APPENDIX II

Record Plans for Rt. 29

I hereby certify that on the 24th day of June 1965 the State Highway Commissioner approved this map as revised and corrected, and directed that it be filed in Hunterdon County.

Kenneth D. Rice
Secretary

Scale:- 1" = 50'

Filed in the Office of the Clerk of Hunterdon County
Date 7-9-65
File No. 238

New Jersey
State Highway Department
GENERAL PROPERTY PARCEL MAP
ROUTE 29A (1927) SECTION 4
ROUTE 29 (1953)
From one mile north of Byram to Kingwood Station
Showing Existing Right of Way
& Parcels To Be Acquired In The
Township of Kingwood County of Hunterdon
Scales as Shown May 1953

1/6

APPR. SHC 6/27/63

29-356

DELAWARE RIVER
BELVIDERE DELAWARE RAILROAD
PROPOSED R.O.W. LINE
EXISTING R.O.W. LINE
SURVEY LINE "A"
BASE LINE
Existing Dirt Road
TO BYRAM
TO FRENCHTOWN
16A
16B AREA=0.004 Ac.±
3 AREA=0.515 Ac.±
4 AREA=0.649 Ac.±
5 AREA=0.300 Ac.±
6 AREA=0.468 Ac.±
7 AREA=0.947 Ac.±
8 AREA=3.230 Ac.±
16C AREA=0.045 Ac.±
9A AREA=1.840 Ac.±
9B AREA=0.941 Ac.±
9C
Δ=4°08'-04" R=9000' L=649.44'
Δ=8°56'-32" R=3000' L=468.21'
Δ=5°36'-12" R=9500' L=929.07'
Δ=8°01'-24" R=9600 L=1344.32'
JOSEPH O. BUSIK Jr. et ux
JAMES COOPER 110-31
FANNY COOPER 386-476
RICHARD H. RAUTENBERG & JUNE M. RAUTENBERG 488-261
EUGENE J. EVERSON, et ux. 436-381
PAUL D. LOWMAN, et ux. 487-211
SAMUEL W. KAHN & MORRIS D. BARR 359-242
FRANK & ELIZABETH BOHREN 508-277
N.J. PLANE CO-ORD SYSTEM
IRON PIN SET
MON. SET
CROSS CUT IN ROCK
House
House Ruins
Ruins
Scale:-1"=50'
New Jersey
State Highway Department
GENERAL PROPERTY PARCEL MAP
ROUTE 29A (1927) SECTION 4
ROUTE 29 (1953)
From one mile north of Byram to Kingwood Station
Showing Existing Right of Way
& Parcels To Be Acquired In The
Township of Kingwood
County of Hunterdon
Scales as Shown
May 1953
2/6

BELVIDERE-DELAWARE RAILROAD
SURVEY LINE "A"
PROPOSED R.O.W. LINE
EXISTING R.O.W. LINE
Existing Dirt Road
BASE LINE N 13°-46'-20" W
MON. SET
IRON PIN SET
R.R. Mon.
TO BYRAM
House Ruins
Δ = 8°-01'-24"
R = 9600'
L = 1344.32'
Δ = 8°-44'-16"
R = 4900'
L = 747.27'
16D AREA = 0.804 Ac. ±
9C AREA = 2.601 Ac. ±
10A AREA = 1.311 Ac. ±
11A
⑫ S 5°43' E 300.3' (D.)
⑪ S 2° E 398.64' (D)
⑩ S 1°45' E 153.1' (D.)
P.T. 567+11.05
P.C. 570+44.05
② N 9°24' W 521.40' (D)
① N 29°09' W 139.92' (D)
S 65°10' E 286.44
① N 77°45' E 580.06' (D.)
TRACT #3
FRANK & ELIZABETH BOHREN
508-277
MICHAEL UBEL, et ux.
489-175 TRACT #1
PAUL JUDSON ROHRICH
N.J. PLANE CO-ORD SYSTEM
DELAWARE RIVER
Boat Landing
Δ = 18°-15'-16"
R = 2500'
L = 796.50'
AREA = 0.049 Ac. ±
11B
12B AREA = 0.019 Ac. ±
16D AREA = 0.804 Ac. ±
Δ = 7°-07'-24"
R = 3912.40'
L = 486.41'
Δ = 11°-42'-30"
R = 6000'
L = 1226.09'
⑧ S 12° W 222.42' (D.)
⑦ S 17°15' W 104.28
⑥ S 18°17' W 197.92' (D)
⑤ S 21°30' W 170.28' (D)
⑦ S 14°44' W 194.7' (D)
⑨ N 26°30' E 161.04' (D)
⑧ N 5°30' W 135.96' (D)
⑨ S 6° W 194.70' (D)
1 Sty. Fr. House
BOHREN DEED 271.92'
TO FRENCHTOWN
12A AREA = 0.781 Ac. ±
293.13' (D)
Drive
House fdn.
N 7°30' W
RUN
13 AREA = 2.486 Ac. ±
11A AREA = 0.964 Ac. ±
CROSS CUT IN ROCK
11C AREA = 0.054 Ac. ±
11D AREA = 0.074 Ac. ±
House
Dirt Road
P.C.C. 585+87.81
P.C.C. 590+74.22
P.C. 577+91.31
IRA JEWELL WILLIAMS, et al.
401-275
GEORGE M. DITTRICH
515-89
NOTE:- CONSTRUCTION ℄ AS MONUMENTED BETWEEN STATION 577+91.31 & 604+75.09 DOES NOT COINCIDE WITH R.O.W. BASE LINE.
NOTE:- SEE SHEET #6 FOR DRIVEWAY PARCEL 10B
TRACT #3
TRACT #1
④ N 10°45' W 263.34' (D)
⑤ N 4°36' E 205.92' (D)
PAUL JUDSON ROHRICH
428-80
MICHAEL UBEL, et ux.
489-175
Scale:- 1" = 50'
New Jersey
State Highway Department
GENERAL PROPERTY PARCEL MAP
ROUTE 29A (1927) SECTION 4
ROUTE 29 (1953)
From one mile north of Byram to Kingwood Station
Showing Existing Right of Way
& Parcels To Be Acquired In The
Township of Kingwood
County of Hunterdon
Scales as Shown
May 1953
3
6
29-356


NOTE:-
CONSTRUCTION ℄ AS MONUMENTED BETWEEN STATION 577+91.31 & 604+75.09 DOES NOT COINCIDE WITH R.O.W. BASE LINE.
N.J. PLANE CO-ORD SYSTEM
Δ = 11°-42'-30"
R = 6000'
L = 1226.09'
Δ = 7°-40'-03"
R = 4500'
L = 602.20'
BELVIDERE DELAWARE RAILROAD
PROPOSED R.O.W. LINE
EXISTING
Existing Dirt Road
SURVEY LINE "A"
BASE LINE
N-32°-03'-06"E
MON. SET
CROSS CUT IN ROCK
13
14A AREA = 7.713 Ac.±
PROPOSED R.O.W. LINE
595+79±
598+01±
P.T. 603+00.32
P.C. 604+75.09
S 60° W 4405.5' (D)
N 64° E 1474.1' (D)
IRA JEWELL WILLIAMS, et al.
401-275
ALCESTE ROXANNE MILBURY
482-198
MON. SET
100' (Set)
N.J. PLANE CO-ORD SYSTEM
124
16E AREA = 0.124 Ac.±
611+31±
618+39±
Δ = 6°-02'-32"
R = 6153.56'
L = 648.93'
Δ = 9°-50'
R = 10,000'
L = 1,716.24
BELVIDERE DELAWARE RAILROAD
PROPOSED
SURVEY LINE "A"
EXISTING R.O.W. LINE
Existing Dirt Road
N 24°-23'-03"E
MON. SET
BASE LINE
14A AREA = 7.713 Ac.±
WOODS
PROPOSED R.O.W. LINE
P.T. 610+77.30
P.C. 613+86.19
P.S.C. 620+35.12
ALCESTE ROXANNE MILBURY
482-198
Scale:- 1" = 50'
New Jersey
State Highway Department
GENERAL PROPERTY PARCEL MAP
ROUTE 29A (1927) SECTION 4
ROUTE 29 (1953)
From one mile north of Byram to Kingwood Station
Showing Existing Right of Way
& Parcels To Be Acquired In The
Township of Kingwood
County of Hunterdon
Scales as Shown
May 1953
4
6

29-356


RIVER
CREEK
16F AREA=0.041 Ac. ±
16G AREA=0.003 Ac. ±
Δ = 9°50'
R = 10,000'
L = 1716.24'
R.R. Mon.
BELVIDERE DELAWARE RAILROAD
PROPOSED R.O.W. LINE
SURVEY LINE "A"
Existing Ditch
Existing Dirt Road
EXISTING R.O.W. LINES
BASE LINE N 8°30'31" E
MON. SET
(29) N 18°34' E 1305.2' (D)
(29) N 23°49' E 439.7' (D)
(29) S 23°49' W 259.7' (D)
14A
14B
AREA=0.342 Ac. ±
WOODS
TO BARBERTOWN
WARFORD
CROSS CUT IN HEADWALL
15 AREA = 7.110 Ac. ±
PROPOSED R.O.W. LINE
ALCESTE ROXANNE MILBURY
482-198
WILMOT ARTHUR MILBURY
398-98 TRACT #1
&
ALCESTE ALTHEA MILBURY
452-350 TRACT #1
N.J. PLANE CO-ORD SYSTEM
DELAWARE RIVER
BELVIDERE DELAWARE RAILROAD
Existing Ditches
EXISTING R.O.W. LINE & PROPOSED R.O.W. LINE
(29) N 18°34' E 1305.2' (D)
(30) N 19°04' E 1094.4' (D)
Existing Dirt Road
MON. SET
EXISTING R.O.W. LINE
N 8°30'31" E BASE LINE
15 AREA = 7.110 Ac. ±
PARCELS 1A-2, 1-B & 1-C
ACQUIRED IN 1936
ROUTE 29A, SECTION #1
PROPOSED R.O.W. LINE
EXISTING R.O.W. LINE
WILMOT ARTHUR MILBURY
398-98 TRACT #1
&
ALCESTE ALTHEA MILBURY
452-350 TRACT #1
Scale:- 1" = 50'
New Jersey
State Highway Department
GENERAL PROPERTY PARCEL MAP
ROUTE 29A (1927) SECTION 4
ROUTE 29 (1953)
From one mile north of Byram to Kingwood Station
Showing Existing Right of Way
& Parcels To Be Acquired In The
Township of Kingwood
County of Hunterdon
Scales as Shown
May 1953
5/6

29-356

STATE OF NEW JERSEY
HIGHWAY DEPARTMENT

PLANS OF

ROUTE 29A (1927) SECTION 5A
ROUTE 29 (1953)
From Raven Rock to one mile north of Byram

PARTIAL GRADING

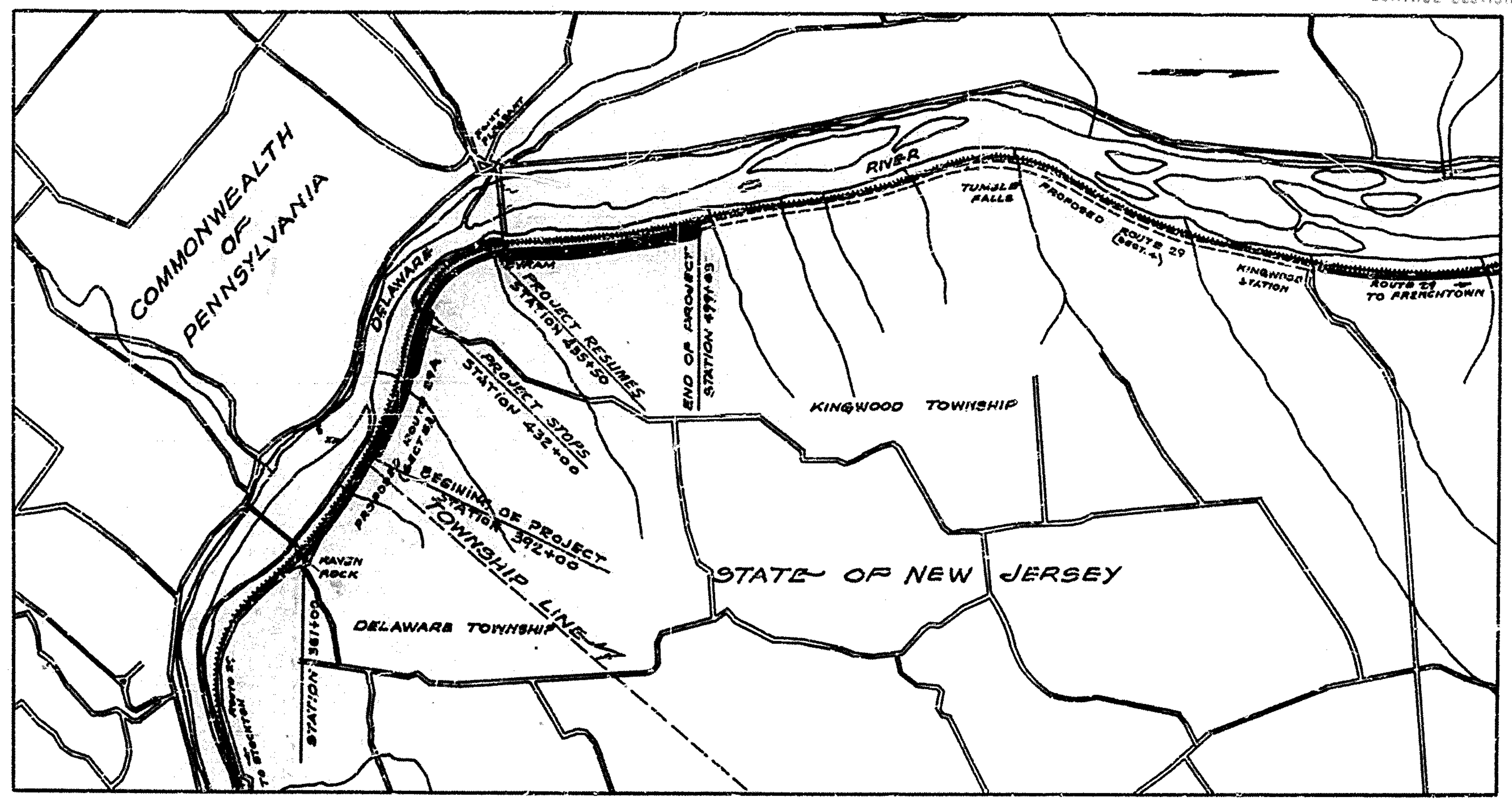
Delaware and Kingwood Townships — Hunterdon County

Scales as Indicated — December 1953

AS - BUILT

INDEX OF SHEETS	
1	KEY SHEET
2	TYPICAL SECTIONS & ESTIMATE OF QUANTITIES SHEET
3	DISTRIBUTION SHEET
4 to 11	PLAN SHEETS
12	TIE SHEET
13 to 33	X-SECTION SHEETS
34	EARTHWORK CHART
35 to 36	PROFILES & X-SECTION OF CULVERTS
37 to 40	CONSTRUCTION DETAILS

CONTROL SECTION 1008



UTILITIES
PENNSYLVANIA RAILROAD CO. NEW YORK CITY, N.Y.
N.J. BELL TELEPHONE CO. TRENTON, N.J.
N.J. POWER & LIGHT CO. PHILLIPSBURG, N.J.

LAYOUT & KEY MAP

SCALE - 1" = $\frac{1}{2}$ MILE

LENGTH OF PROJECT - 8,413 Lin.Ft. - 1.593 Miles

STANDARD HIGHWAY SPECIFICATIONS OF , TO GOVERN

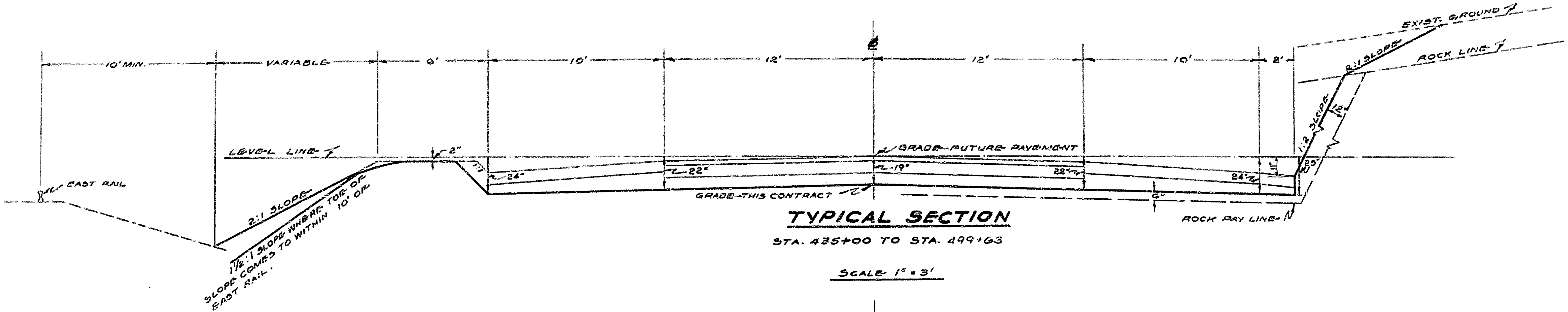
Submitted by Fred L. Gerard — 12-29-53
Ass't. Director and Chief Road Engineer — Date

Approved by O. Herbert Gutzschler — 12-29-53
Ass't. State Highway Engineer — Date

Approved by — 12-29-53
State Highway Commissioner — Date

1-32

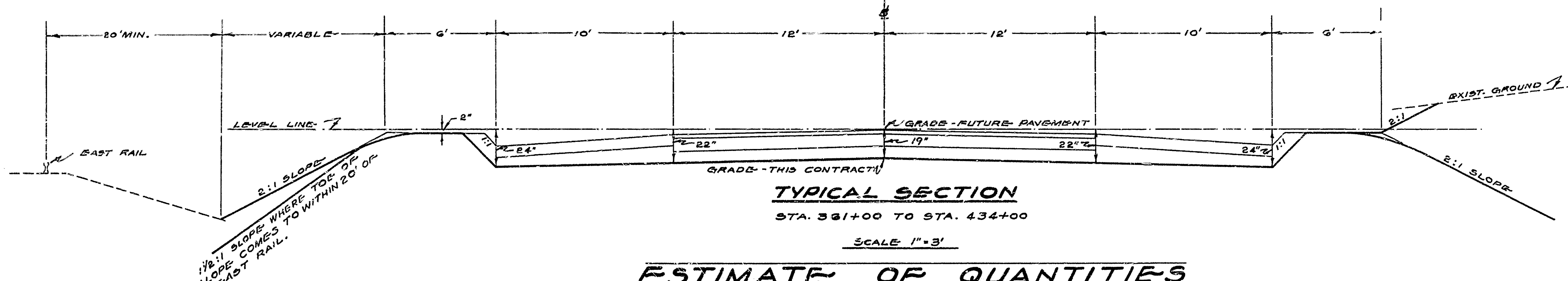
1008 001 040



TYPICAL SECTION

STA. 435+00 TO STA. 499+63

SCALE 1" = 3'



TYPICAL SECTION

STA. 381+00 TO STA. 434+00

SCALE 1" = 3'

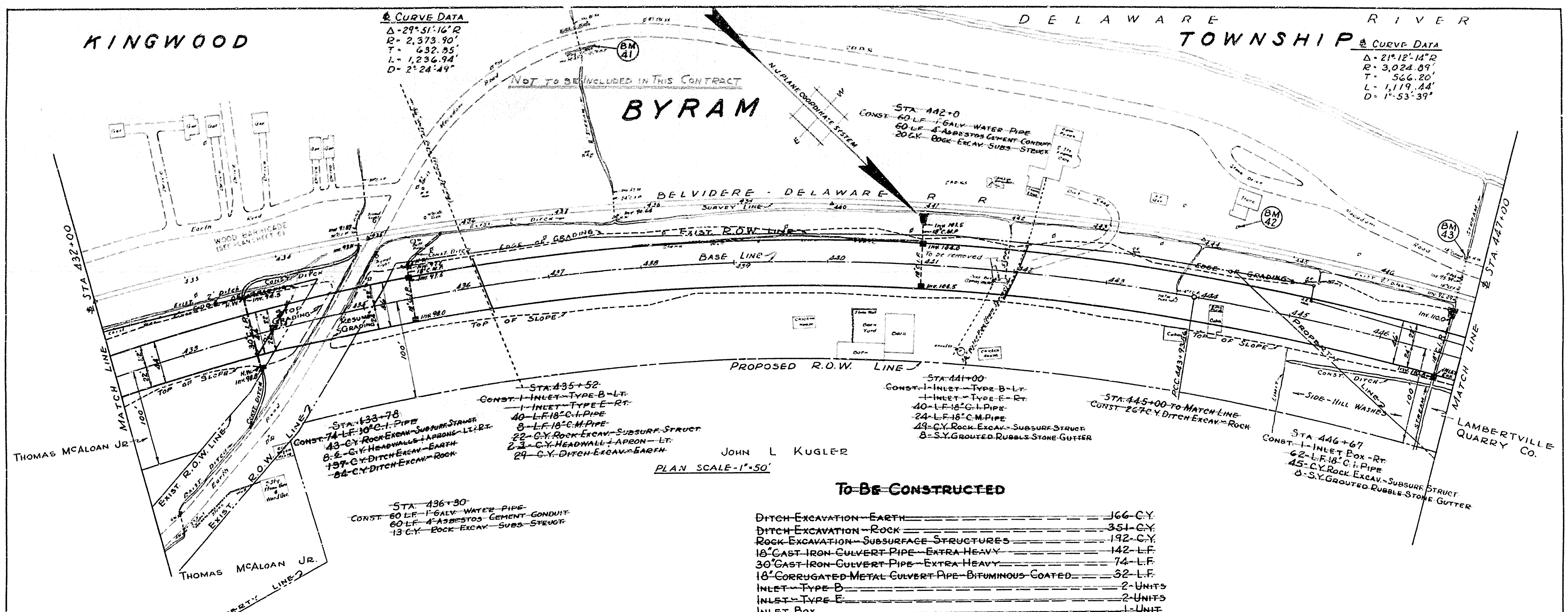
ESTIMATE OF QUANTITIES

ITEM	DESCRIPTION	UNIT	QUANTITY	AS BUILT	ITEM	DESCRIPTION	UNIT	QUANTITY	AS BUILT	ITEM	DESCRIPTION	UNIT	QUANTITY	AS BUILT
1	FIELD OFFICE	L.S.	LUMP SUM	LUMP SUM	27	GROUTED RUBBLE STONE GUTTER	S.Y.	80	54					
2	CLEARING SITE	L.S	LUMP SUM	LUMP SUM	28	HEADWALLS	C.Y.	150	180					
3	STRIPPING, 8" DEPTH	ACRE	10	10	29	WOOD BARRICADE	L.F	200	179					
4	ROADWAY EXCAVATION, EARTH	C.Y.	15,168	0	30	DEMOLITION OF 2 STORY FRAME DWELLING, AT STATION 457+15	L.S.	LUMP SUM	LUMP SUM					
5	ROADWAY EXCAVATION, ROCK	C.Y.	114,012	0	SA-1	ROADWAY EXCAVATION UNCLASSIFIED	C.Y.		199,158					
6	BORROW EXCAVATION	C.Y.	15000	NONE	SA-4	CLEARING SITE	ACRES		5					
7	CHANNEL EXCAVATION	C.Y.	500	212	SA-4	CALCIUM CHLORIDE	TONS		2					
8	DITCH EXCAVATION, EARTH	C.Y.	400	329										
9	DITCH EXCAVATION, ROCK	C.Y.	200	73										
10	ROCK EXCAVATION, SUBSURFACE STRUCTURES	C.Y.	1000	434										
11	EARTH EXCAVATION, SUBSURFACE STRUCTURES, ADDITIONAL DEPTH	C.Y.	100	NONE										
12	4" TOP SOILING	S.Y.	25000	27,090										
13	MULCHING (HAY)	S.Y.	20000	27,090										
14	BROKEN STONE OR WASHED GRAVEL	TONS	260	60										
15	UNDERDRAIN, TYPE F	L.F.	2,000	185										
16	18" REINFORCED CONCRETE CULVERT PIPE	L.F.	646	724										
17	24" REINFORCED CONCRETE CULVERT PIPE	L.F.	66	89										
18	30" REINFORCED CONCRETE CULVERT PIPE	L.F.	90	90										
19	18" CAST IRON CULVERT PIPE, EXTRA HEAVY	L.F.	200	205										
20	18" CORRUGATED METAL CULVERT PIPE BITUMINOUS COATED PAVED INVERT	L.F.	178	178										
21	6'-5"x4'-10" CORRUGATED METAL PLATE PIPE ARCH	L.F	74	74										
22	11'-10"x7'-7" CORRUGATED METAL PLATE PIPE ARCH	L.F.	100	101										
23	INLETS, TYPE B	UNIT	15	15										
24	INLETS, TYPE E	UNIT	5	5										
25	INLET BOXES	UNIT	2	2										
26	EXTRA DEPTH OF INLETS, BELOW 8 FEET	L.F.	20	15										

