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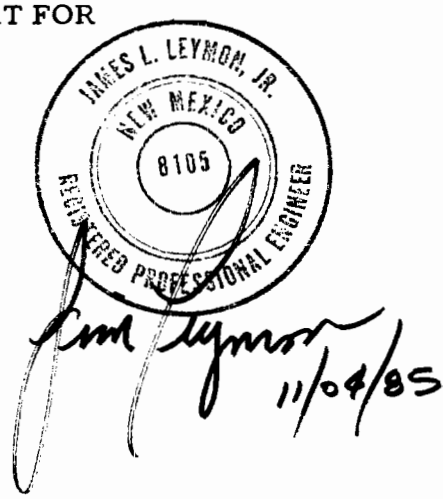
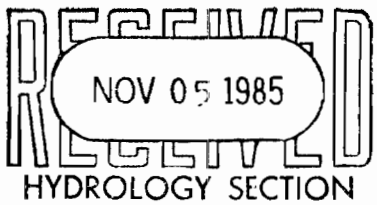
DRAINAGE REPORT FOR PARADISE BLUFF



Prepared for:

Horizon Corporation
4554 Paradise Boulevard NW
Albuquerque, New Mexico 87114



October, 1985

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PURPOSE AND SCOPE

The purpose of this report is to establish the criteria for controlling stormwater runoff from the future development of Lots 1 through 5 in a manner which is acceptable to the City of Albuquerque and the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA). The acceptance of this drainage report will facilitate the filing of the bulk land transfer plat for Paradise Bluff, Lots 1 through 5. The report determines the stormwater runoff quantities resulting from the 100-year frequency/6-hour duration design storm falling within the project site under existing and developed conditions. The subject site lies within the Piedras Marcadas Drainage Basin. The "Piedras Marcadas Basin Drainage Management Plan", prepared by Tom Mann and Associates for AMAFCA, is referenced throughout this report. The drainage basins encompassing and affecting the future development of Paradise Bluff, Lots 1 through 5, are discussed in this management plan.

The scope of this plan is to ensure that the future development of this site will be protected from stormwater runoff and that the project will not increase the flooding potential of adjacent properties and downstream areas. The report also serves to identify necessary infrastrucure required for the future development of Paradise Bluff.

LOCATION AND DESCRIPTION

The Paradise Bluff parcel is located south of Paradise Boulevard NW, east of Lyon Boulevard NW, and north of the middle branch of the Piedras Marcadas Arroyo. A "bulk land transfer" plat is being prepared for the subject site, Paradise Bluff, Lots 1 through 5. The Vicinity Map, Figure 1, graphically depicts the location of the site.

The site contains approximately 126.3 acres and is presently undeveloped. The north portion of the site, comprised of Lots 1 and 5, slopes from south to north at grades ranging from 2% to 15%. The south portion of the site, comprised of Lots 2 through 4, slopes from north to south at grades ranging from 2% to 15%. The volcanic escarpment, typical of the West Mesa terrain, is located in the south and east portions of the subject site.

The parcel will contain five (5) lots which are zoned for residential uses with the exception of a portion of lot 4 which has been zoned for commercial uses. The subject site only recently was annexed into the City of Albuquerque as a portion of the Paradise Hills annexation.

Paradise Boulevard NW and Lyon Boulevard NW should be classified as arterial type streets. The "Plan for Major Open Space" has projected the adjacent land to the south of the subject site for future acquisition by the City in the ultimate condition. The land to the south is commonly referred to as the Petroglyph Canyon area. At this time, the City of Albuquerque has purchased a number of tracts in this area to be utilized as major open space and the City has obtained an option to acquire additional tracts for these uses.

DESIGN CRITERIA

The analysis of stormwater runoff generated by the project site is based on the "Rational Method" as outlined in the City of Albuquerque's "Development Process Manual". This approach determines the peak discharge and volume of stormwater runoff for the 100-year frequency/6-hour duration design storm falling within the study area.

Two previous reports have provided a detailed analysis of the existing conditions and anticipated developed conditions of Piedras Marcadas Drainage Basin and the Paradise Hills area. A third report contains the design analysis for the Piedras Marcadas outfall facility. These reports are listed below:

1. "Piedras Marcadas Drainage Basin Management Plan," prepared by Tom Mann & Associates, Albuquerque, New Mexico, February 1983.
2. "Engineer's Report: Paradise Hills Master Drainage Plan," prepared by Leverton-Denny Engineers, Inc., Albuquerque, New Mexico, 1975.
3. "Piedras Marcadas Detention Dam," prepared by Wilson & Company Engineers, Albuquerque, New Mexico, 1983.

