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UNITED WESTERN ENGINEERS
632-3593 / 1000 W. FILLMORE
COLORADO SPRINGS, COLORADO

February 7, 1964

Director of Public Works
City of Colorado Springs
City Hall
Colorado Springs, Colorado

Re: 19th Street Drainage Basin

Dear Sir:

At your request, we have restudied the drainage of the minor basin ending at 19th Street and Manitou Blvd. Colorado Springs, Colorado.

Reference should be made to our previous report of April 30, 1963, concerning this same basin and the recommendations concerning drainage and flood control given to the owner of the property at 19th and Manitou Blvd. In summation, the maximum flow was computed and two reservoirs were sized on the property in that corner of 19th and Manitou Blvd. These reservoirs were of different size and shape to allow different types of planning in the land surrounding the reservoirs. The computations for the area indicated that a total reservoir capacity of under 25-Acre Feet was required to satisfactorily store the water coming from the above referenced basin. This computation was made assuming that the pipe which exists under Manitou Blvd. was maintained in its present size.

A total of forty acre feet is produced by a 2-inch intensity, 1-hour duration rainfall in the basin. The flood routing through the reservoir was shown in both cases including the discharge from the reservoir in cubic feet per second, and the cumulative storage. The cumulative storage indicated that less than 25-Acre Feet was needed in either reservoir design 1 or 2. Reservoir No. 1 was designed with a capacity of 36-1/2 Acre Feet, and Reservoir No. 2 was designed with a capacity of 27.8 Acre Feet. This allowed a considerable margin of safety.

It was noted, however, that the discharge from the reservoir in cubic feet per second was somewhat higher than the discharge which normally occurred in the reservoir as it has existed over the past several years. The City Department of Public Works at this point requested that a new study be made establishing the following criteria:

1. That the Reservoir capacity be 50-Acre Feet, and

2. That the discharge from the reservoir not exceed the discharge which has been normally coming through the dam in the past.

This investigation, then basically was made up of two parts. The first part was a closer examination of the actual discharge and flood routing in the basin. The second part was the computation of the original routing through the site and a proposed routing through the site.

19th Street Basin Routing:

As shown on the basin location diagram, the general flow is from the north to the south. The extreme north portion of the basin lies at about the intersection of Mesa Road with Friendship Lane and flows southerly through Oswego Street onto 19th Street, thence southerly on 19th Street and into the reservoir site at Manitou Blvd. The edges of the basin are quite steep and will be very difficult to develope in the future. The center of the basin is considerably less steep and can be devloped with relative ease.

For the sake of easiness in computation, points of computation were selected at intervals along the basin. These points are marked on the Location Diagram by circled letters and are as follows:

Point "A" lies approximately at the northern extremity of Oswego Street.

Point "B" lies at the intersection of Oswego Street with 19th Street.

Point "C" lies at approximately the intersection of 19th Street andDale Streets. Point "C" is the major junction point prior to entering the reservoir of the site.

The water drains down this line of computations points rather rapidly due to the extreme slopes involved on the side hills and the relatively steep street grades. At Point A, when the general drainage water will enter Oswego Street, the quantity flowing is 88 cfs. This can be easily handled by Oswego Street considering the slope of the street and the design of the curb. However, it should be noted that by the time Oswego Street joins 19th Street, the quantity has risen to 222 cfs. This is considerably above the capacity of Oswego Street

and for that matter, is considerably above the capacity of 19th Street. By the time the runoff reaches Point C at Dale and 19th, it has risen to slightly over 400 cfs which, of course, is well above the capacity of 19th Street.

It will prove to be very difficult to re-route this water in any other way than down Oswego and 19th Streets. This is due to the fact that the basin is relatively narrow with steep sides and that 19th Street lies in the low point in the basin. Although the correction of this excess amount of water on 19th Street is beyond the scope of this particular report, it can be done in several manners which shall be briefly summarized:

1. A storm drain can be constructed which extends from approximately the reservoir site at Mesa and 19th to a point about 400 feet north from the intersection of 19th and Oswego. This is a large line in general and will be expensive. This solution is so expensive, in fact, that it should be avoided if any other solution is possible.

2. Much of the land within the basin is relatively undeveloped. A close study of possible routes has not been made, but it appears to be possible from the topographic map of the area to construct a ditch or series of ditches on either side of 19th Street. By this, it is not mean that the ditches will necessarily will be immediately adjacent to 19th Street but could be, in fact, one or two blocks away and up the hillsides. With these ditches, a certain amount of water could be carried around the valley on the upper slopes of the hills thereby not allowing the total amount of water to enter 19th Street. Eventually, of course, all of these ditches would enter the reservoir site at Manitou Blvd.

