

*RSL*

City of Broomfield  
Urban Drainage and Flood  
Control District

DIRECT FLOW AREA 3207  
DETENTION ALTERNATIVE STUDY

July 1982

Amended Dec. 1982



Wright-McLaughlin Engineers  
Denver, Colo.

COMPLETE ENGINEERING SERVICES  
IN THE SPECIALTY FIELDS OF

WATER SUPPLY AND DISTRIBUTION  
WATER AND SEWAGE TREATMENT  
SEWAGE COLLECTION AND REUSE  
STORM DRAINAGE  
FIRE PROTECTION  
FLOOD CONTROL  
OTHER WATER-ORIENTED PRODUCTS

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December 16, 1982

Mr. Ben Urbonas  
Chief, Major Drainageway Planning  
Urban Drainage and Flood Control District  
2480 West 26th Avenue, Suite 156B  
Denver, Colorado 80211

Dear Ben:

We are pleased to submit the following amended report for the Direct Flow Area 3207 Detention Alternative Study. The report is divided into two parts. The first half contains the original data and report completed in July of 1982. The second half is the addendum which contains the results and discussion of additional analyses performed to include existing and committed detention sites and to evaluate the effectiveness of Brunner Reservoir. The recommendations and conclusions presented in the addendum supercede the recommendations made in the first half of the report.

Please feel free to contact us if further assistance is needed.

Sincerely,



John M. Pflaum

JMP:cr

822-058.000



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CITY OF BROOMFIELD  
URBAN DRAINAGE AND FLOOD  
CONTROL DISTRICT

DIRECT FLOW AREA 3207  
DETENTION ALTERNATIVE STUDY

JULY 1982

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WRIGHT-McLAUGHLIN ENGINEERS  
ENGINEERING CONSULTANTS  
2420 Alcott Street  
Denver, Colorado 80211

822-058.000

PART 1

ORIGINAL JULY 1982 REPORT

## INTRODUCTION

This report describes the analyses conducted by Wright-McLaughlin Engineers to determine the feasibility and effectiveness of alternative detention pond sites in the Direct Flow Area 3207 drainage basin. The appropriate official at the City of Broomfield and the Urban Drainage and Flood Control District can utilize this report to select the stormwater management plan which best fits the objectives of flood hazard reduction and control of runoff from future development.

## AUTHORIZATION

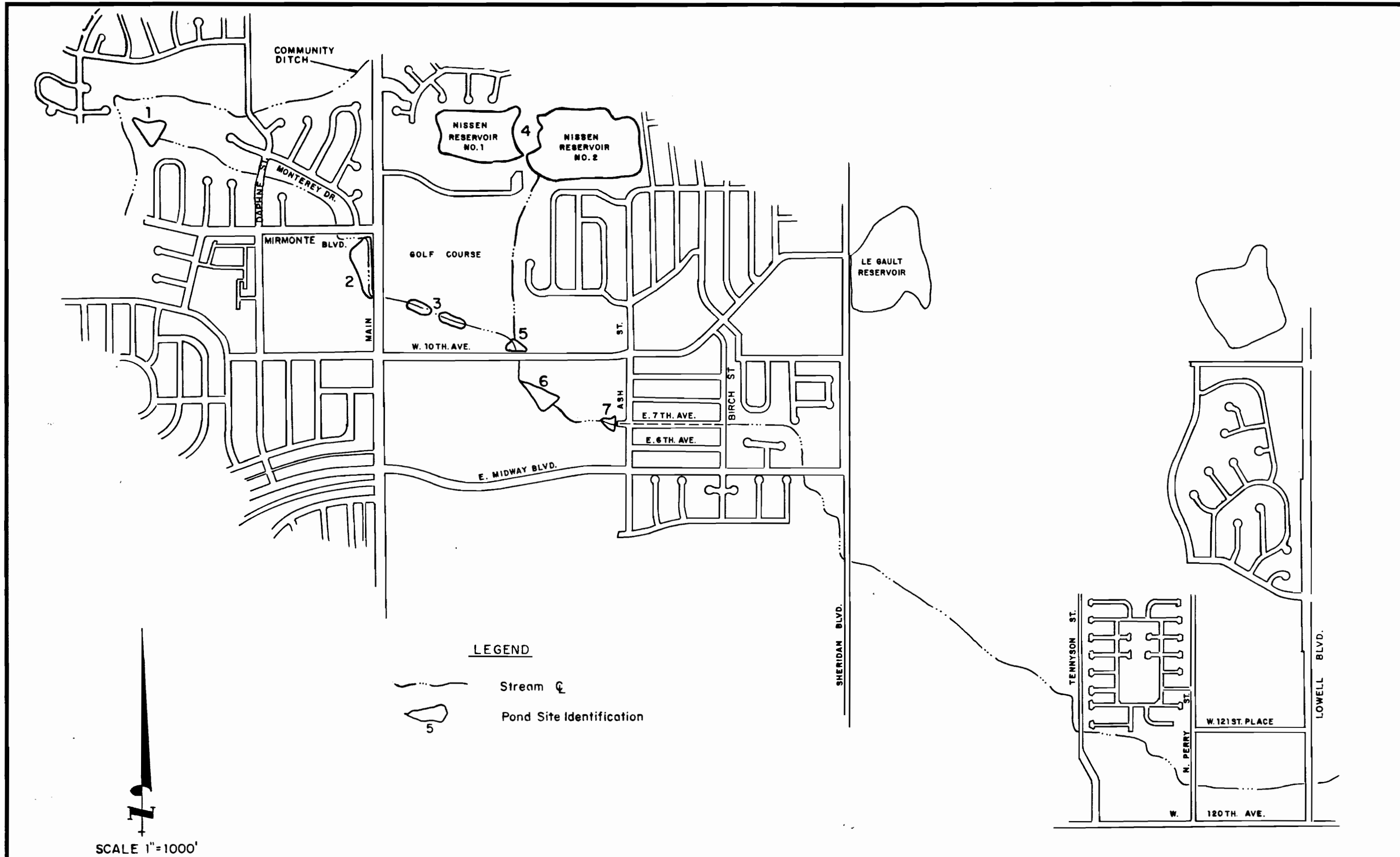
This study was authorized by the City of Broomfield and the Urban Drainage and Flood Control District by Agreement No. 82-6.2 with Wright-McLaughlin Engineers.


## POND SITE DISCUSSION

Figure 1 shows the location of the detention pond site within the 3207 basin. A brief discussion of each site follows.

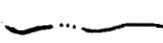
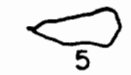
SITE NO. 1 is the existing dry pond located just downstream from the Community Ditch at the northwest corner of the drainage basin. Figure 2 illustrates the conceptual layout for the site, which provides approximately 19 acre-feet of storage at the elevation of the emergency spillway (5407). To convert the site to an effective detention pond (normally dry) the dam would require rehabilitation to insure structural integrity, installation of an adequate primary pipe spillway and riprap emergency spillway and grading of the site to provide the required storage capacity.

SITE NO. 2, shown in Figure 3, is located at the existing high school ball-fields just west of Main Street. While the site is relatively flat, some detention storage could be obtained by construction of a landscaped berm or decorative wall along Main Street. Approximately 8 acre-feet of storage is possible with a dam or wall set at elevation 5367 and the emergency spillway at elevation 5365.



  
 SCALE 1"=1000'

**LEGEND**

-  Stream
-  Pond Site Identification

WRIGHT-McLAUGHLIN ENGINEERS 2420 ALCOY STREET DENVER COLORADO 80211 TELEPHONE (303) 466-8271	DESIGNED _____ DATE _____
	DRAWN _____ DATE _____
	CHECKED _____ DATE _____
	REVISED _____ DATE _____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT  
 CITY OF BROOMFIELD