Hydrograph analysis is based upon the accepted procedures and methods outlined in the City of Albuquerque's "Development Process Manual."

EXISTING DRAINAGE CONDITIONS

The subject site is presently undeveloped as previously mentioned. Paradise Boulvard NW is an existing estate-type street located in a 106' right-of-way. Residential development has occurred between Paradise Boulevard NW and the subject site. Estate-type paving is predominant throughout this residential development. Two apartment complexes exist at the northeast corner of the intersection of Justin Drive NW and Buglo Avenue NW. Justin Drive NW and Buglo Avenue NW are existing streets with curb and gutter, and sidewalks adjacent to the apartment developments. Paradise Hills, Unit 1 is an undeveloped subdivision on the west side, and the remaining areas to the south and west of the subject site are also undeveloped.

The soils located within the site are an Alemeda Sandy Loam (AmB), a Bluepoint Loamy Fine Sand (BCC), and a Kokan-Rock Outcrop Association (KR). These soils belong to Hydrologic Soil Groups C, B, and A respectively and comprise approximately 75%, 20%, and 5% of the area of the site. This information was determined from the "Soil Survey of Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico", prepared by the USDA Soil Conservation Service.

The subject site is located in the 200 and 300 series areas of the Piedras Marcadas Drainage Basin identified in the "Piedras Marcadas Basin Drainage Management Plan", prepared by Tom Mann and Associates, Inc., prepared for the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA). More specifically, Lots 1 and 5 are located in Subbasin 204 which drains from south to north and contributes stormwater runoff to Paradise Boulevard NW and ultimately discharges to the North Branch of the Piedras Marcadas Arroyo. The major portion of Lots 3 and 4 is located in Sub-Basin 205 which drains from northwest to southeast and contributes stormwater runoff to the North Branch of the Piedras Marcadas Arroyo. A minor portion of these two lots drains to the north, to Paradise Boulevard NW and ultimately contributes runoff to the North Branch of the Piedras Marcadas

Arroyo. Lot 2 is located in Subbasin 305 which drains from north to south and contributes storm water runoff to the Middle Branch of the Piedras Marcadas Arroyo. The stormwater runoff quantities generated by each lot in the existing condition are shown in Table 1.

Lot No.	Peak Discharge (cfs)	Runoff Volume (cf)
1	58.2	99,870
2	40.2	78,275
3	47.3	83,145
4	85.0	155,340
5	4.1	7,085

TABLE 1
Stormwater Runoff Quantities
Existing Condition

No offsite flows are anticipated to enter the subject site from any direction. A channel has been constructed approximately located in the Lyon Boulevard NW right-of-way. This channel collects stormwater runoff from a dip-section located at intersection of Paradise Boulevard NW and Lyon Boulevard NW and diverts it south. The channel also intercepts stormwater runoff existing as sheetflow which could enter the site from the west. The subject site is lcoated on a prominent ridge, a part of the volcanic escarpment. Therefore, no offsite flows will enter the subject site from the north, east or south due to this topographic feature.

Two problem areas that will have an effect on the future development of the the subject site were identified by a report prepared by Leverton-Denny Engineers, Inc., "Engineer's Report: Paradise Hills Master Drainage Plan". One problem is the capacity of the Paradise Boulevard NW right-of-way. The second problem occurs at the intersection of Golf Course Boulevard NW and Paradise Boulevard where a 24" pipe conveys flows generated by the golf course underneath

Paradise Boulevard NW to an existing arroyo; that arroyo being the North Branch of the Piedras Marcadas Arroyo. From a field investigation, it appears that neither of these problems have been resolved as suggested by the aforementioned report or the management plan.

The major result of the Piedras Marcadas Drainage Basin Management Plan was the construction of a major downstream facility which provides a safe outfall for stormwater runoff generated by the entire developed basin. The downstream facility is an earthen detention dam located on the west side of Coors Boulevard NW. An engineering report, "Piedras Marcadas Detention Dam" prepared by Wilson & Company Engineers, presents the final design of the facility. The dam ultimately discharges to the Rio Grande under controlled discharge conditions. This dam is owned and maintained by AMAFCA.

PROPOSED DRAINAGE CONDITIONS

The Drainage Plan, Figure 2, is included in the back pocket of this report. This plan shows 1) Existing and proposed drainage basins, 2) Existing and developed peak flow rates, 3) Existing contours at 2'-0" intervals, 4) Proposed drainage flow patterns, and 5) Proposed public drainage easements.

