STORM DRAINAGE ANALYSIS

BASELINE PARK SUBDIVISION

Highway 41 North @ Baseline Road
Evansville, Indiana

BLA Project No. 198-0094-0PD

Prepared for:

Baseline Properties, Inc.
14649 Highway 41 North
Evansville, IN 47711

By:

Bernardin, Lochmueller & Associates, Inc.
6200 Vogel Road
Evansville, IN 47715-4006
(812) 479-6200

August 20, 1998

INTRODUCTION

The proposed Baseline Park Subdivision is to be constructed along the Highway 41 North corridor at the southeast quadrant of the intersection of Baseline Road and U.S. Highway 41 North in Evansville, Indiana. No part of this site falls within the 100 year Zone "A", as noted on Community Panel No. 180256 0015 C of the Flood Insurance Rate Maps dated August 5, 1991. The proposed office/light industrial park is situated on cultivated fields ranging in slope from 2% to 5%. The entire tract, except for a very small area near the northeast corner of the subject tract, slopes from west to east.

This drainage report will address the storm detention requirements for this proposed development in accordance with the current Vanderburgh County Drainage Ordinance. This ordinance states that a 10 year undeveloped condition should be compared to a 25 year developed condition and the quantitative difference in runoff experienced under these conditions be temporarily detained. Due to the sensitivity of drainage throughout this area, the developer has agreed to provide a safeguard in that the criteria will not only be calculated for the standard 10/25 year comparison, but also calculated with a 10/100 and 1/25 year comparison.

By analyzing both situations, a dual outlet structure can be installed with a smaller primary outlet pipe cast into the face of a box having a secondary outlet to allow the larger 10 year undeveloped storm out before overtopping the dam on the lake. The results will show how much stormwater storage should be made available onsite. The allowable outflow rate will also be determined. A storm detention lake will be constructed on Lots 1, 2 and 3. Storm sewers will run to this lake from each direction thereby providing adequate opportunity for each lot development to convey runoff to the lake. An outlet control structure will be designed and constructed to limit the allowable outflow rate from this site. The lake will be sized to detain the additional runoff generated from this development.

All storm runoff will be routed through a holding facility.

.1OD

.he Rational Method (Q = cia) will be used to compute the 1 and 10-year undeveloped flows. These values will be used as the allowable outflow rates for the developed site.

"c" = Runoff Coefficient. The existing land slopes from west to east. The area is currently cultivated fields ranging from 2% to 5% in slope. This suggests an undeveloped runoff coefficient of 0.35 be used as shown in Table 803 of the drainage ordinance.

"i" = Intensity. Kerby's Formula will be used to determine the Time of Concentration for the undeveloped site and the corresponding 10-year intensity will be calculated. For the area flowing from the south and west towards the basin, a value of 46.6 minutes was calculated. The resulting 1 year intensity equals 1.2727 and the 10 year intensity equals 1.90 (See Appendix "B"). For the area flow from the Baseline Road lots a Tc value of 34.35 minutes was calculated. The resulting 1 year intensity equals 1.6781 and the 10 year intensity equals 2.52.

"a" = Area. The undeveloped contributory area flowing into the north end of the basin is 10.6 acres and 34.67 acres flow from the west and south into the basin. This area to the west also includes a portion of the Steckler property west of the ridge that runs across the property as shown on the drainage plan. This area is also included in the calculation as a developed site and therefore no adverse impact should result if this area is added to this drainage basin.

In addition a developed "c" factor of 0.7 will be used based on the proposed land use and anticipated surface improvements.

To the product of the developed "c" value and the area "a", a range of intensity value for different duration storms having a 25 year and 100 year specified return rate will be multiplied to compute expected inflow rates.

The difference between the inflow rates and outflow rates for each interval will establish the required storage for that interval. From this data a curve can be generated and the peak or largest value attained will be used as the required storage basin capacity.