3. A possible solution exists in that at least three sites for very small retention reservoirs are available along the hillside. One of these sites is slightly north a nd west of Point A on the Location Diagram. A second is almost due west of Point B, and a third is almost due east of Point C. This series of reservoirs would accomplish one thing. It would keep enough water off of 19th Street for a long enough period to greatly reduce the peak flow. The time of flow would, of course, be increased, but at least the flow could be kept within the street.

4. A variation of solution 2 lies in allowing para llel roads to be constructed both east and west of 19th Street. These roads should

be roughly parallel to 19th and Oswego and further up the hill. In fact, these would act the same as the ditches previously proposed in that the drainage water would be spread between three streets which would then not be overloaded as opposed to all concentrated in a single street. The primary objection to this fourth method would be that some of the area is already subdivided and this portion of the area would have to be worked around.

The fourth solution mentioned would be the simplest and most likely the least expensive method of the four. The pipeline is by far the most expensive method. Methods 2 and 3, the ditch proposal and the small storage dam proposal, are probably of about the same order of expense and both have a number of disadvantages. It is sometimes impractical to put ditches or reservoirs of this type above houses. The potential dangers are sometimes great enough to destroy the advantages they are attempting to obtain.

If none of the above proposals proves feasible after study, then two alternatives are still open.

1. 19th Street could be curbed and guttered as a normal street with an inverted crown. This is ordinarily recommended due to damage to asphalt and the difficulty of cars moving through water.

2. 19th Street can be maintained as a country type road with side ditches rather than curb and gutter. These ditches can be easily designed to contain the amount of water flowing, and although driveway crossings will be numerous and must be made of relatively large pipe, they would still be much less expensive than a continuous pipe for the full length of the street.

It is strongly recommended that the feasibility of these various proposals be studied at the earliest opportunity if this basin is to develop much further.

Lower Damsite:

The existing agreement between the owner of the site and the City of Colorado Springs is that a reservoir of 50 Acre Feet shall be maintained here. The quantity mentioned in this agreement, 50 Acre Feet, was arrived by a sort of horseback estimate made a t the time the City agreed to exchange property with the now owner of the site.

This estimate was not arrived at by computations and is somewhat high, although on the safe side. This study indicates that 50 Acre Feet is considerably too large a reservoir for all practical purposes and is unneccessary. Consequently, we have shown as proposal 3 a reservoir site with 40 Acre Feet and in reservoir No. 4 a site of 50 Acre Feet capacity. Sites one and two have already been described.

The second criteria was that the outfall from the reservoir not exceed the outfall which has occurred in the past. Some complaints have been received from residents downstream, even though this reservoir is of very long standing and the water has flowed down this path for many, many years.

The first computation, therefore, was to determine what the outflow of this original reservoir probably was. This can be seen on Sheet 4 of the Appendix, to be approximately 112 cfs. At the same time, the original reservoir stored approximately 25 Acre Feet with a high water line at elevation 30, or 8 feet below Manitou Blvd.

On Sheets 5 and 6 of the Appendix, reservoir proposal No. 3 is shown. This reservoir has a total capacity of 40 Acre Feet and a surface area of 3.07 Acres at the overflow line of 38. Flood routing through this reservoir indicates that a 30-inch round pipe must be used to choke the existing pipe outlet under Manitou Blvd. in order to keep the outflow below the previous original outflow. Assuming that this outfall pipe is choked down to 30-inches, the maximum outflow will be 79 cfs; the maximum water stored in the reservoir will be 29.7 Acre Feet at an elevation of about 34.3, or 3.7 feet below Manitou Blvd. at the outfall. This outflow is well below the criteria and sufficient area remains in the reservoir at its high water line to allow safety.

Sheets 7 and 8 show reservoir proposal No. 4. This reservoir has a capacity at overflow line of 38 of 50.7 Acre Feet with a surface area of 3.85 Acres at that point. An outfall pipe of 36-inch diameter can be used with this reservoir. Using this pipe, a total outflow is 94 cfs maximum, and the maximum storage within the reservoir is 28 Acre Feet at an elevation of 31.2, or 6.8 feet below Manitou Blvd. overflow line.

Examination of these two reservoirs, Nos. 3 and 4, and of the original report indicates that only reservoir No. 4 will meet all the criteria given for the design of the proposed retention area. It should be noted, however, that reservoir No. 3 actually accomplishes the same purpose at a saving of nearly 3/4 of an acre of ground with no particular loss in safety factor. It should be again strongly emphasized that using the City's design storm for this basin, a total of 40 Acre Feet, only, is produced and that in either case the reservoirs will contain at any given time less than 30 Acre Feet.

