LOWELL - LOCAL PROTECTION

ESTIMATE 11/7/40

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject LOWELL - LOCAL PROTECTION - INTERCEPTOR COST

Computation COST TO CITY OF LOWELL

Computed by [illegible] Checked by Date 11-8-40

COST AS COMPUTED FROM FIGURES PROPOSED BY H. CONWAY & F. SAUNDERS - CITY ENGINEERS OFFICE - LOWELL MASS (11-8-40)

ALL MANUAL LABOR

LAKEVIEW AREA

FRONT ST-COBURN (600' @ 24" - 14' cut)	600 x $25	=	15,000
COBURN ST-WEST (1100' @ 48" - 14' cut)	1100 x $50	=	55,000
MANHOLES 4 @ 100		=	400
CATCH BASIN 8 @ 75		=	600
			$71,000

ROSEMONT AREA

NEW YORK-OTTAWA (220 @ 15" - 13' cut)	220 x $12	=	2,640
OTTAWA-CAMPAW (220 @ 18" - 13' cut)	220 x 15	=	3,300
CAMPAW-BEAVER (200 @ 21" - 15' cut)	220 x 22	=	4,840
CONDUIT-BEAVER (220 @ 21" - 20' cut)	220 x 28	=	6,160
PUMP STATION (50 @ 48" - 16' cut)	50 x 50	=	2,500
MANHOLES 5 @ 100			500
CATCH BASINS 5 @ 75			375
			$20,300

LAKEVIEW AREA - $71,000

ROSEMONT AREA - $20,300

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

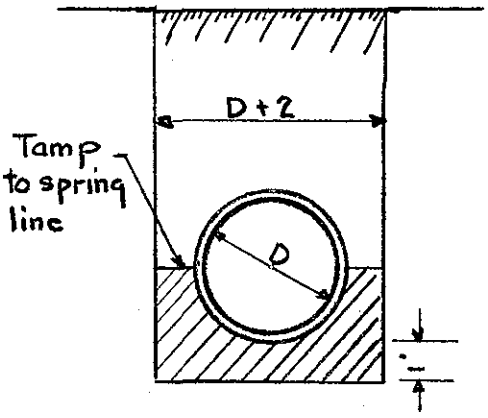
Subject: LOWELL - LOCAL PROTECTION - INTERCEPTOR

Computation: COST TO CITY OF LOWELL

Computed by: JWF Checked by: Date: 11-8-40

CHECK COST BASED ON SEVERAL COMPARISONS - JWF

BASE ASSUMPTIONS



ITEM	% Cost
Excavation	54.2
Lay & Line	10.0
Miscellaneous Work	1.7
Tamp to spring line	2.0
Backfill	22.5
Supervision	9.6

Sheeting 15¢ / □' (including wales, etc)

Cost of pipe

15"	- $1.20
18"	1.50
21"	1.90
24"	2.40
48"	7.00

Excavation (manual)

12' depth	0.6 - 1.15 c.y./m.h.
15' depth	0.55 - 1.05 c.y./m.h.

Common labor - 60¢/hr.

LAKEVIEW AREA

Excavation -

a.) 600' - 24" pipe - 10' cover = 600 x 13 x 4 x 1/27 = 1160 c.y.

b.) 1100' - 48" pipe - 10' cover = 1100 x 15 x 6 x 1/27 = 3670 c.y.

4830 c.y.

This job will be W.P.A. ∴ use low figure 0.55 c.y/hr.

∴ Cost of excavation = 4830 ÷ 0.55 x $0.60 = $5,250

Cost of all trench work exclusive of sheeting & pipe =

$5,250 ÷ 0.542 = $9,700

Sheeting = 2 [600 (13) + 1100 (15)] 0.25 = $12,200

Subject: LOWELL - LOCAL PROTECTION - INTERCEPTOR
Computation: COST TO CITY OF LOWELL
Computed by: [illegible] Checked by: Date: 11-8-40

LAKEVIEW (CONTINUED)

Pipe 600 @ 2.40 + 1100 @ 7.00 = 9,140

TOTAL COST

Excavation, backfill, etc	- 9,700
Sheeting	- 12,200
Pipe	- 9,100
Manholes & catchbasins (see sh#1)	2,000
	$33,000

ROSEMONT AREA

EXCAVATION

640 - av 18" pipe - 11' cover = 640 x 3.5 x 13.5 x 1/27 = 1120 c.y.

220 - 21 pipe - 17' cover = 220 x 19.75 x 4.5 (AV.) x 1/27 = 725 c.y.

50 - 48 pipe - 11' cover = 50 x 16 x 6 x 1/27 = 175 c.y.

2020 c.y.

Excav. = 2020 ÷ 0.55 x 0.60 = $2200

Excav, backfill, etc = 2200 ÷ 0.542 = $4,060

Sheeting = 2[640(13.5) + 220(19.75) + 50(16)] 0.75 = 6,900

Pipe = 220(1.20) + 220(1.50) + 420(1.90) + 50(7.00) = 1,750

Manholes & catchbasins (see sh#1) 1750

TOTAL 4,060 + 6,900 + 1,750 + 1750 = $14,500

LAKEVIEW AREA - $33,000

ROSEMONT AREA - $14,500

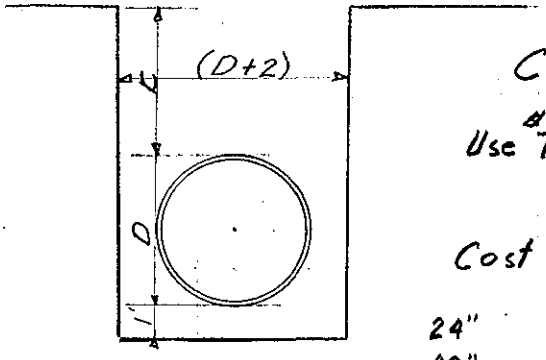
WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOWELL LOCAL PROTECTION

Computation: INTERCEPTOR COSTS

Computed by: [illegible] Checked by: Date 11-6-40



$V = (D+2)(D+C+1)\frac{1}{27}$

COST / l.f.

Use $7.00/c.y. excavation for cost of excavation, sheeting & backfill

	Cost of pipe	Placing	Total
24"	2.40	1.80	4.20
48"	7.00	3.50	10.50
15"	1.10	1.00	2.10
18"	1.50	1.40	2.90
21"	1.90	1.60	3.50
48"	7.00	3.50	10.50
54"	8.80	4.00	12.80

LAKEVIEW AVE

FRONT ST - COBURN ST

Pipe - 600' @ 24" = 600 x 4.20 : 2,520

Excav. etc (10' cover) 600 x 1/27 (4)(13) @ 7.00 : 8,100

COBURN ST - WEST ST.

Pipe - 1100' @ 48" = 1100 x 10.50 : 11,550

Excav. - (10' cover) 1100 x 1/27 (6)(15) @ 7.00 : 25,700

Manholes - 4 @ $350 : 1,400

CATCH BASINS 8 @ 80 : 640

$ 49,900

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOWELL - LOCAL PROTECTION

Computation: INTERCEPTOR COSTS

Computed by: [illegible] Checked by: Date: 11-6-40

ROSEMONT AREA

NEW YORK - OTTAWA (11' cover)

Pipe - 220' @ 15" = 220 x 2.10	(2.60)	=	460
Excav - 220 x 1/27 (3.25)(13.25) 7.00	13.25 8.00	=	2,450

OTTAWA - CAMPAW (11' cover)

Pipe - 220' @ 18" = 220 x 2.90	(3.00)	=	640
Excav - 220 x 1/27 (3.5)(13.5) 7.00	15.15 14.00	=	2,690

CAMPAW - BEAVER (11' cover)

Pipe - 200' @ 21" = 200 x 3.50	(4.30)	=	700
Excav. - 200 x 1/27 (3.75)(13.75) 7.00	16.35	=	2,670

CONDUIT - BEAVER (17' cover)

Pipe - 220 @ 21" = 220 x 3.50	(7.50)	=	770
Excav - 220 x 1/27 (5.00)(19.75) 7.00	29.75	=	5,650

PUMP STATION (11' cover)

Pipe - 50' @ 48" = 50 x 10.50	35.50 43.00	=	525
Excav. - 50 x 1/27 (6)(16) 7.00		=	1250
Manholes 1 @ 350		=	
4 @ 150		=	950
Catch Basins 5 @ 80		=	400
			$ 19,150

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOWELL - LOCAL PROTECTION - LAKEVIEW AREA

Computation: COST SUMMARY

Computed by: [illegible] Checked by: Date: 11-5-40

(a)

~~CONSTRUCTION COST~~

ITEM	QUANTITY	UNIT COST	COST
PILING WALL			
STEEL SHEET PILING	31,500 s.f.	1.25	39,400
STRUCTURAL STEEL (capping)	24,300 lbs.	0.12	2,900
BACKFILL		L.S.	600
MISCELLANEOUS (pointing, etc.)		L.S.	1,000
EMBANKMENT			
COMMON EXCAVATION	24,600 c.y.	0.40	9,800
TRENCH EXCAVATION	3,100 c.y.	0.80	2,500
IMPERVIOUS FILL	9,800 c.y.	0.80	7,800
DUMPED FILL	27,000 c.y.	0.55	14,900
SAND & GRAVEL DRAIN	2,600 c.y.	2.50	6,500
SEEPAGE PIPE	1,360 l.f.	2.00	2,700
DRAIN WELLS	91	34.00	3,100
GRADING & SEEDING		L.S.	2,500
PUMPING			
PUMPING STATION (112,000 G.P.M.)		L.S.	100,000
DISCHARGE CONDUIT		L.S.	5,000
SUB-TOTAL ~~CONSTRUCTION COST~~			198,700
Engr, inspection, o'h'd & cont. (35%)			69,300
TOTAL CONSTRUCTION COST, LAKEVIEW SECTION			$ 268,000
CONTRIBUTION OF CITY OF LOWELL FOR INTERCEPTOR			70,000
TOTAL COST			$ 338,000

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject LOWELL - LOCAL PROTECTION

Computation PUMPING COSTS (from chart

Computed by E. G. Checked by Date

WEST ST.

H = 20'±

250 c.f.s. x 449 = 112,500 G.P.M.

ESTIMATED COST (excl 35%) - $100,000

BEAVER ST

H = 20'±

40 c.f.s. x 449 = 18,000 c.f.s.

ESTIMATED COST (excl. 35%) - $ 34,000

WAR DEPARTMENT

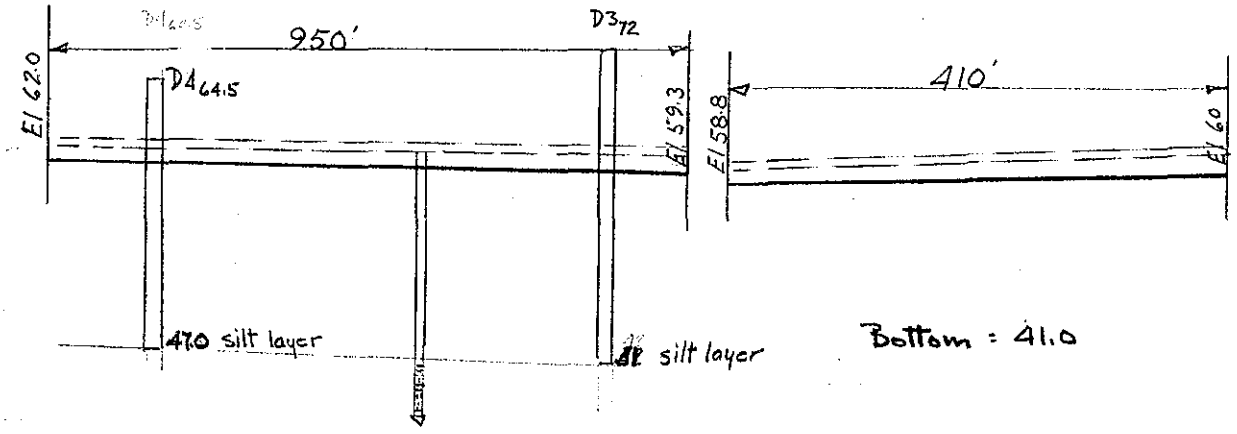
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOWELL - LOCAL PROTECTION - LAKEVIEW AREA

Computation: WELL POINT DRAINAGE SYSTEM

Computed by: JWL Checked by: ____ Date: ____

TOTAL LENGTH = 1360' WELL POINT SPACING - 15'-0" cc



WELL POINT to be double screen extending into silt layer completely

Average well point above screen - 20.0'

1360 ÷ 15 = 91 well points 2" - #80 gauge - Great Lakes Supply - P479

180½ 2" - 78" - 72"
$256/doz.

15' - 2" W.I.P. @ $0.37/ft.
2 - couplings @ 0.29 each

∴ Cost per well point (equip.) = (256 ÷ 12) 15(0.37) + 0.58 =
21.33 + 5.55 + 0.58 = $27.50 list price

deducting 30% from list price - net price = $19.25

Installation = $15.00 ∴ Total cost = $34.25 use $ 34.00

Seepage pipe = $2.00/l.f

ROSEMONT add 7 × 0.37 × 70% = 1.80 to cost

∴ use $ 36.00

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject LOWELL - LOCAL PROTECTION

Computation FRONT ST. SHEET PILING

Computed by JWL Checked by Date 11-4-40

TOP OF SHEET PILE WALL TO BE EL 72.0
BOTTOM OF SHEET PILING TO BE EL 39.0 (3' penetration of silt stratum)

TOTAL LENGTH OF WALL = 950'

① TOTAL SHEET PILING = 950 x 33 = 31,350 s.f.

Figuring on Weirton WZ-27 section d = 7 3/8" requires a 10" x 3½" @ 21.9# ship channel for capping.

② ∴ TOTAL WGT capping = 21.9 x 950 = 20,800 #
allowance for clip angles -10% = 2,200
23,000 #

③ WALL CONNECTION AT BRIDGE ST.

Allow 6' sheet piling = 6 x 33 = 200 s.f.
and 60' angle = 60 x 22 = 1320 #

∴ TOTAL AT FRONT ST.

SHEET PILING 31,350 + 200 = 31,500 s.f.

STRUCTURAL STEEL 23,000 + 1300 = 24,300 #

Dunbar-Wolfe Ptg. Co. Boston 8-40 10m

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOCAL PROTECTION - LOWELL - DIKE BRIDGEST - AIKEN ST

Computation: DIKE QUANTITIES - WITH 6' TOE TRENCH - RIVER SIDE. - THIS REVISED TO 4' TOE TRENCH. -

Computed by: M.J.G. M.N.T. Date: 11/2/40 Checked by: Date: Checked by:

Page 14

STA	DIST	EXCAVATION AREA	EXCAV. ME. AR.	EXCAV. VOL. CY	EXCAV. DRAIN AREA	EXCAV. DRAIN ME. AR.	EXCAV. DRAIN VOL. CY	IMPERV. BLANKET AREA	IMPERV. BLANKET ME. AR.	IMPERV. BLANKET VOL. CY	DUMPED FILL AREA	DUMPED FILL ME. AR.	DUMPED FILL VOL. CY	SAND & GRAVEL AREA	SAND & GRAVEL ME. AR.	SAND & GRAVEL VOL. CY
A	1	0			0			0			0			0		
	100															
B.		0			0			0			0			0		
	100		142	526					70	259		160	592			
C.		284						140			320					
	170		330	2114					134	859		292	1871			
E		376			0			128			264			0		
	128		386	1830					132	626		308	1460			
G		396			0			136			352			0		
	127		490	2304		12	56		142	668		370	1740		12	56
I		584			24			148			388			24		
	98		540	1960		22	80		150	544		392	1423		25	91
K		496			20			152			396			26		
	75		476	1322		10	28		150	417		380	1055		36	100
L		456			0			148			364			46		
	100		402	1489		12	44		136	504		352	1303		35	130
M		348			24			124			340			24		
	100		358	1327		35	130		128	474		338	1252		37	137
N		368			45			132			336			50		
	100		402	1489		61	226		130	481		312	1153		60	222
O		436			78			128			288			70		
	100		416	1540		88	326		124	459		280	1037		84	311
P		396			98			120			272			98		
	139		306	1575		42	422		108	556		276	1421		81	417
Q		216			64			96			280			64		
	102		224	846		59	223		100	378		280	1058		44	166
R		232			52			104			280			24		
	100		238	881		70	259		102	378		258	955		37	137
S		244			88			100			236			50		
	100		238	881		88x10 / 104x10	33 / 39		106	393		268	992		50x10 / 80x10	19 / 30
T		232			104			111			300			80		
	100		268	992		88	326		114	422		296	1096		58	215
U		304			72			117			292			36		
	100		278	1029		80	296		111	411		280	1037		51	189
V		252			88			105			268			65		
	100		282	1044		70	259		109	404		288	1066		52	193
W		312			52			114			308			39		
	100		338	1252		55	204		114	422		328	1215		37	137
X		364			58			114			348			36		
	100		352	1303		29	107		111	411		320	1185		18	67
Y		340			0			108			292			0		
	100		286	1059					101	374		254	941			
Z		232						93			216					
	175		224	1452					94	609		246	1594			
A-A		216						96			276					
	225		212	1767					92	767		256	2133			
B-B.		208						87			236					
				29,984			3058			10,816			27,579			2,617

6' TOE TRENCH	30,000	3,100	10,800	27,600	2600
LESS:	5,400		1,000	4,000	
	24,600 C.Y.		9,800 C.Y.	23,600 C.Y.	

1.25 Acres

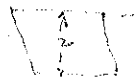
Dunbar-Wolfe Ptg. Co. Boston 8-40 10m

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject LOCAL PROTECTION - LOWELL.
Computation DIKE QUAN. - REVISION - RIV. S. DE TOE TRENCH - 6'-to 4'
Computed by ..... Date ..... Checked by ..... Page 2

	Dist.	Excavation Area	Me. Ar.	Vol. cu.	Dumped Fill Area	Me. Ar	Vol cu
A		0			0		
	100						
B		0			0		
	100		24	89		18	67
C		48			36		
	173		52	334		40	256
E		56			44		
	128		62	294		50	237
G		68			56		
	127		72	338		56	264
I		76			56		
	98		74	269		56	204
K		72			56		
	75		70	194		56	156
L		68			56		
	100		62	230		50	185
M		56			44		
	100		58	215		46	170
N		60			48		
	100		62	230		46	170
O		64			44		
	100		64	237		44	163
P		64			44		
	139		56	288		40	206
Q		48			36		
	102		50	189		38	144
R		52			40		
	100		52	193		40	148
S		52			40		
	100		54	200		42	156
T		56			44		
	100		54	200		44	163
U		52			44		
	100		54	200		44	163
V		56			44		
	100		56	208		44	163
W		56			44		
	100		60	222		44	163
X		64			44		
	100		66	244		42	156
Y		68			40		
	100		60	222		38	141
Z		52			36		
	175		56	363		38	246
A-A		60			40		
	225		56	467		36	300
B-B		52			32		
				5426			4,021
				5400			4,000

IMPERVIOUS BLANKET



$\frac{5.4 \times 2 \times 2542}{27} = 1016.8$ (0.2)

1000 C.Y.

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Computed by ..... Date ..... Checked by ..... Page 45

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOWELL - LOCAL PROTECTION - ROSEMONT AREA

Computation: COST SUMMARY

Computed by: JWL Checked by: Date: 11-7-40

CONSTRUCTION COST

ITEM	QUANTITY	UNIT COST	COST
PILING WALL			
STEEL SHEET PILING	14,800 s.f.	1.25	18,500
STRUCTURAL STEEL (capping)	18,500 lb	0.12	2,200
BACKFILL	2,000 c.y.	0.55	1,100
EMBANKMENT			
COMMON EXCAVATION	4,800 c.y.	0.30	1,400
TRENCH EXCAVATION	6,400 c.y.	0.60	3,800
IMPERVIOUS FILL	5,900 c.y.	0.80	4,700
RANDOM FILL (blanket)	3,400 c.y.	0.60	2,000
DUMPED FILL	2,700 c.y.	0.45	1,200
SAND & GRAVEL DRAIN	900 c.y.	2.50	2,300
STEEL SHEET PILING CUTOFF	1,300 c.y.	1.25	1,600
SEEPAGE PIPE	700 l.f.	2.00	1,400
DRAIN WELLS	46	37.00	1,700
DISPOSAL WASTE MATERIAL	3000 c.y.	0.25	800
GRADING & SEEDING		L.S.	2,000
BULKHEAD		L.S.	6,000
PUMPING			
PUMPING STATION (18,000 GPM)		L.S.	34,000
SUB-TOTAL ~~CONSTRUCTION COST~~			84,700
Eng'r, inspection, o'h'd, & cont. (35%)			29,300
TOTAL CONSTRUCTION COST, ROSEMONT SECTION			$114,000
CONTRIBUTED BY CITY OF LOWELL FOR INTERCEPTOR			20,000
TOTAL COST			$134,000

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOWELL - LOCAL PROTECTION - ROSEMONT AREA

Computation: COST SUMMARY

Computed by: [illegible] Checked by: Date: 11-5-40

CONSTRUCTION COST

ITEM	QUANTITY	UNIT COST	COST
PILING WALL			
STEEL SHEET PILING	14,800 s.f.	1.25	18,500
STRUCTURAL STEEL (capping)	18,500 lb.	0.12	2,200
BACKFILL	2,000 c.y.	0.55	1,100
EMBANKMENT			
COMMON EXCAVATION	4,800 c.y.	0.30	1,400
TRENCH EXCAVATION	5,200 c.y.	0.60	3,100
IMPERVIOUS FILL	5,900 c.y.	0.80	4,700
RANDOM FILL (blanket)	3,400 c.y.	0.60	1,500
DUMPED FILL	2,400 c.y.	0.45	1,100
STEEL SHEET PILING CUTOFF	1,300 c.y.	1.25	1,600
SURFACE DRAINAGE		L.S.	2,000
DISPOSAL WASTE MATERIAL	2,200 c.y.	0.25	600
GRADING & SEEDING		L.S.	2,000
BULKHEAD		L.S.	6,000
PUMPING			
PUMPING STATION (20,000 G.P.M.)		L.S.	36,000
SUB-TOTAL CONSTRUCTION COST			81,800
Engr, inspection, o'hd, & cont. (35%)			28,200
TOTAL CONSTRUCTION COST			$ 110,000

Superseded

WAR DEPARTMENT

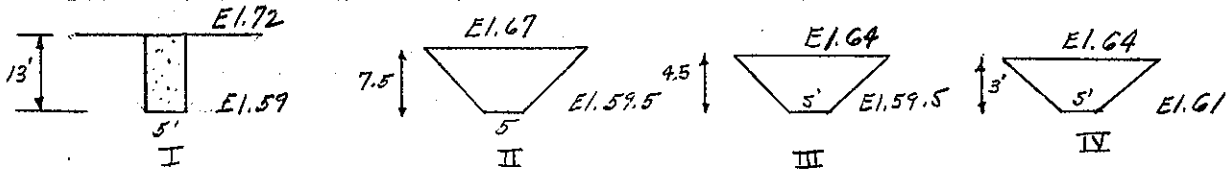
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject: LOCAL PROTECTION - LOWELL, MASS -

Computation: SAND & GRAVEL DRAIN - ROSEMONT AREA -

Computed by: W.W.T. Checked by: Date: 11/8/40



$A_I = 5 \times 13 = 65^{\square'}$ $A_{II} = \frac{5+20}{2} \times 7.5 = 94^{\square'}$ $A_{III} = \frac{5+14}{2} \times 4.5 = 43^{\square'}$ $A_{IV} = \frac{5+11}{2} \times 3 = 24^{\square'}$

$85 \times 94 \times 1/27 = 300$ C.Y.

$505 \times \frac{43+24}{2} \times 1/27 = 635$ C.Y.

935 C.Y. EXCAVATION & SAND AND GRAVEL FOR DRAIN

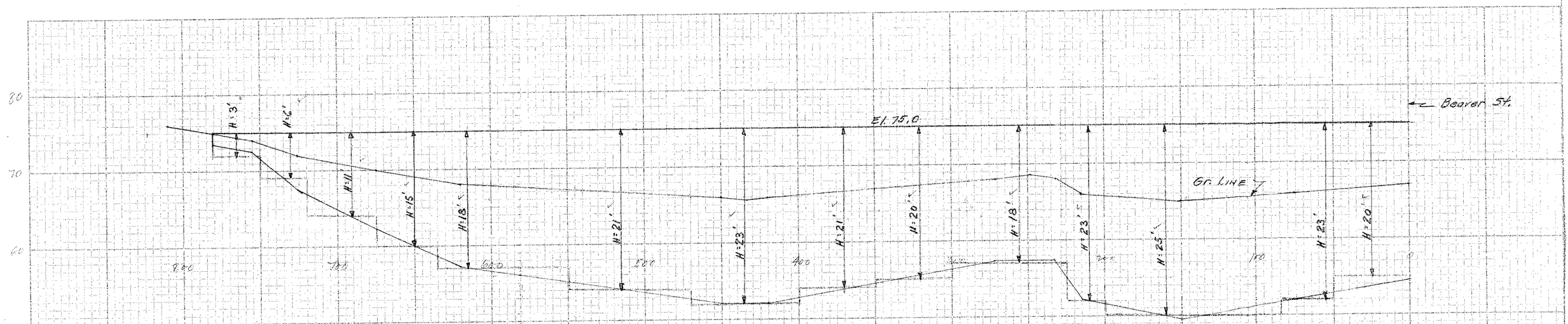
$110 \times 65 \times 1/27 = 265$ C.Y. SHEATHED EXCAVATION & BACKFILL.

