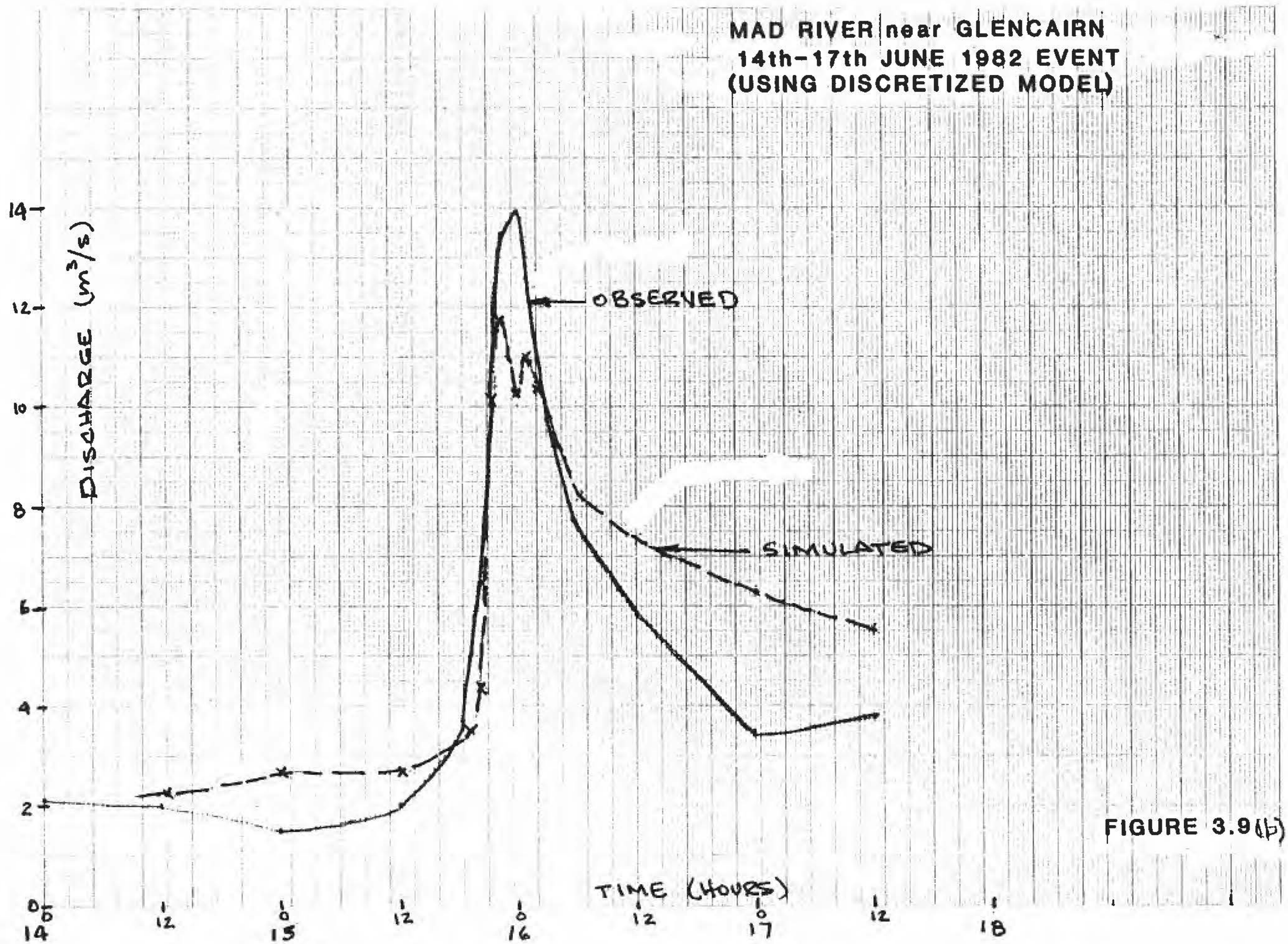

MAD RIVER near GLENCAIRN
14th-17th JUNE 1982 EVENT
(USING DISCRETIZED MODEL)
OBSERVED
SIMULATED
DISCHARGE (m^3/s)
TIME (HOURS)
14
12
10
8
6
4
2
0
0
12
0
12
0
12
0
12
14
15
16
17
18

FIGURE 3.9(b)

WILLOW CREEK above LITTLE LAKE

27th-30th JULY 1980 EVENT
(USING DISCRETIZED MODEL)