New Jersey
State Highway Department
ESTIMATE OF QUANTITIES
TYPICAL SECTIONS
ROUTE 29A (1927) SECTION 5A
ROUTE 29 (1953)
From Raven Rock to one mile north of Byram
PARTIAL GRADING
Scales as Indicated

2/40

1008 002 040



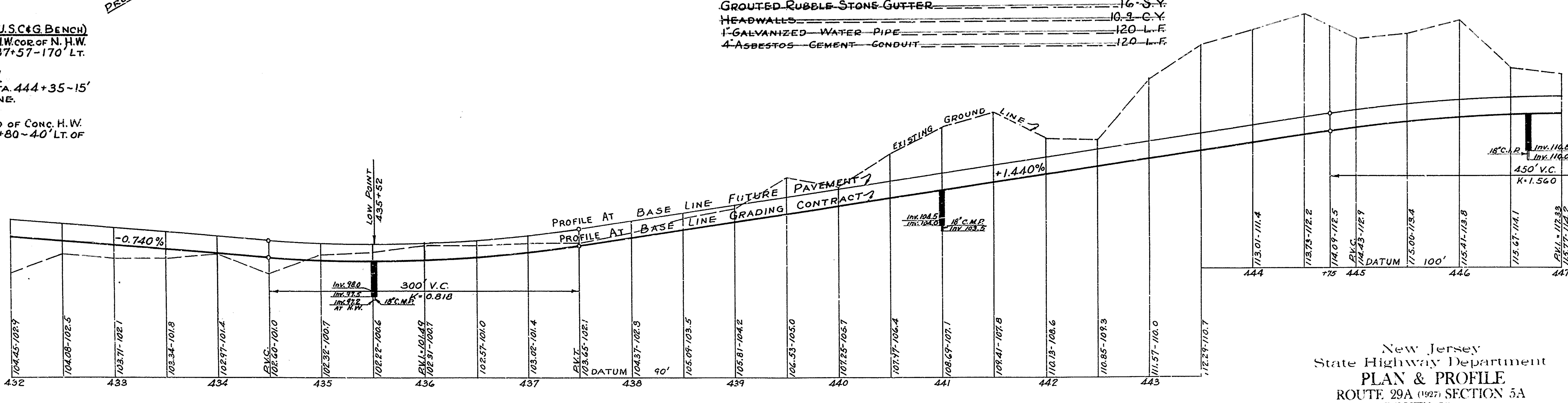
~~To Be Constructed~~

~~Ditch Excavation - Earth~~	~~166-C.Y.~~
~~Ditch Excavation - Rock~~	~~351-C.Y.~~
~~Rock Excavation - Subsurface Structures~~	~~192-C.Y.~~
~~18" Cast Iron Culvert Pipe - Extra Heavy~~	~~142-L.F.~~
~~30" Cast Iron Culvert Pipe - Extra Heavy~~	~~74-L.F.~~
~~18" Corrugated Metal Culvert Pipe - Bituminous Coated~~	~~32-L.F.~~
~~Inlet - Type B~~	~~2-Units~~
~~Inlet - Type E~~	~~2-Units~~
~~Inlet Box~~	~~1-Unit~~
~~Grouted Rubble Stone Gutter~~	~~16-S.Y.~~
~~Headwalls~~	~~10.9-C.Y.~~
~~1" Galvanized Water Pipe~~	~~120-L.F.~~
~~4" Asbestos Cement Conduit~~	~~120-L.F.~~

B.M. #41 - EL. 93.53 (U.S.C.&G. BENCH)
U.S.C.&G. MARKER IN N.W. COR. OF N. H.W. OF BRIDGE - STA. 437+57 - 170' LT. OF SURVEY LINE.

B.M. #42 - EL. 100.67
SPIKE IN POLE - STA. 444+35 - 15' LT. OF SURVEY LINE.

B.M. #43 - EL. 97.32
CROSS CUT IN S. END OF CONC. H.W. #K-11 - STA. 446+80 - 40' LT. OF SURVEY LINE.

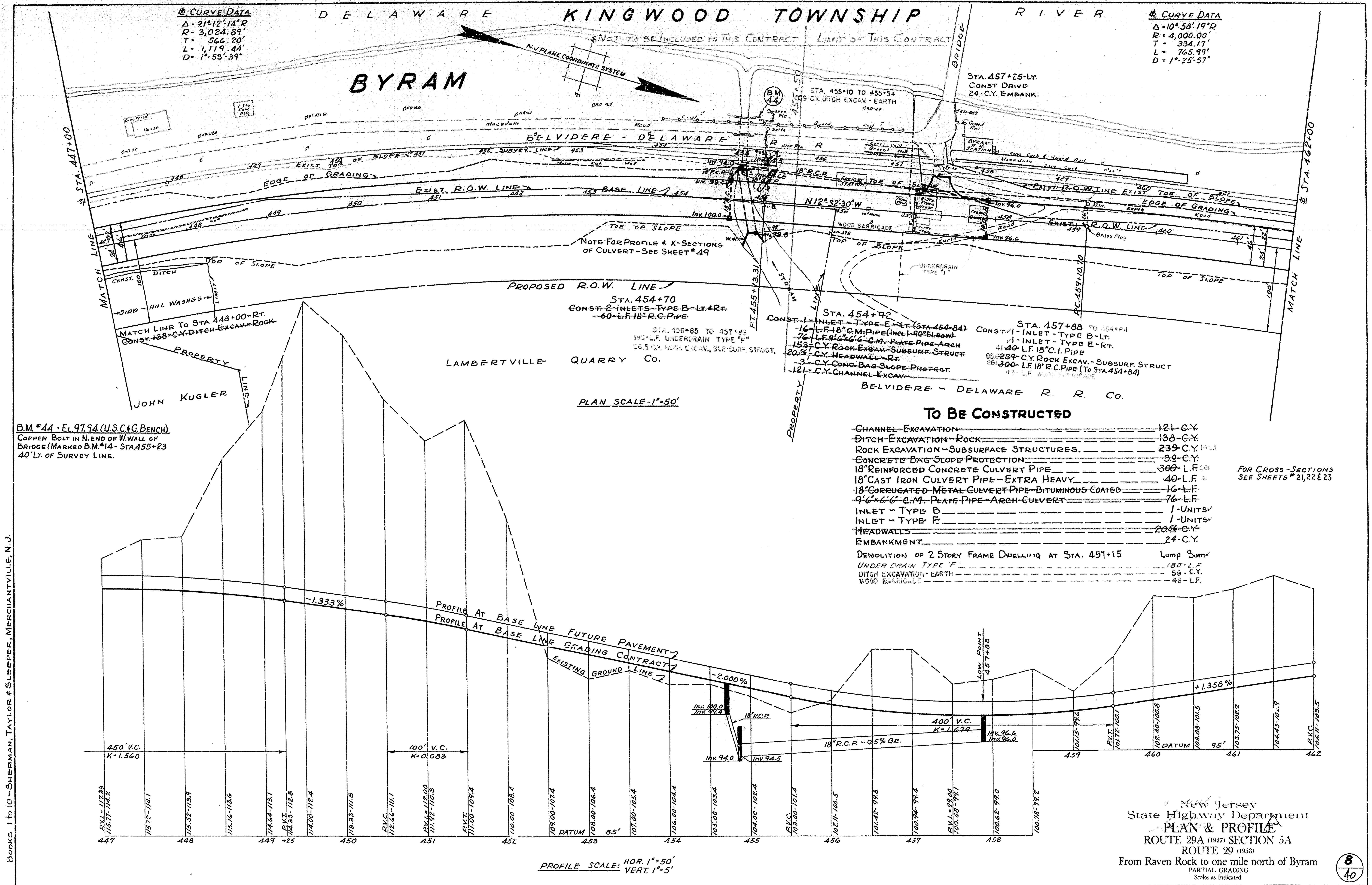


PROFILE SCALE: HOR. 1" = 50'
VERT. 1" = 5'

New Jersey
State Highway Department
PLAN & PROFILE
ROUTE 29A (1927) SECTION 5A
ROUTE 29 (1953)
From Raven Rock to one mile north of Byram
PARTIAL GRADING
Scales as Indicated

7
40

BOOKS 1 to 10 ~ SHERMAN, TAYLOR & SLEEPER, MERCHANTVILLE, N.J.



To Be Constructed

~~Channel Excavation~~	~~121-C.Y.~~
~~Ditch Excavation-Rock~~	~~138-C.Y.~~
Rock Excavation-Subsurface Structures	~~239~~ C.Y.
~~Concrete Bag Slope Protection~~	~~3.0-C.Y.~~
18" Reinforced Concrete Culvert Pipe	~~300~~ L.F.
18" Cast Iron Culvert Pipe-Extra Heavy	~~40~~ L.F.
~~18" Corrugated Metal Culvert Pipe-Bituminous Coated~~	~~16-L.F.~~
~~9'6"x6'6" C.M. Plate Pipe-Arch Culvert~~	~~76-L.F.~~
Inlet - Type B	1-Units
Inlet - Type E	1-Units
~~Headwalls~~	~~20.56-C.Y.~~
Embankment	24-C.Y.
Demolition of 2 Story Frame Dwelling at Sta. 457+15	Lump Sum
Under Drain Type "F"	185-L.F.
Ditch Excavation - Earth	59-C.Y.
Wood Barricade	45-L.F.

New Jersey
State Highway Department
PLAN & PROFILE
ROUTE 29A (1927) SECTION 5A
ROUTE 29 (1953)
From Raven Rock to one mile north of Byram
PARTIAL GRADING
Scales as Indicated

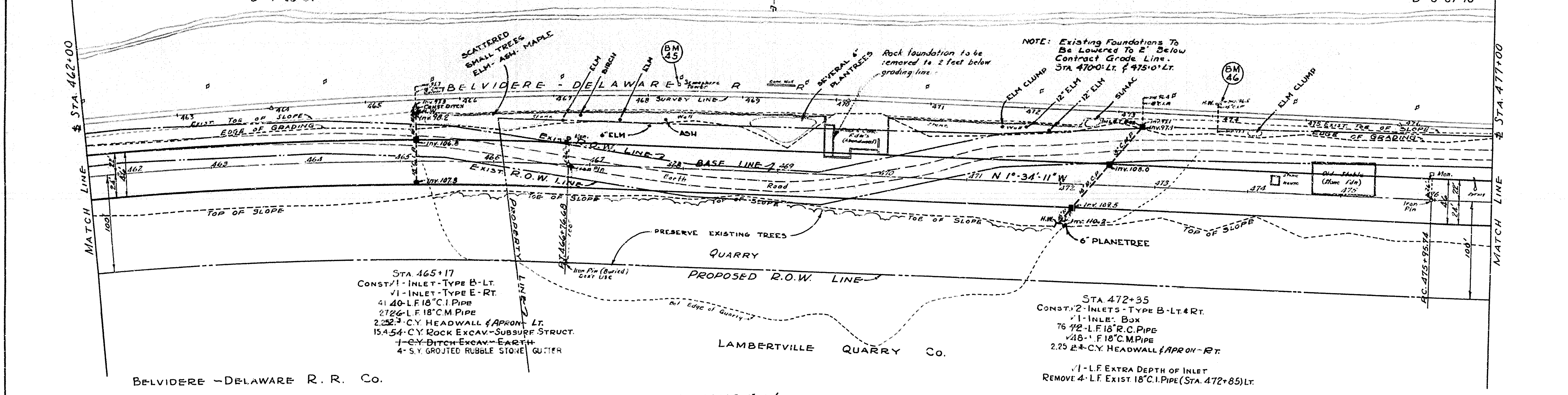
8
40

Books 1 to 10 - Sherman, Taylor & Sleeper, Merchantville, N.J.

1008 008 040

℄ CURVE DATA
Δ = 10°-58'-19" R
R = 4,000.00'
T = 384.17'
L = 765.99'
D = 1°-25'-57"

℄ CURVE DATA
Δ = 9°-48'-53" L
R = 6,000.00'
T = 515.16'
L = 1,027.80'
D = 0°-57'-18"



PLAN SCALE - 1" = 50'

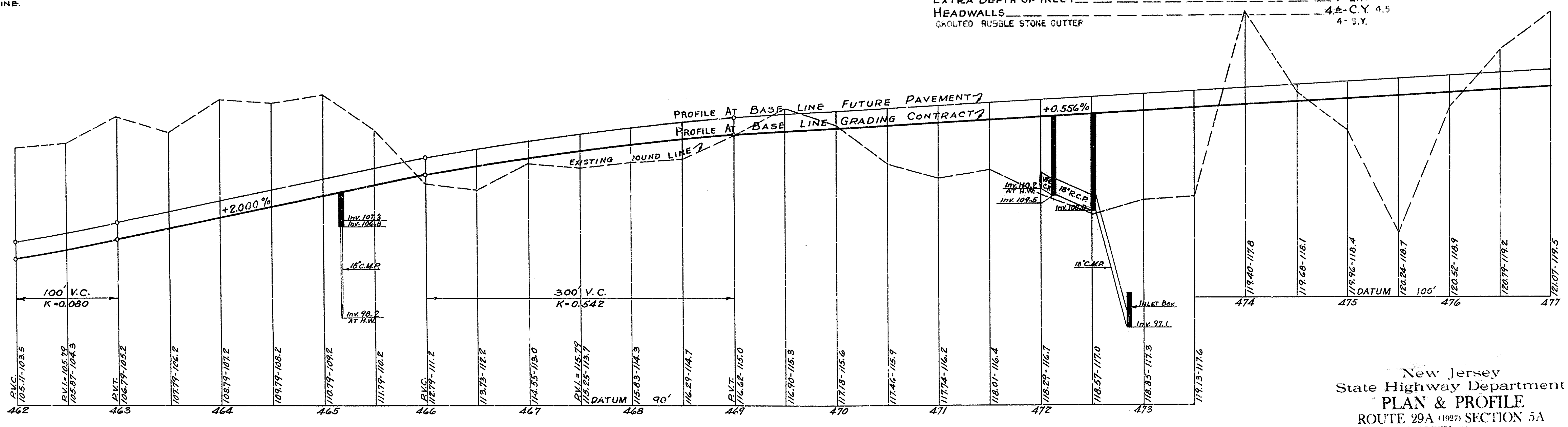
To Be Constructed

~~Ditch Excavation - Earth~~	~~1 - C.Y.~~
Rock Excavation - Subsurface Structures	54 - C.Y. 15.4
18" Reinforced Concrete Culvert Pipe	72 - L.F. 76
18" Cast Iron Culvert Pipe - Extra Heavy	40 - L.F. 41
18" Corrugated Metal Culvert Pipe - Bituminous Coated	74 - L.F. 75
Inlet - Type B	3 - Units
Inlet - Type E	1 - Unit
Inlet Box	1 - Unit
Extra Depth of Inlet	1 - L.F.
Headwalls	4.6 - C.Y. 4.5
Grouted Rubble Stone Gutter	4 - S.Y.

For Cross - Sections See Sheets # 23, 24, 25 & 26

B.M. #45 - El. 99.87
S.E. cor. of Conc. Base of Semaphore - Sta. 468+33 - 12' Lt. of Survey Line.

B.M. #46 - El. 98.34
N.W. cor. of Headwall - Sta. 474+08 - 9' Lt. of Survey Line.



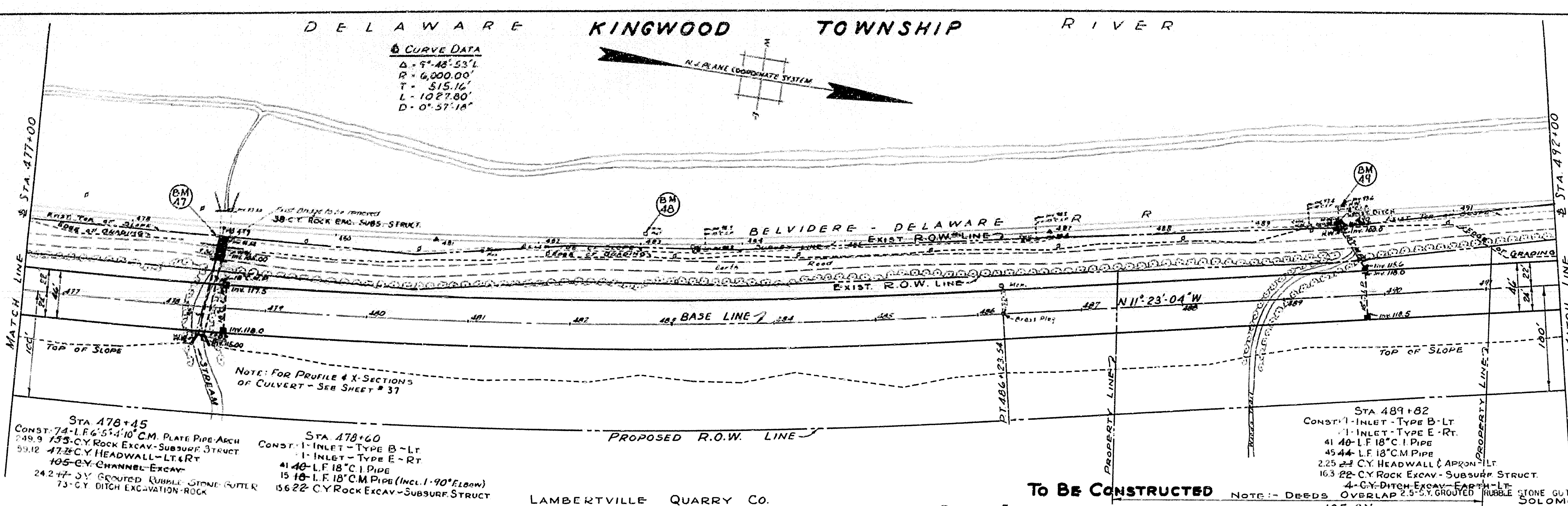
PROFILE SCALE: HOR. 1" = 50' VERT. 1" = 5'

Books 1 to 10 - Sherman, Taylor & Sleeper, Merchantville, N.J.

New Jersey
State Highway Department
PLAN & PROFILE
ROUTE 29A (1927) SECTION 5A
ROUTE 29 (1953)
From Raven Rock to one mile north of Byram
PARTIAL GRADING
Scales as Indicated

9 / 40

1008 009 040



To Be Constructed

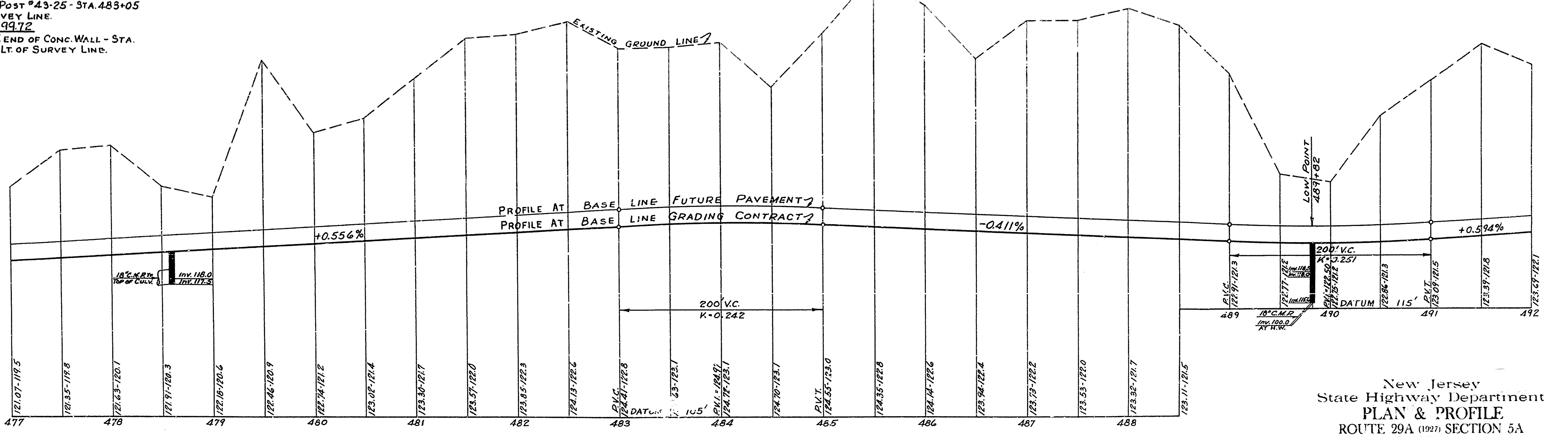
Channel Excavation	105-C.Y.
~~Ditch Excavation - Earth~~	4-C.Y.
Rock Excavation - Subsurface Structures	237-C.Y. 281.8
18" Cast Iron Culvert Pipe - Extra Heavy	~~80~~ L.F. 82
18" Corrugated Metal Culvert Pipe - Bituminous Coated	~~62~~ L.F. 60
6'-5"×4'-10" C.M. Plate Pipe-Arch Culvert	74-L.F.
Inlet - Type B	2-Units
Inlet - Type E	2-Units
Headwalls	~~50.96~~ C.Y. 61.37
Grouted Rubble Stone Gutter	~~17~~-S.Y. 27
Ditch Excavation - Rock	73-C.Y.

