EXHIBIT C

Drainage Study for APN 191-05-801-007

CLARK COUNTY, NEVADA

MEMO

FROM Gus Cederberg OFFICE Flood Control

☐ URGENT – REPLY IMMEDIATELY
☐ NO REPLY REQUIRED

DATE: 12/3/84

TO: James C. Smith

SUBJECT: PM 141-84 Drainage Study

MESSAGE: Subject drainage study is approved. "Post & wire revetment" shall be installed ~~along~~ along the east flow line of the channel. Bonding or construction is required prior to release of PM.

REPLY:

CLARK COUNTY, NEVADA

MEMO

FROM Gus Cederberg OFFICE Flood Control

☐ URGENT – REPLY IMMEDIATELY
☐ NO REPLY REQUIRED

DATE: 12/3/84

TO: James C. Smith

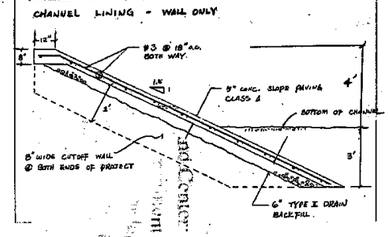
SUBJECT: PM 141-84 Drainage Study

MESSAGE: Subject drainage study is approved. "Post & wire revetment" shall be installed ~~along~~ along the east flow line of the channel. Bonding or construction is required prior to release of PM.

REPLY:

PM 141-84 (SUPPLEMENT TO DRAIN. STUDY) 10/18/84

CHANNEL LINING - WALL ONLY



COST ESTIMATE

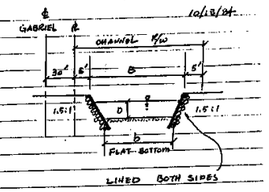
TOTAL VOLUME OF CONC.
= 2(5.6944)(303.59) + 22.3888 $(\frac{8}{12})(2)(2)$
= 3517.23 C.F.
= 130.27 C.Y.

TOTAL COST
= 130 (150) = 19,500.00
5% CONTINGENCIES = 975.00
20,475.00

* THE PAYMENT SHALL BE FULL COMPENSATION FOR ALL OTHER MATERIALS, LABOR, AND EQUIPMENTS.

10/18/84

Q = 4550 CFS
n = 0.025
S = 0.011
1' FREEBOARD



- ASSUME b = 120'

$K' = \frac{4550(0.025)}{120^{8/3} \cdot 0.011^{1/2}} = 0.03095$

$\frac{D}{b} = 0.0243$, $D = 0.0243(120) = 2.92'$

- ASSUME b = 115'

$K' = \frac{4550(0.025)}{115^{8/3} \cdot 0.011^{1/2}} = 0.03467$

$\frac{D}{b} = 0.0260$, $D = 0.0260(115) = 2.99'$

CHANNEL R/W:

B+10 = b + 2×6 + 10 = 115 + 12 + 10 = 137' ≅ 140'

USE 140' CHANNEL R/W AS A MINIMUM

CHANNEL VELOCITY

$Q_{25} = 3350$, $n = 0.025$, $S = 0.011$

$K' = \frac{3350(0.025)}{115^{8/3} \cdot 0.011^{1/2}} = 0.00255$

$\frac{D}{b} = 0.0216$, $D = 2.49$

$V = \frac{Q}{A} = \frac{3350}{298.75} = 11.21$ FPS

---

112 VISCOUS FLOW

Table 5-5. Values of the Roughness Coefficient n (continued)

Type of channel and description	Minimum	Normal	Maximum
C. Roughness on Dimension			
a. Earth, straight and uniform	0.016	0.018	0.020
1. Clean, recently completed	0.018	0.022	0.025
2. Clean, after weathering	0.022	0.027	0.030
3. Gravel, uniform section, clean	0.022	0.025	0.030
4. With short grass, few weeds	0.022	0.027	0.033
b. Earth, winding and sluggish			
1. No vegetation	0.023	0.025	0.030
2. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
3. Earth bottom and rubble sides	0.028	0.030	0.035
4. Stony bottom and weedy sides	0.025	0.035	0.040
5. Cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. No vegetation	0.025	0.028	0.033
2. Light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. Smooth and uniform	0.025	0.035	0.040
2. Jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. Dense weeds, high as flow depth	0.050	0.070	0.080
2. Clean bottom, brush on sides	0.040	0.050	0.080
3. Same, highest stage of flow	0.045	0.070	0.110
4. Dense brush, high stage	0.080	0.100	0.140
D. Natural Streams			
D-1. Minor streams (top width at flood stage < 100 ft)			
a. Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, lower stages, more stones and weeds	0.040	0.048	0.055
6. Sluggish reaches, rather weedy, deep pools	0.045	0.050	0.060
7. Mountain streams, no vegetation, bottom pools	0.050	0.070	0.080
8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150

