8 ANALYSIS OF TANK MODEL

8.1 Analysis of Three Check Dams By Tank Model

8.1.1 Conceptualization

Tank Model consisting of total 16 tanks distributed in m x n structure is developed considering the area to be divided into four zones. The gauging site for runoff measurements is somewhere at the middle of the entire catchment. So the calibration is done for the catchment of the area up to gauging site only. We further assume that the response of the entire catchment is hydrologically similar to the considered part of the catchment up to gauging site. The rainfall pattern of the rain gauge station in area up to gauging site and the rainfall pattern of the rain gauge station in area beyond that (in a part of catchment not considered) is similar. Looking to the similarity of these two patterns, one can say that - the response of the entire catchment is hydrologically similar to the considered part of the catchment up to gauging site.

The model uses area ratio of different zones so the model can be applied without any difficulty to any area keeping ratio same and dividing accordingly. The error in the calibration are analysed by two ways:

1. Calculating Root Mean Squares of the observed and calculated (simulated) values and finding error in it.
2. Calculating % error in Observed Runoff and Calculated Runoff.

Normally for flood analysis instantaneous behaviour of the catchment at some specific instant of time is important to study while in case of study like recharging overall response of the catchment over a longer period is important to study. So component of the runoff, like base flow, that plays vital role in recharging. Therefore RMSE will be less significant than the error in total flow. So we are considering error in total flow to be decisive factor for checking the accuracy of the analysis.

The area of the basin up the location of the gauging site works out to be 155 km^2. Three check dams falls within this area, namely Kachumber, Simaliya and Wankol. The effects of all these three check dams are analysed.

8.1.2 Calibration and Sensitivity Analysis

Calibration of the model is done following conceptual procedure as described in chapter 4 in Para 4.8.7 As explained above the model is calibrated for the catchment area up to Wankol, 155 km^2. Along with calibration sensitivity of the parameters like area divisions, XP, XS and height of the side outlets were checked to finalize their values.

Recession Constants i.e. decreasing ratios were determined for each year from 1993-2004. It was found to be ranging from 0.70 to 0.96 with an average value of 0.83. T_c values were also noted corresponding to these values of 'α' and they were found to be ranging from 1.04 to 1.42 with an average value of 1.22. So considering this value 1.22 as base value calibration was started for the year 1994. Total 23 trials were made varying values of T_c from 0.85 to 1.97. It was observed that the accuracy of the results obtained were highest for the different values of T_c from 1.17 to 1.2, from 99.13 to 101.46 % It was found that the percentage accuracy is highest (99.96 %) for the T_c = 1.189

After T_c trials were carried out to fix up value of h_1 and h_2. It is found that h_1 is more sensitive than h_2. After several trials values of h_1 = 12 and h_2 =37 were found to be most appropriate giving results with 99 % accuracy. Then values of PS, SS, XP and XS were finalized by various trials. It is found that XP and PS are more sensitive than XP and SS. Table 8.1 lists values of various parameters finalized after various trials.

Model is calibrated for the year 1993 and 1994.1993 is normal rainfall year and 1994 was good rainfall year. In both this years no check dam was constructed up to Wankol. Model is then tested and proved for the year 1995. The results are then obtained for year 1996 by considering one check dam at Kachumber as amongst three check dams it was constructed first in the year 1995. Check dam at Wankol was constructed in 1996 and at Simaliya was constructed in 1998. So results for the years 1997 and 1998 are obtained by considering two check dams one at Kachumber and another at Wankol. Results were then obtained from 1999 to 2004 by considering all three check dams one at Kachumber (in zone 4), second at Wankol (in zone 3) and third at Simaliya (in zone 2).

Table – 8.1 Finalized Values of Parameters of Tank Model

Sr. No.	Name of Parameter	Symbol	Value
1	Decreasing ratio	α	0.84
2	Time constant	Tc	1.19
3	Discharge coefficient for bottom outlet of first tank	A_0	0.59
4	Discharge coefficient for first side outlet of first tank	A_1	0.64
5	Discharge coefficient for second side outlet of first tank	A_2	0.61
6	Discharge coefficient for bottom outlet of second tank	B_0	0.12
7	Discharge coefficient for side outlet of second tank	B_1	0.12
8	Discharge coefficient for bottom outlet of third tank	C_0	0.02
9	Discharge coefficient for side outlet of third tank	C_1	0.02
10	Constant for water movement T_1	b_0	0.10
11	Constant for water movement T_1	b	4.00
12	Constant for water movement T_2	c_0	0.15
13	Constant for water movement T_2	c	5.95
14	Head for first side outlet in top tank	h_1	12.00
15	Head for second side outlet in top tank	h_2	37.00
16	Primary soil moisture depth	PS	40.00
17	Secondary soil moisture depth	SS	125.00
18	Initial storage of primary soil moisture	XP	0.50
19	Initial storage of secondary soil moisture	XS	1.00