For Cross-Sections See Sheets # 26, 27, 28, 29 & 30

B.M. #47 - El. 98.78
Cross cut in S. end of E. Headwall Sta. 478+83 - 8' Rt. of Survey Line.

B.M. #48 - El. 103.97
Top of Mile Post #43-25 - Sta. 483+05 10' Lt. of Survey Line.

B.M. #49 - El. 99.72
N.W. cor. of W. end of Conc. Wall - Sta. 489+85 - 10' Lt. of Survey Line.



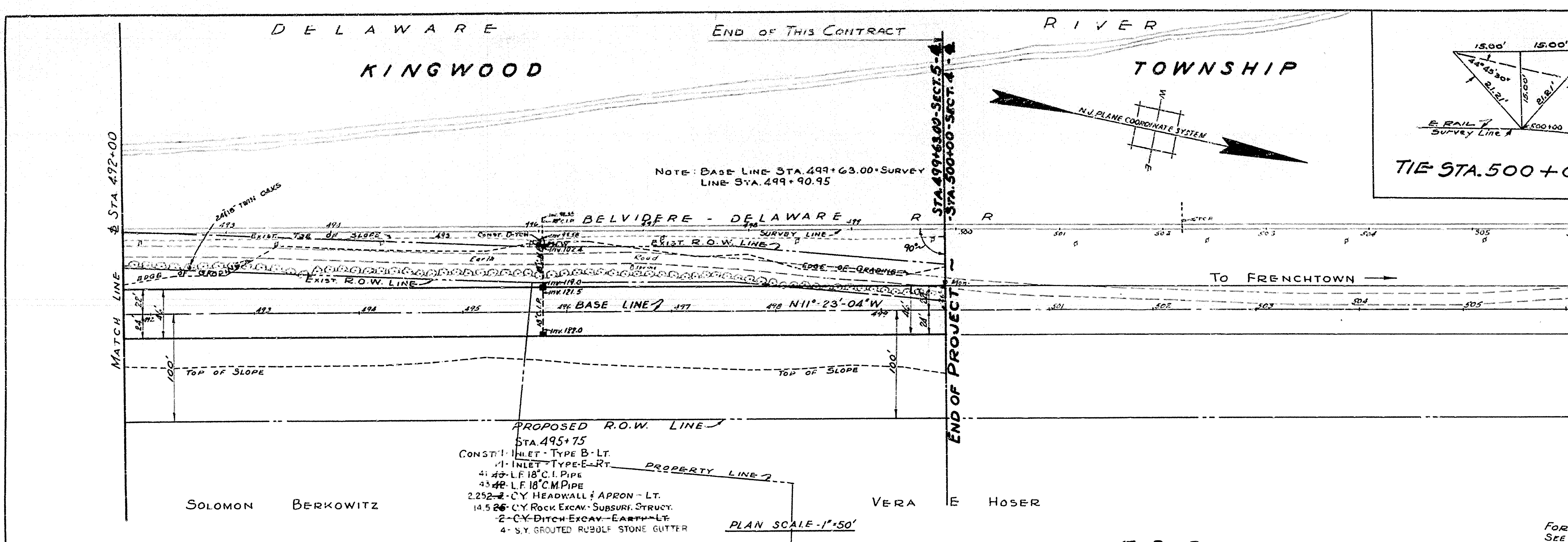
PROFILE SCALE: HOR. 1"=50' VERT. 1"=5'

Books 1 to 10 - Sherman, Taylor & Sleeper, Merchantville, N.J.

New Jersey
State Highway Department
PLAN & PROFILE
ROUTE 29A (1927) SECTION 5A
ROUTE 29 (1953)
From Raven Rock to one mile north of Byram
PARTIAL GRADING
Scales as Indicated

10/40

1008 010 | 040

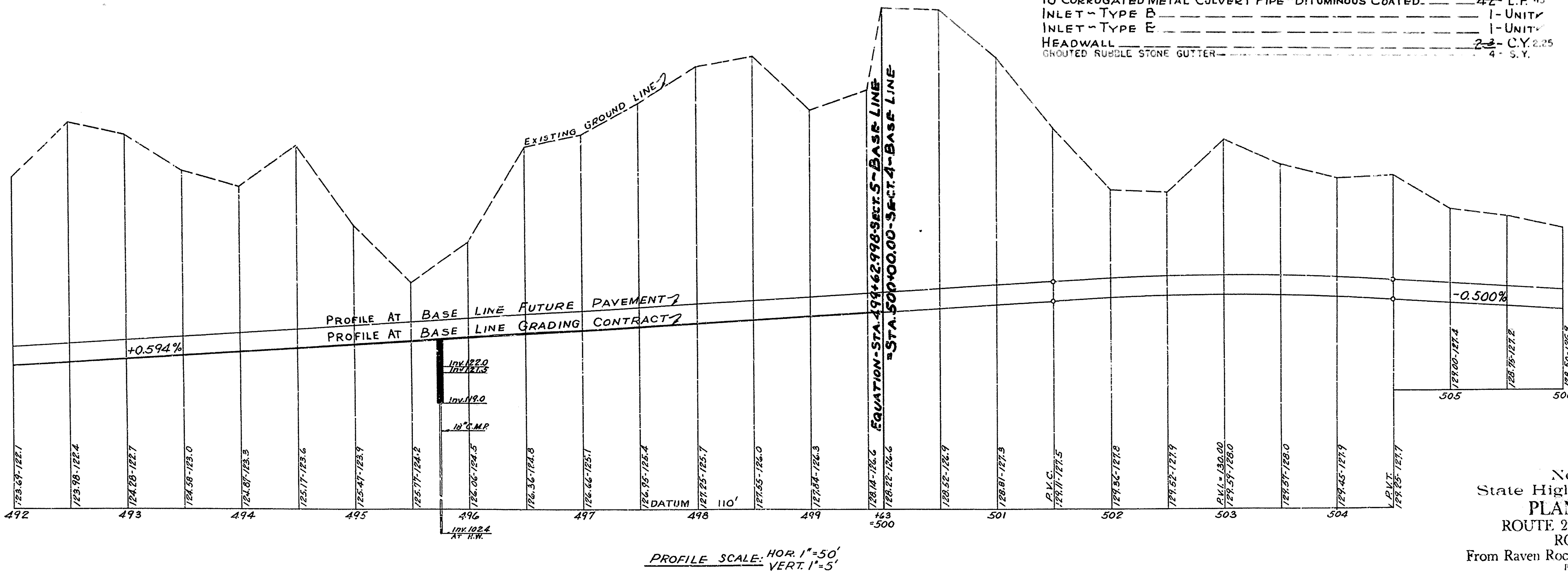


For Cross-Sections See Sheets # 31, 32, & 33

B.M. #50 - EL. 100.74 (U.S.C.&G. BENCH)
Copper Bolt in Top of N. End of W. Wall of Bridge - Sta. 507+75 - 21' Lt. of Survey Line.

To Be Constructed

~~Ditch Excavation - Earth~~	~~2 - C.Y.~~
Rock Excavation - Subsurface Structures	~~25~~ - C.Y. 14.5
18" Cast Iron Culvert Pipe - Extra Heavy	~~40~~ - L.F. 41
18" Corrugated Metal Culvert Pipe - Bituminous Coated	~~42~~ - L.F. 43
Inlet - Type B	1 - Unit
Inlet - Type E	1 - Unit
Headwall	~~2.3~~ - C.Y. 2.25
Grouted Rubble Stone Gutter	4 - S.Y.

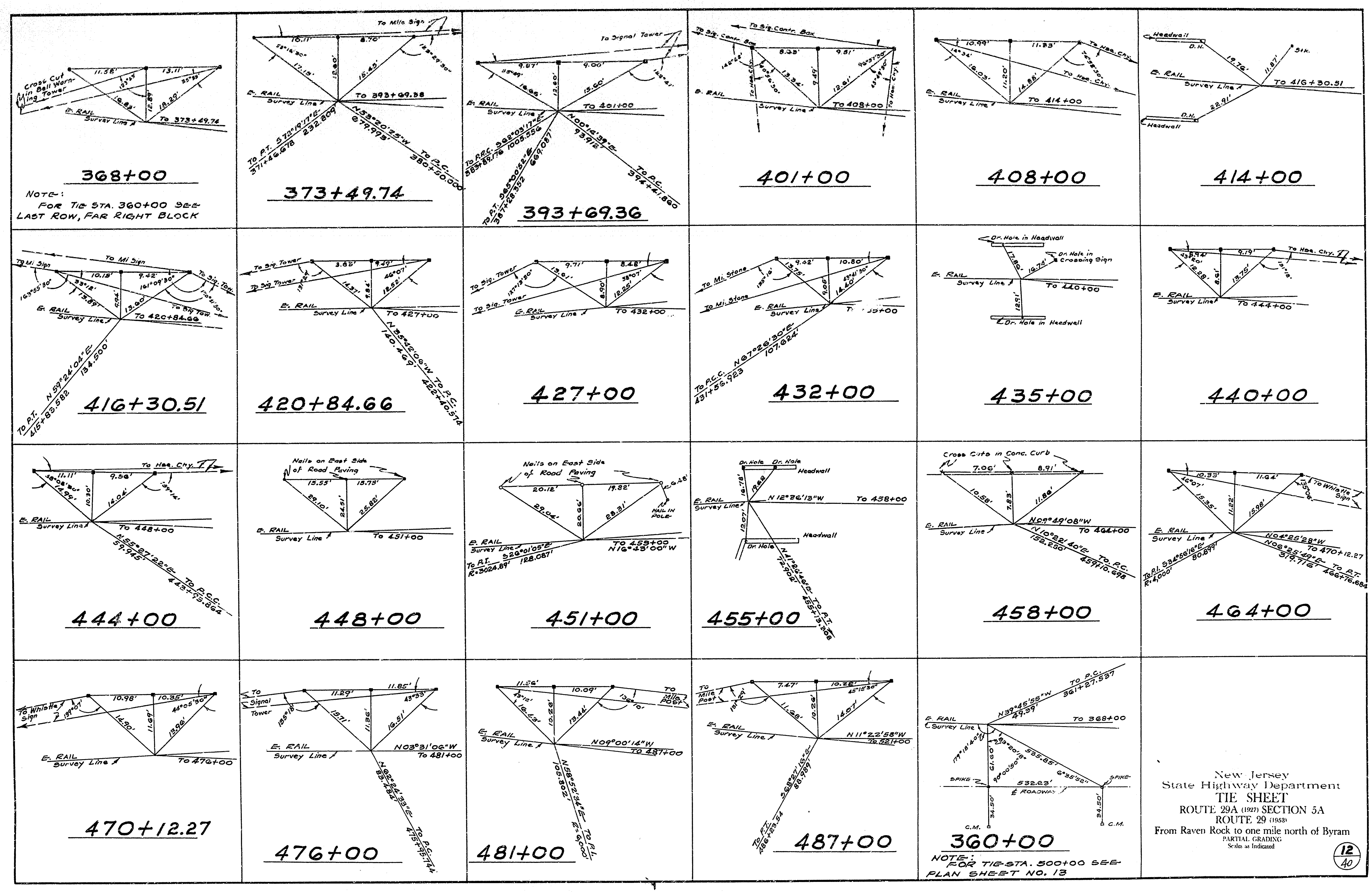


PROFILE SCALE: HOR. 1" = 50' VERT. 1" = 5'

Books 1 to 10 - Sherman, Taylor & Sleeper, Merchantville, N.J.

New Jersey
State Highway Department
PLAN & PROFILE
ROUTE 29A (1927) SECTION 5A
ROUTE 29 (1953)
From Raven Rock to one mile north of Byram
PARTIAL GRADING
Scales as Indicated

11/40



New Jersey
State Highway Department
TIE SHEET
ROUTE 29A (1927) SECTION 5A
ROUTE 29 (1953)
From Raven Rock to one mile north of Byram
PARTIAL GRADING
Scales as Indicated

12
40

1008 012 | 040

STATE OF NEW JERSEY

HIGHWAY DEPARTMENT

PLANS OF

ROUTE 29A (1927) SECTIONS 5B & 4A
ROUTE 29 (1953)
From Byram to Kingwood Station

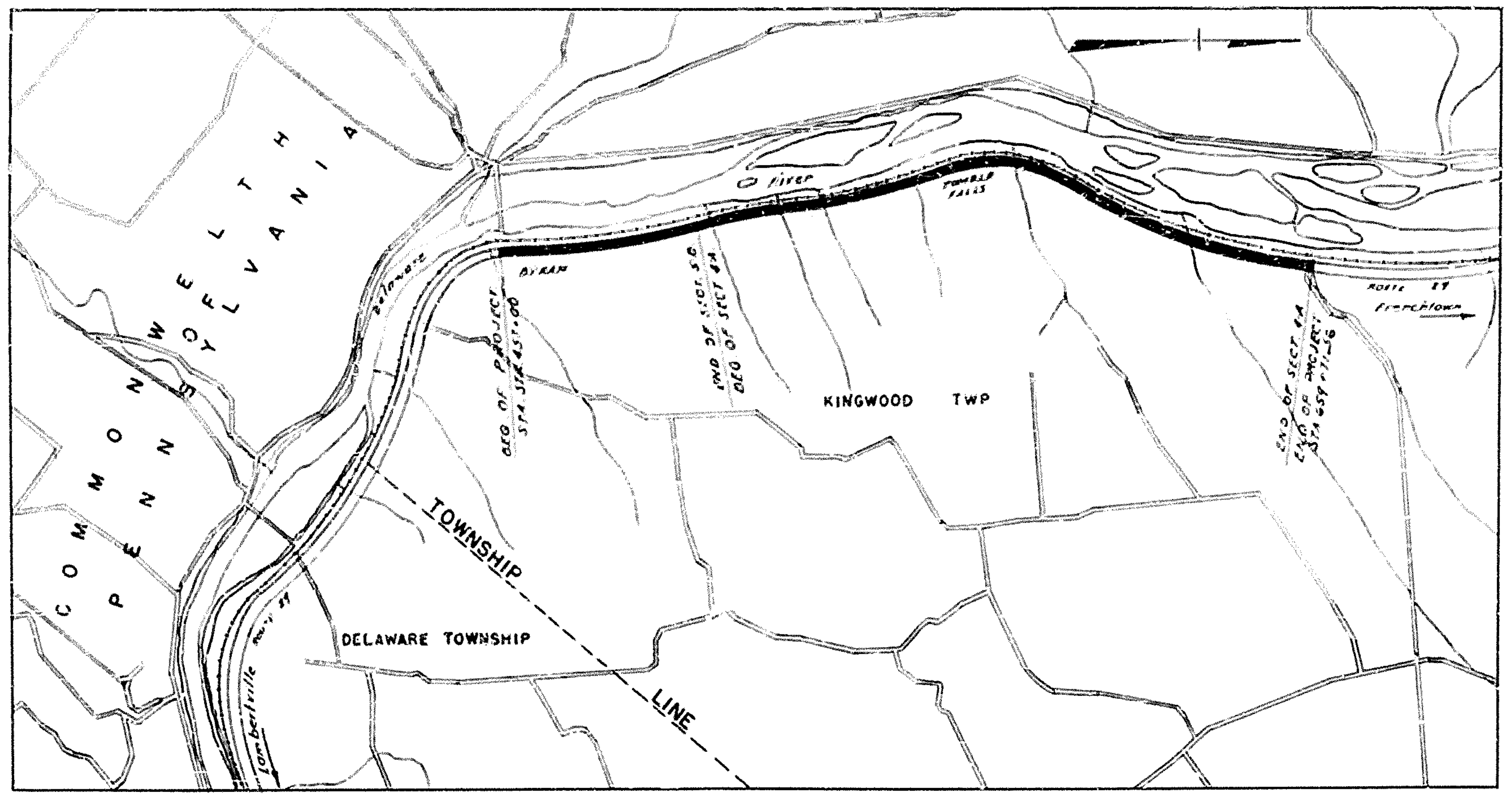
PAVING

Kingwood Township — Hunterdon County

Scales as Indicated — June 1955

As Built

NO	INDEX DESCRIPTION
1	KEY SHEET
2	ESTIMATE OF QUANTITIES
	TAKE OFF SHEET
	TYPICAL SECTIONS
3 - 6	PLANS
7	DETAIL SHEET



KEYMAP

SCALE 1" = 1/2 MILE

LENGTH OF PROJECT 20,235.03 LIN. FT. 3.832 MILES

STANDARD HIGHWAY SPECIFICATIONS OF 1941 TO GOVERN

Submitted by O. Hubert [illegible] 6-10-55
Director & Chief Engineer, Division of Planning, Research, Soils & Tests — Date

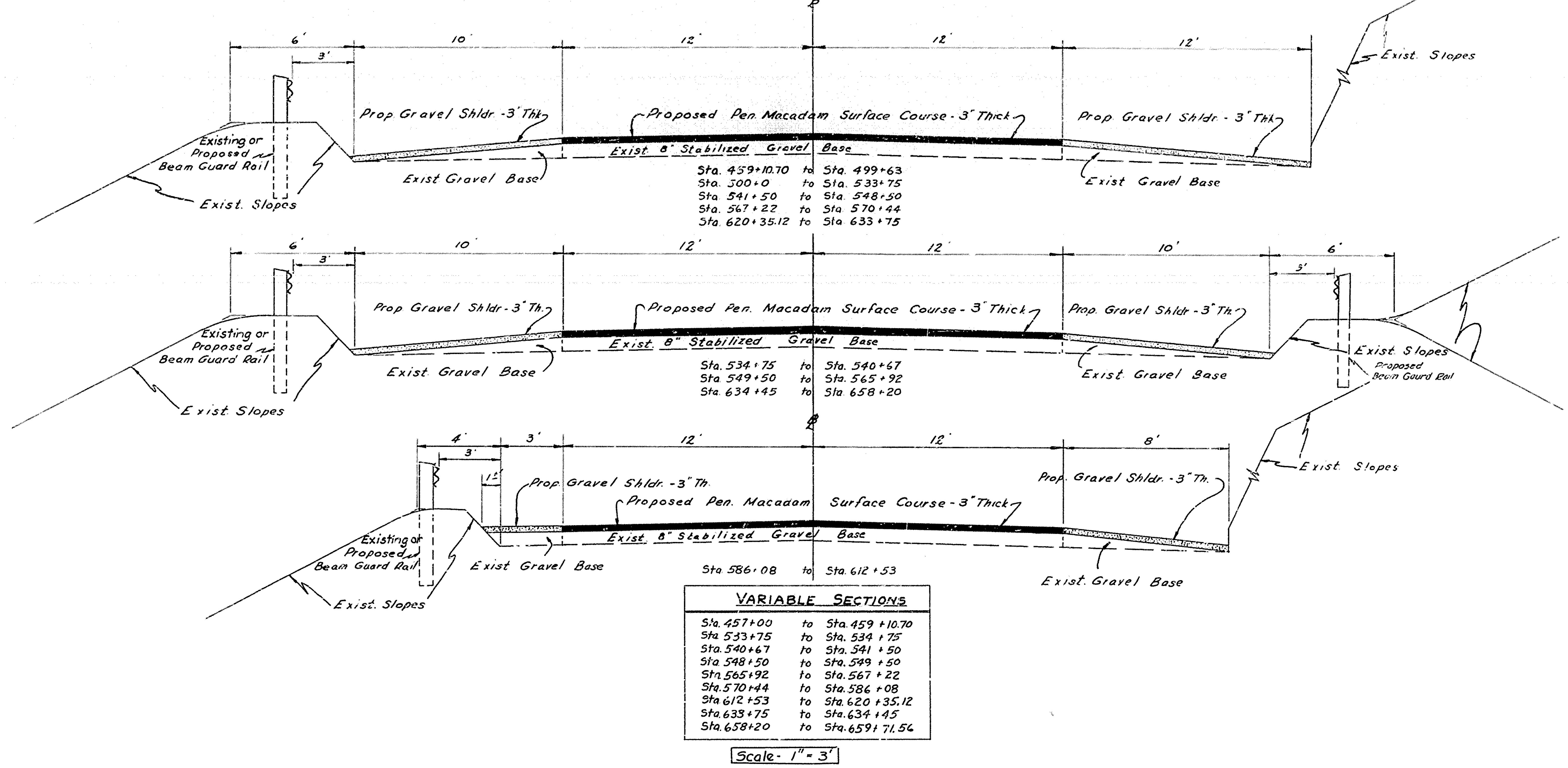
Approved by [illegible] 6-13-55
State Highway Engineer — Date

Approved by ______ ______
State Highway Commissioner — Date

1/7

1008 001 007

TYPICAL SECTIONS



ESTIMATE OF QUANTITIES

Item No.	Description	Unit	Contract Quantity	As Built Quantity
1	FIELD OFFICE	L.S.	1	1
2	GRAVEL SHOULDER 3" THICK	S.Y.	43,600	41063
3	PENETRATION MACADAM SURFACE COURSE HOT APPL. 3" THICK	S.Y.	54,500	54259
4	BITUMINOUS MATERIAL 1ST & 2ND HOT APPLICATION	Gals.	149,875	150121
5	PENETRATION MACADAM 3RD HOT APPLICATION	S.Y.	54,500	54259
6	BEAM GUARD RAIL	L.F.	17,700	17464
S.A.*1	1½" STONE FOR EXTRA DEPTH OF MACADAM PAV'T TO 4 INCHES	TONS	100	123
SA*1	¾" STONE WITH SCREENINGS FOR REPAIR	TONS	100	158
SA*1	GRAVEL FOR EXTRA DEPTH - GRAVEL SHOULDERS	TONS	100	—

