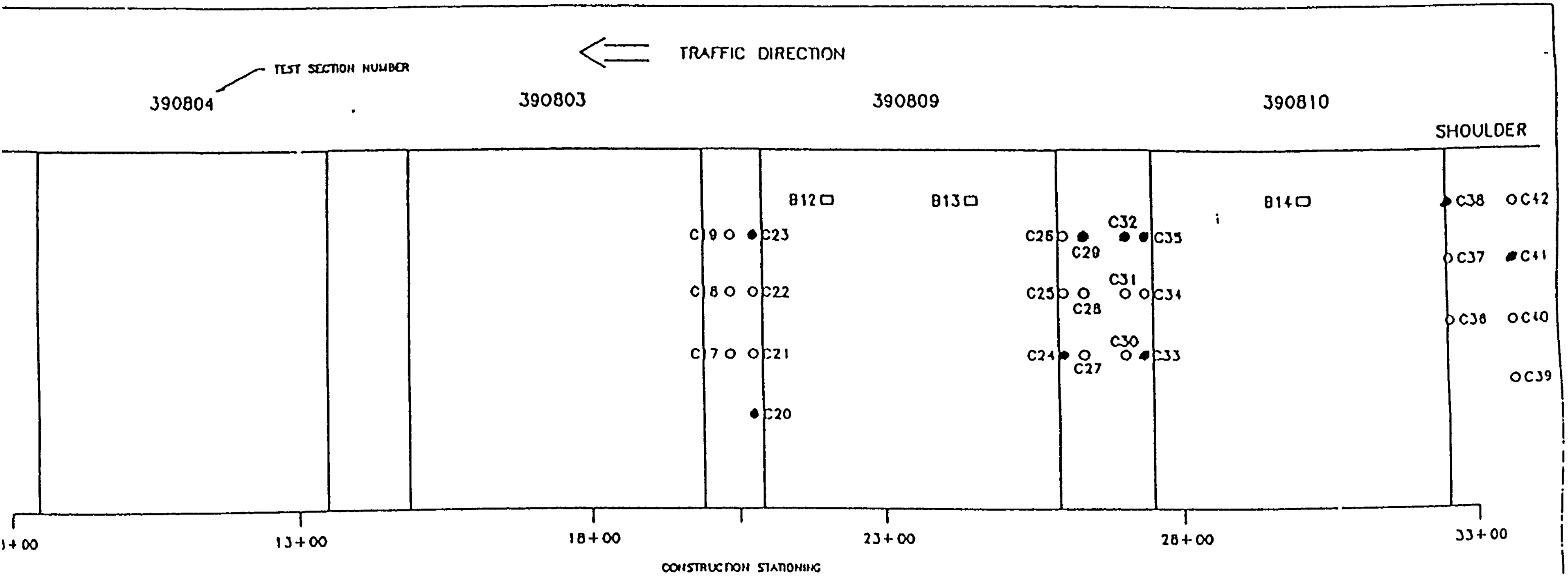


Note: Bulk samples + nuclear density testing were compled on both the surface and the intermediate courses. Samples and test sheets were marked accordingly. Examples: B9i, B9s, T33i, T33s

NOTES

1. C – CORES, B – BULK SAMPLES
   T – NUCLEAR DENSITY TESTS
2. OBTAIN BULK SAMPLES FROM THE INTERMEDIATE COURSE AND SURFACE COURSE AT THE SPECIFIED LOCATIONS FROM THE PAVER OR HAUL VEHICLE
3. OBTAIN 3, 5 GAL. SAMPLES OF ASPHALT CEMENT FROM PLANT
4. CONDUCT NUCLEAR DENSITY TESTS AFTER COMPLETION OF INTERMEDIATE AND SURFACE COURSE
5. CONDUCT ELEVATION MEASUREMENTS ON THE FINISHED AC SURFACE

FIG II – OVERVIEW OF SAMPLING AND TESTING ON ASPHALT CONCRETE



Note: Cores marked ● are the 1 year cores to be taken 10/7/95

NOTES

1. C – CORES, B – BULK SAMPLES
   T – NUCLEAR DENSITY TESTS
2. OBTAIN BULK SAMPLES FROM THE HAUL VEHICLE AT THE SPECIFIED LOCATIONS
3. CONDUCT SLUMP TEMPERATURE AND AIR CONTENT TEST ON BULK SAMPLES
4. FROM EACH BULK SAMPLE MOLD SIX CYLINDERS (6" X 12") AND THREE BEAMS (6" X 6" X 20")
5. OBTAIN CORES AT THE SPECIFIED TIMES
6. PERFORM ELEVATION MEASUREMENTS ON THE FINISHED PCC SURFACE