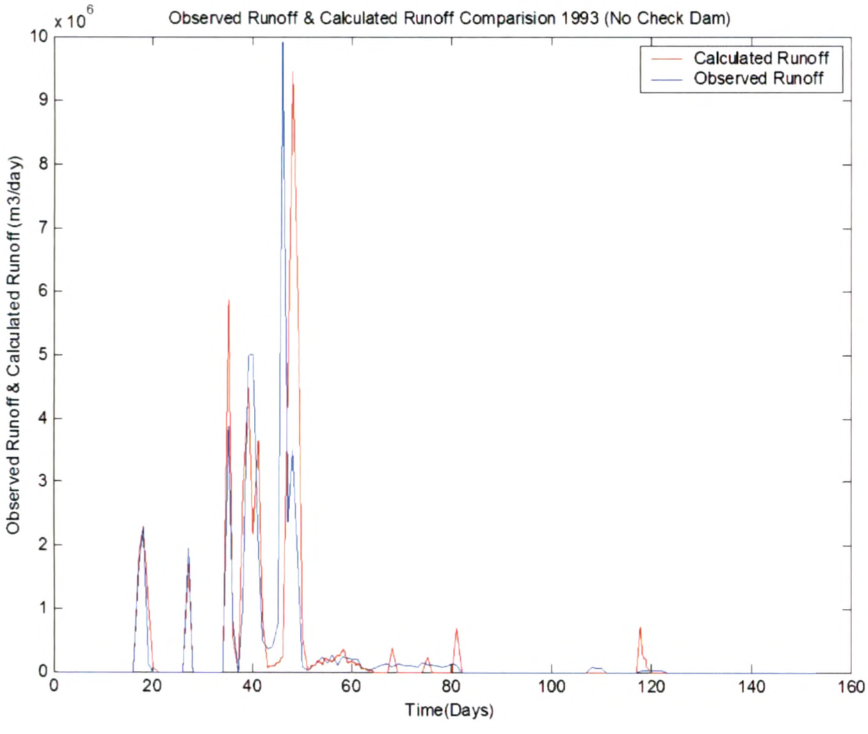
8.1.3 Running of Model

After finalizing parameter values and calibration, model was run for a period 1993-2003 except years 2000 and 2002 because these years were years of severe drought. To evaluate the effect of check dams model was run for five selected years 1994, 1995, 1999, 2001 and 2003 for the conditions no Check Dams to One Check Dam, Two Check Dams and then Three Check Dams. Following graphs 8.1 to 8.39 are the graphs of Observed and Calculated Runoff Vs Time, Inter Flow Vs Time and Base Flow Vs Time for years 1993-99, 2001 and 2003. Graphs 8.40 to 8.45 are some specimen graphs which illustrate the effect of check dams.

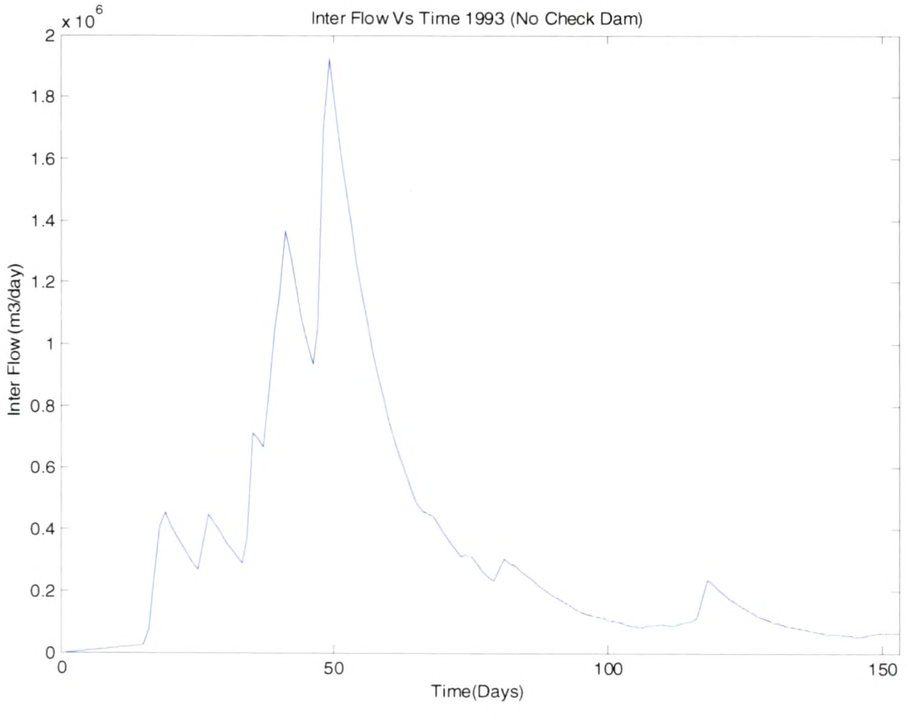
8.1.4 Discussion on Analysis by Tank Model