A lake will be constructed on Lots 1, 2 and 3 to detain this storage. The outflow for this pond will be sized to limit the outflow from this increased runoff.

RESULTS

The required storage volume based on a 10/25 year analysis is 0.79 + 2.72 = 3.51 acre/feet (153,000 cf).

The required storage volume based on a 10/100 year analysis is 1.07 + 3.63 = 4.70 acre/feet (204,000 cf). The required storage volume based on a 1/25 year analysis is 1.00 + 3.34 = 4.34 acre/feet (189,050 cf).

The available storage volume in this pond at staged levels is as follows:

• From elevation 438.50 (pool) to elevation 439.00	=	52,653 cf
• From elevation 439.00 to elevation 440.00	=	57,756 cf
• From elevation 440.00 to elevation 441.00	=	62,947 cf
• From elevation 441.00 to elevation 442.00	=	68,238 cf
Total cubic feet	=	215,901 cf

The allowable 10 year outflow rate for this basin is 30 CFS. A 24 inch in diameter outlet pipe is required to enable the 30 cfs to pass through the pipe under a headwater equal to 3.5 feet. However, the outlet control structure will consist of a smaller diameter low water outlet pipe18 inches in diameter to be constructed in the face of the outlet control structure which will allow smaller storms (1 year frequency and higher) to also be detained. The secondary spillway will allow for additional capacity through the rim on top of casting set at elevation 442. At this elevation the required storage of 204,000 cubic feet will have been satisfied. A secondary 24 inch diameter outlet pipe will exit this control structure.

A third outflow or emergency spillway will be constructed at elevation 442.50.

SUMMARY

The Owner of Lots 1, 2 and 3 will assume maintenance of the proposed storm water facility.

All runoff from all paved areas and roof tops constructed on all of the lots and a portion of the Steckler property west of the existing ridge will be routed through this basin. In addition, the runoff from the public roadways within the dedicated site will be routed through this basin.

The south roadside ditch along Baseline, east of the proposed north/south frontage road, will also be routed through the basin.

Based on a allowable outflow rate equivalent to a 10 year storm, the required storage volume for this lake to detain the calculated stormwater storage for the 25 year storm is 153,000 cubic feet. To increase the storage to the 100 year storm detention, the required volume is 204,000 cubic feet.

By providing a dual outlet structure, storms of lesser frequency than required by local ordinances can be detained. In addition, the lake is sized to handle runoff for a 100 year storm should the need arise.

If overtopping of the facility were to occur due to unforseen circumstances, the earthen spillway on the lake will redirect the runoff to the same 84 inch x 53 inch arch plate which lies beneath the highway and currently drains approximately 170 acres. This pipe has a capacity of 200 cfs under a headwater elevation of 443.2± at which point it would then overtop Baseline Road. This project accounts for approximately 25% ± of the total contributory area directed to this structure beneath the highway, but the allowable 30 cfs outflow is only 15% of the 200 cfs that the pipe is capable of conveying, thus no backup of water within the right-of-way is anticipated. None of the subject property lies within the 100 year flood plain, but due to the possibility of stormwater storage reaching elevation as high as 443, it is recommended that all buildings or structures constructed on these frontage lots have a minimum floor elevation set no lower than 445.

Once the outlet control structures are in place, this site development should exceed the requirements of the current Vanderburgh County Drainage Ordinance.

APPENDICES INDEX

APPENDIX "A"
GRADING PLAN

APPENDIX "B"
TIME OF CONCENTRATION / INTENSITY

TIME OF CONCENTRATION
(To Basin - North Route)

SHEET FLOW

$$TC = .827\left[\frac{(N)(L)}{\sqrt{S}}\right]^{.467}$$ (Kerby's Formula)

N = 0.4 Coefficient Grass
L = Length
S = Slope

L = 1100'
H = 465 - 440 = 25'
S = .0227

$$Tc = .827\left[\frac{(0.4)(1100)}{\sqrt{.0227}}\right]^{.467} = 34.35 \text{ minutes}$$