CLARK COUNTY, NEVADA

MEMO

FROM Gus Cederberg OFFICE Flood Control

☐ URGENT – REPLY IMMEDIATELY
☐ NO REPLY REQUIRED

DATE: 10/10/84

TO: James C. Smith

SUBJECT: PM 141-84 Drainage Study

LARRY HOLMES 737-8022

MESSAGE: Please revise 10 & 25 yr runoff Q's to reflect a rainfall of 2" & 2.4". Verify velocity in channel for Q_{25} as no-erosive and not a danger to development or armor channel. Drainage R/W to be dedicated. Revise grading plan per marking.

REPLY:

RECIPIENT - RETAIN WHITE COPY - RETURN PINK COPY - TO MAIL IN WINDOW ENVELOPE - USE FOLD MARKS

NOT LEGIBLE FOR MICROFILMING

10/11/84

SUPPLEMENT
TO
DRAINAGE STUDY FOR PICKS MAP 141-84
by
James C Smith, Pe/Ms # 6351

RECEIVED
OCT 12 1984
CLARK COUNTY PUBLIC WORKS

Printed by jyatson at 9/24/2015 12:23:42 PM

CONTENTS:

1. INFLOW HYDROGRAPHS WERE RECALCULATED FOR 10 YR. & 25 YR STORM USG 1.2 & 3. USING NOAA, ATLAS 2, U.S. Dept. of Commerce
2. The Channel sizes were increased to 160' (bottom) to accomodate the newly calculated Q25 the vel & Q for 25 yr design is on Pg 4 Also, areas of a 100 yr storm was calculated on Pg 4
3. Pad grades are greater than 1B inches above the 100 yr H.G.L.
4. A 160 ft drainage Easement is proposed for the western portion of PM 141-84.

25 YR. STORM
2.4 in. Rainfall in 24 HRS

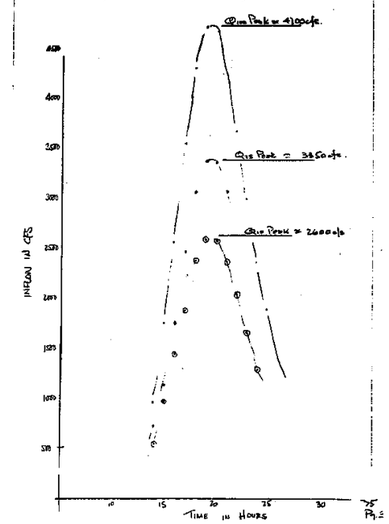
	Area #1	Area #2	Area #3	Area #4	Area #5	Area #6	Comp'd Hydrograph
Tc	7.71	8.21	1.0	0.6	1.6	4.3	
Tr	7.35	4.00	.94	.73	2.5	0	
Q2.4	8.1	9.35	6.61	1.49	1.82	8.21	
Tb/2.4	3.4	2.4	2.4	2.4	2.4	2.4	
L/W	Tc	Tc	Tc	Tc	Tc	Tc	
Rcoeff	1.44	1.44	1.44	1.44	1.44	1.44	
0	1.3	0.3	0	1.1	62.3	446.8	701.6
15	3.8	318.7	3.2	5.4	498.3	895.7	1112.1
30	11.5	1056.9	18.0	17.5	306.1	236.2	1792.3
45	21.5	1765.1	86.1	101.1	235.5	180.9	2494.7
60	238.9	2401.8	258.7	221.1	166.1	137.2	3041.9
75	547.7	1834.8	499.1	344.4	92.7	106.4	3347.3 ← Peak
90	812.2	1294.9	640.2	453.3	36.4	84.6	3342.8
105	1172.8	1013.7	670.3	572.4	27.6	69.0	3052.8
120	1667.7	783.1	491.3	672.6	49.7	57.1	
135	2146.8	604.9	345.4	803.6	44.3	49.4	
150	2475.5	481.8	238.1	784	40.5	43.5	
165	2.45.8		173.4	615	30.1	37.6	
180	5812						
195	3424						
210	3484						
225	2634						
240	2327						
255	1824						
270	1521						
285	1165						
300	815						

P. 1

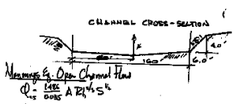
10 YR. STORM
2.0 in. Rainfall in 24 HRS.

