(Addendum #1) To The

MASTER DRAINAGE STUDY
OF
COMSTOCK ESTATES

October 8, 1996

Prepared For:

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"I hereby certify that this Addendum to the Master Drainage Study of Comstock Estates Subdivision was prepared under my direct supervision".

Reviewed By:
Philip M. Hart P.E.
State of Colorado, #19346

COLORADO REGISTERED PHILIP M. HART 19346 PROFESSIONAL ENGINEER

I. PURPOSE AND SCOPE OF ADDENDUM

The purpose of this Addendum is to evaluate the affects of development of the Comstock Estates Subdivision Filing No. ONE only and the restrictions applicable to the allowable release rate from the proposed detention pond. A hydrologic analysis of the project's tributary watersheds for historic and developed conditions has been preformed and was presented as the MASTER DRAINAGE STUDY OF COMSTOCK ESTATES.

II. PROJECT LOCATION AND DESCRIPTION

Location:

Comstock Estates Subdivision is located in the City of Fruita, Mesa County, Colorado, more particularly being in the SW Corner of Section 7, Township One North, Range 2 West of the Ute Meridian.

Streets in the vicinity include K Road (Ottley Avenue) running east to west. K Road is adjacent to and defines the south boundary of the project site. 17 Road (Coulson Avenue) runs north to south adjacent to and defines the east boundary of the site.

Development in the vicinity includes Downer Subdivision to the south, Roberson West Subdivision to the east and the Oaks Retirement Village to the west. Vacant land is located north, northwest and northeast of the project.

Description:

The project contains approximately 78.31 acres of land and is planned for 292 single family building sites. The first phase of development will contain approximately 9.85 acres and is planned for 35 single family and 3 duplex building sites. The average lot size for this development is 7,500 square feet.

The site currently vacant of any structures and is in a fallow state. Irrigation water is available to the site, however recent agricultural production has not occurred on the site.

III. RESTRICTIONS TO ALLOWABLE RELEASE RATES

The Master Drainage Study defines the Historic runoff rate at 25 CFS for the overall development of 78.31 acres. The allowable release from Filing No. ONE to Little Salt Wash of 3.15 CFS is based on a ratio of the flowrates in CFS vs. developed area in acres. The calculation for the release rate is shown on Exhibit 2.0 of the Appendix. To regulate the release rate the top of the detention pond outlet works shall be retro-fitted with a galvanized restrictor plate. The restrictor plate shall have a 3-inch by 3-inch blockout cut into the center of the plate and is to be mounted under the inlet grate. The blockout shall serve only as an emergency overflow element in the event the lowflow blockout becomes plugged. The 8-inch diameter lowflow blockout shall not be modified and shall release the allowable 100 year rate of 3.15 CFS at a maximum water surface elevation of 94.60 CFS. Revised stage storage calculations are presented as Exhibits 1.0 thru 10.0 od the Appendix.

IV. K ROAD IRRIGATION DITCH

The existing irrigation ditch adjacent to the North R.O.W. of K Road currently functions as a tailwater ditch for irrigation runoff from the project site. The project is not currently being farmed or irrigated and shall not be in the future as a result of this development. The ditch is to be filled in and all references to a culvert crossing at K Road and Comstock Drive have been removed from the construction plans.

V. CONCLUSIONS:

The allowable release rates from the detention pond to Little Salt Wash shall be recalculated with each future phase of the project. The outlet works restrictor plate shall be modified accordingly to regulate flows to maximum allowable for each phase.

References

1. MESA COUNTY STORMWATER MANAGEMENT MANUAL, Mesa County, Colorado, May, 1996.

2. HEC1 Flood Hydrograph Package, Hydrologic Engineering Center, US Army Corps of Engineers, Davis, CA., September, 1990.

3. Soil Survey, Grand Junction Area, Colorado, Series 1940, No. 19, US Department of Agriculture, issued November, 1955.

4. Flowmaster I, Version 3.16, Haestad Methods, Inc., Copyright 1990.

5. Subsurface Soils Exploration, Comstock Subdivision, Fruita, Colorado, Lincoln DeVore Inc., Grand Junction, Colorado, May 31, 1996.

6. Flood Insurance Study, Town of Fruita, Colorado, Mesa County, Federal Emergency Management Agency, Community No. 080194, Revised: July 15, 1992.

7. Flood Insurance Rate Map, Town of Fruita, Colorado, Mesa County, Federal Emergency Management Agency, Community Panel No. 080194 0003 B, Revised: July 15, 1992.