$13 \times 110 \times 2 = 2860$ S.F. SHEATHING

700 LIN. FT. 1'-0" DIA. SEEPAGE PIPE

46 DRAINAGE WELLS 28'-0" lg. AVE.

R1



SHEET PILING - BACKMAN TO BEAVER STS.

Red tree indicates bottom of sheet piling - [illegible]

1" = 50' HOR.
1" = 10' VERT.

TOTAL SHEET PILING:

H = 3'-0'		30 × 3	= 90
H = 6'-0'		30 × 6	= 180
H = 11'-0'		45 × 11	= 495
H = 15'-0'		40 × 15	= 600
H = 18'-0'	85 + 75	= 160 × 18	= 2,880
H = 20'-0		= 100 × 20	= 2,000
H = 21'-0	80 + 50	= 130 × 21	= 2,730
H = 23'-0	70 + 25 + 35	= 130 × 23	= 2,990
H = 25'-0		115 × 25	= 2,875
		780'	= 14,840 □ ft

use 14,800 □' WZ-27

SHEET PILE CUTOFF 15 × 85 = 1300 □'

14,800 + 1,300 = 16,100 □'

CAPPING 21.9 × 780 + 10% = 16,850 + 1,650 = 18,500#

SHEET PILING - BEAVER ST - BACHMAN ST

LOWELL, MASS

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page R2

Subject: LOCAL PROTECTION - LOWELL, MASS.

Computation: DIKE - BELOW BEAVER ST.

Computed by: W.W.T. Checked by: Date: 11/4/40

Sta.	Dist Ft.	Top Excavation Area □'	Top Excavation Ave Area	Top Excavation Vol. C.Y.	Trench Excavation A	Trench Excavation Ave A	Trench Excavation Vol. C.Y.	Blanket (Imperv.) A.	Blanket (Imperv.) Ave A.	Blanket (Imperv.) Vol. C.Y.	Random Fill A	Random Fill Ave A	Random Fill Vol C.Y	Fill - Dry Side A	Fill - Dry Side Ave A.	Fill - Dry Side Vol. C.Y.
Z.		0			160			136			208			25		
	84					198	616		136	423		220	684		15	47
Y.		0			236			136			232			4		
	56		21	44		185	384		140	290		160	332		2	4
X.		42			134			144			88			0		
	76		63	177		147	414		160	450		96	270		48	135
B.		84			160			176			104			96		
	100		140	518		136	504		172	637		100	370		105	389
C.		196			112			168			96			114		
	100		197	729		145	537		174	644		114	422		122	452
D.		198			178			180			132			130		
	100		189	700		119	441		172	637		120	444		118	437
E.		180			60			164			108			106		
	100		171	633		61	226		158	585		100	370		124	459
F.		162			62		3122	152			92			142		
	100		175	648		133	492		180	667		70	259		97	359
G.		188			204			208			48			52		
	100		182	674		205	759		209	774		44	163		28	104
H.		176			206			210			40			4		
	100		194	718		235	870		225	833		36	133		3	11
I.		212			264			240			32			2		
				4841			5243			5940			3447			2397

USABLE TRENCH } 3125
TOP EX - 4840

TOT. EX. 7965 C.Y
SAY - 8000 "

RAN FILL - 3447
FILL D.S. - 2397

TOT FILL 5844
SAY 5850 C.Y

8000 C.Y.
- 5850
2150 C.Y.
EXCESS

WAR DEPARTMENT

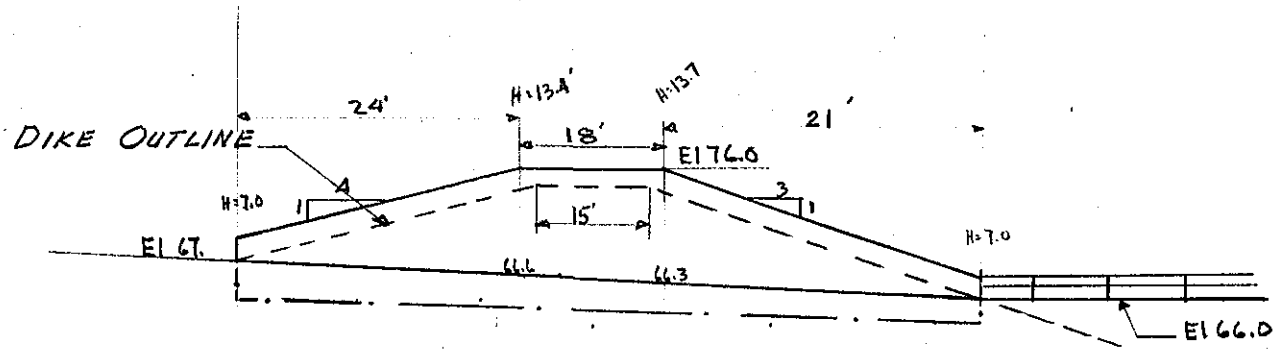
U. S. ENGINEER OFFICE, BOSTON, MASS.

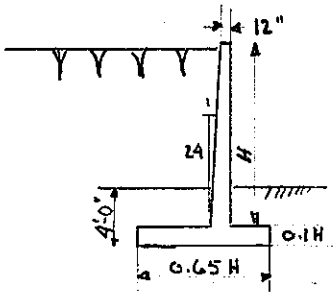
Page R3

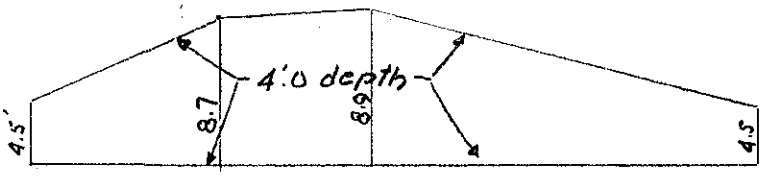
Subject: LOWELL LOCAL PROTECTION - ROSEMONT AREA

Computation: CONCRETE BULKHEAD - BEAVER ST

Computed by: [illegible] Checked by: Date: 11-4-40







EXCAVATION

$$V = \frac{1}{27}\left[0.065H^2 + 2H + \frac{H^2}{24}\right]$$

$$= \frac{1}{27}\left[.107H^2 + 2H\right]$$

CONCRETE:

H = 7.0	$\frac{1}{27}[5.25 + 14.0]$	= 0.715 c.y./l.f.
H = 13.4	$\frac{1}{27}[19.2 + 26.8]$	= 1.705 c.y./l.f.
H = 13.7	$\frac{1}{27}[20.5 + 27.4]$	= 1.77 c.y./l.f.

$$2\left[24(0.715+1.705)\tfrac{1}{2} + 18(1.705+1.77)\tfrac{1}{2} + 21(1.77+0.715)\tfrac{1}{2}\right] =$$

$$2(29.1 + 31.2 + 26.1) = 173 \text{ c.y.}$$

Reinforcing = 173 × 100 = 17,300 #

Sill = 40 × 4 × 2 × 1/27 = 12 c.y.

Excavation = $2\left[24(4.5+8.7)\tfrac{1}{2} + 18 \times 8.8 + 21(8.9+4.5)\tfrac{1}{2}\right]4 \div 27$ =

$(158 + 158 + 140)8 \div 27$ = 135 c.y.

sill + 25 c.y.

SHEET PILING = 40 × 15 = 600 □'

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOWELL LOCAL PROTECTION - ROSEMONT AREA

Computation: CONCRETE BULKHEAD - BEAVER ST

Computed by: JWH Checked by: Date: 11-4-40

COST OF BULKHEAD

CONCRETE:			
Walls	173 @ 16.00	=	2,770
Sill	12 @ 7.00	=	80
REINFORCING	17,300 @ 0.05	=	860
Piling	600 □' @ 1.25	=	750
Excavation	160 c.y @ .70	=	110
REMOVAL EXIST. BULK.	L.S.	=	200
STOP LOGS & A-Frames	L.S.	=	1330
	TOTAL		$6,000

WAR DEPARTMENT

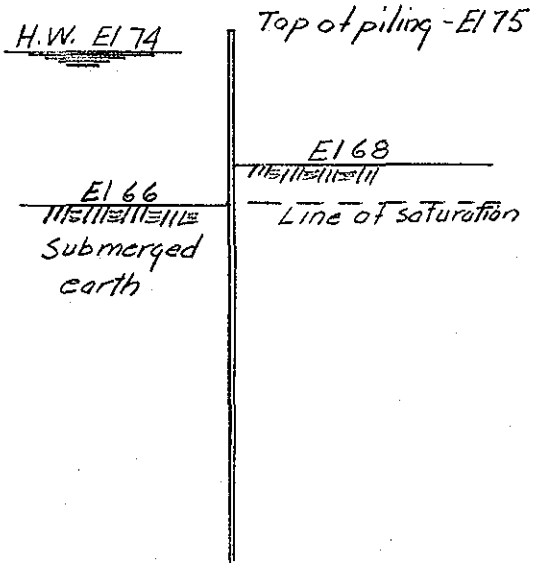
U. S. ENGINEER OFFICE, BOSTON, MASS.

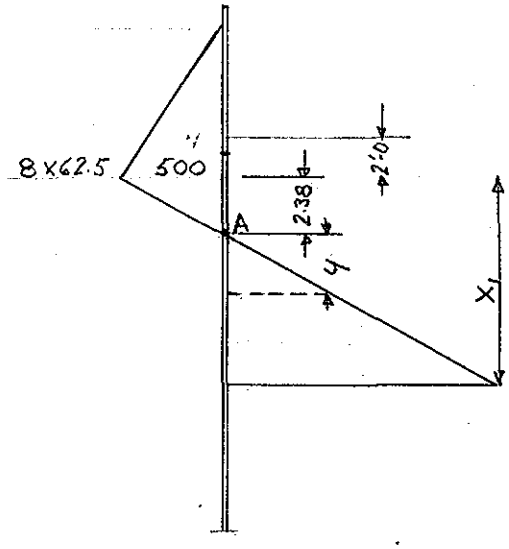
Subject: LOWELL LOCAL PROTECTION

Computation: BEAVER ST. SHEET PILING

Computed by: JWL Checked by: Date: 10-16-40

Reference: Steel Sheet Piling as Cantilevers in Soil - 1938





$W_e = 100^{\#}$ $\phi = 33^\circ - 41'$

W_e in water $= 65^{\#}$ $P_p = 65 \times 3.49 = 227^{\#}/\square'$

$P_{e\,in\,w} = 65 \times .2864 = 18.6$ use $20^{\#}/\square'$

$\therefore P_p - P_{e\,in\,w} = 227 - 18.6 = 208$ use $210^{\#}/\square'$

$500 \div 210 = 2.38$ - point of equal pressures

$$\Sigma M_A = \begin{array}{lll} 500 \times 8 \times \tfrac{1}{2} = 2000^{\#} & \times (2.38 + 2.67) = & 10{,}100'^{\#} \\ 500 \times 2.38 \times \tfrac{1}{2} = \underline{\;595\;} & \times (2.38 \times \tfrac{2}{3}) = & \underline{\;940\;}'^{\#} \\ \quad 2595 & & 11{,}040'^{\#} \end{array} \quad \therefore a = 4.26$$

1.) $\therefore$ Penetration

$$x_1^3 - \frac{6 \times 2595}{210} x_1 - \frac{6 \times 2595 \times 4.26}{210} \qquad \text{(equa. \#1)}$$

$x_1^3 - 74 x_1 = 316$ $\therefore x_1 = 10.15' + 2.38 = 12.53'$

$F_1 = 12.53 \div 8 = 1.57$ $\frac{x}{x_1} = 1.08$ $\therefore x = 12.53 \times 1.08 = 13.5'$

Total length of piling $= 22.5'$

Cont. on pg 2

Subject: LOWELL LOCAL PROTECTION
Computation: BEAVER ST. SHEET PILING
Computed by: [illegible] Checked by: Date: 10-16-40

2.) BENDING MOMENT

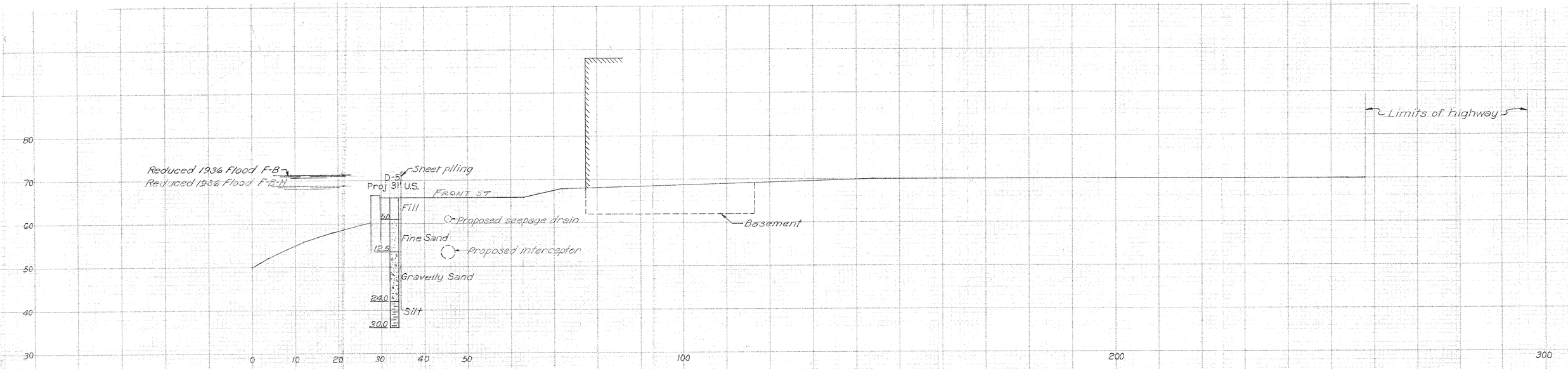
$y = \sqrt{2(2595) \div 210} = 4.96'$ (equa. #10)

∴ Max moment (equa. #11): $2595(4.26 + 4.96) - \frac{210}{6}(12.2) = 19{,}660$

$S = 19{,}660 \times 12 \div 20{,}000 = 11.8 \text{ in}^3$ per ft

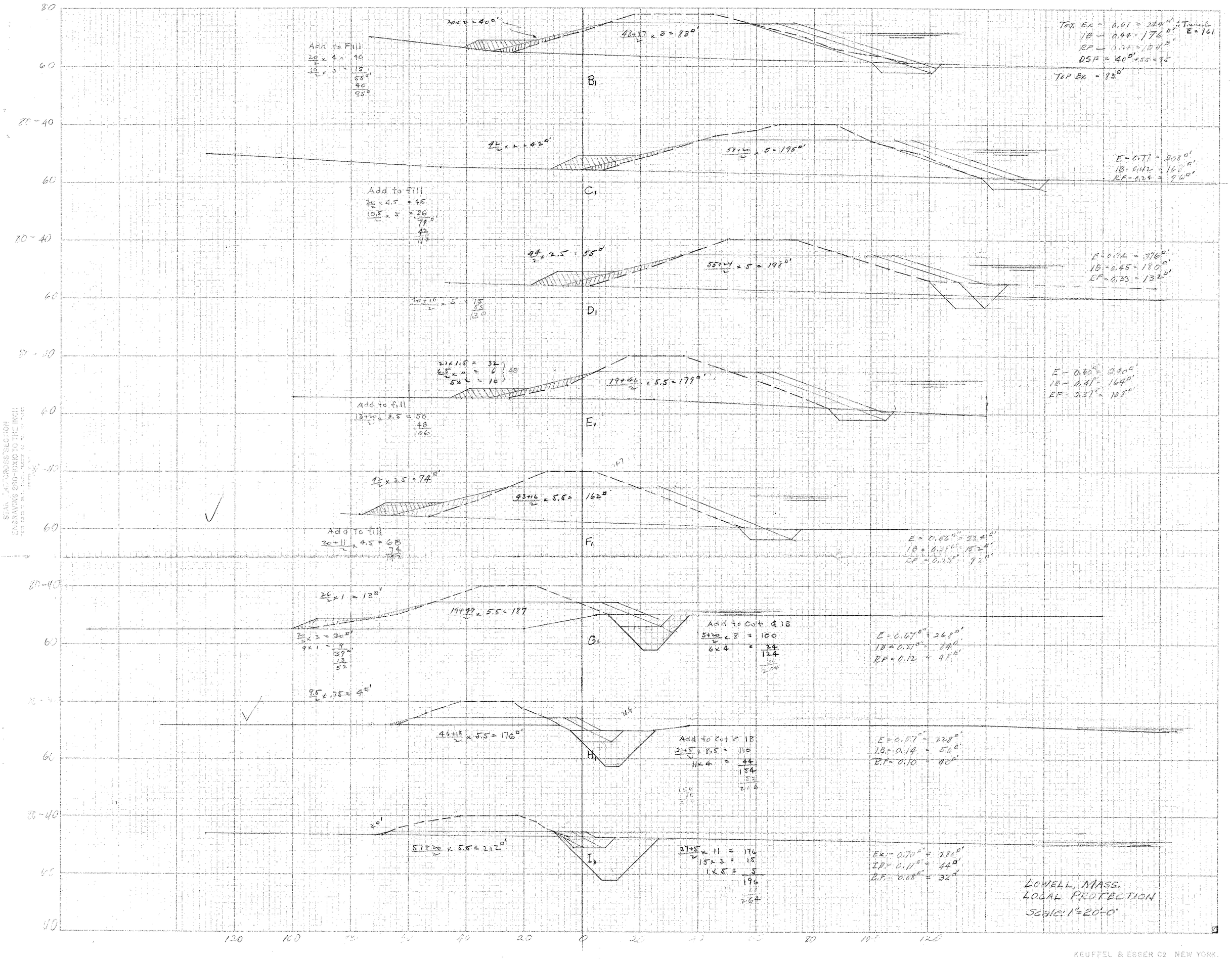
∴ Use MZ-32 ($S = 38.3$) in 22'-6" lengths (Carnegie)

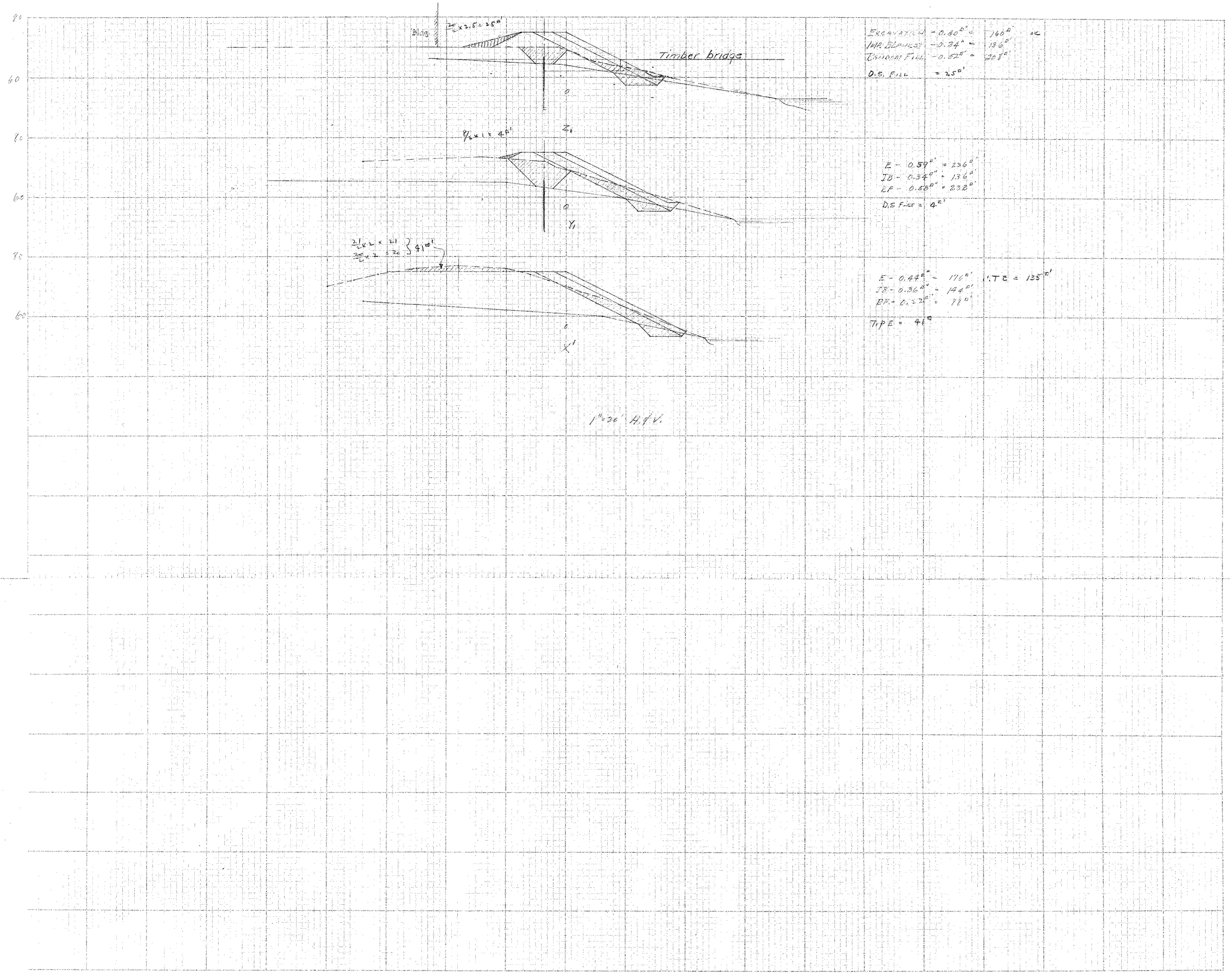
or WZ-27 ($S = 19.0$) in 22'-6" " * (Weirton)



SECTION I-1

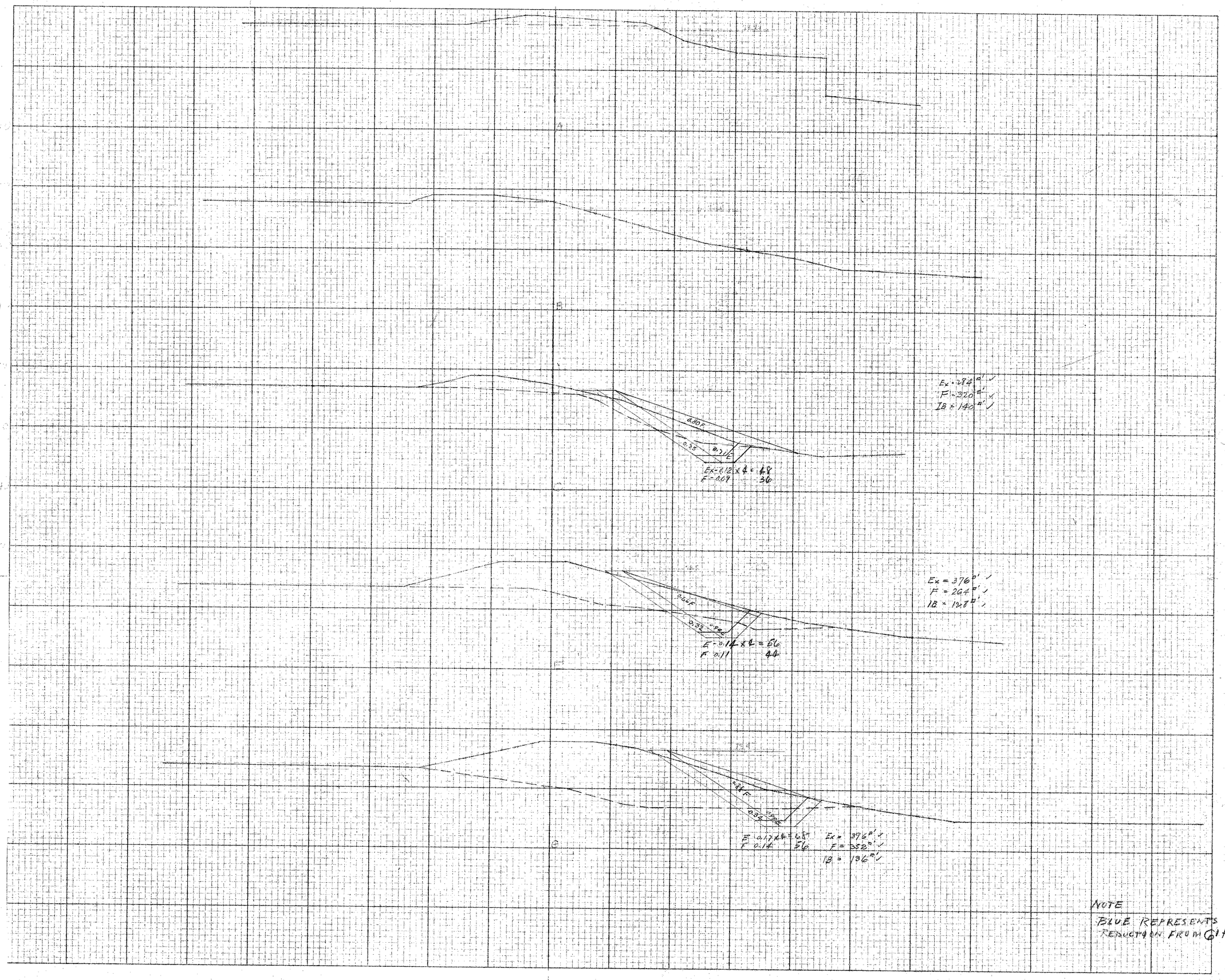
Scale: 1" = 10'-0"


B1
Add to Fill
20/2 x 4 = 40
10/2 x 3 = 15
55'
40
95'
20x2 = 40'
48+37/2 x 3 = 83'
Tot. Ex = 0.61 = 244'
IB = 0.44 = 176'
RP = 0.24 = 104'
DSF = 40' + 55 = 95
Total E = 161
Top Ex = 83'
C1
42/2 x 2 = 42'
58+62/2 x 5 = 195'
E = 0.77 = 308'
IB = 0.42 = 168'
RF = 0.24 = 96'
Add to fill
24/2 x 4.5 = 45
10.5 x 5 = 26
71'
42
113
D1
24/2 x 2.5 = 55'
55+24/2 x 5 = 198'
E = 0.94 = 376'
IB = 0.45 = 180'
EF = 0.33 = 132'
20+10/2 x 5 = 75
30
105
E1
21+1.5 = 32
6.5/2 x 4 = 6
5x2 = 10
48
19+46/2 x 5.5 = 179'
E = 0.60 = 240'
IB = 0.41 = 164'
EF = 0.27 = 108'
Add to fill
13+10/2 x 3.5 = 58
48
106
F1
42/2 x 3.5 = 74'
43+16/2 x 5.5 = 162'
Add to fill
20+11/2 x 4.5 = 68
74
142
E = 0.56 = 224'
IB = 0.38 = 152'
EF = 0.23 = 92'
G1
26/2 x 1 = 13'
19+39/2 x 5.5 = 187
36/2 x 3 = 36'
9 x 1 = 9
38'
13
52
Add to Cut & IB
5+20/2 x 8 = 100
6x4 = 24
124
264
E = 0.67 = 268'
IB = 0.21 = 84'
RF = 0.12 = 48'
9.5/2 x .75 = 4'
H1
46+18/2 x 5.5 = 176'
Add to Cut & IB
21+5/2 x 8.5 = 110
11x4 = 44
154
264
E = 0.57 = 228'
IB = 0.14 = 56'
RF = 0.10 = 40'
I1
20'
57+20/2 x 5.5 = 212'
27+5/2 x 11 = 176
15x3 = 15
1x5 = 5
196
264
Ex = 0.70 = 280'
IB = 0.11 = 44'
RF = 0.08 = 32'
LOWELL, MASS.
LOCAL PROTECTION
Scale: 1" = 20'-0"
STAN. AV. CROSS SECTION
ENGRAVING 200-1X10 TO THE INCH
KEUFFEL & ESSER CO. NEW YORK.