The future development will be assumed to consist of high-density residential development and commercial development. An impervious ratio equal to 85% has been assumed for stormwater runoff calculations. Stormwater runoff quantities generated by the subject site in the future developed condition are shown in Table 2.

Lot No.	Peak Discharge (cfs)	Runoff Volume (cf)
1	125.5	215,510
2	70.3	136,985
3	82.7	145,500
4	172.1	314,570
5	9.8	16,885

TABLE 2
Stormwater Runoff Quantities
Developed Condition

The future development of Lots 1 and 5 will be consistent with the recommendations presented in the Piedras Marcadas Drainage Basin Management Plan previously mentioned. Lots 1 and 5 are located in the 200 series area of the entire Piedras Marcadas Basin, the series which defines the drainage basin of the North Branch of the Piedras Marcadas Arroyo. The recommendations are summarized below:

1. Reconstruct Paradise Boulevard NW to adequately convey 160 cfs from Lyon Boulevard NW to Golf Couse Boulevard NW.

2. Construct an all-weather crossing at the intersection of Paradise Boulevard NW and Golf Course Boulevard NW.

3. Construct channel improvements on the North Branch of the Piedras Marcadas Arroyo as per the recommendations in the management plan. An alternative that may be used in lieu of the channel improvements, is that the anticipated 100-year flood plain in the ultimate condition should be respected. The flood plain limits vary from approximately 100 to 200 feet in width.

4. Future development within the North Branch of the Piedras Marcadas Drainage Basin should ultimately be permitted the free discharge of stormwater runoff if the above items 1 through 3 are satisfied.

From field observation, it appears that Paradise Boulevard NW has not been reconstructed or has the all-weather crossing been constructed at the intersection of Paradise Boulevard NW and Golf Course Boulevard NW. Since these storm drainage facilities have not been constructed, the free discharge of stormwater runoff from Lots 1 and 5 is not appropriate at this time. Therefore, this report shall establish the interim criteria to be used in order for the future development of Lots 1 and 5 to occur. The following criteria are listed below:

1. The future development of Lots 1 and 5 shall be restricted to the historic discharge of stormwater runoff from each particular lot.

2. An area located at the "low-end" of each lot shall be designated as a private drainage easement adequately-sized to detain the volume of ponding required by hydrograph analysis for that lot. The volume of ponding required as determined by the Hydrograph Analysis and the area required for the private drainage easement is shown on Table 3.

3. Due to the probable depth of the detention facility, fences shall be required for adequate safety.

4. Approved storm drainage improvements shall be utilized to convey stormwater runoff to the detention facility.

5. No major infrastructure shall be required in the interim period; therefore, the future development of these lots shall be allowed.

The future private drainage easements required for Lots 1 and 5 are shown on the Drainage Plan, Figure 2.

The future development of Lots 2, 3 and 4 will also be consistent with the recommendations presented in the management plan. Lot 2 is located in the 300 series area and Lots 3 and 4 are located in the 200 series area of the Piedras Marcadas Drainage Basin. In the ultimate condition, these three lots shall drain from north to south and discharge to the Petroglyph Canyon area under the free discharge conditions set forth in the management plan. The Petroglyph Canyon area is located adjacent to the subject site on the south and is part of the areas designated for major open spaces uses. The Piedras Marcadas Drainage Basin Management Plan established the criteria that developing lands upstream from the Petroglyph Canyon area cannot be permitted free discharge until the recommended low-flow channel or an accepted alternate design is constructed on the Middle Branch of the Piedras Marcadas Arroyo.

In lieu of the construction of the low-flow channel, the interim criteria presented for the future development of Lots 1 and 5 shall be established for Lots 2 through 4. The locations of the future private drainage easements required for these lots are also shown on the Drainage Plan, Figure 2.

As a closing note, it should be emphasized that the detention ponds located in future private drainage easements will not be required if the storm drainage facilities previously discussed are in place prior to the future development of Lots 1 through 5, Paradise Bluff.

Lot	Ponding Volume Required (cf)	Proposed Area of Public Drainage Easement (sf)
1	62,590	42,000
2	24,380	17,000
3	27,610	19,000
4	81,005	55,000
5	5,815	4,000

TABLE 3
Ponding Volume and Drainage
Easement Areas

CONCLUSIONS

The following conclusions are recommended for the future development of Paradise Bluff.

1. Controlled discharge is appropriate for the future development of this site, based upon the analysis of downstream conditions. The peak discharge from each lot shall be restricted to the historic discharge rate (see Table 1) until downstream capacity is increased.