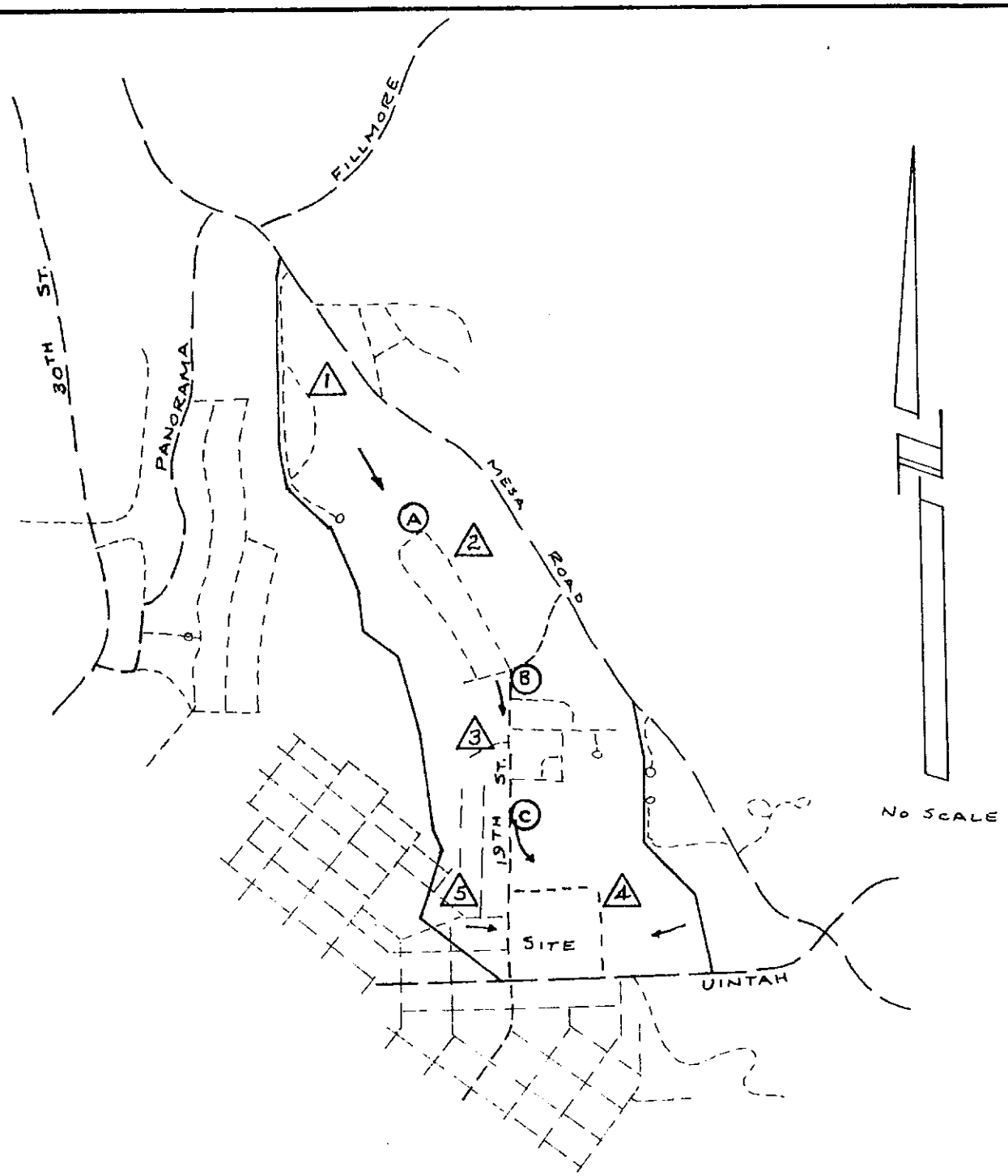
It is therefore the recommendation of this report that the criteria involving the storage of 50 Acre Feet be disregarded and that a reservoir with the hydraulic characteristics of that labeled No. 3 be designed and used in this site.

Respectfully submitted,

UNITED WESTERN ENGINEERS

George D. Morris, P. E.

GDM/jb



BASIN LOCATION DIAGRAM
GENERAL FLOW

LINCOLN-DeVORE TESTING LABORATORY
COLORADO SPRINGS, COLORADO

Major Basin	Sub Basin	Area		Basin		Tc	Ditch		V	Tpo	Flow		Tb.
		Ac.	Mi.	L	H		L	S			Q	δ_p	
19TH ST. NORTH OF MANITOU BLVD.	1	58.9	.092	2200	145	.130	—	—	—	.578	1.15	88.6	1.54
	2	82.8	.129	1400	125	.083	2500	.0288	8.8	.550	1.20	136.2	1.47
	3	112.6	.176	1650	142	.094	1850	.0290	11.6	.556	1.25	191.5	1.48
	4	65.2	.102	1100	123	.063	—	—	—	.538	1.10	100.9	1.44
	5	23.9	.037	960	84	.062	—	—	—	.537	1.40	46.7	1.43