INTENSITY

$$i( ) = \frac{C(T)^{\alpha}}{(Tc+d)^{\beta}}$$

Factors for Evansville

C = 1.9533 T = duration
α = 0.1747 Tc = Time of Concentration (10 yr. undeveloped)
d = 0.522
β = 1.6408

$$i_{10} = \frac{1.9533(10)^{0.1747}}{(34.5/60+0.522)\ 1.6408} = \frac{2.9361}{1.1640} = 2.52$$

$$i_{2} = \frac{1.9533(2)^{0.1747}}{(34.5/60+0.522)\ 1.6408} = \frac{2.2047}{1.1640} = 1.89$$

TIME OF CONCENTRATION
(To Basin - South Route)

SHEET FLOW

$$TC = .827\left[\frac{(N)(L)}{\sqrt{S}}\right]^{.467}$$

(Kerby's Formula)

N = 0.4 Coefficient Grass
L = Length
S = Slope

L = 1700'
H = 467 - 442 = 25'
S = .0147

$$Tc = .827\left[\frac{(0.4)(1700)}{\sqrt{.0147}}\right]^{.467} = 46.58 \text{ minutes}$$

INTENSITY

$$i( ) = \frac{C(T)^{\alpha}}{(Tc+d)^{\beta}}$$

Factors for Evansville

C = 1.9533 T = duration
α = 0.1747 Tc = Time of Concentration (10 yr. undeveloped)
d = 0.522
β = 1.6408

$$i_{10} = \frac{1.9533(10)^{0.1747}}{(46.58/60+0.522)^{1.6408}} = \frac{2.9206}{1.5348} = 1.90$$

$$i_{2} = \frac{1.9533(2)^{0.1747}}{(34.5/60+0.522)^{1.6408}} = \frac{2.2047}{1.5348} = 1.4365$$

Example 2.2.3

Using the IDF equation, determine the 10-year, 15-minute rainfall intensity for the City of Indianapolis.

From Table 2.2.2, c=2.1048 α=0.1733 d=0.470 β=1.1289

Referring to the IDF equation,

$$i = \frac{c\,T_r^{\alpha}}{(t+d)^{\beta}} = \frac{2.1048\ (10)^{0.1733}}{\left(\frac{15}{60}+0.470\right)^{1.1289}} = 4.545 \ \textit{inches/hour}$$

Table 2.2.2
Regional Coefficients for the IDF Equation (Eq. 2.2.13)
(Purdue et al., 1992)

Station	c	α	d	β
0.083 hour < t ≤ 1 hour				
Indianapolis	2.1048	0.1733	0.470	1.1289
South Bend	1.7204	0.1753	0.485	1.6806
Evansville	1.9533	0.1747	0.522	1.6408
Fort Wayne	2.0030	0.1655	0.516	1.4643
1 hour < t < 36 hour				
Indianapolis	1.5899	0.2271	0.725	0.8797
South Bend	1.2799	0.1872	0.258	0.8252
Evansville	1.3411	0.2166	0.300	0.8154
Fort Wayne	1.4381	0.1878	0.525	0.8616

APPENDIX "C"
STORAGE VOLUME DATA

South Contributing Area

PROJECT: BASELINE PARK DATE: 07/15/98
ENGINEER:BERNARDIN LOCHMUELLER AND ASSOCIATES, INC

25yr storage Basin w/ 10yr Release Rate of 20.65

DESIGN RETURN PERIOD: 5\10\25\100
RELEASE RATE PERIOD: 5\10\25\100
WATERSHED AREA (ACRES): 31
TIME OF CONCENTRATION UNDEV. (min): 46.58
RAINFALL INTENSITY (INCHES/HR): 2.42 1.902938 2.079752
UNDEVELOPED RUNOFF COEFFICIENT: 0.35
UNDEVELOPED RUNOFF RATE (CFS): 20.65
DEVELOPED RUNOFF COEFFICIENT: 0.7

i_{10} (undeveloped)