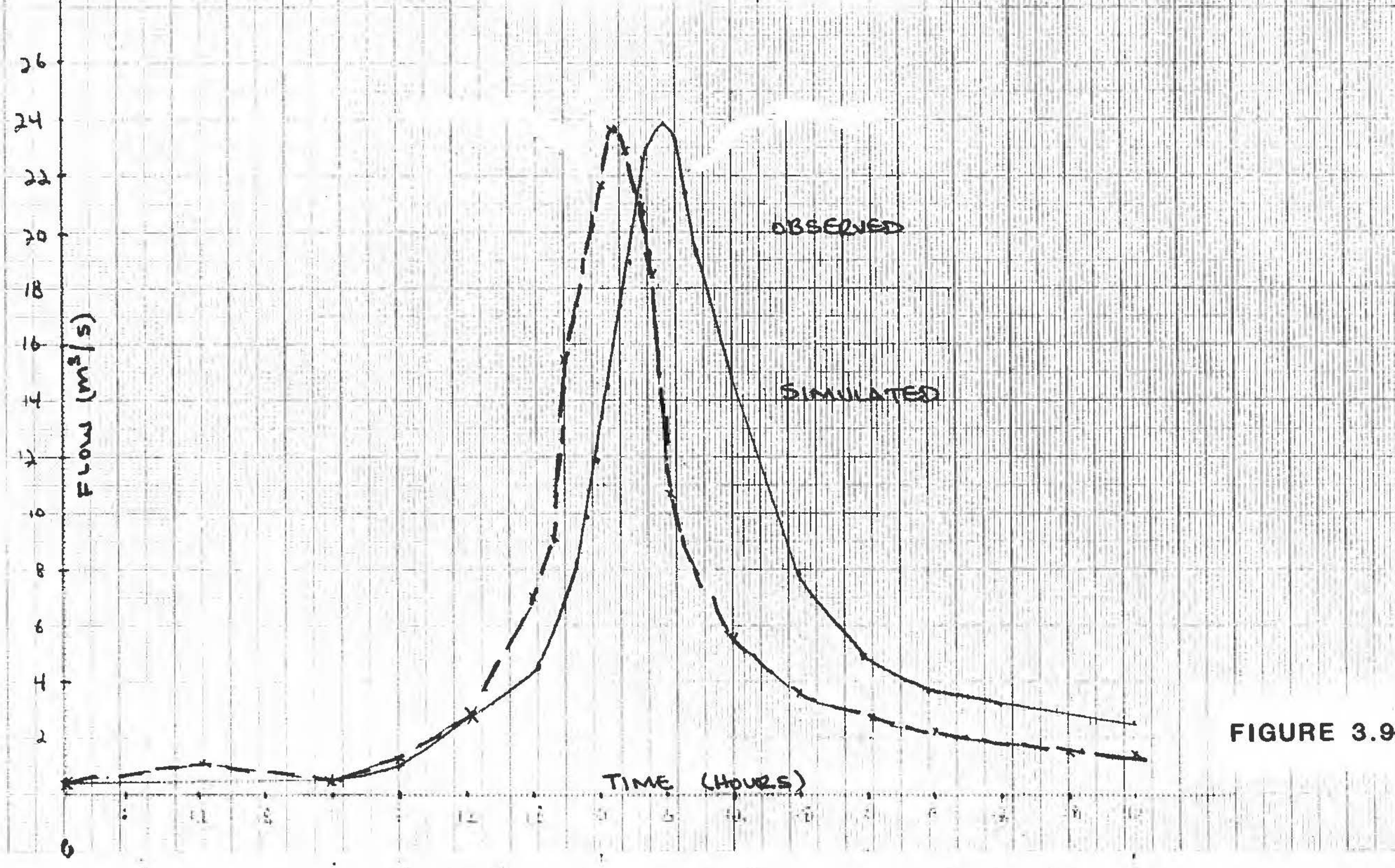


FIGURE 3.9(a)

Initial simulations produced notable discrepancies with recorded flows during a number of years for the Boyne River at Earl Rowe Park and Nottawasaga River at Baxter.

It was found that for most of the events the best overall results were obtained when the SI value was reduced to 64 mm (2.5") for these two sub-catchments. As a result of the above investigation, the following parameters were used:

i) All areas tributary to the Nottawasaga River near Baxter

SI = 64 mm (2.5")	MFMAX = 0.005
UADJ = 0.057	MFMIN = 0.0018

ii) Pine River, Mad River and Willow Creek

The same parameter values as above were used except SI was left at 127 mm (5").

Further analysis indicated that refinement in the value of some parameters was required to achieve a reasonable computation of spring flows during 1971, 1975, 1977, 1978 and 1982. These are described for each year in the following text.