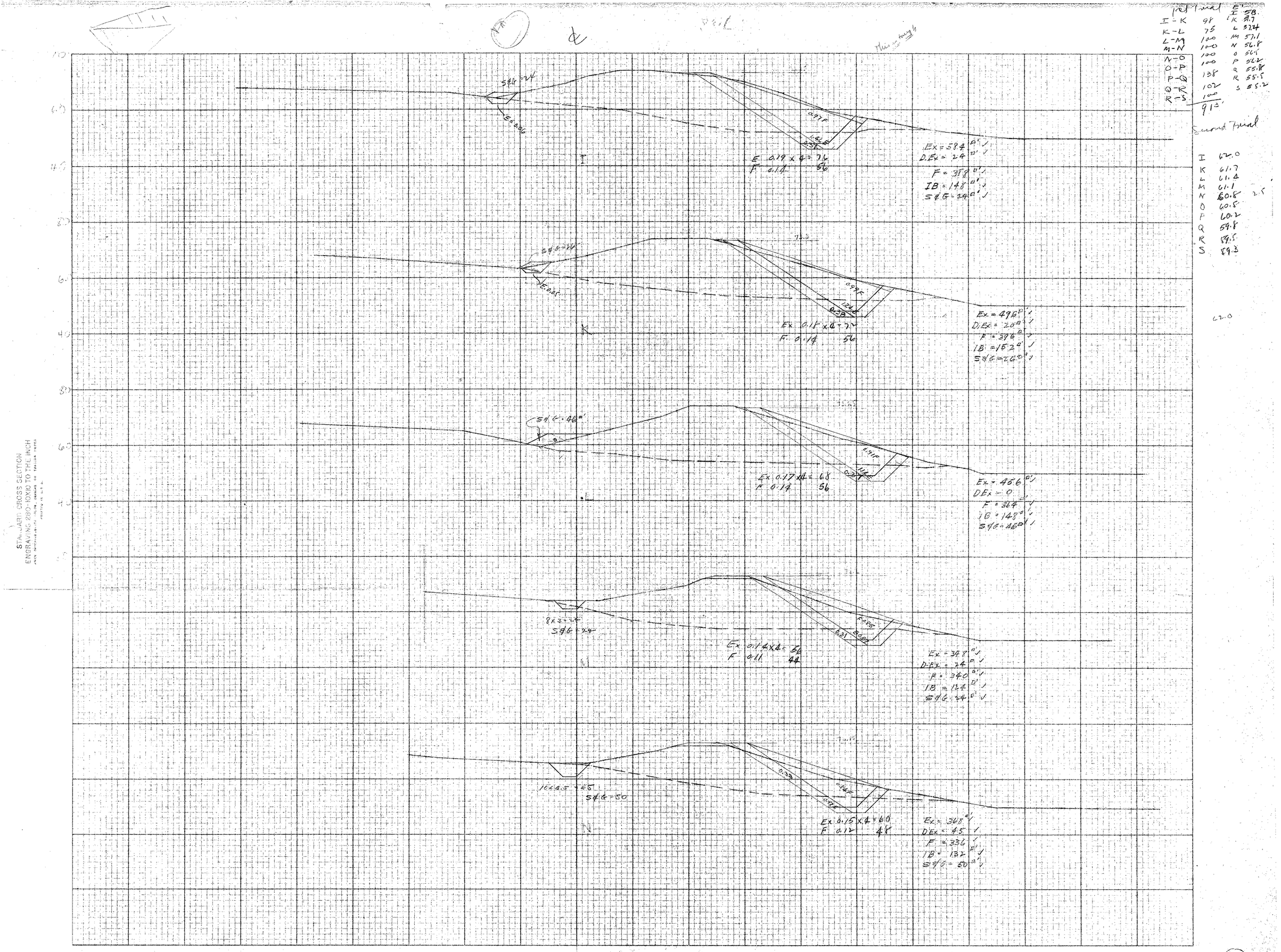
STAN. CROSS SECTION
ENGRAVING 280-10X10 TO THE INCH

KEUFFEL & ESSER CO. NEW YORK.



NOTE
BLUE REPRESENTS
REDUCTION FROM 6' toe to 4' toe.

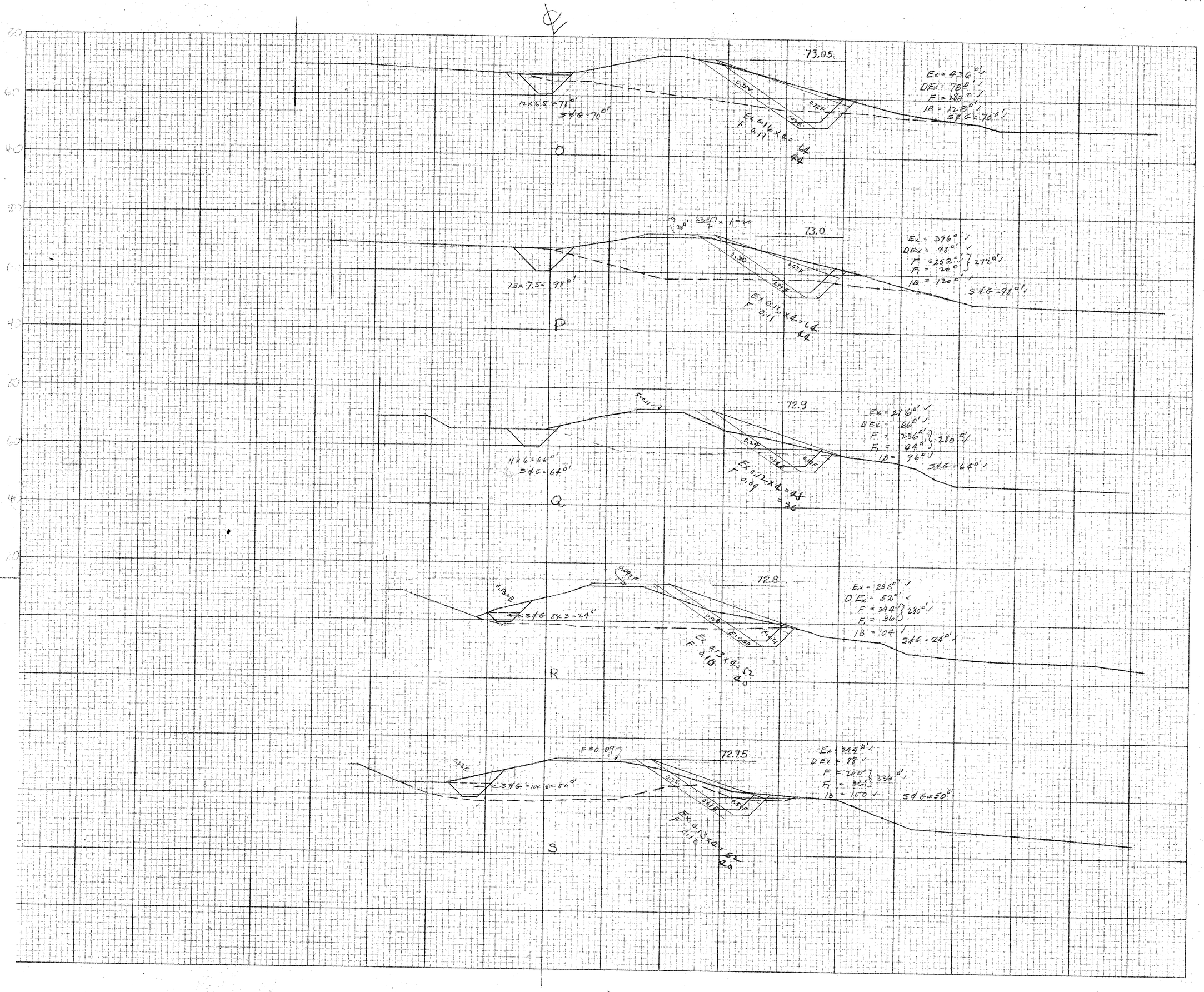
STANDARD CROSS SECTION
ENGRAVING 280-10X10 TO THE INCH
KEUFFEL & ESSER CO. NEW YORK.



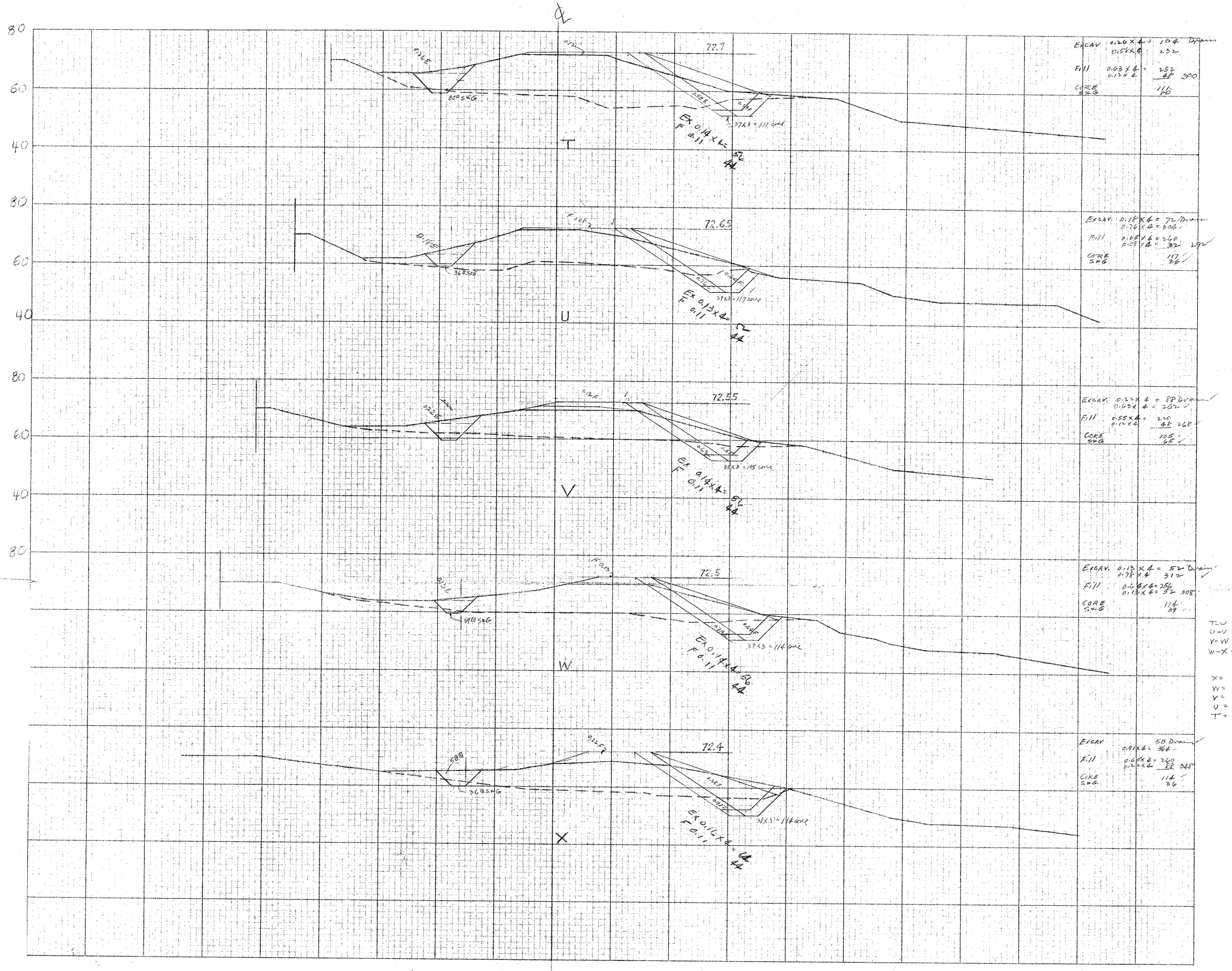
STANDARD CROSS SECTION
ENGRAVING 280-10X10 TO THE INCH

KEUFFEL & ESSER CO. NEW YORK.

2



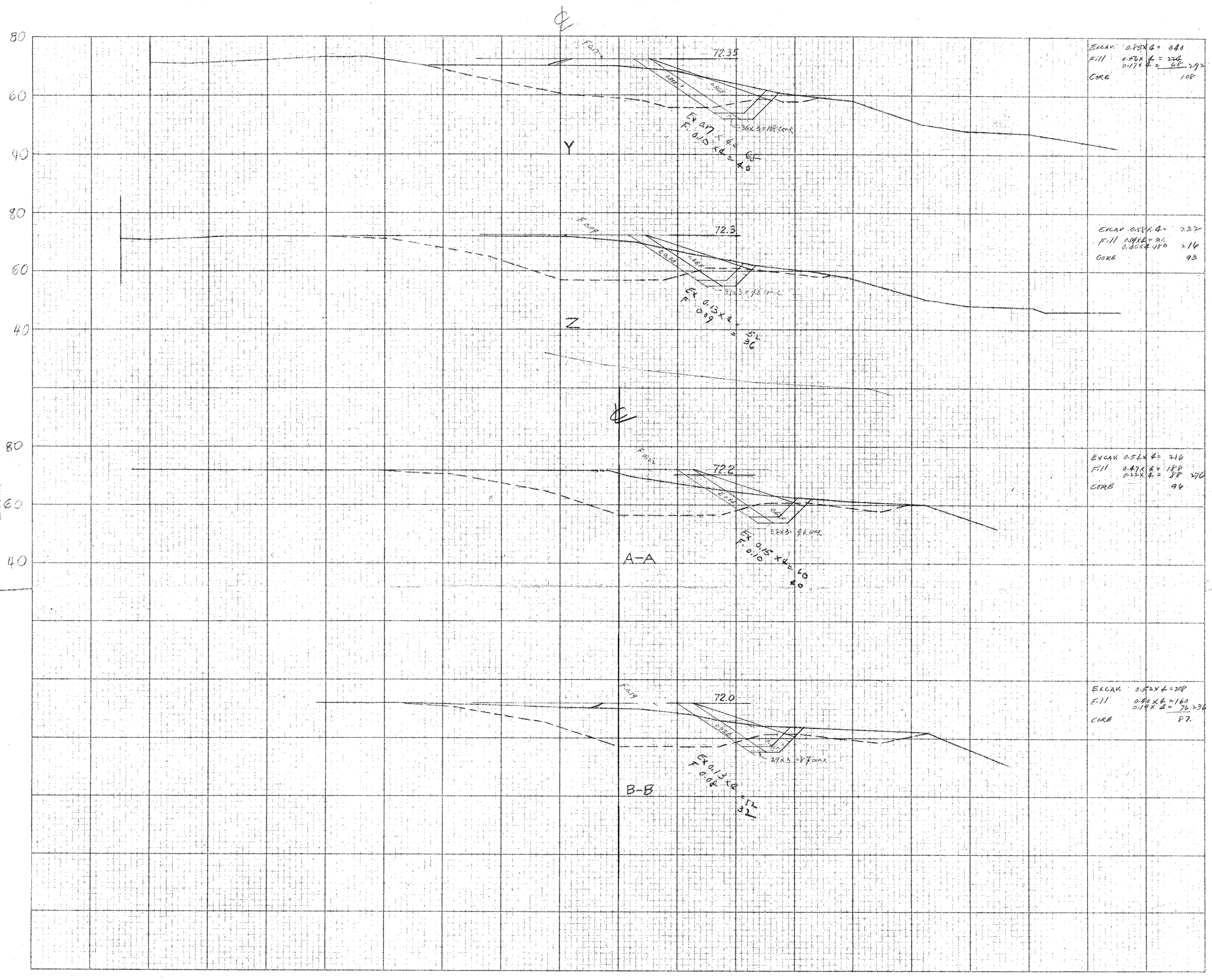
STANDARD CROSS SECTION
ENGRAVING 280-10X10 TO THE INCH



STAND CROSS SECTION
ENGRAVING 80-10X10 TO THE INCH

KLUEPFEL & ESSER CO. NEW YORK.

4



STANDARD CROSS SECTION
ENGRAVING 260 - OXIC TO THE NCH

KEUFFEL & ESSER CO. NEW YORK

5

LOWELL - LOCAL PROTECTION

ESTIMATE 10-23-40

Excav. + Backfill $1.50/c.y.
Sheeting .25¢/s.F.

Excav + Backfill	4830 × $1.50 =	$7,250.
Sheeting	50,000 × .25 =	12,500
24" Pipe	600 × 2.40 =	1440
48" "	1100 × 7.00 =	7,700
Laying 24"	600 × .50 =	300
" 48"	1100 × 2.00	2200
		$31,390
Manholes. 4 @ 400		1600
Catch basins 8 @ 150		1200
		34190
Supervision 10%		3410
		37,600

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOWELL LOCAL PROTECTION

Computation: STRUCTURE COST (exclusive of drainage)

Computed by: [illegible] Checked by: Date: 10-23-40

LAKEVIEW AVE.

ITEM	QUANTITY	UNIT COST	COST
STEEL SHEET PILING	29,800 s.f.	@ 1.25	37,300
CAPPING		@ L.S.	600
BACKFILL	500 c.y.	@ 1.00	500
MISCELLANEOUS (pointing, etc)		@ L.S.	1,000
COMMON EXCAVATION	48,300 c.y.	@ 0.45	21,700
IMPERVIOUS FILL	15,500 c.y.	@ 0.80	12,400
DUMPED FILL	23,600 c.y.	@ 0.50	11,800
SAND & GRAVEL	10,500 c.y.	@ 1.00	10,500
SEEPAGE PIPE	2,700 l.f.	@ 1.80	4,900
CLEARING & DRESSING		@ L.S.	2,500
DISPOSAL MATERIAL	19,800 c.y.	@ 0.25	5,000
SUB-TOTAL			108,200
Eng'r. inspec. o'h'd & cont. (35%)			37,800
TOTAL COST			$ 146,000

ROSEMONT AREA

$ 50,000

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject .....

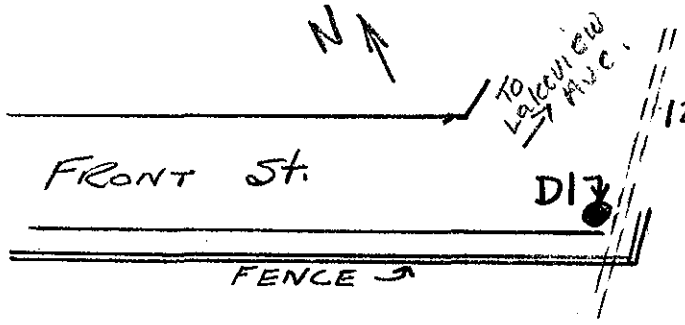
Computation .....

Computed by..... Checked by..... Date .....

Re Lowell

Dear John,

We do not have the exact location on any drill holes or test pits as yet so I can only give you an approximate location on D1. This is the best I can do at present.



Test pits #1 & #2 are located approximately 200 feet downstream from D4 and are on the river side of the dike. T1 at elev. approx 54 and T2 at elev. approx. 62. Am inclosing general classification of first 5 test pits. T5 is the auger hole between Beaver & Backman Streets. If you want anything else call me up or drop me a line

Glen Butterfield

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
~~Flood Control Division~~

Sheet 1 of 1

Date 10-31-[illegible]

GEOLOGICAL REPORT OF TEST PITS

Site [illegible]

Test Pits TP

Test Pit #	Depth From	Depth To		Sample #	Description
TP	[illegible]	[illegible]			SAND and GRAVEL fill. [illegible]
	4.1	6.0			[illegible] silty SAND [illegible] at 4.3' [illegible] SAND and GRAVEL [illegible]

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
~~Flood Control Division~~
Soils Laboratory

Sheet 1 of 1

Date 10-31-40

GEOLOGICAL REPORT OF TEST PITS

Site [illegible]

Test Pits T-[illegible]

Test Pit #	Depth From	Depth To		Sample #	Description
T2P					[illegible] fill.
	0.0	6.0			Strata of [illegible] sandy [illegible] from [illegible]

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
~~Flood Control Division~~
Soils Laboratory

Sheet 1 of 1

Date 10-31-40

GEOLOGICAL REPORT OF TEST PITS

Site [illegible]

Test Pits 75p

Test Pit #	Depth From	Depth To		Sample #	Description
75p	[illegible]	[illegible]			Ash fill with [illegible] [illegible] of foreign matter

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
~~Flood Control Division~~
Soils Laboratory

Sheet 1 of 1

Date 10-31-[illegible]

GEOLOGICAL REPORT OF TEST PITS

Site [illegible]

Test Pits T5p

Test Pit #	Depth From	Depth To		Sample #	Description
T5p	0.0	1.0			Loose to soil and sandy loam.
	1.0	11.5			Loose, silty, [illegible] SAND.
	11.5	14.5			Loose, fine to [illegible] SAND [illegible] SAND.

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
~~Flood Control Division~~
Soils Laboratory

Sheet 1 of 1

Date 10-31-40

GEOLOGICAL REPORT OF TEST PITS

Site [illegible]

Test Pits TAP

Test Pit #	Depth From	Depth To		Sample #	Description
TAP	0.0	15.5			Loose, uniform and medium dirty SAND. (Little amount of organic material). Ground Water at [illegible]

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
Flood Control Division

Sheet ____ of ____

Date _____

GEOLOGICAL REPORT OF TEST PITS

Site Lowell Dike

Test Pits D1

Test Pit #	Depth From	Depth To		Sample #	Description
	0.0				Filled Land
	4.0				Fine Sand
	14.5				Gravelly Sand
	22.0				Silt
	25.0				Silty & Gravelly Sand
	30.0				

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
Flood Control Division

Sheet ____ of ____

Date _____

GEOLOGICAL REPORT OF TEST PITS

Site Lowell Dike

Test Pits D2

Test Pit #	Depth From	Depth To		Sample #	Description
	0				Fill
	4.0				Fine Sand
	12.0				Gravelly Sand grading coarser toward bottom
	24.0				Silt.
	30.0				

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
Flood Control Division

Sheet ____ of ____

Date _____

GEOLOGICAL REPORT OF TEST PITS

Site Lowell Duke

Test Pits D3

Test Pit #	Depth From	Depth To		Sample #	Description
	0.0				Fill
	13.6				Fine Sand
	22.0				Gravelly Sand
	30.0				

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
Flood Control Division

Sheet ____ of ____

Date _____

GEOLOGICAL REPORT OF TEST PITS

Site Lowell Dike

Test Pits D 4

Test Pit #	Depth From	Depth To		Sample #	Description
	0.0				Portable Fill
					Gravelly Sand
	12.5				
					Silty Sand & Gravel
	20.0				

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
Flood Control Division

Sheet ____ of ____

Date _____

GEOLOGICAL REPORT OF TEST PITS

Site Lowell Duke

Test Pits D5

Test Pit #	Depth From	Depth To		Sample #	Description
	0.0				Fill
	5.0				Fine Sand
	12.5				Gravelly Sand
	24.0				Silt.
	30.0				

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
Flood Control Division

Sheet ____ of ____

Date _____

GEOLOGICAL REPORT OF TEST PITS

Site Lowell Dike

Test Pits D6

Test Pit #	Depth From	Depth To		Sample #	Description
	0.0				Fill
					Silty Sand
	17.0				
					Fine to Coarse Sand
	25.0				
					Silt.
	30.0				

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
Flood Control Division

Sheet ____ of ____

Date [redacted]

GEOLOGICAL REPORT OF TEST PITS

Site Lowell Dike

Test Pits D7

Test Pit #	Depth From	Depth To		Sample #	Description
	0.0				Fill Ashes, gravel, sand
	25.0 ↓				Gravelly Sand Probably 8 to 10 feet.