8. Urban Storm Drainage Criteria Manual, Volume 2, Wright-McLaughlin Engineers, Denver, Colorado, March, 1969.

APPENDIX

Comstock Estates
Filing No. 1

HYDROLOGIC REPORT

STAGE / STORAGE / DISCHARGE

RESERVOIR NUMBER = 1

RESERVOIR NAME = RES NO. 1... (* Controlled by Culv Structure A)
STORAGE VALUES WERE INPUT MANUALLY

DISCHARGE VALUES: CULVERT STRUCT A. Q = .6 *A*[2gh/k]^.5 * 1
* CULVERT STRUCT B. Q = .6 *A*[2gh/k]^.5 * 1
WEIR STRUCT A. Q = 2.7 * 1 * H ^ 1.5
WEIR STRUCT B. Q = 3 * 0 * H ^ 1.5

ELEVATION	DISCHARGE (cfs)			
	CULVERT A	CULVERT B	WEIR A	WEIR B
90.67	0.00	0.00	0.00	0.00
91.00	0.87	0.34	0.00	0.00
92.00	10.79	1.61	0.00	0.00
93.00	24.96	2.28	0.00	0.00
94.00	34.08	2.80	0.00	0.00
95.00	41.47	3.22	0.95	0.00
96.00	47.74	3.63	4.96	0.00
97.00	53.05	3.99	10.67	0.00
0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00

STAGE	ELEVATION	INC STOR cu ft	TOT STOR cu ft	OUTFLOW cfs
0.00	90.67	0	0	0.00
0.33	91.00	54	54	0.34
1.33	92.00	8379	8433	1.61
2.33	93.00	20137	28570	2.28
3.33	94.00	25049	53619	2.80
4.33	95.00	27275	80894	4.18
5.33	96.00	29551	110445	8.59
6.33	97.00	32101	142546	14.66
0.00	0.00	0	0	0.00
0.00	0.00	0	0	0.00
0.00	0.00	0	0	0.00

EXHIBIT 1.0

8" Ø LOWFLOW BLOCKOUT

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OUTLET STRUCTURES é
 Reservoir:   1
CULVERT STRUC   A. Q=CoA[2gh/k]^.5     CULVERT STRUC   B. Q=CoA[2gh/k]^.5

1. WIDTH   (in)      = 30.               9. WIDTH   (in)      = 8..
2. HEIGHT (in)       = 30.              10. HEIGHT (in)       = 8..
3. No. BARRELS       = 1..              11. No. BARRELS       = 1..
4. INVERT ELEV.      = 90.67....        12. INVERT ELEV.      = 90.67....
5. Co = 0.60                            13. Co = 0.60
6. CULVERT LENGTH (ft) = 95.5           14. CULVERT LENGTH (ft) = .5..
7. CULVERT SLOPE (%)   = .5..           15. CULVERT SLOPE (%)    = 0...
8. MANNING'S N-VALUE   = .013           16. MANNING'S N-VALUE    = .013
                                        17. MULTI-STAGE OPTION ? (Y/N) Y

WEIR STRUCTURE A.          Q=CwLH^EXP    WEIR STRUCTURE B.          Q=CwLH^EXP

18. CREST LENGTH (ft)      = 1......    23. CREST LENGTH (ft)    = 0......
19. CREST ELEVATION        = 94.5...    24. CREST ELEVATION      = 0......
20. Cw = 2.70                           25. Cw = 3.00
21. EXP = 1.50                          26. EXP = 1.50
22. MULTI-STAGE OPTION ? (Y/N) N        27. MULTI-STAGE OPTION ? (Y/N) N

hange item number: 0                                          to cont
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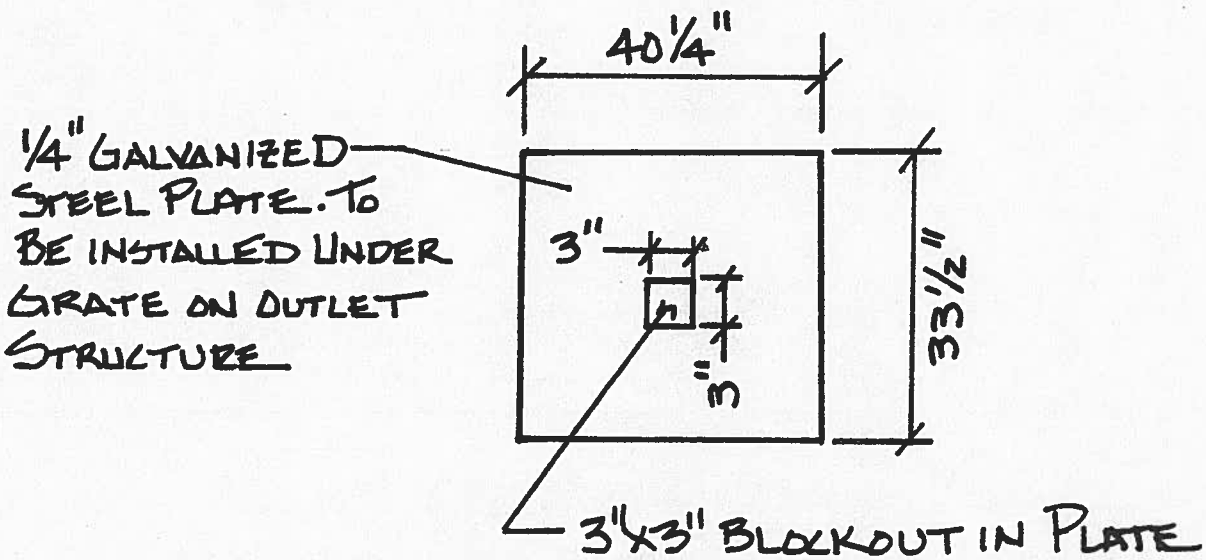
3"x3" BLOCKOUT (crest length 1)