FIG 12 – OVERVIEW OF SAMPLING AND TESTING ON PCC

TABLE 4. SUMMARY OF FIELD TESTS FOR EACH LAYER – SPS8

Layer Type and Field Test	Total Tests	SHRP Protocol
SUBGRADE – 4 Sections		
Density and Moisture Tests (Nuclear Gauge)	15	Section 3.3.14, Reference 8
Continuous Subgrade Sampling to 20 feet	2	Directive M–5
Elevation Measurements		Reference 2
Falling Weight Deflectometer Tests		P59
EMBANKMENT – 3 Sections		
Density and Moisture Tests (Nuclear Gauge)	13	Section 3.3.14, Reference 7
Elevation Measurements		Reference 2
Falling Weight Deflectometer Tests		P59
AGGREGATE BASE – 4 Sections		
Density and Moisture Tests (Nuclear Gauge)	15	Section 3.3.14, Reference 8
Elevation Measurements		Reference 2
Falling Weight Deflectometer Tests		P59
ASPHALT SURFACE – 2 Sections		
Density Tests – Intermediate Course	6 Tests	Section 3.3.14, Reference 8
Density Tests – Surface Course	6 Tests	Section 3.3.14, Reference 8
Elevation Measurements		Reference 2
PORTLAND CEMENT CONCRETE – 2 sections		
Air Content (Perform on Bulk Samples)	3	Air Content (ASTM C231)
Slump (Perform on Bulk Samples)	3	Slump (ASTM C143)
Temperature (Perform on Bulk Samples)	3	Temperature (ASTM C1064)
Elevation Measurements		Reference 2

TABLE 5. LABORATORY TEST PLAN FOR EACH LAYER – SPS8

Test	SHRP Test Designation	SHRP Protocol	No. of Tests	Test Conducted by:	
				State	FHWA
SUBGRADE/EMBANKMENT					
Sieve Analysis	SS01	P51	9	–	X
Hydrometer to 0.001mm	SS02	P42	9	–	X
Atterberg Limits	SS03	P43	9	–	X
Classsification – Bulk Samples	SS04	P52	9	–	X
Classification – Thin wall (visual manual only)	SS04	P52	18	X(12)	X(6)
Moisture–Density Relations	SS05	P55	9	–	X
Resilient Modulus (Thin wall tubes)	SS07	P46	6	–	X
Unit Weight	SS08	P56	12	X	–
Natural Moisture Content	SS09	P49	9	–	X
Unconfined Comp. Strength	SS10	P54	10	X	–
Permeability (thin – wall tube)	SS11	P57	2	X	–
Expansion Index (Material from continuous sampling at two locations)	SS12	P60			
AGGREGATE BASE					
Particle Size Analysis	UG01	P41	3	–	X
Sieve Analysis (washed)	UG02	P41	3	–	X
Atterberg Limits	UG04	P43	3	–	X
Moisture–Density Relations	UG05	P44	3	–	X
Resilient Modulus	UG07	P46	3	–	X
Classification	UG08	P47	3	–	X
Permeability	UG09	P48	3	X	–
Natural Moisture Content	UG10	P49	3	–	X
ASPHALT CONCRETE (SURFACE AND INTERMEDIATE COURSE)					
Core Examination/Thickness	AC01	P01	16	–	X
Bulk Specific Gravity	AC02	P02	32	–	X
Maximum Specific Gravity	AC03	P03	6	X	–
Asphalt Content (Extraction)	AC04	P04	6	X	–
Moisture Susceptibility	AC05	P05	6	X	–
Creep Modulus	AC06	P06	2	–	X
Resilient Modulus	AC07	P07	18	–	X
Tensile Strength	AC07	P07	24	–	X
Asphalt Cement (Extracted)					
Abson Recovery	AE01	P21	6	X	–
Penetration at 77°F and 115°F	AE02	P22	6	X	–
Specific Gravity (60°F)	AE03	P23	6	X	–
Viscosity at 77°F	AE04	P24	6	X	–
Viscosity at 140°F, 275°F	AE05	P25	6	X	–

TABLE 5. LABORATORY TEST PLAN FOR EACH LAYER – SPS 8(CONTINUED)