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
Flood Control Division

Sheet ____ of ____

Date _____

GEOLOGICAL REPORT OF TEST PITS

Site Lowell Dike

Test Pits T4

In Flat behind North End of Dike below Beacon Bridge

Test Pit #	Depth From	Depth To		Sample #	Description
	0.0				Fill
	1.0				Recent river fill Fine Sand
	7.5				Uniform fine Sand
	15.5				

D. O. Form 99

WAR DEPARTMENT

United States Engineer Office
Boston, Mass.
Flood Control Division

Sheet ____ of ____

Date _____

GEOLOGICAL REPORT OF TEST PITS

Beaver Brook

Site Lowell Dike

Test Pits T5

Test Pit #	Depth From	Depth To		Sample #	Description
		0.0			
					Fine Sand
		11.5			
					Coarse Sand
		15.0			

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOWELL LOCAL PROTECTION
Computation: STRUCTURE COST (exclusive of drainage)
Computed by: [illegible] Checked by: Date: 10-23-40

LAKEVIEW AVE.

ITEM	QUANTITY		UNIT COST	COST
STEEL SHEET PILING	29,800 s.f.	@	1.25	37,300
CAPPING		@	L.S.	600
BACKFILL	500 c.y.	@	1.00	500
MISCELLANEOUS (pointing, etc)		@	L.S.	1,000
COMMON EXCAVATION	48,300 c.y.	@	0.45	21,700
IMPERVIOUS FILL	15,500 c.y.	@	1.00	15,500
DUMPED FILL	23,600 c.y.	@	0.50	11,800
SAND & GRAVEL	10,500 c.y.	@	0.60	6,300
SEEPAGE PIPE	2,700 l.f.	@	1.80	4,900
CLEARING & DRESSING		@	L.S	2,500
DISPOSAL MATERIAL	19,800 c.y.	@	0.25	5,000
SUB-TOTAL				107,100
Eng'r. inspec. o'h'd & cont. (35%)				37,400
TOTAL COST				$144,500

ROSEMONT AREA

$ 50,000

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

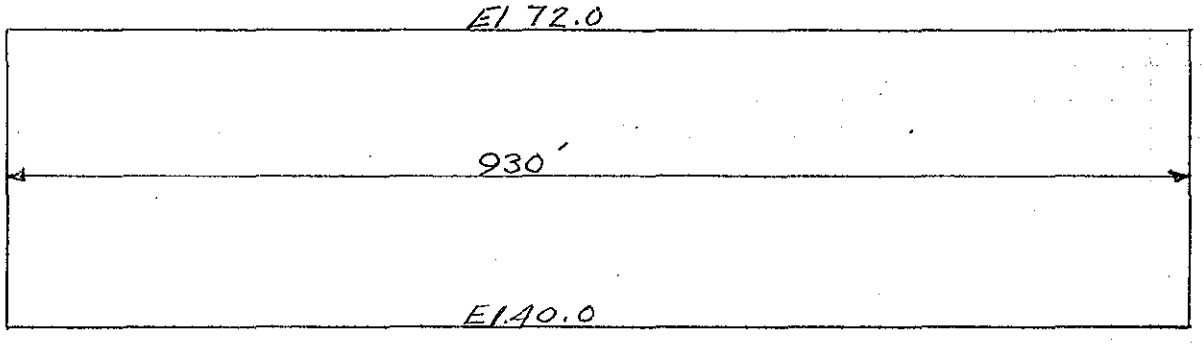
Subject: LOWELL LOCAL PROTECTION

Computation: SHEET PILING ALONG FRONT ST

Computed by: JWL Checked by: Date:

From drill holes in the vicinity the penetration depth is El 40

∴ SHEET PILING



Total Sheet Piling = 32 x 930 = 29,760 s.f.

Cost Sheet Piling = 29,760 @ 1.25 = $37,200

Capping $ 600

Total $37,800

Dunbar-Wolfe Ptg. Co. Boston 8-40 10m

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: Lowell Local Protection
Computation: Dike
Computed by: E.H. & P.A.B.
Checked by:
Date: 10-23-40
Page:

Sta	L	① L.S. Excavation			② W.S. Excavation			③ Top Pervious Fill			④ Slope (Pervious Fill)			⑤ Trench (Pervious Fill)			⑥ Impervious Fill			⑦ Sand & Gravel		
Q		104			280			15			120			84			144			150		
	100		92	9,200		292	29,200		15	1,500		128	12,800		106	10,600		136	13,600		125	12,500
R		80			304			15			136			128			128			100		
	100		96	9,600		324	32,400		15	1,500		104	10,400		120	12,000		158	15,800		106	10,600
S		112			344			15			72			112			188			111		
	100		126	12,600		446	44,600		16	1,600		154	15,400		110	11,000		178	17,800		94	9,400
T		140			548			17			236			108			168			77		
	100		94	9,400		446	44,600		16	1,600		184	18,400		88	8,800		144	14,400		87	8,700
U		48			344			15			132			68			120			96		
	100		60	6,000		330	33,000		32	3,200		134	13,400		64	6,400		122	12,200		84	8,400
V		73			316			49			136			61			124			73		
	100		74	7,400		296	29,600		45	4,500		128	12,800		66	6,600		136	13,600		74	7,400
W		74			276			41			120			70			148			74		
	100		90	9,000		280	28,000		62	6,200		142	14,200		87	8,700		142	14,200		90	9,000
X		107			284			84			164			104			136			107		
	100		166	16,000		304	30,400		66	6,600		158	15,800		102	10,200		152	15,200		122	12,200
Y		224			324			48			152			100			168			138		
	100		234	23,400		246	24,600		48	4,800		116	11,600		119	11,900		146	14,600		121	12,100
Z		244			168			48			80			138			124			104		
	175		242	42,350		264	46,200		34	5,950		110	19,250		139	24,325		162	28,350		102	17,850
AA		240			360			20			140			140			200			100		
	225		220	49,500		380	85,500		30	6,750		160	36,000		126	28,350		200	45,000		94	21,150
BB		200			400			40			180			112			200			88		
	1300			194,450			428,100			44,200			180,000			138,900			205,000			129,300
				7,200			15,900			1,640			6,660			5,140			7,600			4,800
Cross Trench				1,990												960			1,030			
				9,190												6,100			8,630			

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

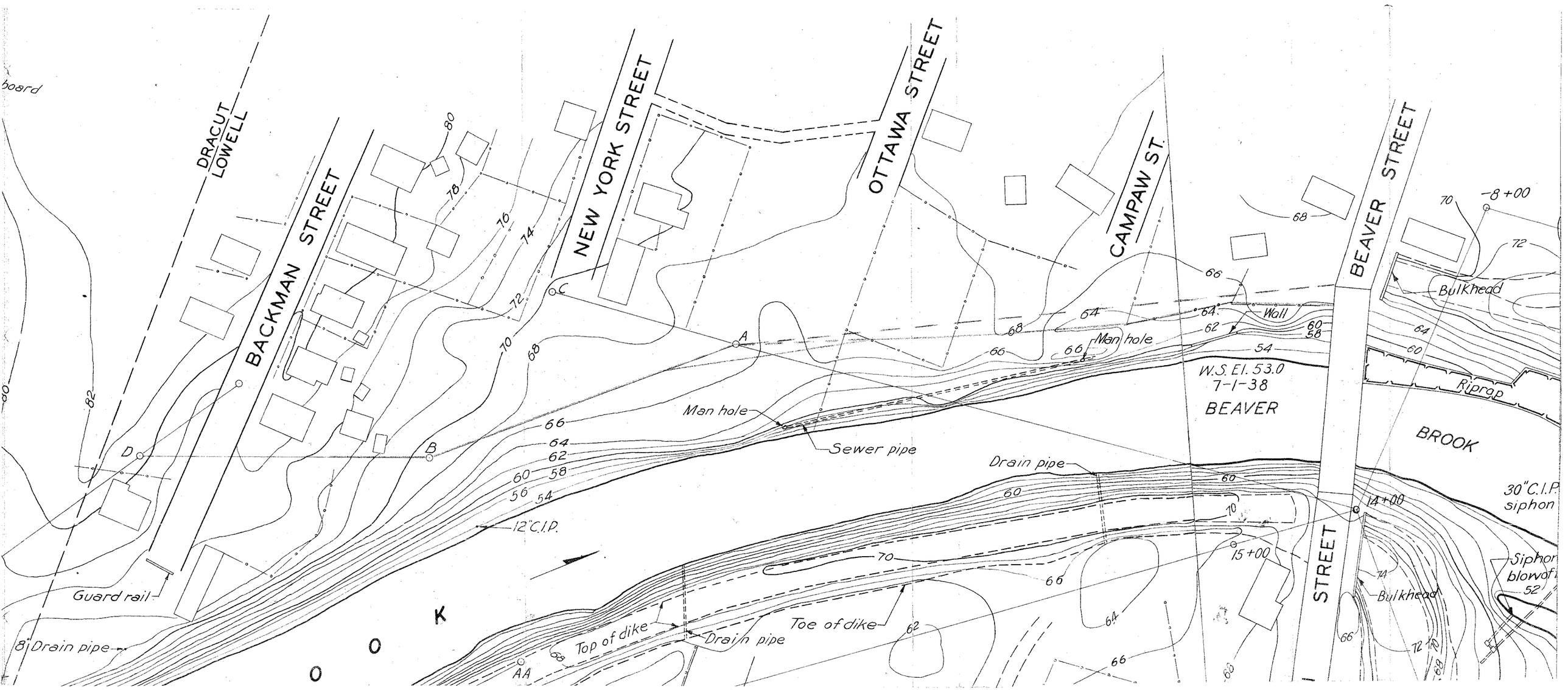
Page

Subject: LOCAL LOCAL PROTECTION

Computation: LAKEVIEW AVE - A-P

Computed by: MJG Checked by: Date:

STA	STA	DIST	EXCAVATION			IMP. BLANKET			SAND & GRAV.			Backfill		
			AREA	AVE AR.	VOL CY	AREA	AVE. AR.	VOL. CY	AREA	AVE AR.	VOL CY	Area	Ave Area	Vol cy
A	0+00		336			64			75			60		
		100		342	1266		64	237		75	278		60	222
B	1+00		348			64			75			60		
		100		324	1200		69	256		76	281		63	234
C	2+00		300			74			76			65		
		100		420	1555		101	374		77	285		64	237
D	3+00		540			128			79			64		
		72		500	1334		112	299		82	219		62	165
E	3+72		460			96			85			60		
		70		518	1343		132	342		88	228		70	182
F	4+42		576			168			91			80		
		58		670	1439		178	382		110	236		140	309
G	5+00		764			188			128			208		
		80		732	2168		176	521		134	397		272	807
H	5+80		700			164			120			336		
		42		636	989		162	252		132	205		308	479
I	6+22		572			160			124			280		
		64		598	1417		180	427		104	246		326	773
J	6+86		624			200			84			372		
		39		622	898		204	299		90	130		366	288
K	7+25		620			208			96			360		
		75		632	1755		200	555		92	255		474	1315
L	8+00		644			192			88			588		
		100		586	2170		220	815		112	415		468	1734
M	9+00		528			248			136			348		
		100		484	1792		218	807		162	600		256	950
N	10+00		440			188			188			164		
		100		480	1777		166	615		228	844		196	727
O	11+00		520			144			268			228		
		100		574	2126		188	696		296	1096		196	727
P	12+00		628			232			324			164		
		100												9149 c.y.
					23,229			6,877			5715			


board
DRACUT
LOWELL
BACKMAN STREET
NEW YORK STREET
OTTAWA STREET
CAMPAW ST.
BEAVER STREET
STREET
BEAVER
BROOK
O O K
W.S. El. 53.0
7-1-38
Man hole
Sewer pipe
Drain pipe
Man hole
Wall
Bulkhead
Riprap
30" C.I.P.
siphon
Siphon
blowoff
Bulkhead
12" C.I.P.
Guard rail
8" Drain pipe
Top of dike
Drain pipe
Toe of dike
-8+00
14+00
15+00
A
B
C
D
AA
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52

Dunbar-Wolfe Ptg. Co. Boston 8-40 10m

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

Subject: LOCAL PROTECTION - LOWELL, MASS

Computation

Computed by: Jwk Checked by: Date: 10-7-40

ITEM	CONTRIBUTING AGENCY U.S.	CONTRIBUTING AGENCY LOCAL
A. BRIDGE ST - AIKEN ST.		
WALL PROTECTION - 850 l.f.		
CONCRETE & REINFORCING	10,400	
STEEL SHEET PILING	18,800	
MISCELLANEOUS	1,900	
EMBANKMENT - 2700 l.f.	79,300	
DRAINAGE		
PUMPING STATION	87,600	
INTERCEPTING SEWERS - 1800 l.f.		39,000
SEEPAGE DRAINS	6,000	
LAND & BUILDINGS		4,500
AGENCY COST	204,000	43,500
TOTAL COST	$ 247,500	
B. ROSEMONT		
EMBANKMENT		
BACHMAN ST - BEAVER ST. - 850 l.f.	15,300	
BEAVER ST downstream - 850 l.f.	16,700	
BULKHEAD (BEAVER ST)	4,000	
DRAINAGE		
PUMPING STATION	34,000	
INTERCEPTING SEWERS - 950 l.f.		13,500
SEEPAGE DRAINS	1,500	
LAND & BUILDINGS		1,500
AGENCY COST	71,500	15,000
TOTAL COST	$ 86,500	

LOCAL PROTECTION - GRAND TOTAL - $ 334,000

Dunbar-Wolfe Ptg. Co. Boston 8-40 10m

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOWELL LOCAL PROTECTION

Computation: COST SUMMARY

Computed by: [illegible] Checked by: Date: 10/5/40

Page:

		PROTECTED AREA								
		BRIDGE-AIKIN STS.			BEAVER ST. downstream			BEAVER-BACHMAN STS.		
		Q	Unit Cost	Cost	Q	Unit Cost	Cost	Q	Unit Cost	Cost
	PILING WALL									
s.f.	STEEL SHEEET PILING	11,100	1.25	13,900						
c.y.	CONCRETE CAPPING	315	20.00	6,300						
#	REINFORCING	28,500	0.05	1,400						
c.y.	EXCAVATION	300	1.00	300						
c.y.	BACKFILL	200	0.50	100						
	MISCELLANEOUS	L.S.		1,000						
	EMBANKMENT									
c.y.	STRIPPING				2,000	0.40	800	3,900	0.40	1,600
"	COMMON EXCAVATION	30,200	0.45	13,600	1,000	0.40	400	1,200	0.40	500
"	COMPACTED FILL							7,800	0.60	4,700
"	IMPERVIOUS BLANKET	21,100	0.80	16,900	7,000	0.80	5,600	3,900	0.80	3,100
s.f.	SHEET PILING				2,600	1.25	3,300			
c.y.	SAND & GRAVEL	6,200	0.60	3,700	3,000	0.60	1,800	2,000	0.60	1,200
Acres	SEEDING	1.5	1000.00	1,500	0.5	1000.00	500	0.2	1000.00	200
	BULKHEAD (BEAVER ST.)							L.S.		3,000
	SUB-TOTAL			58,700			12,400			14,300
	En'g, o'h'd, inspection - 35%			20,300			4,300			5,000
	TOTAL	$79,000			$16,700			$19,300		

∴ BRIDGE - BEAVER STS. = $ 95,700

BRIDGE - BACHMAN STS. = $ 115,000

Dunbar-Wolfe Ptg. Co. Boston 8-40 10m

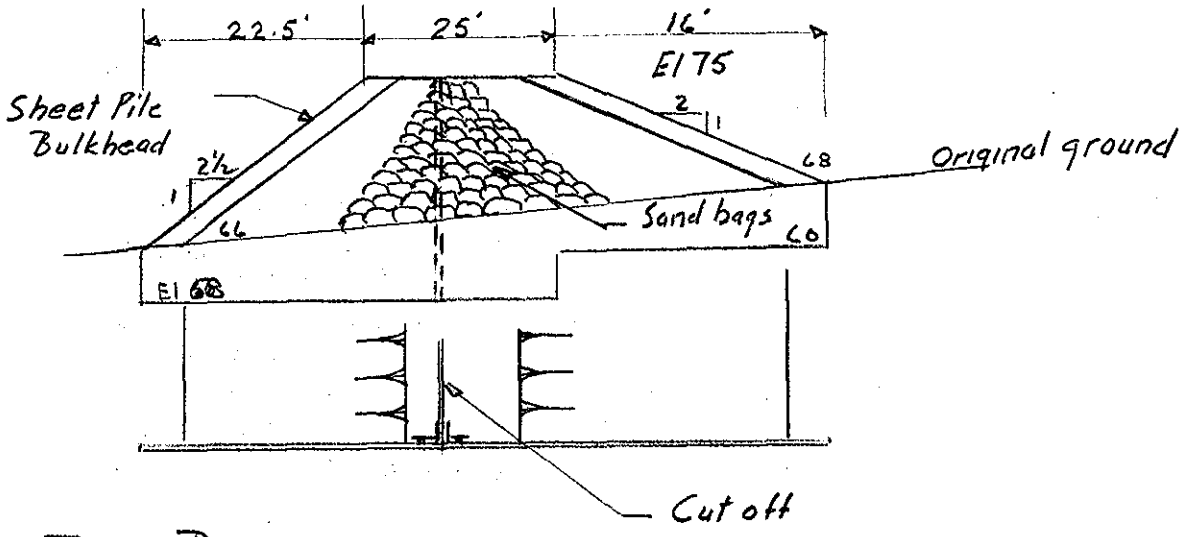
WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOWELL LOCAL PROTECTION

Computation: BEAVER ST BULKHEAD

Computed by: JWL Checked by: Date:



TOTAL PILING

Walls 17 x 25 + 8 x 22.5 + ½ x 9 x 22.5 + 16 x 8 + ½ x 16 x 7 = 890 □'

Cut off 17 x 10 170 □'

1060

∴ 2 x 1060 = 2120 @ 1.25 = $2,650

Say $2,700

CONSTRUCTION OF SAND BAG STORAGE & SAND + CONCRETE CAP - $ 300

TOTAL COST OF BULKHEAD - $ 3,000

Dunbar-Wolfe Ptg. Co. Boston 8-40 10m

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

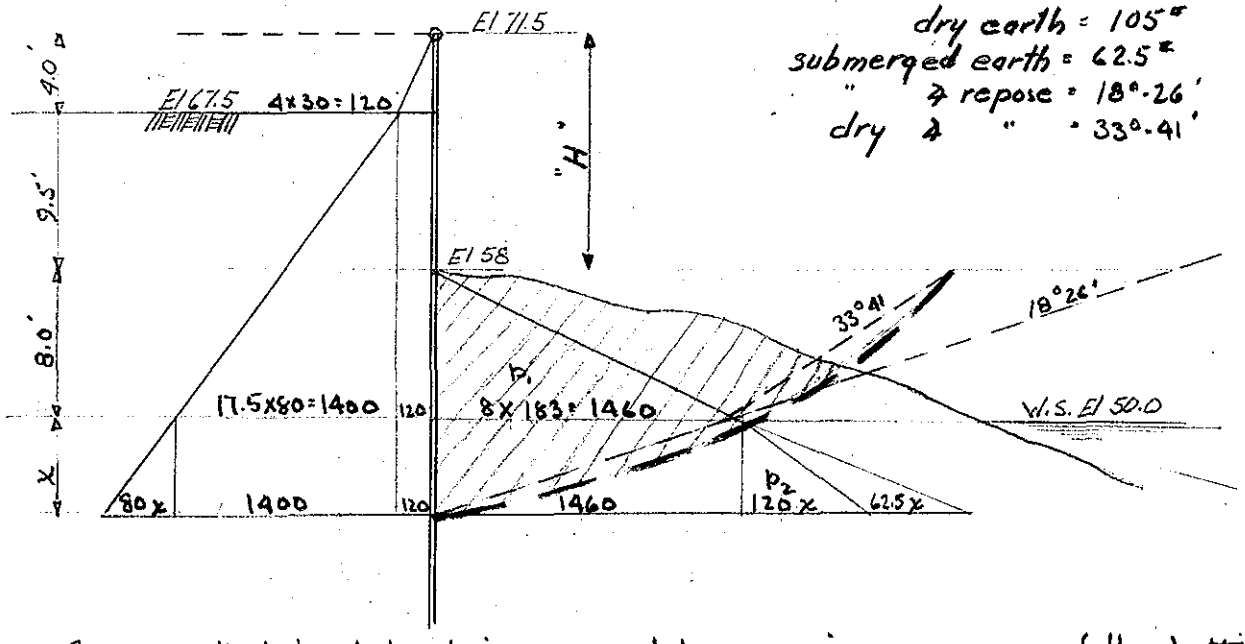
Subject: LOCAL PROTECTION - LOWELL, MASS.

Computation: SHEET PILING

Computed by: [illegible] Checked by: Date: 9-23-40

Scale 3/32" = 1'-0"

dry earth = 105#
submerged earth = 62.5#
" ∠ repose = 18°-26'
dry ∠ " = 33°-41'



Assume that land load is opposed by passive pressure of the bottom

$p_1 = 105 \tan^2[45° + \frac{1}{2}(33°41)] = 105\,(3.49)$

since ground is not level assume 50% load factor

$\therefore p_1 = 105\,(3.49)\,(0.5) = 183$ #/□

$p_2 = 62.5 \tan^2[45° + \frac{1}{2}(18°26')] = 62.5\,(1.925) = 120$ #/□

$$1460(4)(18.83) + 1460(x)\left(21.5 + \frac{x}{2}\right) + 182.5(x)\left(\frac{x}{2}\right)\left(21.5 + \frac{2x}{3}\right) =$$

$$120(2)(2.67) + 1400\left(\frac{17.5}{2}\right)(15.67) + 80x\left(\frac{x}{2}\right)\left(21.5 + \frac{2x}{3}\right) + 1520x\left(21.5 + \frac{x}{2}\right) + 120(17.5)(12.75)$$

$$110{,}000 + 102.5(x)\left(\frac{x}{2}\right)\left(21.5 + \frac{2x}{3}\right) = 640 + 192{,}000 + 60x\left(21.5 + \frac{x}{2}\right) + 26{,}800$$

$$-109{,}500 + 1095x^2 + 34x^3 = 1290x + 30x^2$$

$$34x^3 + 1065x^2 + 1290x = 109{,}500$$

x	
7	11,650 + 52,150 + 9,000 = 72,800
8	17,400 + 68,000 + 10,300 = 95,700
8.5	21,100 + 77,300 + 11,000 = 109,400

$\therefore x = 8.5'$

Depth of penetration = 16.5'

" " " = 125% H

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: LOCAL PROTECTION - LOWELL, MASS

Computation: SHEET PILING

Computed by: [illegible] Checked by: Date:

$M_{at\ El\ 58} = 120(4)(\tfrac{1}{2})(10.83) + 120(9.5)(4.75) + \tfrac{1}{2}(80)(9.5)(9.5)(3.17)$

$= 2600 + 5400 + 11{,}400 = 19{,}400$ ft #

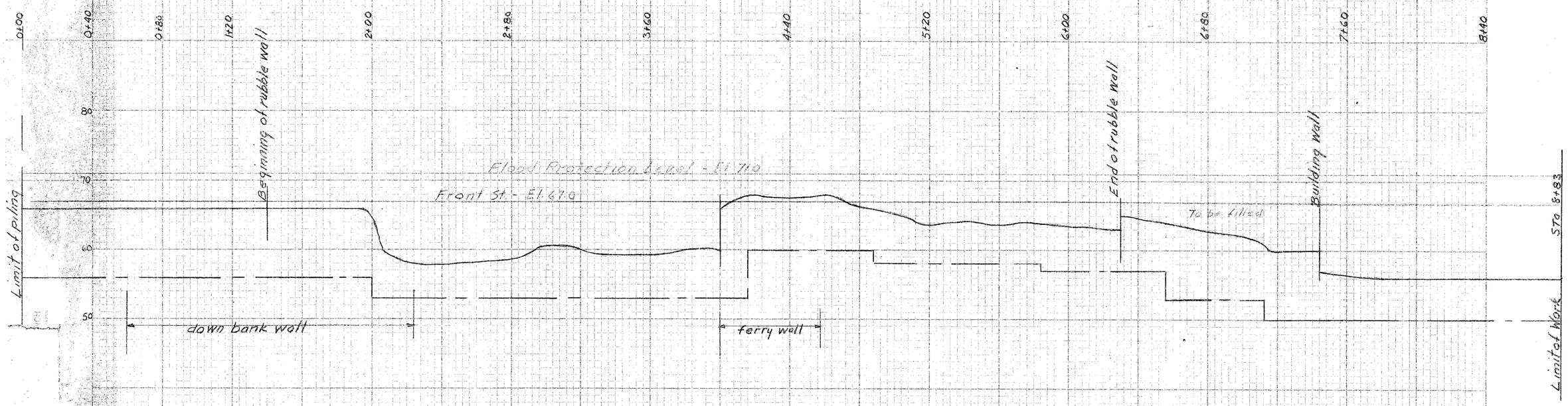
$S = M \div f = 19{,}400 \times 12.0 \div 20{,}000 = 11.7\ in^3$ / ft. of wall

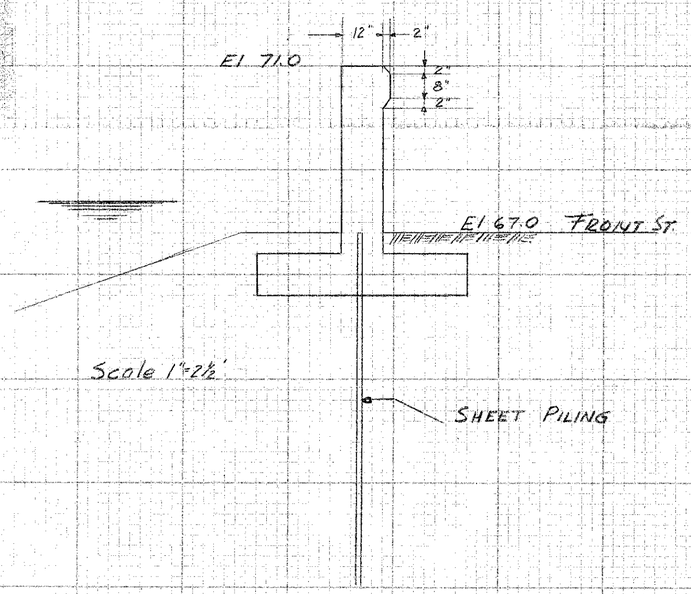
S requires MZ 32 - $S = 38.3\ in^3$ - wgt = 32 #/□

or M 110 - $S = 15.3\ in^3$ - wgt = 32 #/□

although these piles weigh the same the increased beam strength of the MZ32 under exigencies dictates its selection

∴ Use MZ32 Carnegie Z Piles





Cost of Wall Protection - LOWELL MASS.

