06VE005

DESIGN PLAN

FOR

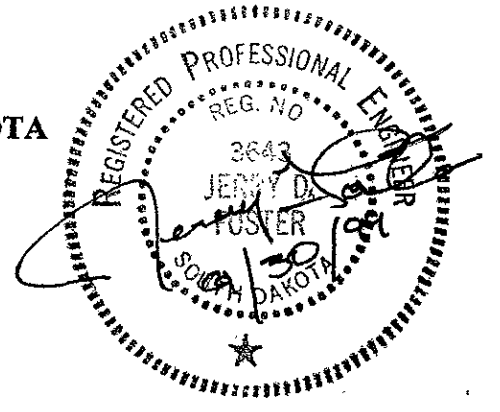
PERRINE DRAINAGE BASIN

SEPTEMBER 30, 1999

PREPARED FOR:

CITY OF RAPID CITY

RAPID CITY, SOUTH DAKOTA



FMG, INC. 3700 Sturgis Road, Rapid City, South Dakota 57702-0317 605/342-4105
FAX 605/342-4222

The recommended minimum size of the outfall channel to Rapid Creek is the same 10 foot channel described for the area upstream of the railroad. Consideration should be given to increasing the weir and channel size to account for other flows that may be entering the irrigation ditch west of the Perrine Basin.

Other alternates are available for the irrigation ditch and outfall channel. One option would be to increase the size of the irrigation ditch and Kennel Drive crossing. The storm water would then follow the irrigation ditch until it reaches the railroad tracks. At this point an overflow weir and channel would be constructed to carry the flow along the railroad east to the City recreation complex. The flow would then enter an existing drainage system that drains to Rapid Creek. Other options are (1) convey the storm water under the irrigation ditch to the Creek with a pipe system, (2) enclose the irrigation ditch with a pipe and/or siphon and build a channel over the pipe, and (3) carry the stormwater eastward along the south side of the tracks, including a Kennel Drive crossing, through the irrigation ditch to the City recreation complex.

Element 8 was UDSWM2 modeled with a 10 foot-wide bottom, 3:1 side slopes, an n value of 0.044, and an invert slope of 0.0090 ft/ft. Peak routed flow is 304 cfs.

Element 100

Element 100 is direct flow element. It is used to summarize flows from sub-basin 2 and Element 3. The flow calculated at this element is the total inflow to Detention Pond 201. Peak discharge is 657 cfs.

Element 101

Element 101 is a direct flow element. It summarizes flows from sub-basin 3 and Element 4 to provide an inflow hydrograph to Detention Pond 300. Peak discharge is 414 cfs.

Element 102

Element 102 is a direct flow element. It summarizes flows from sub-basin 4 and Element 5 to provide an inflow hydrograph to Detention Pond 202. Peak discharge is 374 cfs.

Element 103

Element 103 is a direct flow element. It summarizes flows from sub-basin 5 and Detention Pond 202. Peak discharge is 305 cfs.

The existing discharge system is a 54" RCP outlet with a 96" diameter standpipe. The top of standpipe is at elevation 3238 and a 12" round orifice low flow opening is at elevation 3230. A second 12" orifice opening is at elevation 3232. The second opening is currently covered with a steel plate.

Improvements to the standpipe are recommended. The improvements are (1) remove plate covering the second orifice, (2) add a third 12" round orifice at elevation 3238, and (3) raise the top of the standpipe to elevation 3242. The existing standpipe has a removable top section.

Peak inflow is 657 cfs, peak outflow is 159 cfs, and required storage is 18.2 acre-feet. Top of pool for 18.2 acre-feet is at approximate elevation 3243. Stage/storage/discharge data for the pond is given below.

STAGE/STORAGE/DISCHARGE DATA - ELEMENT 201		
ELEV.	STORAGE (AC-FT)	DISCHARGE (CFS)
3230	0.0	0
3232	0.0	5
3234	0.7	12
3236	2.6	16
3238	5.7	19
3240	10.0	26
3242	15.1	30
3244	20.7	265
3246	26.9	330

Element 202

Element 202 is an existing detention pond located at Highway 44. Improvements are recommended.

