HYDROLOGY F23/D1 SEVEN PLA

























CHAPTER 7. HYDROLOGIC SOIL GROUPS

This chapter gives definitions of four soil groups that are used in determining hydrologic soil-cover complexes (chap. 9), which are used in a method for estimating runoff from rainfall (chap. 10). A table gives the group-classifications of more than 4,000 soils in the United States and Puerto Rico. Methods of making and using the classifications are briefly discussed.

Watershed-Soils Classification

Soil properties influence the process of generation of runoff from rainfall and they must be considered, even if only indirectly, in methods of runoff estimation. When runoff from individual storms is the major concern, as in flood prevention work, the properties can be represented by a hydrologic parameter: the minimum rate of infiltration obtained for a bare soil after prolonged wetting. The influences of both the surface and the horizons of a soil are thereby included. The influence of ground cover is treated independently, as discussed in chapters 8, 9, and 10.

The parameter, which indicates the runoff potential of a soil, is the qualitative basis of the classification in this chapter of all soils into four groups. The classification is broad but the groups can be divided into subgroups, as shown in example 7.1, whenever such a refinement is justified. Chapter 9 describes how the groups are given quantitative significance in the runoff-estimation method of chapter 10.

DEFINITIONS

In the definitions to follow, the infiltration rate is the rate at which water enters the soil at the surface and which is controlled by surface conditions, and the transmission rate is the rate at which the water moves in the soil and which is controlled by the horizons. The hydrologic soil groups, as defined by SCS soil scientists, are:

BY JBD DATE 1-9-01 SUBJECT TIERRA ANADA - DRAINAGE SHEET NO. 7 OF 10
CHKD. BY ..... DATE ..... CALCULATIONS JOB NO. 01-00.01

AREA (A-3) EAST LOTS BACKYARD & ½ ROOF

TOTAL AREA = 37,900 FT²

IMPERVIOUS AREA = $\frac{(36)(44)}{2}(7) + (36)(44)(4) + (22)(20) + (18)(20)$

= 15,620 FT²

PERVIOUS AREA = 22,280 FT²

$$C = \frac{(0.4)(22280) + (0.9)(15,620)}{37,900} = \underline{0.61}$$

$$Q_{100} = (0.61)(5.4)\left(\frac{37,900}{43,560}\right) = \underline{2.87 \text{ cfs}}$$

AREA (A-5) SOUTH LOTS BACKYARD & ½ ROOF

TOTAL AREA = 26,050 FT²

IMPERVIOUS AREA = $\frac{(36)(46)}{2}(7)$ = 5796 FT²

PERVIOUS AREA = 20,254 FT²

$$C = \frac{(0.4)(20,254) + (0.9)(5796)}{26,050} = \underline{0.51}$$

$$Q_{100} = (0.51)(5.4)\left(\frac{26050}{43560}\right) = \underline{1.65 \text{ cfs}}$$

A. (Low runoff potential). Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

B. Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C. Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

D. (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

The Soil List

The list at the end of this chapter contains the names of more than 4,000 soils in the United States and Puerto Rico. The capital letter following a name designates the hydrologic soil group classification.

The original classifications were based on the use of rainfall-runoff data from small watersheds or infiltrometer plots, but the majority are based on the judgments of soil scientists and correlators who used physical properties of the soil in making their decisions. They classified a soil in a particular group by comparing its profile with profiles of soils already classified. They assumed that the soil surfaces were bare, maximum swelling had taken place, and rainfall rates exceeded surface intake rates. Thus, most of the classifications are based on the premise that similar soils (similar in depth, organic-matter content, structure, and degree of swelling when saturated) will respond in an essentially similar manner during a rainstorm having excessive intensities.

The classification of a soil in the list can be checked by using the procedure of example 5.4. The soil in question must be the only one

BY JEB DATE 1-9-01 SUBJECT TIERRA AMADA - DRAINAGE SHEET NO. 3 OF 10
CHKD. BY DATE CALCULATIONS JOB NO. 01-00-01

PONDED LOTS - BACKYARD ONLY - NO ROOF DRAINAGE

AREA (A-4)

TOTAL AREA = 8975 FT^2

$Q_{100} = (0.4)(5.4)\left(\frac{8975}{43560}\right) = 0.45$ cfs

VOLUME = $\frac{2.4}{12}(.4)(8975) = 718$ FT^3

VOLUME PER LOT = $\frac{718}{7} = 103$ FT^3/LOT

CONTRIBUTING AREA TO MAIN POND

TOTAL AREA OF SITE =	452,749
(A-2)	- 30,575
(A-3)	- 37,900
(A-4)	- 8,975
(A-5)	- 26,050
(A-1) =	349,249 = **8.02 ACRES**

AREA (A-1)

TOTAL AREA = 349,249
IMPERVIOUS AREA = 193,139
PERVIOUS AREA = 156,110

$C = \frac{(0.4)(156,110) + (0.9)(193,139)}{349,249} = 0.68$

$Q_{100} = (0.68)(5.4)\left(\frac{349,249}{43,560}\right) = 29.44$ cfs

TABLE 7.—*Engineering classification*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture of representative profile	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Feet	*Feet*	*Inches*				*Percent*
Brasito: Br, Bs, Bt	>5	>5	0–9	Fine sandy loam to silty clay loam.	SM, CL–ML, or CL	A–4 or A–6	
			9–60	Sand	SP or SP–SM	A–3	
Burnac: BUE	>5	>5	0–6	Gravelly loam and very gravelly loam.	GM	A–2 or A–4	5–20
			6–14	Gravelly sandy clay loam.	SC–SM or SC	A–2, A–4, or A–6	5–15
			14–60	Clay	CH	A–7	
Carlito: CAF	>5	>5	0–4	Stony loam	CL–ML or CL	A–4	15–45
			4–60	Clay and silty clay.	CL or CH	A–7	
Cut and fill land: Cu No valid estimates; material too variable.	>5	>5					
*Embudo: EmB, EtC For Tijeras part of EtC, see Tijeras series.	>5	>5	0–20	Gravelly fine sandy loam and gravelly sandy loam.	SM	A–2, A–4	
			20–60	Gravelly loamy coarse sand.	SM	A–1	
Escabosa Mapped only with Laporte soils and Rock outcrop.	1.5–3.5	>5	0–15	Loam	CL–ML or ML	A–4	
			15–23	Gravelly loam	GM or CL–ML	A–4	0–10
			23	Bedrock.			
*Gila:							
GA, Gb, Ge, GH For Hants part of GH, see Hants series.	>5	[1]>5	0–44	Stratified loam to sandy loam.	SM or ML	A–4	
			44–60	Sand	SP or SP–SM	A–3	
Gc, Gd, GF	>5	[1]3–>5	0–60	Stratified loam to sandy loam.	SM or ML	A–4	
Glendale: Gk, Gm, Gs	>5	[1]>5	0–6	Clay loam or loam.	CL–ML or CL	A–4 or A–6	
			6–38	Silt loam	CL	A–6	
			38–60	Clay loam	CL	A–6	
Hants: Ha	>5	[1]>5	0–65	Silty clay	CL or MH	A–7	
Ildefonso: ILC	>5	>5	0–60	Gravelly and very gravelly sandy loam.	GM or SM	A–1 or A–2	0–15
*Kim: KaB, KbB, KD No valid estimates for Badland part of KD.	>5	>5	0–60	Loam and clay loam.	CL–ML or CL	A–4 or A–6	
*Kokan: KOE, KR No valid estimates for Rock outcrop part of KR.	>5	>5	0–60	Gravelly sand and very gravelly sand.	GP, GP–GM, or GM	A–1	0–30

See footnotes at end of table.

BY JEB DATE 1-9-81 SUBJECT TIERRA AMADA - DRAINAGE SHEET NO. 4 OF 10
CHKD. BY ..... DATE ..... CALCULATIONS JOB NO. 81-00-01

VOLUME OF RUNOFF

$$V_{100} = (0.68)\left(\frac{2.4}{12}\right)(349{,}249) = \underline{47{,}500 \text{ FT}^3}$$

$$Q_{100} = \underline{29.44 \text{ cfs}}$$

T_c = 10 MIN. = TIME FOR RISING AND FALLING LIMBS

VOLUME = AREA UNDER HYDROGRAPH

$$V = \frac{1}{2} Q T_c = \frac{1}{2}(29.44)(10)(60) = 8832 \text{ FT}^3$$

$$(8832)(2) = 17{,}664 \text{ FT}^3$$

VOLUME REMAINING = $47{,}500 - 17{,}664 = 29{,}836 \text{ FT}^3$

$$T_R = \frac{29{,}836}{(29.44)(60)} = 16.89 = \underline{17 \text{ MIN.}}$$

$$T_B = 10 + 10 + 17 = \underline{37 \text{ MIN.}}$$

and estimated properties—Continued

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Risk of corrosion to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
						Inches per hour	*Inches per inch of soil*	*pH*	*Millimhos per centimeter at 25° C*			
----	100	70–100	40–95	15–35	0–15	0.6–2.0	0.13–0.21	7.9–8.4	1–4	Low to moderate.	Moderate...	Low.
----	100	65–85	0–10	NP	NP	6.0–20.0	0.05–0.07	7.9–8.4	0–1	Low.....	Low.....	Low.
40–70	35–65	30–60	20–50	<30	NP–5	0.6–2.0	0.09–0.11	6.6–7.3	0–1	Low.....	Low.....	Low.
70–80	65–75	55–65	20–40	20–35	5–15	0.6–2.0	0.12–0.14	6.1–6.5	0–1	Low.....	Low.....	Low.
90–100	85–95	35–90	70–85	50–65	25–35	<0.06	0.14–0.16	6.1–7.3	0–1	High.....	High.....	Low.
95–100	90–100	75–100	60–90	20–30	5–10	0.2–0.6	0.14–0.18	7.4–7.8	0–1	High.....	High.....	Low.
----	100	90–100	75–95	40–55	20–30	0.06–0.2	0.15–0.18	7.8–8.4	0–1	High.....	High.....	Low.
85–95	70–85	40–75	25–50	NP	NP	0.6–0.2	0.07–0.09	7.9–8.4	0–1	Low.....	Low.....	Low.
80–95	50–70	20–45	10–25	NP	NP	>20	0.04–0.06	7.9–8.4	0–1	Low.....	Low.....	Low.
----	100	85–95	60–70	20–35	5–10	0.6–2.0	0.16–0.18	7.9–8.4	0–1	Low.....	High.....	Low.
65–95	60–90	50–85	40–65	20–30	0–5	0.6–2.0	0.13–0.15	7.9–8.4	0–1	Low.....	High.....	Low.
----	100	95–100	40–60	NP	NP	0.6–2.0	0.13–0.18	7.9–8.4	0–1	Low.....	Moderate...	Low.
----	100	50–90	0–10	NP	NP	6.0–2.0	0.05–0.07	7.9–8.4	0–1	Low.....	Low.....	Low.
----	100	95–100	40–75	NP	NP	0.6–2.0	0.07–0.12	7.9–9.0	4–8	Low.....	High.....	Low.
----	100	90–100	60–80	25–35	5–15	0.2–0.6	[3]0.16–0.20	7.4–7.8	[3]1–4	Moderate...	High.....	Low.
----	100	90–100	75–90	30–40	10–15	0.2–0.6	[3]0.19–0.21	7.9–8.4	[3]1–4	Moderate...	High.....	Low.
----	100	90–100	70–80	30–40	10–15	0.2–0.6	[3]0.19–0.21	7.4–8.4	[3]1–4	Moderate...	High.....	Low.
----	100	95–100	90–95	40–65	20–30	<0.06	0.10–0.12	8.5–9.0	4–8	High.....	High.....	Low.
40–75	35–60	20–40	10–30	20–25	0–4	2.0–6.0	0.06–0.08	7.9–9.0	2–4	Low.....	High.....	Low.
----	100	85–100	60–80	25–35	5–15	0.6–2.0	0.16–0.20	7.4–8.4	0–1	Moderate...	Moderate...	Low.
45–60	40–55	20–45	0–20	NP	NP	>20.0	0.03–0.05	7.4–7.8	0–1	Low.....	High.....	Low.