OUTLET WORKS RESTRICTOR PLATE

Q_{100} ALLOWABLE RELEASE = $\frac{25\text{ CFS}}{78.31\text{ AC.}} = \frac{X}{9.85}$

X = 3.15 CFS Q_{100}

EXHIBIT 2.0

Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually
Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

ELEVATION	DISCHARGE (cfs) CULVERT A		CULVERT B		WEIR A	WEIR B	TOTAL
90.67	0.00		0.00	-	0.00	0.00	0.00
90.70	0.02	IC	0.00	IC	0.00	0.00	0.00
90.74	0.09	IC	0.03	IC	0.00	0.00	0.03
90.77	0.11	IC	0.06	IC	0.00	0.00	0.06
90.80	0.13	IC	0.06	IC	0.00	0.00	0.06
90.83	0.33	IC	0.11	IC	0.00	0.00	0.11
90.87	0.36	IC	0.16	IC	0.00	0.00	0.16
90.90	0.39	IC	0.21	IC	0.00	0.00	0.21
90.93	0.78	IC	0.23	IC	0.00	0.00	0.23
90.97	0.83	IC	0.32	IC	0.00	0.00	0.32
91.00	0.87	IC	0.34	IC	0.00	0.00	0.34

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Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually
Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

ELEVATION	DISCHARGE (cfs) CULVERT A		CULVERT B		WEIR A	WEIR B	TOTAL
91.00	0.87	IC	0.34	IC	0.00	0.00	0.34
91.10	1.63	IC	0.54	IC	0.00	0.00	0.54
91.20	2.69	IC	0.79	IC	0.00	0.00	0.79
91.30	2.93	IC	0.92	IC	0.00	0.00	0.92
91.40	4.37	IC	1.05	IC	0.00	0.00	1.05
91.50	4.66	IC	1.16	IC	0.00	0.00	1.16
91.60	6.45	IC	1.16	OC	0.00	0.00	1.16
91.70	6.79	IC	1.37	OC	0.00	0.00	1.37
91.80	8.82	OC	1.44	IC	0.00	0.00	1.44
91.90	9.26	IC	1.53	IC	0.00	0.00	1.53
92.00	10.79	OC	1.61	IC	0.00	0.00	1.61

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EXHIBIT 3.0

Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually
Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

ELEVATION	DISCHARGE (cfs)						
	CULVERT A		CULVERT B		WEIR A	WEIR B	TOTAL
92.00	10.79	OC	1.61	IC	0.00	0.00	1.61
92.10	11.96	IC	1.68	IC	0.00	0.00	1.68
92.20	12.66	OC	1.76	IC	0.00	0.00	1.76
92.30	14.79	IC	1.83	IC	0.00	0.00	1.83
92.40	17.11	IC	1.90	IC	0.00	0.00	1.90
92.50	19.24	IC	1.97	IC	0.00	0.00	1.97
92.60	19.76	IC	2.04	IC	0.00	0.00	2.04
92.70	21.64	IC	2.10	IC	0.00	0.00	2.10
92.80	22.17	IC	2.16	IC	0.00	0.00	2.16
92.90	23.74	IC	2.22	IC	0.00	0.00	2.22
93.00	24.96	IC	2.28	IC	0.00	0.00	2.28

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Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually
Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

ELEVATION	DISCHARGE (cfs)						
	CULVERT A		CULVERT B		WEIR A	WEIR B	TOTAL
93.00	24.96	IC	2.28	IC	0.00	0.00	2.28
93.10	25.88	IC	2.34	IC	0.00	0.00	2.34
93.20	26.74	IC	2.40	IC	0.00	0.00	2.40
93.30	27.76	IC	2.45	IC	0.00	0.00	2.45
93.40	28.75	IC	2.51	IC	0.00	0.00	2.51
93.50	29.71	IC	2.56	IC	0.00	0.00	2.56
93.60	30.63	IC	2.61	IC	0.00	0.00	2.61
93.70	31.53	IC	2.66	IC	0.00	0.00	2.66
93.80	32.40	IC	2.71	IC	0.00	0.00	2.71
93.90	33.25	IC	2.76	IC	0.00	0.00	2.76
94.00	34.08	IC	2.80	IC	0.00	0.00	2.80