DIRECT FLOW AREA 3207 DETENTION STUDY  
 DETENTION POND LOCATION MAP

FIGURE  
 1



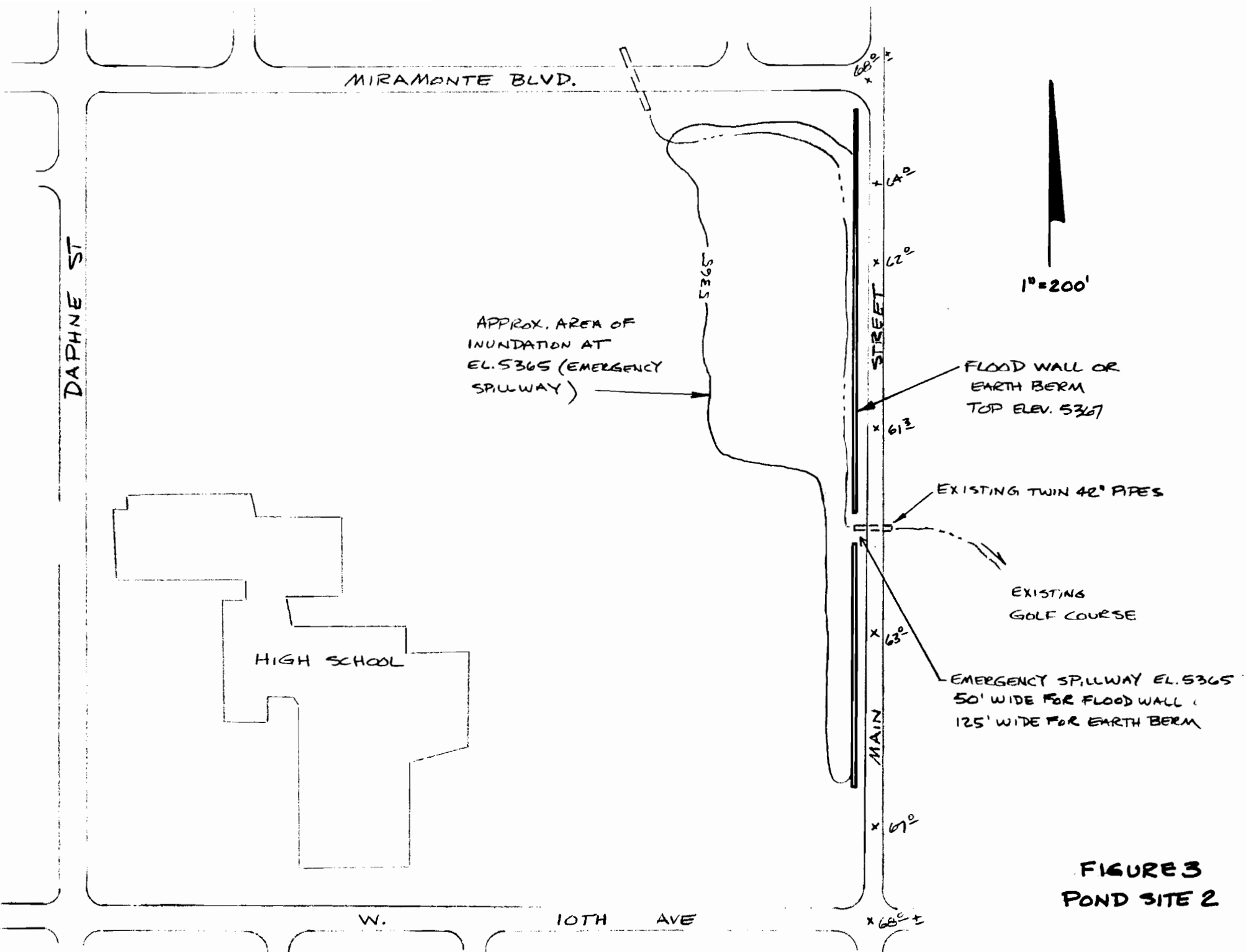


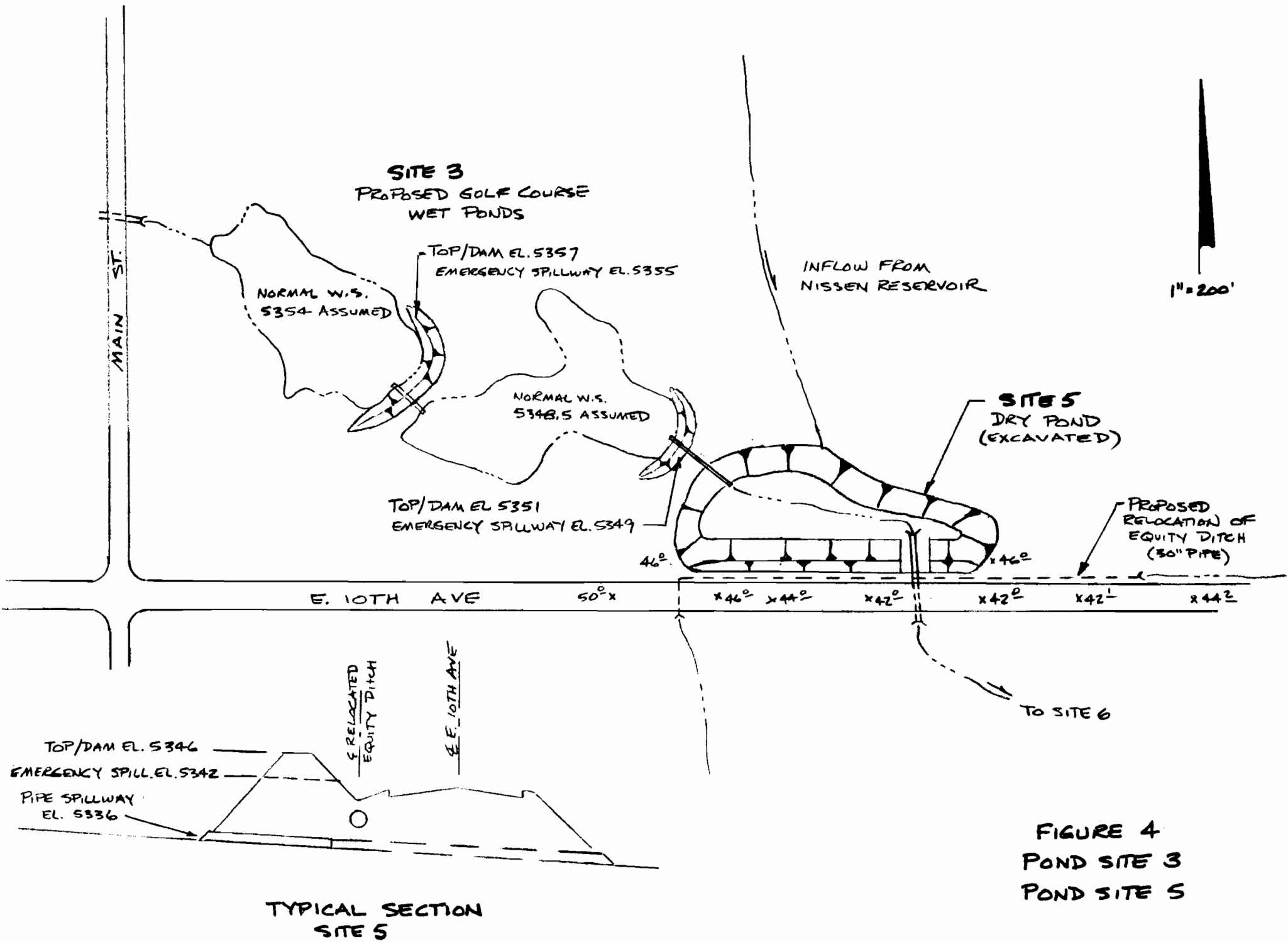
FIGURE 3  
POND SITE 2

SITE NO. 3 is the location of the proposed wet ponds for the Broomfield Country Club. Under an improvement program, the three existing golf course ponds will be replaced by two ponds, each approximately 1.5 acres in surface area. Figure 4 illustrates how the ponds would operate in series, with the upper pond draining to the lower pond which in turn would drain to Pond Site No. 5 discussed later in this section. The proposed golf course ponds would contribute little to the alternation of flood flows in the basin since they are planned to be wet ponds and would have little storage capacity above the normal water surface. However, they could be reconfigured to increase their effectiveness if it was needed to do so.

Figure 5 shows SITE NO. 4 which is the existing Nissen Reservoir site. The Major Drainageway Plan for Flow Area 3207 utilized only the west pond for stormwater detention, since at that time plans were to fill and develop the east pond. Present plans are to maintain both ponds and relocate the existing spillway approximately 400 feet east as shown in Figure 5. Nissen Reservoir is presently providing detention storage for the Broomfield Country Club First Filings and will also serve portions of the proposed Third Filing. Approximately 96 acre-feet of storage is available between the normal water surface of 5388.5 and the spillway elevation of 5392.2. Release flows from Nissen Reservoir will flow southward toward Site No. 5 at East 10th Avenue.

SITE NO. 5 is shown on Figure 4 and is located just north of East 10th Avenue and downstream of the proposed golf course ponds. This would be a dry pond under normal conditions, created by construction of a small earth dam north of East 10th Avenue and excavation of an area upstream of the dam that would drain via the existing pipeline under the road. Available storage below the emergency overflow spillway (set at the elevation of the road) is approximately 8.5 acre-feet. It is also possible to provide a permanent pool in the bottom of this pond by excavating below the proposed outlet; however, the pond surface would be small and not very visible.

POND SITE NO. 6 is the existing wet pond south of East 10th Avenue on land presently owned by AT&T (Figure 6). With some rehabilitation to the dam and spillways, the structure can become an effective detention site, providing approximately 16.7 acre-feet of storage between the existing water surface of 5332.9 and the proposed overflow spillway at elevation 5337.5.



**FIGURE 4**  
**POND SITE 3**  
**POND SITE 5**

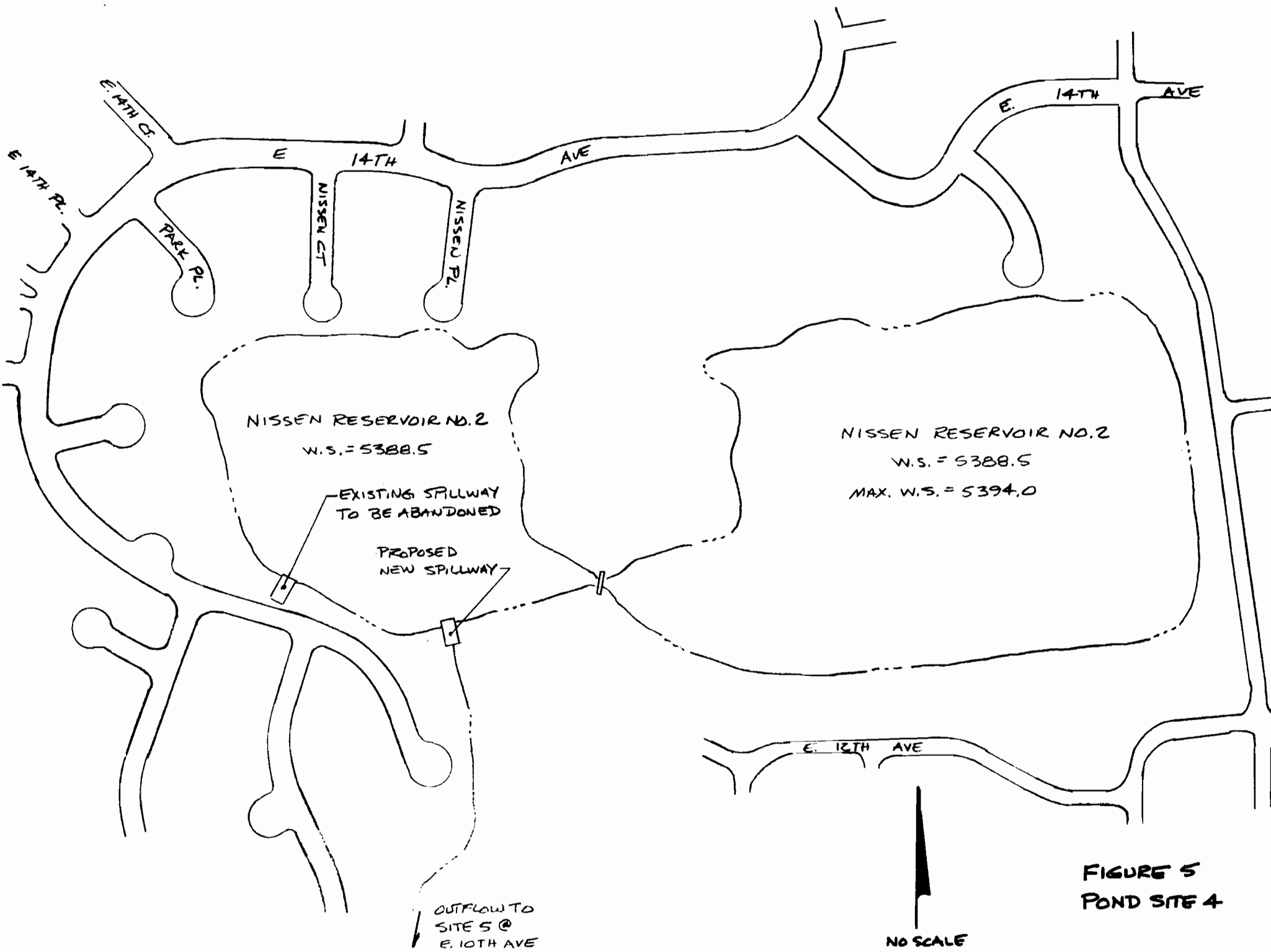
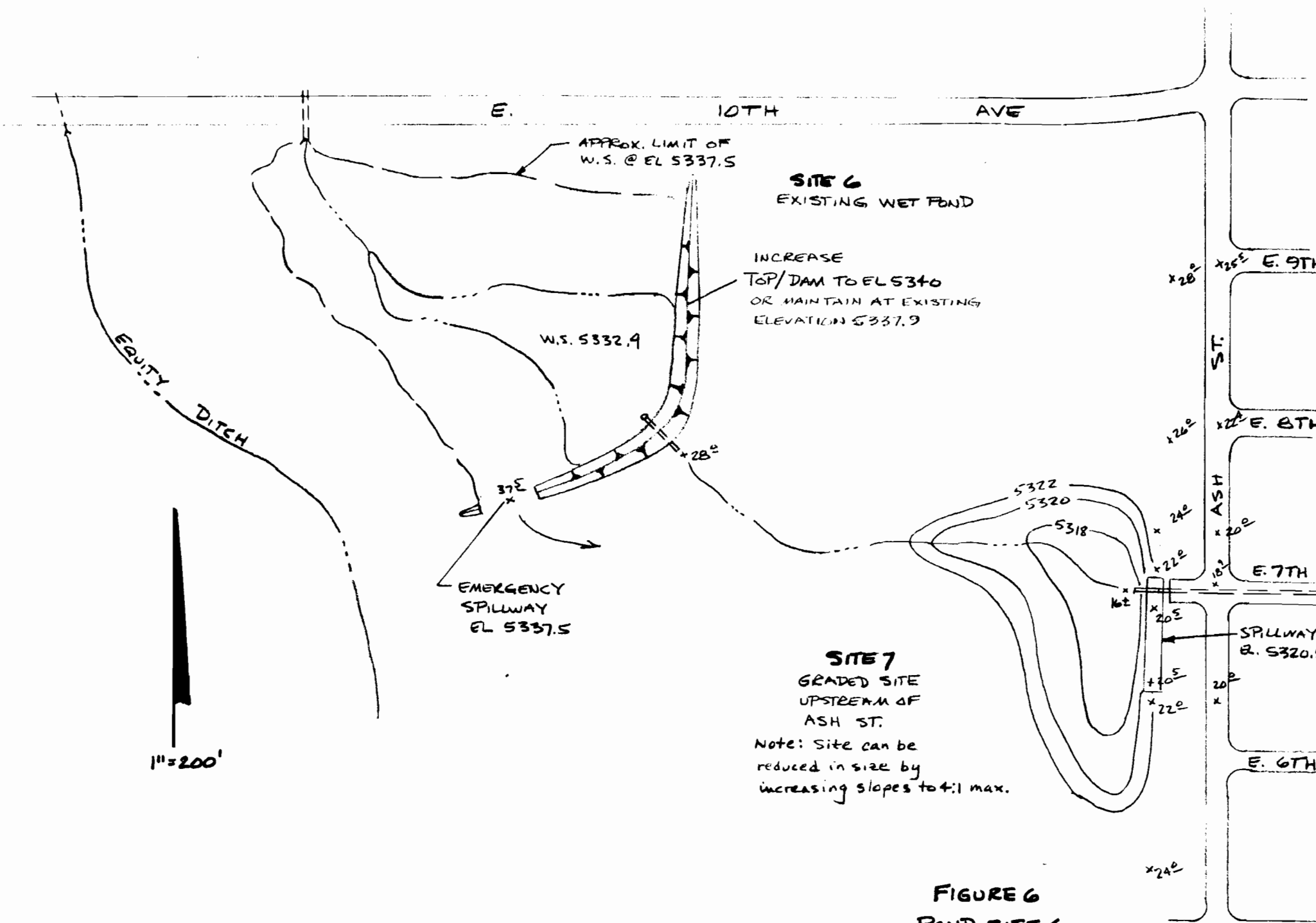


FIGURE 5  
POND SITE 4

NO SCALE



**FIGURE 6**  
**POND SITE 6**  
**POND SITE 7**

This dam may need rehabilitation to safeguard against piping through the installation of a granular drainage blanket and toe drain on the downstream face. It is recommended that this be investigated during final design.