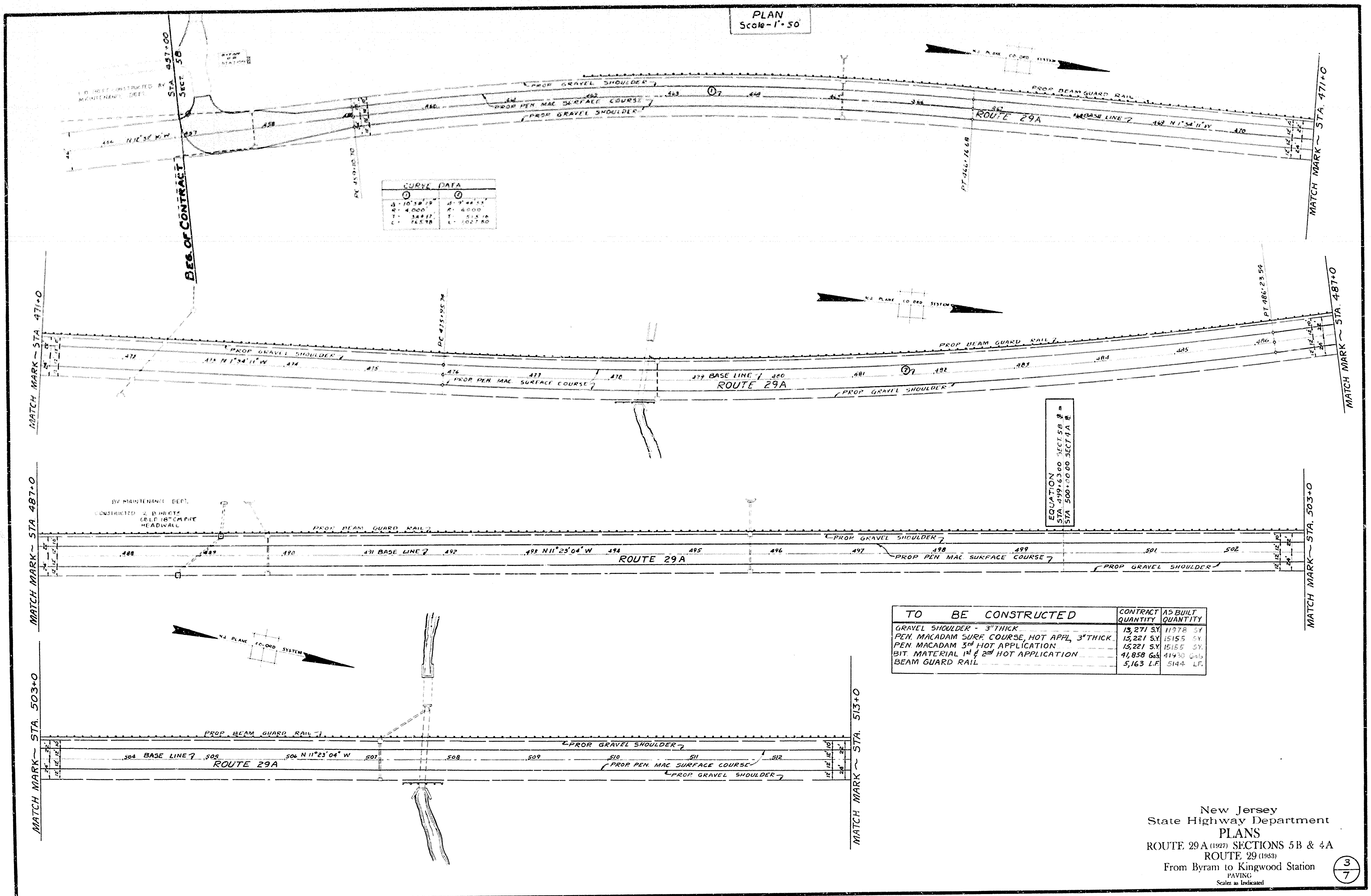
DISTRIBUTION OF QUANTITIES

Item No.	Plan Sheet No. 3		Plan Sheet No. 4		Plan Sheet No. 5		Plan Sheet No. 6		IF and Where Directed	
	Estimate	As Built	Estimate	As Built	Estimate	As Built	Estimate	As Built		
1										
2	13,271	11978	10,648	9825	9,954	10232	9,577	9028	150	
3	15,221	15155	12,000	12002	16,000	16003	11,091	11099	188	
4	41,858	41930	33,000	33207	44,000	44276	30,499	30708	518	
5	15,221	15155	12,000	12002	16,000	16003	11,091	11099	188	
6	5,163	5144	4,700	4690	3,312	3345	4,422	4285	103	
S.A.*1										
SA*1										
SA*1										

New Jersey
State Highway Department
ESTIMATE OF QUANTITIES
TAKE OFF SHEET
TYPICAL SECTIONS
ROUTE 29 A (1927) SECTIONS 5 B & 4 A
ROUTE 29 (1953)
From Byram to Kingwood Station
PAVING
Scales as Indicated

2/7

1008 002 007



TO BE CONSTRUCTED	CONTRACT QUANTITY	AS BUILT QUANTITY
GRAVEL SHOULDER - 3" THICK	13,271 S.Y.	11978 S.Y.
PEN. MACADAM SURF. COURSE, HOT APPL., 3" THICK	15,221 S.Y.	15155 S.Y.
PEN. MACADAM 3rd HOT APPLICATION	15,221 S.Y.	15155 S.Y.
BIT. MATERIAL 1st & 2nd HOT APPLICATION	41,858 Gals.	41930 Gals.
BEAM GUARD RAIL	5,163 L.F.	5144 L.F.

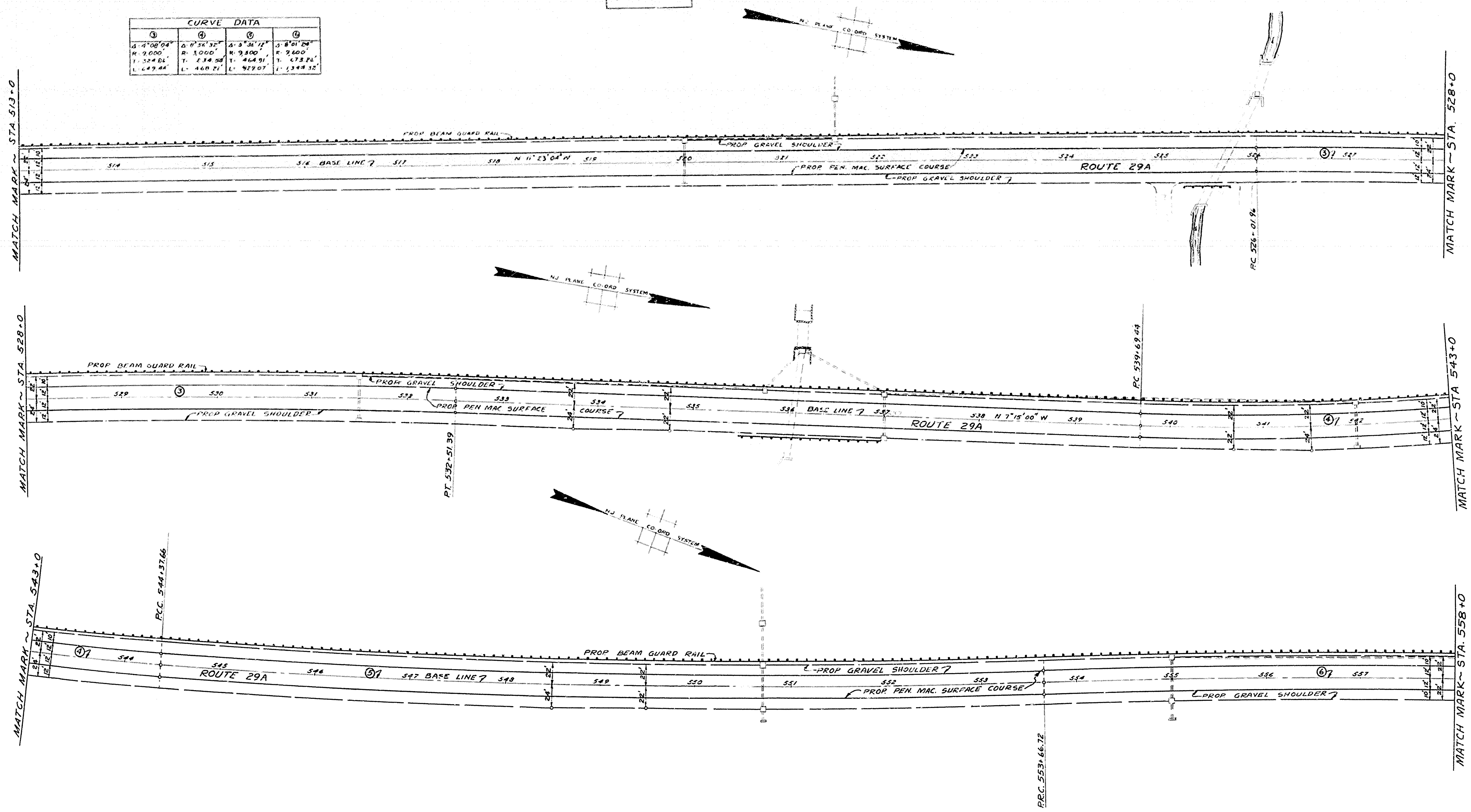
New Jersey
State Highway Department
PLANS
ROUTE 29 A (1927) SECTIONS 5 B & 4 A
ROUTE 29 (1953)
From Byram to Kingwood Station
PAVING
Scales as Indicated

3/7

1008 003 007

PLAN
Scale ~ 1" = 50'

CURVE DATA			
3	4	5	6
Δ 4°08'04"	Δ 8°56'32"	Δ 5°36'12"	Δ 8°01'24"
R 2,000'	R 3,000'	R 9,500'	R 9,600'
T 324.86'	T 234.55'	T 464.91'	T 673.26'
L 649.44'	L 468.21'	L 927.07'	L 1,344.32'

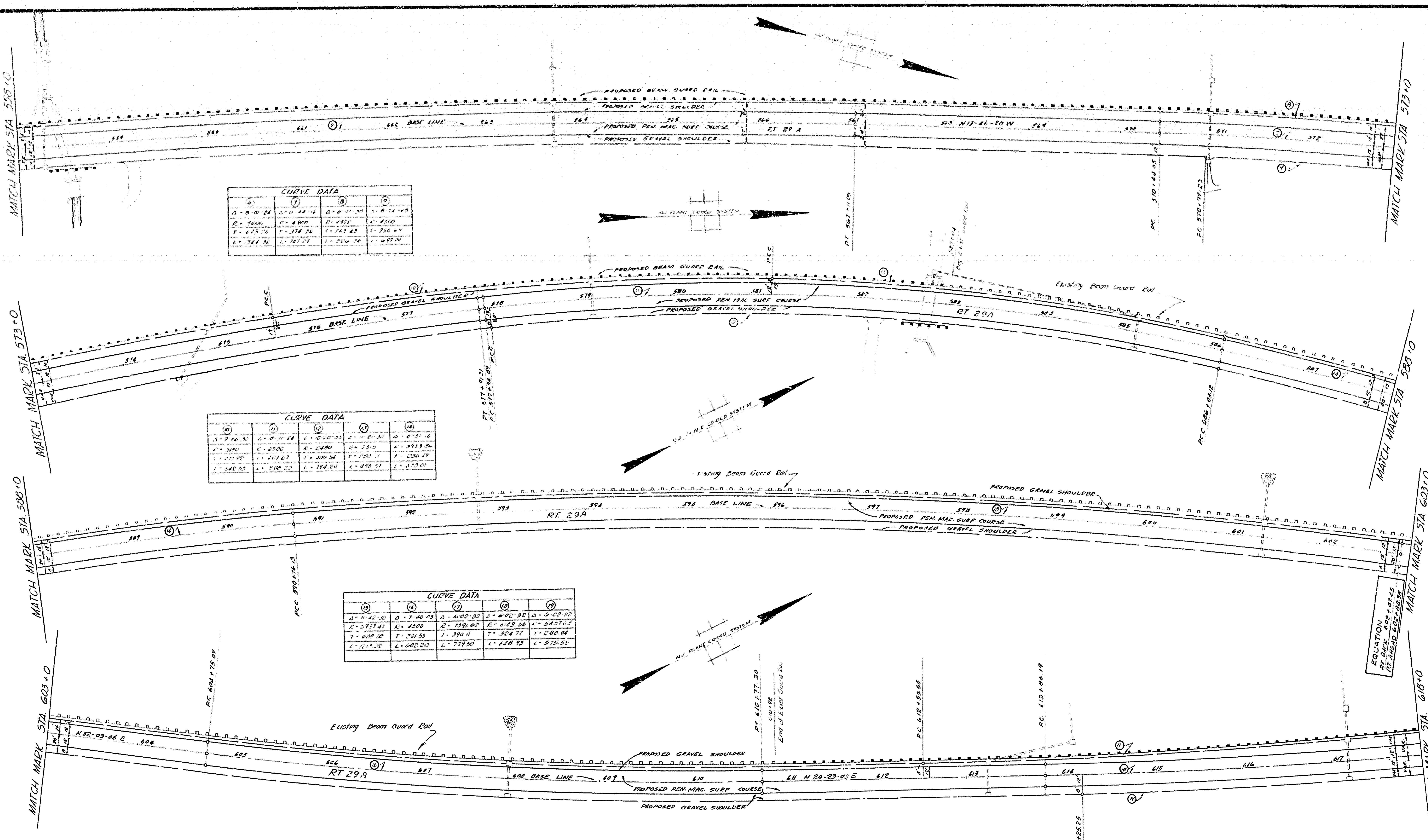


TO BE CONSTRUCTED	CONTRACT QUANTITY	AS BUILT QUANTITY
GRAVEL SHOULDER - 3" THICK	10,648 S.Y.	9825 SY
PEN. MACADAM SURF. COURSE, HOT APPL., 3" THICK	12,000 S.Y.	12002 SY
PEN. MACADAM 3rd APPLICATION	12,000 S.Y.	12002 SY
BIT. MATERIAL 1st & 2nd HOT APPLICATION	33,000 Gals	33207 Gal
BEAM GUARD RAIL	4,700 L.F.	4690 LF

New Jersey
State Highway Department
PLANS
ROUTE 29 A (1927) SECTIONS 5 B & 4 A
ROUTE 29 (1953)
From Byram to Kingwood Station
PAVING
Scales as Indicated

4/7

1008 004 007



CURVE DATA			
6	7	8	9
Δ = 8°01'26	Δ = 0°44'16	Δ = 6°01'34	Δ = 8°54'45
R = 9600	R = 4900	R = 4922	R = 2300
T = 673.26	T = 374.36	T = 263.43	T = 350.44
L = 1344.36	L = 747.21	L = 520.34	L = 699.78

CURVE DATA				
10	11	12	13	14
Δ = 9°46'30	Δ = 5°11'24	Δ = 8°20'33	Δ = 11°21'30	Δ = 6°51'16
R = 3150	R = 2200	R = 2480	R = 2510	R = 3953.84
T = 271.92	T = 201.01	T = 400.54	T = 250.11	T = 236.19
L = 542.53	L = 402.29	L = 799.20	L = 498.51	L = 473.01

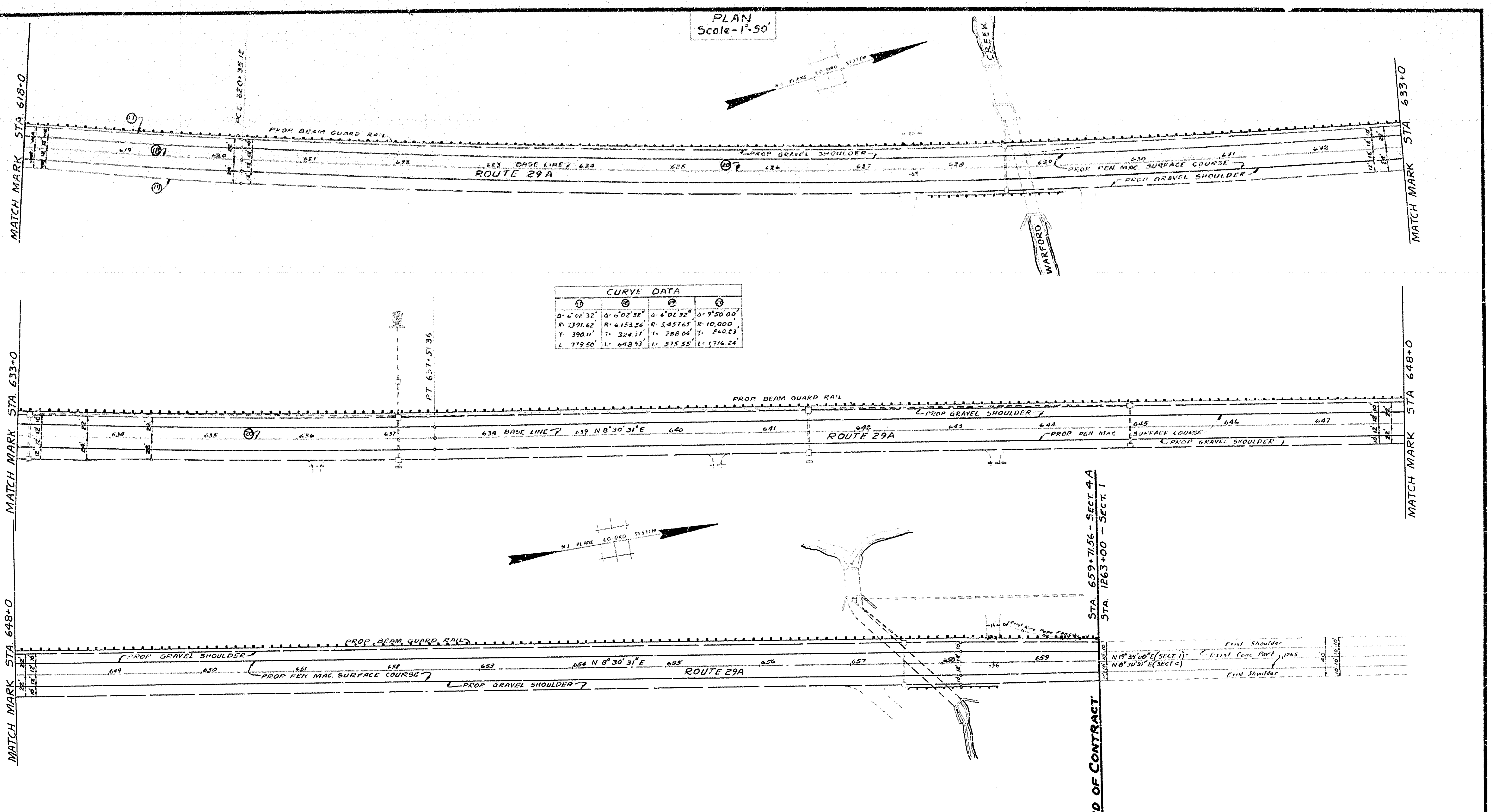
CURVE DATA				
15	16	17	13	19
Δ = 11°42'30	Δ = 7°40'03	Δ = 6°02'32	Δ = 6°02'32	Δ = 6°02'32
R = 5931.41	R = 4500	R = 7391.62	R = 6153.56	R = 5457.65
T = 608.78	T = 301.55	T = 390.11	T = 324.77	T = 288.04
L = 1212.32	L = 602.20	L = 779.50	L = 648.93	L = 575.55

TO BE CONSTRUCTED	CONTRACT QUANTITY	AS BUILT QUANTITY
GRAVEL SHOULDER 3" THICK	9,954 sy	10232 SY
PEN. MACADAM SURF. COURSE HOT APPL. 3" TH.	16,000 sy	16003 SY
BIT. MATERIAL 1st & 2nd HOT APP	44,000 gals.	44276 Gal
PEN. MACADAM 3RD HOT APPL.	16,000 sy	16003 SY
BEAM GUARD RAIL	3312 LF.	3345 LF

New Jersey
State Highway Department
PLANS
ROUTE 29 A (1927) SECTIONS 5 B & 4 A
ROUTE 29 (1953)
From Byram to Kingwood Station
PAVING
Scales as Indicated

5/7

1008 005 007



CURVE DATA			
17	18	19	20
Δ = 6° 02' 32"	Δ = 6° 02' 32"	Δ = 6° 02' 32"	Δ = 9° 50' 00"
R = 7,391.62'	R = 6,153.56'	R = 5,457.65'	R = 10,000'
T = 390.11'	T = 324.71'	T = 288.04'	T = 860.83'
L = 779.50'	L = 648.93'	L = 575.55'	L = 1,716.24'

TO BE CONSTRUCTED	CONTRACT QUANTITY	AS BUILT QUANTITY
GRAVEL SHOULDER 3" THICK	9,577 S.Y.	9028 SY
PEN. MACADAM SURF. COURSE, HOT APPL., 3" THICK	11,091 S.Y.	11099 SY
PEN. MACADAM 3rd APPLICATION	11,091 S.Y.	11099 SY
BIT. MATERIAL, 1st & 2nd HOT APPLICATION	30,499 Gals.	30708 Gals
BEAM GUARD RAIL	4,422 L.F.	4285 LF

New Jersey
State Highway Department
PLANS
ROUTE 29 A (1927) SECTIONS 5 B & 4 A
ROUTE 29 (1953)
From Byram to Kingwood Station
PAVING
Scales as Indicated

6/7

1008 006 007

CS 1008

PUBLIC UTILITIES	
N. J. POWER AND LIGHT CO. 400 LINCOLN ST.	PHILLIPSBURG, N. J.
N. J. BELL TELEPHONE CO. LOCAL OFFICE 9 OAKLAND AVE.	NEWARK, N. J. TRENTON, N. J.
PENNSYLVANIA RAILROAD PENNSYLVANIA STATION	NEW YORK, N. Y.