	Area #1	Area #2	Area #3	Area #4	Area #5	Area #6	Comp'd Hydrograph
Tc	5.71	5.81	1.0	0.6	1.6	4.3	
Tr	3.33	4.00	2.3	1.8	2.5	0	
Q2.4	6.1	6.34	4.31	1.15	1.82	5.31	
Tb/2.4	2.4	2.4	2.4	2.4	2.4	2.4	
L/W	Tc	Tc	Tc	Tc	Tc	Tc	
Rcoeff	1.44	1.44	1.44	1.44	1.44	1.44	
0	1.3	0.3	0	1.1	62.3	446.8	531.1
15	3.8	318.7	3.2	5.4	498.3	895.7	918.0
30	11.5	1056.9	18.0	17.5	306.1	236.2	1413.1
45	21.5	1765.1	86.1	101.1	235.5	180.9	1892.3
60	238.9	2401.8	258.7	221.1	166.1	137.2	2361.8
75	547.7	1834.8	499.1	344.4	92.7	106.4	2521.4 ← Peak
90	812.2	1294.9	640.2	453.3	36.4	84.6	2328.8
105	1172.8	1013.7	670.3	572.4	27.6	69.0	2341.6
120	1667.7	783.1	491.3	672.6	49.7	57.1	2502.7
135	2146.8	604.9	345.4	803.6	44.3	49.4	2528.5
150	2475.5	481.8	238.1	784	40.5	43.5	2289.4
165	2.45.8		173.4	615	30.1	37.6	1289.1
180	5812						
195	3424						
210	3484						
225	2634						
240	2327						
255	1824						
270	1521						
285	1165						
300	815						

P. 2



P. 3



Manning's Eq. Open Channel Flow

$Q = \frac{1.486}{0.035} A R^{2/3} S^{1/2}$

$Q_{25} = 3347.3 - 150 = 3197.3$ cfs

$3197.3 = \frac{1.486}{0.035}\left[24.5 + 160x + 1.5x^2\right]\left[\frac{A}{160 + 2\sqrt{1.5^2+1^2}\,x}\right]^{2/3}(0.011)^{1/2}$

$717.83 = \left[24.5 + 160x + 1.5x^2\right]\left[\frac{A}{160 + 2\sqrt{2.25+1}\,x}\right]^{2/3}$

$x = 2.3' = \left[400.435\right]\left[\frac{400.435}{168.293}\right]^{2/3}$

400.435×1.7874

717.873 717.875

Check Velocity @ depth 2.3'

$V_d = Q/A = 3197.3/400.435 = 7.98'/s < 8'/s$ OK.

Calc depth of Water (x) for $Q_{100} = 4100 - 150 = 4550$ cfs

$1021.61 = \left[24.5 + 160x + 1.5x^2\right]\left[\frac{A}{160 + 2\sqrt{1.5^2+1^2}\,x}\right]^{2/3}$

Try x=3

$518.40 \left[\frac{518}{170.867}\right]^{2/3}$

1021.61 ≠ 1089.27

x=2.9

$501.12 \left[\frac{501.12}{170.4561}\right]^{2/3}$; use depth Q_{100} = 2.9'

1021.61 ≠ 1032.09

x=2.8

$484.26 \quad \frac{484.26}{170.096}$

1021.61 ≠ 976.

P. 4

CLARK COUNTY, NEVADA

MEMO

☐ URGENT – REPLY IMMEDIATELY
☐ NO REPLY REQUIRED

FROM: Bob Lucchesi OFFICE: Flood Control
NAME: G. Swallen
DATE: 10/10/84
SUBJECT: PM 141-84
DRAINAGE STUDY

TO:

PHONE: HIGHLINE 739-8622

MESSAGE: Please Revise 10 & 25 yr runoff Q: to reflect a rainfall of 2.42.". Verify velocity in channel for Q25 as no-erosion and not a concern to development or other channel. Drainage E/W to be dedicated. Revise grading plan per mailing.