SHEET PILING

Abutment Seal	6 x 17	=	102	@ 1.25	= 150
STA 0+00 - 2+00	11 x 200	=	2,200		
2+00 - 4+16	14 x 216	=	3,024		
4+16 - 4+88	7 x 72	=	504		
4+88 - 5+84	9 x 96	=	864		
5+84 - 6+56	10 x 72	=	720		
6+56 - 7+12	14 x 56	=	784		
7+12 - 8+83	17 x 171	=	2,907		
		Total	11,000 □'	@ $1.25	= $13,750
					$13,900

CONCRETE CAP

Stem	4½ x 1	= 4.50
Base	5 x 1	= 5.00
Coping (1+0.67)½ x ½		= 0.14
		9.64 c.f. = 0.358 c.y./l.f.

∴ Total concrete = 0.358 x 883 = 315 c.y. @ 20.00 = $ 6,300
Reinforcing = 315 x 90 = 28,500# @ 0.05 = 1,400

TOTAL CAPPING $ 7,700

EXCAVATION

½7 x 6 x 1.5 x 883 = 300 c.y. @ 1.00 = $300

BACKFILL

½7 x 40 x 120 x ½ x 7 x ⅓ = 210 c.y. @ 0.50 = $ 100

MISCELLANEOUS

500

TOTAL WALL COST $22,500

KEUFFEL & ESSER CO. NEW YORK.

Dunbar-Wolfe Ptg. Co. Boston 8-40 10m

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

Subject: Lowell ~ Local Protection

Computation: Dike Quantities - Beginning at Beaver St & going South to Dump

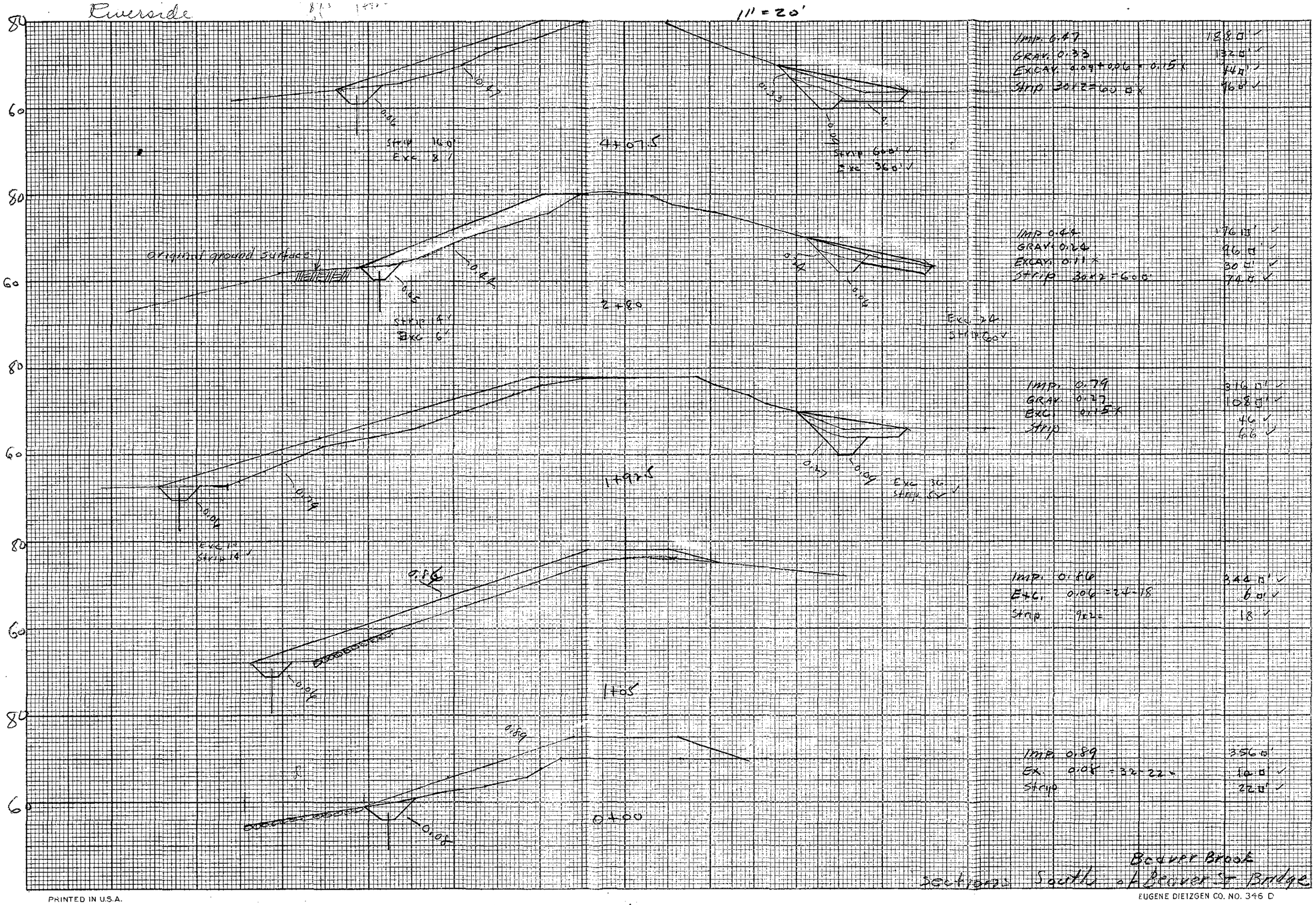
Computed by: V.K. Checked by: M.J.G. Date: 10/5/40

Sta		Stripping A	Stripping Av			Excavation		Gravel			Impervious			Sheeting			Seeding Av	
0+00		22.			10.			0			356.							
	105		20.	2100		8.	840		0	0		350.	36750.				15	1575
1+05		18.			6.			0			344.							
	87.5		42.	3675.		26.	2275		54	4725.		330.	28875.				21	1840.
1+92.5		66.			46.			108.			316.							
	87.5		70.	6125.		38.	3325		102.	8925.		246.	21525.				32	2800.
2+80		74.			30.			96.			176.							
	127.5		75.	9562.		37.	4718		114.	14535.		182.	23205.				33	4210
4+07.5		76.			44.			132.			188.							
	127.5		74.	9435.		38.	4845		130.	16575.		190.	24225.				26	3320
5+35		72.			32.			128.			192.							
	82.5		72.	5940.		32.	2640.		130.	10725.		194.	16005.				25	2065
6+17.5		72.			32.			132.			196.			10'				
	82.5		72.	5940.		28.	2310.		120.	9900.		194.	16005.		10	825	28	2310.
7+00		72.			24.			108.			192.			10				
	90		70.	6300.		35	3150		98.	8820.		150.	13500.		10	900	30	2700
7+90		68.			46.			88.			108.			10				
	90		49.	4410.		34	3060		60.	5400.		82.	7380.		10	900	25	2250
8+80		30.			22.			32.			56.			10				
	880																	
			53487			22163			79605			187470				2625 □'		23,070
			1981			1006			2948			6943						

Stripping	1980 c.y
Excavation	1010 c.y.
Gravel	2950 c.y.
Impervious	6940
Sheeting	2620 □'
Seeding	153 Acres

Riverside

1" = 20'



Section: South of Beaver St Bridge

Beaver Brook

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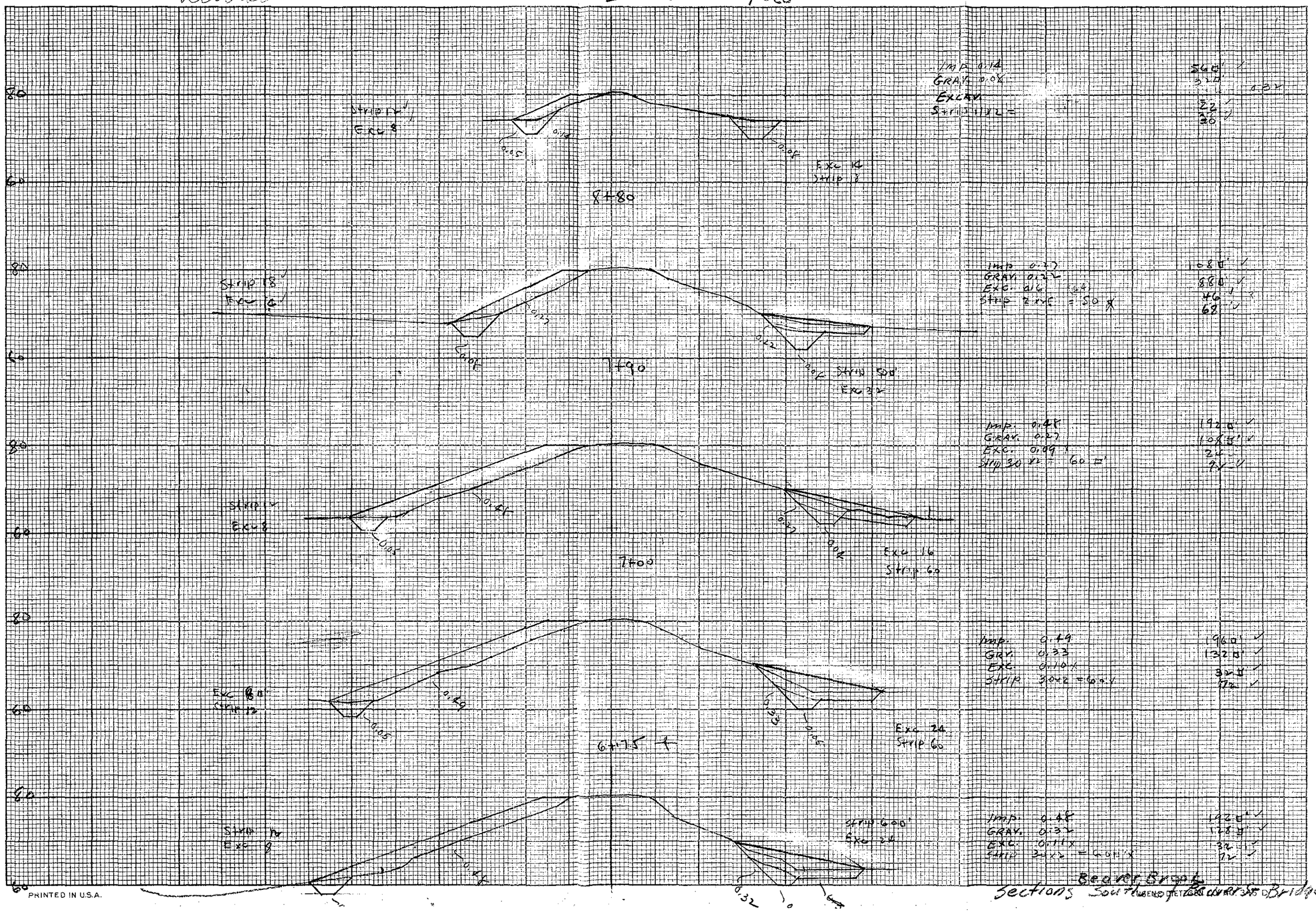
EUGENE DIETZGEN CO. NO. 346 D

0+00



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Dunbar-Wolfe Ptg. Co. Boston 8-40 10m

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

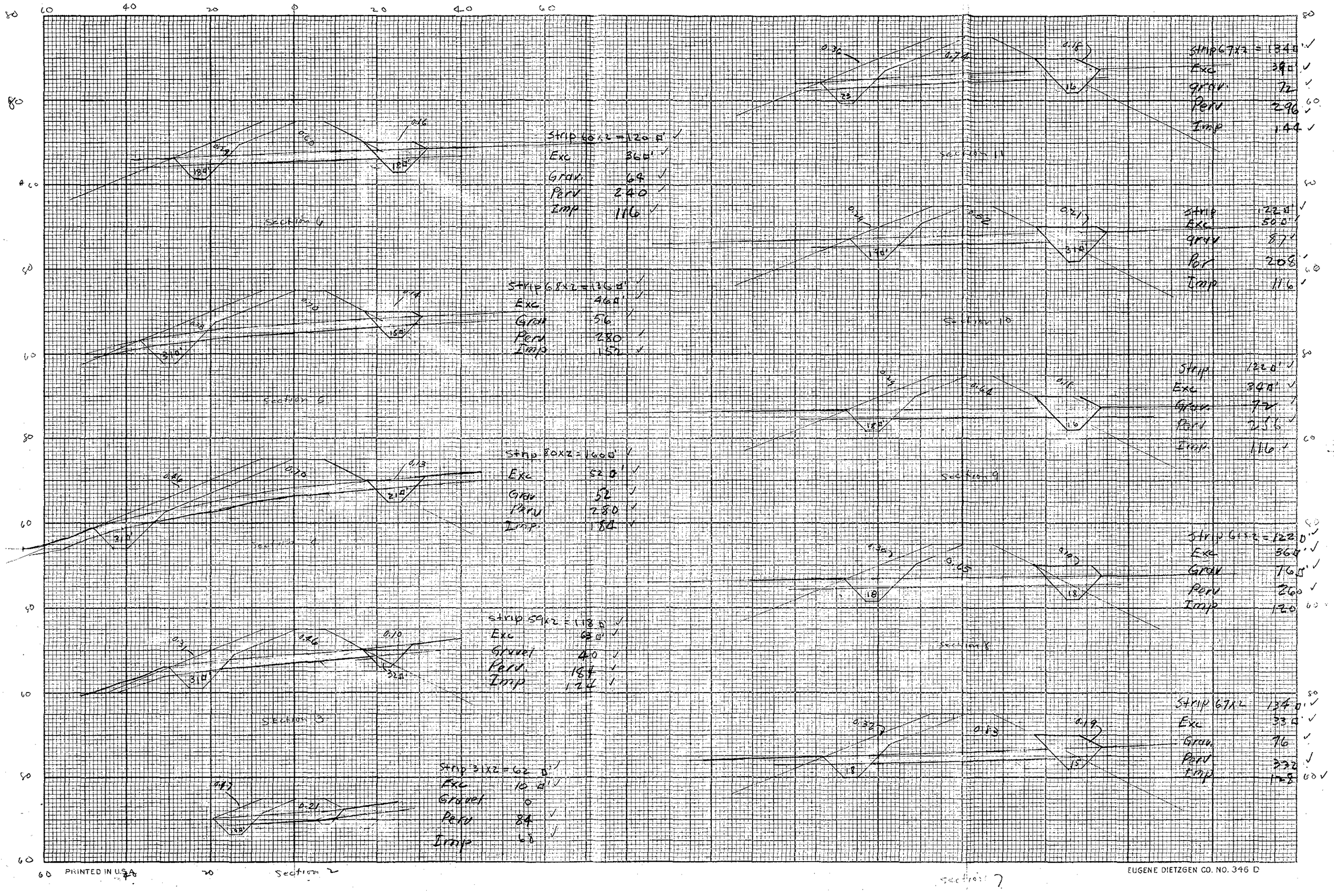
Subject Lowell ~ Local Protection

Computation Dike North of Beaver St Bridge to Backman

Computed by M.G **Checked by** V.H.K **Date**.....

	Stripping				Excavation			Gravel			Pervious			Imp		
	L															
1		0			0			0			0			0		
	54		31	1680.		5	270.		0	0		42	2270.		34	1840.
2		62			10			0.			84			68.		
	62		90	5580.		36	2230.		20	1240.		134	8300.		96	5950.
3		118.			63.			40.			184			124		
	46		139	6400.		58	2670.		46	2120.		232	10700		154	7100.
4		160.			52.			52			280			184		
	40		148	5920.		49	1960.		54	2160.		280	11200.		168	6720.
5		136.			46.			56.			280			152		
	100		128	12800.		41	4100.		60	6000.		260	26000.		134	13400.
6		120			36.			64.			240			116		
	100		127	12700.		34	3400.		70	7000.		286	28600.		122	12200.
7		134.			33.			76			332			128		
	84		128	10750.		35	2940.		76	6380.		296	24800.		124	10400.
8		122.			36.			76			260			120		
	32		122	3910.		35	1120.		74	2370.		258	8250.		118	3780.
9		122.			34.			72.			256			116		
	50		122	6100.		42	2100.		80	4000.		232	11600.		116	5800.
10		122			50.			87			208			116		
	108		128	13800.		45	4860.		79	8530.		252	27200.		130	14050.
11		134.			39.			72			296			144		
	50		134	6700.		36	1800.		74	3700.		302	15100.		142	7100.
12		134			33.			76			308			140		
	66		130	8600.		38	2510.		80	5280.		284	18760.		130	8600.
13		126.			44			84			260			120		
	66		125	8250.		42	2780.		82	5410.		256	16900.		122	8060.
14		124			41.			80			252			124		
				103190			32740			54190			209680			105,000
				3821.			1210			2005			7750			3885

Stripping	3 820 cy
Excavation	1210
Gravel	2000
Pervious	7750
Impervious	3890
Seeding	121 acres



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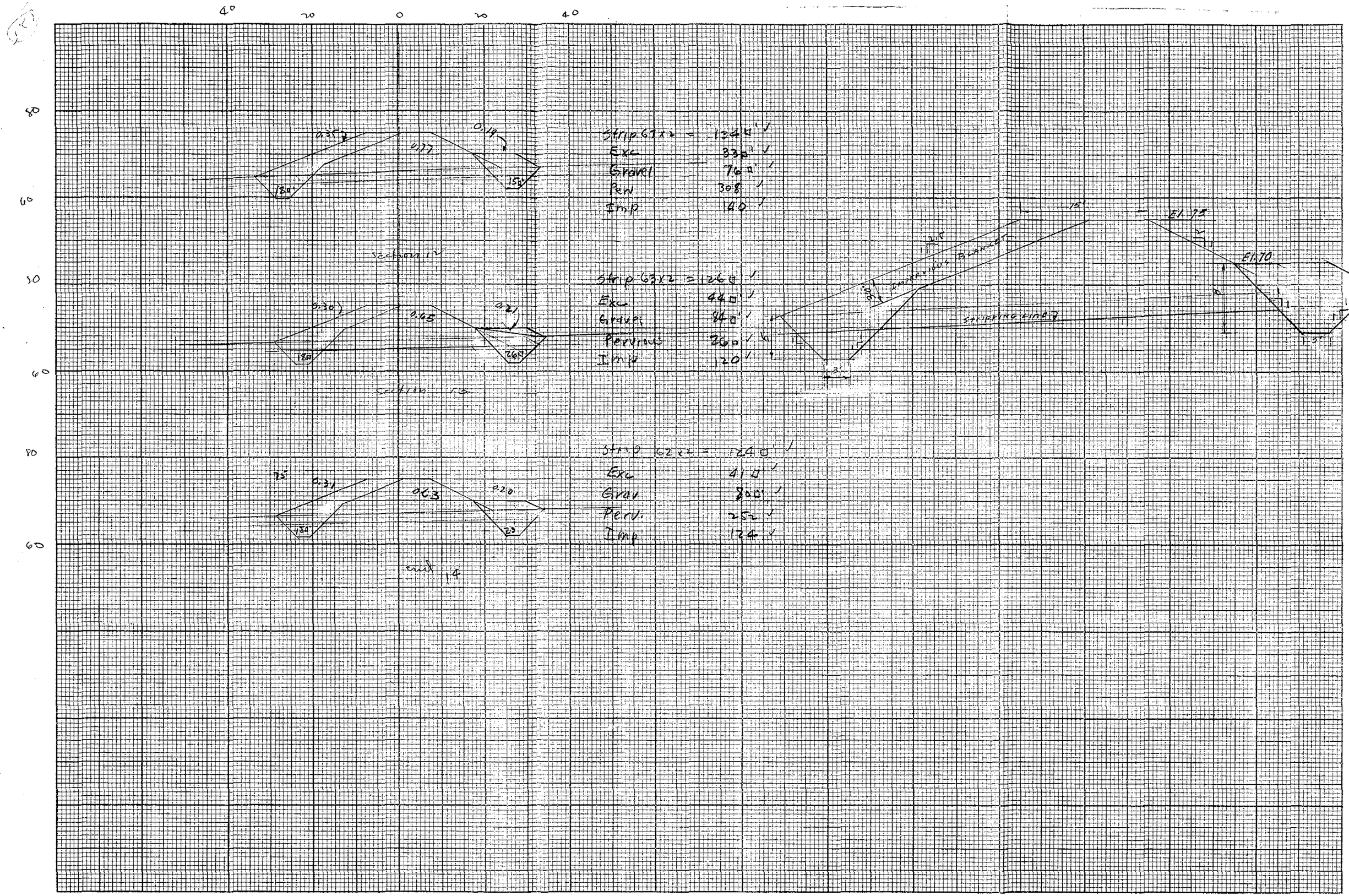
EUGENE DIETZGEN CO. NO. 346 D



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EUGENE DIETZGEN CO. NO. 346 D

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

Subject: LOWELL LOCAL PROTECTION

Computation: DIKE - BRIDGE ST - AIKEN ST

Computed by: W.W.T. Checked by: J.F.H- Date: 10/4/90

STA.	D.	Excavation			Material A (2')			Material B (3')		
		A.	Av. A.	Vol. c.y.	A	Av. A.	Vol. c.y.	A	Av. A.	Vol. c.y.
A		312			132			212		
	151		324	1,811		136	761		218	1,219
B		336			140			224		
	176		342	2,229		120	782		214	1,395
C		348			100			204		
	155		402	2,307		112	643		208	1,194
D		456			124			212		
	257		490	4,664		142	1,352		220	2,094
E		524			160			228		
	191		434	3,070		144	1,019		212	1,500
F		344			128			196		
	112		308	1,278		136	564		204	846
G		272			144			212		
	171		296	1,875		176	1,115		190	1,203
H		320			208			168		
	177		258	1,691		196	1,285		190	1,245
J		196			184			212		
	230		264	2,249		152	1,295		200	1,704
K		332			120			188		
	186		344	2,369		150	1,033		224	1,543
L		356			180			260		
	230		302	2,572		174	1,482		242	2,061
M		248			168			224		
	217		192	1,543		214	1,720		210	1,688
N		136			260			196		
	187		148	1,025		320	2,216		210	1,454
P		160			380			224		
	326		126	1,521		230	2,777		162	1,956
Q		92			80			100		
				30,204			18,044			21,102

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

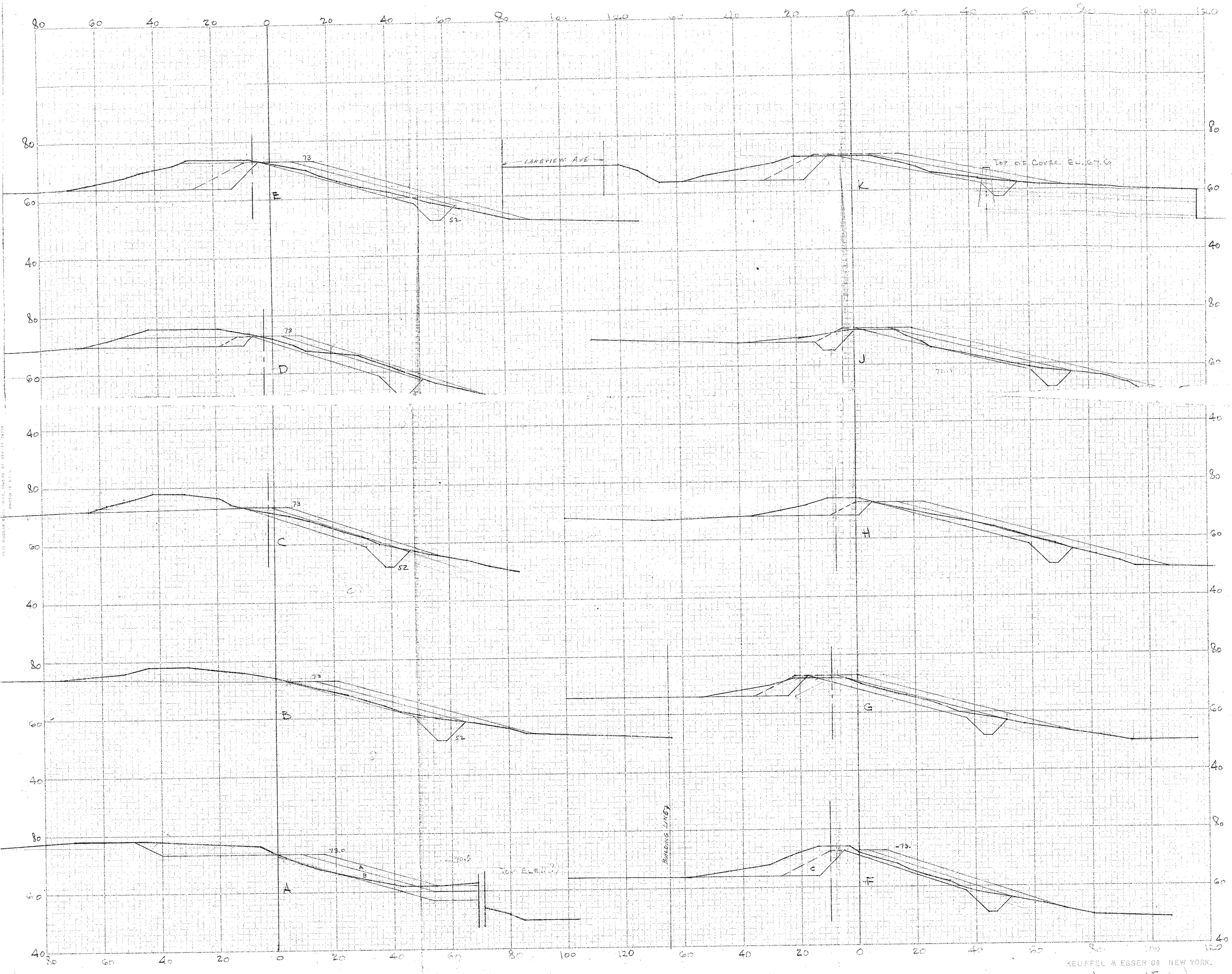
Subject.....