POND SITE NO. 7, also shown on Figure 6, is just downstream of Site No. 6 and at the same location as the 5-year detention site in the Master Plan for Basin 3207. A depression presently exists between the elevation of East 7th Avenue (5320<sup>±</sup>) and the upstream invert of the existing 24-inch pipe (5316<sup>±</sup>). Figure 6 shows a conceptual scheme whereby the area upstream of the pipe entrance could be graded to provide approximately 4.5 acre-feet of storage. The topography indicates that no dam (i.e., raised embankment) would be required and only a level area at an approximate elevation of 5320.5 would need to be provided for emergency overflow. This site is a logical area for a multi-purpose park which normally would provide recreational open space for existing and proposed development and function as a detention pond during storm events.

Table 1 presents a summary of the detention pond sites and their hydraulic characteristics.

#### ANALYSIS METHODOLOGY AND RESULTS

The hydrologic analysis of the 3207 Basin was completed originally in 1978 in conjunction with preparation of the Major Drainageway Plan for the basin. A version of the Environmental Protection Agency's Stormwater Management Model (SWMM) computer program as modified by the Army Corps of Engineers was utilized to conduct the study. The Corps' modification allows input of detention ponding at selected locations within the basin.

The original 3207 Basin computer model was obtained from the Urban Drainage and Flood Control District and updated to include any changes in proposed land use and drainage routes which may have occurred since the master plan was completed. For example, the east pond of Nissen Reservoir was added to the reservoir storage-outflow data to provide additional storage capacity (the original master plan model had assumed the east pond would be filled and developed).

The first computer run was a baseline run without any detention storage so that results could be verified with the original master plan hydrology. The results were within a reasonable percentage of the master plan flows. Next, the detention sites were chosen and storage vs. outflow data for each pond was prepared by doing a conceptual layout as shown earlier in Figures 2

TABLE 1  
SUMMARY OF POND HYDRAULIC CHARACTERISTICS

Pond Site No.	Type	Pipe Spillway Size	Maximum Discharge Thru Pipe Spillway	Available Storage At Elevation of Overflow Spillway	Residual Storage Above Overflow Spillway	Overflow Spillway Capacity
1	Dry	12" dia.	7 cfs @ 5409.5	19.4 AF @ 5407	10.9 AF between 5307 and 5309.5	550 cfs @ 5409.5
2	Dry	Twin 42" RCP	279 cfs @ 5367	8.2 AF @ 5365	8.5 AF between 5365 and 5367	1000 cfs @ 5367
3	Wet	12" dia. pipe & riser	5 cfs @ top of dams	2.2 AF to Spillway Crest	5.8 AF to top of dams	1000 cfs
4	Wet	Overflow only	N.A.	81 AF @ 5392.2	40 AF between 5392.2 and 5394	340 cfs @ 5394
5	Dry	18" CMP	42 cfs @ 5346	8.7 AF @ 5342	7.8 AF between 5342 and 5346	1100 cfs @ 5346
6	Wet	18" dia. pipe with 12" dia. riser	18 cfs @ 5340	16.7 AF @ 5337.5	16.4 AF between 5337.5 and 5340.	1100 cfs @ 5340
7	Dry	24" RCP	16 cfs @ 5322	4.4 AF @ 5320.5	3.1 AF between 5320.5 and 5322	1200 cfs @ 5322

through 6. For each pond site (except Site 4, Nissen Reservoir) the overflow spillway was sized according to the magnitude of the 100-year flow without detention. A series of computer runs were made as various detention schemes were investigated. These computer runs are summarized in Tables 2, 3 and 4 for the 2-, 5-, and 100-year floods, respectively, and are described as follows:

Columns 1 through 4 list the location, computer model link number (refer to Exhibit 1, the SWMM basin map), the results of the original 1978 baseline run and the results of the revised baseline run conducted under this study. The results of the 1982 baseline run are roughly within 20 percent of the original baseline run. This results from altered drainage networks and surface conditions.

Column 5 lists the peak flows at various locations in the basin for the adopted master plan for the 3207 Basin. As described in the Phase B Report published in November 1979, the adopted plan included a detention facility upstream of Ash Street with volume equal to that of the 5-year flood event. This structure reduces the 100-year peak flow along East 7th Avenue from approximately 1,400 cfs to between 600 and 700 cfs. Columns 6 through 10 show the results of the various detention schemes that were investigated as possible alternative plans for control of peak flows.

Modification 1 (Column 6) shows the results of the initial run with detention Sites 1 through 6 described previously in place in the basin. The results were unrealistically favorable for the 100-year comparisons due to oversizing of some of the detention sites and so this run was basically discarded for the 100-year flood control alternate.

Modification 2 (Column 7) summarizes the results of a computer run which included refinements in the reservoir sizing and the addition of Site 7 upstream of Ash Street.

Modification 3 (Column 8) is basically the same as the previous run except a wider spillway was incorporated at Site 2 to model that facility as an earth dam.

The computer run for Modification 4 (Column 9) modelled an additional refinement at Site 6 where the storage capacity was reduced by assuming no grading work would be done upstream of the dam.

Modification 5 (Column 10) shows the results of removal of Site 2 at the high school upstream of Main Street.

Under Modification 5A (Column 11) link 11 was routed into Pond Site 7 upstream of Ash Street to examine the effect of possible storm drainage improvements at the intersection of East 10th Avenue and Ash Street. Under the proposed improvements, inlets would drain the intersection and the flow routed directly by pipeline to Pond Site 7. Only the 2-year and 5-year events were modelled for this case since 100-year flows would still be routed down Ash Street to East 7th Avenue downstream of Pond Site 7.

TABLE 2  
 DIRECT FLOW AREA 3207  
 SUMMARY OF COMPUTER RESULTS  
 2-YEAR STORM  
 (Values in Cubic Feet Per Second)

1 Location	2 End of Link*	3 Baseline 1978	4 Baseline 1982	5 Master Plan	6 Modification (1)	7 Modification (2)	8 Modification (3)	9 Modification (4)	10 Modification (5)	11 Modification (5A)
Pond Site 1	87 101	20 -	69 -	80 110	69 4	69 4	69 4	69 4	69 4	69 4
Daphne Street	1	86	96	140	30	30	30	30	30	30
Miramonte Blvd.	86	128	131	185	73	91	91	91	91	91
Main Street/ Pond Site 2	4	150	181	260	134	180	180	147	147	147
	85	247	205	260	160	196	196	173	173	173
Pond Site 3	207	-	199	260	136	152	152	157	172	172
Pond Site 3	307 7	- 224	198 200	260 265	109 109	183 187	183 187	152 149	165 168	165 168
Pond Site 5	107	-	243	270	-	103	103	37	37	37
Pond Site 6	110 10 11	- - -	259 266 -	275 280 -	10 47 26	14 40 -	14 40 -	12 40 -	12 40 26	14 40 26
Pond Site 7	56	230	265	21	48	15	15	15	15	18
Ash Street	84 12	253 253	278 271	30 60	74 62	34 33	34 33	34 33	34 33	18 18
Birch Street	83	286	312	150	141	111	111	111	111	93
Midway Blvd.	18 90	304 309	325 331	160 175	163 172	132 145	132 145	132 145	132 145	117 130
Sheridan Blvd.	82 22	372 363	394 381	250 260	243 237	216 214	216 214	216 214	216 214	201 202
Perry Street	23	361	378	260	229	209	209	209	209	196
Confluence w/City Park Basin	60	359	376	260	229	208	208	208	208	196

\* Refer to basin (Exhibit 1) at the end of the report.

TABLE 3  
 DIRECT FLOW AREA 3207  
 SUMMARY OF COMPUTER RESULTS  
 5-YEAR STORM  
 (Values in Cubic Feet Per Second)

1 Location	2 End of Link*	3 Baseline 1978	4 Baseline 1982	5 Master Plan	6 Modification (1)	7 Modification (2)	8 Modification (3)	9 Modification (4)	10 Modification (5)	11 Modification (5A)
Pond Site 1	87 101	29 -	100 -	100 165	100 4	100 4	100 4	100 4	100 4	100 4
Daphne Street	1	132	143	200	45	45	45	45	45	45
Miramonte Blvd.	86	195	198	265	105	135	135	135	135	135
Main Street/ Pond Site 2	4 85	225 368	277 311	375 375	183 217	188 203	188 203	207 240	219 261	219 261
Pond Site 3	207	-	309	375	207	216	216	238	258	258
Pond Site 3	307 7	- 335	301 297	380 380	192 194	217 217	217 217	235 241	235 238	235 238
Pond Site 5	107	-	381	385	-	182	182	123	124	124
Pond Site 6	110 10 11	- - -	396 418 -	390 395 -	- 63 38	77 77 38	77 77 38	14 59 38	14 59 38	14 59 38
Pond Site 7	56	363	419	30	65	77	77	17	17	22
Ash Street	84 12	399 395	437 435	40 85	103 91	78 78	78 78	51 46	51 46	22 22
Birch Street	83	451	492	210	215	164	164	164	164	140
Midway Blvd.	18 90	463 483	497 519	235 250	239 251	196 212	196 212	196 212	196 212	171 192
Sheridan Blvd.	82 22	577 570	614 600	360 365	362 355	324 324	324 324	324 324	324 324	303 304
Perry Street	23	566	596	365	358	327	327	327	327	308
Confluence w/City Park Basin	60	560	587	365	346	317	317	317	317	298

\*Refer to basin map (Exhibit 1) at the end of the report

TABLE 4  
 DIRECT FLOW AREA 3207  
 SUMMARY OF COMPUTER RESULTS  
 100-YEAR STORM  
 (Values in Cubic Feet Per Second)

1 Location	2 End of Link*	3 Baseline 1978	4 Baseline 1982	5 Master Plan	6 Modification (1)**	7 Modification (2)	8 Modification (3)	9 Modification (4)	10 Modification (5)
Pond Site 1	87 101	75 -	260 -	360 -	260 41	260 41	260 41	260 41	260 41
Daphne Street	1	401	412	585	130	130	130	130	130
Miramonte Blvd.	86	599	593	790	271	379	379	379	379
Main Street/ Pond Site 2	4 85	625 1062	804 883	1100 1105	321 368	349 397	401 456	414 491	625 742
Pond Site 3	207	-	903	1130	365	402	466	483	700
Pond Site 3	307 7	- 1090	918 924	1155 1160	360 360	396 396	457 455	480 482	688 677
Pond Site 5	107	-	1245	1180	400	483	540	548	703
Pond Site 6	110 10 11	- - -	1310 1348 -	1220 1260 -	- - 105	387 401 -	399 417 -	388 399 -	415 435 105
Pond Site 7	56	1117	1344	580	280	402	410	400	425
Ash Street	84 12	1248 1244	1413 1375	590 690	264 256	416 413	427 426	414 413	442 444
Birch Street	83	1404	1580	700	601	458	472	463	497
Midway Blvd.	18 90	1512 1562	1643 1706	715 750	628 750	520 639	520 639	520 639	520 639
Sheridan Blvd.	82 22	1890 1875	2034 1988	1095 1095	1118 1133	1006 1040	1006 1040	1006 1040	1006 1040
Perry Street	23	1844	1958	1095	1111	1030	1030	1030	1030
Confluence w/City Park Basin	60	1809	1912	1095	1087	1005	1005	1005	1005

\* Refer to basin map (Exhibit 1) at the end of the report

\*\* Not used for the 100-year comparison, unrealistic 100-year storage volumes.

## RECOMMENDATION

The consultant recommends that Modification 5 or 5A be implemented in the 3207 basin because they can reduce peak flows upstream of Birch Street for the 2-, 5-, and 100-year floods to a similar extent that the selected Master Plan developed in 1979 does. The 1979 Master Plan concentrates flood hazard mitigation efforts at a single detention site located upstream of Ash Street. Consequently, flows upstream of the site are not affected, and while no structures are damaged, road crossing costs are high. Construction of detention ponds at Sites 1 through 7 (excluding Site 2 at Main Street) provides similar flood protection at the 7th Avenue residential area while reducing flows at upstream road crossings. Figures 7, 8 and 9 are graphical representations of the data presented earlier in Tables 2, 3 and 4, respectively. Modification 5 (without storm flow interception at 10th and Ash) will require at least 2.5 acre feet of storage at Site 7 and Modification 5A (with flow interception at 10th and Ash) will require at least 4.5 acre feet of storage at Site 7.