Hydrologic Computation-Basic Data
19TH ST. BASIN - COLORADO SPRINGS

UNITED WESTERN ENGINEERS
COLORADO SPRINGS, COLORADO

Line	From	To	base qp	base Tp	Ditch L	Ditch S	Ditch Time	Tp @ point	Tp of next	dif	qp	Street cpy	Remarks
1	1	A	88.6	.578					.550		88.6		use 8" curb, flat st. @ 70' R/W
	A	B	88.6	.655	2500	.0288	.077	.594	.556		222	185	REQ-54"ϕ OR =
	B	C	222	.637	1850	.0290	.043	.605			407	185	REQ-78"ϕ OR =
													SEE REPORT FOR POSSIBLE VARIATIONS
2	4	RES.	100.9	.538							91		OVERLAND - No DEV. AS YET.
3	5	Res	46.7	.537							42		WEST ENTRY

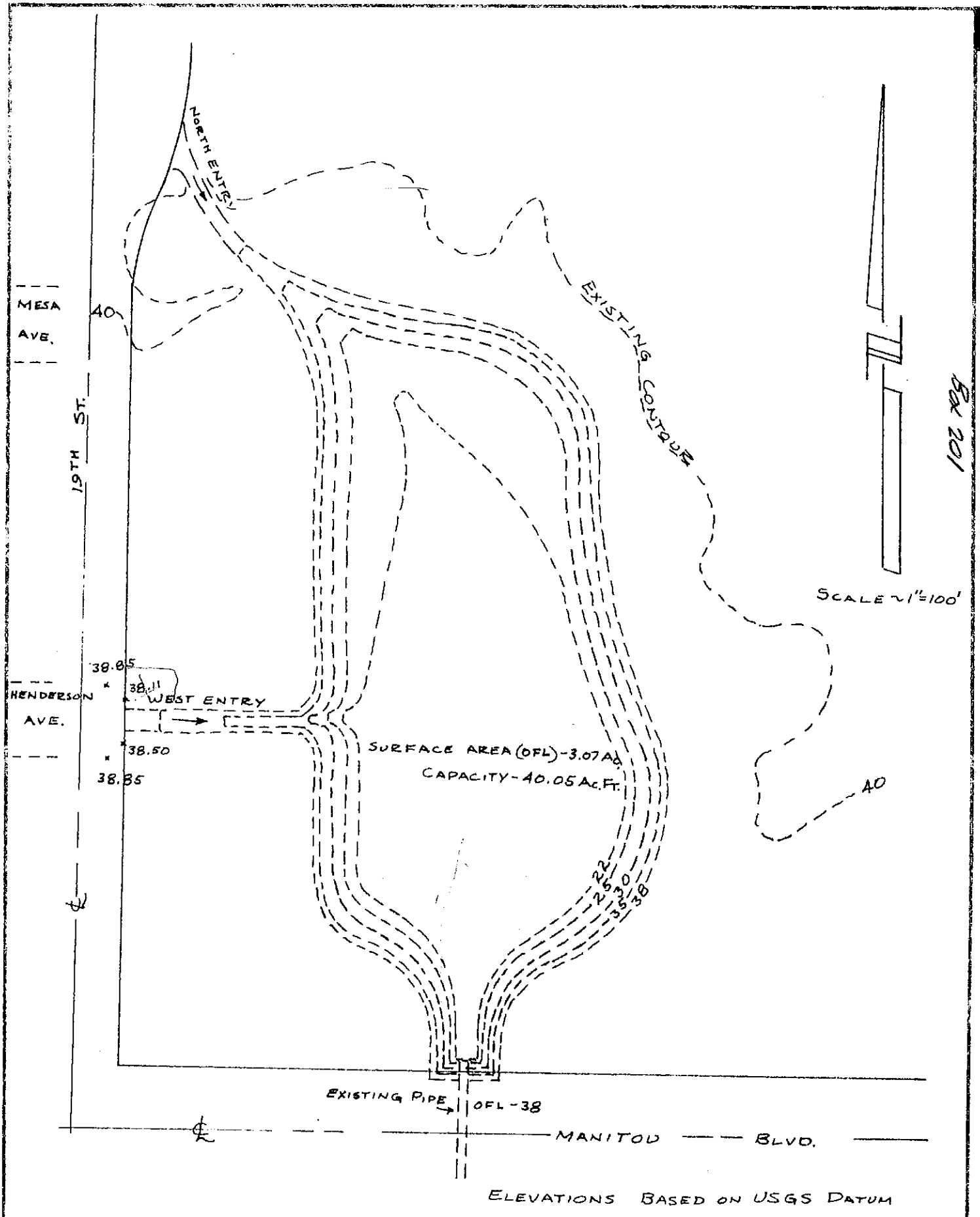
Existing Reservoir Area - prior to fill or other improvement