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EXHIBIT 4.0

Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually

Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1

Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1

Weir struct A. Q = 2.7 * 1 * H ^ 1.5

Weir struct B. Q = 3 * 0 * H ^ 1.5

ELEVATION	DISCHARGE (cfs) CULVERT A		CULVERT B		WEIR A	WEIR B	TOTAL
94.00	34.08	IC	2.80	IC	0.00	0.00	2.80
94.10	34.89	IC	2.84	IC	0.00	0.00	2.84
94.20	35.68	IC	2.88	IC	0.00	0.00	2.88
94.30	36.46	IC	2.92	IC	0.00	0.00	2.92
94.40	37.22	IC	2.96	IC	0.00	0.00	2.96
94.50	37.96	IC	3.01	IC	0.00	0.00	3.01
94.60	38.69	IC	3.05	IC	0.09	0.00	3.14
94.70	39.40	IC	3.09	IC	0.24	0.00	3.34
94.80	40.11	IC	3.14	IC	0.44	0.00	3.58
94.90	40.80	IC	3.18	IC	0.68	0.00	3.87
95.00	41.47	IC	3.22	IC	0.95	0.00	4.18

TOP OF BOX → 94.50

← 100 YEAR RELEASE

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eservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

torage values were input manually

ischarge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1

Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1

Weir struct A. Q = 2.7 * 1 * H ^ 1.5

Weir struct B. Q = 3 * 0 * H ^ 1.5

ELEVATION	DISCHARGE (cfs) CULVERT A		CULVERT B		WEIR A	WEIR B	TOTAL
95.00	41.47	IC	3.22	IC	0.95	0.00	4.18
95.10	42.14	IC	3.27	IC	1.25	0.00	4.52
95.20	42.80	IC	3.31	IC	1.58	0.00	4.89
95.30	43.45	IC	3.35	IC	1.93	0.00	5.28
95.40	44.09	IC	3.39	IC	2.31	0.00	5.70
95.50	44.71	IC	3.43	IC	2.70	0.00	6.13
95.60	45.33	IC	3.47	IC	3.11	0.00	6.59
95.70	45.95	IC	3.51	IC	3.55	0.00	7.06
95.80	46.55	IC	3.55	IC	4.00	0.00	7.55
95.90	47.15	IC	3.59	IC	4.47	0.00	8.06
96.00	47.74	IC	3.63	IC	4.96	0.00	8.59

to cont [PgUp] [PgDn] [Esc] to exit

EXHIBIT 5.0

Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually
Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

ELEVATION	DISCHARGE (cfs)						
	CULVERT A		CULVERT B		WEIR A	WEIR B	TOTAL
96.00	47.74	IC	3.63	IC	4.96	0.00	8.59
96.10	48.32	IC	3.66	IC	5.46	0.00	9.13
96.20	48.89	IC	3.70	IC	5.98	0.00	9.69
96.30	49.46	IC	3.74	IC	6.52	0.00	10.26
96.40	50.02	IC	3.77	IC	7.07	0.00	10.85
96.50	50.58	IC	3.81	IC	7.64	0.00	11.45
96.60	51.12	IC	3.85	IC	8.22	0.00	12.06
96.70	51.17	OC	3.88	IC	8.81	0.00	12.69
96.80	51.81	OC	3.92	IC	9.42	0.00	13.34
96.90	52.44	OC	3.95	IC	10.04	0.00	13.99
97.00	53.05	OC	3.99	IC	10.67	0.00	14.66

] to cont [PgUp] [PgDn] [Esc] to exit

EXHIBIT 6.0

Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually
Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

STAGE	ELEVATION	INC STOR cu ft	TOT STOR cu ft	OUTFLOW cfs
0.00	90.67	0	0	0.00
0.03	90.70	5	5	0.00
0.07	90.74	5	11	0.03
0.10	90.77	5	16	0.06
0.13	90.80	5	22	0.06
0.16	90.83	5	27	0.11
0.20	90.87	5	32	0.16
0.23	90.90	5	38	0.21
0.26	90.93	5	43	0.23
0.30	90.97	5	49	0.32
0.33	91.00	5	54	0.34

] to cont [PgUp] [PgDn] [Esc] to exit

Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually
Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

STAGE	ELEVATION	INC STOR cu ft	TOT STOR cu ft	OUTFLOW cfs
0.33	91.00	5	54	0.34
0.43	91.10	838	892	0.54
0.53	91.20	838	1730	0.79
0.63	91.30	838	2568	0.92
0.73	91.40	838	3406	1.05
0.83	91.50	838	4244	1.16
0.93	91.60	838	5081	1.16
1.03	91.70	838	5919	1.37
1.13	91.80	838	6757	1.44
1.23	91.90	838	7595	1.53
1.33	92.00	838	8433	1.61