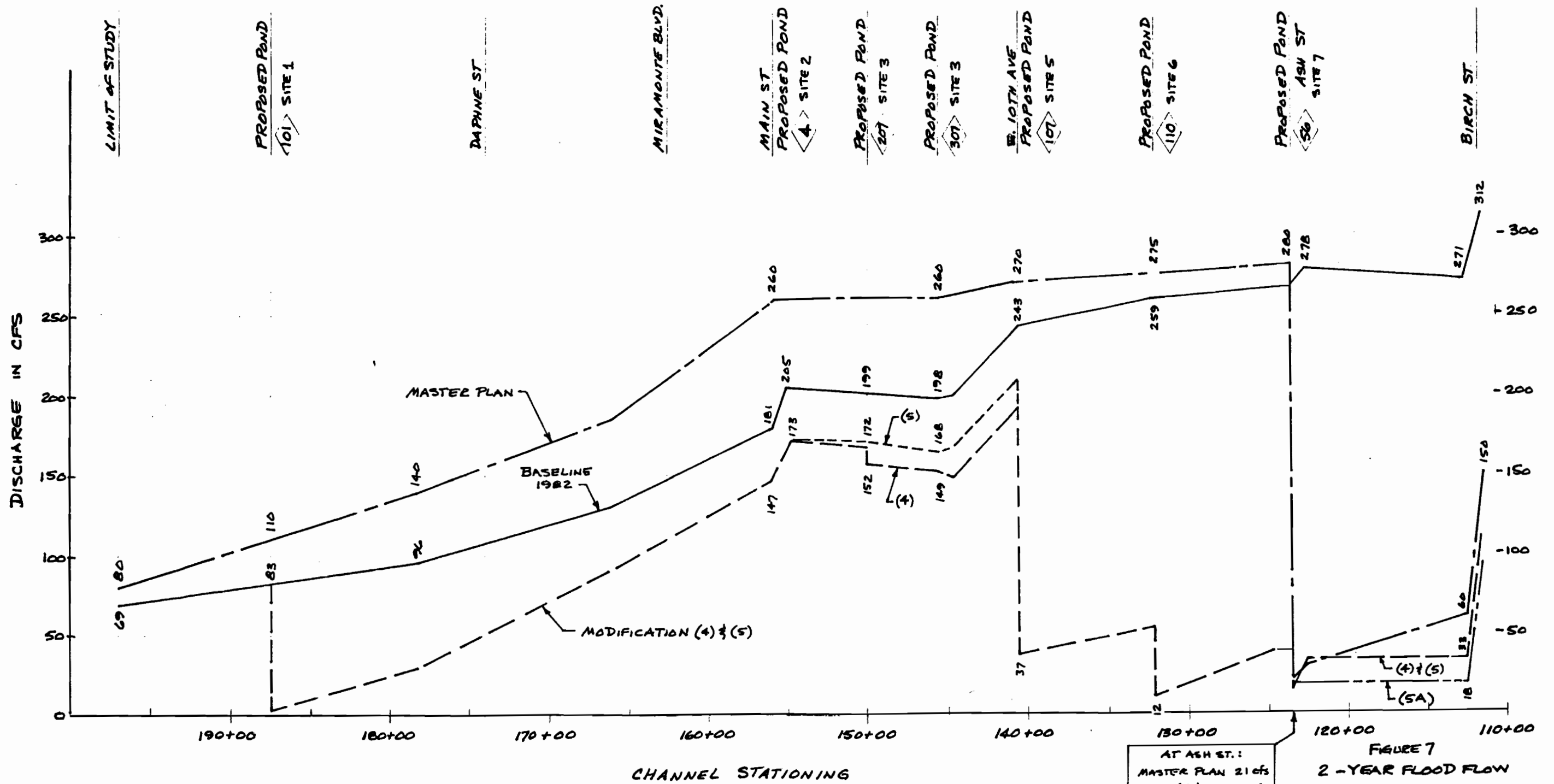
The hydrologic modelling showed that if proposed storm drainage inlets are constructed at the intersection of East 10th Avenue and Ash Street and the collected flows are then routed to Site 7, further reduction of flow can be realized along 7th Avenue for the 2-year and 5-year events (Modification 5A). Downstream of the 7th Avenue area peak flows under Modifications 5 and 5A are similar to the 1979 Master Plan, and it is therefore recommended that the plans and cost estimates for improvements shown in the Master Plan remain the adopted course of action for the basin. For example, at Sheridan Boulevard, a new drop structure and double 10-foot x 6-foot box culvert (\$255,600.00 in 1982 Dollars) are still necessary improvements and an integral part of the overall Master Plan for the basin.

## CAPITAL COSTS

Table 5 presents a summary of preliminary costs for the proposed detention sites. The total estimated cost for construction of Sites 1, 3, 5, 6 and 7 is approximately \$732,500.00 excluding Right-of-Way and Operation and Maintenance costs. This compares favorably with the cost of \$811,150.00 (1979 Dollars) for the single 5-year detention facility in the 1979 Master Plan. While several sites have existing dam embankments, a significant cost is

incurred to renovate or replace pipe and emergency overflow spillways, provide overflow scour protection for the spillways and embankments and to provide seepage control for the old embankments. Costs were estimated assuming that the existing dam embankments are sound and only minor seepage problems exist. Final design of the detention sites should include detailed soils investigations to verify the suitability of existing embankments for detention ponding.

To conclude this study, the consultant has updated the improvement costs presented in the November 1979 Master Plan. Table 6 summarizes the costs of the adopted Master Plan for the 3207 basin with Detention Modification 5 substituted for the original 5-year detention site. The Engineering News Record Construction Cost Index indicates that costs have increased approximately 30 percent since publication of the original Master Plan, and so costs have been adjusted to reflect this increase. Costs also include 30% for engineering and contingencies and 1% for fiscal, legal and administrative expenses. The revised total improvement cost of \$2.3 million can be attributed to the effect of inflation on channel improvement and street crossing costs.



AT ASH ST. :  
 MASTER PLAN 21 cfs  
 MOD. (4) & (5) 15 cfs  
 MOD. (5A) 18 cfs

FIGURE 7  
 2-YEAR FLOOD FLOW  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UD & FCD WME

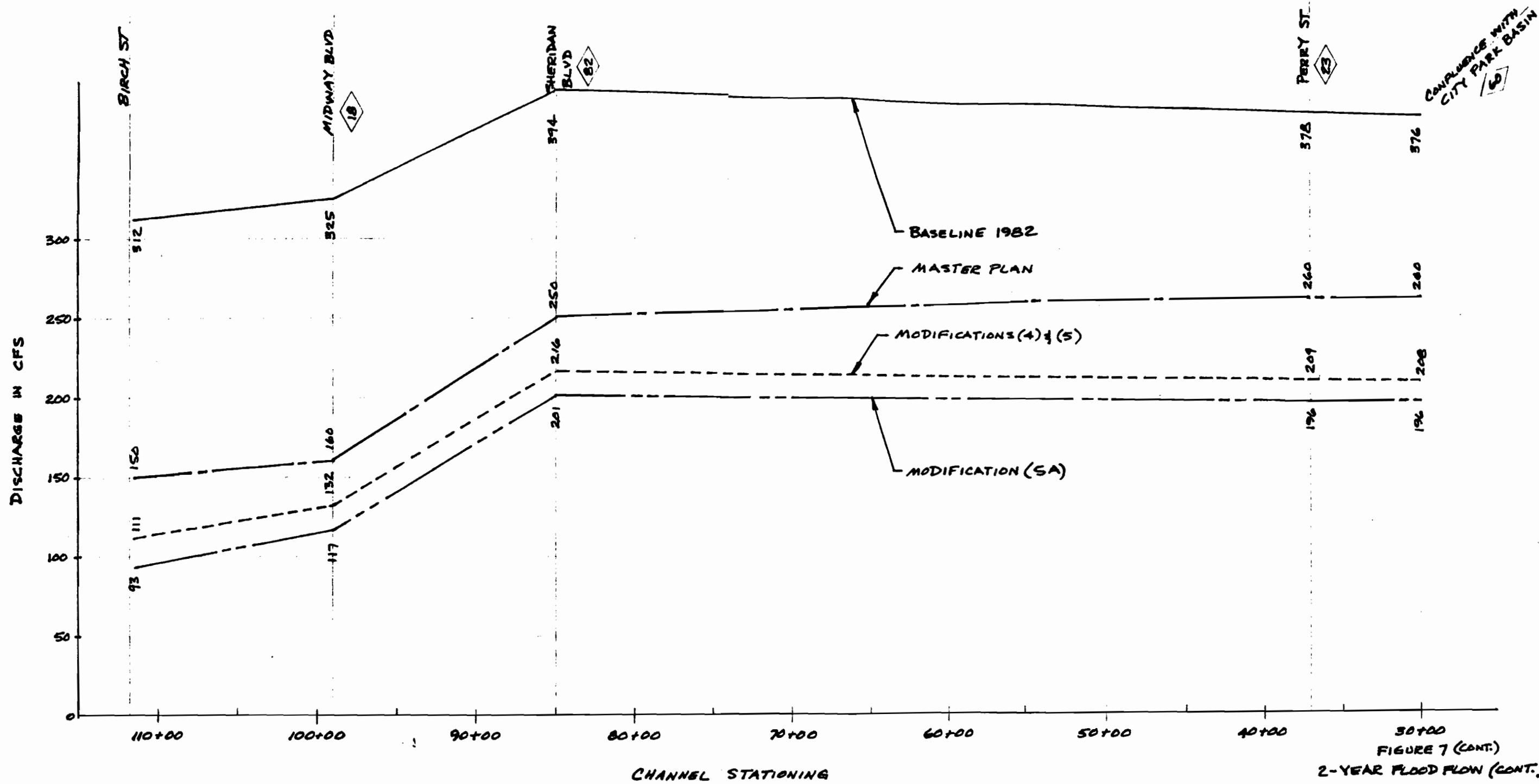
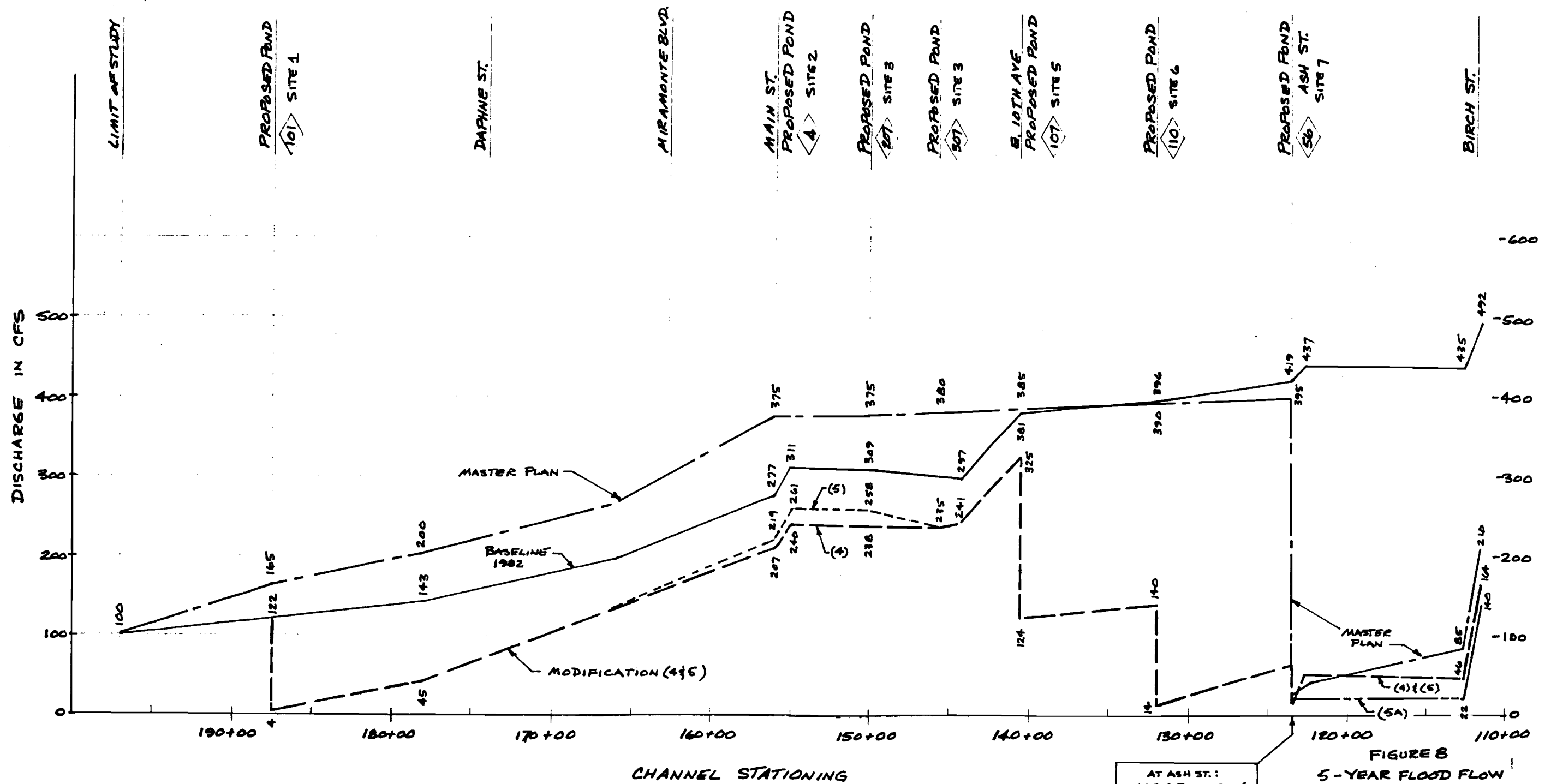