Test	SHRP Test Designation	SHRP Protocol	No. of Tests	Test Conducted by:	
				State	FHWA
Extracted Aggregate					
Specific Gracity – Coarse Aggregate	AG01	P11	6	X	–
Specific Gravity – Fine Aggregate	AG02	P12	6	X	–
Gradation of Aggregate	AG05	P14	6	X	–
NAA Test for Fine Aggregatae	AG05	P14A	6	X	–
Asphalt Cement (From Tanker)					
Penetration at 77°F, 115°F	AE02	P22	3	X	–
Specific Gravity (60°F)	AE03	P23	3	X	–
Viscosity at 77°F	AE04	P24	3	X	–
Viscosity at 140°F, 275°F	AE05	P25	3	X	–
PORTLAND CEMENT CONCRETE					
Compressive Strength – 14 day – Field Molded	PC01	P61	3	X	–
Compressive Strength – 28 day – Field Molded	PC01	P61	3	X	–
Compressive Strength – 1 year – Field Molded	PC01	P61	3	X	–
Splitting Tensile Strength – 14 day – Field Molded	PC02	P62	3	X	–
Splitting Tensile Strength – 28 day – Field Molded	PC02	P62	3	X	–
Splitting Tensile Strength – 1 year – Field Molded	PC02	P62	3	X	–
Flexural Strength – 14 day – Field Molded	PC09	P69	3	X	–
Flexural Strength – 28 day – Field Molded	PC09	P69	3	X	–
Flexural Strength – 1 year – Field Molded	PC09	P69	3	X	–
Compressive Strength – 14 day – Cores	PC01	P61	3	X	–
Compressive Strength – 28 day – Cores	PC01	P61	3	X	–
Compressive Strength – 1 year – Cores	PC01	P61	3	X	–
Splitting Tensile Strength – 14 day – Cores	PC02	P62	3	X	–
Splitting Tensile Strength – 28 day – Cores	PC02	P62	3	X	–
Splitting Tensile Strength – 1 year – Cores	PC02	P62	3	X	–
Unit Weight – Cores	PC05	P65	9	X	–
Static Modulus of Elasticity – 28 day –Cores	PC04	P64	3	X	–
Static Modulus of Elasticity – 1 year –Cores	PC04	P64	3	X	–
Air Content – 28 day – Cores	PC08	P68	1	X	–
Coefficient of Thermal Expansion – Cores	PC03	P63	1	–	X

APPENDIX G

LETTER REPORTING ON AC PROBLEMS

soil and materials engineers, inc.
43980 Plymouth Oaks Blvd Plymouth, MI 48170-2584 (313) 454-9900 FAX (313) 454-0629

September 5, 1995

Mr. William F. Edwards, P.E.
Engineer of Research and Development
Ohio Department of Transportation
25 South Front Street
P.O. Box 899
Columbus, OH 43216-0899

Re: SPS-8, Ramp A
US-23 Delaware County
FHWA - LTPP
SME Project P18400

Dear Mr. Edwards:

In early July, 1995, Roger Green informed us that some settlements and rutting had developed in sections 390803 and 390804 on the asphalt concrete portion of your SPS-8 environmental effects study. Included with the letter were measurements which you made of the location of the settlements and some rut depth measurements made with a 10 ft. straight edge. On July 27, 1995, we visited the site to investigate these settlements and perform a condition survey with dipstick measurements to determine the extent of the rutting. We also requested that your FWD conduct deflection testing within test section 390803 and we requested traffic data from your installation on the ramp.

In addition, we understand there were some problems with the asphalt concrete surface mix (Type 2) placed on the test sections and that mix design has been disallowed for future use. We have reviewed the results of your lab's findings regarding the surface mix and discussed the matter with Dave Powers, your Bituminous Engineer.

FIELD INVESTIGATION

During our site visit we obtained measurements of the location and used a stringline to determine the maximum elevation difference at each of the settlement locations. The results and our comments are presented in Table 1.

A pavement condition survey was performed at the site. There was no observable distress in either test section. Due to the coarse gradation of the surface course, the pavement has the appearance of low severity raveling/weathering.

Dipstick measurements were collected in both of the test sections to determine the extent of the rutting. These measurements were made at 50 ft. intervals within the test section. A post construction condition survey which included dipstick measurements was performed in December, 1994. Appendix A provides the calculated rut depths for test section 390803 (1994 and 1995) while Appendix B provides the results for section 390804 (1994 and 1995).