The event that occurred on April 13, 1971, was primarily a snowmelt event but 5-10 mm of rainfall did fall over a two day period. It was found that in order to reduce the simulated peak at Baxter, the maximum melt factor (MFMAX) had to be increased to 0.009. Increasing the melt factor was felt to be a reasonable strategy since the event occurred in the middle of April. The above strategy produced reasonable results for most of the hydrometric stations except for the Mad River at Glencairn where the simulated peak was about five times the observed peak. The model seemed to accumulate more snowpack than was likely to exist in the Mad River catchment. However, there were no snow course data in the area in 1971 to check the simulated snowpack amounts. Increasing the minimum melt factor (MFMIN) to the upper limit of 0.0035 reduced the simulated peak to 113 m^3/s as compared with 37.9 m^3/s observed. As a result of the inconsistency encountered, the 1971 event for the Mad River was not plotted in the scatter diagram nor included in the frequency analysis.

The event that occurred on April 19-20, 1975, was primarily a rainfall event with 16.7 to 36.1 mm of rainfall recorded within the NVCA. Although the snowpack had disappeared by the first week in April, the model indicates that when the rainfall occurred there was still snow on the ground. In order to reduce the simulated peaks it was found necessary to reduce the snowmelt contributing to the peak. To achieve this, it was required to increase MFMIN to 0.0035 and MFMAX to 0.009. No change was made to the SI parameter.

The events that occurred in 1977, 1978 and 1982 were all primarily rainfall on snowmelt events. The 1977 event occurred in the second week in March, the 1978 event in middle of April and the 1982 event at the end of March. As was the case with the 1971 and 1975 events, adjustments to the melt factors were required for the 1977, 1978 and 1982 events. For the 1977 and 1978 events, MFMIN and MFMAX were increased to 0.0035 and 0.009, respectively. For the 1982 event the MFMIN was left at 0.0018 and the MFMAX was increased to 0.009. No changes to the SI parameters were required.

The scatter diagrams for the various hydrometric stations are presented in Figures 3.10(a) to 3.10(d).

As a further check on the accuracy of the QUALHYMO simulation of annual instantaneous peak flows, frequency analyses using the three parameter log normal and the Wakeby distributions were carried out by Environment Canada on behalf of the consultant using the following four conditions:

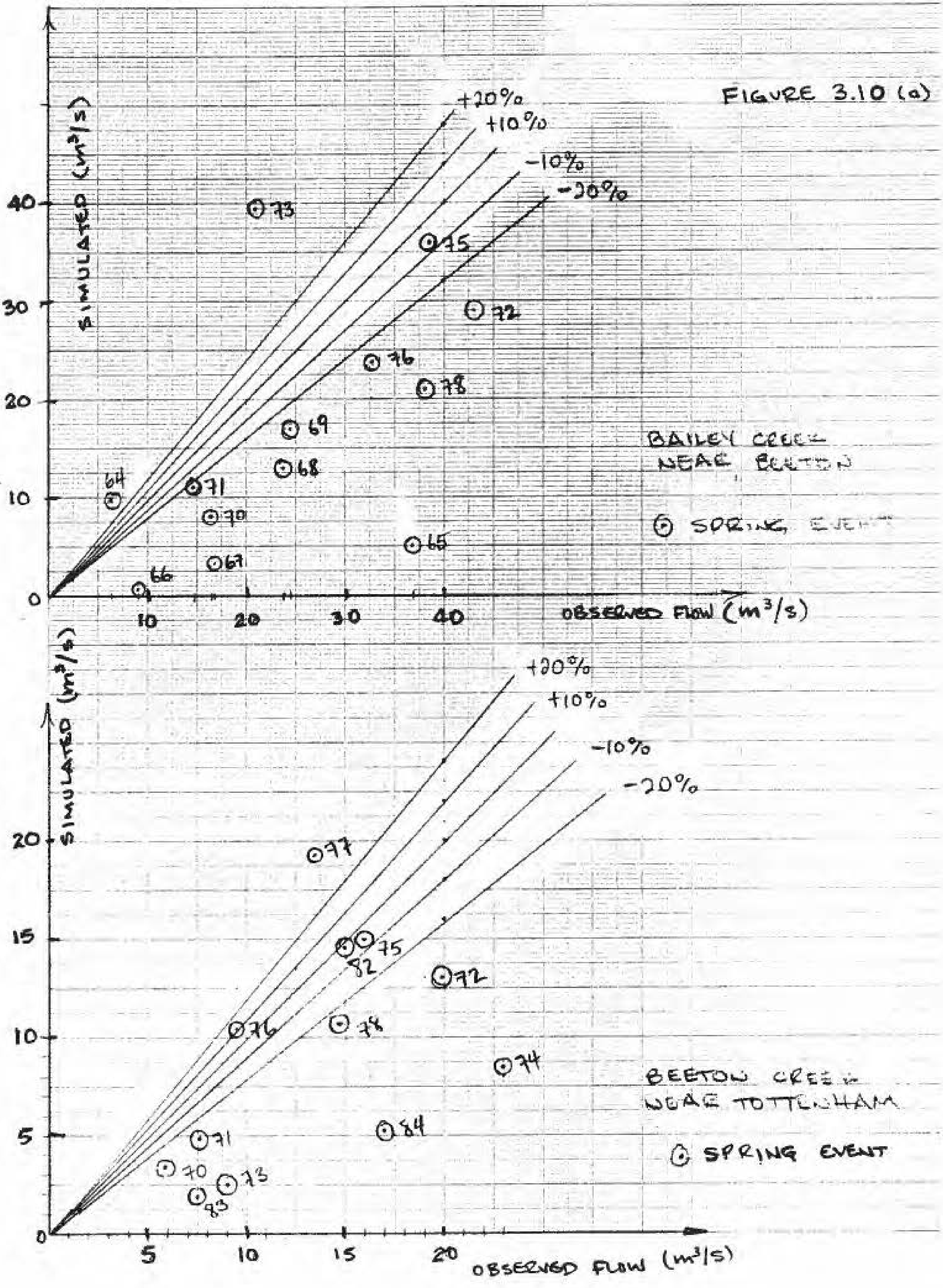

SIMULATED (m³/s)
OBSERVED FLOW (m³/s)
+20%
+10%
-10%
-20%
BAILEY CREEK NEAR BEETON
⊙ SPRING EVENT
64
66
67
70
71
73
75
72
76
78
69
68
65
SIMULATED (m³/s)
OBSERVED FLOW (m³/s)
+20%
+10%
-10%
-20%
BEETON CREEK NEAR TOTTENHAM
⊙ SPRING EVENT
77
75
82
72
76
78
74
84
71
70
73
83

FIGURE 3.10 (a)