2. Construct a detention pond located at the low end of Lots 1 through 5 with adequate capacity to control the volume of ponding required as determined by hydrograph analysis (see Table 3).

3. The detention facility shall be located in a future dedicated private drainage easement as shown on the Drainage Plan, Figure 2.

4. Approved storm drainage improvements shall be utilized to convey flows within each lot to the required detention facility.

5. Free discharge will be appropriate for the future development of Paradise Bluff if and when the following items as recommended by the previously mentioned management plan are addressed:

   A. Lots 1 and 5
      (i) The capacity of Paradise Boulevard NW between Lyon Boulevard NW and Golf Course Boulevard NW is increased.
      (ii) An all-weather crossing is constructed at the interesection of Paradise Boulevard NW and Golf Course Boulevard NW.
      (iii) Construct channel improvements on the North Branch of the Piedras Marcadas Arroyo or respect the anticipated 100-year flood plain which varies from 100' to 200' in width.

B. Lots 2 and 4

(i) Construct low flow channel on the Middle Branch of the Piedras Marcadas Arroyo.

6. The future development will not increase the flooding potential of adjacent or downstream properties.

7. An approved grading and drainage plan shall be required for each lot prior to release of building permit or work order.

8. Erosion control measures shall be detailed at the time of each lot's development.

9. No major infrastructure improvements shall be rquired as an interim measure; therefore, the bulk land transfer plat should be approved.

I. Existing Condition

A. Areas

Lot No.	Area Acres	Area Square Feet
1	32.91	1,433,550
2	20.42	889,500
3	21.69	944,810
4	48.63	2,118,300
5	2.61	113,700

B. Rainfall – From DPM Plate 22.2 D-1

$P_{100} = 2.2$ in/hr

C. Time of Concentration

$$t_c = 0.0078 \frac{L^{0.77}}{S^{0.385}}$$

Lot No.	ΔH (ft)	L (ft)	S	t_c (minutes)
1	72	1800	0.0400	8.6 *
2	15	1500	0.0100	12.8
3	25	1500	0.0167	10.5
4	25	1600	0.0156	11.3
5	25	1000	0.0250	6.6 *

* Use $t_c = 10.0$ minutes

D. INTENSITY – FROM DPM PLATE 22.2 D-2

$$i = P_{100}\,(6.84)\,t_c^{-0.51}$$

LOT NO.	i (IN/HR)
1	4.65
2	4.10
3	4.54
4	4.37
5	4.65

E. SOILS

ALAMEDA SANDY LOAM, AMB, HSG "C"

BLUEPOINT LOAMY FINE SAND, BCC, HSG "B"

KOKAN-ROCK OUTCROP ASSOCIATION, KR, HSG "A"

LOT NO.	AMB (%)	BCC (%)	KR (%)
1	25	75	0
2	90	5	5
3	90	5	5
4	65	10	25
5	0	100	0

F. % IMPERVIOUS

- IS ZERO FOR ALL LOTS IN THE EXISTING CONDITION.

G. "C" FACTOR - FROM DPM PLATE 22.1 C-1

LOT NO.	WEIGHTED "C" FACTOR
1	0.38
2	0.48
3	0.48
4	0.40
5	0.34

H. PEAK DISCHARGE AND RUNOFF VOLUME

$Q_{100} = CiA$ $\quad V_{100} = C\ P_{100}/12\ A$

LOT NO.	Q_{100} (CFS)	V_{100} (CF)
1	58.2	99,870
2	40.2	78,275
3	47.3	83,145
4	85.0	155,340
5	4.1	7,085

II. Developed Condition

A. – E. (No Change)

F. % Impervious

– is estimated @ 85 % for all development.

G. "C" Factor – from DPM Plate 22.1 C-1

Lot No.	Weighted "C" Factor
1	0.82
2	0.84
3	0.84
4	0.81
5	0.81

H. Peak Discharge and Runoff Volume

$Q_{100} = C\,i\,A$ $\quad V_{100} = C\,P_{100}/12\,A$

Lot No.	Q_{100} (cfs)	V_{100} (cf)
1	125.5	215,510
2	70.3	136,985
3	82.7	145,500
4	172.1	314,570
5	9.8	16,885

III. REQUIRED POND VOLUMES AND SURFACE AREAS

LOT NO.	VOLUME (CF)	AREA (SF)
1	62,590	42,000
2	24,380	17,000
3	27,610	19,000
4	81,005	55,000
5	5,815	4,000

SURFACE AREAS ARE CALCULATED USING A POND DEPTH OF 1.5'