] to cont [PgUp] [PgDn] [Esc] to exit

EXHIBIT 7.0

Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually
Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

STAGE	ELEVATION	INC STOR cu ft	TOT STOR cu ft	OUTFLOW cfs
1.33	92.00	838	8433	1.61
1.43	92.10	2014	10447	1.68
1.53	92.20	2014	12460	1.76
1.63	92.30	2014	14474	1.83
1.73	92.40	2014	16488	1.90
1.83	92.50	2014	18502	1.97
1.93	92.60	2014	20515	2.04
2.03	92.70	2014	22529	2.10
2.13	92.80	2014	24543	2.16
2.23	92.90	2014	26556	2.22
2.33	93.00	2014	28570	2.28

to cont [PgUp] [PgDn] [Esc] to exit

eservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

torage values were input manually
ischarge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

STAGE	ELEVATION	INC STOR cu ft	TOT STOR cu ft	OUTFLOW cfs
2.33	93.00	2014	28570	2.28
2.43	93.10	2505	31075	2.34
2.53	93.20	2505	33580	2.40
2.63	93.30	2505	36085	2.45
2.73	93.40	2505	38590	2.51
2.83	93.50	2505	41094	2.56
2.93	93.60	2505	43599	2.61
3.03	93.70	2505	46104	2.66
3.13	93.80	2505	48609	2.71
3.23	93.90	2505	51114	2.76
3.33	94.00	2505	53619	2.80

to cont [PgUp] [PgDn] [Esc] to exit

EXHIBIT 8.0

Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually
Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

STAGE	ELEVATION	INC STOR cu ft	TOT STOR cu ft	OUTFLOW cfs
3.33	94.00	2505	53619	2.80
3.43	94.10	2728	56347	2.84
3.53	94.20	2728	59074	2.88
3.63	94.30	2728	61802	2.92
3.73	94.40	2728	64529	2.96
3.83	94.50	2728	67257	3.01
3.93	94.60	2728	69984	3.14
4.03	94.70	2728	72712	3.34
4.13	94.80	2728	75439	3.58
4.23	94.90	2728	78167	3.87
4.33	95.00	2728	80894	4.18

TOP OF BOX

100 YEAR RELEASE

] to cont [PgUp] [PgDn] [Esc] to exit

Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually
Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

STAGE	ELEVATION	INC STOR cu ft	TOT STOR cu ft	OUTFLOW cfs
4.33	95.00	2728	80894	4.18
4.43	95.10	2955	83849	4.52
4.53	95.20	2955	86804	4.89
4.63	95.30	2955	89759	5.28
4.73	95.40	2955	92714	5.70
4.83	95.50	2955	95670	6.13
4.93	95.60	2955	98625	6.59
5.03	95.70	2955	101580	7.06
5.13	95.80	2955	104535	7.55
5.23	95.90	2955	107490	8.06
5.33	96.00	2955	110445	8.59

to cont [PgUp] [PgDn] [Esc] to exit

EXHIBIT 9.0

COMSTOCK ESTATES
FILING No. 1

Reservoir No. 1 STAGE / STORAGE / DISCHARGE RES NO. 1...

Storage values were input manually
Discharge values: Culvert struct A. Q = .6 * A * [2gh/k]^.5 * 1
Culvert struct B. Q = .6 * A * [2gh/k]^.5 * 1
Weir struct A. Q = 2.7 * 1 * H ^ 1.5
Weir struct B. Q = 3 * 0 * H ^ 1.5

STAGE	ELEVATION	INC STOR cu ft	TOT STOR cu ft	OUTFLOW cfs
5.33	96.00	2955	110445	8.59
5.43	96.10	3210	113655	9.13
5.53	96.20	3210	116865	9.69
5.63	96.30	3210	120075	10.26
5.73	96.40	3210	123285	10.85
5.83	96.50	3210	126496	11.45
5.93	96.60	3210	129706	12.06
6.03	96.70	3210	132916	12.69
6.13	96.80	3210	136126	13.34
6.23	96.90	3210	139336	13.99
6.33	97.00	3210	142546	14.66