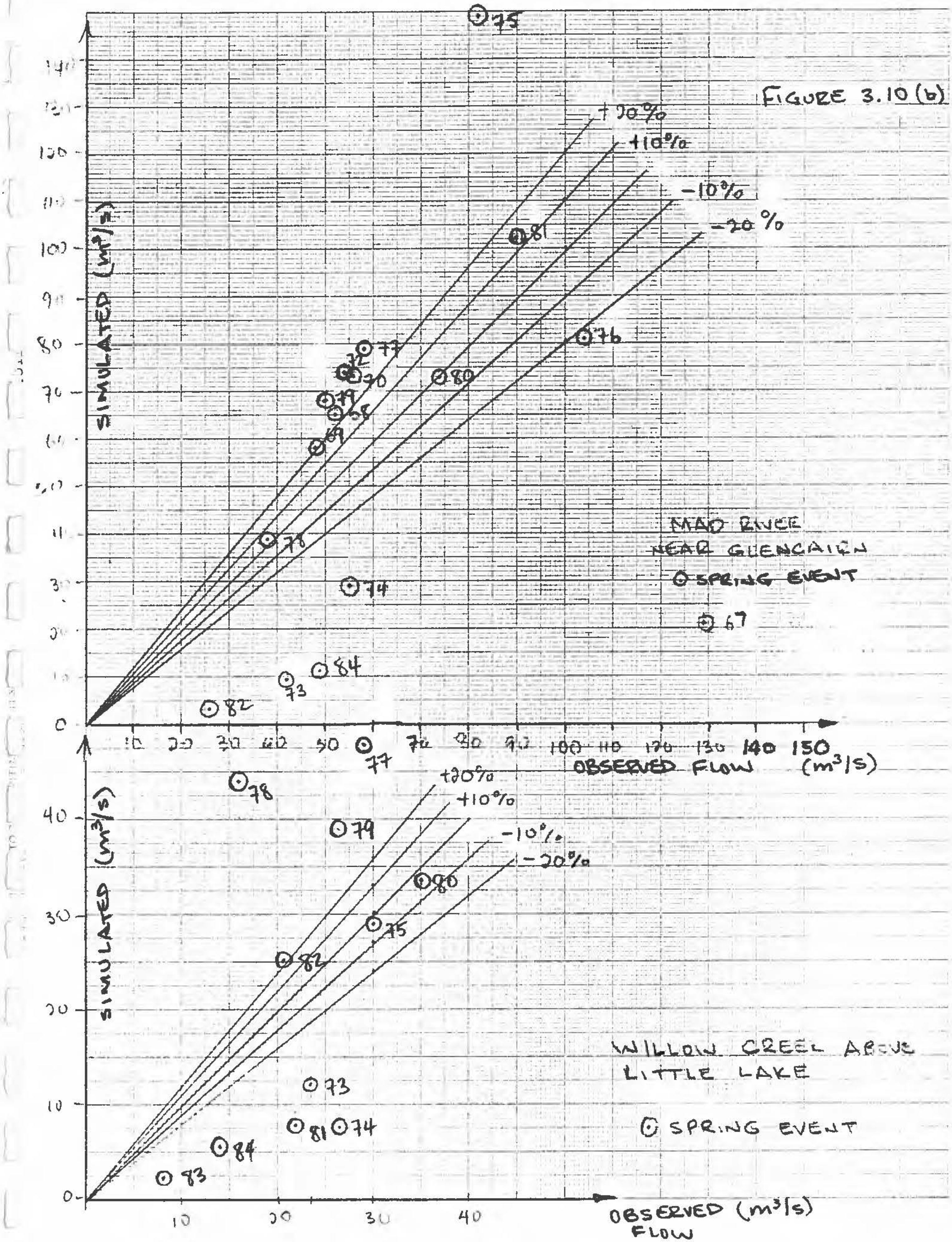
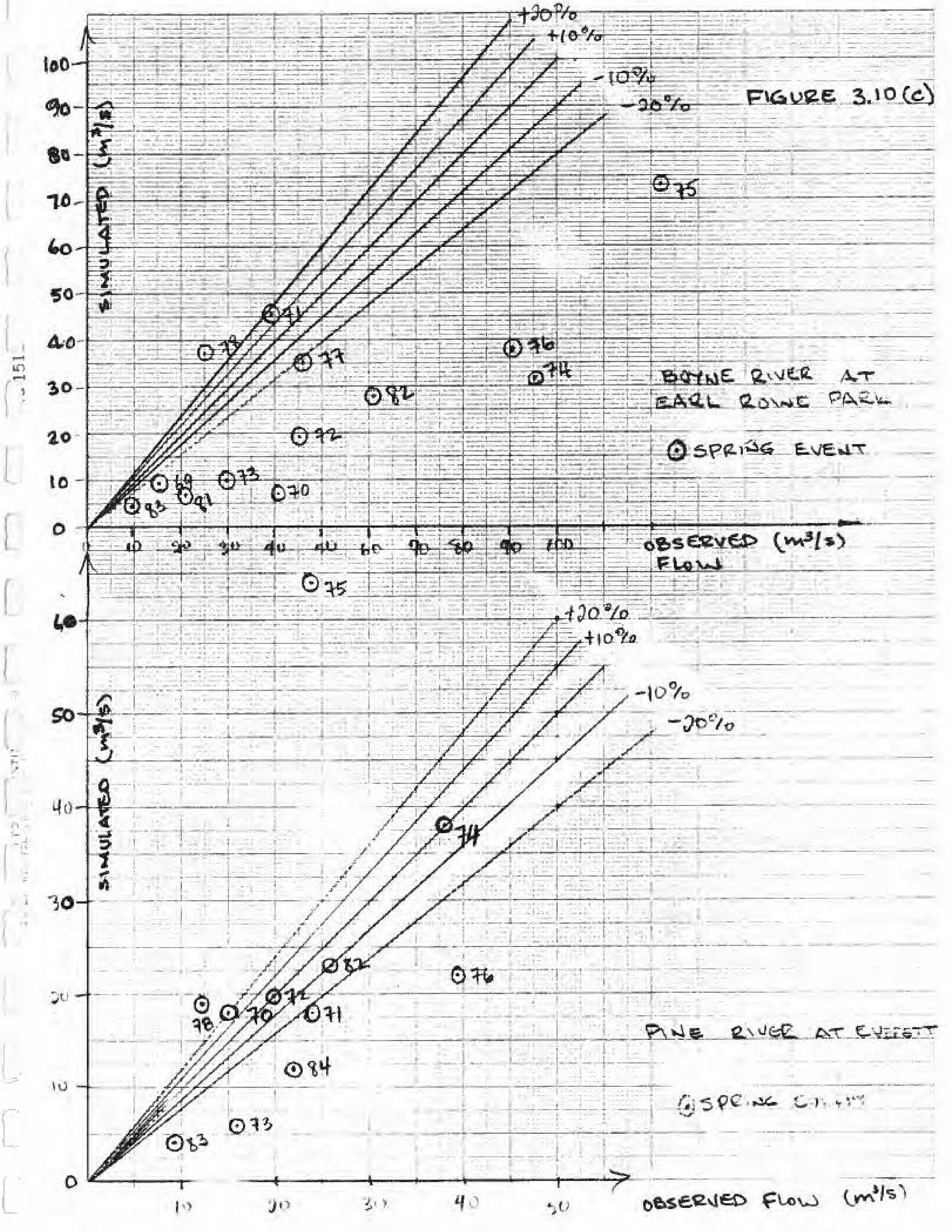
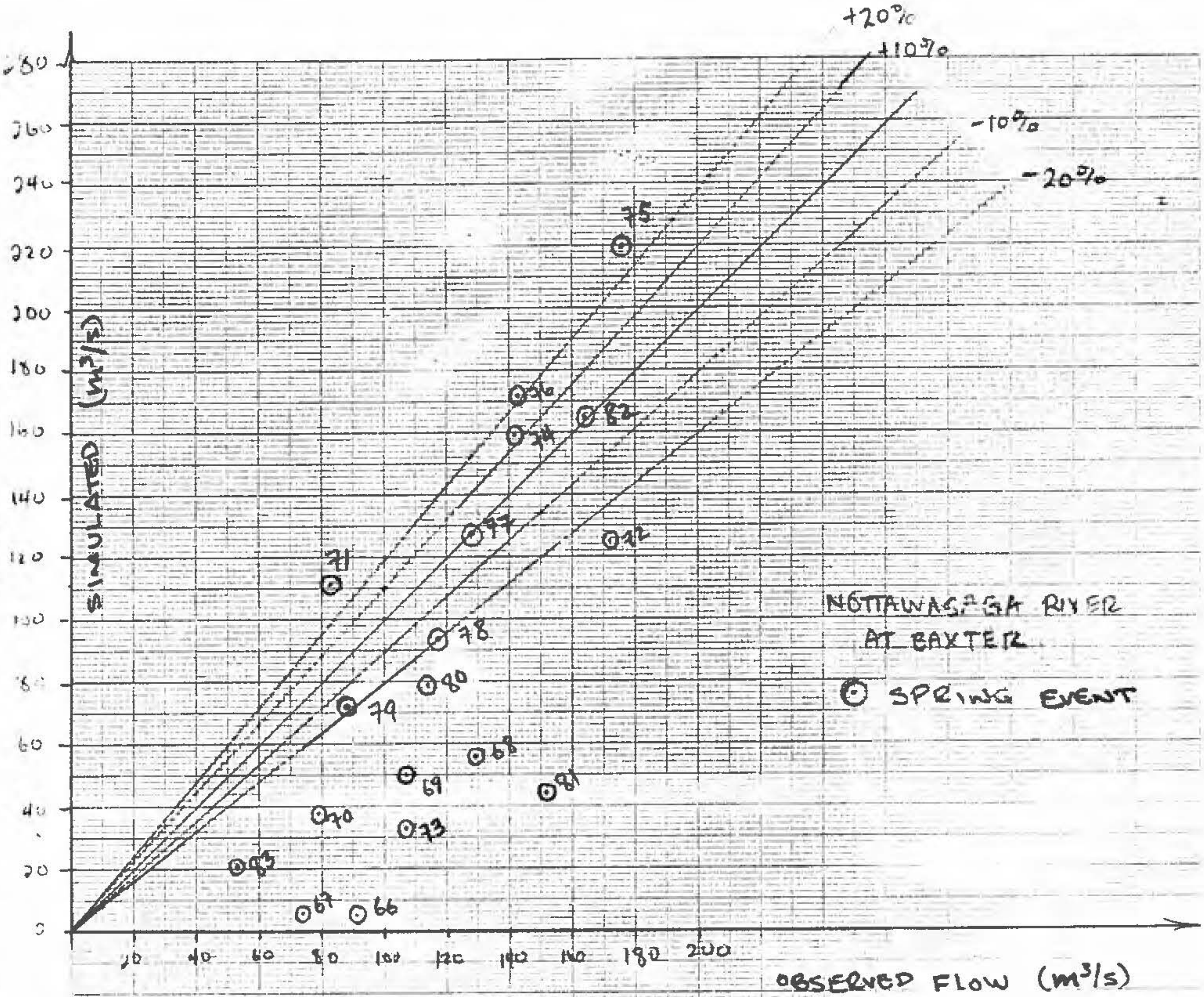