ESPEY, HUSTON & ASSOCIATES INC.
Engineering & Environmental Consultants

SUBJECT HYDROGRAPH ANALYSIS

SHEET 1 OF 5 BY JTO
DATE 10/18/85 CK BY

PARADISE BLUFF

LOT 1

$V_I = \frac{1}{2}\ 125.5 \times 10 \times 60 = 37,650\ CF$

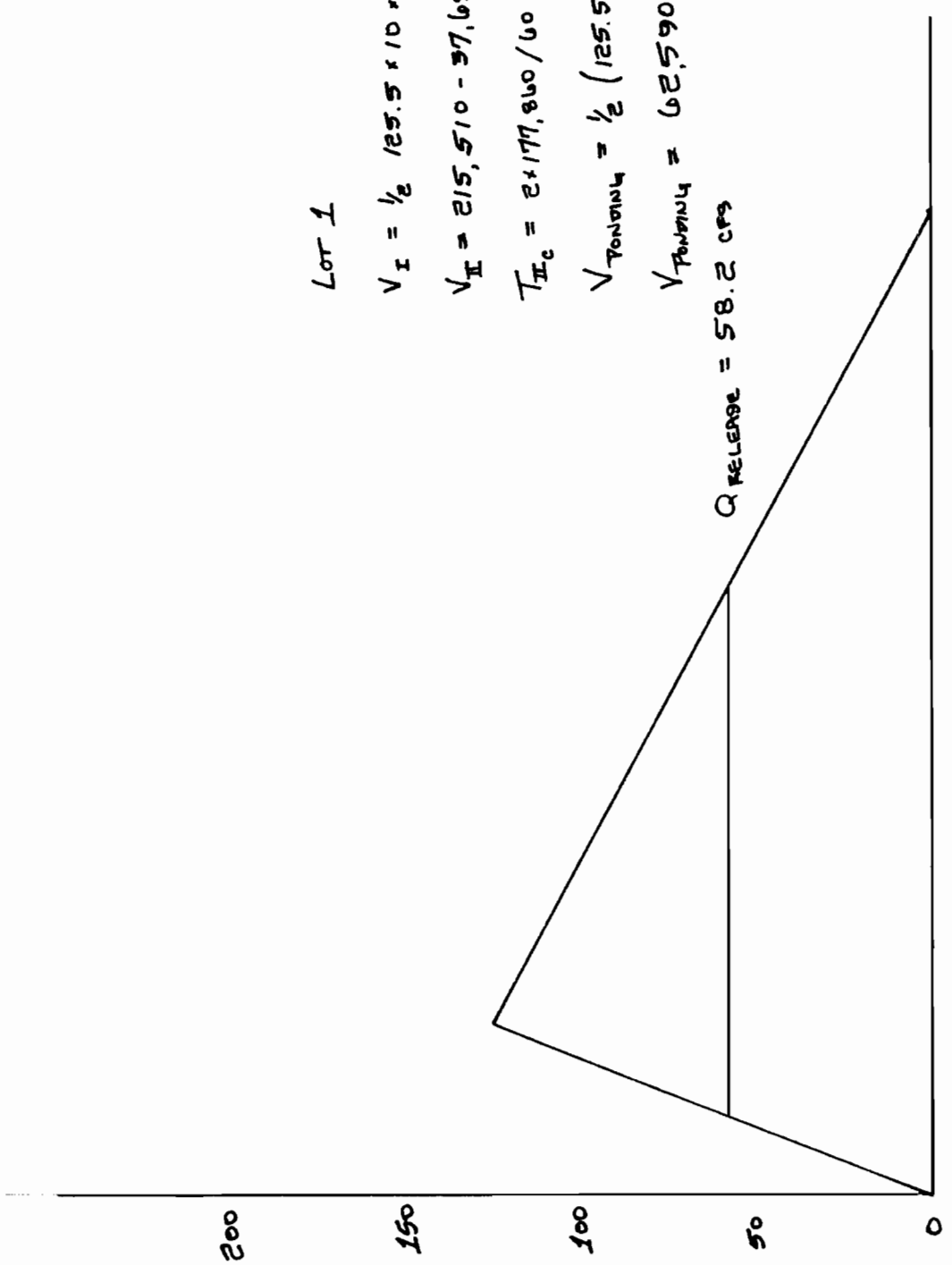
$V_{II} = 215,510 - 37,650 = 177,860\ CF$