The simulated hydrographs by the final calibrated tank model is plotted along with the observed hydrograph for year 1993-99 and 2001 and 2004. These graphs show that the overall fit of the computed hydrograph with observed one is good. Peak flows are matching well. For years 1993, 94, 99, peak flows match is very good. For remaining years peak flows match well but some of the peaks are overestimated i.e. calculated values are found little higher than observed flow values. In year 1993, 95, 97, 98, 99 some peak flows shows time lag. This is because the daily observation time artificially divides the day e.g. a rainstorm might by chance be considered to be in one day or in the following day depending on the observation time therefore we cannot expect the observed and computed peaks to be on the same day always. It is observed that the simulation is comparatively poor for lower peaks. In the study area actual rainfall does not occur continuously on all the days during entire monsoon season. The observed runoff also shows occurrence of flow on some days with lack of continuity. The similar characteristic is reflected by the model. Most remarkable feature of the performance of developed model is that it simulates a steady inter flow and base flow for long dry period of no rainfall.

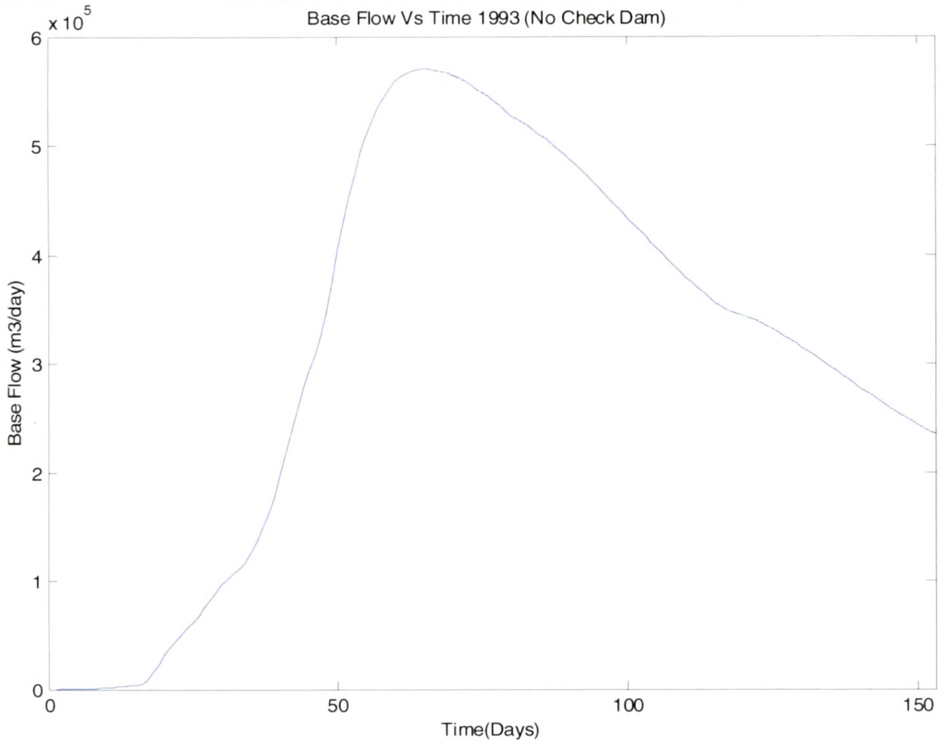
8.1.5 Calibration Trial for year 1993



Graph – 8.1 Observed Runoff & Calculated Runoff Vs Time 1993

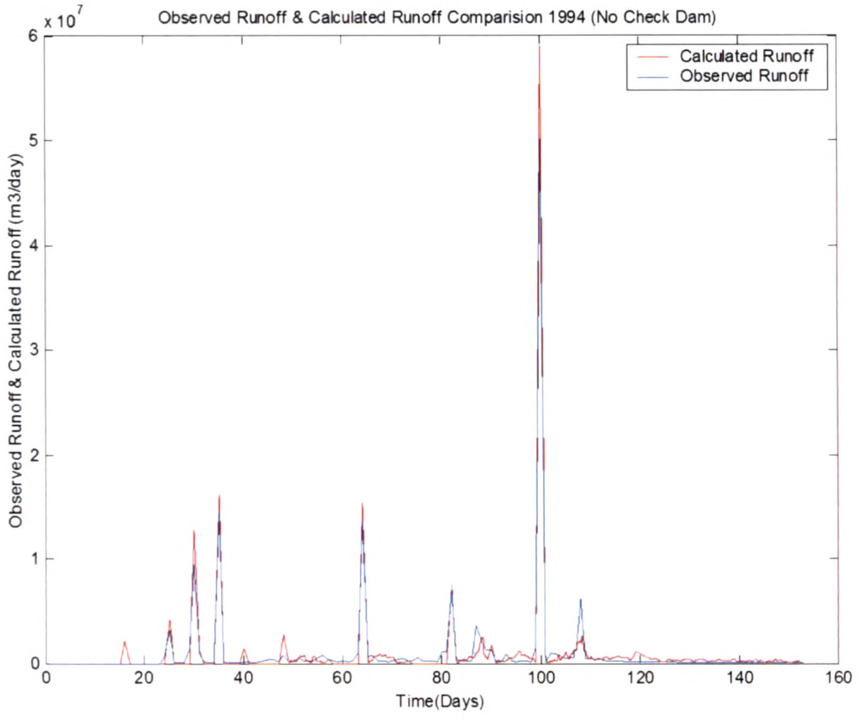


Graph – 8.2 Inter Flow vs Time for year 1993

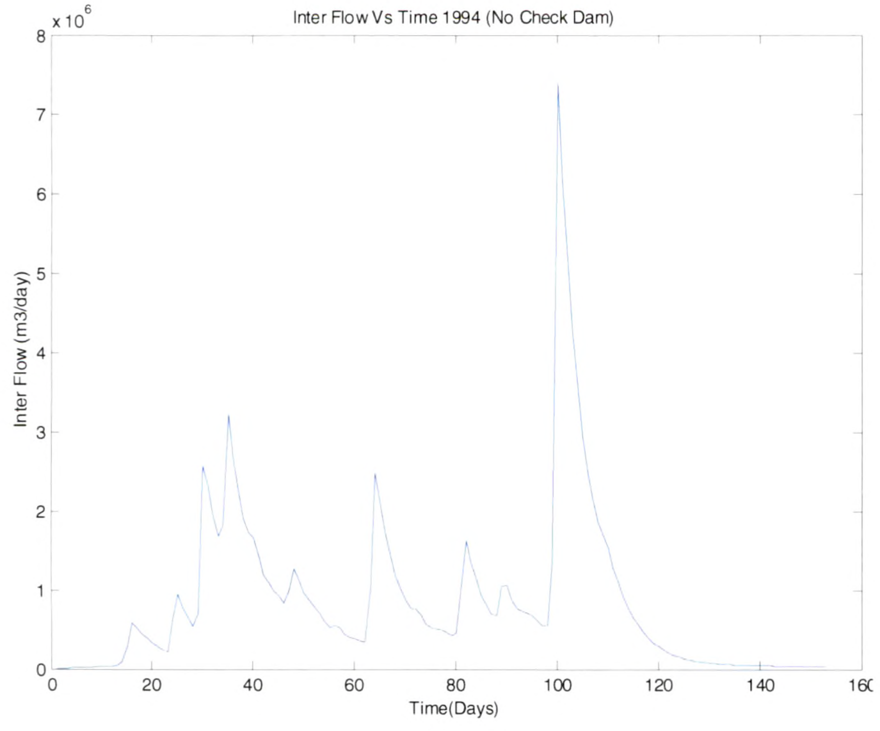


Graph – 8.3 Base flaw Vs time for year 1993