Computation.....

Computed by..... Checked by..... Date.....

Material C (S&G)

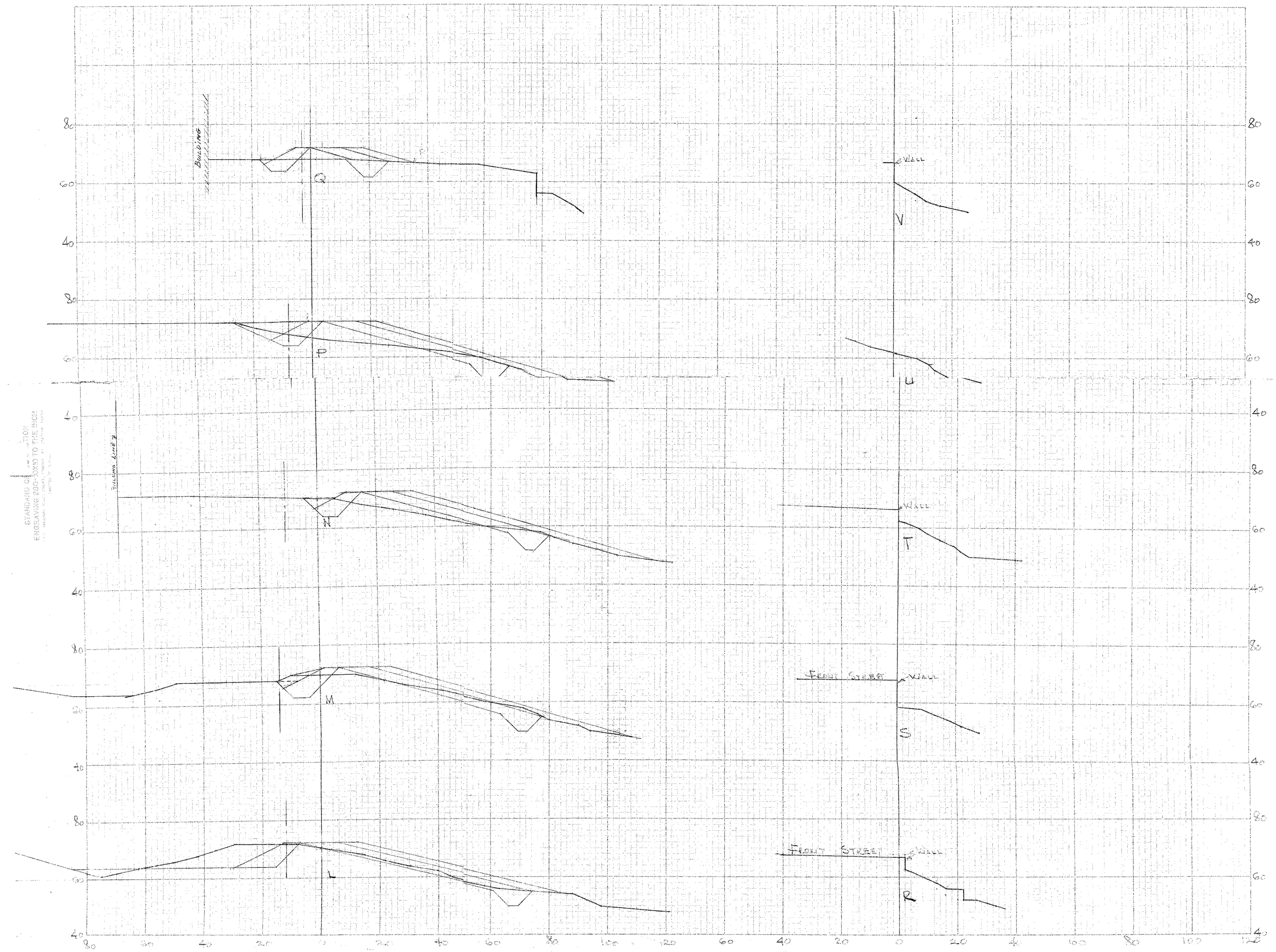
0		
	10	57
20		
	52	495
84		
	82	580
80		
	70	290
60		
	48	304
36		
	46	302
56		
	68	579
80		
	84	579
88		
	98	835
108		
	98	788
88		
	76	526
64		
	68	821
72		
		6,156



KEUFFEL & ESSER CO. NEW YORK.

LOWELL

SCALE 1"=20' H &



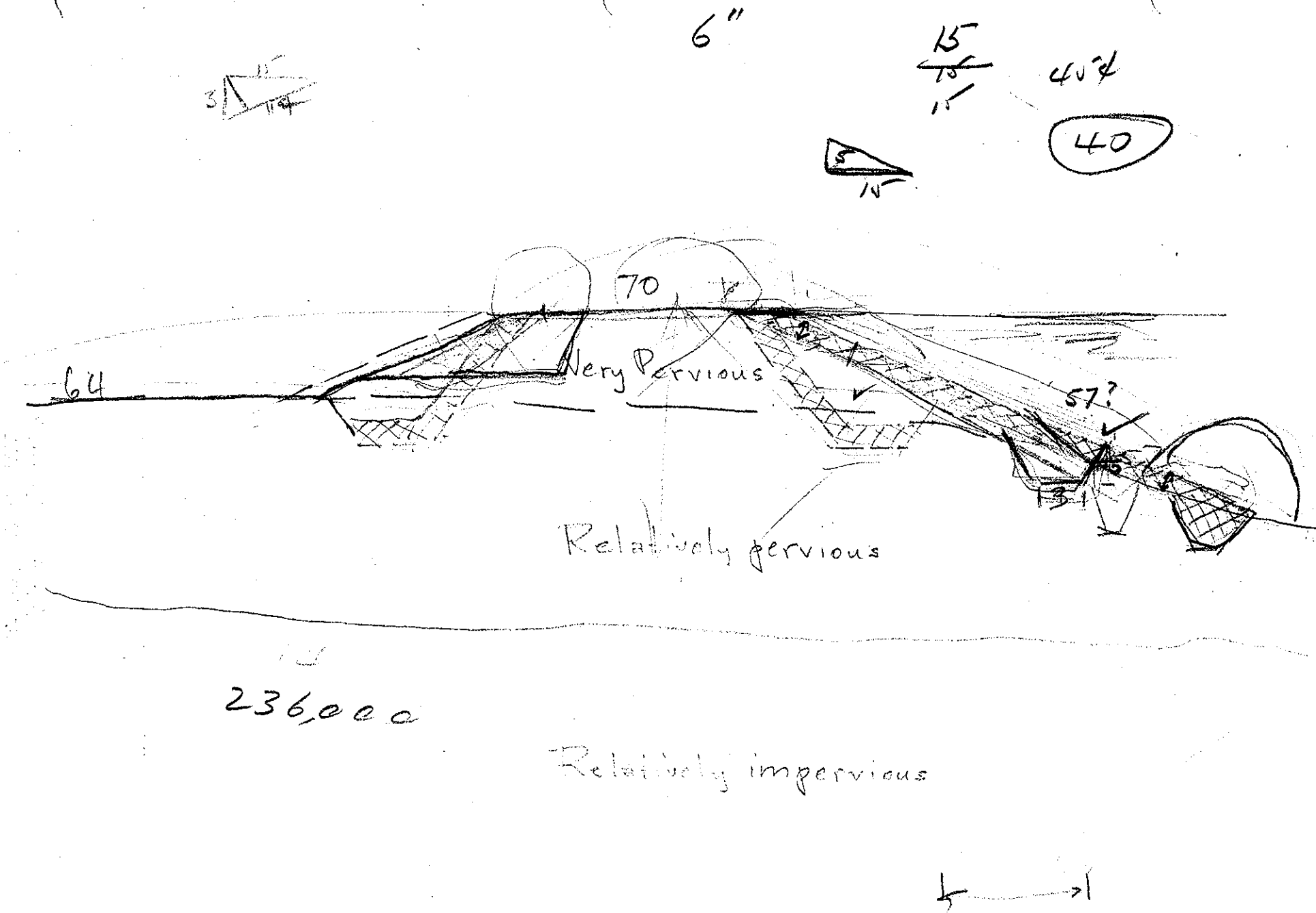
STANDARD CROSS SECTION
ENGRAVING 280-10X10 TO THE INCH

KEUFFEL & ESSER CO. NEW YORK.

LOWELL

SCALE 1"=20'

H & V


6"
40
70
64
Very Pervious
57?
Relatively pervious
236,000
Relatively impervious

WAR DEPARTMENT

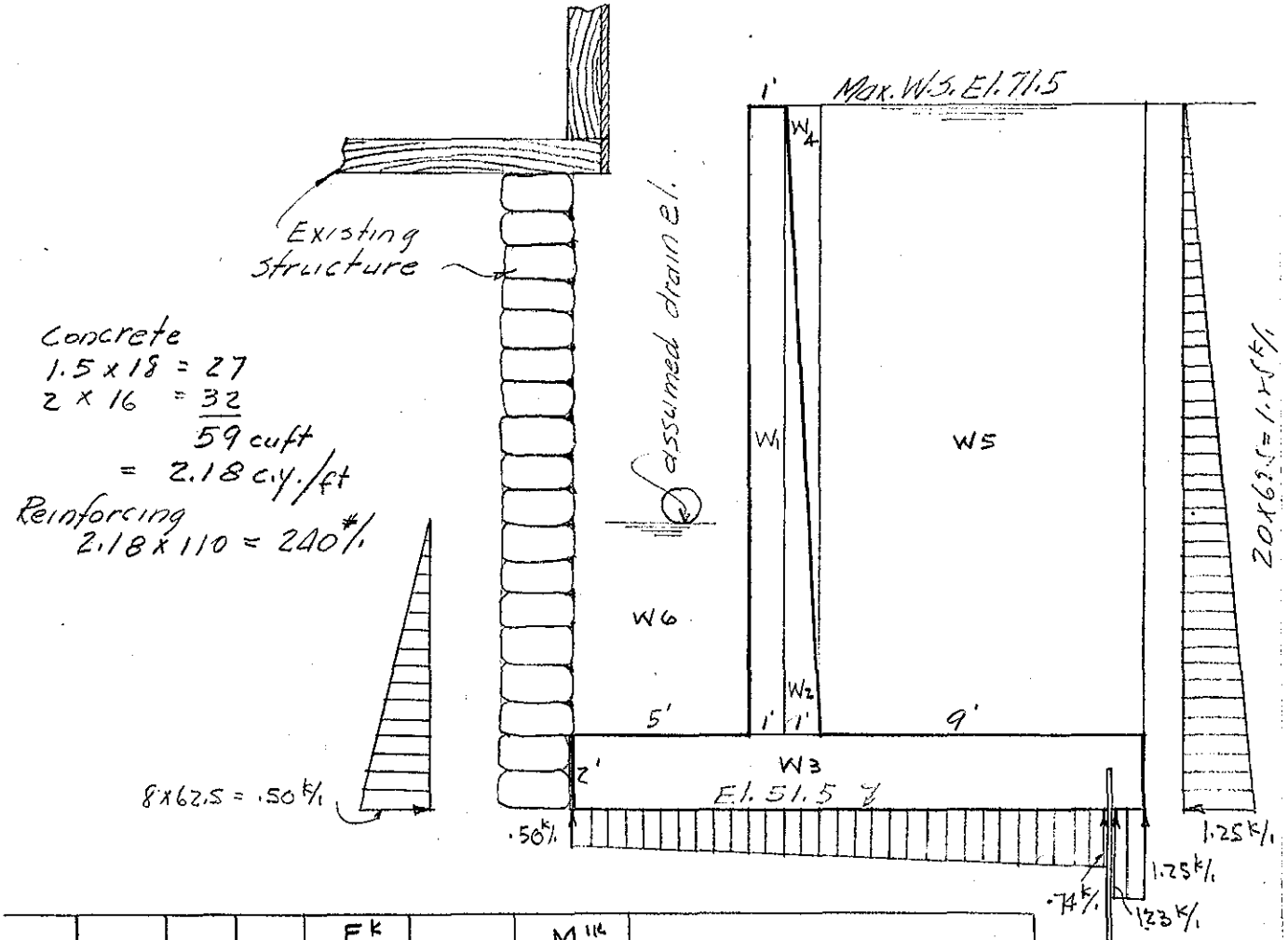
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page 1

Subject Lowell

Computation Local Protection Section thru' Bldg adj. to Bridge St.

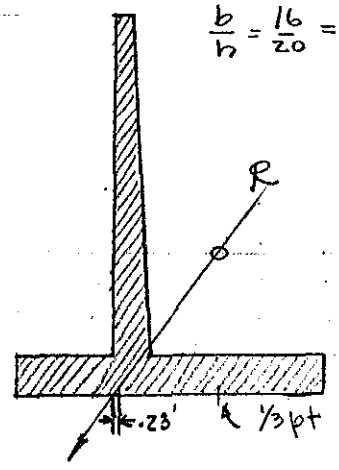
Computed by V.H.K. Checked by W.W.T. Date 9/27/40



				F k		M 'k
W1	1 x 18	18	150	2.70	5.50	14.85
2	.5 x 18	9	150	1.35	6.33	8.56
3	2 x 16	32	150	4.80	8.00	38.40
4	.5 x 18	9	62.5	.56	6.67	3.74
5	9 x 18	162	62.5	10.15	11.50	117.00
6	5 x 6	30	62.5	1.88	2.50	4.70
Pile				4.00	15.00	60.00
U1	.50 x 15			-7.50	7.50	-56.25
U2	.12 x 15			-1.80	10.00	-18.00
U3	1.24 x 1			-1.24	15.50	-19.30
			ΣV	14.90		
P1	1.25 x 10			-12.50	6.67	-83.30
P2	.50 x 4			+2.00	2.67	+5.33
			ΣH	-10.50	ΣM	75.73

$\frac{\Sigma H}{\Sigma V} = \frac{10.50}{14.90} = .7$

$\frac{b}{h} = \frac{16}{20} = .80$



$\frac{\Sigma M}{\Sigma V} = \frac{75.73}{14.90} = 5.1'$

1/3 pt. = 5.33'

outside .23'

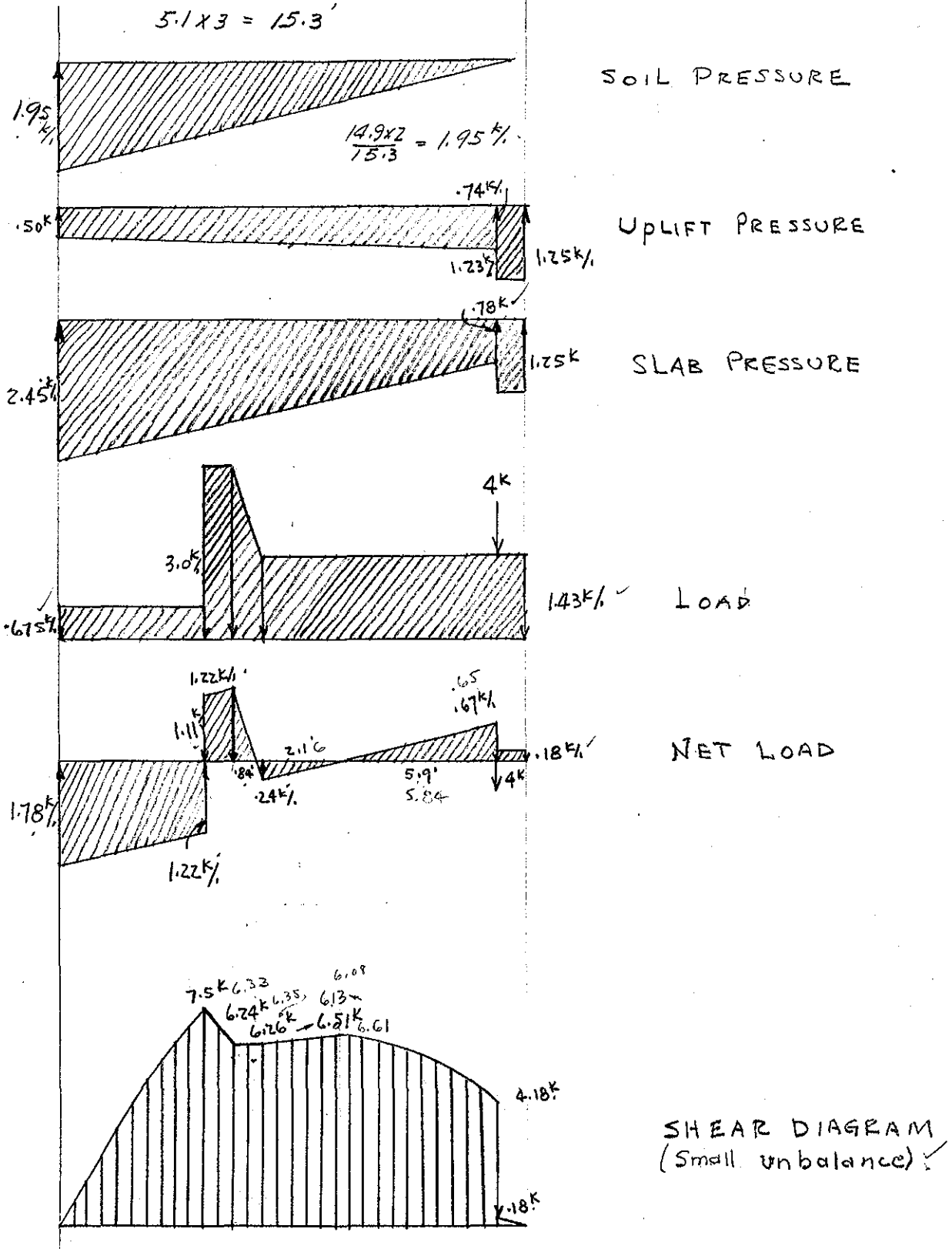
WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: Lowell

Computation: Local Protection

Computed by: V.H.K Checked by: W.W.T. Date:

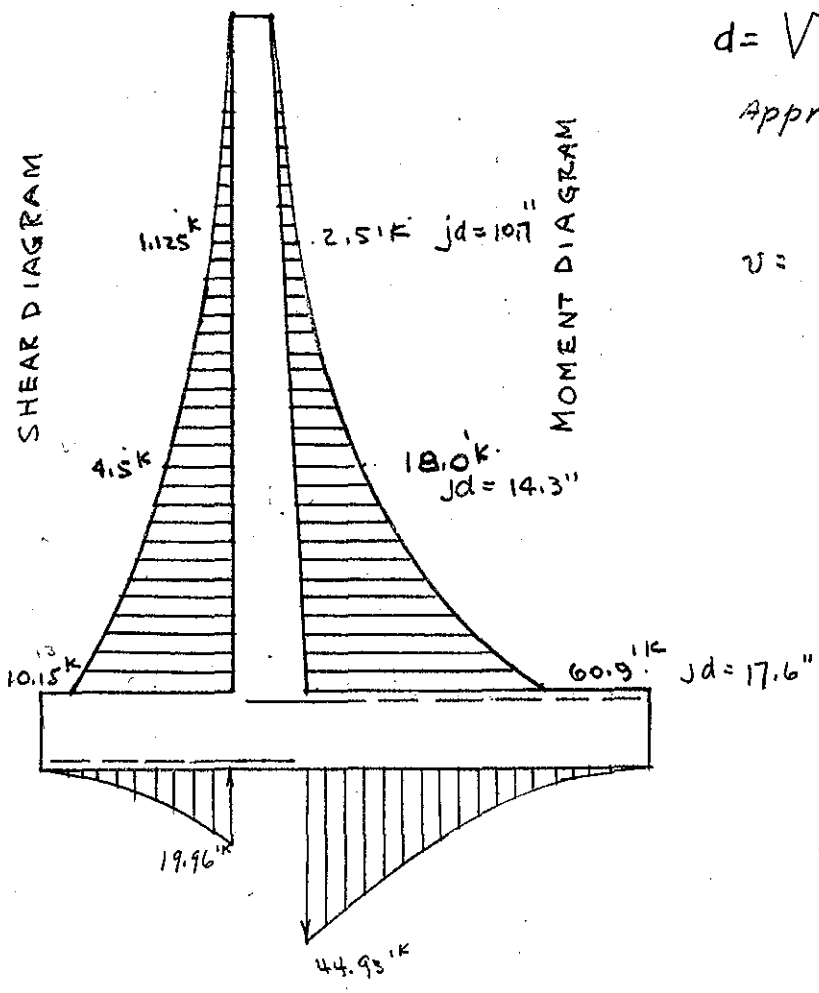


Subject Lowell
Computation Local Protection
Computed by V.H.K Checked by W.W.T. Date

assume j = .9 ; 4.5" to ℄ bar

$d = \sqrt{\frac{60900 \times 12}{180 \times 12}} = 18.4$ ✓
Approx.
4.5
22.9
Say 24"

$v = \frac{10150}{12 \times .9 \times 19.5} = 48\#/\square''$ ok.