$T_{II_c} = 2 \times 177,860 / 60 / 128.5 = 47.2\ MIN.$

$V_{PONDING} = \frac{1}{2}\ (125.5 - 59.2) \times 31.0 \times 60$

$V_{PONDING} = 62,590\ CF$

$Q_{RELEASE} = 58.2\ CFS$



LOT 2

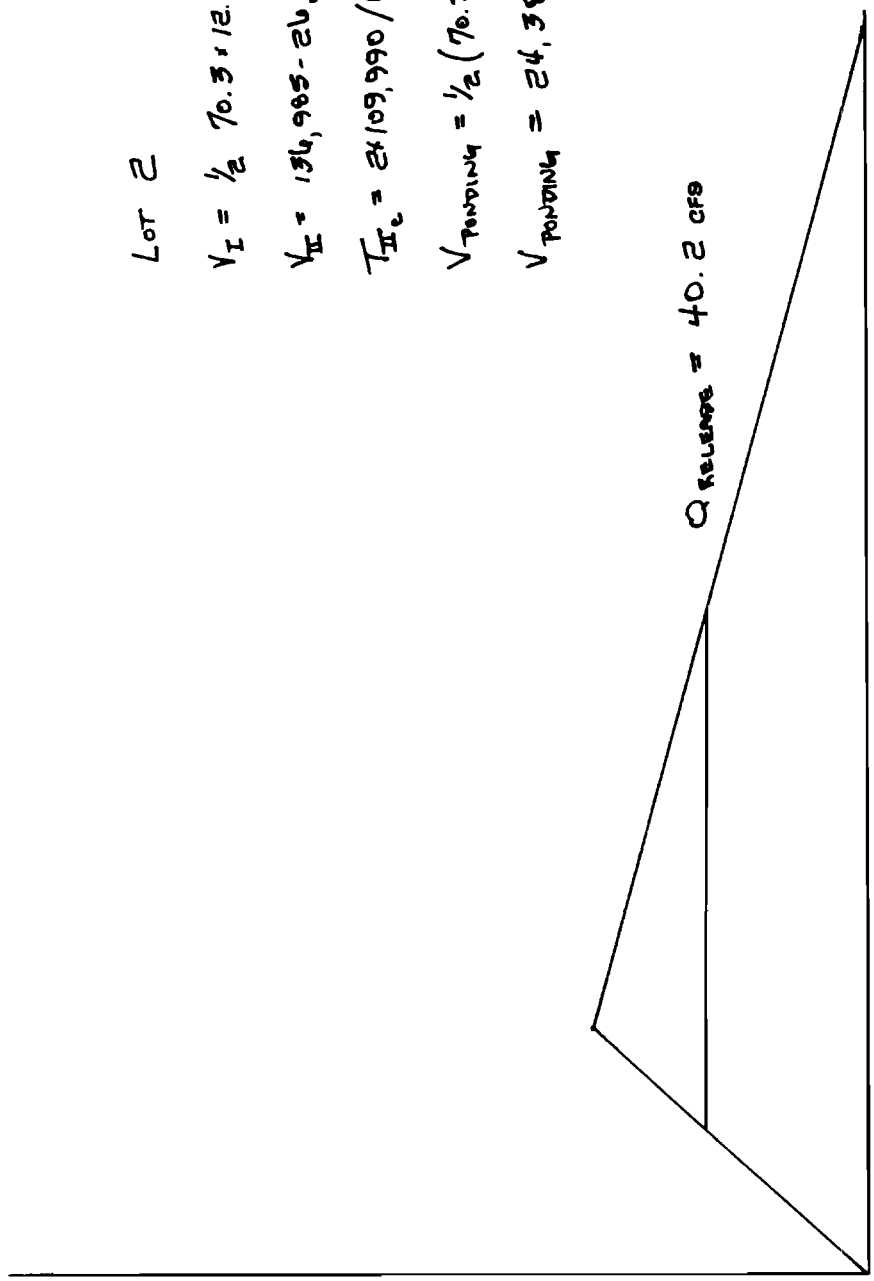
$V_I = \frac{1}{2}\ 70.3 \times 12.8 \times 60 = 16{,}995$ CF

$V_{II} = 131{,}995 - 26{,}995 = 109{,}990$ CF

$T_{II_c} = 2 \times 109{,}990 / 60 / 70.3 = 52.2$ MIN.