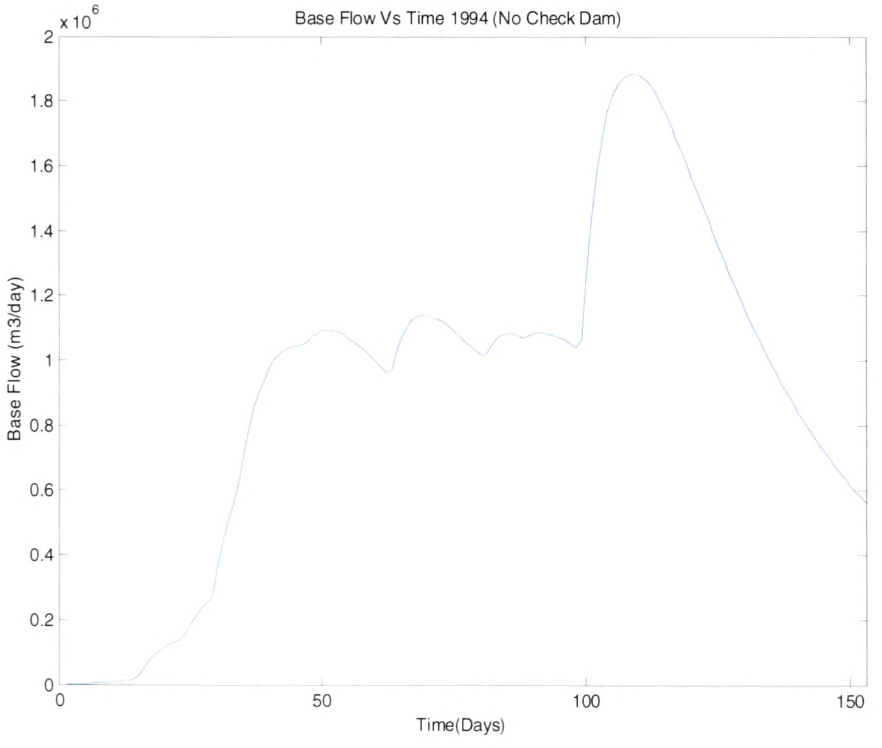
8.1.6 Calibration for year 1994



Graph – 8.4 Observed Runoff & Calculated Runoff Vs Time 1994

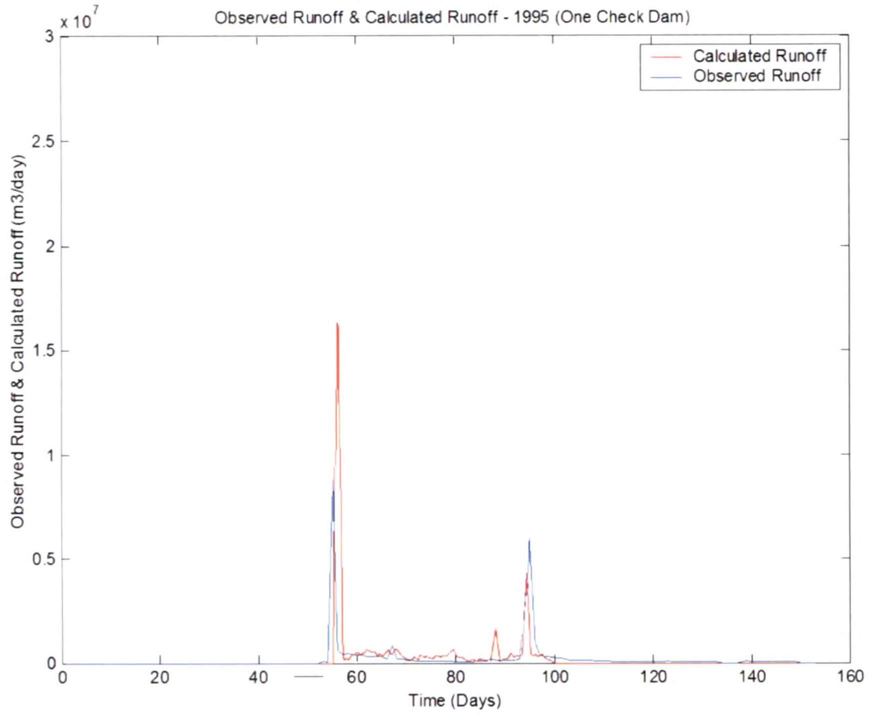


Graph – 8.5 Inter Flow Vs Time for year 1994

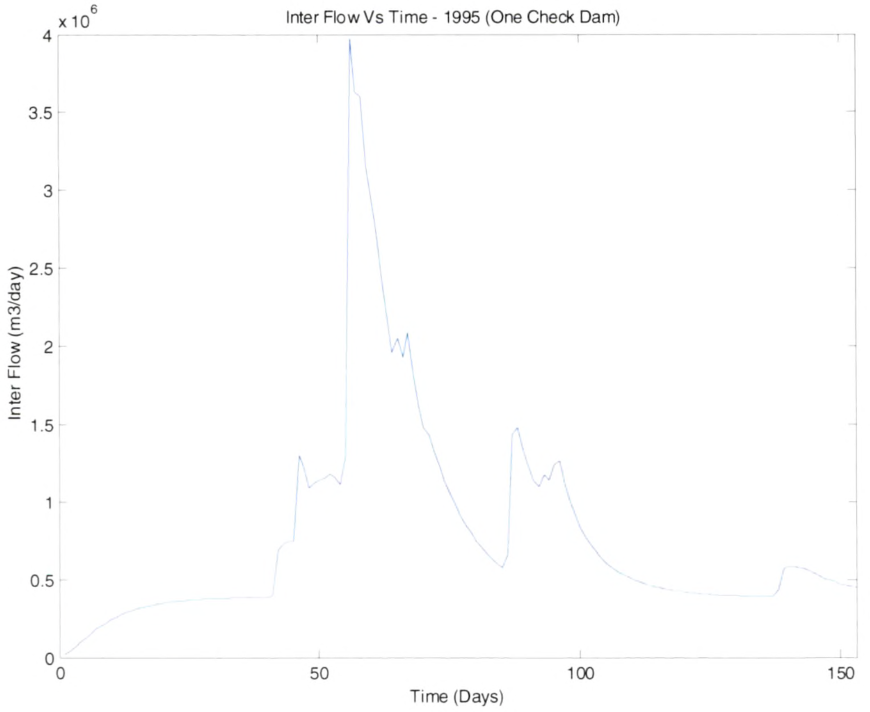


Graph – 8.6 Base flow Vs Time for year 1994

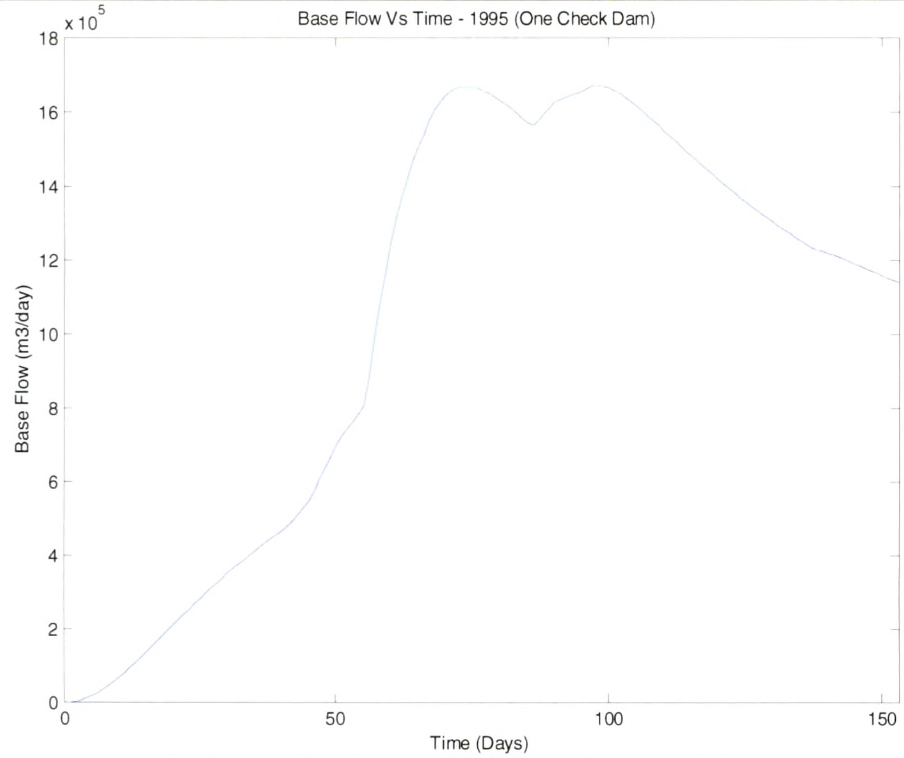
8.1.7 Proving of Model for 1995



Graph – 8.7 Observed Runoff & Calculated Runoff Vs Time 1995



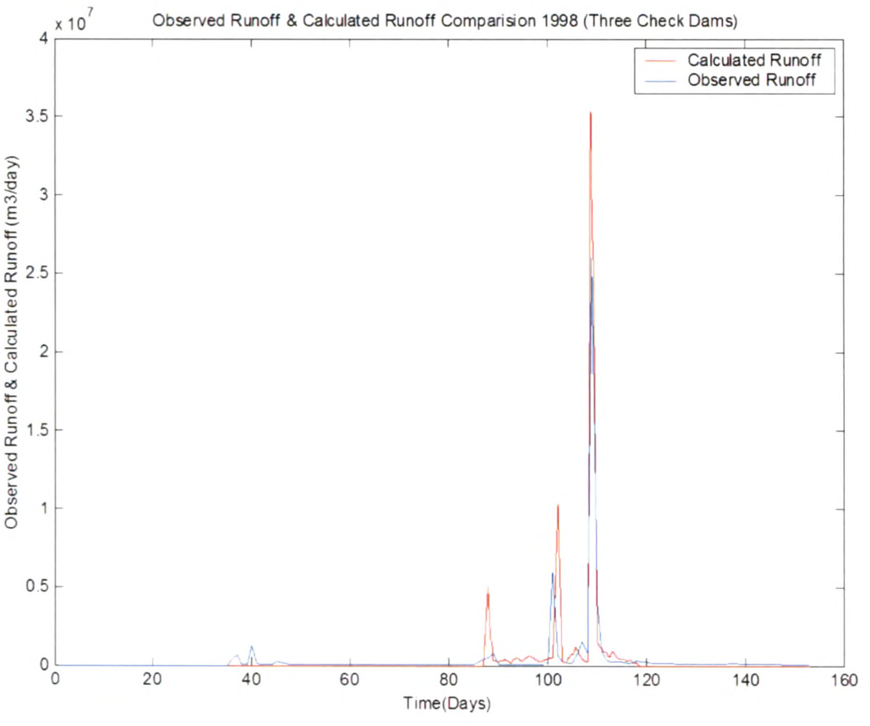
Graph – 8.8 Inter Flow Vs Time for year 1995