INDEX	
SHEET NUMBER	DESCRIPTION
1	KEY MAP
2	ESTIMATE OF QUANTITIES
	TYPICAL SECTIONS
3	DISTRIBUTION OF QUANTITIES
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11 - 31	CROSS SECTION SHEETS
32	EARTHWORK SUMMARY
33 - 39	CONSTRUCTION DETAILS

STATE OF NEW JERSEY
HIGHWAY DEPARTMENT

PLANS OF

ROUTE 29 (1953) SECTION 1
From Raven Rock to Byram

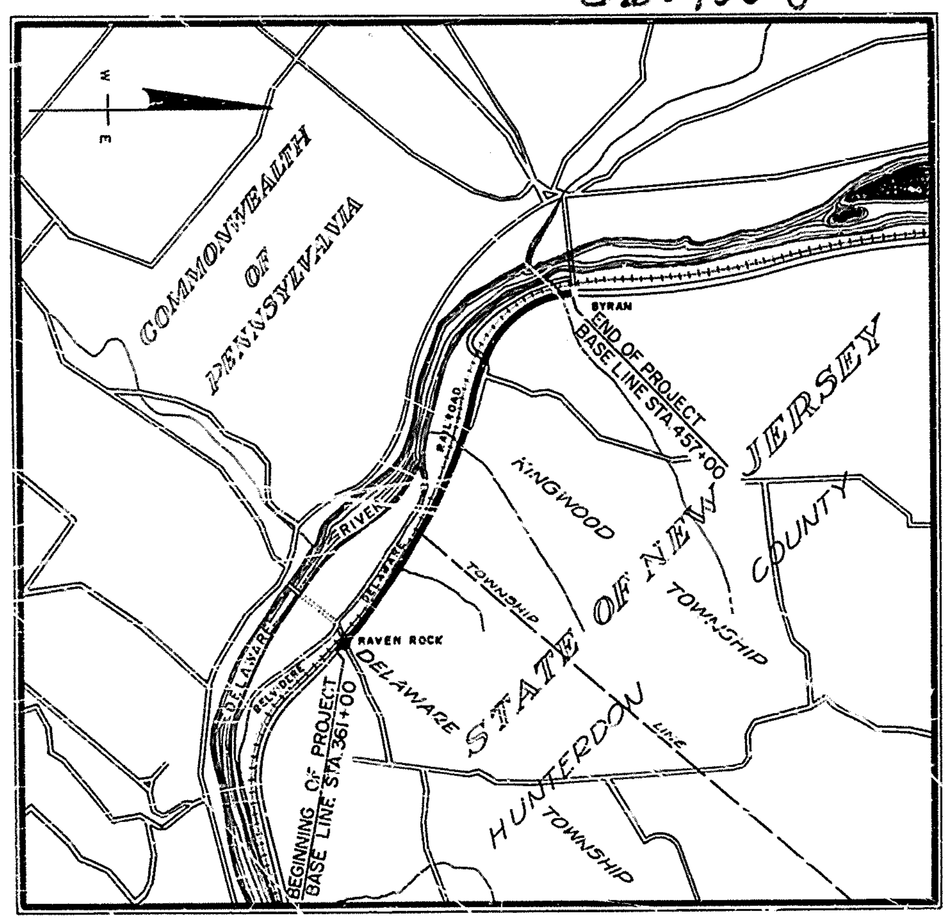
GRADING and PAVING

Townships of Delaware and Kingwood — Hunterdon County

Scales as Indicated — May 1959

As Built - SEPT. 1960

C.S. 1008



KEY MAP

SCALE 2" = 1 MILE

LENGTH OF PROJECT 9600.00 LIN. FT. 1.818 MILES

STANDARD HIGHWAY SPECIFICATIONS OF 1941 TO GOVERN

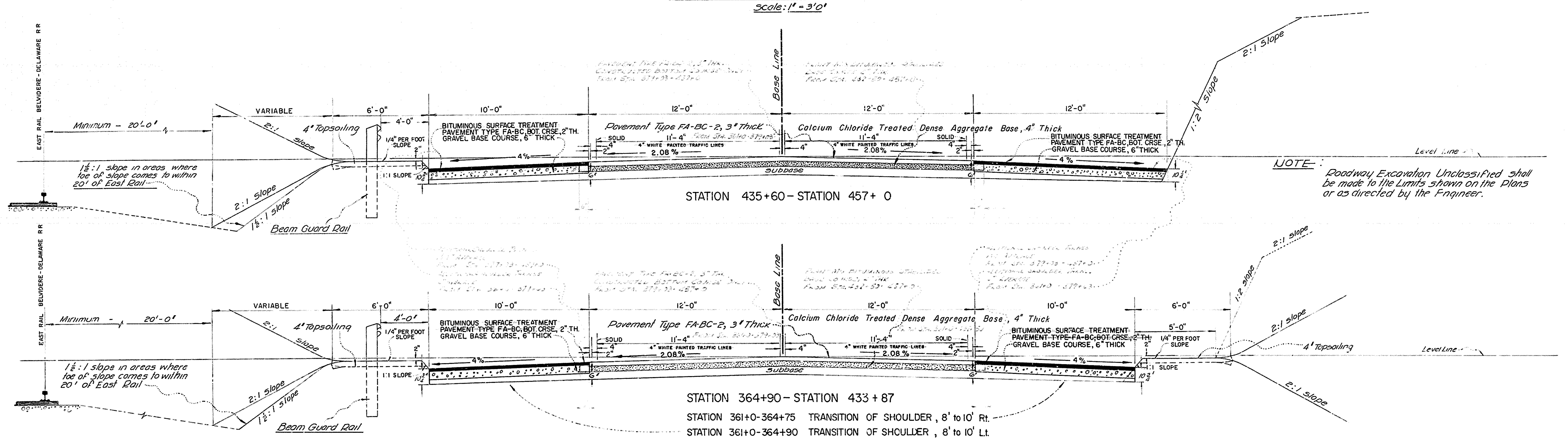
Submitted by A. W. Gyfin — Director and Chief Engineer, Division of Roads, Design and Construction — Date 5-13-59

Approved by A. H. [illegible] — State Highway Engineer — Date 6-14-59

Approved by ______ State Highway Commissioner — Date ______

TYPICAL SECTIONS

Scale: 1" = 3'0"



ESTIMATE OF QUANTITIES

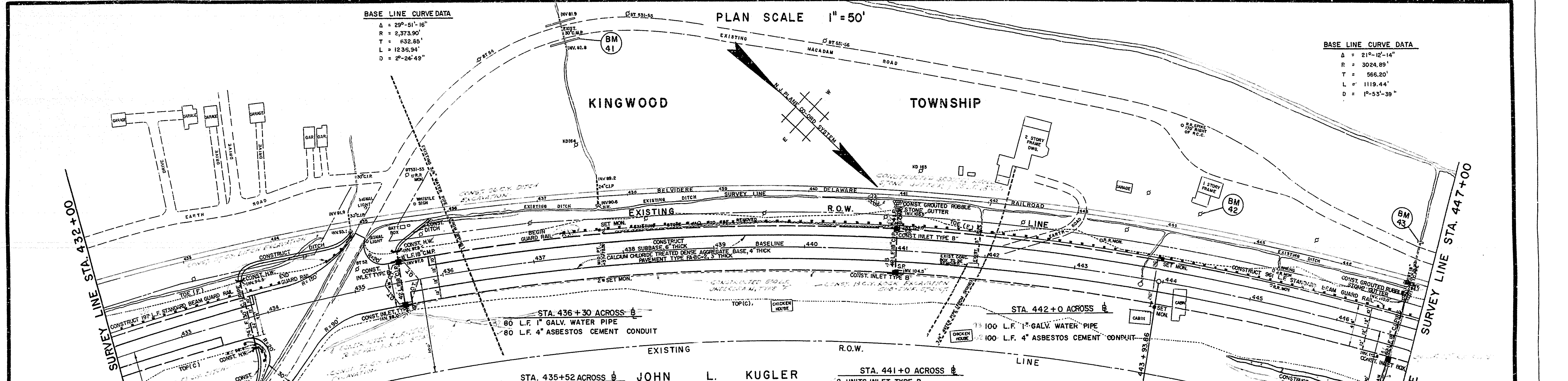
ITEM NO.	DESCRIPTION	UNIT	CONTRACT QUANTITY	AS-BUILT QUANTITY
1	FIELD OFFICE	LUMP SUM	LUMP SUM	Lump Sum
2	CLEARING SITE	LUMP SUM	LUMP SUM	Lump Sum
3	STRIPPING	ACRE	2	[illegible]
4	ROADWAY EXCAVATION, UNCLASSIFIED	CU. YD.	58,946	[illegible]
5	WET EXCAVATION	CU. YD.	4500	[illegible]
6	CHANNEL EXCAVATION, UNCLASSIFIED	CU. YD.	300	[illegible]
7	DITCH EXCAVATION	CU. YD.	600	[illegible]
8	EARTH EXCAVATION FOR TEST PITS	CU. YD.	10	[illegible]
9	ROCK EXCAVATION, SUBSURFACE STRUCTURES	CU. YD.	700	[illegible]
10	EARTH EXCAVATION SUBSURFACE STRUCTURES, ADDITIONAL DEPTH	CU. YD.	25	[illegible]
11	BORROW EXCAVATION, ZONE 2	CU. YD.	4500	[illegible]
12	BORROW EXCAVATION, ZONE 3	CU. YD.	5,000	[illegible]
13	4" TOPSOILING	SQ. YD.	11,000	[illegible]
14	CONCRETE BAG SLOPE PROTECTION	CU. YD.	15	[illegible]
15	CALCIUM CHLORIDE TREATED DENSE AGGREGATE BASE, 4" THICK	SQ. YD.	27,450	[illegible]
16	PAVEMENT TYPE FA-BC-2, 3" THICK	SQ. YD.	27,450	[illegible]
17	BROKEN STONE OR WASHED GRAVEL	CU. YD.	60	[illegible]
18	PRIME COAT	GALLON	12,120	[illegible]
19	12" REINFORCED CONCRETE CULVERT PIPE	LIN. FT.	50	[illegible]
20	18" REINFORCED CONCRETE CULVERT PIPE	LIN. FT.	112	[illegible]
21	24" REINFORCED CONCRETE CULVERT PIPE	LIN. FT.	290	[illegible]
22	18" CAST IRON CULVERT PIPE, EXTRA HEAVY	LIN. FT.	314	316
23	30" CAST IRON CULVERT PIPE, EXTRA HEAVY	LIN. FT.	74	74
24	6" CORRUGATED METAL PIPE	LIN. FT.	84	84
25	18" CORRUGATED METAL CULVERT PIPE	LIN. FT.	240	[illegible]
26	6'-1" x 4'-7" STRUCTURAL PLATE PIPE ARCH	LIN. FT.	96	96
27	7'-0" x 5'-1" STRUCTURAL PLATE PIPE ARCH	LIN. FT.	92	92
28	9'-6" x 6'-5" STRUCTURAL PLATE PIPE ARCH	LIN. FT.	76	76
29	INLETS, TYPE B	UNIT	12	12
30	INLETS, TYPE E	UNIT	4	[illegible]
31	INLET BOXES	UNIT	1	NONE
32	RESET INLET HEADS	UNIT	8	[illegible]
33	GROUTED RUBBLE STONE GUTTER	SQ. YD.	20	[illegible]
34	HEADWALLS, APRONS AND PIPE PLUGS	CU. YD.	95	[illegible]
35	STANDARD BEAM GUARD RAIL	LIN. FT.	6,677	[illegible]
36	4" ASBESTOS CEMENT CONDUIT	LIN. FT.	180	[illegible]
37	1" GALVANIZED WATER PIPE	LIN. FT.	180	[illegible]
38	MONUMENTS	UNIT	20	[illegible]
39	FERTILIZING AND SEEDING	SQ. YD.	14,000	[illegible]
40	MULCHING (HAY)	SQ. YD.	25,000	[illegible]
41	UNDERDRAIN, TYPE F	LIN. FT.	1,000	[illegible]
42	CALCIUM CHLORIDE	TON	28	[illegible]
43	SUBBASE	CU. YD.	6,800	[illegible]
44	GRAVEL BASE COURSE, 6" THICK	SQ. YD.	21,227	[illegible]
45	PAVEMENT TYPE FA-BC, BOTTOM COURSE, 2" THICK	SQ. YD.	21,006	[illegible]
46	SURFACE TREATMENT BITUMINOUS MATERIAL	GAL.	8,404	[illegible]
47	SURFACE TREATMENT COVER MATERIAL	TON	292	[illegible]
48	9" x 20" WHITE CONCRETE VERTICAL CURB	LIN. FT.	200	[illegible]
49	4" WHITE PAINTED TRAFFIC LINES	LIN. FT.	25,000	NONE
50	INLET HEAD, TYPE E	UNIT	1	1

ITEM No.	DESCRIPTION	UNIT	CONTRACT QUANTITY	AS-BUILT QUANTITY	ITEM No.	DESCRIPTION	UNIT	CONTRACT QUANTITY	AS-BUILT QUANTITY
C.O.#3	BITUMINOUS SHOULDERS BASE COURSE, 3" THK	S.Y.	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
C.O.#3	RECONSTRUCT PAVEMENT TYPE FA-BC-2, 3" THK	S.Y.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
C.O.#3	RECONSTRUCT PAVEMENT TYPE FA-BC-2, 1½" THK.	S.Y.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
C.O.#3	ADDITIONAL SHOULDER THICKNESS 2" AVERAGE	S.Y.	[illegible]	[illegible]	C.O.#4	ROADWAY EXCAVATION, EARTH	C.Y.		1707
C.O.#3	ADDITIONAL SHOULDER THICKNESS 1½" AVERAGE	S.Y.	[illegible]	[illegible]					
C.O.#3	TAR GRADE RT-9 or RT-10	GAL.	[illegible]	[illegible]					

New Jersey
State Highway Department
ESTIMATE OF QUANTITIES
TYPICAL SECTIONS
ROUTE 29 (1958) SECTION 1
From Raven Rock to Byram
GRADING and PAVING
Scales as Indicated

2
39

1008 002 039



STA. 436+30 ACROSS ℄
80 L.F. 1" GALV. WATER PIPE
80 L.F. 4" ASBESTOS CEMENT CONDUIT

STA. 442+0 ACROSS ℄
100 L.F. 1" GALV. WATER PIPE
100 L.F. 4" ASBESTOS CEMENT CONDUIT

EXISTING R.O.W. LINE

JOHN L. KUGLER

STA. 435+52 ACROSS ℄
2 UNITS INLETS, TYPE B
42 L.F. 18" C.I. PIPE, EXTRA HEAVY
8 L.F. 18" C.M. PIPE
11.6 C.Y. BROKEN STONE OR WASHED GRAVEL
2.3 C.Y. HEADWALL & APRON
29 C.Y. DITCH EXCAVATION
12 L.F. 6" C.M. PIPE
20 L.F. 9"X 20" WH. CONC. VERTICAL CURB

STA. 433+78 ACROSS ℄
74 L.F. 30" C.I. PIPE, EXTRA HEAVY
221 C.Y. DITCH EXCAVATION
8.6 C.Y. HEADWALLS & APRONS

STA 437+75.39 LT. & RT. ℄
2 UNITS MONUMENTS

STA. 437+35 TO STA 446+89 ℄ LT.
961 L.F. STANDARD BEAM GUARD RAIL

STA. 441+0 ACROSS ℄
2 UNITS INLET, TYPE B
8 S.Y. GROUTED RUBBLE STONE GUTTER
42 L.F. 18" C.I. PIPE, EXTRA HEAVY
24 L.F. 18" C.M. PIPE
2 C.Y. ROCK EXCAV. SUB-SURF. STRUCTURES
6 L.F. 6" C.M. PIPE
0.3 C.Y. BROKEN STONE OR WASHED GRAVEL
20 L.F. 9"X 20" WH. CONC. VERTICAL CURB

STA. 444+87 TO STA. 446+89 ℄
202 C.Y. DITCH EXCAVATION

STA. 446+67 ACROSS ℄
1 UNIT INLET BOX
62 L.F. 18" C.I. PIPE, EXTRA HEAVY
~~15 C.Y. ROCK EXCAV. SUB-SURF. STRUCTURES~~
8 S.Y. GROUTED RUBBLE STONE GUTTER

STA 432+23 TO STA. 446+89 ℄
4429 S.Y. PAVEMENT TYPE FA-BC-2, 3" THICK
1048 C.Y SUBBASE
~~92 C.Y. ROADWAY EXCAVATION, UNCLASSIFIED~~
4429 S.Y. CALCIUM CHLORIDE TREATED DENSE AGGREGATE BASE, 4" THICK
1867 GAL. PRIME COAT
3037 S.Y. GRAVEL BASE COURSE, 6" THICK
~~3037 S.Y. PAVEMENT TYPE FA-BC, BOTTOM CRS. 2" THICK~~
1215 GAL. SURFACE TREATMENT, BITUMINOUS MATERIAL
42 TONS SURFACE TREATMENT, COVER MATERIAL

STA. 443+93.86 LT. & RT. ℄
2 UNITS MONUMENTS

MATCH LINE

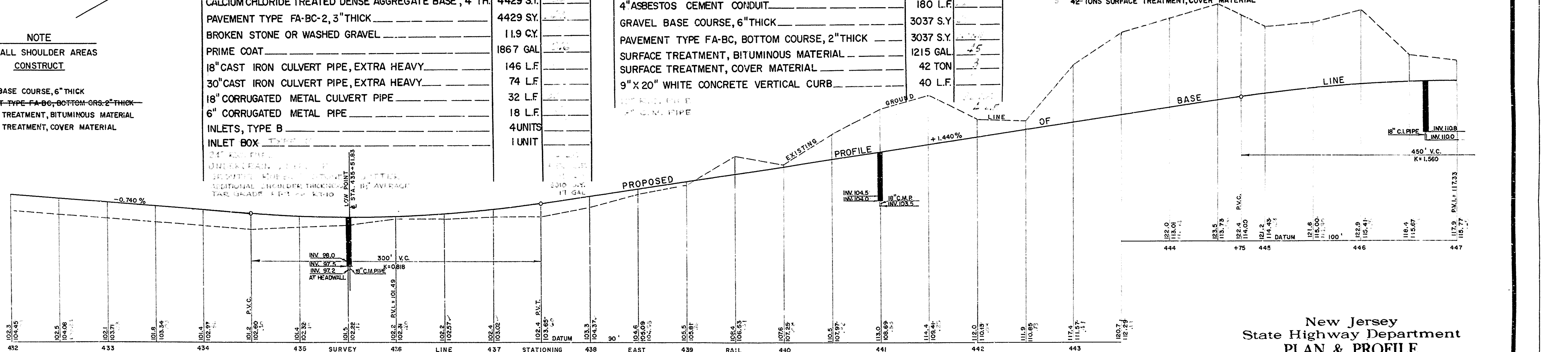
THOMAS Mc ALOAN JR.

STA. 432+23 TO STA. 434+20 ℄ LT.
197 L.F. STANDARD BEAM GUARD RAIL

TO BE CONSTRUCTED	CONTRACT QUANTITY	AS-BUILT QUANTITY
ROADWAY EXCAVATION, UNCLASSIFIED	92 C.Y.	
DITCH EXCAVATION	452 C.Y.	
MONUMENTS	4 UNITS	
ROCK EXCAVATION, SUB-SURFACE STRUCTURES	15 C.Y.	
SUBBASE	1048 C.Y.	
STANDARD BEAM GUARD RAIL	1158 L.F.	
CALCIUM CHLORIDE TREATED DENSE AGGREGATE BASE, 4" TH.	4429 S.Y.	
PAVEMENT TYPE FA-BC-2, 3" THICK	4429 S.Y.	
BROKEN STONE OR WASHED GRAVEL	11.9 C.Y.	
PRIME COAT	1867 GAL	
18" CAST IRON CULVERT PIPE, EXTRA HEAVY	146 L.F.	
30" CAST IRON CULVERT PIPE, EXTRA HEAVY	74 L.F.	
18" CORRUGATED METAL CULVERT PIPE	32 L.F.	
6" CORRUGATED METAL PIPE	18 L.F.	
INLETS, TYPE B	4 UNITS	
INLET BOX	1 UNIT	

TO BE CONSTRUCTED	CONTRACT QUANTITY	AS-BUILT QUANTITY
HEADWALLS & APRONS	10.9 C.Y.	
GROUTED RUBBLE STONE GUTTER	16 S.Y.	
1" GALVANIZED WATER PIPE	180 L.F.	
4" ASBESTOS CEMENT CONDUIT	180 L.F.	
GRAVEL BASE COURSE, 6" THICK	3037 S.Y	
PAVEMENT TYPE FA-BC, BOTTOM COURSE, 2" THICK	3037 S.Y.	
SURFACE TREATMENT, BITUMINOUS MATERIAL	1215 GAL.	45
SURFACE TREATMENT, COVER MATERIAL	42 TON	3
9" X 20" WHITE CONCRETE VERTICAL CURB	40 L.F.	