$V_{PONDING} = \frac{1}{2}(70.3 - 40.2) \times 27.0 \times 60$

$V_{PONDING} = 24{,}380$ CF



LOT 3

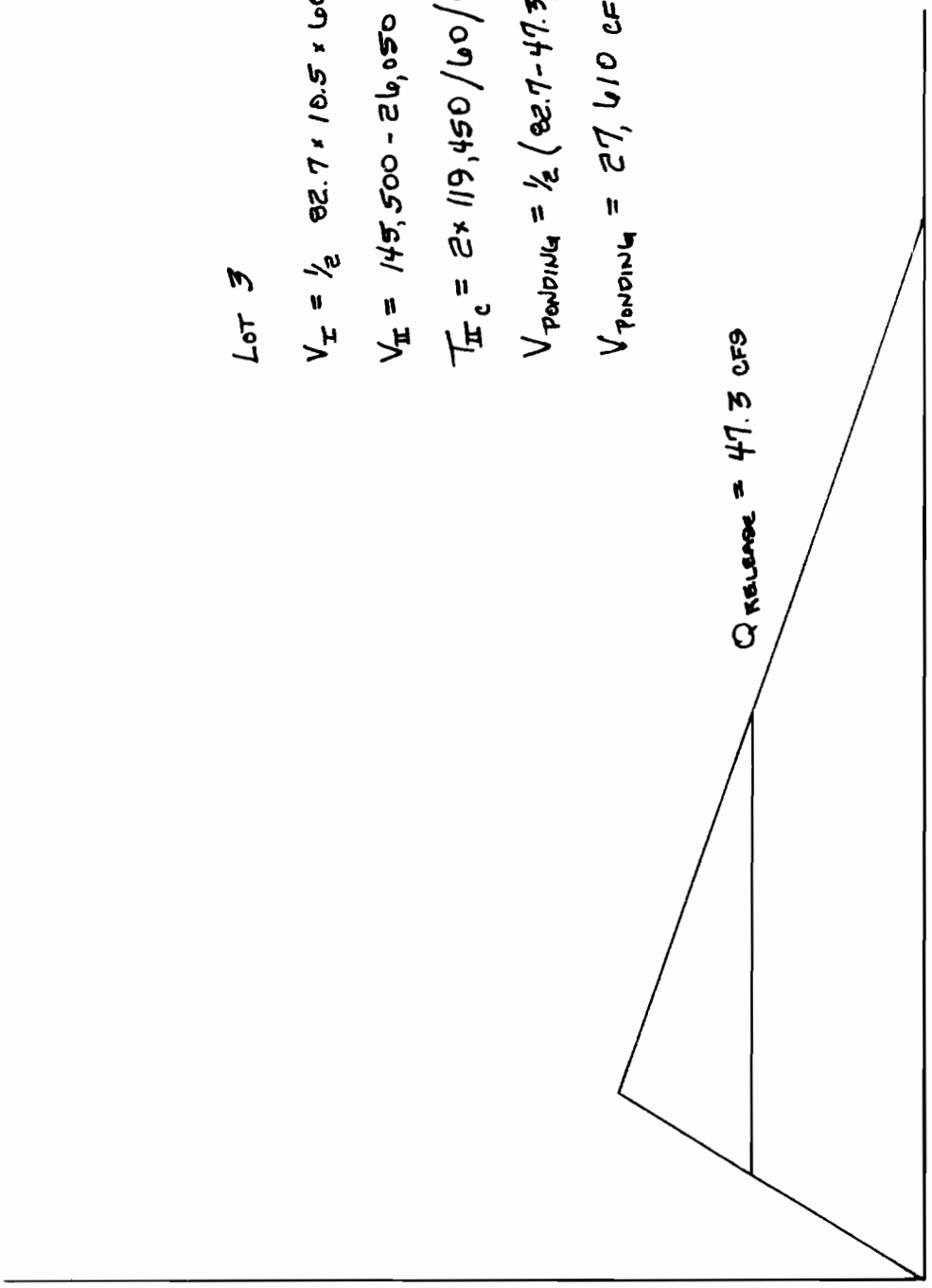
$V_I = \frac{1}{2}$ 82.7 × 10.5 × 60 = 26,050 CF

V_{II} = 145,500 − 26,050 = 119,450 CF

T_{II_c} = 2 × 119,450/60/82.7 = 48.1 min.