SIMULATED (m³/s)
+20%
+10%
−10%
−20%
MAD RIVER
NEAR GLENCAIRN
⊙ SPRING EVENT
OBSERVED FLOW (m³/s)
SIMULATED (m³/s)
WILLOW CREEK ABOVE
LITTLE LAKE
⊙ SPRING EVENT
OBSERVED FLOW (m³/s)

FIGURE 3.10 (b)



+20%
+10%
-10%
-20%
SIMULATED (m³/s)
OBSERVED (m³/s) FLOW
BOYNE RIVER AT EARL ROWE PARK
SPRING EVENT
71
78
77
76
74
82
72
73
70
69
81
83
75
PINE RIVER AT EVERETT
SPRING
OBSERVED FLOW (m³/s)

FIGURE 3.10 (c)



+20%
+10%
-10%
-20%
SIMULATED (m³/s)
OBSERVED FLOW (m³/s)
NOTTAWASAGA RIVER
AT BAXTER
SPRING EVENT

FIGURE 3.10 (d)

i) simulated annual peak flows for the 22 years from 1963 to 1984

ii) simulated annual peak flows from 1963 to 1984 for the same years in which observed annual peaks are available in iii)

iii) observed annual peak flows which are available from 1963 to 1984 if this duration is shorter than the record period

iv) observed annual peak flows for the period of record.