FIGURE 7 (CONT.)  
 2-YEAR FLOOD FLOW (CONT.)  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UD & FCD WME



AT ASH ST.:

MASTER PLAN	30 cfs
MOD. (4) & (5)	17 cfs
MOD. (5A)	22 cfs

FIGURE B  
 5-YEAR FLOOD FLOW  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UD & FCD WME

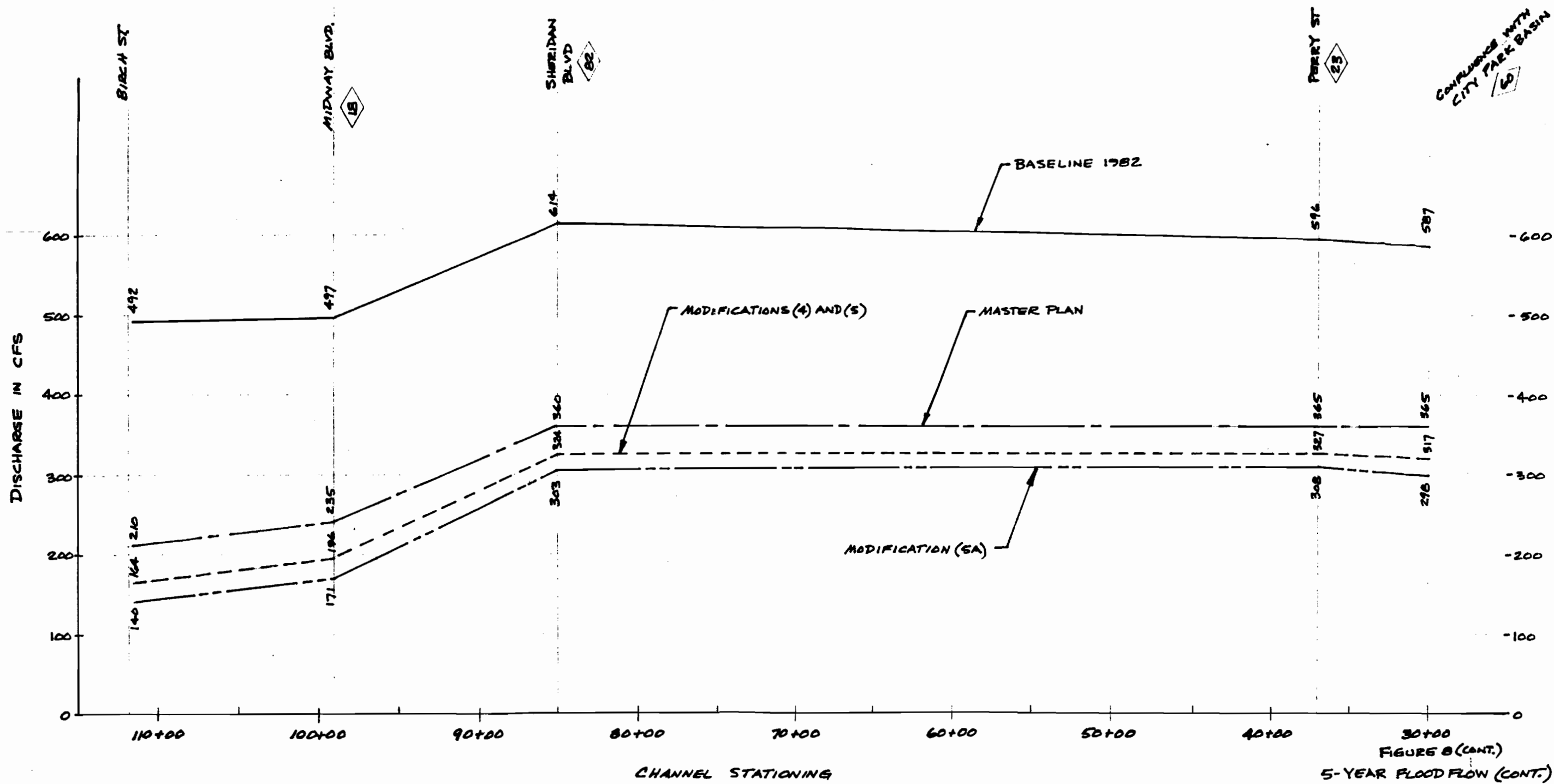


FIGURE B (CONT.)  
 5-YEAR FLOOD FLOW (CONT.)  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UD&FCD WME

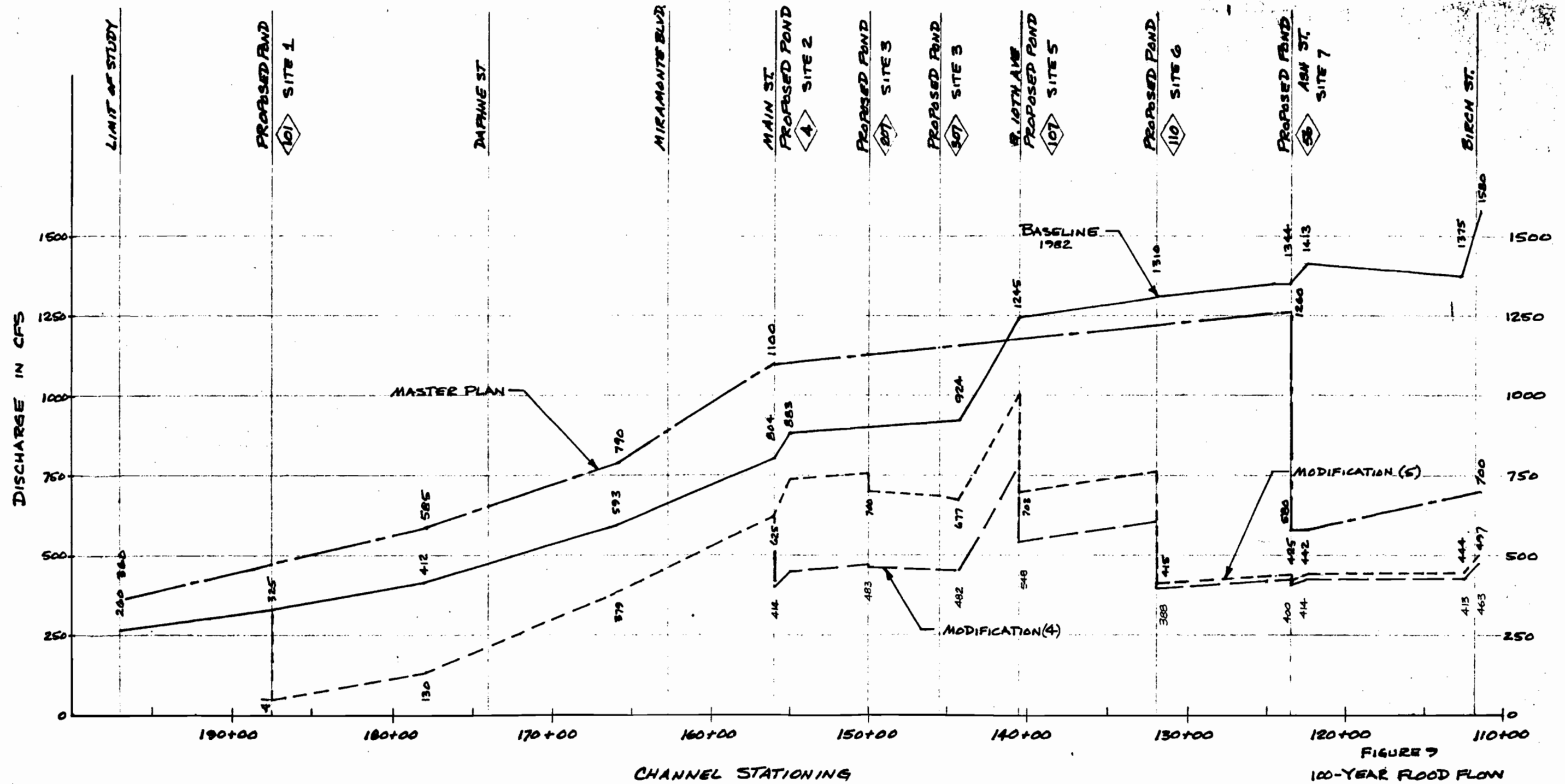


FIGURE 7  
 100-YEAR FLOOD FLOW  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UDC&PCD WME

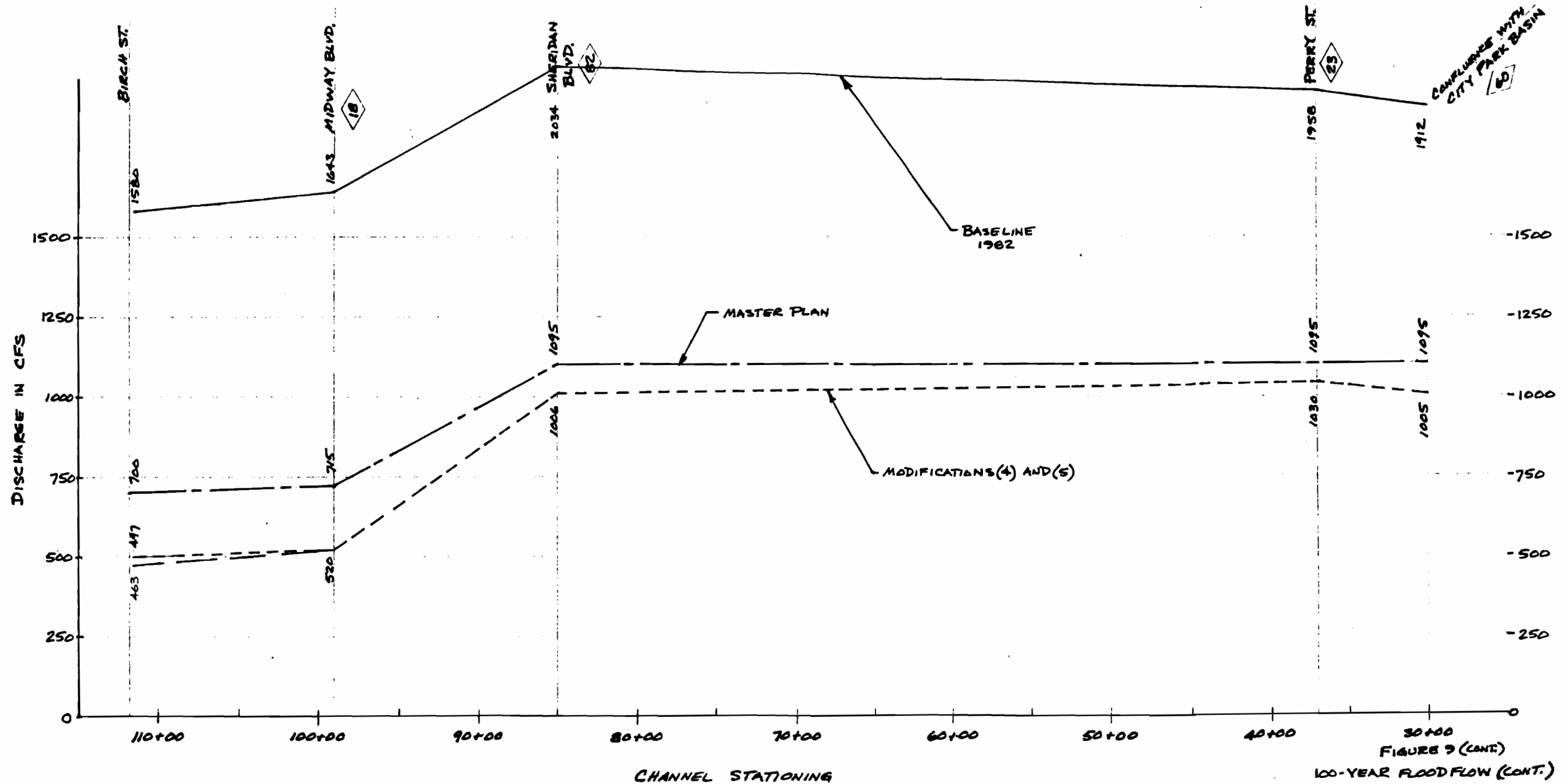


FIGURE 9 (CONT.)  
 100-YEAR FLOODFLOW (CONT.)  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UD&FCD WME