RESULTS

Based on our measurements the settlements at the four locations tested ranged from 1/4 inch to 1-1/2 inches, were generally across both lanes, and ranged in length from 12 to 20 ft. It appears that the settlements in Areas 2 and 4 are related to transition areas between two different pavement thicknesses (Area 2) or between the new pavement and the old pavement (Area 4). As a matter of fact, FWD measurements taken in transition areas on the SPS-8 site indicated increased deflections in these areas. The settlement in Area 3 may be related to the abandoned 18 inch culvert which was shown on the plans but which we could not locate in the field.

The rut depths were computed by the SHRP Profscan program. They are slightly higher than what was measured in the field, however these discrepancies can probably be attributed to the method by which the program computes the rut depths from the transverse elevation (dipstick) measurements and that our measurements were made in different locations. The data confirms our observation that the outside wheelpath is rutting more than the inside wheelpath on both test sections and that section 390803 has deeper ruts than 390804. The average rut depth in test section 390803 was 16.2 mm (0.66 in.) in the outer wheelpath and 8.6 mm (0.33 in.) in the inner wheelpath. The average rut depth in test section 390804 was 4.8 mm (0.19 in.) in the outer wheelpath and 1.8 mm (0.07 in.) in the inner wheelpath.

Preliminary analysis of the FWD deflection data indicates that the subgrade modulus ranged from 2,600 psi to 4,400 psi, with an average value of 3,250 psi. The in-place structural number of the pavement ranged from 1.73 to 2.30 with an average value of 1.96. The structural number of 4 inches of asphalt concrete on 8 inches of crushed stone base is about 2.64 based on the AASHTO design method. Appendix C contains Figure 1 which provides a plot of the deflection data throughout the length of the test section.

Traffic information encompassing the period from December 15, 1994, and July 31, 1995, was provided. It indicated an ADT of 448 vehicles with 6% truck traffic. The total ESAL count for the period was 4,504. The requirements for the SPS-8 study impose a limit of 10,000 ESAL/year to maintain a "low volume" status. A copy of the data is included in Appendix D.

Finally, based on the results of your laboratory testing on the Type 2 surface mix placed on the project, it appears that the mix as compacted in the laboratory had about 6% air voids while the JMF for the material had 4% air voids. In addition, although the mix satisfied the specifications for gradation, it was on the coarse side of the gradation band. We understand that this mix design is not being used to pave the mainline pavement.

CONCLUSIONS AND RECOMMENDATIONS

The settlements which have occurred (2 of which are within test sections) may be patched with a full depth patch to improve the ride quality and overcome any safety concerns you may have.

Since the SPS-8 experiment is designed to study the effect of the environment on pavements in the absence of heavy loads, the rutting which is occurring on test section 390803 is excessive considering the relatively low volume of traffic on the pavement to date. This rutting may create a safety hazard. We recommend that a test pit be excavated to determine the source of the rutting. Based on the results of the test pit, the test section should then be reconstructed for it to remain in the experiment.

Given that the experiment is an environmental study, the possibility of high air voids in the mix creates problems since the material is more permeable and has a higher potential to ravel or weather than would a standard mix at a reduced air void level. In addition, the coarse nature of the surface itself will tend to increase the potential for raveling and weathering. We recommend that an air voids analysis be performed on the as-placed material. Cores have already been sent to your lab and have been designated for bulk specific gravity testing, while bulk samples of the mix which were taken can be used to determine the maximum theoretical specific gravity. Should the in-place air voids correspond with those obtained in the laboratory, we would recommend that the surface be milled off and a new layer placed. If the in-place air voids are similar to those obtained with the JMF, a decision will have to be made whether the coarse nature of the surface will have any long-term effects on the performance of the test sections. The removal of the surface course may be necessary if test section 390803 is reconstructed since the two test sections would then have different mixes which would pose a problem in the future analysis of the project.

Should you have any questions concerning this information, please contact our office.

Very truly yours,

SOIL AND MATERIALS ENGINEERS, INC.

Cary T. Keller, P.E.
Senior Engineer

Chuck A. Gemayel, P.E.
Senior Associate

Enclosures: Appendix A: Rutting Statistics: 390803
Appendix B: Rutting Statistics: 390804
Appendix C: FWD Deflection Profile 390803
Appendix D: SPS-8 Traffic Data

1 pc: Richard Ingberg, Regional Engineer
John Miller, PCS/Law Engineering
Monte Symons, FHWA LTPP