The direct comparison between simulated and observed frequency distributions was carried out between ii) and iii) with other sample periods used for further background information. Three parameter log normal frequency plots are provided in Appendix F while a comparison is given in Table 3.11. A further comparison between 100 year flow magnitudes which are computed from the QUALHYMO simulations, the observed record, and regional flood frequency analyses (Ref. 22, 23, 24) at hydrometric gauge locations is presented on Table 3.12. A similar comparison at three ungauged locations involving the frequency analysis of QUALHYMO annual peak simulations (Wakeby and three parameter lognormal distribution), and two Regional analyses is given in Table 3.13.

A sample of the values of the watershed parameters (B) (Ref. 12) which has been reported to vary from about 600 in steep terrain to 300 in very flat swampy country (Ref. 14) are presented in Table 3.14 and Appendix H.

3.2.5.5 Conclusions/Recommendations

The frequency plots and scatter diagrams in the previous figures represent the final results that can be achieved with calibrated parameters for soil moisture storage and snowmelt processes within the QUALHYMO Model. Substantial effort was spent in trying to obtain a reasonable agreement between the simulated and observed peaks. During this process, precipitation and

TABLE 3.11

SUMMARY OF SINGLE STATION FLOOD FREQUENCY ANALYSIS
(All Flows in m^3/s)

HYDROMETRIC STATIONS	D.A. (Km^2)	RETURN PERIOD	3 PARAMETER LOG NORMAL DISTRIBUTION: SIMULATED (1963-84) (1)	PARTIAL SIMUL. (2)	PARTIAL OBS. (3)	DOE (4)	WAKEBY DISTRIBUTION: SIMULATED (1963-84) (1)	PARTIAL SIMUL. (2)	PARTIAL OBS. (3)	DOE (4)
Beeton Creek near Tottenham	95	5	10	14	18	18	10.7	14.6	18.0	18.1
		20	20	22	28	28	17.5	20.0	21.9	25.8
		100	35	32	45	42	23.7	22.9	25.8	33.4
Bailey Creek near Beeton	207	5	25	26	35	39	27.0	27.5	36.7	37.7
		20	48	49	45	59	43.4	42.0	46.6	58.1
		100	83	83	55	84	57.2	52.4	51.1	84.4
Boyne River at Earl Rowe Park	211	5	31	48	78	70	31.8	50.0	79.2	69.0
		20	62	96	127	115	56.6	72.9	126.0	117.0
		100	112	172	190	176	84.0	92.0	172.0	175.0
Pine River near Everett	195	5	25	34	30	32	23.7	31.1	29.7	31.7
		20	45	58	42	49	42.1	55.9	42.6	48.4
		100	73	88	56	69	78.9	97.0	55.8	69.0
Mad River near Glencairn	295	5	78	91	82	75	83.3	89.9	78.7	71.2
		20	183	128	115	109	122.0	129.0	120.0	109.0
		100	377	163	155	149	146.0	159.0	176.0	167.0
Nottawasaga River near Baxter	1180	5	125	136	148	179	131.0	144.0	151.0	171.0
		20	212	224	177	264	201.0	211.0	187.0	268.0
		100	330	339	203	370	259.0	261.0	211.0	418.0
Willow Creek above Little Lake	95	5	26	335	30	30	27.3	41.5	29.1	29.8
		20	74	459	35	34	49.3	54.8	37.1	36.6
		100	184	605	39	37	73.9	60.1	46.6	45.1

(1) Simulated annual max. inst. discharges using QUALHYMO for 1963-1984 period.

(2)&(3) Simulated and observed flows for corresponding poeriods between 1963 and 1984 where observed max. inst. discharges exist.

(4) Flood frequency analysis conducted by Environment Canada for gauge record period.