NOTE
IN ALL SHOULDER AREAS
CONSTRUCT
SUBBASE
GRAVEL BASE COURSE, 6" THICK
~~PAVEMENT TYPE FA-BC, BOTTOM CRS. 2" THICK~~
SURFACE TREATMENT, BITUMINOUS MATERIAL
SURFACE TREATMENT, COVER MATERIAL

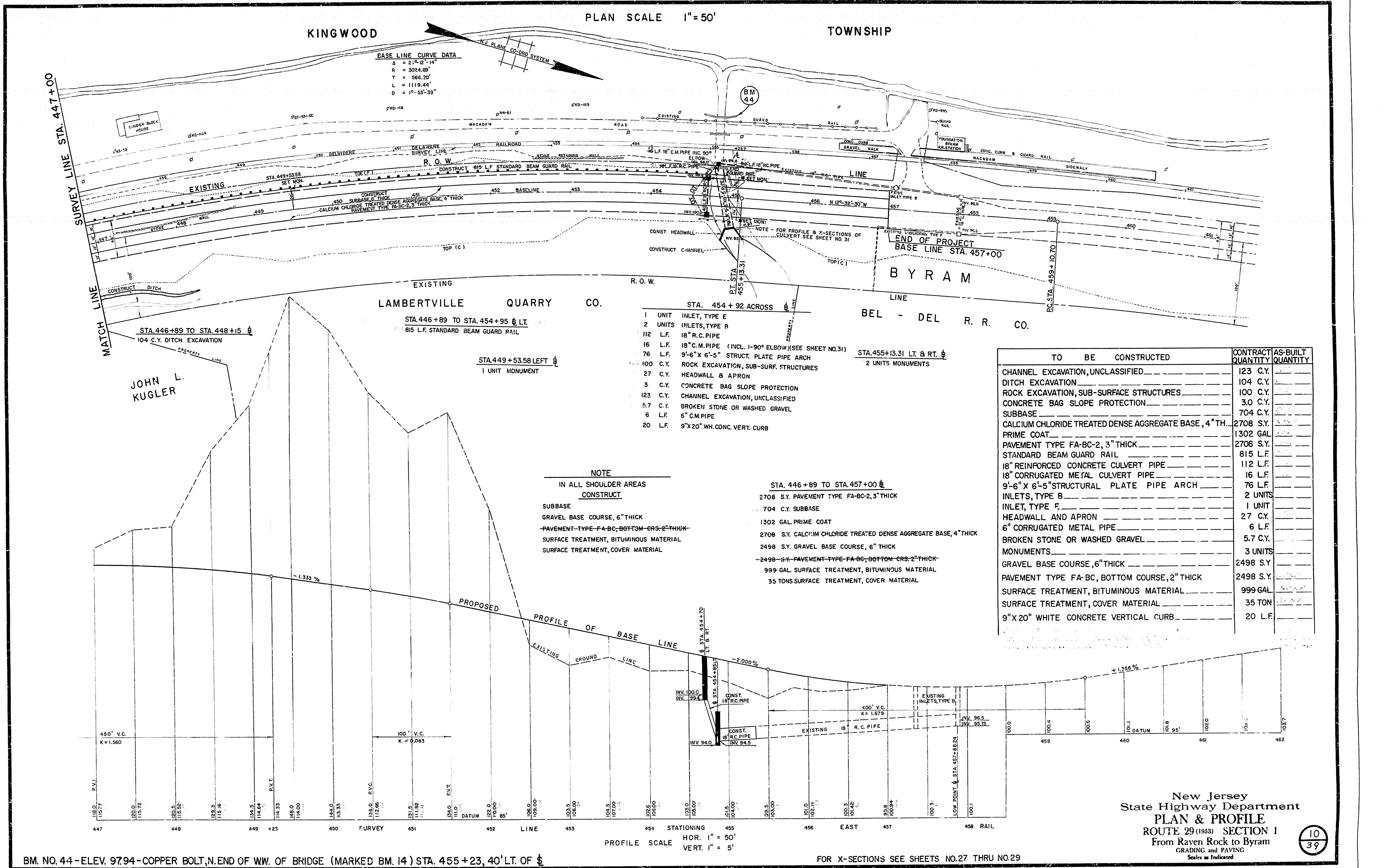


BM. NO. 41 - ELEV. 93.53 - U.S.C.&G. MARKER IN N.W. COR. NORTH H.W. OF BRIDGE STA. 437+57, 170' LT. ℄
BM NO. 42 - ELEV. 100.67 - SPIKE IN POLE, STA. 444+35 - 15' LT. ℄
BM NO. 43 - ELEV. 97.32 - CROSS CUT IN S. END OF CONC. H.W. NO. K-11, STA. 446+80, 40' LT. ℄

PROFILE SCALE HOR. 1" = 50'
VERT. 1" = 5'

FOR X-SECTIONS SEE SHEETS NO. 23 THRU NO. 27

New Jersey
State Highway Department
PLAN & PROFILE
ROUTE 29 (1953) SECTION 1
From Raven Rock to Byram
GRADING and PAVING
Scales as Indicated



STA. 446+89 TO STA. 448+15 ℄
104 C.Y. DITCH EXCAVATION

STA. 446+89 TO STA. 454+95 ℄ LT.
815 L.F. STANDARD BEAM GUARD RAIL

STA. 449+53.58 LEFT ℄
1 UNIT MONUMENT

STA. 454 + 92 ACROSS ℄

1	UNIT	INLET, TYPE E
2	UNITS	INLETS, TYPE B
112	L.F.	18" R.C. PIPE
16	L.F.	18" C.M. PIPE (INCL. 1-90° ELBOW)(SEE SHEET NO. 31)
76	L.F.	9'-6" X 6'-5" STRUCT. PLATE PIPE ARCH
100	C.Y.	ROCK EXCAVATION, SUB-SURF. STRUCTURES
27	C.Y.	HEADWALL & APRON
3	C.Y.	CONCRETE BAG SLOPE PROTECTION
123	C.Y.	CHANNEL EXCAVATION, UNCLASSIFIED
5.7	C.Y.	BROKEN STONE OR WASHED GRAVEL
6	L.F.	6" C.M. PIPE
20	L.F.	9"X20" WH. CONC. VERT. CURB

STA. 455+13.31 LT. & RT. ℄
2 UNITS MONUMENTS

NOTE

IN ALL SHOULDER AREAS
CONSTRUCT

SUBBASE
GRAVEL BASE COURSE, 6" THICK
~~PAVEMENT TYPE FA-BC, BOTTOM CRS. 2" THICK~~
SURFACE TREATMENT, BITUMINOUS MATERIAL
SURFACE TREATMENT, COVER MATERIAL

STA. 446+89 TO STA. 457+00 ℄

2708 S.Y. PAVEMENT TYPE FA-BC-2, 3" THICK
704 C.Y. SUBBASE
1302 GAL. PRIME COAT
2708 S.Y. CALCIUM CHLORIDE TREATED DENSE AGGREGATE BASE, 4" THICK
2498 S.Y. GRAVEL BASE COURSE, 6" THICK
~~2498 S.Y. PAVEMENT TYPE FA-BC, BOTTOM CRS. 2" THICK~~
999 GAL. SURFACE TREATMENT, BITUMINOUS MATERIAL
35 TONS SURFACE TREATMENT, COVER MATERIAL

TO BE CONSTRUCTED	CONTRACT QUANTITY	AS-BUILT QUANTITY
CHANNEL EXCAVATION, UNCLASSIFIED	123 C.Y.	
DITCH EXCAVATION	104 C.Y.	
ROCK EXCAVATION, SUB-SURFACE STRUCTURES	100 C.Y.	
CONCRETE BAG SLOPE PROTECTION	3.0 C.Y.	
SUBBASE	704 C.Y.	
CALCIUM CHLORIDE TREATED DENSE AGGREGATE BASE, 4" TH.	2708 S.Y.	
PRIME COAT	1302 GAL	
PAVEMENT TYPE FA-BC-2, 3" THICK	2706 S.Y.	
STANDARD BEAM GUARD RAIL	815 L.F.	
18" REINFORCED CONCRETE CULVERT PIPE	112 L.F.	
18" CORRUGATED METAL CULVERT PIPE	16 L.F.	
9'-6" X 6'-5" STRUCTURAL PLATE PIPE ARCH	76 L.F.	
INLETS, TYPE B	2 UNITS	
INLET, TYPE E	1 UNIT	
HEADWALL AND APRON	27 C.Y.	
6" CORRUGATED METAL PIPE	6 L.F.	
BROKEN STONE OR WASHED GRAVEL	5.7 C.Y.	
MONUMENTS	3 UNITS	
GRAVEL BASE COURSE, 6" THICK	2498 S.Y	
PAVEMENT TYPE FA-BC, BOTTOM COURSE, 2" THICK	2498 S.Y.	
SURFACE TREATMENT, BITUMINOUS MATERIAL	999 GAL.	
SURFACE TREATMENT, COVER MATERIAL	35 TON	
9"X20" WHITE CONCRETE VERTICAL CURB	20 L.F.	

PROFILE SCALE HOR. 1" = 50' VERT. 1" = 5'

BM. NO. 44 - ELEV. 97.94 - COPPER BOLT, N. END OF W.W. OF BRIDGE (MARKED BM. 14) STA. 455+23, 40' LT. OF ℄

FOR X-SECTIONS SEE SHEETS NO. 27 THRU NO. 29

New Jersey
State Highway Department
PLAN & PROFILE
ROUTE 29 (1953) SECTION 1
From Raven Rock to Byram
GRADING and PAVING
Scales as Indicated

10/39

1008 010 039

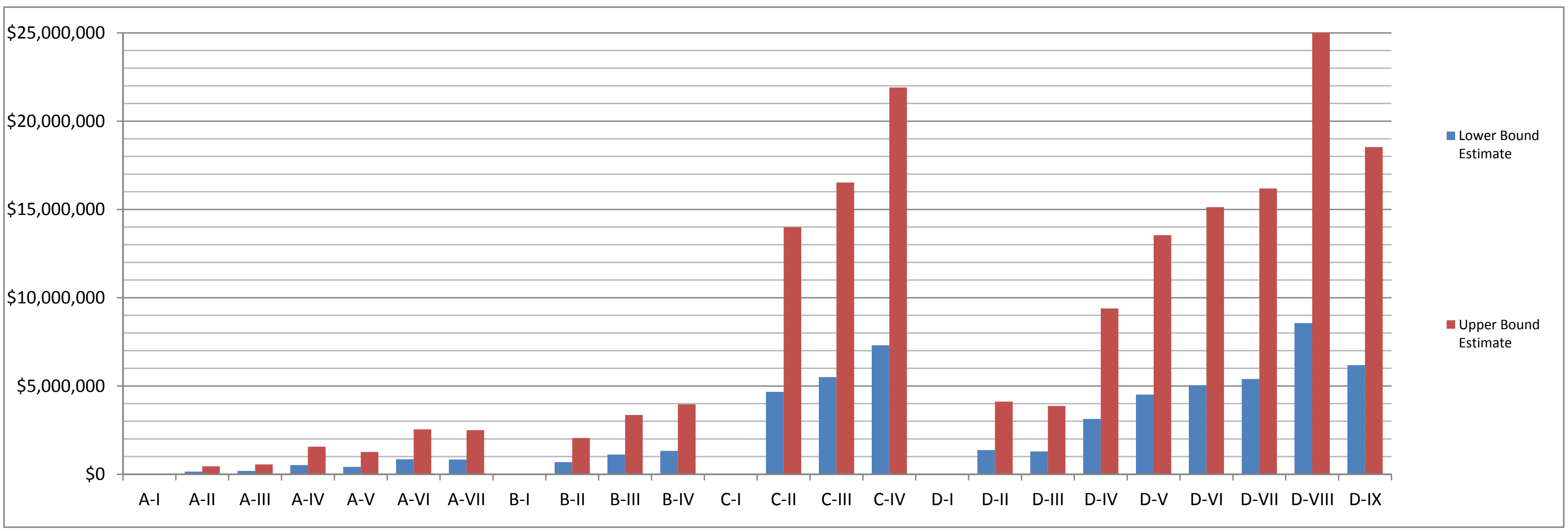
APPENDIX III

Cost Analysis

RT. 29 ROCKFALL CONCEPT DEVELOPMENT CONSTRUCTION COST ESTIMATE SUMMARY

Area	Option	Description	ESTIMATE COST	LOWER BOUND	UPPER BOUND
A	I	**No Action**	$ -	$ -	$ -
	II	**Removal** – Regrade with Catchment Ditch	$ 299,000	$ 150,000	$ 449,000
	III	**Removal** – Remove Vegetation and Scale	$ 371,000	$ 186,000	$ 557,000
	IV	**Removal / Protection** - Remove Vegetation, Scale, and Install Draped Mesh	$ 1,040,000	$ 520,000	$ 1,560,000
	V	**Removal / Protection** – Reslope and Construct Catchment Ditch, Install Draped Mesh on Upper Portion of Lower Slope	$ 841,000	$ 421,000	$ 1,262,000
	VI	**Reinforcement** – Install Grouted Dowels and Shotcrete Facing	$ 1,693,000	$ 847,000	$ 2,540,000
	VII	**Reinforcement** – Install Anchored Mesh, Spot Dowels / Rock Bolts	$ 1,664,000	$ 832,000	$ 2,496,000
B	I	**No Action**	$ -	$ -	$ -
	II	**Protection** – Reslope, Construct Catchment Ditch, and Fence at Crest of Lower Slope	$ 1,366,000	$ 683,000	$ 2,049,000
	III	**Protection** – Hybrid System - Barrier at Crest of Lower Slope and Draped Mesh on Lower Face	$ 2,240,000	$ 1,120,000	$ 3,360,000
	IV	**Protection** – Improved Catchment with Hybrid System (Combination of Options II and III)	$ 2,640,000	$ 1,320,000	$ 3,960,000
C	I	**No Action**	$ -	$ -	$ -
	II	**Protection** – Reslope, Construct Catchment Ditch, and Fence at Crest of Lower Slope	$ 9,334,000	$ 4,667,000	$14,001,000
	III	**Protection** – Hybrid System - Barrier at Crest of Lower Slope and Draped Mesh on Lower Face	$11,013,000	$ 5,507,000	$16,520,000
	IV	**Protection** – Improved Catchment with Hybrid System (Combination of Options II and III)	$14,603,000	$ 7,302,000	$21,905,000
D	I	**No Action**	$ -	$ -	$ -
	II	**Warning** – Install Rockfall Warning Fence	$ 2,745,000	$ 1,373,000	$ 4,118,000
	III	**Monitoring** – Inclinometer, Tiltmeters, and/or Routinely Scheduled LiDar Survey	$ 2,579,000	$ 1,290,000	$ 3,869,000
	IV	**Removal** – Trim blasting and Rock Removal Using Airbags and Scaling	$ 6,261,000	$ 3,131,000	$ 9,392,000
	V	**Reinforcement** – Install Tensioned Rock Bolts, Dental Concrete, and Anchored Mesh	$ 9,025,000	$ 4,513,000	$13,538,000
	VI	**Protection** – Install Hybrid System Barrier at Crest of Lower Slope and Draped Mesh below, or Draped Mesh with Sacrificial Fences	$10,086,000	$ 5,043,000	$15,129,000
	VII	**Protection** – Raise Roadway Elevation or shift Roadway West to Create Catchment	$10,792,000	$ 5,396,000	$16,188,000
	VIII	**Protection** – Rock Shed over Road	$17,128,000	$ 8,564,000	$25,692,000
	IX	**Combination - Localized Trim Blasting, Reinforcement of Devil's tea Table and Shotcrete or Dental Concrete**	$12,356,000	$ 6,178,000	$18,534,000

Green cells indicate preliminary preferred alternative.



For:	Rt. 29 Rockfall	Job Number:	59447	Sheet No.	
By:	BTF	Check By:	NN & JS	Check by:	PDT
Date:	1/19/2015	Date:	1/20/2014	Date:	2/20/2015

HNTB

CONCEPT DEVELOPMENT QUANTITY AND COST ESTIMATE

			Lower Slope				Upper Slope														
Area	Option	Description	Slope Length (ft)	Slope Height (ft)	Slope Angle (degrees)	Slope Face Area (sf)	Slope Length (ft)	Slope Height (ft)	Slope Angle (degrees)	Slope Face Area (sf)	Total Slope Face Area (sf)	Cut Area (ft^2/ft) (See Attached)	Item	QUANTITY		UNIT	UNIT COST	ESTIMATE COST	ESTIMATE COST	LOWER BOUND	UPPER BOUND
A	I	No Action	500	75	60	43,301				-	43,301	-	-	-	0	-	$0.00	$0	$0	$0	$0
	II	**Removal** – Regrade with Catchment Ditch	500	75	60	43,301				-	43,301	152	Rock Excavation	Cut Area x L /27	2,823	CY	$90.00	$254,048	$298,927	$149,463	$448,390
													Embankment	8'H x2'V x 0.5' x L / 27	148	CY	$40.00	$5,926			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	294	Tons	$90.00	$26,453			
													Rock Drain Holes	L / 50 spacing * 50' long	500	ft	$25.00	$12,500			
	III	**Removal** – Remove Vegetation and Scale	500	75	60	43,301				-	43,301	-	Vegetation Removal	Slope Face Area / 9	4,811	SY	$3.00	$14,434	$370,929	$185,465	$556,394
													Rock Scaling	Slope Face Area / 27	529	CY	$600.00	$317,543			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	294	Tons	$90.00	$26,453			
													Rock Drain Holes	L / 50 spacing * 50' long	500	ft	$25.00	$12,500			
	IV	**Removal / Protection** - Remove Vegetation, Scale, and Install Draped Mesh	500	75	60	43,301				-	43,301	-	Vegetation Removal	Slope Face Area / 9	4,811	SY	$3.00	$14,434	$1,039,647	$519,823	$1,559,470
													Rock Scaling	Slope Face Area / 27	529	CY	$600.00	$317,543			
													Rock Dowels	Dowel Length x (L / Draped Mesh Anchor Spacing)	625	LF	$100.00	$62,500			
													Draped Mesh	Slope Face Area	43,301	SF	$14.00	$606,218			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	294	Tons	$90.00	$26,453			
													Rock Drain Holes	L / 50 spacing * 50' long	500	ft	$25.00	$12,500			
	V	**Removal / Protection** – Reslope and Construct Ditch, Install Draped Mesh on Upper Slope	500	75	60	43,301				-	43,301	152	Rock Excavation	Cut Area x L /27 x 0.5	1,411	CY	$90.00	$127,024	$840,620	$420,310	$1,260,931
													Embankment	8'H x2'V x 0.5' x L / 27	148	CY	$40.00	$5,926			
													Rock Dowels	Dowel Length x (L / Draped Mesh Anchor Spacing)	625	LF	$100.00	$62,500			
													Draped Mesh	Slope Face Area	43,301	SF	$14.00	$606,218			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	294	Tons	$90.00	$26,453			
													Rock Drain Holes	L / 50 spacing * 50' long	500	ft	$25.00	$12,500			
	VI	**Reinforcement** – Install Grouted Dowels and Shotcrete Facing	500	75	60	43,301				-	43,301	-	Vegetation Removal	Slope Face Area / 9	4,811	SY	$3.00	$14,434	$1,692,617	$846,309	$2,538,926
													Rock Scaling	Slope Face Area * Thickness / 27	529	CY	$600.00	$317,543			
													Rock Dowels	[(H' / Anchor Spacing) x (L' / Anchor Spacing)] Dowel L	6,000	LF	$100.00	$600,000			
													Shotcrete	Slope Face Area / 9	4,811	SY	$150.00	$721,688			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	294	Tons	$90.00	$26,453			
													Rock Drain Holes	L / 50 spacing * 50' long	500	ft	$25.00	$12,500			
	VII	**Reinforcement** – Install Anchored Mesh, Spot Dowel / Rock Bolts	500	75	60	43,301				-	43,301	-	Vegetation Removal	Slope Face Area / 9	4,811	SY	$3.00	$14,434	$1,663,750	$831,875	$2,495,624
													Rock Scaling	Slope Face Area * Thickness / 27	529	CY	$600.00	$317,543			
													Rock Dowels	[(H' / Anchor Spacing) x (L' / Anchor Spacing)] Dowel L	6,000	LF	$100.00	$600,000			
													Anchored Mesh	Slope Face Area	43,301	SF	$16.00	$692,820			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	294	Tons	$90.00	$26,453			
													Rock Drain Holes	L / 50 spacing * 50' long	500	ft	$25.00	$12,500			
B	I	No Action	580	35	35	35,392	580	35	85	20,378	55,770	-	-	-	0	-	$0.00	$0	$0	$0	$0
	II	**Protection** – Reslope, Construct Catchment Dithc, and Fence at Crest of Lower Slope	580	35	35	35,392	580	35	85	20,378	55,770	170	Rock Excavation	Cut Area x L /27	3,645	CY	$90.00	$328,012	$1,366,071	$683,035	$2,049,106
													Embankment	8'H x2'V x 0.5' x L / 27	172	CY	$40.00	$6,874			
													Rockfall Barrier	Slope Length	580	LF	$1,700.00	$986,000			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	341	Tons	$90.00	$30,685			
													Rock Drain Holes	L / 50 spacing * 50' long	580	ft	$25.00	$14,500			
	III	**Protection** – Hybrid System - Barrier at Crest of Lower Slope and Draped Mesh on Lower Face	580	35	35	35,392	580	35	85	20,378	55,770	-	Vegetation Removal	Slope Face Area / 9	6,197	SY	$3.00	$18,590	$2,239,525	$1,119,762	$3,359,287
													Rock Scaling	Slope Face Area * Thickness / 27	682	CY	$600.00	$408,976			
													Rockfall Barrier	Slope Length	580	LF	$1,700.00	$986,000			
													Draped Mesh	Slope Face Area	55,770	SF	$14.00	$780,773			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	341	Tons	$90.00	$30,685			
													Rock Drain Holes	L / 50 spacing * 50' long	580	ft	$25.00	$14,500			
	IV	**Protection** – Improved Catchment with Hybrid System (Combination of Options II and III)	580	35	35	35,392	580	35	85	20,378	55,770	-	Vegetation Removal	Slope Face Area / 9	6,197	SY	$3.00	$18,590	$2,640,036	$1,320,018	$3,960,054
													Rock Excavation	Cut Area x L /27	3,645	CY	$90.00	$328,012			
													Rock Scaling	Slope Face Area	682	CY	$600.00	$408,976			
													Rock Dowels	Dowel Length x (L / Draped Mesh Anchor Spacing)	725	LF	$100.00	$72,500			
													Rockfall Barrier	Slope Length	580	LF	$1,700.00	$986,000			
													Draped Mesh	Slope Face Area	55,770	SF	$14.00	$780,773			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	341	Tons	$90.00	$30,685			
													Rock Drain Holes	L / 50 spacing * 50' long	580	ft	$25.00	$14,500			
C	I	No Action	3,450	50	50	225,183						-	-	-	0	-	$0.00	$0	$0	$0	$0
	II	**Protection** – Reslope, Construct Catchment Dithc, and Fence at Crest of Lower Slope	3,450	50	50	225,183						275	Rock Excavation	Cut Area x L /27	35,098	CY	$90.00	$3,158,850	$9,333,513	$4,666,757	$14,000,270
													Embankment	8'H x2'V x 0.5' x L / 27	1,022	CY	$40.00	$40,889			
													Rockfall Barrier	Slope Length	3,450	LF	$1,700.00	$5,865,000			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	2,028	Tons	$90.00	$182,524			
													Rock Drain Holes	L / 50 spacing * 50' long	3,450	ft	$25.00	$86,250			
	III	**Protection** – Hybrid System - Barrier at Crest of Lower Slope and Draped Mesh on Lower Face	3,450	50	50	225,183						-	Vegetation Removal	Slope Face Area / 9	25,020	SY	$3.00	$75,061	$11,012,734	$5,506,367	$16,519,101
													Rock Scaling	Slope Face Area * Thickness / 27	2,752	CY	$600.00	$1,651,340			
													Rockfall Barrier	Slope Length	3,450	LF	$1,700.00	$5,865,000			
													Draped Mesh	Slope Face Area	225,183	SF	$14.00	$3,152,559			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	2,028	Tons	$90.00	$182,524			
													Rock Drain Holes	L / 50 spacing * 50' long	3,450	ft	$25.00	$86,250			
	IV	**Protection** – Improved Catchment with Hybrid System (Combination of Options II and III)	3,450	50	50	225,183						-	Vegetation Removal	Slope Face Area / 9	25,020	SY	$3.00	$75,061	$14,602,834	$7,301,417	$21,904,251
													Rock Excavation	Cut Area x L /27	35,098	CY	$90.00	$3,158,850			
													Rock Scaling	Slope Face Area * Thickness / 27	2,752	CY	$600.00	$1,651,340			
													Rock Dowels	Dowel Length x (L / Draped Mesh Anchor Spacing)	4,313	LF	$100.00	$431,250			
													Rockfall Barrier	Slope Length	3,450	LF	$1,700.00	$5,865,000			
													Draped Mesh	Slope Face Area	225,183	SF	$14.00	$3,152,559			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	2,028	Tons	$90.00	$182,524			
													Rock Drain Holes	L / 50 spacing * 50' long	3,450	ft	$25.00	$86,250			