				V k		M 'k	
	62.5 x 18	1.125	9	10.15	6	60.9	
	62.5 x 12	.75	6	4.50	4	18.0	
Stem	62.5 x 6	.375	3	1.125	2	2.50	
		1.22	5.0	6.10	2.5	15.30	15.25
		.28	5.0	1.40	3.33	4.66	
Slab				7.50		19.96	19.91
		.18	1.0	.18	8.5	1.53	
				4.00	8.0	32.00	
		.33	5.9	1.95	6.03	11.75	
		.12	2.1	-.25	1.4	-.35	
				.26	.72	.19	
Slab				5.88		44.93	44.09

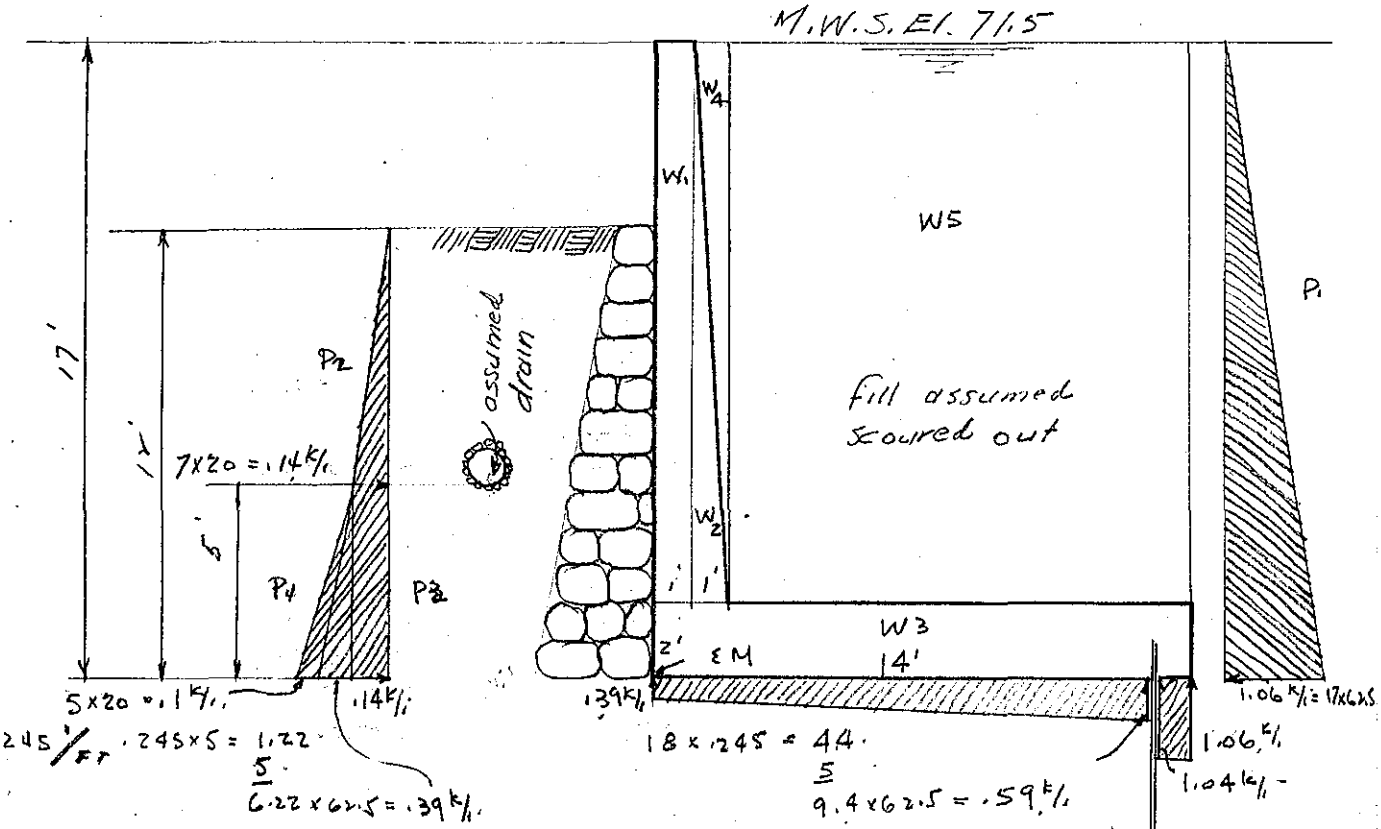
WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

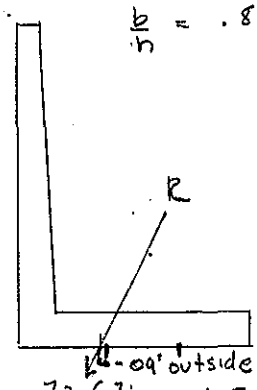
Subject Lowell

Computation Local Protection Section 125' from bridge

Computed by K.H.K **Checked by** W.W.T. **Date** 10/2/40



W1	1x15	15	150	2.25	.50	1.12
2	.5x15	7.5	150	1.125	1.33	1.49
3	2x14	28	150	4.20	7.0	29.40
4	.5x15	7.5	62.5	.47	1.67	.79
5	12x15	180	62.5	11.25	8.0	90.00
Pile				4.0	13.0	52.00
U1	.39x13			-5.07	6.5	-33.00
2	.10x13			-1.30	8.67	-11.28
3	1.05x1			-1.05	13.50	-14.15
			ΣV	15.87		
P1	.53x17			-9.00	5.67	-51.10
2	.07x7			.49	7.33	3.60
3	.14x5			.70	2.50	1.75
4	.49x2.5			1.23	1.67	2.05
			ΣH	-6.58	ΣM	72.67



15'-0" sheeting

4^k assumed

$\frac{\Sigma M}{\Sigma V} = \frac{72.67}{15.87} = 4.58'$

1/3 pt = 4.67'

Outside .09'

$\frac{\Sigma H}{\Sigma V} = \frac{6.58}{15.87} = .41$ (neg. sheet)

Concrete

1.5x15 = 22.5

14x2 = 28

50.5 cf = 1.88 cy

1.88x110 = 206# reinforcing

WAR DEPARTMENT

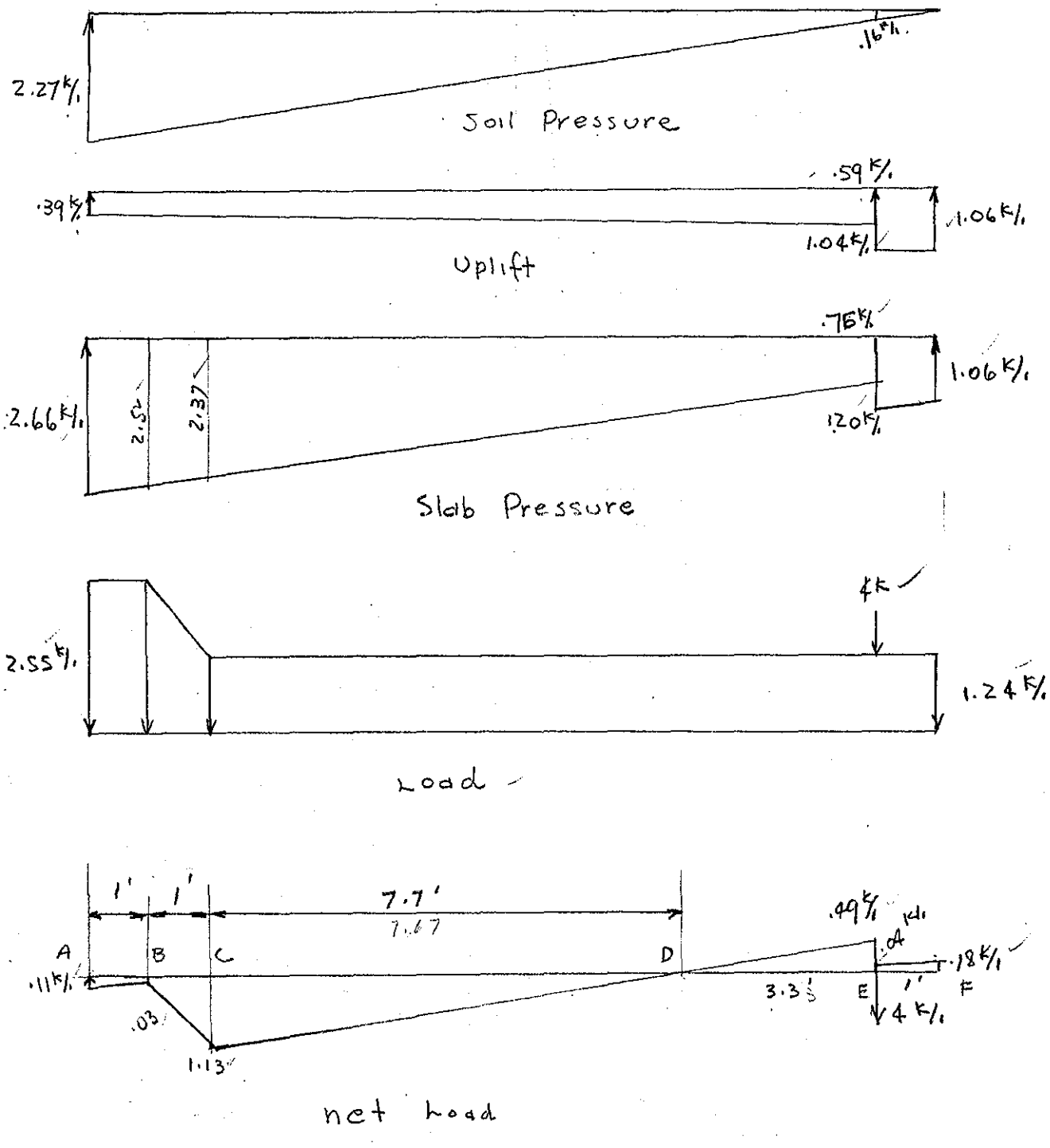
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject Lowell

Computation Local Protection

Computed by V.H.K. **Checked by** W.W.T. **Date**

Assume Resultant at 1/3 pt. $\frac{15.87 \times 2}{14} = 2.27$ k/'



WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject Lowell

Computation Local Protection

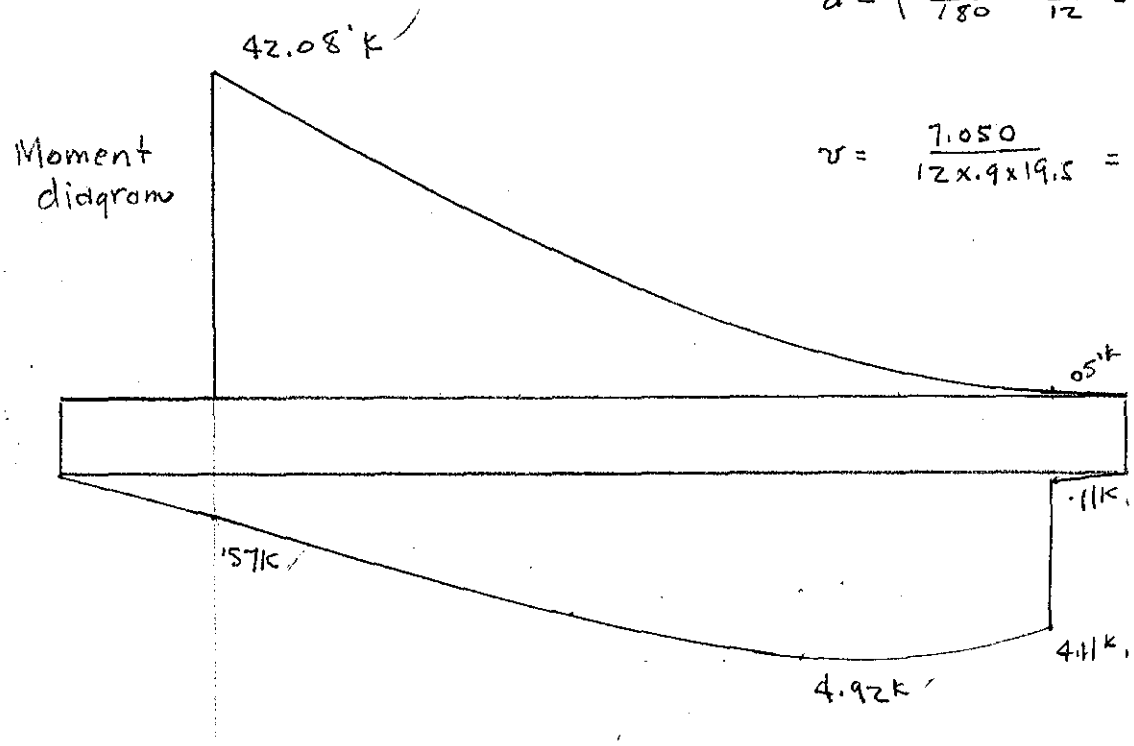
Computed by VHK **Checked by** W.W.T **Date**

Slab		V^k		M'^k
	.04x1	.04	11.5	.46
	.07x1	.07	11.67	.82
		4.00	11.0	44.00
	½x.49x3.3	.81	9.9	8.00
	½x1.13x7.7	-4.35	2.57	-11.20
C		.57k		42.08
Stem	.94x7.5	7.05	5.0	35.20
	.63x5.0	3.15	3.33	10.50
	.31x2.5	.78	1.67	1.31

Stem shear & moment diagram see Sh. 9

$$d = \sqrt{\frac{42080 \times 12}{180} \cdot \frac{12}{12}} = 15.3$$
4.5
19.8"
24" ok.

$$v = \frac{7.050}{12 \times .9 \times 19.5} = 33.5 \ \#/\square''$$
ok.



Shear diagram

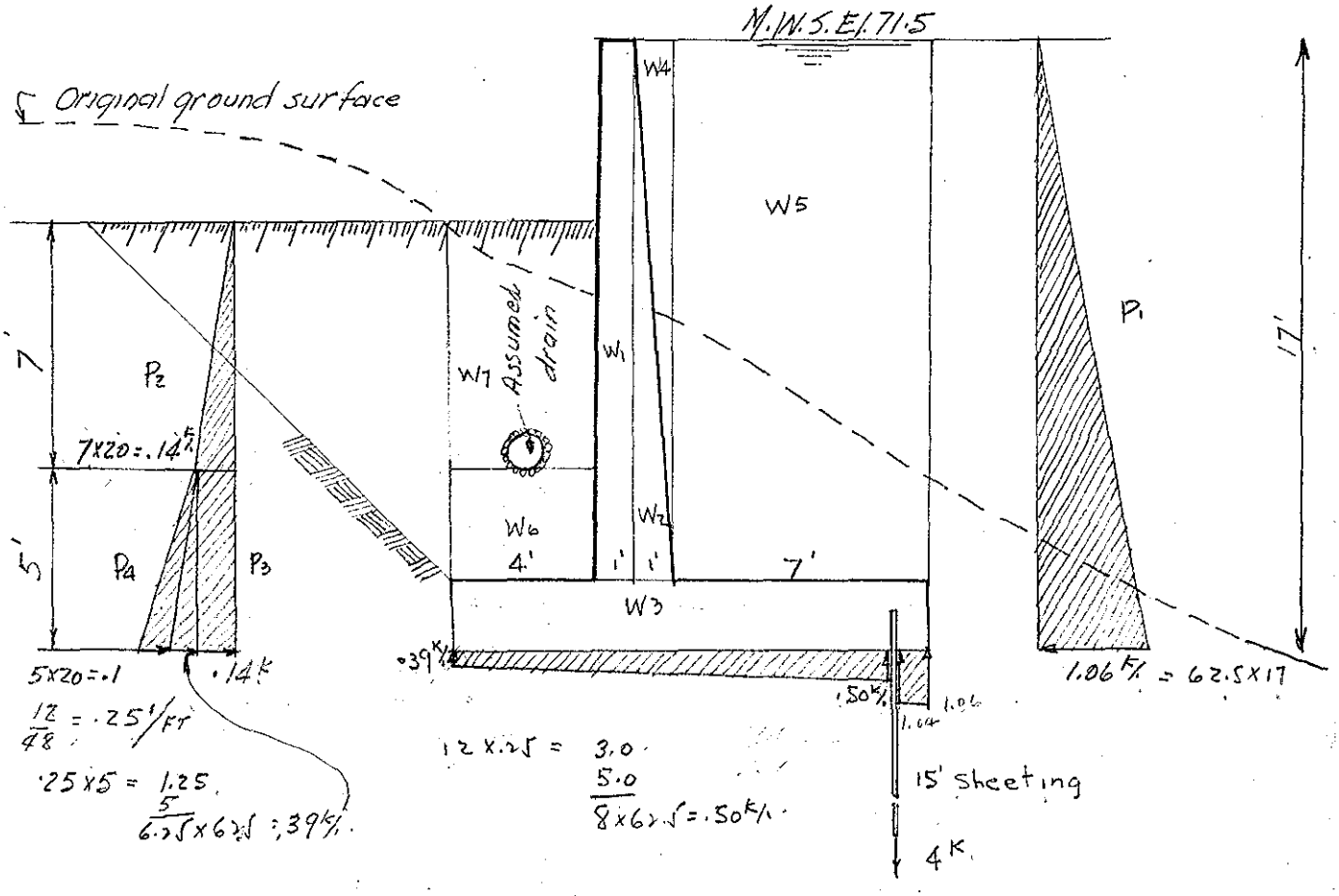
WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

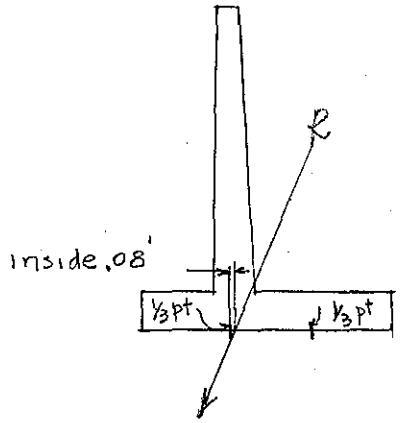
Subject Lowell

Computation Local Protection Section 240' from bridge

Computed by V.H.K **Checked by** W.W.T. **Date** 10/2/40



				V k		M 'k
W1	1x15	15	150	2.25	4.5	10.10
2	.5x15	7.5	150	1.12	5.33	5.96
3	2x13	26	150	3.90	6.50	25.40
4	.5x15	7.5	62.5	.47	5.67	2.66
5	7x15	105	62.5	6.55	9.5	62.30
6	3x4	12	130	1.56	2.0	3.12
7	7x4	28	120	3.36	2.0	6.72
Pile				4.0	12.0	48.0
U1	.39x12			-4.69	6.0	-28.10
U2	.11x6			-.66	8.0	-5.28
U3	1.05x1			-1.05	12.5	-13.10
			ΣV	16.81		
P1	.53x17			-9.00	5.67	-51.10
P2	.07x7			.49	7.33	3.60
P3	.14x5			.70	2.50	1.75
P4	.49x2.5			1.23	1.67	2.06
			ΣH	6.58	ΣM	74.09



Concrete
1.5x15 = 22.5
13x2 = 26
1.8 c.y./ft
1.8x110 = 197#
reinforc.

$\frac{\Sigma M}{\Sigma V} = \frac{74.09}{16.81} = 4.41$

1/3 pt 4.33

Inside .08'

$\frac{\Sigma H}{\Sigma V} = \frac{6.58}{16.81} = .39$ (neglecting sheet.)

$\frac{b}{h} = \frac{13}{17} = .76$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

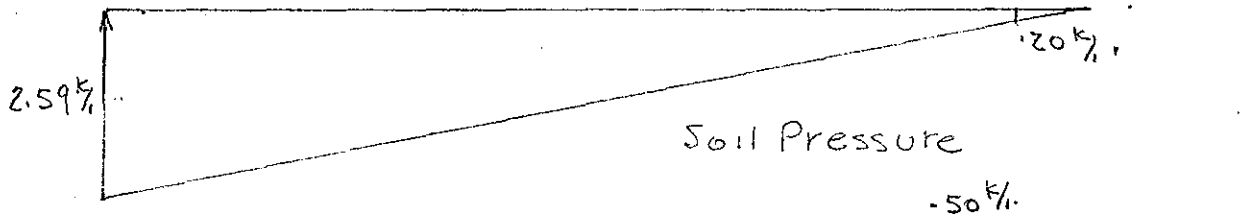
Subject Lowell

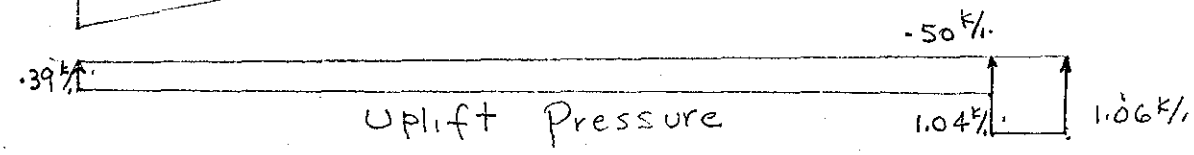
Computation Local Protection

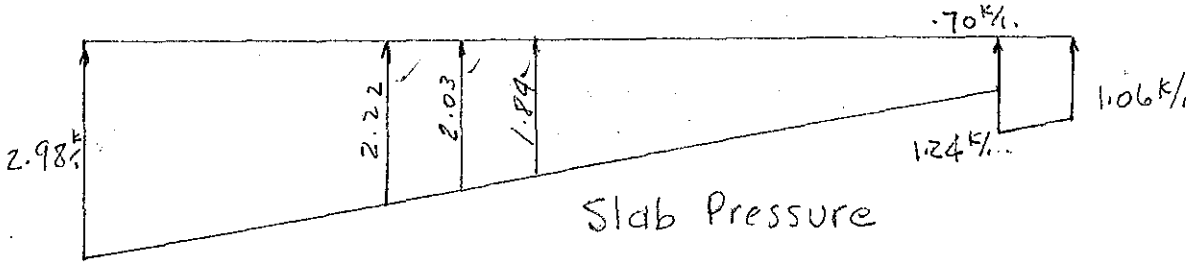
Computed by V.H.K **Checked by** W.W.T. **Date**

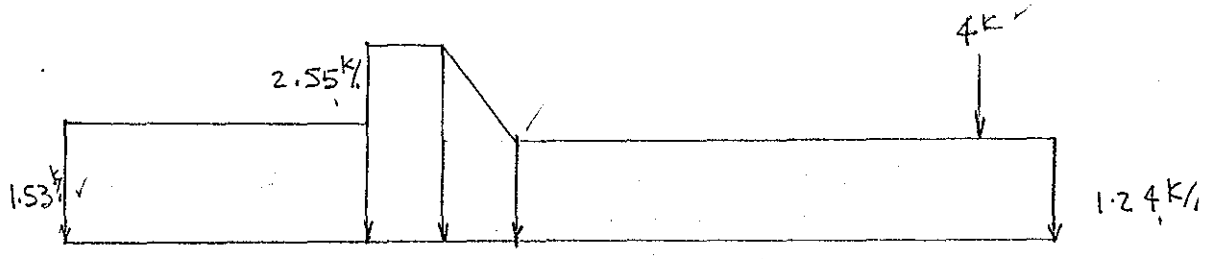
Assume Resultant at 1/3 pt.

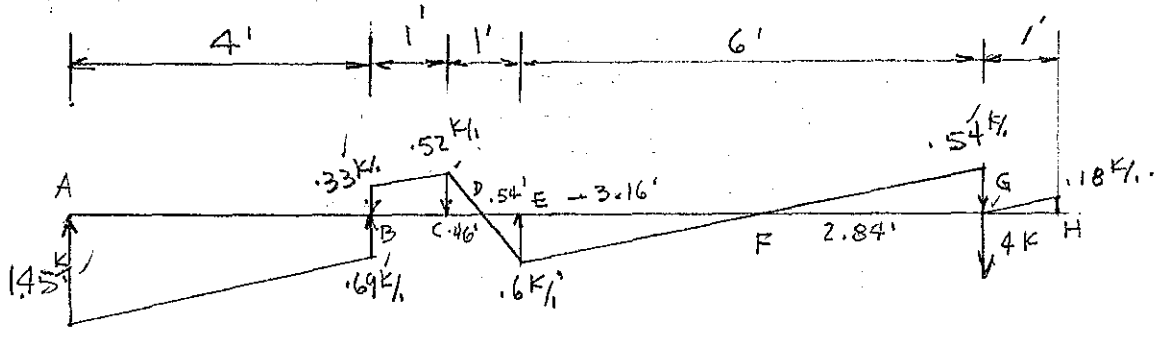
$2 \times \frac{16.8'}{13} = 2.59^{k}/_{1}$











Net Loads

WAR DEPARTMENT

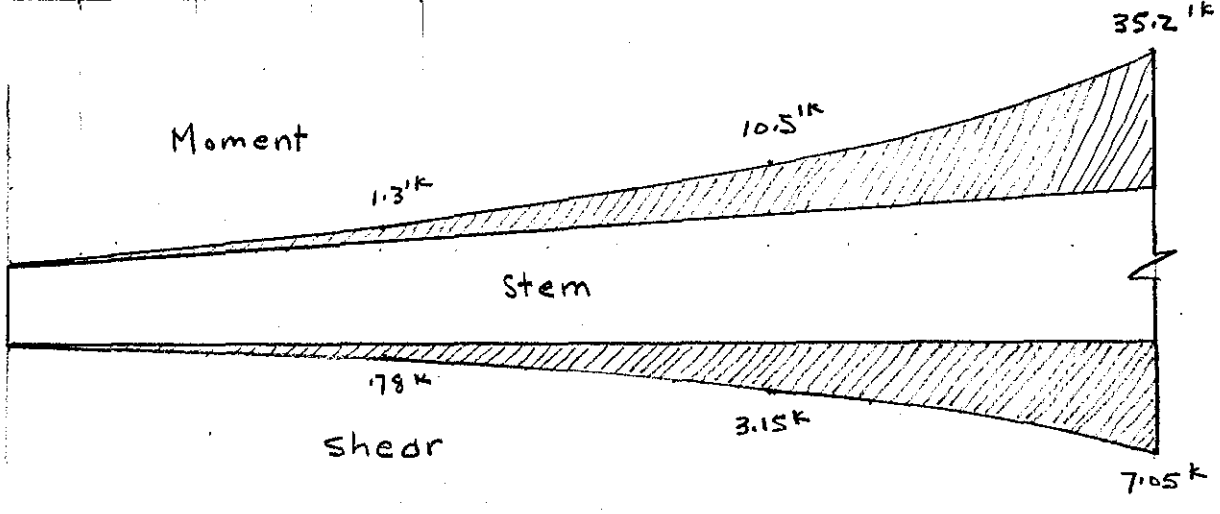
U. S. ENGINEER OFFICE, BOSTON, MASS.