BY JEB DATE 1-9-81 SUBJECT TIERRA MANDA - DRAINAGE SHEET NO. 5 OF 10

CHKD. BY ..... DATE ..... CALCULATIONS JOB NO. 81-00-01

INFLOW HYDROGRAPH - MAIN POND

T (MIN)	Q (cfs)
0	0
3	8.83
6	17.66
9	26.50
12	29.44
15	29.44
18	29.44
21	29.44
24	29.44
27	29.44
30	20.61
33	11.78
36	2.94
39	0

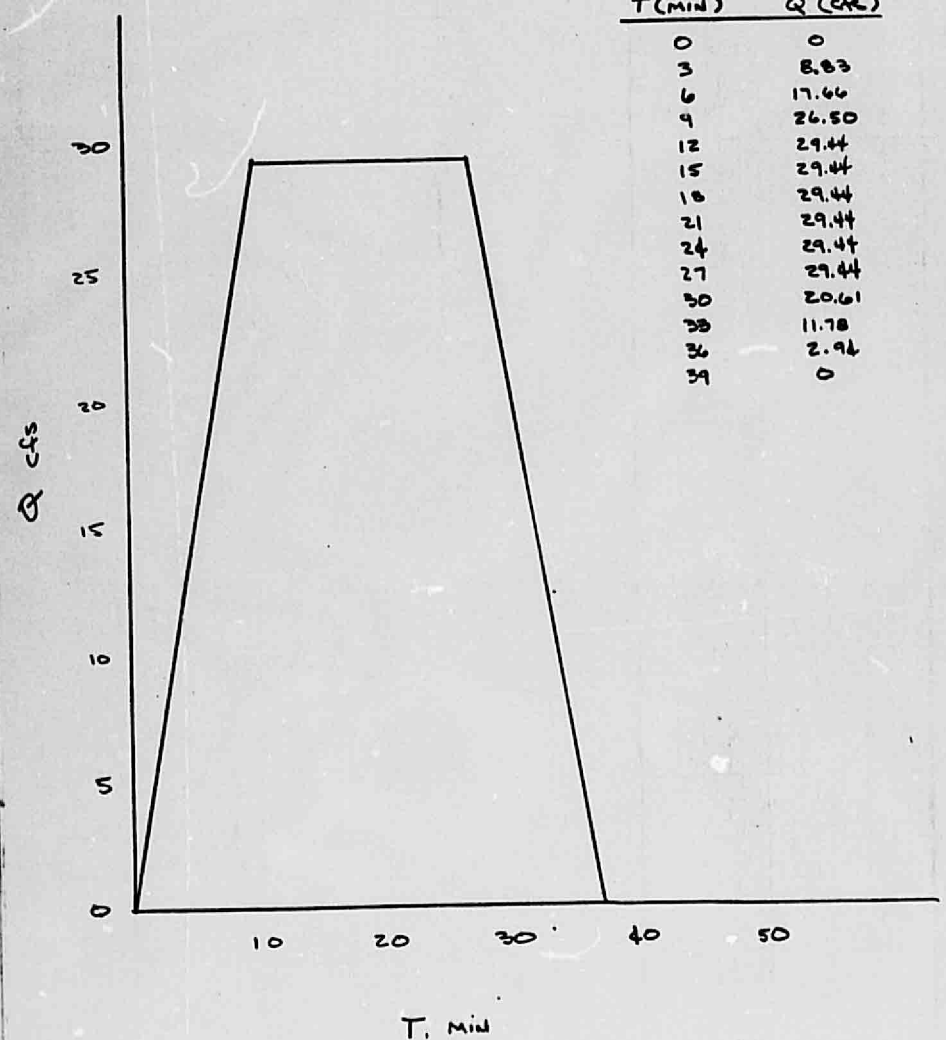


TABLE 7.—*Engineering classification*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture of representative profile	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Feet	*Feet*	*Inches*				*Percent*
*Tesajo: Te For Millett part, see Millett series.	>5	>5	0–60	Very gravelly loam to very gravelly loamy sand.	GP–GM, GM, or SM	A–1	0–10
Tijeras: TgB	>5	>5	0–19	Gravelly fine sandy loam and sandy clay loam.	SM, CL–ML, or CL	A–4	
			19–60	Gravelly sandy loam and very gravelly loamy sand.	SM	A–1 or A–2	0–10
Tome: To	>5	>5	0–11	Silt loam	ML or CL–ML	A–4	
			11–27	Clay loam	CL–ML or CL	A–4 or A–6	
			27–60	Fine sandy clay loam.	CL–ML or CL	A–4 or A–6	
Torrifluvents: TP No valid estimates; material too variable.	>5	[1] 1–5					
*Travessilla: TQC, TR No valid estimates for Rock outcrop part of TR.	0.5–1.5	>5	0–10 10	Sandy loam Bedrock.	SM	A–2 or A–4	0–25
Ustolls No valid estimates; material too variable. Mapped only with Rock outcrop.	1–5	>5					
*Vinton: Va, VbA, VBB, Vc, VF For Brazito part of VF, see Brazito series.	>5	[1] >5	0–10 10–60	Sandy loam Loamy sand	SM SM	A–2 or A–4 A–2	
*Wink: WaB, WeB, WM For Embudo part of WeB, see Embudo series; for Madurez part of WM, see Madurez series.	>5	>5	0–35 35–60	Sandy loam Sandy loam	SM SM or SM–SC	A–2 or A–4 A–2, A–4, or A–6	
Witt Mapped only with Silver soils.	>5	>5	0–60	Silty clay loam	CL or CL–ML	A–6	

[1] Protected from flooding by levees along the Rio Grande.
[2] Nonplastic.
[3] For unit Gs, available water capacity is lower and salinity is 4–8.

BY JEB DATE 1-9-81 SUBJECT TIERRA AMADA SHEET NO. 6 OF 10
CHKD. BY ..... DATE ..... DRAINAGE CALCULATIONS JOB NO. 81-00-01

ALLOWABLE DISCHARGE FROM MAIN POND

Q_5 HISTORIC = 11.72 cfs
DISCHARGE FROM (A-2) = 2.23 cfs
DISCHARGE FROM (A-3) INTO EMBUDITO ∴ N.A.
DISCHARGE FROM (A-4) PONDED ∴ N.A.
DISCHARGE FROM (A-5 = 1.65 cfs

ALLOWABLE DISCHARGE FROM MAIN POND = 7.84 cfs

OUTFLOW FROM POND

C = 0.62 FOR SHARP EDGED FLUSH INLET

$$Q = (0.62) A \sqrt{2g\left(H + \frac{V_A^2}{2g}\right)}$$

$$V_A = \frac{Q_A}{A_A}$$

FOR 24" PIPE

$$V_A = \frac{29.44}{3.141} = 9.37 \text{ FT/SEC.}$$

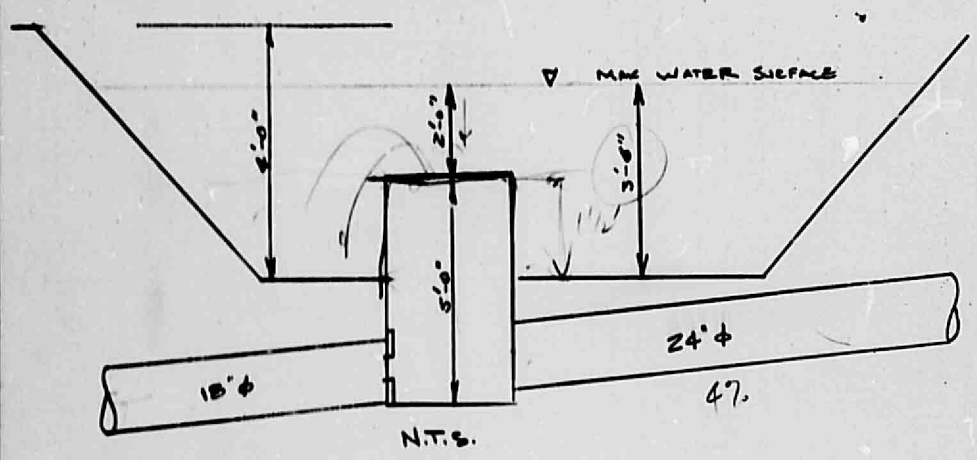
$$Q = 0.62 A \sqrt{64.4 H + 87.82}$$

and estimated properties—Continued

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Risk of corrosion to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
						Inches per hour	Inches per inch of soil	pH	Millimhos per centimeter at 25° C			
55–80	30–55	20–40	10–25	NP	NP	6.0–20.0	0.05–0.07	6.6–7.8	0–1	Low	Low	Low.
80–100	60–80	50–65	35–55	20–30	0–10	0.6–2.0	0.10–0.16	7.9–8.4	0–1	Low to moderate.	High	Low.
70–90	45–70	25–60	15–35	NP	NP	2.0–6.0	0.03–0.09	7.9–8.4	0–1	Low	High	Low.
	100	90–100	50–65	20–30	0–5	0.2–0.6	0.18–0.20	8.5–9.0	0–1	Low	High	Low.
	100	90–100	85–95	25–35	5–15	0.2–0.6	0.18–0.20	7.9–8.4	0–1	Moderate	High	Low.
	100	85–100	75–85	20–30	5–15	0.6–2.0	0.14–0.16	7.9–8.4	0–1	Moderate[1]	High	Low.
75–100	65–95	40–80	20–50	NP	NP	2.0–6.0	0.08–0.13	7.9–8.4	0–1	Low	Low	Low.
	100	60–70	30–40	NP	NP	2.0–6.0	0.10–0.12	7.9–8.4	1–4	Low	High	Low.
	100	60–80	15–35	NP	NP	2.0–6.0	0.06–0.08	7.9–8.4	1–4	Low	High	Low.
	100	80–95	30–40	NP	NP	2.0–6.0	0.09–0.13	7.9–8.4	1–4	Low	High	Low.
	100	80–90	30–50	30–40	5–15	2.0–6.0	0.09–0.13	7.9–8.4	1–4	Low	High	Low.
	100	95–100	75–90	30–40	10–15	0.2–0.6	0.18–0.20	7.4–8.4	0–1	Moderate	High	Low.

[1] Subject to rare flooding.
[2] For unit SnA, reaction is 8.5–9.0 and salinity is 1–4.
[3] Subject to frequent flooding.

BY JEB DATE 1-9-01 SUBJECT TIERRA AMADA SHEET NO. 7 OF 10
CHKD. BY DATE DRAINAGE CALCULATIONS JOB NO. 01-00-01



FOR MAX HEAD = 7' WITH Q_{MAX} = 7.84 cfs

DETERMINE AREA OF ORIFICE

$$Q = 0.62 A \sqrt{64.44 + 87.82}$$

$$7.84 = 0.62 A \sqrt{(64.4)(7) + 87.82}$$

$$A = 0.545 \text{ FT}^2$$

$$A = \frac{\pi D^2}{4} = 0.545$$

$$D = 0.833' = 9.995"$$

USE 10" OPENING

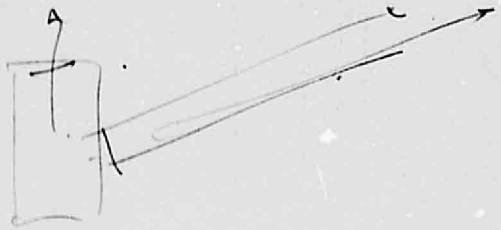


TABLE 8.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill (trench type) [1]	Local road and streets
Carlito: CAF	Severe: slope; perks slowly.	Severe: slope.	Severe: slope; too clayey.	Severe: slope; shrink swell.	Severe: too clayey.	Severe: low strength; shrink swell.
Cut and fill land: Cu	Slight if slope is 1 to 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: seepage.	Moderate: cutbanks cave; slope.	Slight if slope is 1 to 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: seepage.	Slight if slope is 1 to 8 percent, moderate if 8 to 15, severe if more than 15.
*Embudo: EmB, EtC. For Tijeras part of EtC, see Tijeras series.	Slight [2]	Severe: seepage.	Moderate: [3] small stones.	Slight [2]	Severe: seepage.	Slight
Escabosa. Mapped only with Laporte soils and Rock outcrop.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.
*Gila: GA, Gb, Ge, GH. For Hants part of GH, see Hants series.	Moderate: perks slowly.	Moderate: seepage.	Slight	Slight	Slight	Moderate: low strength.
Gc, Gd, GF	Severe: wet.	Moderate: seepage; wet.	Moderate: wet.	Slight	Severe: wet.	Moderate: low strength.
Glendale: Gk, Gm	Severe: perks slowly.	Slight	Moderate: too clayey.	Moderate: shrink swell.	Moderate: too clayey.	Moderate: shrink swell.
Gs	Severe: perks slowly.	Moderate: wet	Moderate: too clayey.	Moderate: shrink swell.	Severe: wet; too clayey.	Moderate: shrink swell
Hants: Ha	Severe: perks slowly; floods.	Slight	Severe: too clayey; rarely floods.	Severe: shrink swell; floods.	Severe: too clayey; floods.	Severe: shrink swell; floods.
Ildefonso: ILC	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: seepage.	Severe if slope is more than 15 percent: small stones.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: seepage.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.
*Kim: KaB, KbB, KD. For Badland part of KD, see Badland.	Slight	Moderate: seepage.	Slight	Moderate: low strength; shrink swell.	Slight	Moderate: shrink swell.
*Kokan: KOE, KR. For Rock outcrop part of KR see Rock outcrop.	Moderate if slope is 10 to 15 percent, severe if more than 15.	Severe: seepage; slope.	Severe: cutbanks cave; small stones.	Moderate if slope is 10 to 15 percent, severe if more than 15.	Severe: seepage; small stones.	Moderate if slope is 10 to 15 percent, severe if more than 15.