TABLE 5  
SUMMARY OF ESTIMATED DETENTION POND COSTS

	Pond Site 1	Pond Site 2	Pond Site 3	Pond Site 4	Pond Site 5	Pond Site 6	Pond Site 7
Earthwork	\$ 14,050	\$ 16,200	\$ 3,850	-	\$ 30,000	\$ 9,000	\$ 16,600
Pipe Spillway	10,000	existing	15,000	-	1,800	10,000	-
Emergency Spillway & Downstream Face Protection	129,700	92,600	11,200	-	37,100	92,600	37,100
Seeding	12,600	4,500	9,600	-	5,400	5,000	3,600
Other	-	-	-	-	48,000**	10,000***	-
Subtotal	\$166,350	\$113,300	\$ 39,650	-	\$122,300	\$126,600	\$ 57,300
30% Engineering and Contingencies	49,900	34,000	11,900	-	36,700	37,900	17,200
10% Fiscal Legal and Administrative	21,650	14,700	5,150	-	16,000	16,400	7,500
TOTAL*	\$237,900	\$162,000	\$ 56,700	-	\$175,000	\$180,900	\$ 82,000

\* Excludes Property Acquisition Costs and O&M Costs

\*\* Cost of Relocating approximately 800 L.F. of the Equity Ditch in a 30-inch RCP

\*\*\* Possible need for seepage control

TABLE 6  
SUMMARY OF REVISED TOTAL COSTS

MAJOR DRAINAGEWAY PLAN  
WITH DETENTION ALTERNATIVE 5  
DIRECT FLOW AREA 3207

Plan & Profile Sheet Number	Channel Improvements Costs	Detention Costs	Street Crossing Costs	Utility Relocation Costs	Property Acquisition Costs*	Total Improvement Costs**	Annual Maintenance Cost
1	\$ 18,600	\$ 237,900	0	0	0	\$ 256,500	\$ 1,000
2			\$ 256,550	\$ 9,300	\$ 2,700	\$ 268,550	\$ 450
3	0	0	0	0	0	0	\$ 1,850
4	0	\$ 412,600	\$ 40,000 <sup>+</sup>	\$ 24,550	0	\$ 477,150	\$ 3,000
5	0	\$ 82,000	0	0	0	\$ 82,000	\$ 1,000
6	0	0	\$ 255,600	\$ 3,700	\$ 12,400	\$ 271,700	\$ 1,100
7	\$ 200,950	0	0	0	\$ 12,400	\$ 213,350	\$ 1,100
8	\$ 61,800	0	\$ 174,750	\$ 7,450	\$ 43,550	\$ 287,550	\$ 1,450
9	<u>0</u>	<u>0</u>	<u>\$ 399,700</u>	<u>\$ 3,700</u>	<u>\$ 32,250</u>	<u>\$ 435,650</u>	<u>\$ 2,750</u>
	\$ 281,350	\$ 732,500	\$1,126,600	\$ 48,700	\$ 103,300	\$2,292,450	\$ 13,700

\* Property acquisition costs are not included for detention sites since these sites are already City-owned or will be dedicated to the City.

\*\* Includes costs for construction, engineering, contingencies, fiscal, legal and administrative expenses. Costs for items other than detention costs have been increased by 30% to account for the effect of inflation since the November 1979 Master Plan Report.

+ Estimated cost for replacement pipeline under W. 10th Avenue. Size to be determined during final design of Site 5.

PART 11

DECEMBER 1982 ADDENDUM

## REPORT ADDENDUM

Following review of this report by the City of Broomfield and the Urban Drainage and Flood Control District, it was determined that additional analyses were necessary to address the following conditions:

1. All existing and committed on-site detention ponds should be included in the hydrologic basin model.
2. The effect of Brunner Reservoir on peak flows in the lower basin should be examined.

A series of SWMM computer runs were identified to evaluate the hydrologic response of the 3207 drainageway for two new baseline conditions with four alternates under each baseline. The basic modified baseline condition included the following:

1. Elimination of Pond Site 1 at the upper end of the basin and substitution of the existing and proposed Ridgeview Heights detention ponds.
2. Pond Sites 2, 3, 4 and 5 remain as defined in this report.
3. Removal of Pond Sites 6 and 7.
4. Addition of existing and committed detention ponds in the basin as identified by the City of Broomfield. Two sites were added to the model; an existing pond west of Main Street serving the Gate 'n Green subdivision and a future on-site pond (2AF<sup>±</sup>) anticipated to serve a future filing (model sub-basin 97) in the Broomfield Country Club area just north of Pond Site 5.

The hydrologic response for the 2-, 5- and 100-year design storm events was modeled using the SWMM model and the modified baseline condition for the following alternates:

Case I - Modified Baseline with Brunner Reservoir in place.

Alternate IA: Do nothing (i.e., baseline run with Brunner Reservoir).

Alternate IB: Detention at Site 6 with dam elevation at 5337.9 (Modification 4 in July report) and detention at Site 7 using Modification 5A described in July report.

Alternate IC: Detention at Site 6 only (remove Site 7).

Alternate ID: Detention at Site 7 only (remove Site 6).

Case II - Modified Baseline with Brunner Reservoir removed.

Alternate IIA: Do nothing (i.e., baseline run).

Alternate IIB: Same detention as in Alternate IB.

Alternate IIC: Same detention as in Alternate IC.

Alternate IID: Same detention as in Alternate ID.

Table 7 summarizes the hydraulic characteristics for the additional sites modeled for the above alternates. Tables 8, 9, and 10 list the results of the alternate schemes for the 2-, 5-, and 100-year events, respectively.

Having reviewed the results of these alternates, the Consultant can make the following comments and recommendations:

1. It appears that the existing and proposed detention sites at the Ridgeview Heights Subdivision are not as effective in reducing flows immediately downstream (Daphne Street/Miramonte Blvd. area) as Pond 1

TABLE 7  
SUMMARY OF POND HYDRAULIC CHARACTERISTICS FOR ADDITIONAL SITES

Pond Site No.	Type	Pipe Spillway Size	Maximum Discharge Thru Pipe Spillway	Available Storage At Elevation of Overflow Spillway	Residual Storage Above Overflow Spillway	Overflow Spillway Capacity
Brunner Reservoir	Wet	N/A	N/A	1.1 AF @ 5314.5*	19.3 AF between 5314.5 & 5316.1	1000 cfs @ 5316.1
Ridgeview Heights Ponds	Dry	3-12" CMP	37 cfs	8 AF + @ 5416	not determined	spills into community ditch
Gate 'n Green Detention Pond	Wet	2-18" RCP	16 cfs	1.9 AF @ 5410 **	2.8 AF between 5410 and 5412	2850 cfs @ 5412
Future Filing Sub-basin 97	Dry	Volume vs outflow curve developed using "Development of Simplified Detention Sizing Relationships" by Urbonas and Glidden. $V_{max} = 1.74$ AF with $Q_{max} = 29.2$ cfs				

\* 200 foot spillway length  
\*\* 400 foot spillway length

described in the July report. This is due to the fact that the Ridgeview Heights ponds do not serve sub-basin 3 (27 acres), southwest of the subdivision. Assuming that sub-basin 3 would be served by its own on-site detention when it is developed, the elimination of Pond 1 appears feasible. It should be noted that the 100-year routing through the Ridgeview Heights ponds filled the ponds to the crest and resulted in a small amount of overflow into the Community Ditch. It is obvious that a minor amount of debris could greatly effect the performance of the ponds' pipe spillways, which are 12-inch diameter pipes, and could result in a large overflow into Community Ditch and subsequent flooding elsewhere. Priority should be placed on maintenance of the pond spillways and a flow separation structure at the ditch (refer also to the Master Plan).

2. Brunner Reservoir does not have a significant effect on peak flows downstream, particularly at the Sheridan Boulevard crossing, and therefore does not warrant the expenditure of funds for spillway improvements.
3. The Consultant recommends the implementation of Alternate IIB as the best detention plan for the 3207 basin. This plan utilizes both Pond Sites 6 and 7 between East 10th Avenue and Ash Street. Alternate IIB was the only alternate studied that prevented future 2- and 5-year flows from overtopping and flowing down East 7th Avenue. However, if for some reason Site 6 was eliminated, then Alternate IID, which utilizes only Site 7 upstream of Ash Street, should be implemented. Under Alternate IID, the final design for Pond Site 7 should include examination of increasing the storage volume at the site. Our investigations indicate that a small increase in volume may enable Site 7 to control overtopping for a 2-year event, but that a significant volume increase would be required for control of 5-year storm flows.

Graphical plottings of the alternate detention plans are presented in Figures 10, 11 and 12 for the 2-, 5-, and 100-year events respectively.

TABLE 8  
DIRECT FLOW AREA 3207  
SUMMARY OF COMPUTER RESULTS  
2-YEAR STORM  
(Values in Cubic Feet Per Second)

Location	End of Link*	Modified Baseline	With Brunner Reservoir				Brunner Reservoir Removed			
			IA	IB	IC	ID	IIA	IIB	IIC	IID
Ridgeview Heights Ponds	187	15	15	15	15	15	15	15	15	15
	87	15	15	15	15	15	15	15	15	15
	101	30	30	30	30	30	30	30	30	30
Daphne Street	1	47	47	47	47	47	47	47	47	47
	2	70	70	70	70	70	70	70	70	70
Miramonte Blvd.	86	98	98	98	98	98	98	98	98	98
Main St./Pond Site 2	4	127	127	127	127	127	127	127	127	127
	85	153	153	153	153	153	153	153	153	153
Pond Site 3	207	150	150	150	150	150	150	150	150	150
Pond Site 3	307	138	138	138	138	138	138	138	138	138
	7	144	144	144	144	144	144	144	144	144
	6	11	11	11	11	11	11	11	11	11
	97	13	13	13	13	13	13	13	13	13
Pond Site 5	107	50	50	50	50	50	50	50	50	50
Pond Site 6	110	50	50	13	13	50	50	13	13	50
	10	63	63	40	40	63	63	40	40	63
	11	26	26	26	26	26	26	26	26	26
Pond Site 7	56	89	89	18	66	42	89	18	66	42
Ash Street	84	90	90	18	67	42	90	18	67	42
	12	81	81	18	57	40	81	18	57	40
Birch Street	83	150	150	93	131	95	150	93	131	95
Midway Blvd.	18	173	173	117	155	118	173	117	155	118
	90	183	183	130	165	131	183	130	165	131
	81	52	26	26	26	26	52	52	52	52
	21	72	40	40	40	40	72	72	72	72
Sheridan Blvd.	82	255	222	168	204	169	255	201	237	202
	22	245	217	175	203	176	245	202	230	203
Perry Street	23	238	213	171	198	173	238	196	223	197
Confluence w/City Park Basin	60	237	211	170	197	171	237	196	223	197

\* Refer to Basin Map (Exhibit 1) at the end of the report.

TABLE 9  
DIRECT FLOW AREA 3207  
SUMMARY OF COMPUTER RESULTS  
5-YEAR STORM  
(Values in Cubic Feet Per Second)

Location	End of Link*	Modified Baseline	With Brunner Reservoir				Brunner Reservoir Removed			
			IA	IB	IC	ID	IIA	IIB	IIC	IID
Ridgeview Heights Ponds	187	21	21	21	21	21	21	21	21	21
	87	21	21	21	21	21	21	21	21	21
	101	45	45	45	45	45	45	45	45	45
Daphne Street	1	70	70	70	70	70	70	70	70	70
	2	104	104	104	104	104	104	104	104	104
Miramonte Blvd.	86	149	149	149	149	149	149	149	149	149
Main St./Pond Site 2	4	193	193	193	193	193	193	193	193	193
	85	235	235	235	235	235	235	235	235	235
Pond Site 3	207	229	229	229	229	229	229	229	229	229
Pond Site 3	307	213	213	213	213	213	213	213	213	213
	7	217	217	217	217	217	217	217	217	217
	6	16	16	16	16	16	16	16	16	16
	97	14	14	14	14	14	14	14	14	14
Pond Site 5	107	127	127	127	127	127	127	127	127	127
Pond Site 6	110	133	133	25	25	133	133	25	25	133
	10	135	135	59	59	135	135	59	59	135
	11	38	38	38	38	38	38	38	38	38
Pond Site 7	56	141	141	22	98	138	141	22	98	138
Ash Street	84	141	141	22	99	138	141	22	99	138
	12	142	142	22	82	137	142	22	82	137
Birch Street	83	234	234	140	204	152	234	140	204	152
Midway Blvd.	18	263	263	171	233	172	263	171	233	172
	90	269	269	192	242	193	269	192	242	193
	81	81	43	43	43	43	81	81	81	81
	21	113	67	67	67	67	113	113	113	113
Sheridan Blvd.	82	378	336	254	307	255	378	303	353	304
	22	374	337	268	313	269	374	304	350	306
Perry Street	23	375	335	269	313	271	375	308	352	309
Confluence w/City Park Basin	60	364	329	264	307	265	364	298	341	299

\* Refer to Basin Map (Exhibit 1) at the end of the report.