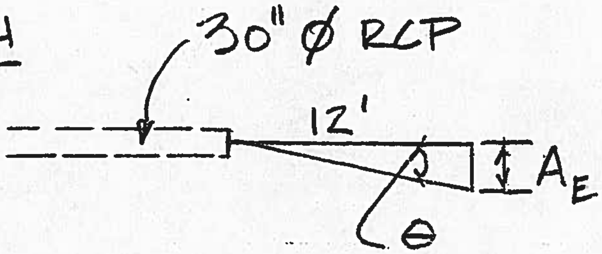
to cont [PgUp] [PgDn] [Esc] to exit

EXHIBIT 10.0

LOCATION LITTLE SALT WASH - STORM SEWER A1

SUBJECT RIP-RAP DESIGN CALCULATIONS AT OUTLET

WIDTH



$$\frac{1}{2\tan\theta} = 3.78$$

$$2\tan\theta = \frac{1}{3.78} = 2\tan\theta = 0.2646$$

$$= \tan\theta = 0.1323$$

$$\theta = 7.5351^\circ$$

$$A_E / 12' = \tan 7.5351^\circ$$

$$A_E / 12' = 0.1323$$

$$A_E = 1.5876'$$

$$\text{WIDTH AT } 12' \text{ LENGTH} = 2(1.5876') + 2.5'$$

$$= 5.67' \quad \text{USE } \underline{6.0'}$$

LOCATION LITTLE SALT WASH STORM SEWER A1

SUBJECT RIP-RAP DESIGN CALCULATIONS AT OUTLET

30" Ø RCP $Q_{100} = 25$ CFS $V_{ACTUAL} = 18.24$ FPS

Y_T = TAILWATER DEPTH = 0.81' $V_{ALLOWED} = 5.5$ FPS

CHECK → $Q/D^{2.5} = 25\text{ cfs}/2.5'^{2.5} = 2.5298$ SUPERCRITICAL FLOW

* 2.5298 < 6.0 USE TABLE FIGURE 5-7 EXHIBIT 127.0, MODIFY BY USING D_A FOR SUPERCRITICAL FLOW

SIZE

Y_N = NORMAL DEPTH IN CULVERT = 0.81'

$D_A = \frac{1}{2}(D + Y_N) = \frac{1}{2}(2.5' + 0.81') = 1.6550'$

CHECK → 1.6550 < 2.5 OK

$Q/D_A^{1.5} = 25\text{ cfs}/1.6550^{1.5} = 11.7420$

$Y_T/D_A = 0.81/1.6550 = 0.4894$

* FROM FIGURE 5-7, EXHIBIT 127.0 USE TYPE L

TYPE L $d_{50} = 9"$ DEPTH = 9" x 1.75 = 16"

LENGTH

$Y_T/D = 0.81'/2.5' = 0.3240$

$Q/D^{2.5} = 2.5298$ FIGURE 5-9 EXHIBIT 128.0 $\frac{1}{2\tan\theta} = 3.78$

$A_T = Q/V = 25\text{ cfs}/5.5\text{ fps} = 4.5455$ ft²

$L = (1/(2\tan\theta))((A_T/Y_T) - D)$

$= (3.78)((4.5455/0.81')) - 2.5)$

$= 11.76'$ USE 12.0'

EXHIBIT 132.0

Y_t = tailwater depth in feet,

θ = the expansion angle of the culvert flow.

$A_t = Q / V$ (Equation 5-10)

Q = design discharge in cubic feet per second

V = the allowable non-eroding velocity in the downstream channel in feet per second.

A_t = required area of flow at allowable velocity in square feet.

In certain circumstances, Equation 5-9 may yield unreasonable results. Therefore in no case should L be less than 3D or 3H, nor does L need to be greater than 10D or 10H whenever the Froude parameter $Q/WH^{1.5}$ or $Q/D^{2.5}$ is less than 8 or 6 respectively. Whenever the Froude parameter is greater than these maximums, increase the maximum L required by one-fourth D or H for each whole number the Froude parameter is greater than 8 or 6 for rectangular or circular pipe respectively.

5.6.4 Multiple Conduit Installations

The procedures outlined in Sections 5.6.1, 5.6.2 and 5.6.3 can be used to design outlet erosion protection for multi-barrel culvert installations, by hypothetically replacing the multiple barrels with a single hydraulically equivalent rectangular conduit. The dimensions of the equivalent conduit may be established as follows: First, distribute the total discharge, Q, among the individual conduits. Where all the conduits are hydraulically similar and identically situated, the flow can be assumed to be equally distributed, otherwise, the flow through each barrel must be computed. Next, compute the Froude parameter $Q_i/D_i^{2.5}$ (circular conduit) or $Q_i/W_iH_i^{1.5}$ (rectangular conduit), where the subscript i indicates the discharge and dimensions associated with an individual conduit. If the installation includes dissimilar conduits, select the conduit with the largest value of the Froude

EXHIBIT 131.0

whenever the culvert flow is supercritical.

D = Diameter of a circular culvert in feet.

H_a = A parameter to be used in Figure 5-8 whenever the culvert flow is supercritical

H = Height of a rectangular culvert in feet.

Y_n = Normal depth of supercritical flow in the culvert.

5.6.3 Extent of Protection

The length of the riprap protection downstream from the outlet depends on the degree of protection desired. If it is to prevent all erosion, the riprap must be continued until the velocity has been reduced to an acceptable value. For purposes of outlet protection during major floods the acceptable velocity is set at 5.5 fps for very erosive soils and at 7.7 fps for erosion resistant soils. The rate at which the velocity of a jet from a conduit outlet decreases is not well known. For the procedure recommended here it is assumed to be related to the angle of lateral expansions, θ, of the jet. The velocity is related to the expansion factor, $(1/(2\tan\theta))$, which may be determined directly using Figure 5-9 or 5-10.