See footnotes at end of table.

BY JEB DATE 1-9-01 SUBJECT TIERRA AMADA SHEET NO. 9 OF 10
CHKD. BY DATE DRAINAGE CALCULATIONS JOB NO. 01-00-01

FOR 10" OPENING

H	Q
0	0
1.0	4.17
2.0	4.97
3.0	5.66
4.0	6.28
5.0	6.84
5.2	6.95
5.4	7.05
5.6	7.16
5.8	7.26
6.0	7.36
6.2	7.46
6.4	7.56
6.6	7.65
6.8	7.75
7.0	7.84
7.2	7.94
7.4	8.03

← MAX DISCHARGE AT Q5 HISTORIC

H VS VOLUME OF POND CALCULATIONS

$$\text{MAX POND VOLUME} = \left[\frac{(12{,}500)+(6825)}{2}\right]4 = 38{,}650\ FT^3$$

$$12{,}500 - 6825 = 5675$$

$$\frac{5675}{4} = 1418.75$$

$$V = \left[\frac{6825 + [6825 + 1418.75H]}{2}\right]H$$

$$V = 6825H + 709.38H^2$$

rpretations—Continued

Suitability as source of—				Soil features affecting—		Hydrologic soil group
Road fill	Sand	Gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	
or: low strength; shrink swell.	Unsuited	Unsuited	Poor: thin layer.	Slope	Hard to pack; low strength; compressible.	C
ood if slope is less than 15 percent, fair if more than 15.	Fair: excess fines.	Unsuited	Poor: small stones.	Seepage	Hard to pack; seepage.	A
ood	Poor: excess fines.	Poor: excess fines.	Poor: small stones.	Seepage	Piping; compressible.	B
oor: thin layer.	Unsuited	Poor: excess fines.	Poor: thin layer; small stones.	Depth to rock; seepage.	Piping; compressible.	C
air: low strength.	Poor: excess fines.	Poor: excess fines.	Good	Seepage	Piping	B
air: low strength.	Poor: excess fines.	Poor: excess fines.	Poor: excess salts.	Seepage	Piping	B
air: shrink swell.	Unsuited	Unsuited	Fair: too clayey.	Favorable	Low strength; piping.	B
air: shrink swell.	Unsuited	Unsuited	Poor: excess fines.	Favorable	Low strength; piping.	B
oor: shrink swell.	Unsuited	Unsuited	Poor: too clayey.	Favorable	Compressible; low strength.	D
ood if slope is less than 15 percent, fair if 15 to 25, poor if more than 25.	Poor: excess fines.	Poor: excess fines.	Poor: small stones.	Seepage	Favorable	B
air: low strength.	Unsuited	Unsuited	Good	Seepage	Piping; low strength.	B
ood if slope is 10 to 15 percent, fair if 15 to 25, poor if more than 25.	Good	Good	Poor: small stones.	Seepage	Seepage	A

BY JEB DATE 1-9-81 SUBJECT TIERRA ANADA SHEET NO. 9 OF 10

CHKD. BY ..... DATE ..... DRAINAGE CALCULATIONS JOB NO. 81-00-01

POND VOLUME VS HEAD

(H MEASURED FROM POND BOTTOM)

H	V
0	0
0.2	1393
0.4	2844
0.6	4351
0.8	5914
1.0	7535
1.2	9212
1.4	10,946
1.6	12,737
1.8	14,585
2.0	16,489
2.2	18,451
2.4	20,469
2.6	22,544
2.8	24,675
3.0	26,864
3.2	29,109
3.4	31,411
3.6	33,770
3.8	36,185
4.0	38,650

TABLE 8.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill (trench type) [1]	Local roads and streets
*Silver: SmA, SnA, SwB, SwC----- For Witt part of SwB and SwC, see Witt series.	Severe: perc slowly.	Slight if slope is less than 2 percent, moderate if 2 to 7, severe if more than 7.	Moderate: too clayey.	Moderate: low strength; shrink swell.	Moderate: too clayey.	Severe: low strength.
*Tesajo: Te----- For Millett part, see Millett series.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: seepage.	Severe: small stones.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: seepage.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.
Tijeras: TgB-----	Slight-----	Severe: seepage.	Severe: small stones; cutbanks cave.	Moderate: shrink swell.	Severe: seepage.	Moderate: shrink swell; low strength.
Tome: To-----	Severe: perc slowly.	Slight-----	Moderate: floods.	Moderate: shrink swell.	Moderate: floods.	Moderate: shrink swell.
Torrifluvents: TP-----	Severe: floods.	Severe: floods; seepage.	Severe: cutbanks cave; floods.	Severe: floods.	Severe: floods; seepage.	Severe: low strength.
*Travessilla: TQC, TR----- For Rock outcrop part of TR, see Rock outcrop.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Ustolls----- Mapped only with Rock outcrop.	Severe: slope; depth to rock.	Severe: slope.	Severe: slope.	Severe: slope; depth to rock.	Severe: depth to rock; slope.	Severe: slope; depth to rock.
*Vinton: Va, VbA, VBB, Vc, VF--- For Brazito part of VF, see Brazito series.	Slight-----	Severe: seepage.	Severe: cutbanks cave.	Slight-----	Severe: seepage.	Slight-----
*Wink: WaB, WeB, WM----- For Embudo part of WeB, see Embudo series; for Madures part of WM, see Madures series.	Slight-----	Severe: seepage.	Slight-----	Slight-----	Severe: seepage.	Slight-----
Witt----- Mapped only with Silver soils.	Severe: perc slowly.	Slight if slope is 1 to 2 percent, moderate if 2 to 7.	Moderate: too clayey.	Moderate: shrink swell.	Moderate: too clayey.	Moderate: shrink swell; low strength.

[1] Onsite study of the underlying strata, the water table, and the hazards of aquifer pollution and drainage into ground water needs to be made for landfill deeper than 5 or 6 feet.

BY JEB DATE 1-9-01 SUBJECT TIERRA AMADA SHEET NO. 10 OF 10

CHKD. BY ..... DATE ..... DRAINAGE CALCULATIONS JOB NO. 81-00-01

FLOOD ROUTING TABLE FOR MAIN POND

TIME	INFLOW Q_i	INFLOW V_i	OUTFLOW Q_o	OUTFLOW V_o	STORAGE	ACCUM. STORAGE	H
0	0	0	0	0	0	0	0
3	8.83	795	6.84	616	179	179	0.03
6	17.66	2384	6.84	1231	1153	1332	0.19
9	26.50	3974	6.84	1231	2743	4075	0.56
12	29.44	5035	6.84	1231	3804	7879	1.04
15	29.44	5299	6.86	1233	4066	11945	1.51
18	29.44	5299	7.11	1258	4041	15985	1.95
21	29.44	5299	7.33	1300	3999	19985	2.35
24	29.44	5299	7.53	1338	3961	23946	2.73
27	29.44	5299	7.72	1372	3927	27872	3.09
30	20.61	4505	7.88	1404	3101	30973	3.36
33	11.78	2915	8.01	1431	1484	32458	3.49
36	2.94	1325	8.07	1447	-122	32336	3.48
39	0	265	8.06	1452	-1187	31149	3.38
42	0	0	8.02	1447	-1447	29,702	3.25
45	0	0	7.96	1438	-1438	28,264	3.13
48	0	0	7.90	1427	-1427	26,836	3.00
51	0	0	7.84	1417	-1417	25,420	2.87
54	0	0	7.78	1406	-1406	24014	2.74
57	0	0	7.72	1395	-1395	22,619	2.61
60	0	0	7.66	1384	-1384	21,235	2.47
63	0	0	7.59	1372	-1372	19,863	2.34
66	0	0	7.53	1361	-1361	18,503	2.21
69	0	0	7.46	1348	-1348	17,155	2.07
72	0	0	7.39	1336	-1336	15819	1.93
75	0	0	7.32	1324	-1324	14,492	1.79
78	0	0	7.25	1312	-1312	13,181	1.65
81	0	0	7.18	1299	-1299	11,882	1.51
84	0	0	7.11	1286	-1286	10,596	1.36
87	0	0	7.03	1272	-1272	9323	1.21
90	0	0	6.95	1258	-1258	8065	1.06

interpretations—Continued

Suitability as source of—				Soil features affecting—		Hydrologic soil group
Road fill	Sand	Gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	
Poor: low strength.	Unsuited	Unsuited	Poor: too clayey.	Slope if more than 2 percent.	Low strength; compressible.	C
Good if slope is less than 15 percent, fair if more than 15.	Poor: excess fines.	Poor: excess fines.	Poor: small stones.	Seepage	Seepage; piping	A
Fair: shrink swell; low strength.	Poor: excess fines.	Poor: excess fines.	Poor: small stones.	Seepage	Low strength; piping.	B
Fair: shrink swell.	Unsuited	Unsuited	Fair: too clayey.	Favorable	Low strength; compressible; piping.	B
Poor: low strength.	Poor: excess fines.	Unsuited	Poor: excess alkali; excess salts; too sandy.	Seepage	Seepage; excess salts; excess alkali.	A
Poor: thin layer; slope.	Unsuited	Unsuited	Poor: area reclaim.	Depth to rock	Thin layer	D
Poor: area reclaim; large stones.	Unsuited	Unsuited	Poor: slope; large stones; thin layer.	Slope; depth to rock.	Large stones; thin layer.	D
Good	Poor: excess fines.	Unsuited	Poor: too sandy.	Seepage	Piping; seepage	B
Fair: low strength.	Unsuited	Unsuited	Good	Seepage	Piping; erodes easily.	B
Fair: low strength; shrink swell.	Unsuited	Unsuited	Fair: thin layer.	Favorable	Compressible; piping; low strength.	B

[1] Some local areas are subject to flooding.
[2] Soil is subject to consolidation under load.