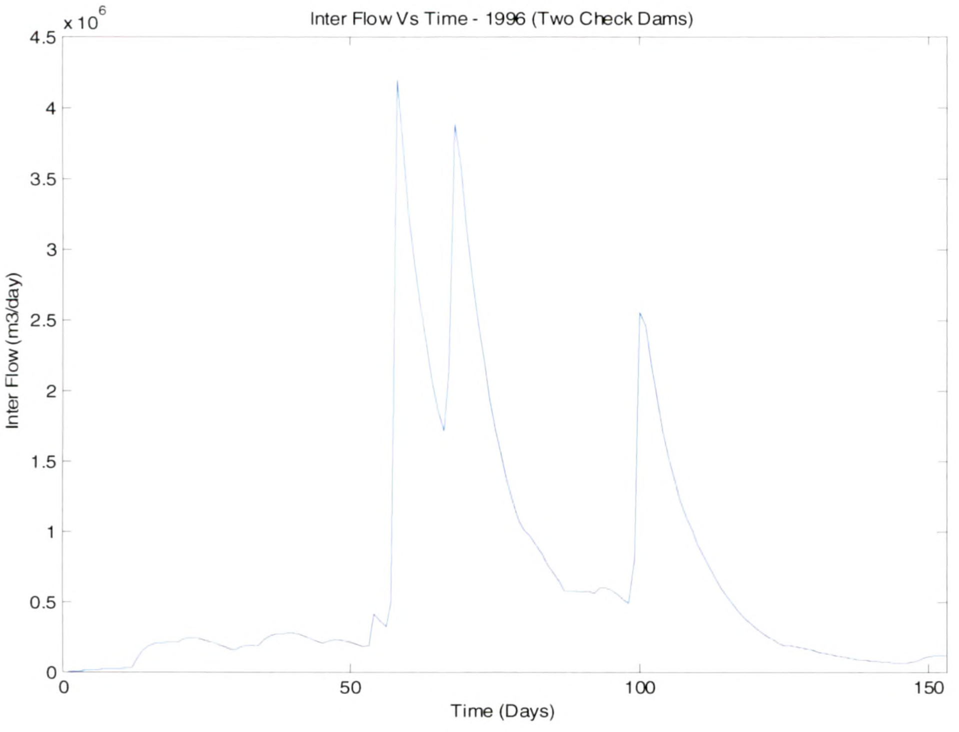
Graph – 8.9 Base flaw Vs time for year 1995