The existing pond is created by the Highway 44 embankment. It is recommended that storage capacity be increased by following contours proposed by Davis Engineering on "Grading Plan, Lots 1 - 5 of Grimm Addition" dated November 22, 1997. This grading will require construction of a berm on the north side of Highway 44 to increase the embankment height for required storage. The maximum berm height will be on the order of 6' high.

It is recommended that the berm be constructed with an armored spillway for emergency overflow. The spillway is proposed at elevation 3200. Top of berm needs to be above elevation 3200 to provide freeboard or the entire berm could be armored as a spillway.

It is recommended the flared end inlet be removed from the 54" RCP. The recommended pipe opening consists of a grooved end projecting inlet. A groove end with headwall could also be used with a resultant slight increase in pond discharge.

Improvements to the 54" RCP downstream of the pond are also recommended as discussed under Element 6.

Peak inflow is 374 cfs, peak outflow is 244 cfs, and required storage is 6.0 acre-feet. Top of pool for 6.0 acre-feet is at approximate elevation 3199.5. Stage/storage/discharge data for the pond is given below.

STAGE/STORAGE/DISCHARGE DATA - ELEMENT 202		
ELEV.	STORAGE (AC-FT)	DISCHARGE (CFS)
3188.5	0.0	0
3190	0.2	12
3192	0.7	65
3194	1.6	130
3196	2.9	185
3198	4.6	225
3200	6.8	255
3202	9.5	685

Element 300

Element 300 is a proposed detention pond located along the south side of sub-basin 3. The pond will be created by the construction of the embankment for Viewfield Avenue along with excavation for storage.

The proposed pond bottom is lower than existing grade. In order to obtain the required elevation it will be necessary to grade a flatter downstream channel as discussed under Element 5.

The recommended discharge system consists of twin 36" RCP culverts with roadway overtopping allowed for large events. Two year and ten year flows will be conveyed through the pipe system with no roadway overtopping. The 100 year flows will overtop the roadway to a depth of about one foot.

The discharge curve for overtopping assumes a 50 foot weir with a c coefficient of 3.0. The final curve will have to be determined at final roadway design, although it would be possible to construct a 50' weir shape with a wall on the upstream side of the roadway. The roadway should be a tilted section with appropriate pavement and slope armoring for the overflows.

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   2   1   1   2
   3   4
WATERSHED   1
PERRINE DRAINAGE BASIN DESIGN PLAN
DESIGN PLAN HYDROLOGIC AND HYDRAULIC CONDITIONS
        48  0 0  5.0                                                    1
         1  200
         2  100
         3  101
         4  102
         5  103
         6  104

   0  200     1 12 2      .1      1.   0.010                  0.016     0.1
      0.0        0.0       0.0       2.0       0.0       6.0       0.1       8.0
      0.5       10.0       1.7      11.0       4.3      12.0       8.9      27.0
     16.3       50.0      26.5      60.0      39.6      70.0      56.6      77.0
   0    1     2     2     3.5     950.   0.015       4       4   0.016     3.5
   0    2     3     1     25.     530.   0.002       4       4   0.044     5.0
   0    3   100     1     10.     600.   0.011      15      10   0.044     5.0
   0  100   201     3              1.
   0  201     4  9 1      .1      1.   0.010                  0.016     0.1
      0.0        0.0       0.0       5.0       0.7      12.0       2.6      16.0
      5.7       19.       10.0      26.0      15.1      30.       20.7     265.0
     26.9      330.
   0    4   101     1     15.    1500.   .0095       4       4   0.044     5.0
   0  101   300     3              1.
   0  300     5  6 2      .1      1.   0.010                  0.016     0.1
      0.0        0.0       0.5      38.0       1.9     100.0       3.7     140.0
      4.7      310.0       5.8     595.0
   0    5   102     1     15.    1250.   .0095       4       4   0.044     5.0
   0  102   202     3              1.
   0  202   103  8 2      .1      1.   0.010                  0.016     0.1
      0.0        0.0       0.2      12.0       0.7      65.0       1.6     130.0
     2.90      185.0      4.60     225.0       6.8     255.0       9.5     685.0
   0  103     6     3              1.
   0    6     7     5       6     350.   0.012                  0.016       6
                            1     350.   0.012      20      20   0.020    10.0
   0    7     8     5       6     600.   0.007                  0.016       6
                            1     600.   0.007      20      20   0.020    10.0
   0    8   104     1      10     900.   .0090       3       3   0.044     5.0