EXHIBITS

APPENDIX II

EXHIBIT A

BY JEB DATE 1-9-81 SUBJECT TIERRA AMADA - DRAINAGE SHEET NO. 1 OF 10
CHKD. BY ..... DATE ..... CALCULATIONS JOB NO. 81-00-01

UNDEVELOPED CONDITIONS

TOTAL SITE AREA = 10.394 ACRES

$$Q = C i A$$

$$Q_{100} = (0.4)(5.4)(10.394) = \underline{22.45 \text{ cfs}}$$

FOR 5 YEAR STORM - DURATION = T_c = 10 MIN
WEATHER BUREAU DATA = $0.47 \text{ in} \left(\frac{60}{10}\right)$ ∴ $i = 2.82 \frac{\text{in}}{\text{HR}}$

$$Q_5 = (0.4)(2.82)(10.394) = \underline{11.72 \text{ cfs}}$$

SHEET FLOW FROM PROPERTY DISCHARGING DIRECTLY OFFSITE

AREA (A-2) WEST LOTS BACKYARD & ½ ROOF

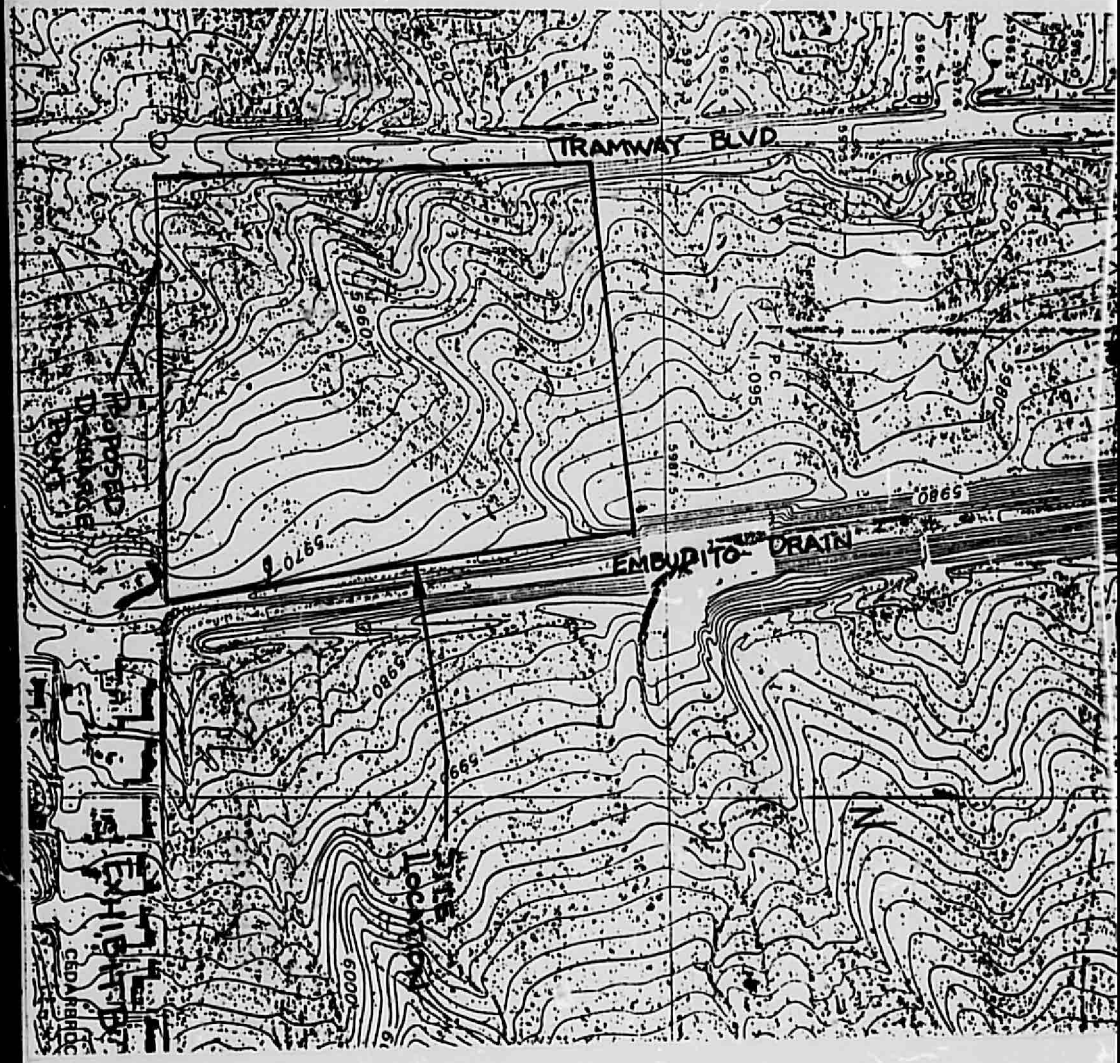
TOTAL AREA = 30,575 FT²

IMPERVIOUS AREA = $\frac{(36)(46)}{2}(14) = 11,592 \text{ FT}^2$

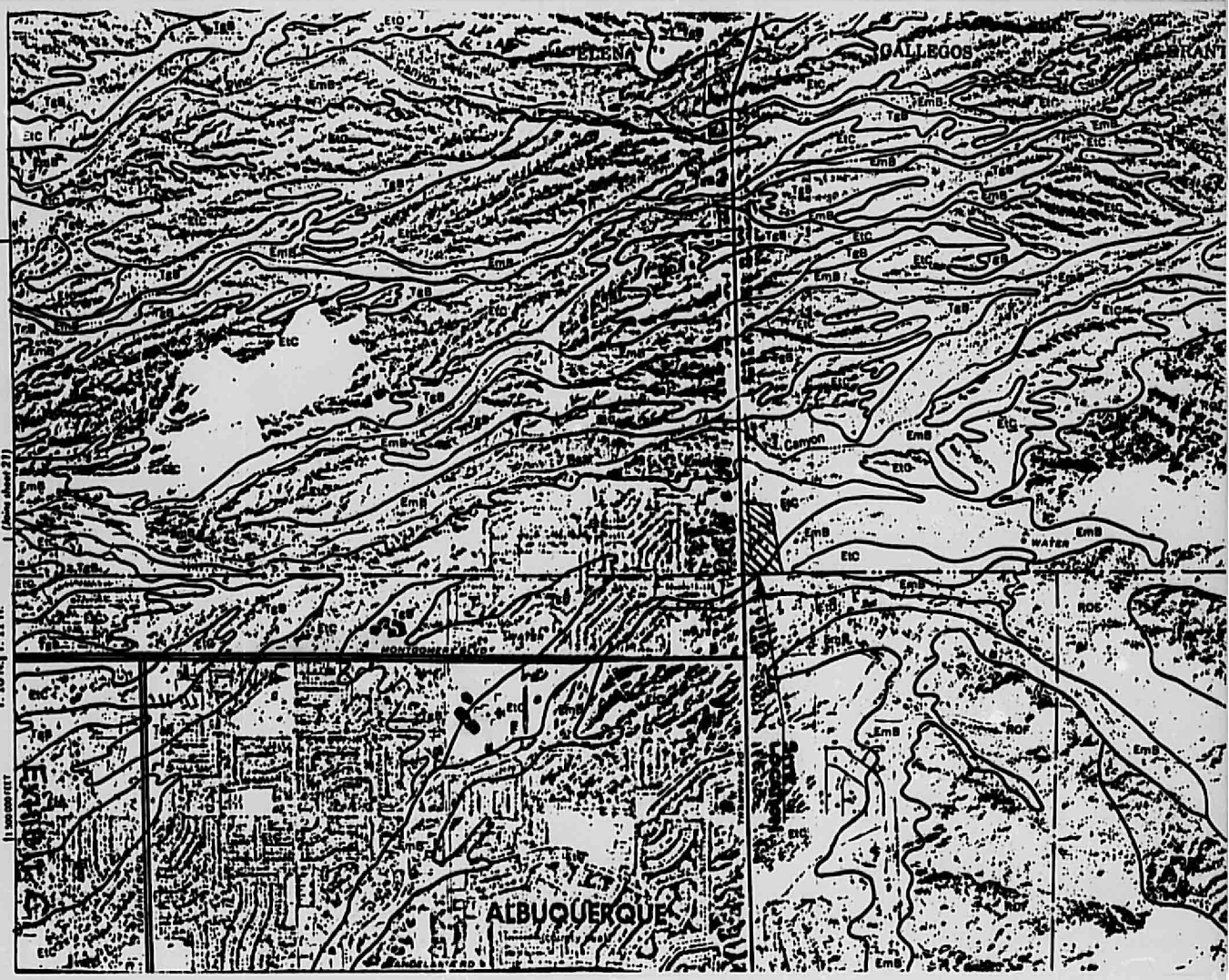
PERVIOUS AREA = 18,983 FT²

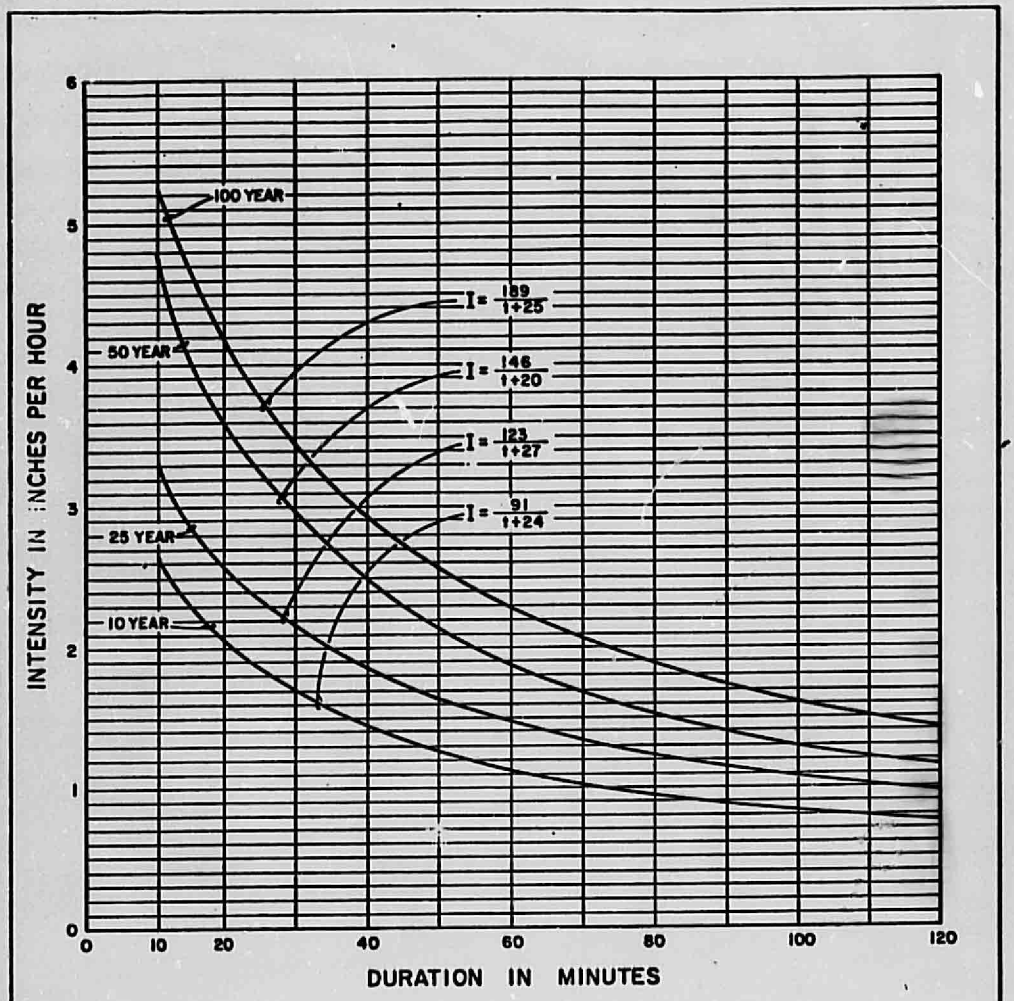
$$C = \frac{(0.4)(18,983) + (0.9)(11,592)}{30,575} = \underline{0.59}$$

$$Q_{100} = (0.59)(5.4)\left(\frac{30,575}{43,560}\right) = \underline{2.23 \text{ cfs}}$$