REPLY

ORIGINATOR - DETACH THIS PART ONLY - SEND REMAINDER INTACT

FS 10/5/84

FLOOD STUDY FOR PM 141-84
LVB S. + SWELLEN
5-23-61

THE FOLLOWING ADDITIONAL INFORMATION IS REQUIRED

1) REVISE 10 YR AND 25 YR RUNOFF CALS (100 YR RUNOFF CAL IS ACCEPTABLE)

2) REVISE 25 YR CHANNEL FLOW VELOCITY BASED ON REVISED RUNOFF VALUE

3) VERIFY THAT NEW 25 YR CHANNEL FLOW IS NOT EROSIVE. (CHANNEL STABILITY STUDY MAY BE REQUIRED)

4) 157' or 164' WIDE DRAINAGE EASEMENT IS REQUIRED. HOWEVER IF 146' WIDE DRAINAGE EASEMENT IS FINAL, THEN REVISE CHANNEL SECTION INCLUDE 5' 1/2' SERVICE ROAD (5' MAY BE USED SINCE CHANNEL ABUTS TO THE STREET)

5) RESUBMIT UPDATED GRADING PLAN

6) PROPOSE METHOD OF DEVELOPING NATURAL WASH EAST SIDE OF THE SITE (LVB S. IS THE ONLY ACCESS FOR LOT 2 AND MAYBE 3)

* PER HARRY NO BOND FOR OFFSITE IMPROVEMENT WAS REQUIRED 10/5/84

SUMMARY OF RESULTS

	PEAK RUNOFF SUBMITTED	PEAK RUNOFF TO BE USED
Q_{10}	899.8 CFS	2581
Q_{25}	1487.8	3348
Q_{100}	4688.4	SAME

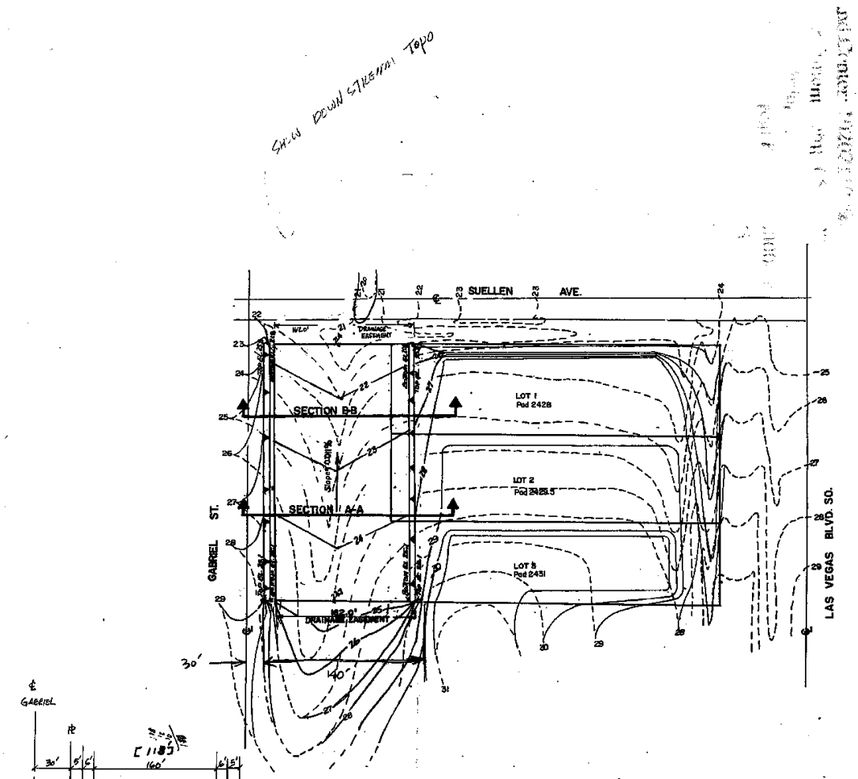
	WATER DEPTH SUBMITTED	WATER DEPTH TO BE USED
H_{25}	1.57'	2.52
H_{100}	3.06	SAME