TABLE 10  
DIRECT FLOW AREA 3207  
SUMMARY OF COMPUTER RESULTS  
100-YEAR STORM  
(Values in Cubic Feet Per Second)

Location	End of Link*	Modified Baseline	With Brunner Reservoir				Brunner Reservoir Removed			
			IA	IB	IC	ID	IIA	IIB	IIC	IID
Ridgeview Heights Ponds	187	37	37	37	37	37	37	37	37	37
	87	37	37	37	37	37	37	37	37	37
	101	125	125	125	125	125	125	125	125	125
Daphne Street	1	217	217	217	217	217	217	217	217	217
	2	322	322	322	322	322	322	322	322	322
Miramonte Blvd.	86	440	440	440	440	440	440	440	440	440
Main St./Pond Site 2	4	590	590	590	590	590	590	590	590	590
	85	688	688	688	688	688	688	688	688	688
Pond Site 3	207	707	707	707	707	707	707	707	707	707
Pond Site 3	307	658	658	658	658	658	658	658	658	658
	7	652	652	652	652	652	652	652	652	652
	6	59	59	59	59	59	59	59	59	59
	97	26	26	26	26	26	26	26	26	26
Pond Site 5	107	688	688	688	688	688	688	688	688	688
Pond Site 6	110	738	738	469	469	738	738	469	469	738
	10	754	754	478	478	754	754	478	478	754
	11	105	105	105	105	105	105	105	105	105
Pond Site 7	56	786	786	496	496	756	786	496	496	756
Ash Street	84	785	785	495	496	765	785	495	496	765
	12	745	745	495	493	769	745	495	493	769
Birch Street	83	837	837	547	602	846	837	547	602	846
Midway Blvd.	18	874	874	553	632	811	874	553	632	811
	90	872	872	571	750	851	872	571	750	851
	81	250	143	143	143	143	250	250	250	250
	21	366	239	239	239	239	366	366	366	366
Sheridan Blvd.	82	1205	1078	802	981	1036	1205	938	1118	1010
	22	1214	1106	889	1020	1043	1214	1002	1132	1066
Perry Street	23	1173	1099	885	1006	1041	1173	993	1109	1054
Confluence w/City Park Basin	60	1179	1089	881	990	1037	1179	982	1088	1054

\* Refer to Basin Map (Exhibit 1) at the end of the report.

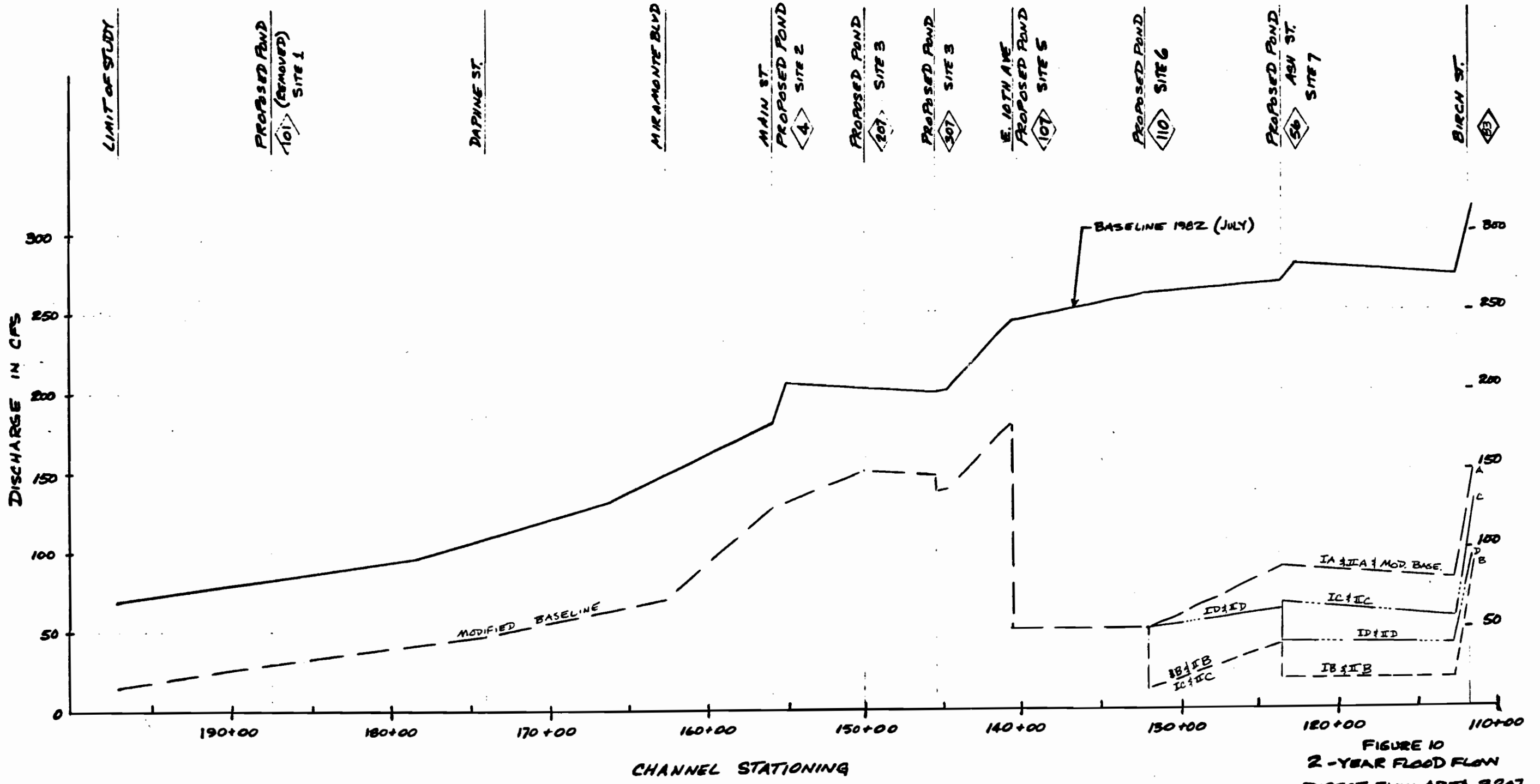


FIGURE 10  
 2-YEAR FLOOD FLOW  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UD&FCD WME

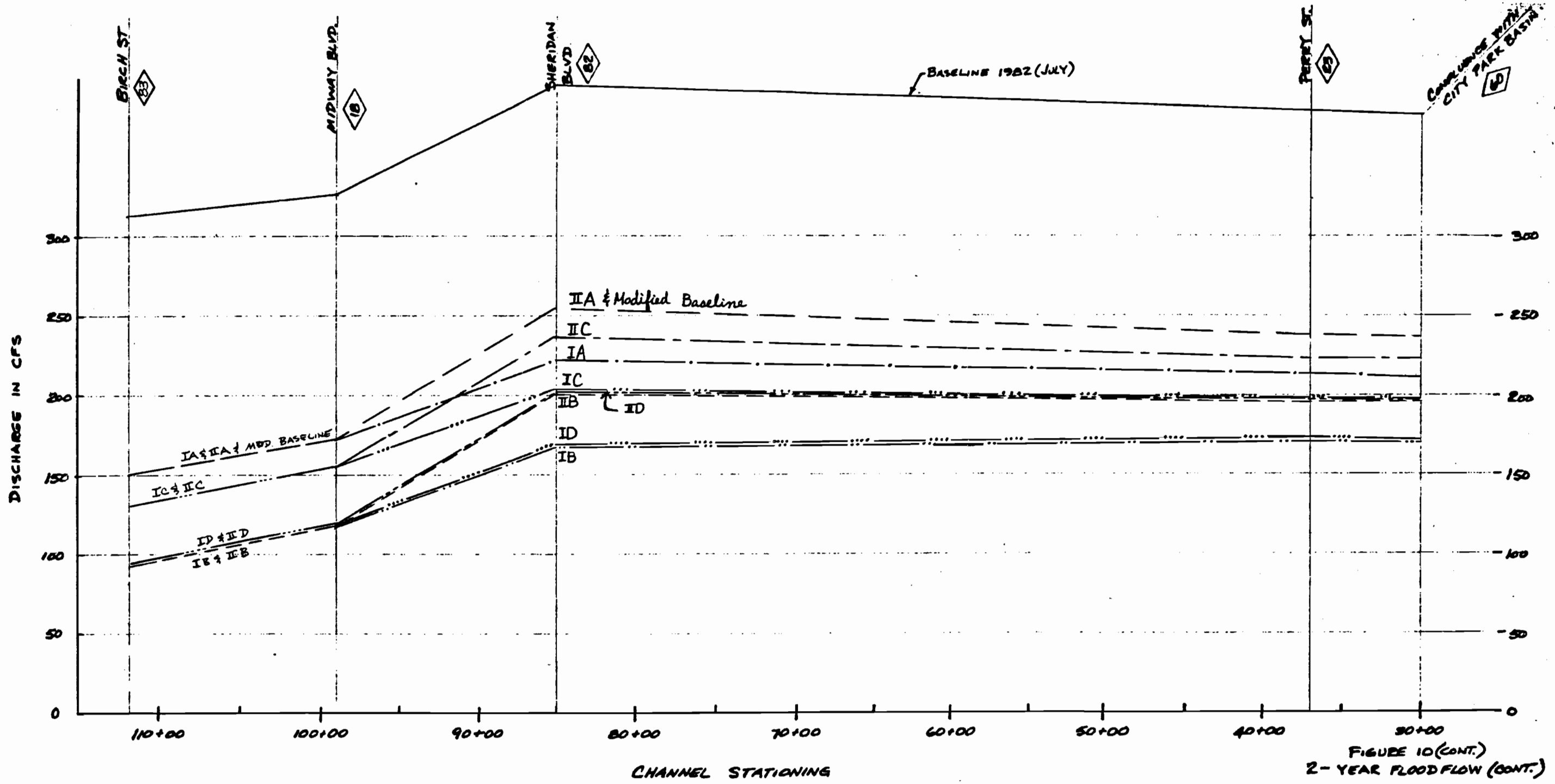


FIGURE 10 (CONT.)  
 2-YEAR FLOOD FLOW (CONT.)  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UDE/FCO WME

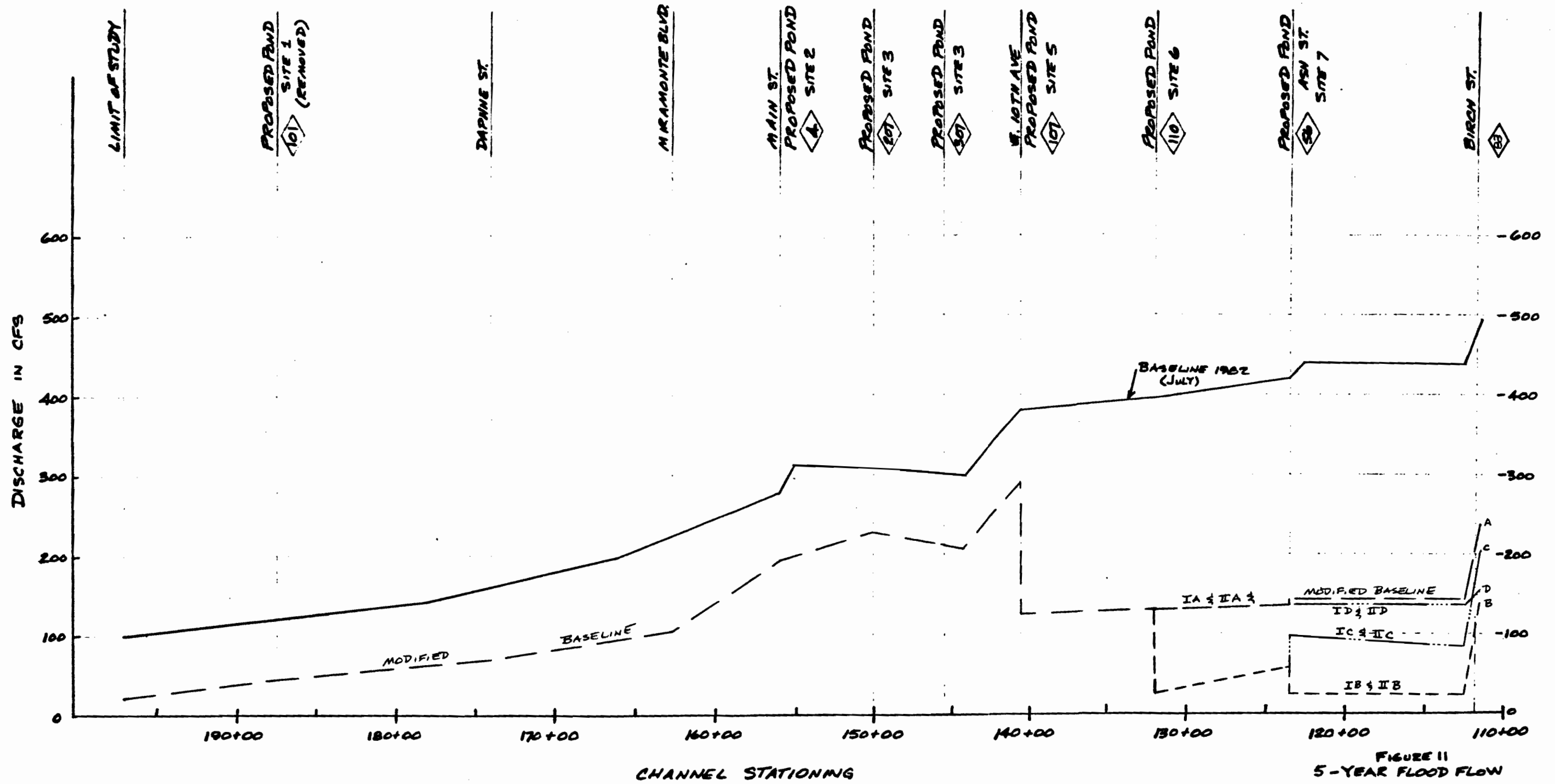


FIGURE 11  
 5-YEAR FLOOD FLOW  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UD & FCD WME