TRAMWAY BLVD
EMBUDITO DRAIN
P.C.
1095
5987.5
5980
5970
5960
5950
5940
5930
5920
5910
5900
5890
5880
5870
5860
5850
5840
5830
5820
5810
5800
5790
5780
5770
5760
5750
5740
5730
5720
5710
5700
5690
5680
5670
5660
5650
5640
5630
5620
5610
5600
5590
5580
5570
5560
5550
5540
5530
5520
5510
5500
5490
5480
5470
5460
5450
5440
5430
5420
5410
5400
5390
5380
5370
5360
5350
5340
5330
5320
5310
5300
5290
5280
5270
5260
5250
5240
5230
5220
5210
5200
5190
5180
5170
5160
5150
5140
5130
5120
5110
5100
5090
5080
5070
5060
5050
5040
5030
5020
5010
5000
4990
4980
4970
4960
4950
4940
4930
4920
4910
4900
4890
4880
4870
4860
4850
4840
4830
4820
4810
4800
4790
4780
4770
4760
4750
4740
4730
4720
4710
4700
4690
4680
4670
4660
4650
4640
4630
4620
4610
4600
4590
4580
4570
4560
4550
4540
4530
4520
4510
4500
4490
4480
4470
4460
4450
4440
4430
4420
4410
4400
4390
4380
4370
4360
4350
4340
4330
4320
4310
4300
4290
4280
4270
4260
4250
4240
4230
4220
4210
4200
4190
4180
4170
4160
4150
4140
4130
4120
4110
4100
4090
4080
4070
4060
4050
4040
4030
4020
4010
4000
3990
3980
3970
3960
3950
3940
3930
3920
3910
3900
3890
3880
3870
3860
3850
3840
3830
3820
3810
3800
3790
3780
3770
3760
3750
3740
3730
3720
3710
3700
3690
3680
3670
3660
3650
3640
3630
3620
3610
3600
3590
3580
3570
3560
3550
3540
3530
3520
3510
3500
3490
3480
3470
3460
3450
3440
3430
3420
3410
3400
3390
3380
3370
3360
3350
3340
3330
3320
3310
3300
3290
3280
3270
3260
3250
3240
3230
3220
3210
3200
3190
3180
3170
3160
3150
3140
3130
3120
3110
3100
3090
3080
3070
3060
3050
3040
3030
3020
3010
3000
2990
2980
2970
2960
2950
2940
2930
2920
2910
2900
2890
2880
2870
2860
2850
2840
2830
2820
2810
2800
2790
2780
2770
2760
2750
2740
2730
2720
2710
2700
2690
2680
2670
2660
2650
2640
2630
2620
2610
2600
2590
2580
2570
2560
2550
2540
2530
2520
2510
2500
2490
2480
2470
2460
2450
2440
2430
2420
2410
2400
2390
2380
2370
2360
2350
2340
2330
2320
2310
2300
2290
2280
2270
2260
2250
2240
2230
2220
2210
2200
2190
2180
2170
2160
2150
2140
2130
2120
2110
2100
2090
2080
2070
2060
2050
2040
2030
2020
2010
2000
1990
1980
1970
1960
1950
1940
1930
1920
1910
1900
1890
1880
1870
1860
1850
1840
1830
1820
1810
1800
1790
1780
1770
1760
1750
1740
1730
1720
1710
1700
1690
1680
1670
1660
1650
1640
1630
1620
1610
1600
1590
1580
1570
1560
1550
1540
1530
1520
1510
1500
1490
1480
1470
1460
1450
1440
1430
1420
1410
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1250
1240
1230
1220
1210
1200
1190
1180
1170
1160
1150
1140
1130
1120
1110
1100
1090
1080
1070
1060
1050
1040
1030
1020
1010
1000
990
980
970
960
950
940
930
920
910
900
890
880
870
860
850
840
830
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
390
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
N
CEDAR AVE.
LOCUST ST.

THIS MICROIMAGE IS THE BEST POSSIBLE
REPRODUCTION DUE TO THE POOR QUALITY
OF THE ORIGINAL DOCUMENT

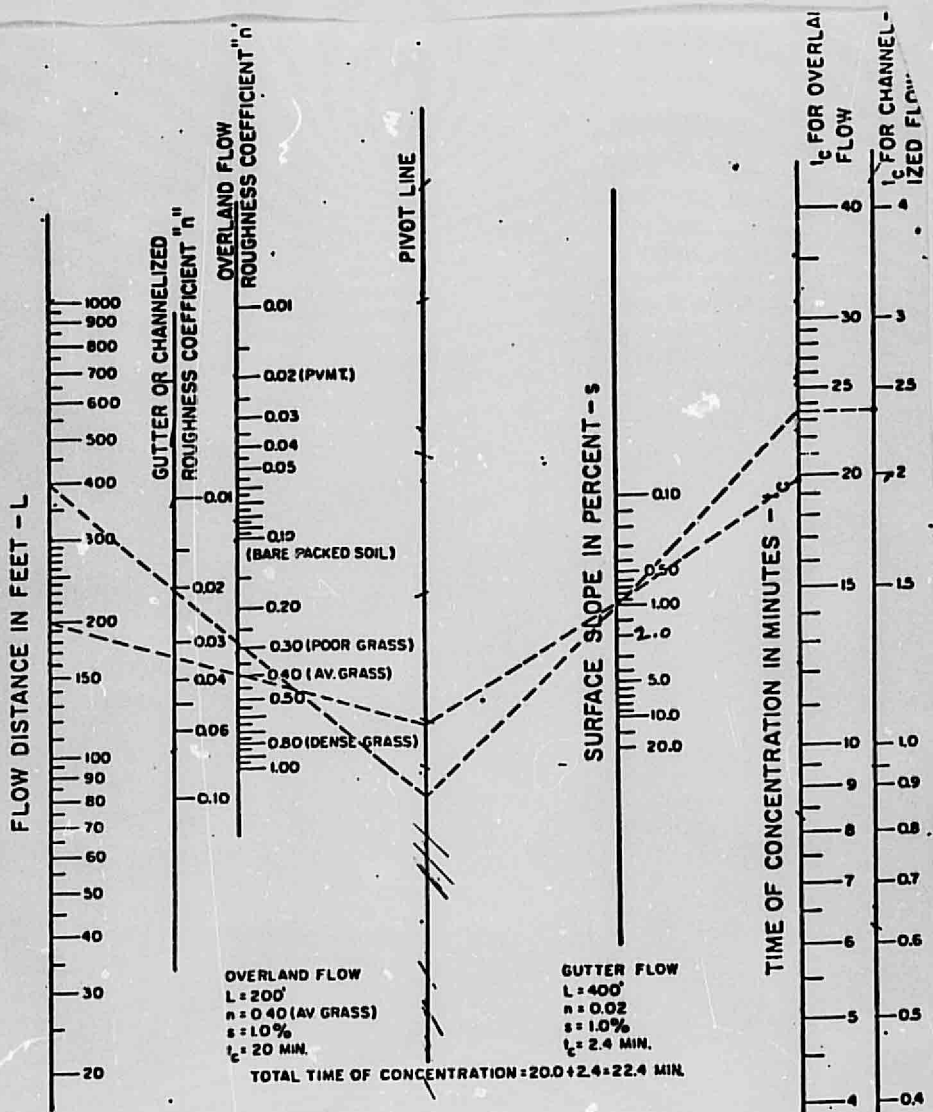




MASTER PLAN OF DRAINAGE
PREPARED BY:
GORDON HERKENHOFF & ASSOCIATES
ALBUQUERQUE, NEW MEXICO

INTENSITY DURATION FREQUENCY CURVES
(ALBUQUERQUE AREA, 1961)

FIGURE - EXHIBIT D



NOMOGRAPH
FOR TIME OF CONCENTRATION

EXHIBIT E
FIGURE



HYDROLOGY

F23/D1
SEVEN PLAN
1 of 2

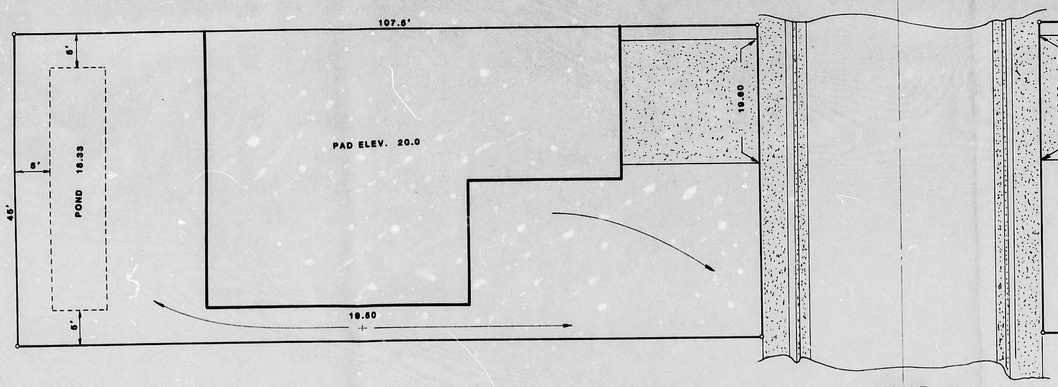
F23-D1

7 PLANS

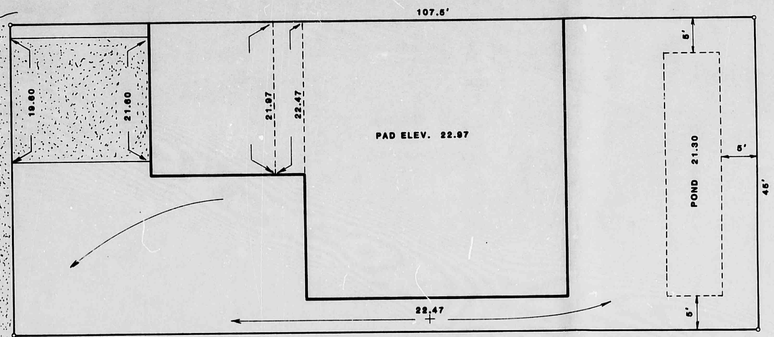
AF 13167A

TYPICAL LOT GRADING

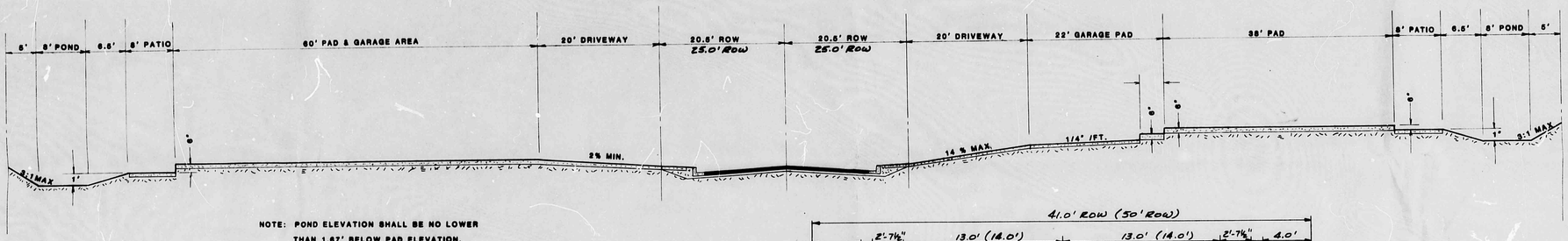
TYPE I



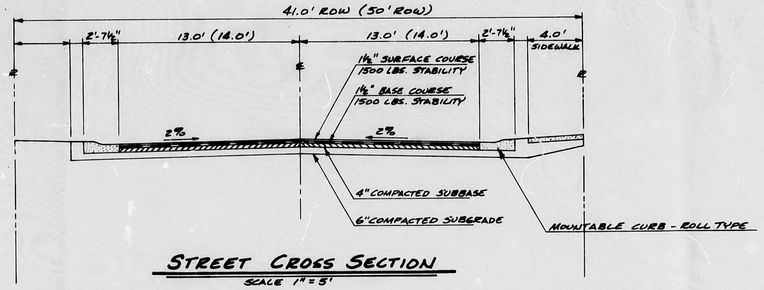
TYPE II



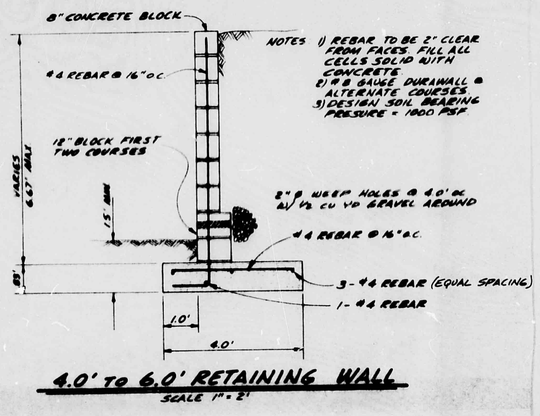
SCALE:
1" = 10' HORZ.
NO VERT. SCALE



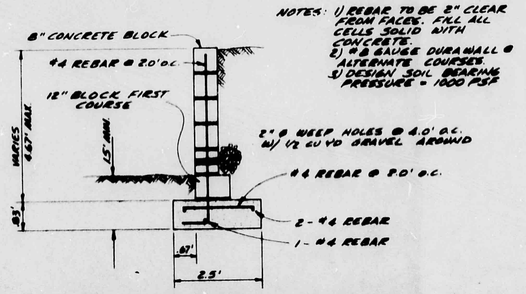
NOTE: POND ELEVATION SHALL BE NO LOWER THAN 1.67' BELOW PAD ELEVATION.