For:	Rt. 29 Rockfall	Job Number:	59447	Sheet No.	
By:	BTF	Check By:	NN & JS	Check by:	PDT
Date:	1/19/2015	Date:	1/20/2014	Date:	2/20/2015

HNTB

CONCEPT DEVELOPMENT QUANTITY AND COST ESTIMATE

			Lower Slope				Upper Slope														
Area	Option	Description	Slope Length (ft)	Slope Height (ft)	Slope Angle (degrees)	Slope Face Area (sf)	Slope Length (ft)	Slope Height (ft)	Slope Angle (degrees)	Slope Face Area (sf)	Total Slope Face Area (sf)	Cut Area (ft^2/ft) (See Attached)	Item	QUANTITY		UNIT	UNIT COST	ESTIMATE COST	ESTIMATE COST	LOWER BOUND	UPPER BOUND
D	I	No Action	3,000	200	65	662,027				-	662,027	-	-	-	0	-	$0.00	$0	$0	$0	$0
	II	**Warning** – Install Rockfall Warning Fence	3,000	200	65	662,027				-	662,027	-	Vegetation Removal	0.1 * Slope Face Area	66,203	SY	$3.00	$198,608	$2,744,581	$1,372,290	$4,116,871
													Rock Scaling	0.2 * Slope Face Area	1,618	CY	$600.00	$970,973			
													Warning Fence	Slope Length	3,000	LF	$500.00	$1,500,000			
													Rock Drain Holes	L / 50 spacing * 50' long	3,000	ft	$25.00	$75,000			
	III	**Monitoring** – Inclinometer, Tiltmeters, and/or Routinely Scheduled LiDar Survey	3,000	200	65	662,027				-	662,027	-	Vegetation Removal	0.1 * Slope Face Area	66,203	SY	$3.00	$198,608	$2,578,581	$1,289,290	$3,867,871
													Rock Scaling	0.2 * Slope Face Area	1,618	CY	$600.00	$970,973			
													Inclinometer	Inclinometers	4	EA	$20,000.00	$80,000			
													Tiltmeter	(No of Tiltmeters / Area) / Slope Face Area	4	EA	$1,000.00	$4,000			
													LiDar Survey	No of LiDar Surveys (Once per year for 25 years)	25	EA	$50,000.00	$1,250,000			
													Rock Drain Holes	L / 50 spacing * 50' long	3,000	ft	$25.00	$75,000			
	IV	**Removal** – Trim blasting and Rock removal Using Airbags and Scaling	3,000	200	65	662,027				-	662,027	97	Vegetation Removal	Slope Face Area x 0.1	66,203	SY	$3.00	$198,608	$6,260,781	$3,130,391	$9,391,172
													Rock Scaling	Slope Face Area	8,091	CY	$600.00	$4,854,863			
													Rock Excavation	Cut Area x L /27	10,818	CY	$90.00	$973,594			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	1,764	Tons	$90.00	$158,717			
													Rock Drain Holes	L / 50 spacing * 50' long	3,000	ft	$25.00	$75,000			
	V	**Reinforcement** – Install Tensioned Rock Bolts, Dental Concrete, and Anchored Mesh	3,000	200	65	662,027				-	662,027	-	Vegetation Removal	Slope Face Area x 0.1	66,203	SY	$3.00	$198,608	$9,025,284	$4,512,642	$13,537,925
													Rock Scaling	Slope Face Area	8,091	CY	$600.00	$4,854,863			
													Rock Dowels	Dowel Length x (L / Draped Mesh Anchor Spacing)	3,750	LF	$100.00	$375,000			
													Rock Bolt Testing	Slope Face Area / (No. of Rock Bolts / Area)	66	EA	$1,800.00	$119,165			
													Shotcrete	0.15 * Slope Face Area / 9	11,034	SY	$150.00	$1,655,067			
													Anchored Mesh	0.15* Slope Face Area	99,304	SF	$16.00	$1,588,864			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	1,764	Tons	$90.00	$158,717			
													Rock Drain Holes	L / 50 spacing * 50' long	3,000	ft	$25.00	$75,000			
	VI	**Protection** – Install Hybrid System Barrier at Crest of Lower Slope and Draped Mesh below, or Draped Mesh with Sacrificial Fences	3,000	200	65	662,027				-	662,027	-	Vegetation Removal	Slope Face Area x 0.1	66,203	SY	$3.00	$198,608	$10,086,194	$5,043,097	$15,129,291
													Rock Scaling	Slope Face Area	8,091	CY	$600.00	$4,854,863			
													Rockfall Barrier	Slope Length x 0.65	1,950	LF	$1,700.00	$3,315,000			
													Rock Dowels	Dowel Length x (0.25xL / Draped Mesh Anchor Spacing)	938	LF	$100.00	$93,750			
													Draped Mesh	Slope Face Area x 0.15	99,304	SF	$14.00	$1,390,256			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	1,764	Tons	$90.00	$158,717			
													Rock Drain Holes	L / 50 spacing * 50' long	3,000	ft	$25.00	$75,000			
	VII	**Protection** – Raise Roadway Elevation or shift Roadway West to Create Catchment	3,000	200	65	662,027				-	662,027	-	Vegetation Removal	Slope Face Area x 0.1	66,203	SY	$3.00	$198,608	$10,791,671	$5,395,835	$16,187,506
													Rock Scaling	Slope Face Area	8,091	CY	$600.00	$4,854,863			
													Embankment	Area of Roadway x Thickness of Roadway	100,000	CY	$40.00	$4,000,000			
													Asphalt	2.16 tn/cy x L x 44' x 1.75' / 27 cf/cy (Full Depth)	18,480	Tons	$90.00	$1,663,200			
													Rock Drain Holes	L / 50 spacing * 50' long	3,000	ft	$25.00	$75,000			
	VIII	**Protection** – Rock Shed over Road	3,000	200	65	662,027				-	662,027	-	Vegetation Removal	Slope Face Area	66,203	SY	$3.00	$198,608	$17,128,471	$8,564,235	$25,692,706
													Rock Scaling	Slope Face Area	8,091	CY	$600.00	$4,854,863			
													Rock Shed	No of Rocksheds	1	EA	$12,000,000.00	$12,000,000			
													Rock Drain Holes	L / 50 spacing * 50' long	3,000	ft	$25.00	$75,000			
	IX	**Combination** – Blasting to Create a Mid-Slope Bench, Reinforcement of Devil's Tea Table with Tensioned Rock Bolts and Shotcrete	3,000	200	65	662,027					662,027	500	Vegetation Removal	Slope Face Area x 0.1	66,203	SY	$3.00	$198,608	$12,356,142	$6,178,071	$18,534,213
													Rock Excavation	Cut Area x L /27	55,556	CY	$90.00	$5,000,000			
													Rock Dowels	Dowel Length x (0.33 L / Draped Mesh Anchor Spacing)	1,238	LF	$100.00	$123,750			
													Rockfall Barrier	Length of Slope	3,000	LF	$1,700.00	$5,100,000			
													Rock Bolt Testing	Assumed 25	25	EA	$1,800.00	$45,000			
													Asphalt	2.16 tn/cy x L x 44' x 0.167' / 27 cf/cy	1,764	Tons	$90.00	$158,717			
													Shotcrete	0.15 * Slope Face Area / 9	11,034	SY	$150.00	$1,655,067			
													Rock Drain Holes	L / 50 spacing * 50' long	3,000	ft	$25.00	$75,000			

References:

1) [ ] Indicates input values, all other cells are equations or descriptive

2) The following assumptions were made throughout the quantity estimates above:

0.33	(ft) = Scaling Thickness
12	(ft) = Anchor Spacing (Draped Mesh)
10	(ft) = Anchor Spacing (Shotcrete or Anchored Mesh)
10	(ft) = Anchor Spacing (Barrier Mesh)
15	(ft) = Dowel Length

3) Unit costs based obtain from a Rockfall Specialty Contractor 1/7/15 and NJDOT Bid Price Reports.

Assumed Unit Costs:

-	-	$0.00	
Vegetation Removal	SY	$3.00	
Embankment	CY	$40.00	
Rock Scaling	CY	$600.00	
Rock Excavation	CY	$90.00	(Pre-Split Drilling Incidental)
Rock Dowels	LF	$100.00	Tensioned rock bolts assumed to have the same unit cost
Anchored Mesh	SF	$16.00	
Draped Mesh	SF	$14.00	
Shotcrete	SY	$150.00	Assuming 4" Thick
Rockfall Barrier	LF	$1,700.00	Includes Rock Anchor Costs
Rock Bolt Testing	EA	$1,800.00	
Warning Fence	LF	$500.00	
Inclinometer	EA	$20,000.00	
Tiltmeter	EA	$1,000.00	
LiDar Survey	EA	$50,000.00	
Rock Shed	EA	$12,000,000.00	
Asphalt	Tons	$90.00	
Rock Drain Holes	ft	$25.00	Assume 50 ft Long Every 50'

APPENDIX IV

2003 Rockfall Hazard Ratings and Report

Area A

RHRS FIELD DATA SHEET

HIGHWAY: REGION:

HIGHWAY # Route 29	Beginning M.P. 27.40	L / R	Ending M.P. 27.50
COUNTY # Hunterdon	DATE 8-26-03	NEW	Rated By P. Ullikashi
CLASS A B	ADT 2400	UPDATE	Speed Limit 50 MPH

CATEGORY	REMARKS	CATEGORY SCORE	
Slope Height 75 ft		SLOPE HEIGHT	27
Ditch Effectiveness G M L N		DITCH EFFECT	95
Average Vehicle Risk 20 %		AVR	25
Sight Distance 525 ft		SIGHT DISTANCE	6
Percent Decision Site Distance 70 %			
Roadway Width 40 ft		ROADWAY WIDTH	5
GEOLOGIC CHARACTER		GEOLOGIC CHARACTER	
CASE 1		CASE 1	
Structural Condition D C/F R A		STRUCT COND	95
Rock Friction R I U P C - S		ROCK FRICTION	45
CASE 2		CASE 2	
Differential Erosion Features F O N M		DIF ER FEATURES	30
Difference in Erosion Rates S M L E		DIF ER RATES	10
Block Size/Volume 3/9 ft/yd³		BLOCK SIZE	40
Climate Precipitation L M H Freezing Period N S L Water on Slope N I C		CLIMATE	22
Rockfall History F O M C		ROCKFALL HISTORY	50
		TOTAL SCORE	310

COMMENTS: Gray siltstone interbedded w/ dark gray diabase. Rock mass Lightly fractured, forming many blocks. Slope face in general dry. Few Talus scree indicating frost wedging action. Few small rock pieces on roadway indicating recent rock falls. Few blocks leaning against trees.

Area B

RHRS FIELD DATA SHEET

HIGHWAY: REGION:

HIGHWAY # Route 29	Beginning M.P. 27.50	L / R	Ending M.P. 27.65
COUNTY # Hunterdon	DATE 8-21-03	NEW	Rated By P. Ullikaski
CLASS A B	ADT 2400	UPDATE	Speed Limit 50 MPH

CATEGORY	REMARKS	CATEGORY SCORE	
Slope Height 50 ft		SLOPE HEIGHT	9
Ditch Effectiveness G M L N		DITCH EFFECT	60
Average Vehicle Risk 30 %		AVR	4
Sight Distance 600 ft Percent Decision Site Distance 83 %		SIGHT DISTANCE	8
Roadway Width 40 ft		ROADWAY WIDTH	5
GEOLOGIC CHARACTER		GEOLOGIC CHARACTER	
CASE 1		CASE 1	
Structural Condition D C/F R A		STRUCT COND	85
Rock Friction R I U P C - S		ROCK FRICTION	30
CASE 2		CASE 2	
Differential Erosion Features F O N M		DIF ER FEATURES	85
Difference in Erosion Rates S M L E		DIF ER RATES	15
Block Size/Volume 3 / 9 ft/yd^3		BLOCK SIZE	40
Climate Precipitation L M H Freezing Period N S L Water on Slope N I C		CLIMATE	22
Rockfall History F O M C		ROCKFALL HISTORY	68
		TOTAL SCORE	316

COMMENTS: Dark gray siltstone w/ massive parallel bedding. Random continuous fractures. Evidence of recent rock falls w/ blocks > 1 yd^3 in size. Damaged vegetation @ places. Many loose blocks on cut slope face sitting metastably. Talus scree indicating frost wedging action. Few blocks leaning against trees. Deer Track found @ one spot in southern end of slope.

Area C

RHRS FIELD DATA SHEET

HIGHWAY: REGION:

HIGHWAY # Route 29	Beginning M.P. 27.78	L / R	Ending M.P. 28.48
COUNTY # Hunterdon	DATE 8-21-03	NEW	Rated By P. Ulikasch
CLASS A B	ADT 2400	UPDATE	Speed Limit 50 MPH

CATEGORY	REMARKS	CATEGORY SCORE	
Slope Height >100 ft		SLOPE HEIGHT	100
Ditch Effectiveness G M L N		DITCH EFFECT	90
Average Vehicle Risk 140 %		AVR	100
Sight Distance 1500 ft Percent Decision Site Distance 80 %		SIGHT DISTANCE	8
Roadway Width 40 ft		ROADWAY WIDTH	5
GEOLOGIC CHARACTER		GEOLOGIC CHARACTER	
CASE 1		CASE 1	
Structural Condition D C/F R A		STRUCT COND	100
Rock Friction R I U P C - S		ROCK FRICTION	40
CASE 2		CASE 2	
Differential Erosion Features F O M N		DIF ER FEATURES	90
Difference in Erosion Rates S M L E		DIF ER RATES	45
Block Size/Volume 5 / 12 ft/yd^3		BLOCK SIZE	100
Climate Precipitation L M H Freezing Period N S L Water on Slope N I C		CLIMATE	22
Rockfall History F O M C		ROCKFALL HISTORY	68
		TOTAL SCORE	628

COMMENTS: Rock varies from fine grained dirty-brown sandstone to dark-gray siltstone - slate. Massively bedded to thinly laminated, moderate to severe erosional features; many overhangs w/ many free falls @ the base of slope. Slope face has many talus screes indicating frost wedging action.

Area D

RHRS FIELD DATA SHEET

HIGHWAY: REGION:

HIGHWAY # Route 29	Beginning M.P. 29.85	L / R	Ending M.P. 30.45
COUNTY # Hunterdon	DATE 8-20-03	NEW	Rated By Pradeep Ullikashi
CLASS A B	ADT 2400	UPDATE	Speed Limit 50 MPH

CATEGORY	REMARKS	CATEGORY SCORE	
Slope Height > 100 ft		SLOPE HEIGHT	100
Ditch Effectiveness G M L N		DITCH EFFECT	50
Average Vehicle Risk 120 %		AVR	100
Sight Distance 500 ft Percent Decision Site Distance 67 %		SIGHT DISTANCE	13
Roadway Width 36 ft		ROADWAY WIDTH	09
GEOLOGIC CHARACTER		GEOLOGIC CHARACTER	
CASE 1		CASE 1	
Structural Condition D C/F R A		STRUCT COND	47
Rock Friction R I U P C - S		ROCK FRICTION	37
CASE 2		CASE 2	
Differential Erosion Features F O N M		DIF ER FEATURES	80
Difference in Erosion Rates S M L E		DIF ER RATES	34
Block Size/Volume 3/9 ft/yd^3		BLOCK SIZE	28
Climate Precipitation L M H Freezing Period N S L Water on Slope N I C		CLIMATE	22
Rockfall History F O M C		ROCKFALL HISTORY	34
		TOTAL SCORE	470

COMMENTS: Presence of recent rockfalls w/ blocks < 1 yd^3 in size. At least 2 trees found to have damage scars; Impact indentation marks on the road @ one spot; Slope has few talus screes indicating frost wedging action. Some spots of slope have undergone extensive weathering; At least 2 rock columns on back slope seen; Seepage on slope face.

Cut slope has 5-6 launching pads.

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June 18, 2004

Project No.: 033-6228
ELECTRONIC MAIL AND FEDEX

The RBA Group
One Evergreen Place
Morristown, New Jersey 07962

DRAFT

Attn: Mr. Andrew M. Muldowney, P.E.

Re: REMEDIAL DESIGN ALTERNATIVES REPORT
NEW JERSEY DEPARTMENT OF TRANSPORTATION
ROUTE 29 ROCKFALL MITIGATION EVALUATION PROJECT
LAMBERTVILLE TO FRENCHTOWN, NEW JERSEY

Ladies and Gentlemen:

Golder Associates Inc. (Golder) is pleased to submit this **Remedial Design Alternatives Report** to The RBA Group (RBA) for the New Jersey Department of Transportation (NJDOT) Route 29 Rockfall Mitigation Evaluation Project. Approval to undertaken and complete this rockfall hazard evaluation project and prepare this report was authorized by RBA under two (2) separate Subconsultant Agreements, dated June 30, 2003 and February 11, 2004.

SCOPE OF SERVICES

Golder was retained to undertake and complete a rockfall hazard review and evaluation to document current conditions, incorporate new data not included within previous studies, develop updated rockfall hazard ratings and develop preliminary, conceptual-level rockfall hazard remedial alternatives for each evaluated slope within the assessment corridor.

For the referenced project, the assessment corridor is defined by Route 29 Mile Posts (MP) 16 thru 34.5, or from the Southside of Lambertville, Mercer County, New Jersey to Frenchtown, Hunterdon County, New Jersey. See Figure 1. See Appendix "A" for drawings including aerial photographs and environmental constraints along the assessment corridor.

In summary, Golder's scope-of-work for the referenced project involved providing the following professional geotechnical engineering services:

1) Review previously completed rockfall hazard ratings of slopes within the assessment corridor;
2) Investigate and review available, historical rockfall data;
3) Inspect and photograph each evaluated slope to document current conditions;
4) Establish updated rockfall hazard ratings for each evaluated slope;

5) Develop preliminary, conceptual-level rockfall hazard remedial alternatives;
6) Provide rockfall hazard mitigation recommendations; and
7) Prepare a rockfall hazard Remedial Design Alternatives Report.

Summaries of completed field investigations and the findings/conclusions related to Items 1 thru 4 above were presented previously within two (2) separate technical memoranda dated November 5, 2003 and April 2, 2004 (see Appendices "B" and "C"). Hence, this report only provides the findings and conclusions related to Items 5 thru 7 above.

PROJECT DESCRIPTION

The Route 29 Rockfall Hazard Mitigation Project involves the identification of existing rockfall hazard risks and establishment of remedial design alternatives to mitigate said risks for rock cut slopes within the assessment corridor (along Route 29 from MP 16 to 34.5). See Figure 1. See Appendix "A".

In general, Route 29 runs parallel to the Delaware River from Trenton, Mercer County, New Jersey to Frenchtown, Hunterdon County, New Jersey. During construction of Route 29, numerous rock cuts were excavated into bedrock to make room for the roadway, and over time these slopes have shed rock debris due to a combination of ice/root jacking and/or geologic erosion mechanics.

The bedrock geology within the assessment corridor is characteristic of the Piedmont physiographic province, which include shales interbedded with sandstone, siltstone and argillites of the Brunswick formation; argillites interbedded with shale of the Lockatong formation; and sandstones interbedded with shale of the Stockton formation. Within the Piedmont province, steep slopes form bluffs along the Delaware River and follow along its tributary streams.

OVERVIEW OF ROCKFALL HAZARD RATINGS

During 1988 and 1989, NJDOT completed a system-wide review of all rock cut slopes along both State and Interstate Highway Systems in New Jersey, and this statewide review program can be summarized as follows:

- Phase I involved reviewing over 450 rock cut slopes, making cursory visual observations of each slope, assigning preliminary ratings and noting appropriate rockfall mitigation measures;

- Phase I identified over 110 rock cut slopes rated in the "High-High" (e.g., high probability of rockfall and high probability of rockfall reaching the travel lanes) category, and one (1) slope was identified as requiring immediate attention; and

- Phase II involved completing detailed hazard ratings on the identified "High-High" rock cut slopes.

In 1994, NJDOT updated its previously established 1988/1989 preliminary and detailed rockfall hazard ratings for the rock cut slopes identified along the referenced project's assessment corridor. See Table 1 for a summary of NJDOT's updated rockfall hazard slope ratings

Table 1 – 1994 Rockfall Hazard Slope Ratings

Start MP	End MP	Roadway Direction	1994 Slope Ratings
16.00		North	HH
17.30	17.80	North	Varies (LL to HH)
17.90		North	HH
18.05		North	HH
18.20		North	LL
18.60		North	HH
21.90		North	LH
23.10		North	HM
23.10		South	MM
23.20		North	HH
23.30		North	HH
26.00		North	HH
27.20		North	HH
27.30		North	HH
27.50		North	HH
27.78	28.38	North	HH
28.50		North	HH
29.10		North	MH
29.63	29.83	North	HH
29.85	30.45	North	HH

Notes:
1) "H" = High; "M" = Medium; "L" = Low
2) "XY" = "X" Potential for a Rockfall
"Y" Potential for a Fall to Reach Roadway

During August 2003 and March 2004, Golder re-inspected and re-evaluated all twenty (20) of the rock cut-slopes identified in Table 1 to collect new, additional, current slope data and to establish updated rockfall hazard ratings. In addition, Golder inspected and documented back-slope conditions above each evaluated rock cut-slope.

See Appendices "B" and "C" for technical memoranda dated November 5, 2003 and April 2, 2004, respectively, for additional information related to Golder's field investigation findings/conclusions and updated rockfall hazard slope ratings.

See Table 2 for a summary of Golder's updated rockfall hazard slope ratings for each of the evaluated rock cut slopes within the referenced project's assessment corridor.