Surface Area - 5.76 Acres + -
Max. Depth at pipt - 17'
Approx. capacity of Reservoir at various elevations (pipe FL @ 21.0)

Elev.	Storage	Max. Pipe Discharge	
21	0	0	
24	4.32	58	
29	17.48	96	
30	25.28	112	
33	38.54	126	- actual amount of water available
34	43.36	132	with fill to 33.5 with no discharge.
35	48.22	136	This is the maximum discharge at this level.
36	53.34	140	Arbitrary 50. Ac. ft. storage will fill
36*	63.44	146	to 35.4 with no discharge. This is max.
*overflow			discharge at this level

Actual performance of the original reservoir is then:

Hours	Cum. Ac. Ft. In.	Cfs out	Cum. Ac. Ft. Out	Cum. Storage	Elev.) 0-20.0
.50	4.63	54	1.12	3.51	
.75	13.47	76	2.57	10.90	
1.00	21.98	98	4.37	17.61	
1.25	29.59	110	6.52	23.07	
1.50	32.48	111	8.80	23.68	29.60
1.75	35.37	112	11.10	24.27	29.90
2.00	38.30	112	13.41	24.89	30.00 - HWL
2.25	39.32	111	15.71	23.61	29.60
2.50	39.68	105	17.94	21.74	
3.00	39.85	97	22.11	17.74	
3.50	40.06	84	26.04	14.02	
4.00	40.06	74	29.30	10.76	
4.50	40.06	64	32.15	7.91	
5.00	40.06	60	34.71	5.35	
5.50	40.06	38	36.78	3.28	
6.00	40.06	26	38.10	1.96	



PROPOSED RESERVOIR SITE No. 3
19TH & MANITOU BLVD., COLORADO SPRINGS

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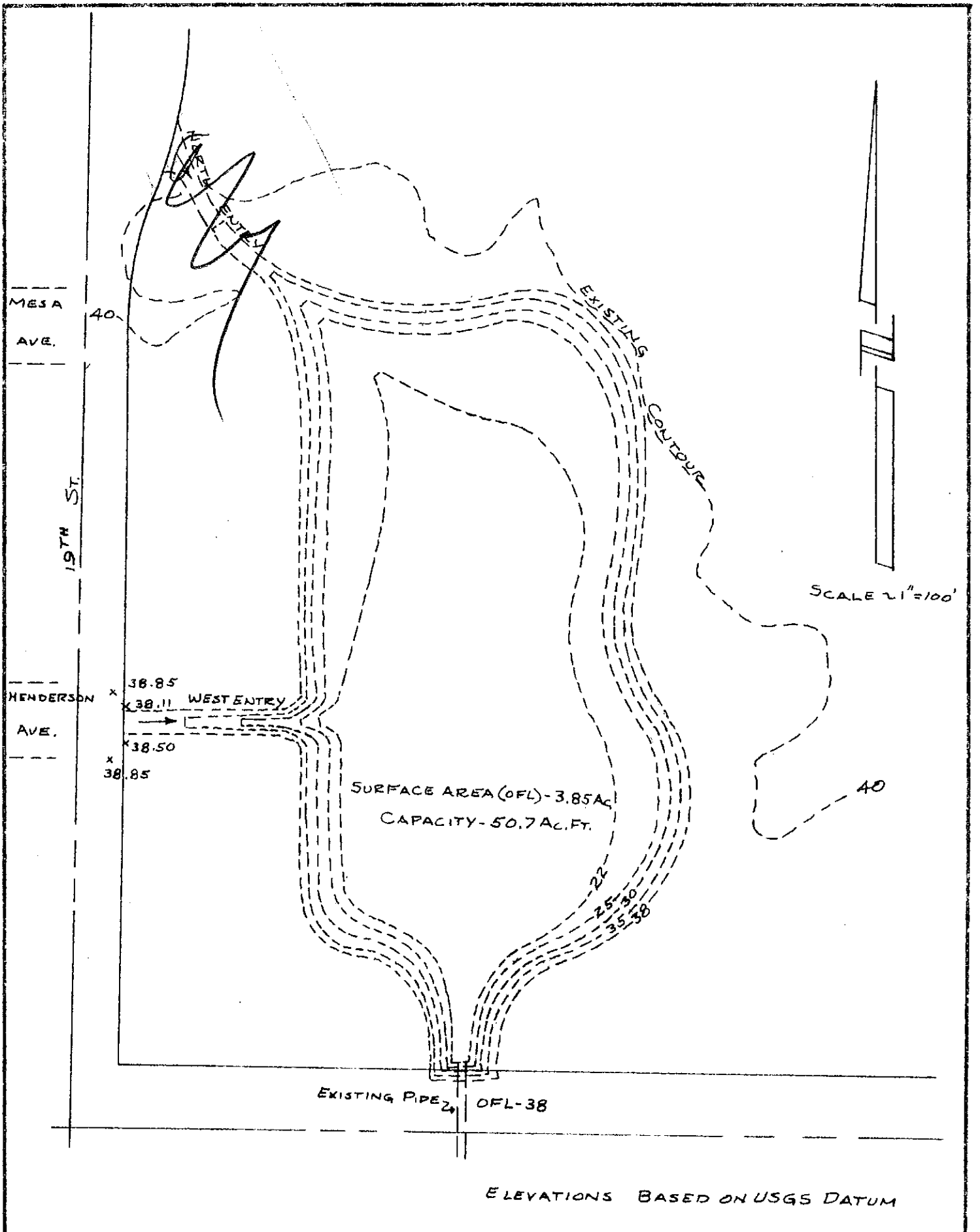
Then the new reservoir (trial #3) has the following characteristics:

Elevation	Area Ac.	Storage (cum) Ac. Ft.
21	0	0
22	1.51	0.76
25	2.13	6.22
30	2.50	17.82
35	2.84	31.17
38	3.07	40.05

Performance is then: 30" @

Hours	Cum. Ac. Ft. In.	Cfs Out	Cum. Ac. Ft. Out	Cum. Storage	Elev.
0.5	4.63	24	0.50	4.13	
0.75	13.47	48	1.22	12.25	
1.00	21.98	64	2.36	19.62	
1.25	29.59	76	3.81	25.78	
1.50	32.48	78	5.40	27.08	
1.75	35.37	78	7.01	28.36	33.8
2.00	38.30	79	8.64	29.66	34.3
2.25	39.32	79	10.27	29.01	34.0
2.50	39.68	76	11.87	27.81	33.6
3.0	39.85	75	13.43	26.42	
3.5	40.06	71	16.36	23.70	
4.0	40.06	66	20.19	19.87	
4.5	40.06	57	22.73	17.33	
5.0	40.06	53	25.00	15.06	
5.5	40.06	51	27.15	12.91	
6.0		45	29.13	10.93	
6.5		39	30.87	9.19	
7.0		36	32.42	7.64	
8.0		28	35.06	5.00	
9.0		22	37.13	2.93	
10.0		16	38.70	1.36	