STREET CROSS SECTION
SCALE 1"=5'



4.0' TO 6.0' RETAINING WALL
SCALE 1"=2'



2.0' TO 4.0' RETAINING WALL
SCALE 1"=2'

ACADEMY ENGINEERING INC.
6565 WYOMING BLVD. SUITE 3 ALBUQUERQUE, N.M. 87109

PLANS PREPARED UNDER THE DIRECTION OF

APPROVED FOR CONSTRUCTION

CITY ENGINEER DATE

CITY OF ALBUQUERQUE
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

TITLE: TIERRA AMADA
GRADING DETAILS

F23/D1

APPROVALS	ENGINEER	DATE	APPROVALS	ENGINEER	DATE
City Engineer			Liquid Waste		
A.C.E. - Design			Traffic		
A.C.E. - Hydrology			Water		

DRAWING NO.

SHEET 4 OF 5

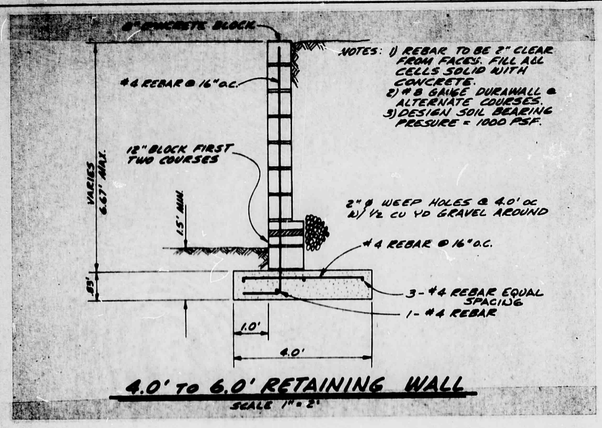
REFERENCES
MAP NO.
EST. NO.
W.O. NO.

SURVEY INFORMATION
FIELD NOTES
NO. BY DATE

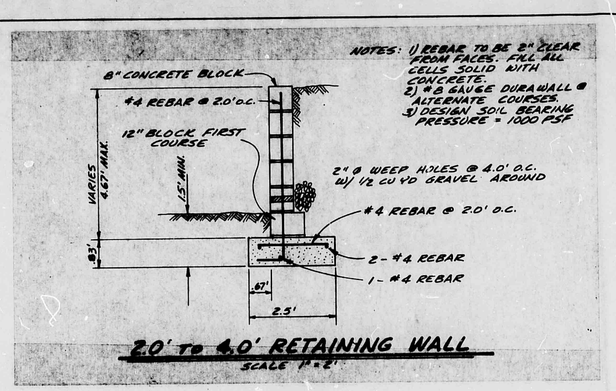
AS BUILT INFORMATION
CONTRACTOR
WORK STAKED BY DATE
INSPECTORS
ACCEPTANCE BY DATE
FIELD
VERIFICATION BY DATE
DRAWING
CORRECTED BY DATE
MICRO-FILM INFORMATION
RECORDED BY DATE
NO.

BENCH MARKS

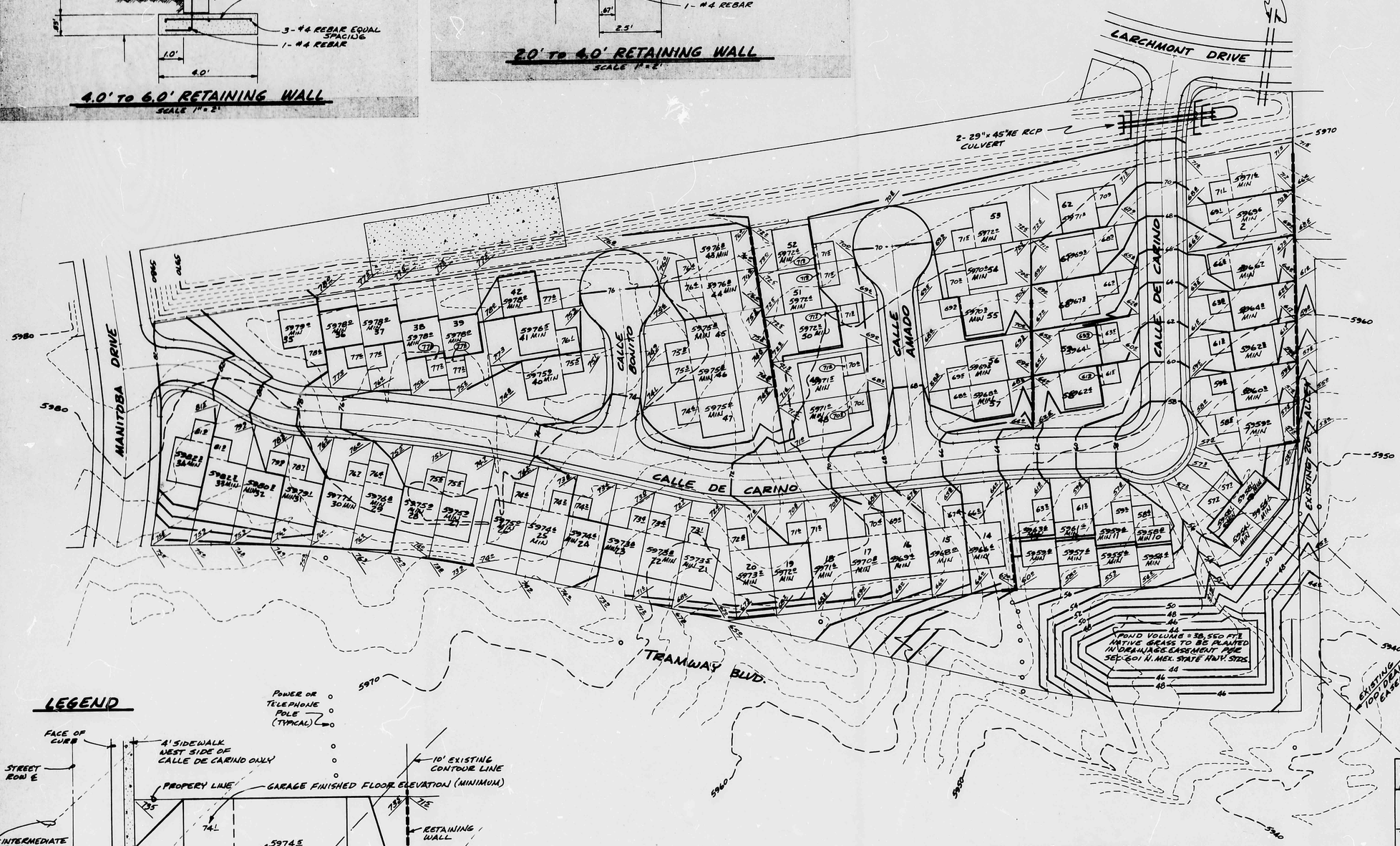
NO. DATE REMARKS BY
REVISIONS
DESIGN
DESIGNED BY DATE
DRAWN BY DATE
CHECKED BY DATE



4.0' TO 6.0' RETAINING WALL
SCALE 1" = 2'

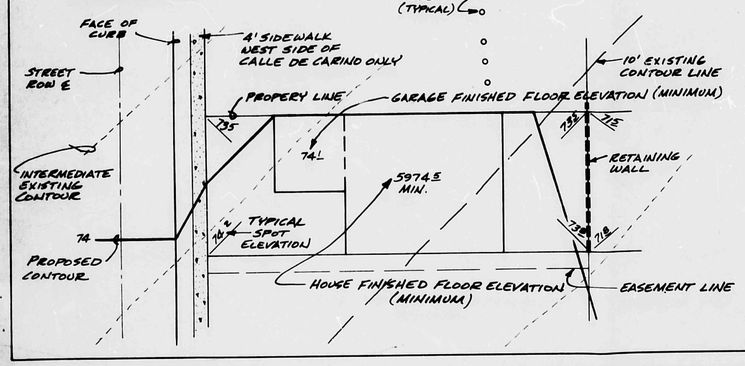


2.0' TO 4.0' RETAINING WALL
SCALE 1" = 2'



SCALE 1" = 50'
CONTOUR INTERVAL = 2'

LEGEND



NOTES: 1) SEE SHEET 4 OF 5 FOR GRADING DETAILS
2) SEE SHEET 3 OF 5 FOR POND AND STORM SEWER DETAILS
3) SEE SHEET 5 OF 5 FOR ADDITONAL EASEMENT LOCATIONS (PLAT)

APPROVED FOR CONSTRUCTION

CITY ENGINEER DATE

PLANS PREPARED UNDER THE DIRECTION OF

ACADEMY ENGINEERING INC.
6363 WYOMING BLVD. SUITE 3
ALBUQUERQUE, NEW MEXICO 87109

CITY OF ALBUQUERQUE
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

TITLE: TIERRA AMADA
GRADING PLAN

F23/01

APPROVALS	ENGINEER	DATE	APPROVALS	ENGINEER	DATE
City Engineer			Liquid Waste		
A.C.E. - Design			Traffic		
A.C.E. - Hydrology			Water		

DRAWING NO.

SHEET 2 OF 5

REFERENCES
MAP NO. F-23
EST. NO.

SURVEY INFORMATION
FIELD NOTES
NO. | BY | DATE
W.O. NO.

BENCH MARKS
ACS BENCH MARK 6-F23 LOCATED AT THE INTERSECTION OF LARCHMONT DRIVE & CEDARBROOK AVE. NE IN THE NORTH-EAST QUADRANT OF THE INTERSECTION. A CONCRETE NAIL DRIVE FLUSH WITH THE TOP OF CURB AT NNE CURB RETURN.
ELEVATION = 5974.957

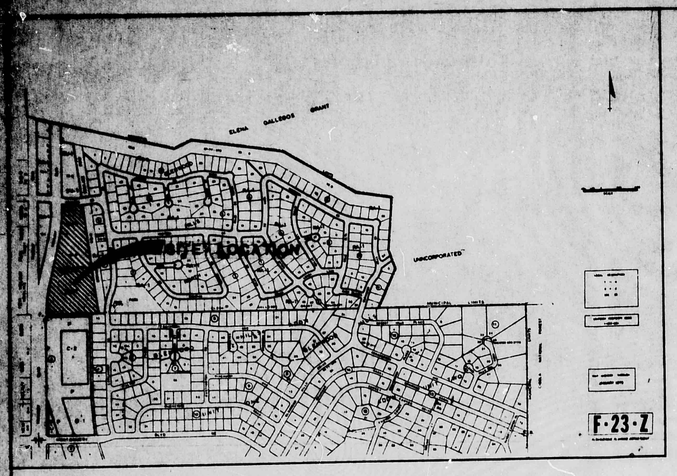
AS BUILT INFORMATION
CONTRACTOR
WORK INSPECTORS ACCEPTANCE BY — DATE
FIELD VERIFICATION BY — DATE
DRAWING CORRECTED BY — DATE
MICRO-FILM INFORMATION
RECORDED BY — DATE
NO.