Assuming that the expanding jet has a rectangular shape:

$$L = (1/(2\tan\theta))(A_t/Y_t - W) \quad \text{(Equation 5-9)}$$

in which:

L = length of protection in feet,

W = width of the conduit in feet (use diameter for circular conduits),

EXHIBIT 130.0

5.6.2 Required Rock Size

The required rock size may be selected from Figure 5-7 for circular conduits and from Figure 5-8 for rectangular conduits. Figure 5-7 is valid for $Q/D^{2.5}$ of 6.0 or less and Figure 5-8 is valid for $Q/WH^{1.5}$ of 8.0 or less. The parameters in these two figures are:

a. $Q / D^{1.5}$ or $Q/WH^{0.5}$ in which Q is the design discharge in cubic feet per second and D is a circular conduit diameter in feet and W and H are the width and height of a rectangular conduit in feet.

b. Y_t/D or Y_t / H in which Y_t is the tailwater depth in feet, D is the diameter of a circular conduit and H is the height of a rectangular conduit in feet. In cases where Y_t is unknown or a hydraulic jump is suspected downstream of the outlet, use $Y_t / D = Y_t / H = 0.40$ when using Figures 5-7 and 5-8.

c. The riprap size requirements in Figures 5-7 and 5-8 are based on the non-dimensional parametric equations 5-5 and 5-6 (11)(25).

Circular Culvert:

$$(d_{50}/D)(Y_t/D)^{1.2} / (Q/D^{2.5}) = 0.023 \qquad \text{(Equation 5-5)}$$

Rectangular Culvert:

$$(d_{50}/D)(Y_t/H)' / (Q/WH^{1.5}) = 0.014 \qquad \text{(Equation 5-6)}$$

The rock size requirements were determined assuming that the flow in the culvert barrel is not supercritical. It is possible to use Equations 5-5 and 5-6 when the flow in the culvert is less than pipe full and is supercritical if the value of D or H is modified for use in Figures 5-7 and 5-8. Whenever the flow is supercritical in the culvert, substitute D_a for D and H_a for H, in which D_a is defined as