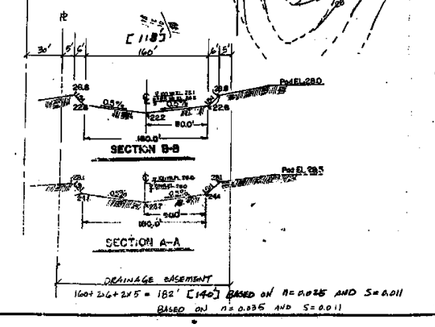
	FLOW VELOCITY SUBMITTED	FLOW VELOCITY TO BE USED
V_{25}	6.8 FPS	9.84

WIDTH OF DRAINAGE EASEMENT SEE FIGURE 1

* REF. S. DUCK CREEK DRAINAGE BY GIL

NOT LEGIBLE FOR MICROFILMING





BENCHMARK
CC. C216W33 ELEVATION 2340.75

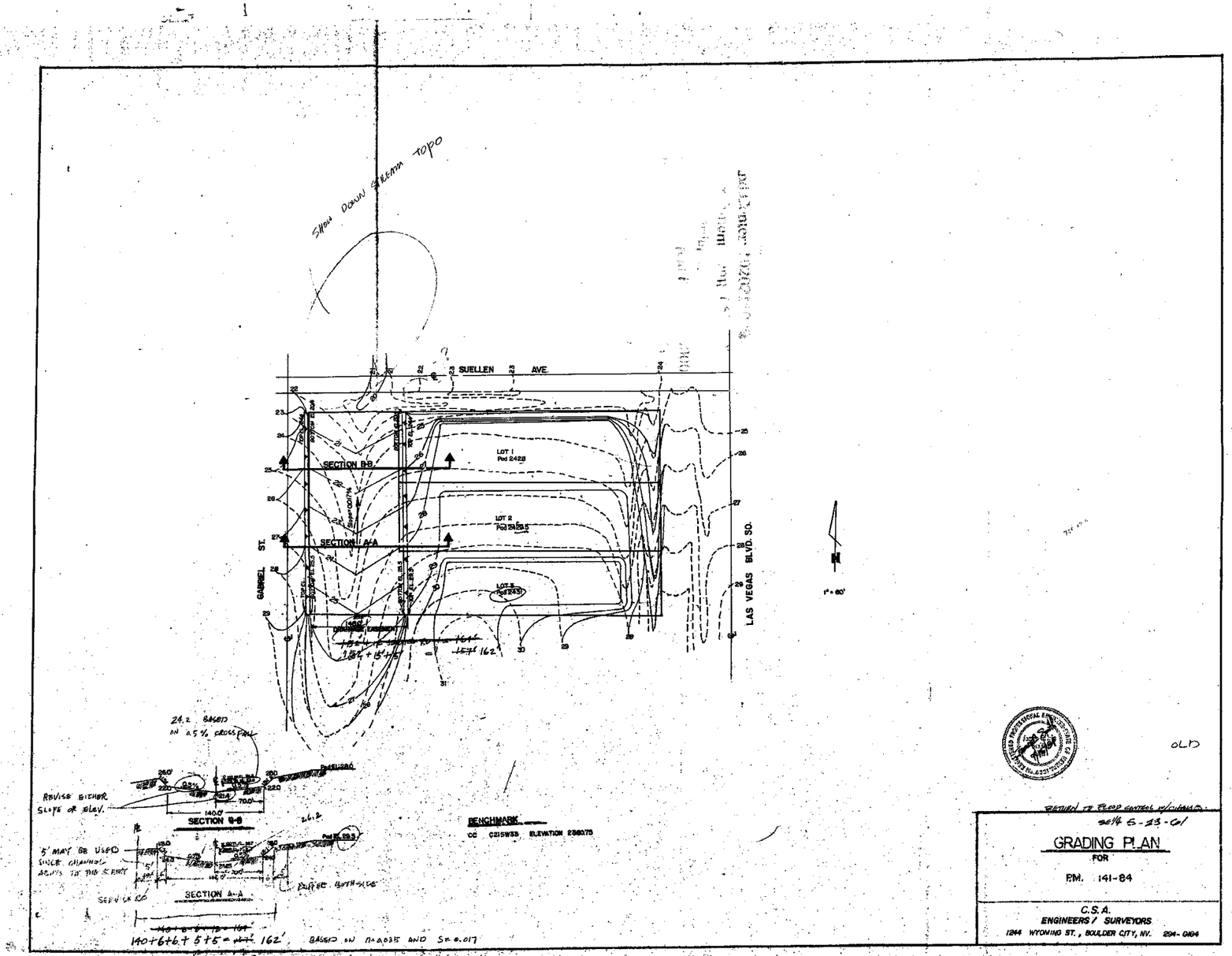
RECEIVED
OCT 1 2 1984
CLARK COUNTY

NEW

GRADING PLAN
FOR
P.M. 141-84

C.S.A.
ENGINEERS / SURVEYORS
1244 WYOMING ST., BOULDER CITY, NV. 294-0164

NOT LEGIBLE FOR MICROFILMING



NOT LEGIBLE FOR MICROFILMING

Printed by jyatson at 9/24/2015 12:19:40 PM