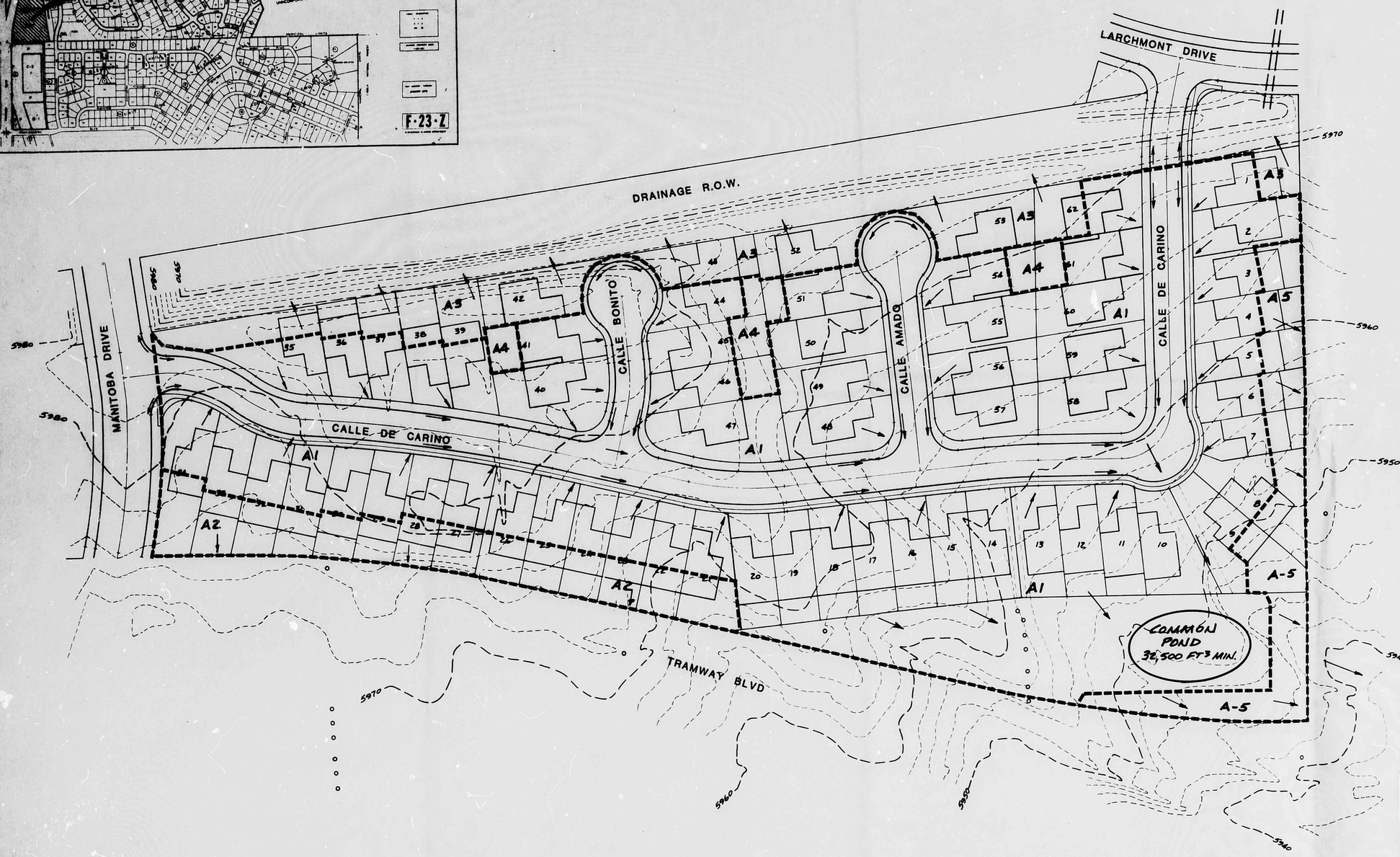
NO.	DATE	REMARKS	BY
		REVISIONS DESIGN	

DESIGNED BY Jim Blackwell. DATE JUNE, 1981
DRAWN BY Ted Lutek. DATE JUNE, 1981
CHECKED BY Jim Blackwell. DATE JUNE, 1981

INDEX TO DRAWINGS

SHT. NO.	DESCRIPTION
1	DRAINAGE PLAN
2	GRADING PLAN
3	24" STORM SEWER
4	GRADING DETAILS
5	PLAT





SCALE 1" = 50'
CONTOUR INTERVAL = 2'

SURVEY INFORMATION
FIELD NOTES

NO.	BY	DATE

BENCH MARKS
ACS BENCH MARK 6-F23 LOCATED AT THE INTERSECTION OF LARCHMONT DRIVE & CEDARBROOK AVE. NE IN THE NORTHEAST QUADRANT OF THE INTERSECTION. A CONCRETE NAIL DRIVE FLUSH WITH THE TOP OF CURB AT NNE CURB RETURN.
ELEVATION = 5974.957

AS BUILT INFORMATION

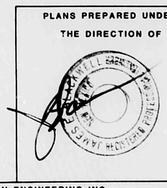
CONTRACTOR		
WORK STAKED BY		DATE
INSPECTORS		
FIELD CHANGE BY		DATE
FIELD VERIFICATION BY		DATE
AS BUILTS BY		
CORRECTED BY		DATE

MICRO-FILM INFORMATION
RECORDED BY
NO. DATE

REFERENCES
MAP NO. F-23
EST. NO.
W.O. NO.

NO.	DATE	REMARKS	BY
		REVISIONS	
		DESIGN	
		DESIGNED BY Jim Blackwell	DATE JUNE, 1981
		DRAWN BY Ted Bitek	DATE JUNE, 1981
		CHECKED BY Jim Blackwell	DATE JUNE, 1981

PLANS PREPARED UNDER THE DIRECTION OF



ACADEMY ENGINEERING INC.
5353 WYOMING BLVD. SUITE 3
ALBUQUERQUE, NEW MEXICO 87109

CITY OF ALBUQUERQUE
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

TITLE: TIERRA AMADA
DRAINAGE PLAN F23/D1

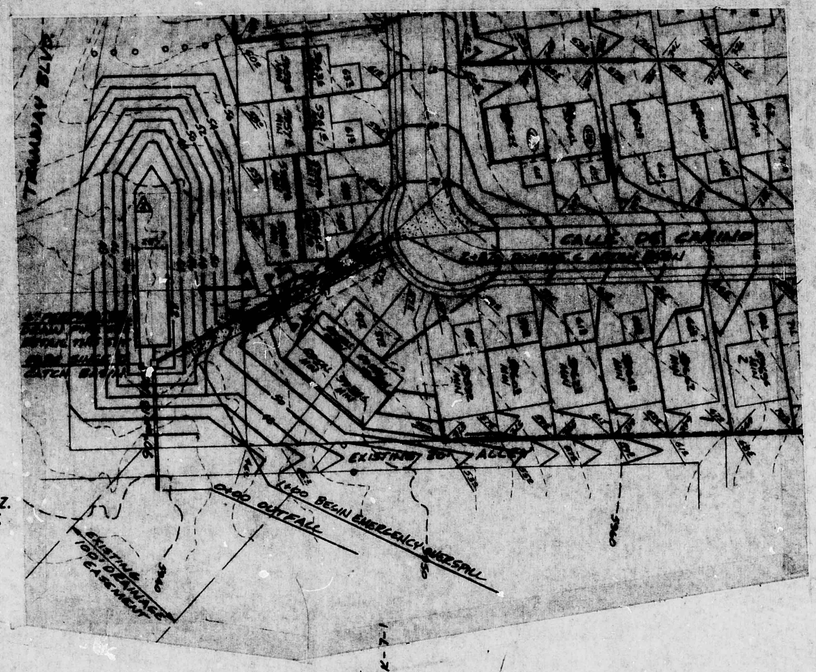
APPROVALS	ENGINEER	DATE	APPROVALS	ENGINEER	DATE
City Engineer			Liquid Waste		
A.C.E. Design			Traffic		
A.C.E. Hydrology			Water		

APPROVED FOR CONSTRUCTION
CITY ENGINEER DATE

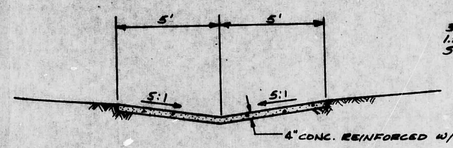
DRAWING NO

SHEET 1 OF 5

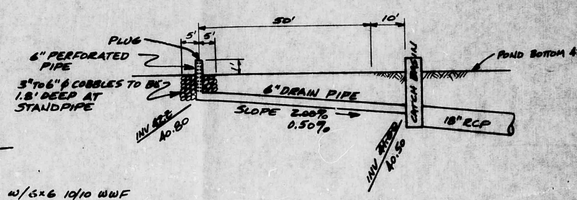
AF 12197A



SCALE:
1" = 50' HORIZ.
1" = 10' VERT.

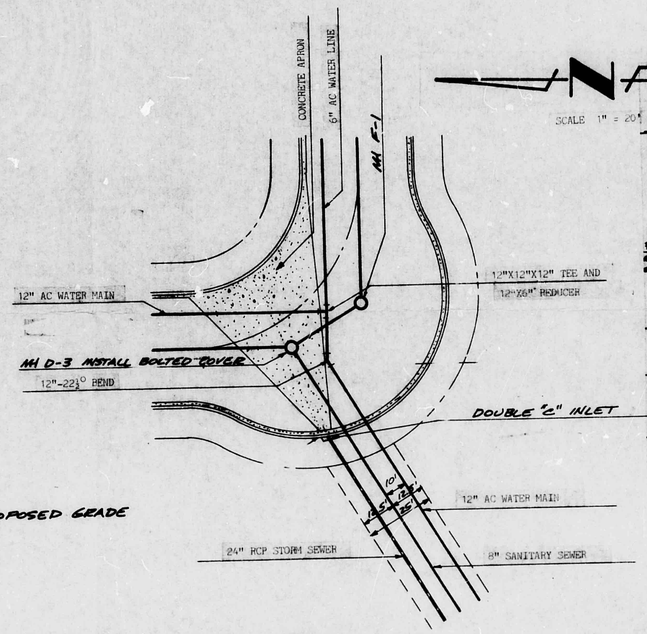


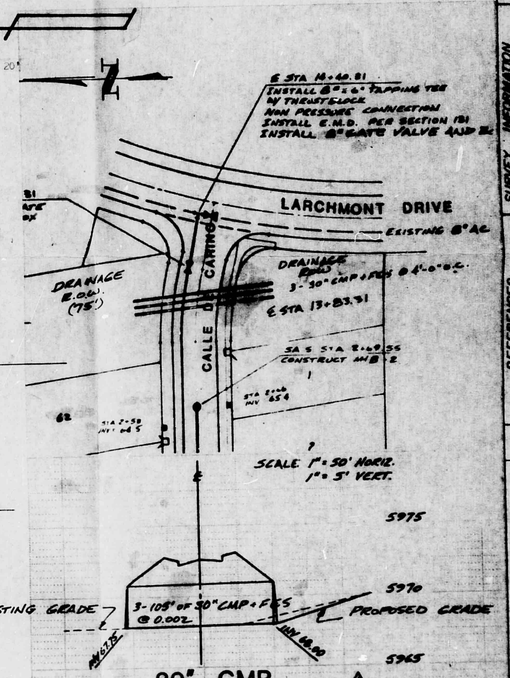
SECTION A-A EMERGENCY OVERSPILL
NO SCALE

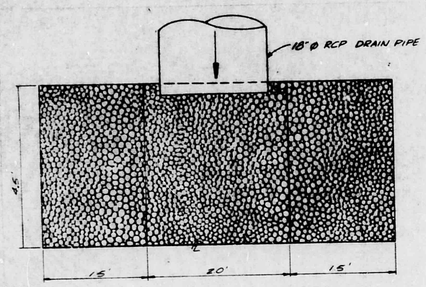


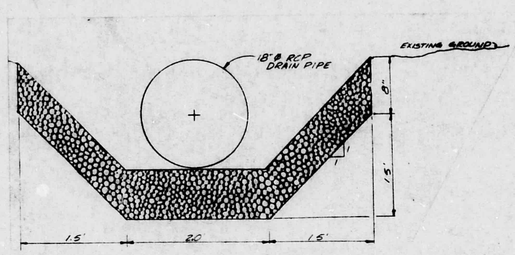
⚠ DETAIL - PERFORATED DRAIN PIPE
NO SCALE

SECTION B-B









AS BUILT INFORMATION
CONTRACTOR
DATE
SIGNED BY
ADDRESS
PHONE
DATE STARTED
DATE COMPLETED

BENCH MARKS
AGS BENCH MARK G-F-23 LOCATED AT THE INTERSECTION OF LARCHMONT DRIVE AND CRANBROOK AVE. N.E., IN THE BOULEVARD EAST QUADRANT OF SAID INTERSECTION. A CONCRETE MON. DRILLED FLUSH WITH TOP OF CURB AT NNE CURB RETURN (ELEV. 5974.357)

SURVEY INFORMATION
FIELD NOTES
NO. | BY | DATE

REFERENCES
MAP NO. F-23 | W.O. NO.
EST. NO.