25 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	8.02	173.94	20.65	153.29	1.022
0.17	6.20	134.50	20.65	113.85	1.613
0.25	5.26	114.24	20.65	93.60	1.950
0.33	4.62	100.24	20.65	79.59	2.189
0.42	4.09	88.68	20.65	68.03	2.381
0.50	3.72	80.73	20.65	60.09	2.504
0.58	3.42	74.28	20.65	53.63	2.592
0.67	3.15	68.29	20.65	47.65	2.660
0.75	2.94	63.82	20.65	43.17	2.698
0.83	2.76	59.95	20.65	39.30	2.719
0.92	2.59	56.18	20.65	35.53	2.724
1.00	2.45	53.24	22.57	30.67	2.556
1.25	2.11	45.88	22.57	23.32	2.429
1.50	1.86	40.41	22.57	17.85	2.231
1.75	1.67	36.17	22.57	13.60	1.984
2.00	1.51	32.76	22.57	10.20	1.699
2.50	1.27	27.61	22.57	5.05	1.051
3.00	1.10	23.88	22.57	1.32	0.329
4.00	0.87	18.81	22.57	-3.75	-1.251

PEAK STORAGE (ACRE/FT): 2.72
PEAK STORAGE (CUBIC FT): *********

} Required storage 10/25

100 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	9.52	206.64	20.65	185.99	1.240
0.17	7.40	160.50	20.65	139.85	1.981
0.25	6.30	136.70	20.65	116.05	2.418
0.33	5.54	120.20	20.65	99.55	2.738
0.42	4.91	106.54	20.65	85.90	3.006
0.50	4.48	97.15	20.65	76.50	3.187
0.58	4.12	89.50	20.65	68.85	3.328
0.67	3.80	82.39	20.65	61.75	3.448
0.75	3.55	77.08	20.65	56.43	3.527
0.83	3.34	72.48	20.65	51.83	3.585
0.92	3.13	67.99	20.65	47.34	3.630
1.00	2.97	64.49	22.57	41.92	3.493
1.25	2.57	55.70	22.57	33.14	3.452
1.50	2.27	49.16	22.57	26.60	3.325
1.75	2.03	44.07	22.57	21.51	3.136
2.00	1.84	39.98	22.57	17.42	2.903
2.50	1.56	33.79	22.57	11.22	2.338
3.00	1.35	29.29	22.57	6.72	1.681
4.00	1.07	23.16	22.57	0.59	0.197

← 3.63 (1.9/100 yr)

South Contributary Ave

PROJECT: BASELINE PARK DATE: 08/18/98
ENGINEER:BERNARDIN LOCHMUELLER AND ASSOCIATES, INC

DESIGN RETURN PERIOD:	5\10\25\100		
RELEASE RATE PERIOD:	5\10\25\100		
WATERSHED AREA (ACRES):	31		
TIME OF CONCENTRATION UNDEV. (min):	46.58		
RAINFALL INTENSITY (INCHES/HR):	2.42	1.272696	2.079752
UNDEVELOPED RUNOFF COEFFICIENT:	0.35		
UNDEVELOPED RUNOFF RATE (CFS):	13.81		
DEVELOPED RUNOFF COEFFICIENT:	0.7		

25 yr storage based on 1 hr Release Rate of 13.81 cfs.