   0
  17
   1   2   3   4   5   6   7   8  100  101  102  103  104  200  201  202
 300
ENDPROGRAM
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1

PERRINE DRAINAGE BASIN DESIGN PLAN
DESIGN PLAN HYDROLOGIC AND HYDRAULIC CONDITIONS

HYDROGRAPHS FROM CUHPE/PC ARE LISTED FOR THE FOLLOWING 6 SUBCATCHMENTS

TIME(HR/MIN)		1	2	3	4	5	6
0	0.	0.	0.	0.	0.	0.	0.
0	5.	0.	0.	0.	0.	0.	0.
0	10.	5.	7.	3.	1.	1.	2.
0	15.	42.	62.	27.	10.	5.	17.
0	20.	94.	154.	77.	26.	11.	40.
0	25.	182.	302.	157.	53.	28.	77.
0	30.	348.	589.	311.	106.	69.	152.
0	35.	330.	648.	399.	125.	103.	164.
0	40.	228.	465.	322.	102.	104.	125.
0	45.	158.	317.	233.	76.	93.	90.
0	50.	117.	231.	173.	57.	82.	66.
0	55.	89.	175.	131.	40.	71.	49.
1	0.	78.	148.	103.	33.	62.	41.
1	5.	75.	140.	93.	30.	55.	38.
1	10.	54.	109.	77.	24.	47.	29.
1	15.	41.	78.	56.	18.	36.	22.
1	20.	29.	57.	42.	13.	25.	16.
1	25.	22.	42.	31.	10.	18.	12.
1	30.	20.	37.	26.	8.	14.	10.
1	35.	20.	36.	23.	8.	11.	10.
1	40.	20.	36.	23.	7.	9.	10.

7	8	0	5	PIPE	6.0	600.	.0070	.0	.0	.016	6.00	0
				OVERFLOW	1.0	600.	.0070	20.0	20.0	.020	10.00	
8	104	0	1	CHANNEL	10.0	900.	.0090	3.0	3.0	.044	5.00	0

OTOTAL NUMBER OF GUTTERS/PIPES, 16
1

PERRINE DRAINAGE BASIN DESIGN PLAN
DESIGN PLAN HYDROLOGIC AND HYDRAULIC CONDITIONS

ARRANGEMENT OF SUBCATCHMENTS AND GUTTERS/PIPES

GUTTER	TRIBUTARY GUTTER/PIPE										TRIBUTARY SUBAREA										D.A.(AC)
1	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55.0
2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55.0
3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55.0
4	201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	169.0
5	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	241.9
6	103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	294.4
7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	294.4
8	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	294.4
100	3	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	169.0
101	4	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	241.9
102	5	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	265.0
103	202	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	294.4
200	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	55.0
201	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	169.0
202	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	265.0
300	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	241.9

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PERRINE DRAINAGE BASIN DESIGN PLAN
DESIGN PLAN HYDROLOGIC AND HYDRAULIC CONDITIONS