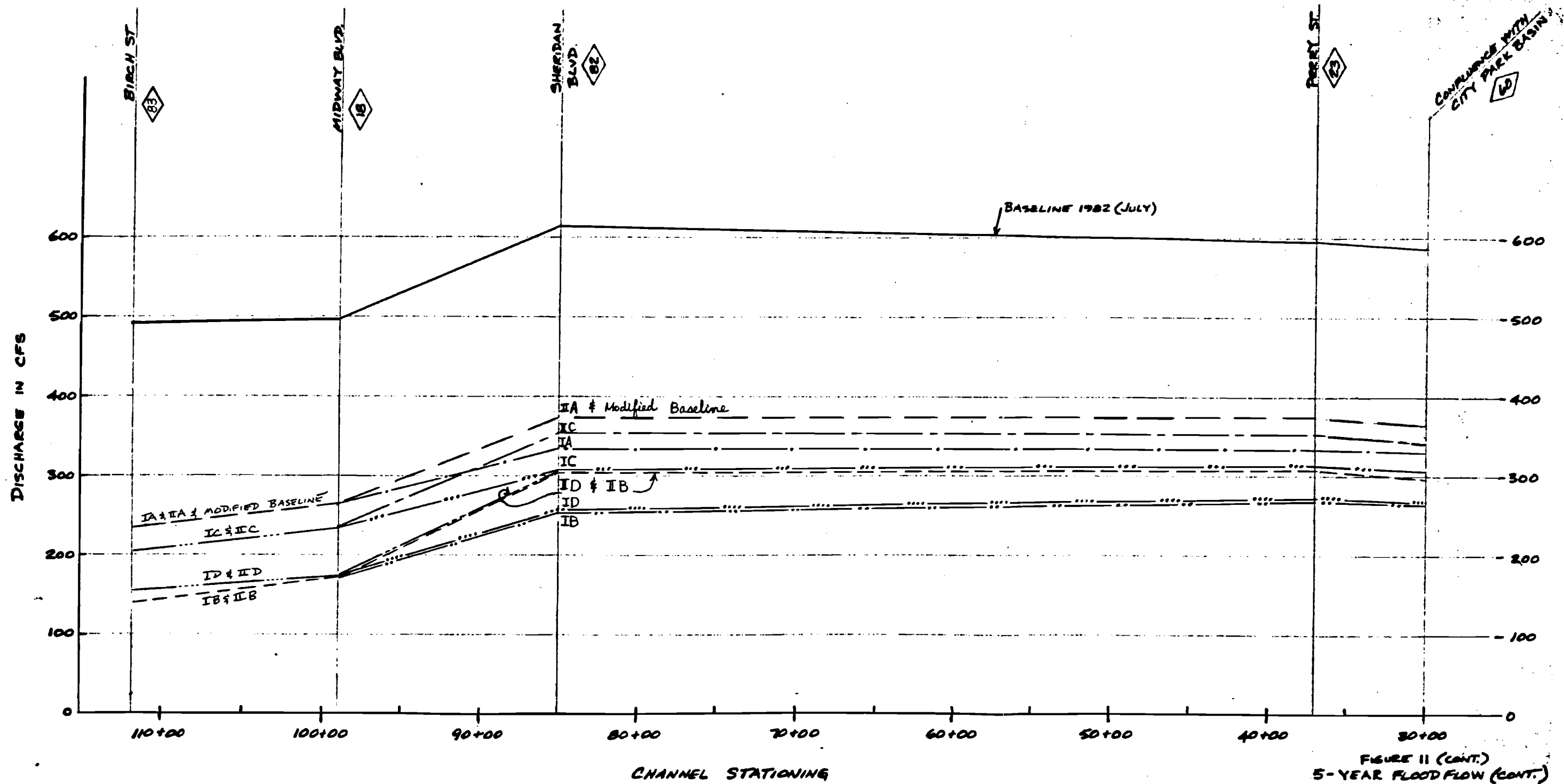


FIGURE 11 (CONT.)  
 5-YEAR FLOOD FLOW (CONT.)  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UD&FCD WME

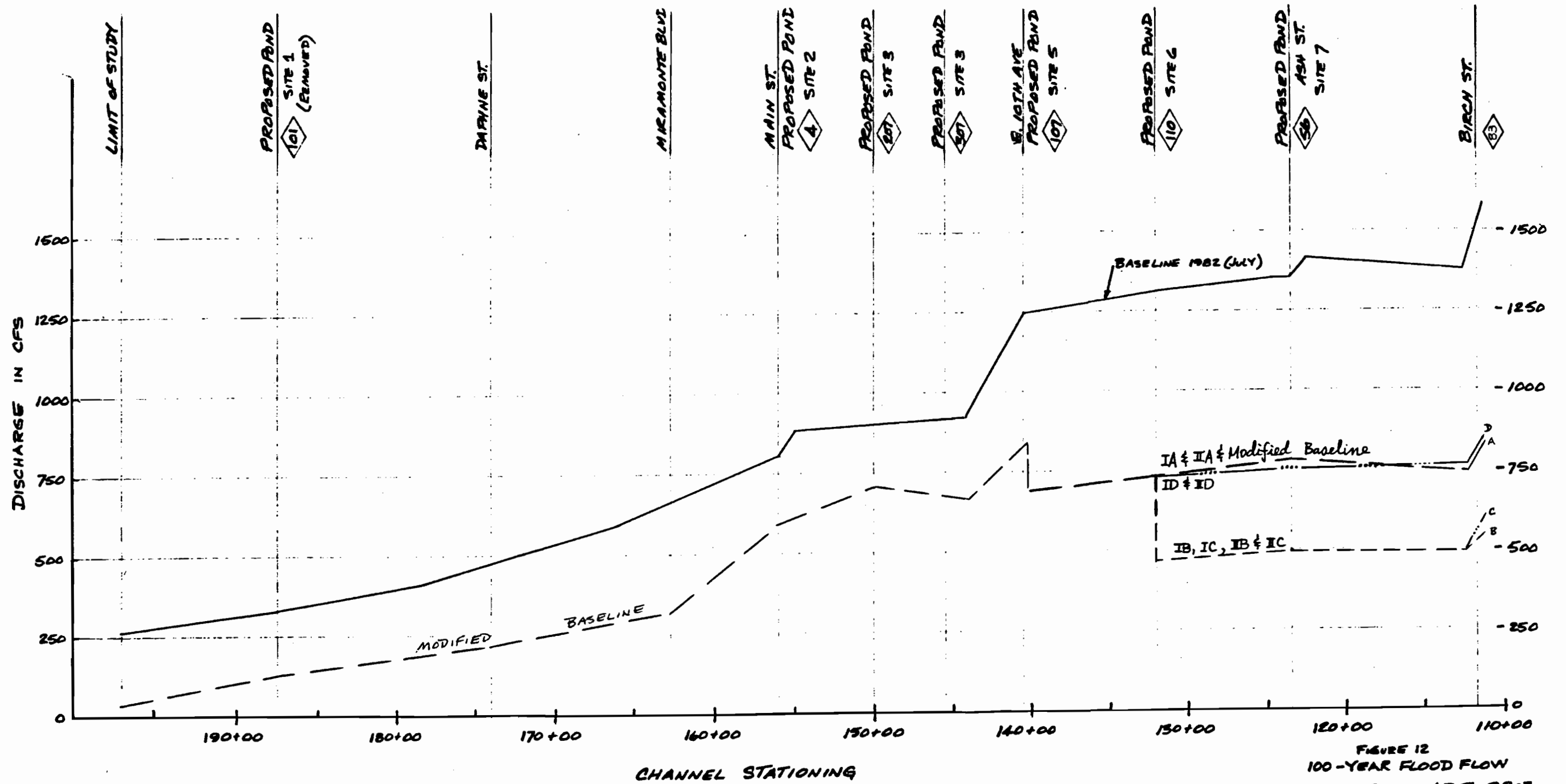


FIGURE 12  
 100-YEAR FLOOD FLOW  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UD & FED WME

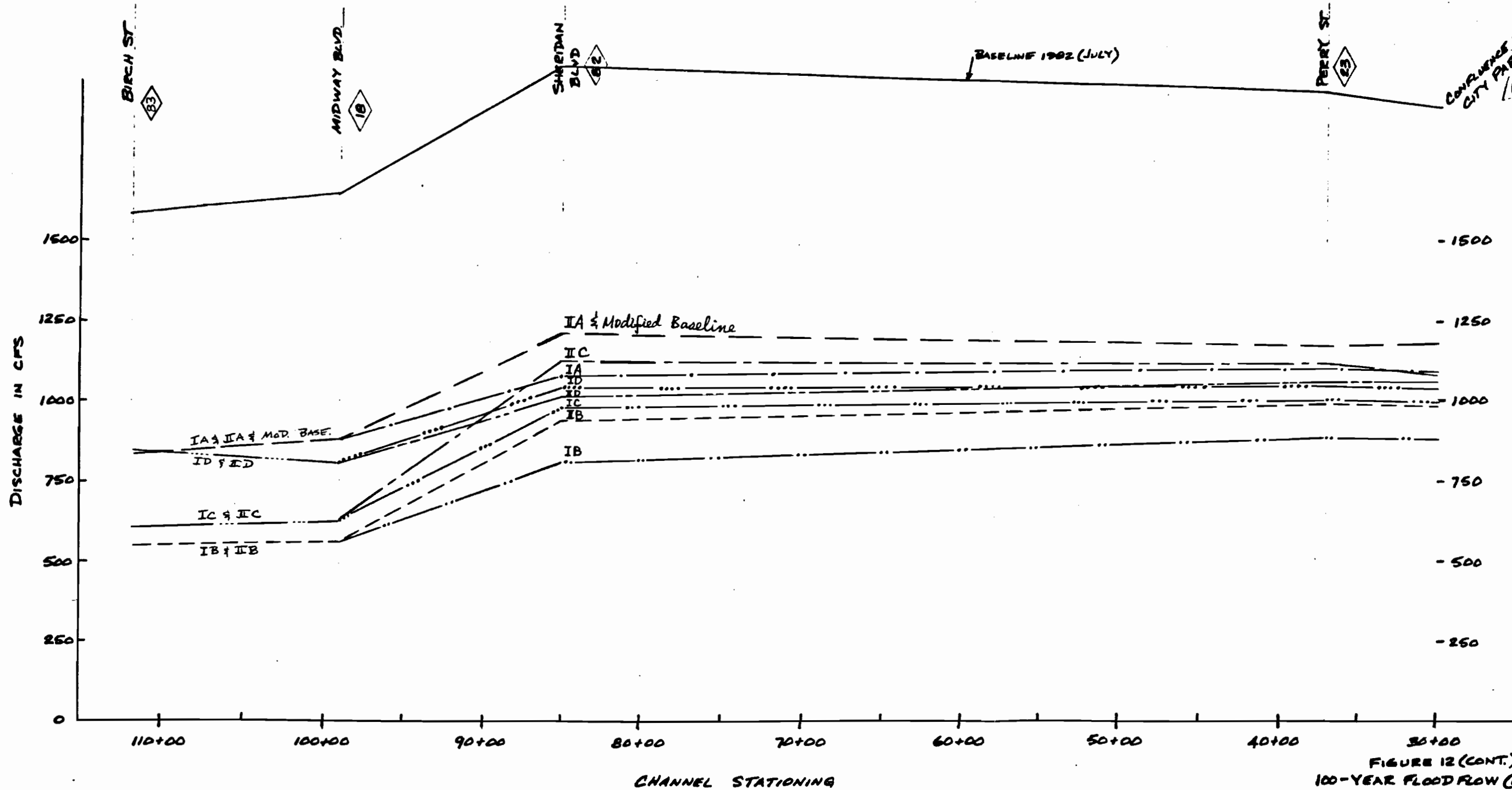


FIGURE 12 (CONT.)  
 100-YEAR FLOOD FLOW (CONT.)  
 DIRECT FLOW AREA 3207  
 CITY OF BROOMFIELD  
 UD & FCD WME