25 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	8.02	173.94	13.81	160.13	1.068
0.17	6.20	134.50	13.81	120.69	1.710
0.25	5.26	114.24	13.81	100.44	2.092
0.33	4.62	100.24	13.81	86.43	2.377
0.42	4.09	88.68	13.81	74.87	2.620
0.50	3.72	80.73	13.81	66.93	2.789
0.58	3.42	74.28	13.81	60.47	2.923
0.67	3.15	68.29	13.81	54.48	3.042
0.75	2.94	63.82	13.81	50.01	3.125
0.83	2.76	59.95	13.81	46.14	3.191
0.92	2.59	56.18	13.81	42.37	3.248
1.00	2.45	53.24	13.81	39.43	3.286
1.25	2.11	45.88	13.81	32.07	3.341 ← 3.34 cfs.
1.50	1.86	40.41	13.81	26.61	3.326
1.75	1.67	36.17	13.81	22.36	3.261
2.00	1.51	32.76	13.81	18.95	3.159
2.50	1.27	27.61	13.81	13.80	2.876
3.00	1.10	23.88	13.81	10.07	2.519
4.00	0.87	18.81	13.81	5.00	1.668
5.00	0.71	15.51	13.81	1.70	0.707
6.00	0.61	13.17	13.81	-0.64	-0.319
7.00	0.53	11.43	13.81	-2.38	-1.388
8.00	0.46	10.08	13.81	-3.73	-2.485
9.00	0.41	9.00	13.81	-4.80	-3.603

South Contributing Area
100 yr storm
Based on 14E
Extreme Rate.

100 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	9.52	206.64	13.81	192.83	1.286
0.17	7.40	160.50	13.81	146.69	2.078
0.25	6.30	136.70	13.81	122.89	2.560
0.33	5.54	120.20	13.81	106.39	2.926
0.42	4.91	106.54	13.81	92.74	3.246
0.50	4.48	97.15	13.81	83.34	3.472
0.58	4.12	89.50	13.81	75.69	3.658
0.67	3.80	82.39	13.81	68.59	3.829
0.75	3.55	77.08	13.81	63.27	3.954
0.83	3.34	72.48	13.81	58.67	4.058
0.92	3.13	67.99	13.81	54.18	4.154
1.00	2.97	64.49	13.81	50.68	4.223
1.25	2.57	55.70	13.81	41.89	4.364
1.50	2.27	49.16	13.81	35.35	4.419 ← 4.41 Ac-ft.
1.75	2.03	44.07	13.81	30.26	4.413
2.00	1.84	39.98	13.81	26.17	4.362
2.50	1.56	33.79	13.81	19.98	4.162
3.00	1.35	29.29	13.81	15.48	3.870
4.00	1.07	23.16	13.81	9.35	3.115
5.00	0.88	19.14	13.81	5.33	2.222
6.00	0.75	16.30	13.81	2.49	1.245
7.00	0.65	14.17	13.81	0.37	0.213
10.00	0.47	10.13	13.81	-3.68	-3.066
24.00	0.19	4.11	13.81	-9.70	-19.392

North Contributory Area

PROJECT: BASELINE PARK DATE: 07/15/98
ENGINEER:BERNARDIN LOCHMUELLER AND ASSOCIATES, INC

DESIGN RETURN PERIOD:	5\10\25\100	
RELEASE RATE PERIOD:	5\10\25\100	
WATERSHED AREA (ACRES):	10.6	
TIME OF CONCENTRATION UNDEV. (min):	34.67	
RAINFALL INTENSITY (INCHES/HR):	2.90	2.498387 2.455856
UNDEVELOPED RUNOFF COEFFICIENT:	0.35	
UNDEVELOPED RUNOFF RATE (CFS):	9.27	
DEVELOPED RUNOFF COEFFICIENT:	0.7	

i_{10} (undeveloped)