		230.	227.	326.	16.	25.	124.	143.				
		.0( )	.0( )	.0( )	5.4(S)	9.5(S)	1.5(S)	3.7(S)				
0	40.	20.	14.	12.	21.	206.	265.	261.	239.	476.	342.	
		1.1( )	.5( )	.4( )	.6( )	2.1( )	3.7( )	4.5( )	2.7( )	.0( )	.0( )	
		308.	267.	363.	21.	29.	163.	319.				
		.0( )	.0( )	.0( )	7.2(S)	13.2(S)	2.4(S)	4.7(S)				
0	45.	24.	19.	15.	32.	298.	290.	286.	276.	332.	264.	
		1.2( )	.7( )	.5( )	.7( )	2.5( )	3.9( )	4.9( )	2.9( )	.0( )	.0( )	
		374.	292.	365.	25.	56.	199.	306.				
		.0( )	.0( )	.0( )	8.4(S)	15.7(S)	3.5(S)	4.7(S)				
0	50.	27.	23.	20.	63.	286.	305.	302.	296.	251.	236.	
		1.2( )	.7( )	.6( )	1.1( )	2.4( )	4.1( )	5.2( )	3.0( )	.0( )	.0( )	
		343.	305.	362.	28.	115.	223.	265.				
		.0( )	.0( )	.0( )	9.1(S)	17.1(S)	4.5(S)	4.4(S)				
0	55.	29.	27.	24.	106.	258.	304.	305.	304.	199.	236.	
		1.3( )	.8( )	.6( )	1.4( )	2.3( )	4.1( )	5.3( )	3.1( )	.0( )	.0( )	
		298.	304.	353.	29.	143.	232.	243.				
		.0( )	.0( )	.0( )	9.6(S)	17.8(S)	5.1(S)	4.3(S)				
1	0.	30.	29.	27.	135.	243.	300.	301.	303.	175.	238.	
		1.3( )	.8( )	.7( )	1.6( )	2.2( )	4.0( )	5.2( )	3.1( )	.0( )	.0( )	
		276.	300.	343.	30.	154.	237.	239.				
		.0( )	.0( )	.0( )	10.0(S)	18.1(S)	5.5(S)	4.3(S)				
1	5.	31.	30.	29.	150.	240.	296.	297.	298.	169.	243.	
		1.3( )	.8( )	.7( )	1.7( )	2.2( )	4.0( )	5.1( )	3.1( )	.0( )	.0( )	
		270.	296.	336.	31.	159.	241.	240.				
		.0( )	.0( )	.0( )	10.3(S)	18.2(S)	5.7(S)	4.3(S)				
1	10.	32.	31.	30.	156.	239.	290.	291.	294.	139.	233.	
		1.4( )	.9( )	.7( )	1.8( )	2.2( )	3.9( )	5.0( )	3.0( )	.0( )	.0( )	
		263.	290.	323.	32.	157.	243.	238.				
		.0( )	.0( )	.0( )	10.5(S)	18.1(S)	5.9(S)	4.3(S)				
1	15.	32.	32.	31.	154.	233.	281.	283.	287.	109.	210.	
		1.4( )	.9( )	.7( )	1.8( )	2.2( )	3.9( )	4.8( )	3.0( )	.0( )	.0( )	
		251.	281.	308.	32.	149.	244.	226.				
		.0( )	.0( )	.0( )	10.6(S)	17.9(S)	6.0(S)	4.2(S)				
1	20.	32.	32.	32.	146.	218.	270.	272.	277.	89.	188.	
		1.4( )	.9( )	.7( )	1.7( )	2.1( )	3.8( )	4.6( )	2.9( )	.0( )	.0( )	

		129.	178.	193.	30.	71.	173.	121.			
		.0( )	.0( )	.0( )	9.9(S)	16.1(S)	2.6(S)	2.8(S)			
2	10.	30.	30.	30.	70.	120.	165.	167.	174.	37.	78.
		1.3( )	.9( )	.7( )	1.2( )	1.5( )	2.8( )	3.3( )	2.3( )	.0( )	.0( )
		122.	164.	176.	30.	64.	161.	116.			
		.0( )	.0( )	.0( )	9.8(S)	15.9(S)	2.3(S)	2.6(S)			
2	15.	29.	30.	30.	64.	114.	153.	155.	161.	32.	67.
		1.3( )	.8( )	.7( )	1.1( )	1.5( )	2.7( )	3.1( )	2.2( )	.0( )	.0( )
		114.	152.	161.	29.	57.	150.	110.			
		.0( )	.0( )	.0( )	9.6(S)	15.7(S)	2.1(S)	2.3(S)			
2	20.	29.	29.	30.	58.	108.	142.	144.	150.	30.	58.
		1.3( )	.8( )	.7( )	1.0( )	1.5( )	2.6( )	3.0( )	2.2( )	.0( )	.0( )
		108.	142.	150.	29.	50.	140.	103.			
		.0( )	.0( )	.0( )	9.4(S)	15.6(S)	1.8(S)	2.0(S)			
2	25.	28.	29.	29.	52.	100.	130.	132.	138.	29.	52.
		1.3( )	.8( )	.7( )	1.0( )	1.4( )	2.4( )	2.9( )	2.1( )	.0( )	.0( )
		100.	129.	138.	28.	45.	131.	93.			
		.0( )	.0( )	.0( )	9.2(S)	15.5(S)	1.6(S)	1.7(S)			
2	30.	27.	28.	28.	47.	90.	120.	121.	127.	28.	47.
		1.3( )	.8( )	.7( )	.9( )	1.3( )	2.3( )	2.7( )	2.0( )	.0( )	.0( )
		90.	119.	127.	27.	41.	117.	81.			
		.0( )	.0( )	.0( )	9.0(S)	15.4(S)	1.4(S)	1.5(S)			
2	35.	27.	27.	28.	42.	80.	105.	107.	115.	28.	42.
		1.2( )	.8( )	.7( )	.9( )	1.2( )	2.2( )	2.5( )	1.9( )	.0( )	.0( )
		80.	103.	115.	27.	38.	105.	71.			
		.0( )	.0( )	.0( )	8.8(S)	15.3(S)	1.2(S)	1.3(S)			
2	40.	26.	27.	27.	39.	71.	95.	96.	102.	27.	39.
		1.2( )	.8( )	.7( )	.8( )	1.2( )	2.0( )	2.4( )	1.8( )	.0( )	.0( )
		71.	95.	102.	26.	35.	93.	63.			
		.0( )	.0( )	.0( )	8.6(S)	15.2(S)	1.1(S)	1.1(S)			
2	45.	26.	26.	27.	36.	63.	83.	85.	91.	27.	36.
		1.2( )	.8( )	.7( )	.8( )	1.1( )	1.9( )	2.2( )	1.7( )	.0( )	.0( )
		63.	81.	91.	26.	33.	83.	57.			
		.0( )	.0( )	.0( )	8.5(S)	15.2(S)	.9(S)	.9(S)			
2	50.	25.	26.	26.	34.	57.	75.	76.	81.	26.	34.
		1.2( )	.8( )	.7( )	.8( )	1.0( )	1.8( )	2.1( )	1.6( )	.0( )	.0( )