$$D_a = \tfrac{1}{2}(D + Y_n) \qquad \text{(Equation 5-7)}$$

in which maximum D_a shall not exceed D, and

$$H_a = \tfrac{1}{2}(H + Y_n) \qquad \text{(Equation 5-8)}$$

in which maximum H_a shall not exceed H, and

D_a = A parameter to be used in Figure 5-7

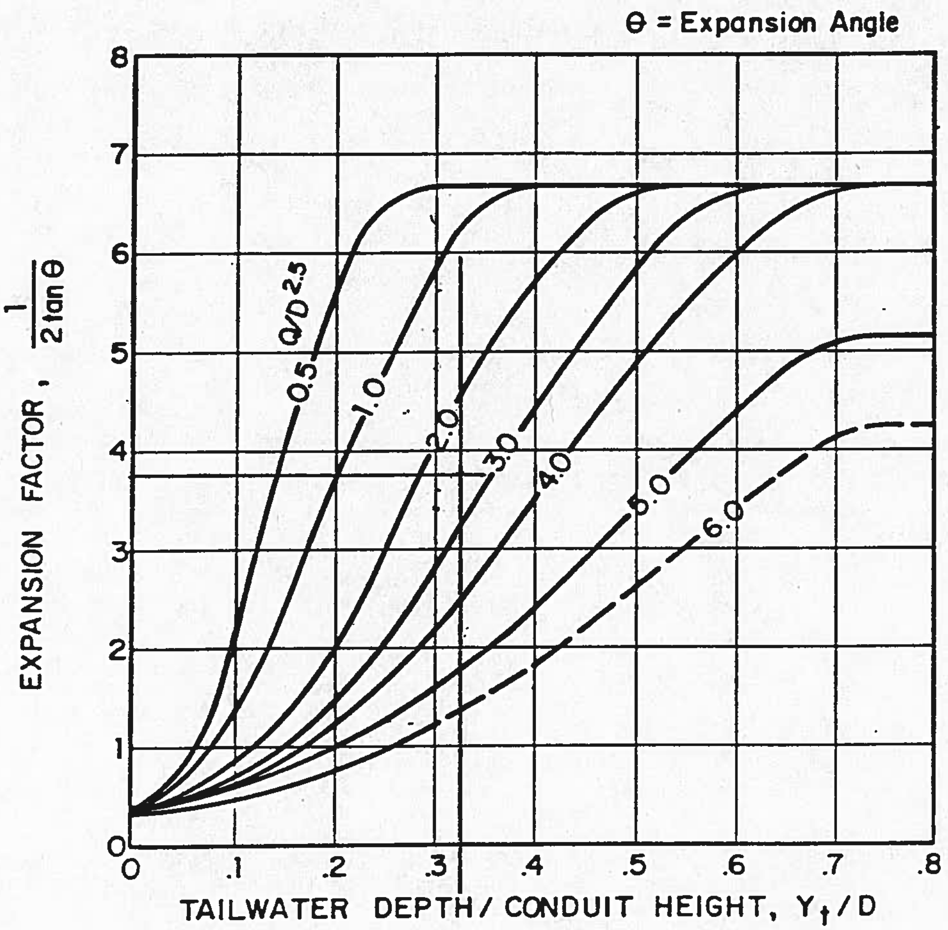
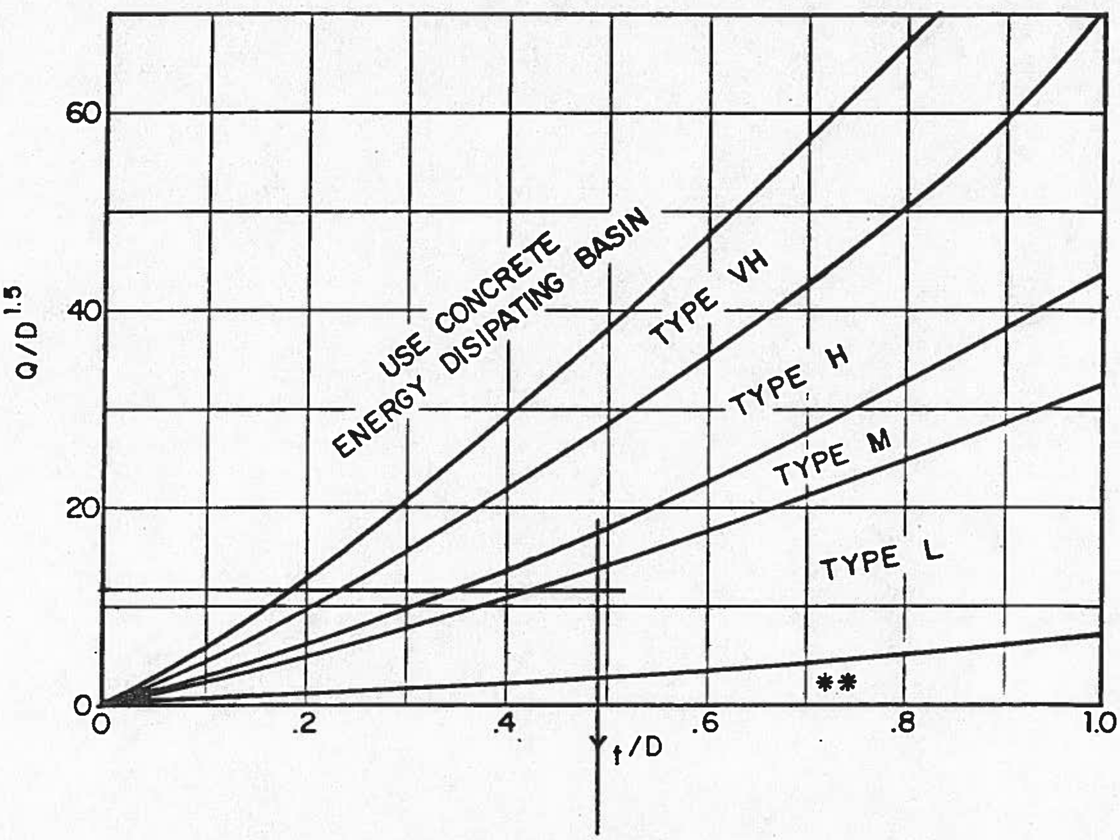


FIGURE 5-9. EXPANSION FACTOR FOR CIRCULAR CONDUITS

EXHIBIT 128.C



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

FIGURE 5-7. RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET.

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: LITTLE SALT OUTLET

Comment: STORM SEWER LINE A1 @ LITTLE SALT WASH

Solve For Actual Depth

Given Input Data:

Diameter..........	2.50 ft — 30"
Slope.............	0.0731 ft/ft
Manning's n.......	0.013
Discharge.........	25.00 cfs — Q_{100}

Computed Results:

Depth.............	0.81 ft — Y_N
Velocity..........	18.24 fps
Flow Area.........	1.37 sf
Critical Depth....	1.70 ft
Critical Slope....	0.0057 ft/ft
Percent Full......	32.28 %
Full Capacity.....	110.90 cfs
QMAX @.94D........	119.29 cfs
Froude Number.....	4.20 (flow is Supercritical) ←

Open Channel Flow Module, Version 3.16 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

EXHIBIT 126.0