25 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	8.02	59.48	9.27	50.21	0.335
0.17	6.20	45.99	9.27	36.72	0.520
0.25	5.26	39.06	9.27	29.79	0.621
0.33	4.62	34.28	9.27	25.01	0.688
0.42	4.09	30.32	9.27	21.05	0.737
0.50	3.72	27.61	9.27	18.34	0.764
0.58	3.42	25.40	9.27	16.13	0.780
0.67	3.15	23.35	9.27	14.08	0.786
0.75	2.94	21.82	9.27	12.55	0.784
0.83	2.76	20.50	9.27	11.23	0.777
0.92	2.59	19.21	9.27	9.94	0.762
1.00	2.45	18.20	9.11	9.09	0.758
1.25	2.11	15.69	9.11	6.58	0.685
1.50	1.86	13.82	9.11	4.71	0.588
1.75	1.67	12.37	9.11	3.26	0.475
2.00	1.51	11.20	9.11	2.09	0.349
2.50	1.27	9.44	9.11	0.33	0.069
3.00	1.10	8.17	9.11	-0.94	-0.236
4.00	0.87	6.43	9.11	-2.68	-0.893

PEAK STORAGE (ACRE/FT): 0.79
PEAK STORAGE (CUBIC FT): 34250.30

} Reqd STORAGE 10/25

100 YEAR STORM

North Contributary Area

100 YR Storage Based on 10 YR Release Rate of 9.27 CFS

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	9.52	70.66	9.27	61.39	0.409
0.17	7.40	54.88	9.27	45.61	0.646
0.25	6.30	46.74	9.27	37.47	0.781
0.33	5.54	41.10	9.27	31.83	0.875
0.42	4.91	36.43	9.27	27.16	0.951
0.50	4.48	33.22	9.27	23.95	0.998
0.58	4.12	30.60	9.27	21.33	1.031
0.67	3.80	28.17	9.27	18.90	1.056
0.75	3.55	26.36	9.27	17.09	1.068
0.83	3.34	24.78	9.27	15.51	1.073 ← 10/100 YR
0.92	3.13	23.25	9.27	13.98	1.072
1.00	2.97	22.05	9.11	12.94	1.078
1.25	2.57	19.05	9.11	9.94	1.035
1.50	2.27	16.81	9.11	7.70	0.962
1.75	2.03	15.07	9.11	5.96	0.869
2.00	1.84	13.67	9.11	4.56	0.760
2.50	1.56	11.55	9.11	2.44	0.509
3.00	1.35	10.01	9.11	0.90	0.226
4.00	1.07	7.92	9.11	-1.19	-0.398

(1.08)

North Contributory Area

PROJECT: BASELINE PARK DATE: 08/18/98
ENGINEER:BERNARDIN LOCHMUELLER AND ASSOCIATES, INC

25 yr storage Based on 1 yr Release Rate of 0.20 CFS

DESIGN RETURN PERIOD:	5\10\25\100		
RELEASE RATE PERIOD:	5\10\25\100		
WATERSHED AREA (ACRES):	10.6		
TIME OF CONCENTRATION UNDEV. (min):	34.67		
RAINFALL INTENSITY (INCHES/HR):	2.90	1.670935	2.455856
UNDEVELOPED RUNOFF COEFFICIENT:	0.35		
UNDEVELOPED RUNOFF RATE (CFS):	6.20		
DEVELOPED RUNOFF COEFFICIENT:	0.7		

25 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	8.02	59.48	6.20	53.28	0.355
0.17	6.20	45.99	6.20	39.79	0.564
0.25	5.26	39.06	6.20	32.86	0.685
0.33	4.62	34.28	6.20	28.08	0.772
0.42	4.09	30.32	6.20	24.12	0.844
0.50	3.72	27.61	6.20	21.41	0.892
0.58	3.42	25.40	6.20	19.20	0.928
0.67	3.15	23.35	6.20	17.15	0.958
0.75	2.94	21.82	6.20	15.62	0.976
0.83	2.76	20.50	6.20	14.30	0.989
0.92	2.59	19.21	6.20	13.01	0.997
1.00	2.45	18.20	6.20	12.01	1.000 ← 1.0 Ac ft.
1.25	2.11	15.69	6.20	9.49	0.988
1.50	1.86	13.82	6.20	7.62	0.952
1.75	1.67	12.37	6.20	6.17	0.899
2.00	1.51	11.20	6.20	5.00	0.834
2.50	1.27	9.44	6.20	3.24	0.675
3.00	1.10	8.17	6.20	1.97	0.492
4.00	0.87	6.43	6.20	0.23	0.078
5.00	0.71	5.30	6.20	-0.90	-0.374
6.00	0.61	4.50	6.20	-1.70	-0.848
7.00	0.53	3.91	6.20	-2.29	-1.336
8.00	0.46	3.45	6.20	-2.75	-1.835
9.00	0.41	3.08	6.20	-3.12	-2.340