		31.	31.	34.	20.	30.	33.	30.			
		.0( )	.0( )	.0( )	6.9(S)	14.7(S)	.4(S)	.4(S)			
3	40.	20.	21.	21.	30.	31.	32.	32.	33.	21.	30.
		1.1( )	.7( )	.6( )	.7( )	.7( )	1.2( )	1.3( )	1.0( )	.0( )	.0( )
		31.	33.	33.	20.	30.	32.	30.			
		.0( )	.0( )	.0( )	6.7(S)	14.7(S)	.4(S)	.4(S)			
3	45.	20.	20.	20.	30.	30.	31.	31.	32.	20.	30.
		1.1( )	.7( )	.6( )	.7( )	.7( )	1.2( )	1.3( )	.9( )	.0( )	.0( )
		30.	29.	32.	20.	30.	31.	30.			
		.0( )	.0( )	.0( )	6.6(S)	14.6(S)	.4(S)	.4(S)			
3	50.	19.	20.	20.	30.	30.	31.	31.	31.	20.	30.
		1.0( )	.7( )	.6( )	.7( )	.7( )	1.2( )	1.3( )	.9( )	.0( )	.0( )
		30.	32.	31.	19.	30.	30.	30.			
		.0( )	.0( )	.0( )	6.5(S)	14.6(S)	.4(S)	.4(S)			
3	55.	19.	19.	20.	30.	30.	30.	30.	31.	20.	30.
		1.0( )	.7( )	.6( )	.7( )	.7( )	1.1( )	1.3( )	.9( )	.0( )	.0( )
		30.	29.	31.	19.	30.	30.	30.			
		.0( )	.0( )	.0( )	6.3(S)	14.5(S)	.4(S)	.4(S)			
4	0.	18.	19.	19.	30.	30.	30.	30.	30.	19.	30.
		1.0( )	.6( )	.6( )	.7( )	.7( )	1.1( )	1.3( )	.9( )	.0( )	.0( )
		30.	32.	30.	18.	29.	30.	30.			
		.0( )	.0( )	.0( )	6.2(S)	14.4(S)	.4(S)	.4(S)			