PROPOSED RESERVOIR SITE NO. 4
19TH & MANITOU BLVD., COLORADO SPRINGS

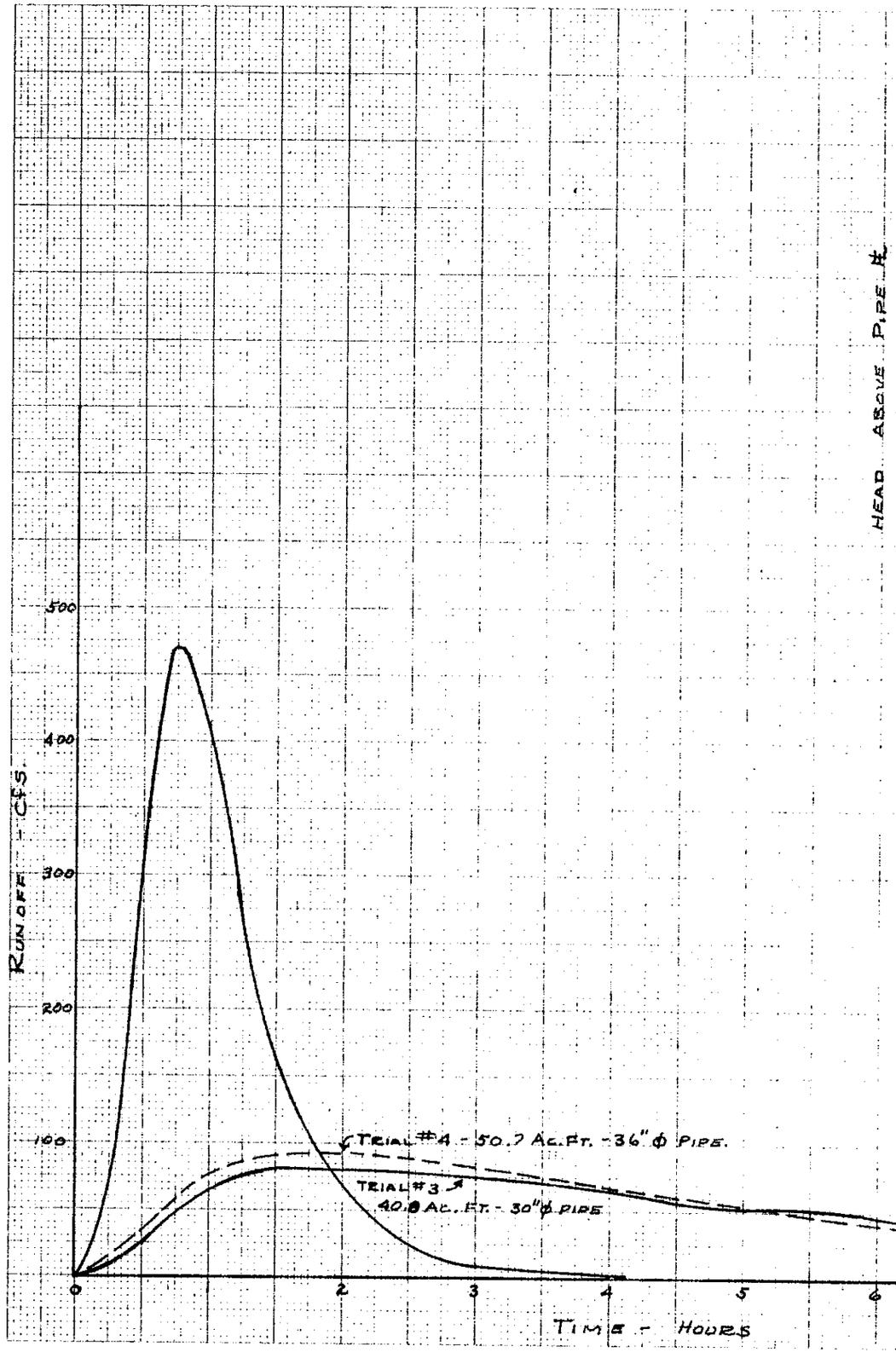
UNITED WESTERN ENGINEERS
COLORADO SPRINGS, COLORADO

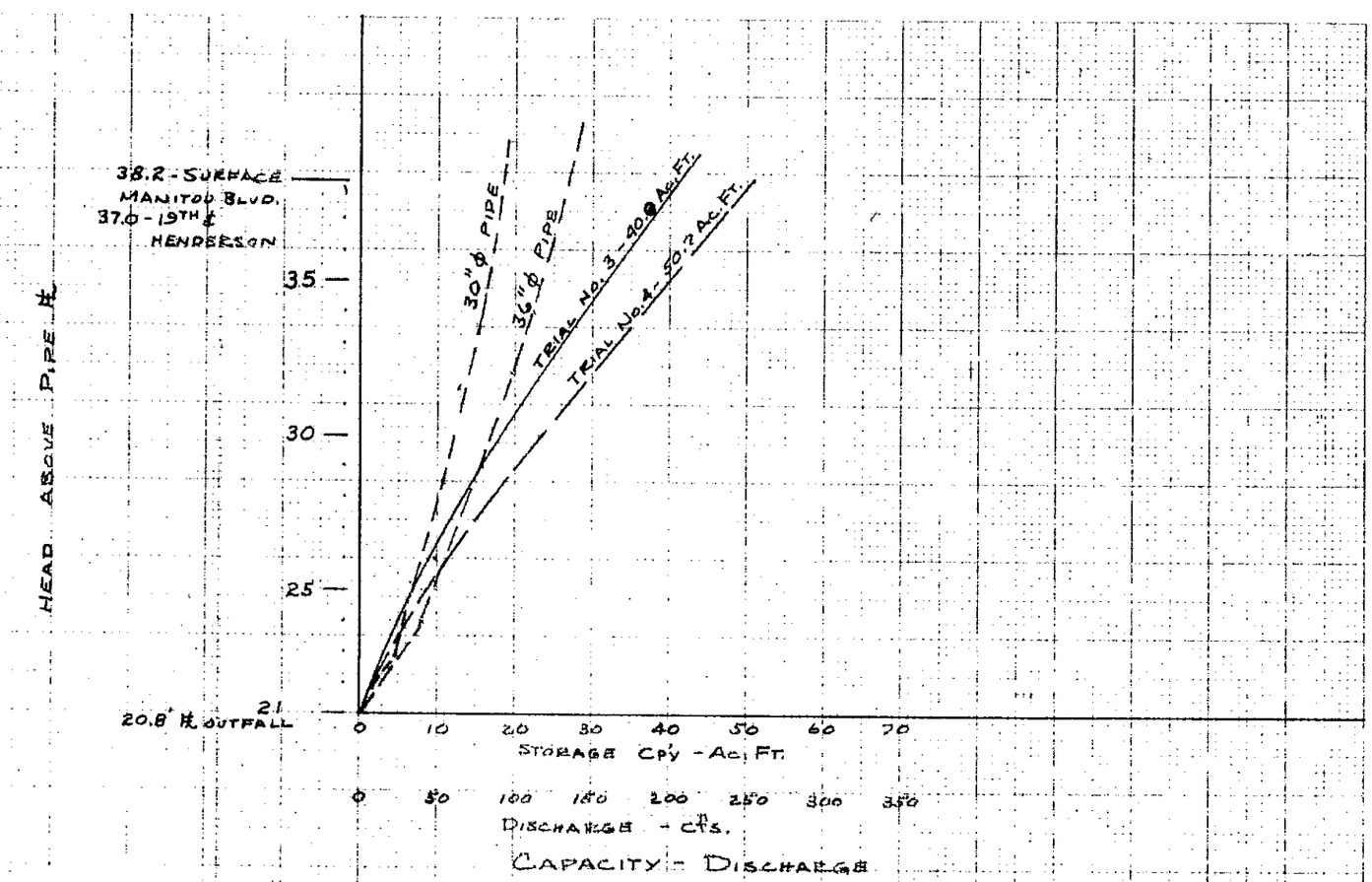
Using the criteria that an agreement for a storage capacity of 50 Ac. Ft. exists, then the reservoir would be as in trial 4, and will react as follows.