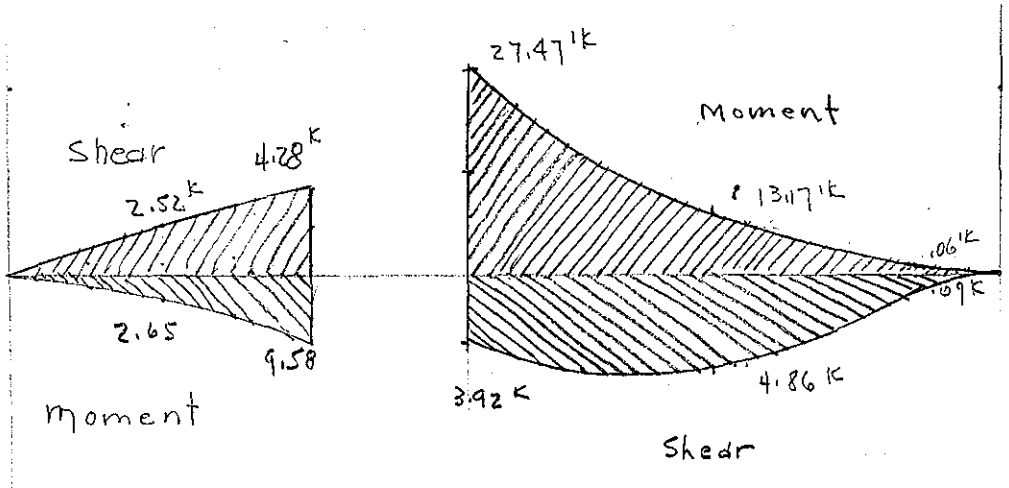
Subject Lowell

Computation Local Protection

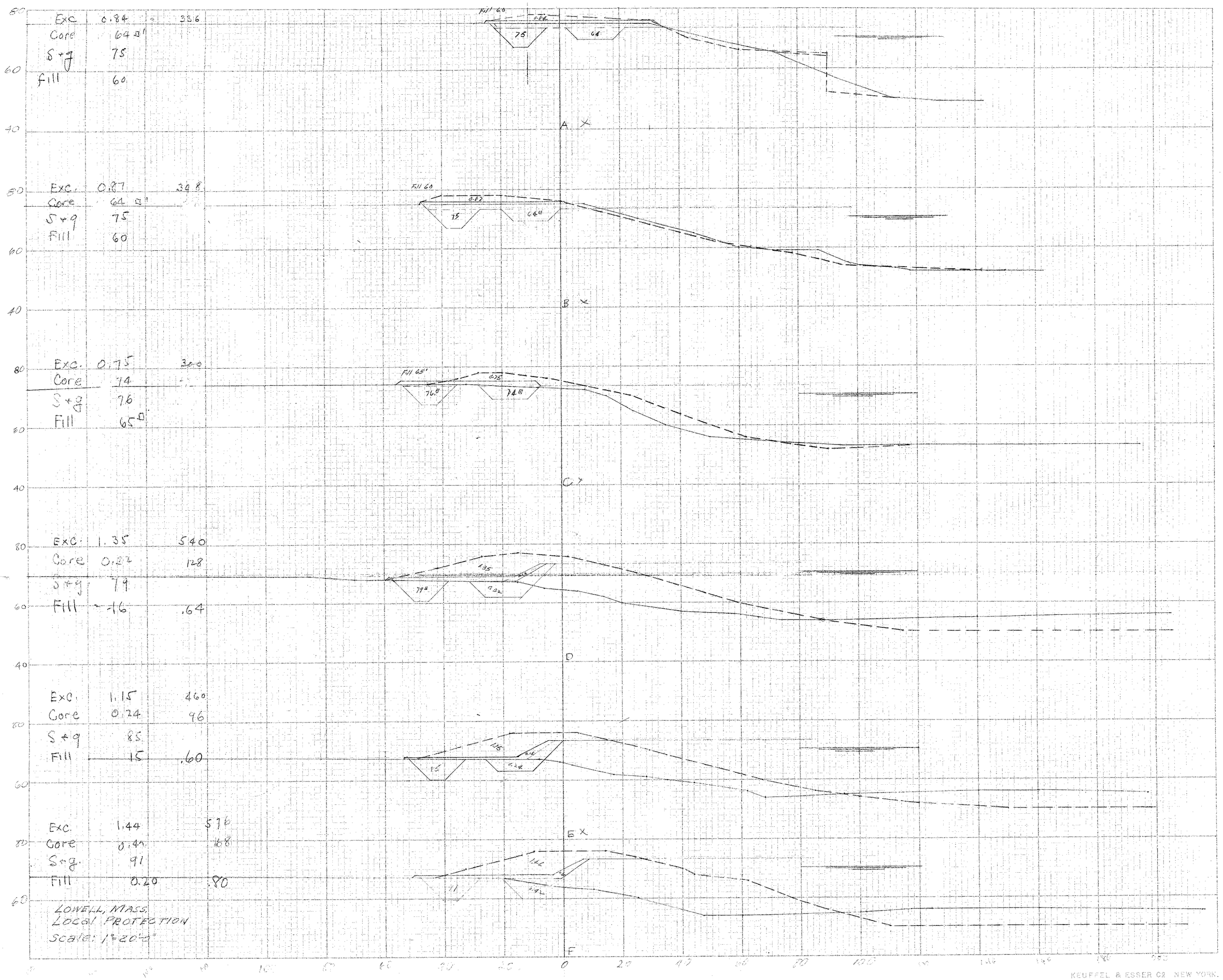
Computed by ..... **Checked by** ..... **Date** .....

Slab		V K		M 'K
	.69 x 4	2.76	2.0	5.52
	.76 x 2	1.52	2.67	4.06
B		4.28		9.58
	.09 x 1	.09	6.67	.60
		4.00	6.00	24.0
	.27 x 2.84	.77	5.05	3.86
	.3 x 3.16	- .94	1.05	- .99
E		3.92		27.47
Stem				
	.94 x 7.5	7.05	5	35.2
	.63 x 5.0	3.15	3.33	10.5
	.31 x 2.5	.78	1.67	1.30

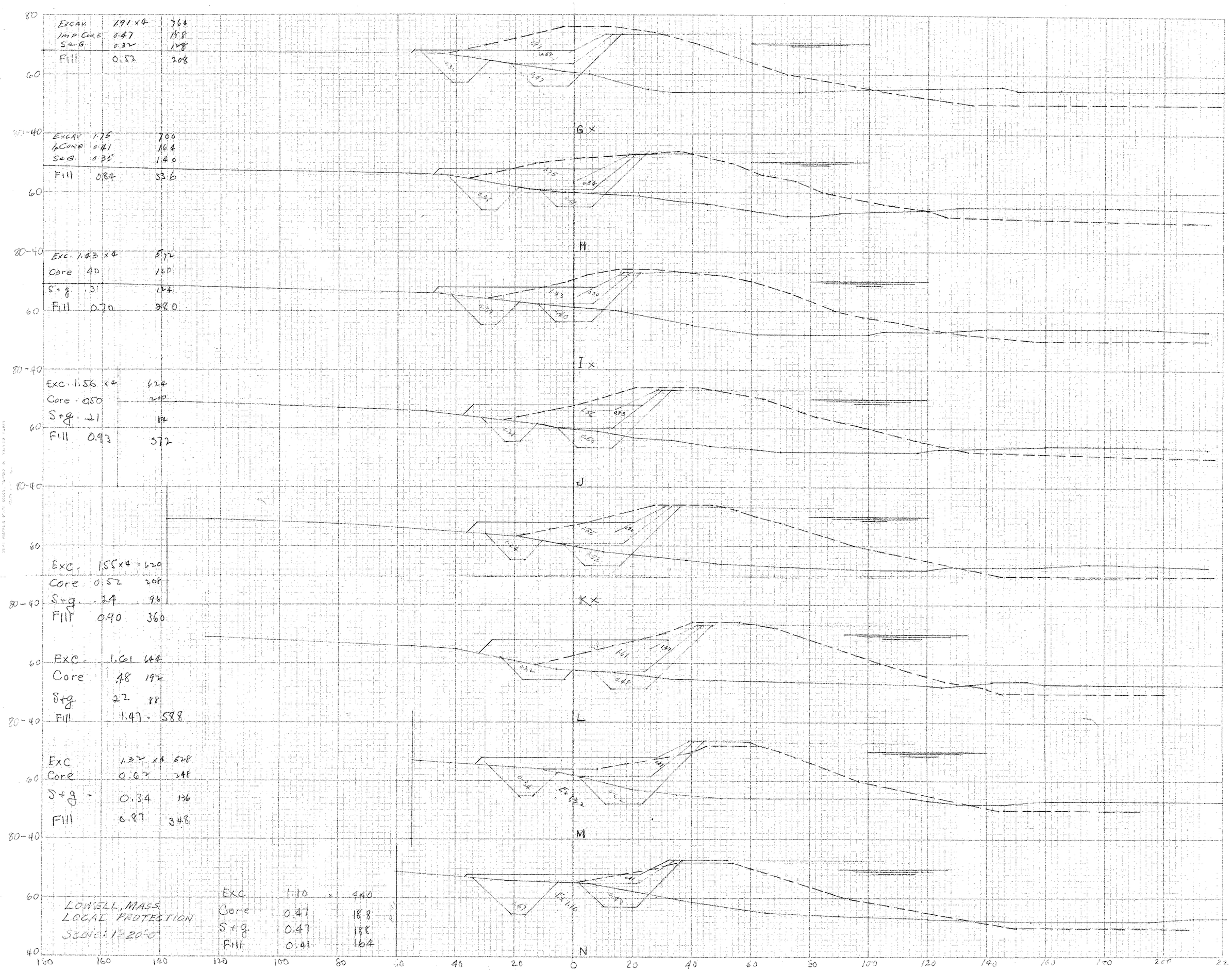




SLAB

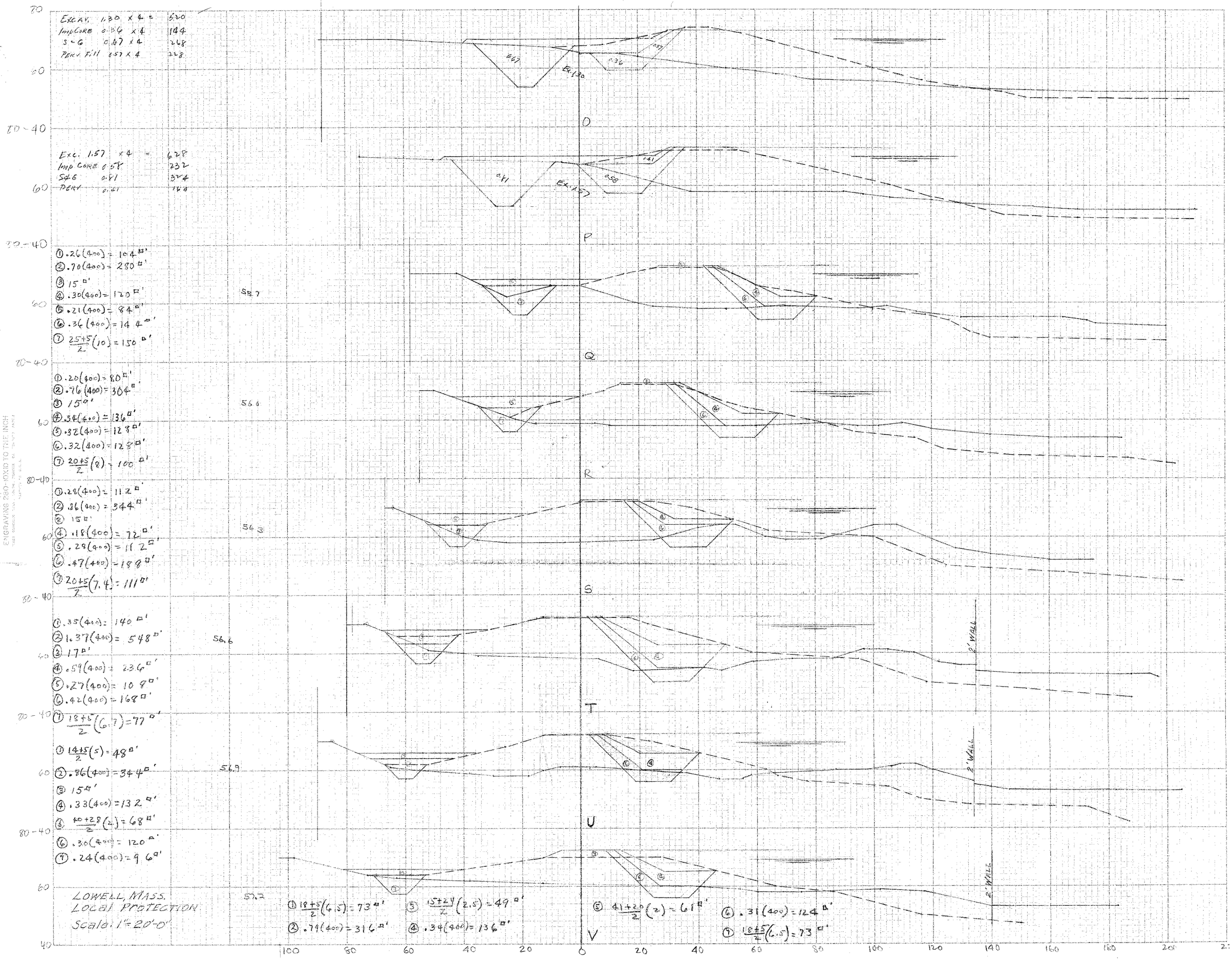


KEUFFEL & ESSER CO. NEW YORK.



STANDARD CROSS SECTION
ENGRAVING 280-10X10 TO THE INCH

KEUFFEL & ESSER CO. NEW YORK.


EXCAV. 1.30 x 4 = 520
IMP CORE 0.36 x 4 144
S#6 0.67 x 4 268
PERV FILL 0.57 x 4 228
O
Exc. 1.57 x 4 = 628
IMP CORE 0.58 232
S#6 0.81 324
PERV 0.21 84
P
① .26(400) = 104 □'
② .70(400) = 280 □'
③ 15 □'
④ .30(400) = 120 □'
⑤ .21(400) = 84 □'
⑥ .36(400) = 144 □'
⑦ 25+5/2 (10) = 150 □'
SS.7
Q
① .20(400) = 80 □'
② .76(400) = 304 □'
③ 15 □'
④ .34(400) = 136 □'
⑤ .32(400) = 128 □'
⑥ .32(400) = 128 □'
⑦ 20+5/2 (8) = 100 □'
SS.6
R
① .28(400) = 112 □'
② .86(400) = 344 □'
③ 15 □'
④ .18(400) = 72 □'
⑤ .28(400) = 112 □'
⑥ .47(400) = 188 □'
⑦ 20+5/2 (7.4) = 111 □'
SS.3
S
① .35(400) = 140 □'
② 1.37(400) = 548 □'
③ 17 □'
④ .59(400) = 236 □'
⑤ .27(400) = 108 □'
⑥ .42(400) = 168 □'
⑦ 18+5/2 (6.7) = 77 □'
SS.6
T
① 14+5/2 (5) = 48 □'
② .86(400) = 344 □'
③ 15 □'
④ .33(400) = 132 □'
⑤ 40+28/2 (2) = 68 □'
⑥ .30(400) = 120 □'
⑦ .24(400) = 96 □'
SS.9
U
SS.2
V
① 18+5/2 (4.5) = 73 □'
② .79(400) = 316 □'
③ 15+24/2 (2.5) = 49 □'
④ .34(400) = 136 □'
⑤ 41+20/2 (2) = 61 □'
⑥ .31(400) = 124 □'
⑦ 18+5/2 (4.5) = 73 □'
2' WALL
LOWELL, MASS.
LOCAL PROTECTION
Scale: 1" = 20'-0"
KEUFFEL & ESSER CO. NEW YORK.

80

④ .30(400) = 120 □'

⑤ $\frac{52+18}{2}$(2) = 70 □'

60 ⑥ .37(400) = 148 □'

⑦ 74 □'

① $\frac{18+5}{2}$(6.4) = 74 □'

② .69(400) = 276 □'

③ $\frac{15+26}{2}$(2) = 41 □'

80-40

① $\frac{20+10}{2}$(7.1) = 107 □'

② .71(400) = 284 □'

③ .21(400) = 84 □'

60 ④ .41(400) = 164 □'

⑤ .26(400) = 104 □'

⑥ .34(400) = 136 □' ⑦ 107 □'

80-40

① .56(400) = 224 □'

② .81(400) = 324 □'

③ .12(400) = 48 □'

60 ④ .38(400) = 152 □'

⑤ .25(400) = 100 □'

⑥ .42(400) = 168 □'

80-40 ⑦ $\frac{24+5}{2}$(9.5) = 138 □'

① $\frac{32+5}{2}$(13.2) = 244 □'

60 ② .42(400) = 168 □'

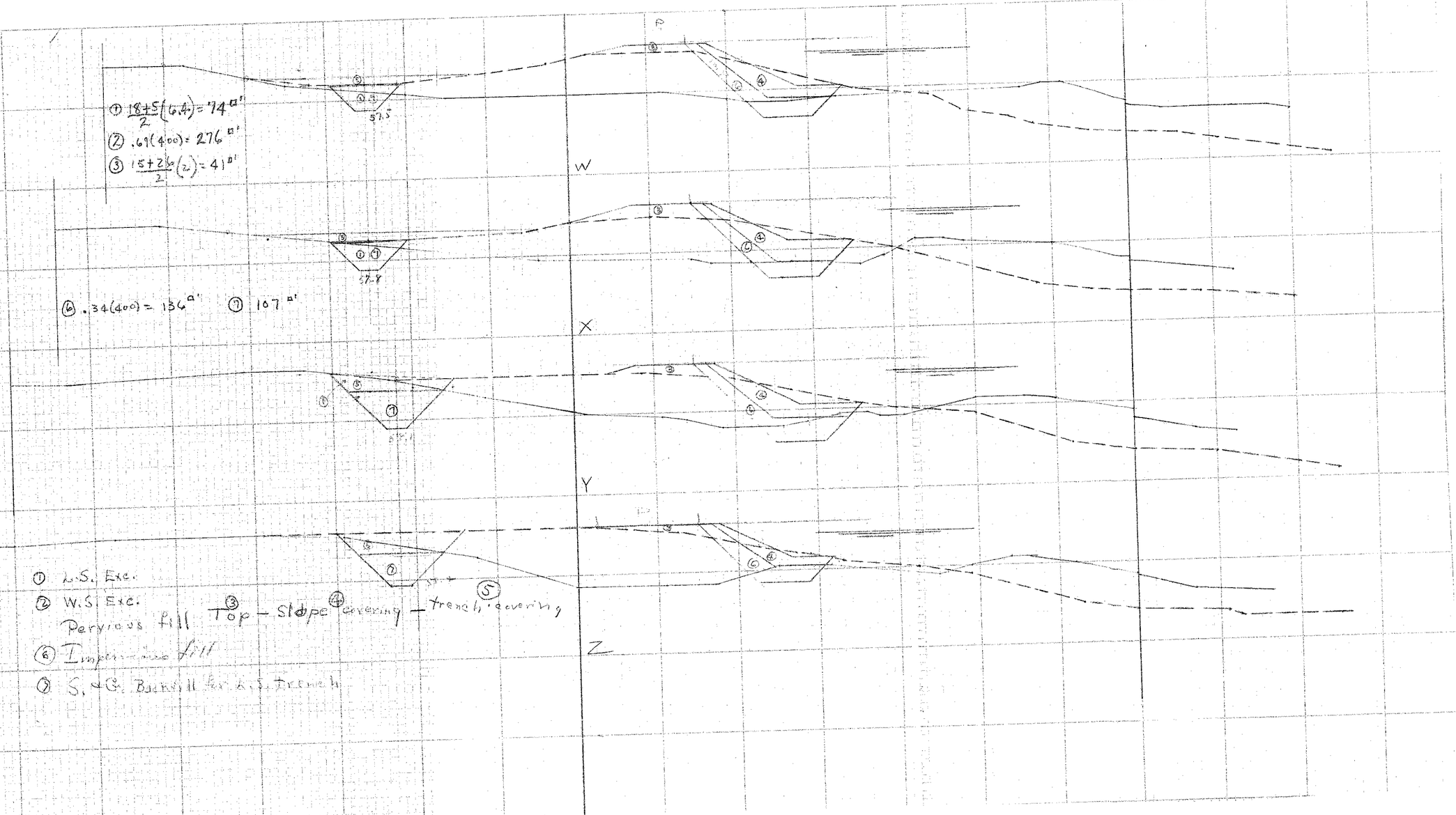
③ .12(400) = 48 □'

④ .2(400) = 80 □'

40 ⑤ $\frac{32+21}{2}$(5.2) = 138 □'

⑥ .31(400) = 124 □'

⑦ $\frac{21+5}{2}$(8) = 104 □'



① L.S. Exc.

② W.S. Exc.

Pervious fill ③ Top – Slope ④ covering – trench ⑤ covering

⑥ Impervious fill

⑦ S. & G. Backfill for L.S. trench

STANDARD CROSS SECTION
ENGRAVING 250 10X10 TO THE INCH

Excavation – 120'

$\left(\frac{44+12}{2}\right)16 \times \frac{120}{27} = 1990$ Cu. Yds

Impervious Fill

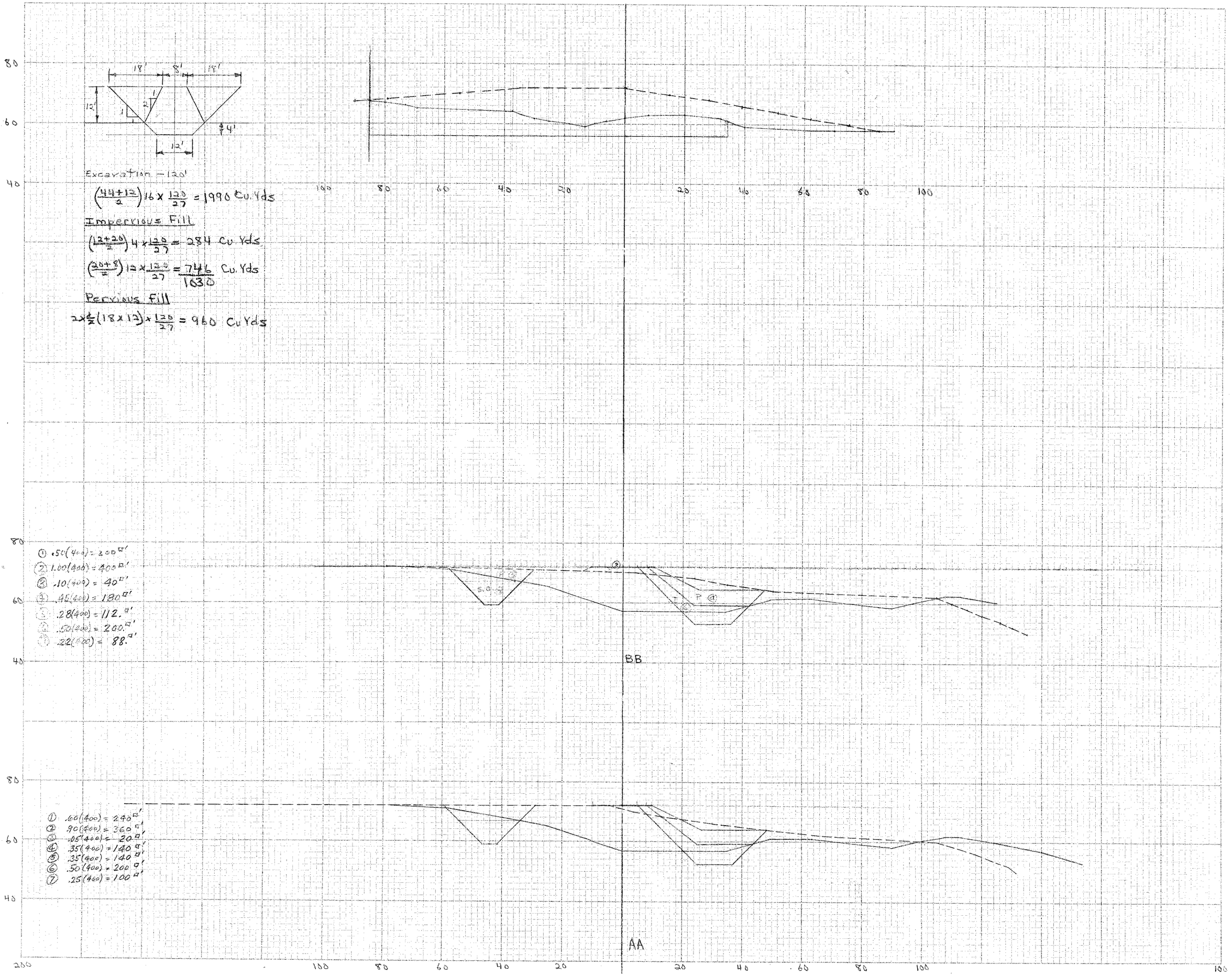
$\left(\frac{12+20}{2}\right)4 \times \frac{120}{27} = 284$ Cu. Yds

$\left(\frac{20+8}{2}\right)12 \times \frac{120}{27} = 746$ Cu. Yds

1630

Pervious Fill

$2 \times \frac{1}{2}(18 \times 12) \times \frac{120}{27} = 960$ Cu. Yds



STD. RD CROSS SECTION
ENGRAVING 280-10X10 TO THE INCH
KEUFFEL & ESSER CO. NEW YORK.