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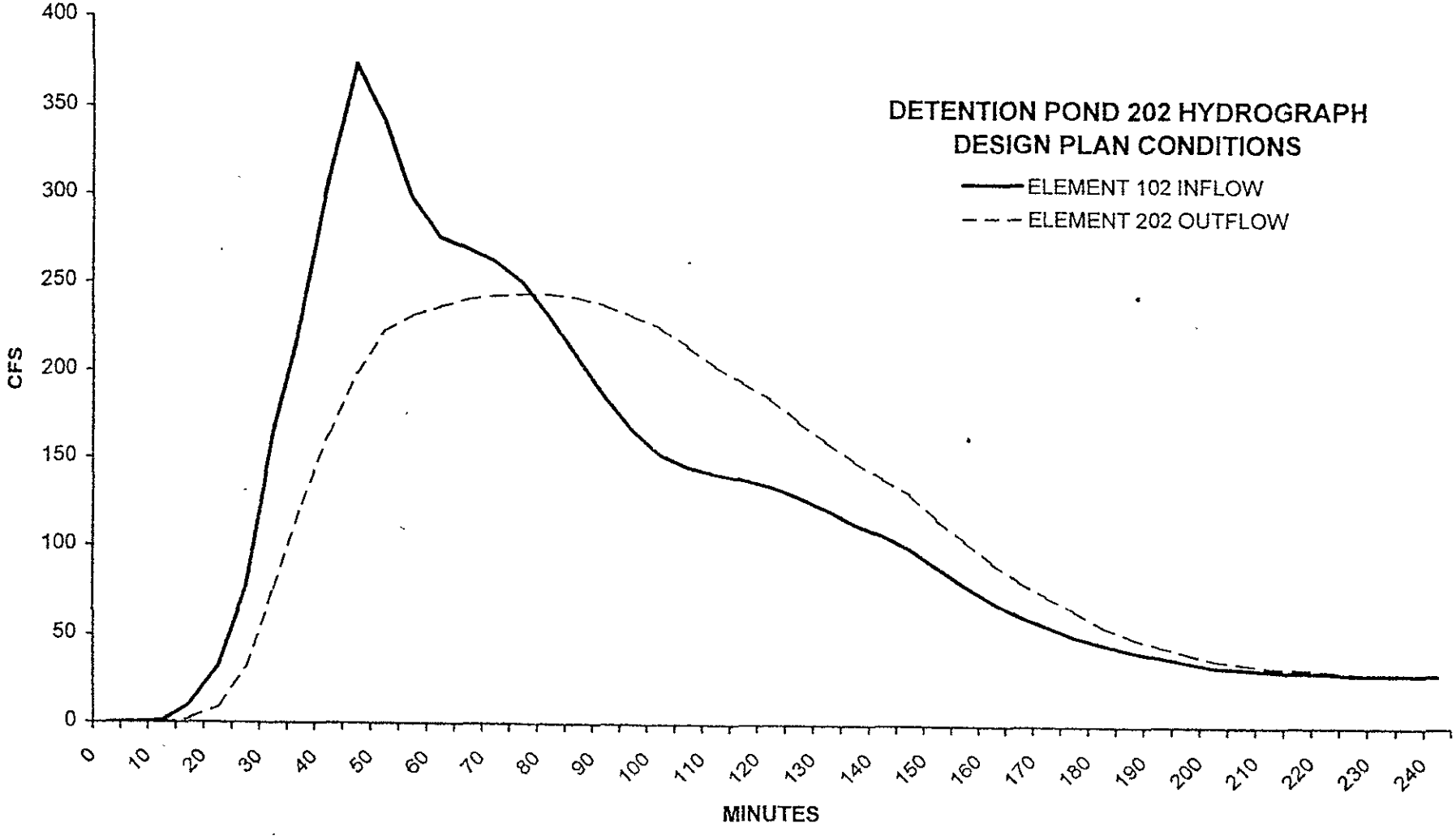
PERRINE DRAINAGE BASIN DESIGN PLAN
DESIGN PLAN HYDROLOGIC AND HYDRAULIC CONDITIONS

*** PEAK FLOWS, STAGES AND STORAGES OF GUTTERS AND DETENSION DAMS ***

CONVEYANCE ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR/MIN)
200	32.	.1	10.7	1 20.
1	32.	1.4		1 20.
2	32.	.9		1 25.
3	32.	.7		1 30.
100	657.	(DIRECT FLOW)		0 35.
201	159.	.1	18.2	1 5.
4	156.	1.8		1 10.
101	414.	(DIRECT FLOW)		0 35.


DETENTION POND 202 HYDROGRAPH
DESIGN PLAN CONDITIONS
ELEMENT 102 INFLOW
ELEMENT 202 OUTFLOW
CFS
400
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
MINUTES