Table 2 – 2004 Rockfall Hazard Slope Ratings

<table>
<tr><th>Start MP</th><th>End MP</th><th>Roadway Direction</th><th>Length (feet)</th><th>Height (feet)</th><th>Back Slope Angle</th><th>2004 Slope Ratings</th></tr>
<tr><td>16.00</td><td>16.01</td><td>North</td><td>75</td><td>25</td><td>60 degrees</td><td>B</td></tr>
<tr><td>17.30</td><td>17.90</td><td rowspan="3">North</td><td rowspan="3">4025</td><td rowspan="3">5 to 25</td><td rowspan="3">Varies</td><td rowspan="3">A</td></tr>
<tr><td>17.90</td><td>18.05</td></tr>
<tr><td>18.05</td><td>18.06</td></tr>
<tr><td>18.10</td><td>18.20</td><td>North</td><td>530</td><td>15</td><td>n/a</td><td>B</td></tr>
</table>

Start MP	End MP	Roadway Direction	Length (feet)	Height (feet)	Back Slope Angle	2004 Slope Ratings
18.60	18.63	North	160	15	n/a	B
21.90	21.97	North	350	40	n/a	B
23.10	23.12	North	80	25	n/a	C
23.10	23.16	South	300	40	n/a	C
23.20	23.23	North	160	30	n/a	C
23.30	23.36	North	330	5 to 25	n/a	C
26.00	26.10	North	530	60	40 degrees	B
27.20	27.30	North	740	20	n/a	B
27.30	27.34					
27.40	27.50	North	530	75	n/a	A
27.50	27.65	North	800	50	45 degrees	A
27.78	28.48	North	3700	>100	35 degrees	A
29.20	29.30	North	530	40	n/a	B
29.63	29.83	North	1060	30	n/a	B
29.85	30.45	North	3200	>100	40 degrees	A

Notes:
1) All lengths, heights and angles presented are approximate, based on field measurements and/or estimations.
2) See Table 3 for detailed rockfall hazard slope rating descriptions.

Table 3 – Slope Rating Descriptions

Slope Rating	Description
A	*High Risk*: High potential for rockfall to reach roadway. Remedial actions are required, and should be developed and implemented following an expedited schedule.
B	*Moderate Risk*: Medium potential for rockfall to reach roadway. Remedial actions might be required, but implementation could possibly be extended over time to accommodate budgetary constraints.
C	*Low Risk*: Low potential for rockfall to reach roadway. Remedial actions may not be required, but inspection and monitoring of these slopes should continue.

For rock cut-slopes between MPs 17.30 and 18.06, it should be noted that rockfall hazard slope ratings could not be established because these slopes consist of a combination of soil slopes with rock fragments on the surface, cut slopes in talus rock masses, and/or historic rock block retaining structures, which have experienced varied degrees of distress.

However, Golder recommends that the slopes between MPs 17.30 and 18.06 be classified as "High Risk", based on qualitative assessments of observed conditions, Golder's experience with similar slope conditions and the fact that this section of the roadway has little to no shoulder lane.

POTENTIAL REMEDIAL DESIGN ALTERNATIVES

Over the course of the project, potential remedial actions for problem slopes were identified, and different methods were identified to mitigate degrees of risk associated with potential rockfall events. In general, these mitigation techniques can be divided into the following three (3) remedial design categories, which are as follows:

1. Rock Removal;
2. Rock Stabilization; and
3. Rockfall Control.

The following sections of this report provide brief descriptions for each of the above categories of rockfall hazard remedial design alternatives.

Rock Removal

Removal of loose or unstable blocks of rock or rock masses would require hand and/or machine scaling to remove loose rocks from crests and slope faces, trim blasting to remove larger rock masses that cannot be easily or safely hand/machine scaled, and/or reduction of slope angles to create rockfall catchment areas adjacent to the roadway.

Where rock removal is performed above active roadways, traffic controls and/or temporary rockfall control measures, where traffic controls cannot be implemented, would be required, as necessary, to protect the active roadway.

Brief descriptions of these rock-removal remedial design alternatives are as follows:

- **Hand Scaling:** The process of scaling by physically removing loose rocks from rock slope crests and/or faces by means of hand tools. Hand scaling is often done following blasting and over the life of a rock slope to mitigate risks associated with future rockfall events. The process of hand scaling usually entails trained personnel rappelling down or using crane/hoist baskets over slope faces to dislodge loose rocks from the face using steel pry bars and/or airbag jacks. Visual impacts and aesthetic effects of scaling tend to be limited. Scaling activities can be timed to reduce impacts on wildlife.

- **Machine Scaling:** The process of machine scaling, like hand scaling, involves removing loose rocks from rock slope crests and/or faces by means of heavy machinery, which could consist of large backhoes, cranes, backhoe mounted hoe-rams (percussion rams), and/or jack-hammers. However, the ability to use heavy machinery is often limited by equipment reach, access and the size of rock material to be removed. Visual impacts following scaling are as noted above for hand scaling. The use of trim blasting is often considered preferable to machine scaling, because the duration of noise and construction is reduced. As with hand scaling, scaling activities can be timed to reduce impacts on wildlife.

- **Trim Blasting:** Trim blasting is used to scale rock blocks or volumes of loose rock that are either too large for hand/machine scaling or are inaccessible to machinery. Trim blasting is also implemented to reduce construction durations. The process of trim blasting involves drilling parallel, drill holes, or pre-split-type holes and placement of small explosive charges behind loose rock blocks or rock masses to effect their scaling from rock slope crests and/or faces. Visual impacts following trim blasting are generally as noted for hand/machine scaling. Construction impacts include drilling noise, dust and blasting. Impacts to wildlife can be minimized by timing the construction. Typically, trim blasting is also followed by hand scaling activities.

- **Slope Angle Reduction:** Where bedding, joint or fracture orientations create potentially unstable rock blocks that are too large to remove using hand/machine scaling and/or trim blast, reducing the slope angle can be the preferred remedial design alternative, if it can be performed within right-of-way restrictions. The process of slope angle reduction involves laying the slope back to a more stable configuration or by creating new rockfall catchment areas. This alternative would entail rock excavation by blasting and reconstruction of ditches at the toes of slope. Visual impacts would include new slope geometries, which could potentially be noticeable by people familiar with the slope. Construction impacts would include equipment noise including rock drills, heavy equipment and blasting, and dust. Impacts to wildlife can be minimized by timing the construction.

Rock Stabilization

Rock stabilization involves securing potentially unstable rock blocks/masses by mechanical means such as rock bolting, buttressing, lashing and/or shotcreting. Rock blocks that are bounded by joint or bedding planes that are relatively tight can be bolted or pinned in place.

The installation of rock bolts and/or pins involves drilling multiple holes through the rock block and into the intact rock mass behind the block. Steel bolts consisting of reinforcing bars are inserted and grouted within the drilled holes. The bolts keep the joint surfaces in tight contact such that maximum friction along the joint surface is maintained and sliding is resisted. In general, rock bolting is not very effective on blocks that have already been displaced and have dilated joints.

Rock lashing involves installing bolts as rock anchors and stringing cables from the installed rock bolts across the blocks to lash them together. Rock lashing is effective for rocks that have dilated joints, which may have undergone some displacement.

Rock lashing, because it is generally conducted on isolated rock blocks rather than large areas of slopes, generally has limited visual impacts. The installation of bolts and lashing is accomplished with percussion drilling techniques. Impacts to wildlife can be minimized by timing the construction.

Buttressing involves constructing concrete props or buttresses to support potentially unstable blocks of rock and/or overhangs. This method of stabilization is not commonly used but it can provide a suitable solution in particular conditions.

Rockfall Control

Rockfall control involves the construction of barriers to catch, stop and/or direct/redirect the trajectory of falling rock blocks/masses. Catching falling rocks can be achieved by constructing rockfall catchment ditches or constructing barriers that would absorb the rocks' impact energy.

In general, catchment ditches at the toes of existing rock slopes within the assessment corridor are very small and in many cases non-existent. The efficiency of catch ditches can be improved by modifying the geometry of the ditch to increase the ditch width and depth, or constructing lips on the outside edge of the ditch such that rocks cannot climb or bounce over while falling.

Impact barriers, including walls or high impact fences, can be constructed along roadway shoulders. These impact barriers can also consist of concrete or timber walls, gabion walls, or cable net fences. Specific design details for such impact barriers depend on the heights needed and the impact energies likely to strike said barriers.

Impact barriers should be separated from the traveled lanes by guardrails or "Jersey" barrier. Post-construction impacts can be aesthetically acceptable. Construction impacts are generally confined to the area close to the roadways so impacts to wildlife should be minimal during construction.

Rockfall drape nets can be use to limit rockfall energies by controlling the rates of rockfall debris falling down slope and conveying said rockfall to designated catchment areas. Hence, rockfall drape nets allows the rock mass to ravel down slope and controls the outward bouncing motion of the rockfall debris, so that it is contained close to the toe of slope.

Steel wire mesh drape nets are generally used to control blocks smaller than 2 feet in nominal dimension. Post construction impacts are visual and can be mitigated, to some extent, by selecting materials (galvanized or coated) that blend with the surrounding rock mass colors. Construction impacts can be limited by scheduling.

In general, rockfall drape nets are constructed as free-hanging meshes supported along rock slope crests, and lengths of coverage depends on slope geometries and location and size of catchment ditches. In addition, drape nets can be supported above rock slope crest surfaces to allow rock blocks tumbling down slope, along back slopes, to be controlled by said drape nets.

RECOMMENDATIONS

As presented in Table 2, a total of seventeen (17) rock cut-slopes within the referenced project's assessment corridor were inspected and evaluated to establish updated rockfall hazard slope ratings, and a summary of these rated rock cut-slopes is as follows:

- Five (5) slopes were rated to be "high-risk", which require expedited remedial actions to mitigate risks associated with rockfall;

- Eight (8) slopes were rated to be "medium risk", which might require remedial actions to mitigate risks associated with rockfall. However, needs for such remedial actions should be further evaluated based on continued, routine slope inspections. Hence, implementation of remedial actions for these slopes could possibly be extended over time; and

- Four (4) slopes were rated to be "low-risk", which do not require remedial action at this time, but should be routinely re-inspected and re-evaluated to identify potential future rockfall hazard risks, if any.

Therefore, recommended rockfall hazard remedial design alternatives for the referenced project can be described by the following three (3) categories: a) Engineered Controls; b) Monitoring and Inspection; and c) Project Pipeline Assignments. The following sections of this report present Golder's recommendations for each of these categories.

Engineered Controls

As previously mentioned, five (5) slopes were rated to be "high risk", and require expedited remedial action to mitigate risks associated with rockfall. Hence, recommendations for each of these five (5) evaluated slopes are as follows:

- **MP-17.30 to MP-18.06:** Slopes within this area are composed of a combination of soil slopes with rock fragments on the surface, cut slopes in talus rock masses and/or historic rock block retaining structures, which have experienced varied degrees of distress.

  The recommended remedial design alternative for this area will ultimately be dependent on whether NJDOT plans to realign and/or widen the roadway in this section of the assessment corridor to establish a full shoulder lane at the toe of the slope.

  If NJDOT elects to demolish the existing historic rock block wall and cut further into the existing soil and talus rock slopes, the preferred remedial design alternative might involve excavating the entire talus rock mass and stabilizing the exposed rock face. However, the spatial extent and volume of this talus rock mass is not currently known.

  Given uncertainty regarding the talus rock mass and NJDOT's future plans to realign/widen the roadway, Golder recommends, at this time, that this section of the assessment corridor be remedied by stabilizing the slope using either gravity (i.e., gabion or bin walls) or drilled soldier pile and pre-cast concrete lagging retaining wall systems.

  In addition, Golder recommends that tops of these retaining walls be raised 5 feet (min.) above the toe of the adjacent back-slope to provide for a rockfall catchment area and prevent rockfall from the back-slope from traveling down slope and into the roadway corridor.

- **MP-27.40 to MP-27.50:** Slopes within this area are composed of grey siltstone and dark grey basalt intersected by numerous fractures dividing the rock mass into discrete rock blocks.

  Golder recommends that this section of the assessment corridor be remedied by the following: a) clearing vegetation from the entire rock cut-slope face utilizing cutting techniques; b) hand scaling the entire rock cut-slope face; and c) installing rockfall drape nets over the entire rock cut-slope face.

- **MP-27.50 to MP-27.65:** Slopes within this area are composed of massively bedded dark grey fine-grained sedimentary rocks (i.e., mudstone or siltstone), which are intersected by both bedding and sub-vertical fracture planes.

  Golder recommends that this section of the assessment corridor be remedied by the following: a) clearing vegetation from the entire rock cut-slope face utilizing cutting techniques; b) hand scaling the entire rock cut-slope face; c) installing rockfall drape nets over the entire rock cut-slope face; d) removing large, unstable rock blocks/masses from back-slope areas; and e) installing rockfall energy impact fences along cut-slope crests to prevent rockfall from tumbling down the back-slope and falling into the roadway.

- **MP-27.78 to MP-28.48:** Slopes within this area are composed of massively bedded to thinly laminated grey to red shale and siltstone rocks, which are intersected by both bedding and sub-vertical fracture planes and exhibit moderate to severe weathering.

  Golder recommends that this section of the assessment corridor be remedied by the following: a) clearing vegetation from the entire rock cut-slope face utilizing cutting techniques; b) hand scaling the entire rock cut-slope face; c) installing rockfall drape nets over the entire rock cut-slope face; d) removing large, unstable rock blocks/masses from back-slope areas; and e) installing rockfall energy impact fences along cut-slope crests to prevent rockfall from tumbling down the back-slope and falling into the roadway.

- **MP-29.85 to MP-30.45:** Slopes within this area are composed of massively bedded light to reddish-brown fine-grained sedimentary rocks (i.e., mudstone or siltstone), which are intersected by both bedding and sub-vertical fracture planes.

  Golder recommends that this section of the assessment corridor be remedied by the following: a) clearing vegetation from the entire rock cut-slope face utilizing cutting techniques; b) hand scaling the entire rock cut-slope face; c) installing rockfall drape nets over the entire rock cut-slope face; d) removing large, unstable rock blocks/masses from back-slope areas; and e) installing rockfall energy impact fences along cut-slope crests to prevent rockfall from tumbling down the back-slope and falling into the roadway.

In addition, Golder recommends that NJDOT implement the above rockfall hazard remedial design alternatives utilizing a phased approach consisting of the following two (2) stages;

Stage I:
1. Clear vegetation from entire cut-slope;
2. Hand scale entire cut-slope; and
3. Remove large, unstable rock blocks/masses from back-slope areas.

Stage II:
1. After scaling, re-inspect, map and re-evaluate rock cut-slope to determine whether or not additional engineered controls (i.e., rock bolts/dowels, drape nets and impact fences) are required;
2. If additional engineering controls are required, define locations for all recommended engineered controls; and
3. Install the recommended engineered solutions in accordance with the technical specifications provided in the Contract Documents.

It is Golder's opinion that the above phased approach should provide NJDOT with adequate controls on project costs by providing engineered controls in areas that warrant such remedial measures. Hence, Golder recommends that NJDOT consider "unit price" contracting options for installing specified engineered controls.

Monitoring and Inspection

Regardless of whether engineered controls are implemented, Golder recommends that each of the evaluated slopes within the assessment corridor be re-inspected and re-evaluated on a routine, continual basis to document changes in slope conditions and identify potential future rockfall hazard risks, if any.

However, periods between re-inspections would likely not be uniform, and depend on previously established rockfall hazard slope ratings. See Table 4 for Golder's recommended monitoring and inspection periods for each rockfall hazard slope rating classification:

Table 4 – Recommended Monitoring and Inspection Periods

Slope Rating	Description	Monitoring and Inspection Period
A	*High Risk*	Annually (min.), or more frequent
B	*Moderate Risk*	Once every year, or as established by NJDOT
C	*Low Risk*	Once every two (2) years, or as established by NJDOT

Ultimately, NJDOT would be responsible for scheduling future rock slope inspections and evaluations, and Golder understands NJDOT would either utilize "in-house" personnel or elect to use external engineering design consultants to undertake and complete this work on a continual basis.

Project Pipeline Assignments

NJDOT has established a project delivery process allowing for all projects to be advanced from feasibility study through design and into construction, and this process is comprised of four (4) project pipelines, which can be summarized as follows:

Project Pipeline	Description
1	Complex projects requiring feasibility assessments; preliminary and final design submissions; and preparation of contract documents and engineer cost estimates.
2	Moderate projects requiring some involvement with Right-of-Way, utilities and/or environmental permits.
3	Moderate to simple projects having clearly defined Scopes-of-Work and minimal involvement with Right-of-Way, utility and/or environmental permits.
4	Simple projects requiring no involvement with Right-of-Way and minimal or no involvement with utility and/or environmental permit. In addition, these projects would be managed by NJDOT Operations.

With exception of the slopes between mileposts MP-17.3 to MP-18.06, it is Golder's opinion that the recommended rockfall hazard remedial design alternatives represent moderate to simple degrees of difficulty. However, it should be noted that, at this time, the degree of involvement with respect to Right-of-Way, utility and environmental permits are not clearly defined.

Therefore, based on the above descriptions, Golder recommends the following project pipelines for each of the designated "high risk" rock slopes and for each work phase:

Mileposts		Work Phase	Work Description	Project Pipeline
Start	End			
17.30	18.06	n/a	n/a	1
27.40	27.50	I	Clear Vegetation/Rock Scaling	4
		II	Engineered Controls	3
27.50	27.65	I	Clear Vegetation/Rock Scaling	4
		II	Engineered Controls	3
27.78	28.48	I	Clear Vegetation/Rock Scaling	4
		II	Engineered Controls	3
29.85	30.45	I	Clear Vegetation/Rock Scaling	4
		II	Engineered Controls	3

PRELIMINARY CONSTRUCTION COSTS

For planning purposes, NJDOT requested that Golder develop conceptual-level, preliminary construction cost estimates for its recommended rockfall hazard remedial design alternatives. Hence, preliminary opinions of potential construction costs were prepared for only those rock cut-slopes designated as “high risk”. See Table 2.

See Table 5 for the referenced project's preliminary construction costs to implement the recommended remedial design alternatives for each of the five (5) designated “high risk” rock cut-slopes. Furthermore, these construction costs have been broken down to show cost components associated with each of the “high risk” rock cut-slopes.

Given the nature and high degree of uncertainty associated with the referenced project, Golder recommends these conceptual-level, preliminary construction cost estimates utilize contingency factors of 40%. Overall, the total estimated construction cost to implement the recommended remedial design alternatives is about $19,452,000 (see Table 5).

However, it should be noted that the costs presented in Table 5 do not include requisite design, inspection, construction management/oversight and/or long-term maintenance costs. In addition, these costs assume that the recommended remedial design alternatives would be aesthetically acceptable to NJDOT and the local community.

Long-term maintenance will be required to maintain the recommended remedial design alternatives, and maintenance activities could include, but would not be limited to, the following: a) removal of rock debris at bases of rock cut-slopes; b) repair/replacement of damages drape nets and/or impact barriers; c) removal of rock debris collected in the installed rockfall impact barriers; and d) clearing of vegetation cover re-growth.

REFERENCES

1. NJDOT, Geotechnical Engineering Unit, Original 1988 Rockfall Mitigation Program, Phase 1, Preliminary Ratings and Methodology.

2. NJDOT, Geotechnical Engineering Unit, Original 1989 Rockfall Mitigation Program, Phase 2, Detailed Ratings and Methodology.

3. NJDOT, Geotechnical Engineering Unit, Comments/Modifications to Reference #6.

4. NJDOT, Updated/Current Preliminary Ratings and Legend, prepared using a modified version of the methodology described in Reference #6.

5. NJDOT, Updated Detailed Ratings, prepared using a modified version of Reference #6.

6. Federal Highway Administration (FHWA), Publication No. FHWA-OR-EG-90-01, entitled “Rockfall Hazard Rating System – Implementation Manual”, 1990.

7. FHWA, Publication No. FHWA-SA-93-057, entitled “Rockfall Hazard Rating System – Participant's Manual”, 1993.

8. FHWA, Publication No. FHWA SA-93-085, entitled "Rockfall Hazard Mitigation Methods – Participant Workbook", 1994.

9. Hoek E. and Bray, J. W., Rock Slope Engineering, Institution of Mining and Metallurgy, London, 1981.

LIMITATIONS

This report was prepared for the exclusive use of RBA and NJDOT for specific applications on the referenced project, in accordance with generally accepted geotechnical engineering practices.

Recommendations contained herein only represent preliminary, conceptual-level rockfall hazard remedial design alternatives, and should not be misconstrued to represent final design recommendations.

Golder assumes that the referenced project's final design would be undertaken and completed by others, and final designs should include, but not be limited to, the following: establish limits of work; define scope and extent of engineered solutions; prepare appropriate contract documents; and establish final engineers' cost estimates.

Recommendations contained herein were based on Golder's current understanding of the referenced project, which is that NJDOT does not intend or plan to realign and/or widen Route 29 through the assessment corridor.

Any realignment or widening of Route 29 through the assessment corridor would directly impact the rockfall hazard slope ratings and remedial design alternatives presented herein. Hence, the recommendations presented herein should be reassessed, if NJDOT elects to consider any realignment and/or widening options.

Recommendations included herein assume that the overall rockfall hazard mitigation program will be visual and aesthetically accepted by NJDOT and the local community. If alternate remedies are required to satisfy more stringent visual and/or aesthetic design criteria, the recommendations and preliminary construction costs presented should be revised accordingly.

Recommendations included herein are contingent upon one another, and no recommendation should be followed independent of others. In addition, Golder's recommendations should be incorporated in the future construction drawings and technical specifications prepared by others.

This report provides no warranties expressed or implied. In addition, Golder cannot be held responsible for claims, damages or liability arising from interpretations or reuse of subsurface information collected and provided by others.

If changes to the nature and/or design of the referenced project are planned, the conclusions and recommendations contained herein should not be construed to be valid, unless said changes are reviewed and associated conclusions modified or verified by Golder in writing.

Furthermore, if design of the recommended remedial measures at "high risk" sections are deferred for more than one (1) year, said associated slopes should be re-inspected, re-evaluated at the frequency recommended in Table 4 herein to determine whether or not slope conditions have changed and require different remedial design approaches.

CLOSURE

Golder is pleased to have had the opportunity to prepare this **Remedial Design Alternatives Report** for RBA, and looks forward to continued participation on the referenced project. If you have any questions, please feel free to contact either of the undersigned at (973) 621-0777.

Very truly yours,

GOLDER ASSOCIATES INC.

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Attachments
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