Elev.	Area (Ac)	Cumulative Storage (Ac. Ft.)
21	0	0
22	1.92	0.96
25	2.82	8.07
30	3.20	23.12
35	3.46	39.77
38	3.85	50.72

36" ø Outlet

Hours	Cum. Ac.Ft.	cfs Out	Cum. Ac. Ft. Out	Cum. Storage	Elev.) 0-20.8'
.50	4.63	32	0.66	3.97	
.75	13.47	58	1.59	11.88	
1.00	21.98	77	2.98	19.00	
1.25	29.59	87	4.67	24.92	
1.50	32.48	91	6.51	25.97	30.8
1.75	35.37	92	8.40	26.97	31.0
2.00	38.30	94	10.32	27.98	31.2
2.25	39.32	92	12.24	27.08	31.0+
2.50	39.68	90	14.12	25.56	30.7+
3.00	39.85	82	17.67	22.18	
3.50	40.06	74	20.89	19.17	
4.00	"	68	23.78	16.28	
4.50	"	61	26.40	13.66	
5.00	"	56	28.82	11.24	
5.50	"	48	30.97	9.09	
6.00	"	42	32.83	7.23	
6.50	"	38	34.49	5.56	
7.00	"	32	35.93	4.13	
8.00	"	18	38.00	2.06	
9.00	"	8	39.07	0.99	





CAPACITY - DISCHARGE

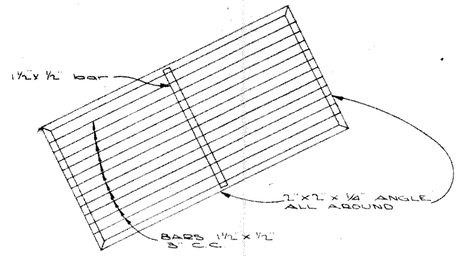
FLOOD ROUTING CHART

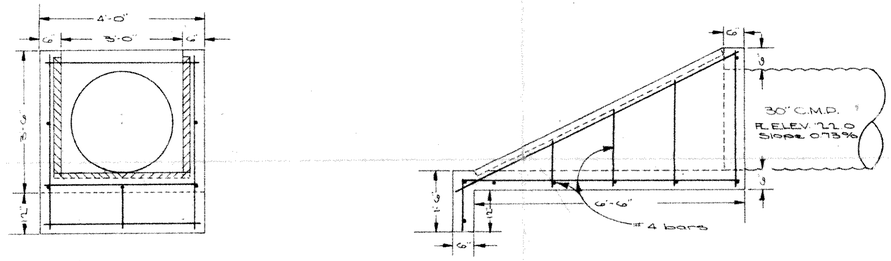
RESERVOIR AT MANITOU BLVD. NEAR 19TH ST.
COLORADO SPRINGS
COLORADO

UNITED WESTERN ENGINEERS
COLORADO SPRINGS, COLORADO

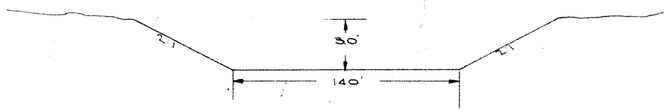
SCALE 1" = 100'

STEEL TRASH RACK DETAILS





DRAIN INLET DETAILS



TYPICAL DITCH SECTION

DETENTION RESERVOIR AT 19TH. ST. & UINTAH ST.

United Western Engineers
Colorado Springs, Colorado