North Carlsbad Area

100 YR storage Rate based on 1 YR Release Rate

100 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	9.52	70.66	6.20	64.46	0.430
0.17	7.40	54.88	6.20	48.68	0.690
0.25	6.30	46.74	6.20	40.54	0.845
0.33	5.54	41.10	6.20	34.90	0.960
0.42	4.91	36.43	6.20	30.23	1.058
0.50	4.48	33.22	6.20	27.02	1.126
0.58	4.12	30.60	6.20	24.40	1.179
0.67	3.80	28.17	6.20	21.97	1.227
0.75	3.55	26.36	6.20	20.16	1.260
0.83	3.34	24.78	6.20	18.58	1.285
0.92	3.13	23.25	6.20	17.05	1.307
1.00	2.97	22.05	6.20	15.85	1.321
1.25	2.57	19.05	6.20	12.85	1.338
1.50	2.27	16.81	6.20	10.61	1.326
1.75	2.03	15.07	6.20	8.87	1.294
2.00	1.84	13.67	6.20	7.47	1.245
2.50	1.56	11.55	6.20	5.35	1.115
3.00	1.35	10.01	6.20	3.82	0.954
4.00	1.07	7.92	6.20	1.72	0.573
5.00	0.88	6.55	6.20	0.35	0.144
6.00	0.75	5.57	6.20	-0.63	-0.313
7.00	0.65	4.85	6.20	-1.35	-0.789
10.00	0.47	3.46	6.20	-2.74	-2.280
24.00	0.19	1.41	6.20	-4.79	-9.586

1.34 Ac-ft

APPENDIX "D"
OUTLET CONTROL
STRUCTURE ANALYSIS

OUTLET CONTROL STRUCTURE

$$cd = Cc \times Cv = (.62)(.97) = .60$$

$Q = cdA\sqrt{2gh}$

Allow Outflow Q = 30 cfs

Allow HW = Top Box Outlet Str. To IE Lower-Water Outlet Pipe

$$(30) = Q = (.60)(A)\sqrt{2(32.2)(3.5)}$$

$$A = \frac{30}{3.405} = 0.333 = \frac{\Pi d^2}{4}$$

d = 2.06 = 24" outlet pipe

18" diameter primary outlet pipe with 3.5' of head will pass 16 cfs and 24" diameter outlet pipe with 3.5' of head will pas 28 cfs / "E" casting in top box with 24" outlet pipe will provide secondary outlet should lake fill up to within 1' of top of dam (see detail).

Primary Outlet Pipe

18" @ hw = 3.5 (.6)(1.767) $\sqrt{2(32,2)(3.5)}$ = 15.92 cfs (20.01 cfs allowable outflow for 1/25 year analysis)

Secondary Outlet Pipe

24" @ hw = 3.5 (.6)(3.1416) $\sqrt{2(32,2)(3.5)}$ = 28.3 cfs (29.76 cfs allowable outflow for 10/25 or 10/100 year analysis)

APPENDIX "E"
BASIN VOLUMES

BASIN VOLUMES

BASIN "A" CAPACITY

Elevation	438.5 (pool)	-	52,653		
				⟩	26,960 cf
Elevation	439.0	-	55,186		
				⟩	57,756 cf
Elevation	440.0	-	60,326		
				⟩	62,947 cf
Elevation	441.0	-	65,567		
				⟩	68,238 cf
Elevation	442.0	-	70,908		
					215,901 cf

4.95 acre/feet