TABLE 3.12

COMPARISON OF 1:100 YEAR PEAK FLOWS USING VARIOUS FLOOD FREQUENCY ANALYSIS

(All Flows in m^3/s)

HYDROMETRIC STATION	DRAINAGE AREA (Km^2)	SINGLE STATION (OBSERVED) PEAKS)	SINGLE STATION (QUALHYMO PEAKS)	MULTIPLE REGRESSION (Ref. 24)	INDEX FLOOD (Ref. 23)	REGIONAL FLOOD FREQUENCY (Ref. 22)
Beeton Creek near Tottenham	95	42	35	38.5	36.1	70.6
Bailey Creek near Beeton	207	84	83	72.6	83.6	76.6
Boyne River at Earl Rowe Park	211	176	112	114	85.1	157.4
Pine River near Everett	195	69	73	76.5	79.0	149.5
Mad River near Glencairn	295	149	377	88.1	117.3	113.6
Nottawasaga River near Baxter	1180	370	330	298.1	441.0	294.3
Willow Creek above Little Lake	95	45	74	60.3	39.6	55.2

TABLE 3.13

SUMMARY OF 1:100 YEAR FLOWS FOR THREE UNGAUGED CATCHMENTS

(All Flows in m^3/s)

	DRAINAGE AREA (Km^2)	WAKEBY [1] DISTRIBUTION	THREE [1] PARAMETER LOG NORMAL DISTRIBUTION	MTC METHOD (Ref. 25)	INDEX FLOOD METHOD (Ref. 23)
Silver Creek at outlet	26.6	49.8	54.9	40.6	28
Spring Creek at outlet	15.3	25.4	25.9	22.9	20
Pretty River at outlet	77.0	90.1	117.0	76.2	70

[1] Annual peak flows between 1963 and 1984 simulated by QUALYHMO model.

<u>TABLE 3.14</u>

<u>ESTIMATES OF B PARAMETER FOR VARIOUS SUB-CATCHMENTS</u>

Watercourse	Sub-Catchment Number	Drainage Area (km^2)	K/Tp	B Parameter
Innisfil Creek	300 + 302 311 312	40.87 24.1 12.65	1.1 1.1 1.7	298 298 210
Beeton Creek	200 + 201 202 205	23.44 10.15 16.49	0.88 1.70 1.80	360 210 201
Bailey Creek	208 211 212	24.74 25.63 18.74	1.00 1.10 1.25	322 322 270
Upper Nottawasaga	102 108 109	10.39 14.11 30.50	1.25 0.80 0.98	270 385 325
Sheldon Creek	113 + 114 115 117	36.82 14.20 34.42	0.75 0.85 1.20	410 368 278
Boyne River	400 401 406 409	30.49 15.21 38.21 26.07	1.15 1.30 1.10 0.85	288 261 298 368
Spring Creek	411 413	5.21 7.22	1.30 1.25	261 270
Pine River	500 + 501 502 506	74.90 29.28 21.83	0.70 1.05 0.90	430 310 351
Bear Creek	600 601 602	33.78 12.77 18.15	0.95 1.10 1.50	337 322 233
Truax Creek	603 604	10.15 10.95	0.90 1.45	351 239
Mad River	801 809 814 816	31.73 41.73 18.37 40.01	1.40 1.10 0.90 1.10	246 298 351 298

TABLE 3.14 (cont'd)

ESTIMATES OF B PARAMETER FOR VARIOUS SUB-CATCHMENTS

Watercourse	Sub-Catchment Number	Drainage Area (km²)	K/Tp	B Parameter
Silver ~~Spring~~ Creek	900	20.32	0.76	403
	901B	1.65	0.90	351
	901C	0.85	1.25	270
Willow Creek	700	16.15	0.90	351
	706	10.11	1.20	278
	707	14.24	1.25	270
	713 + 714	39.84	0.85	368
	712	23.63	1.05	310
	717	45.26	0.95	337

streamflow data were reviewed for discrepancies and various ranges of snowmelt parameters were tested to assess the model sensitivity.

Several reasons are cited as possible explanations for differences between simulated and observed flow peaks.

i) Lack of actual hourly rainfall data for some events during the spring. As indicated previously in some cases the 6-hourly precipitation data from Mt. Forest or distant hourly rainfall stations had to be used to distribute the daily precipitation into hourly data.

ii) Despite the reasonably dense network of meteorologic stations within the vicinity of the Nottawasaga River basin, the areal distribution of precipitation within catchments may introduce a source of error to the computations. During the calibration and validation investigation, point rainfall amounts from stations were selected as most representative of the tributary drainage area above a flow station.

iii) The API technique is used in the QUALHYMO Model under various spring snowmelt conditions under which very little model testing has been undertaken. The effect of frozen ground conditions upon runoff remains a subject of considerable hydrologic research. In addition, the practice of reducing the API during snow cover conditions is largely a matter of conjecture. While many of the larger observed flows were simulated quite well with this approach, a number of smaller runoff events were under-estimated possibly due to unrealistic antecedent moisture conditions based on a declining API. Baseflow magnitudes prior to spring events also often exceeded the predicted base flows especially when preceded by earlier runoff events. A more flexible recession coefficient defining baseflow contributions under these conditions may be a worthwhile addition to the QUALHYMO model.