$V_{PONDING} = \frac{1}{2}(82.7 - 47.3) \times 26.0 \times 60$

$V_{PONDING}$ = 27,610 CF



LOT 4

$V_I = \frac{1}{2}$ 172.1 × 11.3 × 60 = 58,340 cf

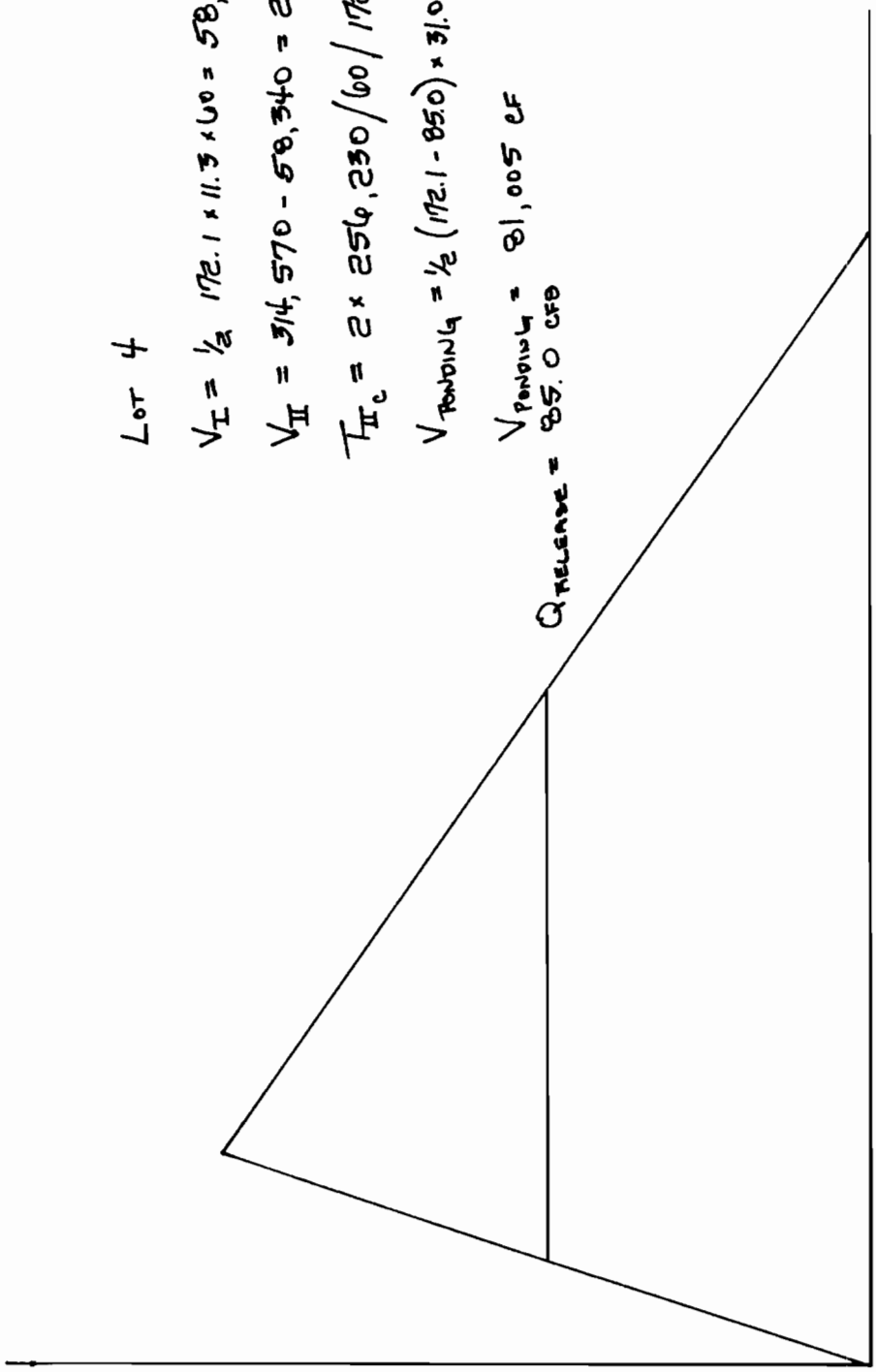
V_{II} = 314,570 − 58,340 = 256,230 cf

T_{II_c} = 2 × 256,230/60/172.1 = 49.6 min.

$V_{PONDING} = \frac{1}{2}(172.1 - 85.0) \times 31.0 \times 60$

$V_{PONDING}$ = 81,005 cf

$Q_{RELEASE}$ = 85.0 CFS



LOT 5

$V_I = \frac{1}{2}\ 9.9 \times 10 \times 60 = 2,940$ cf

$V_{II} = 16,885 - 2940 = 13,945$ cf

$T_{II_c} = 2 \times 13,945 / 60 / 9.8 = 47.4$ min.

$V_{PONDING} = \frac{1}{2}\ (9.8 - 4.1) \times 34.0 \times 60$

$V_{PONDING} = 5,815$ cf