LOWER POND AND GRATE ELEV. | TKW | BY

NO.	DATE	REMARKS	BY
2	5-25-82	LOWER POND & GRATE ELEV.	TKW
1	11-12-81	ADD PLAN & PROFILE	TKW
		REVISIONS	

DESIGNED BY J. BLACKWELL DATE JUNE, 1981
DRAWN BY T. WEBB DATE JUNE, 1981
CHECKED BY J. BLACKWELL DATE JUNE, 1981

ACADEMY ENGINEERING INC.
8363 WYOMING BLVD. NE., SUITE 8 ALBUQUERQUE, NEW MEXICO 87109

PLANS PREPARED UNDER THE DIRECTION OF
JAMES L. BLACKWELL
NEW MEXICO
PROFESSIONAL ENGINEER

APPROVED FOR CONSTRUCTION
CM Lentsch 9/15/82
CITY ENGINEER DATE

CITY OF ALBUQUERQUE
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

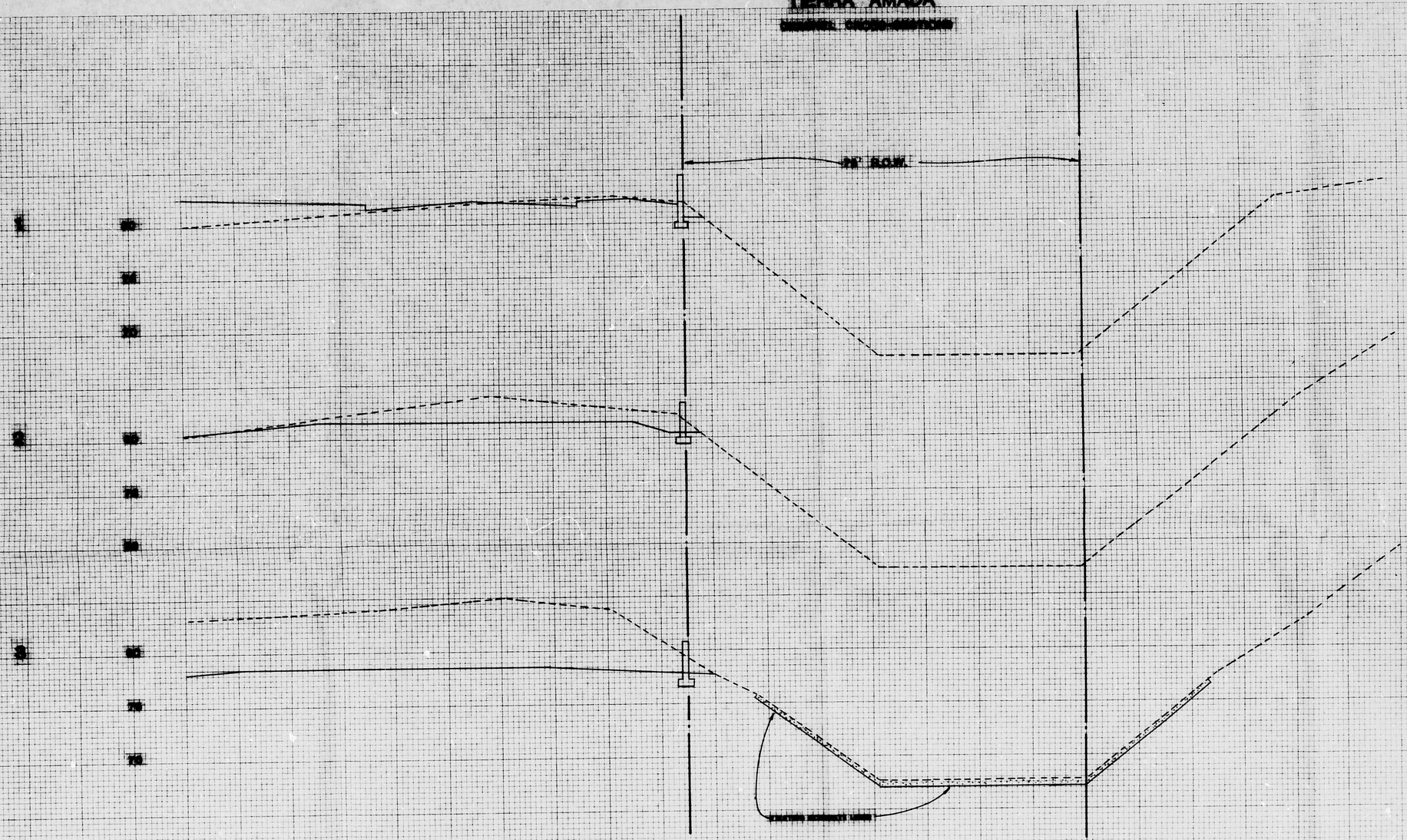
TITLE: 24" R.C.P. STORM SEWER

APPROVALS	ENGINEER	DATE	APPROVALS	ENGINEER	DATE
City Engineer			Liquid Waste		
A.C.E. - Design		9 Sept 82	Traffic		
A.C.E. - Hydrology	CM Lentsch	9/14/82	Water		

DRAWING NO 1160
SHEET 10 OF 11

F23/01

TERRA AMADA



CROSS SECTION 10 x 10
PRINT PAPER CO."
ADE IN U.S.A.

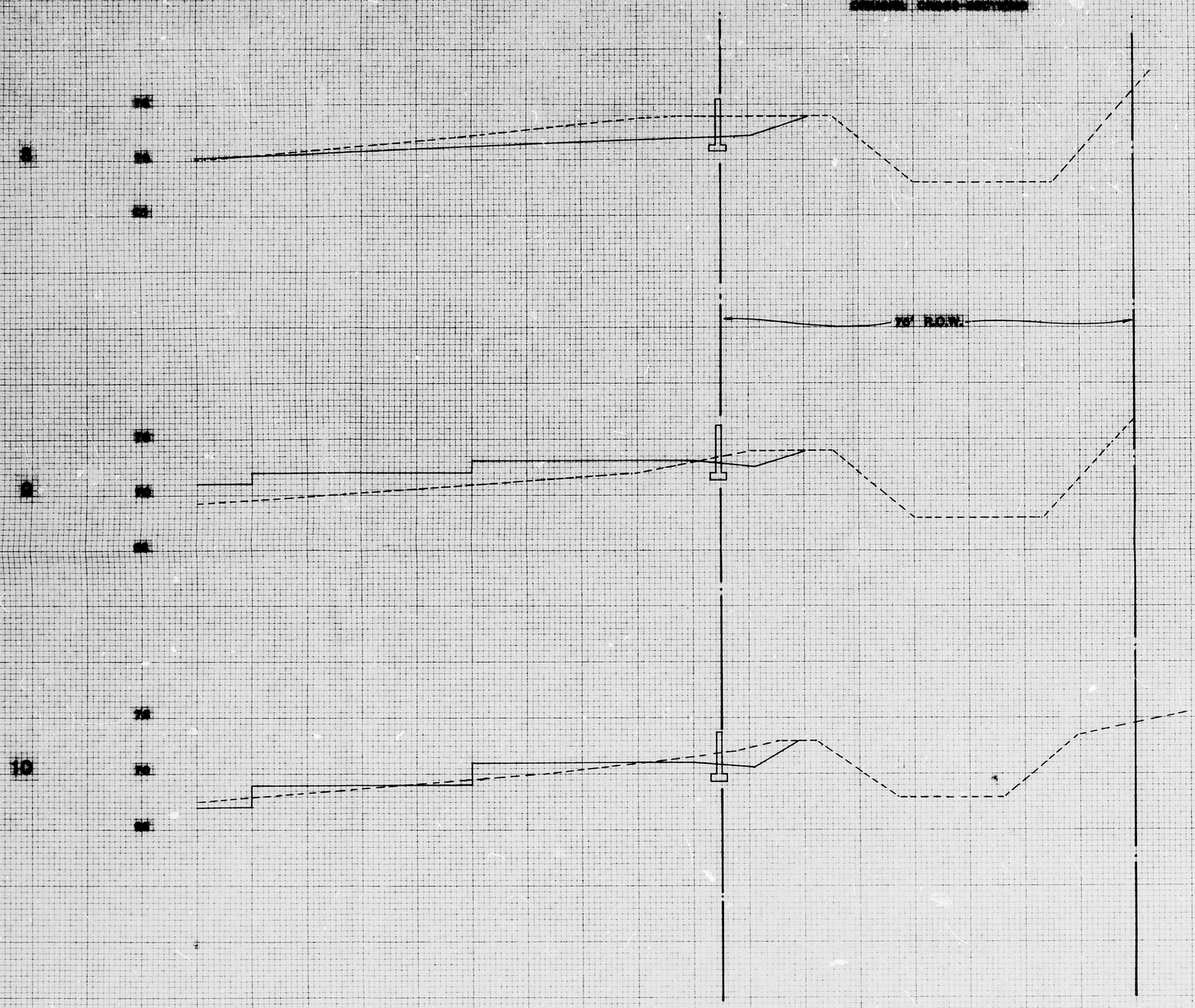
NO. 1294—CROSS SECTION 10 x 10
"CLEARPRINT PAPER CO."
MADE IN U.S.A.

F23/01

HYDROLOGY

F23/D1
SEVEN PLAN
2 of 2

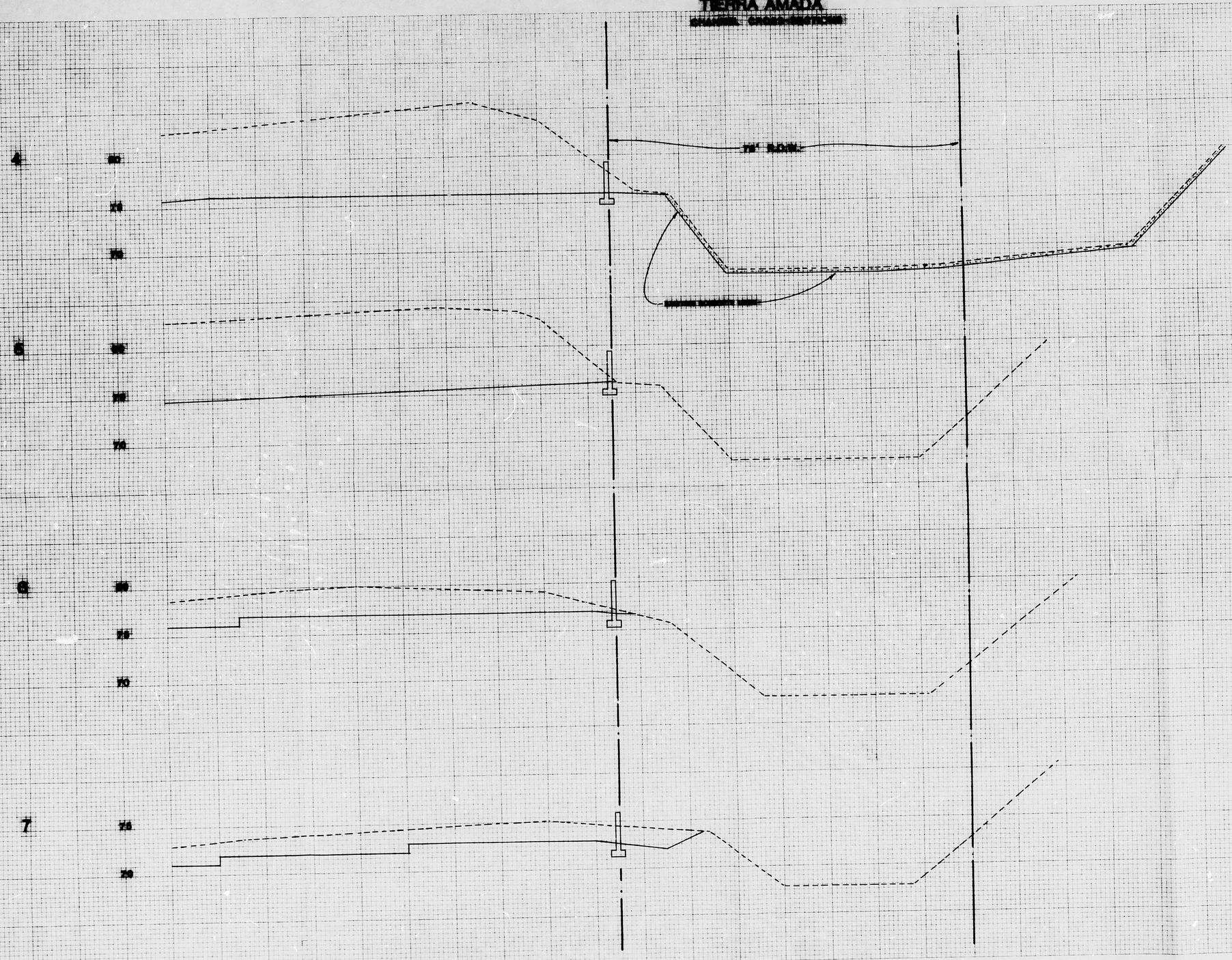
TIERRA AMADA



NO. 1294—CROSS SECTION 10 x 10
"CLEARPRINT PAPER CO."
MADE IN U.S.A.

F23/D1

TIERRA AMADA



NO. 1294—CROSS SECTION 10 x 10
"CLEARPRINT PAPER CO."
MADE IN U.S.A.

F23/D1