8.1.8 Graphs for different years

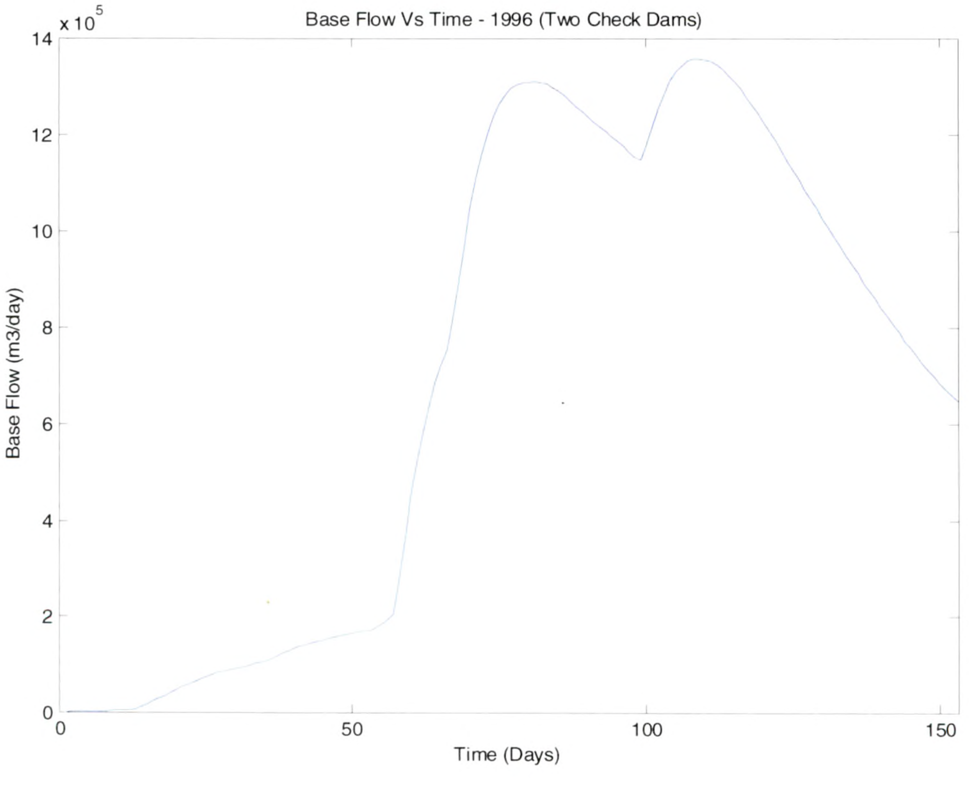
8.1.8.1 Results 1996



Graph – 8.10 Observed Runoff & Calculated Runoff Vs Time 1996

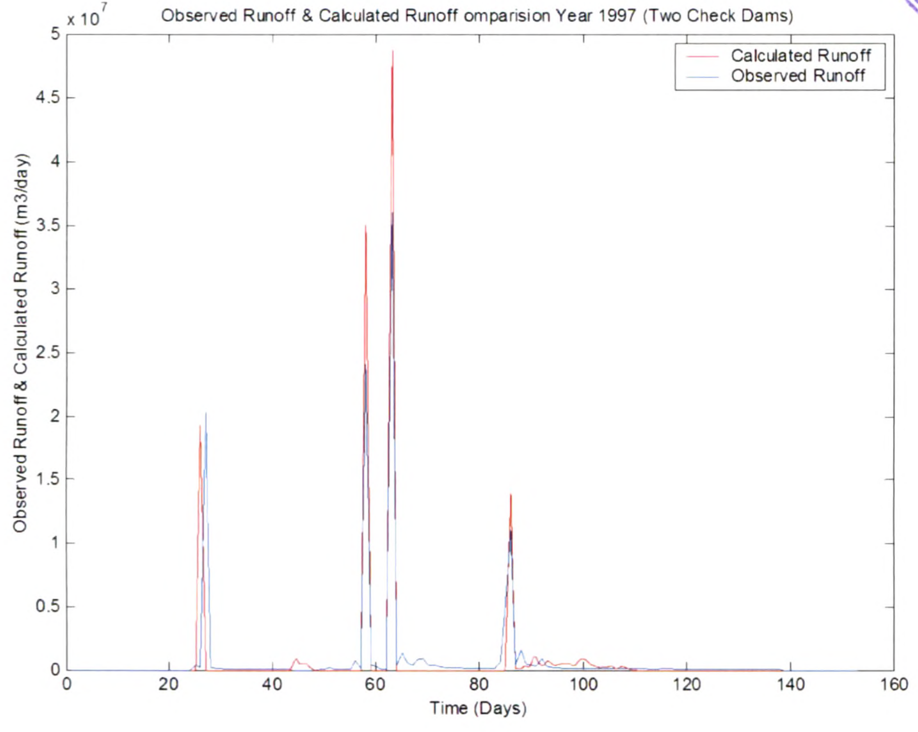


Graph – 8.11 Inter Flow Vs Time for the year 1996

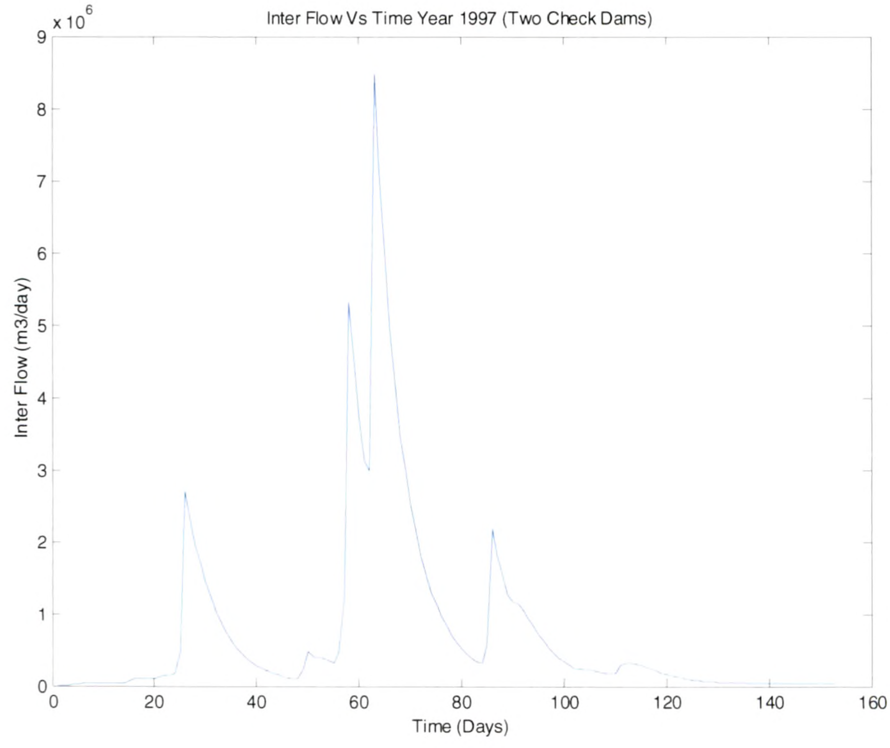


Graph – 8.12 Base Flow Vs Time for year 1996

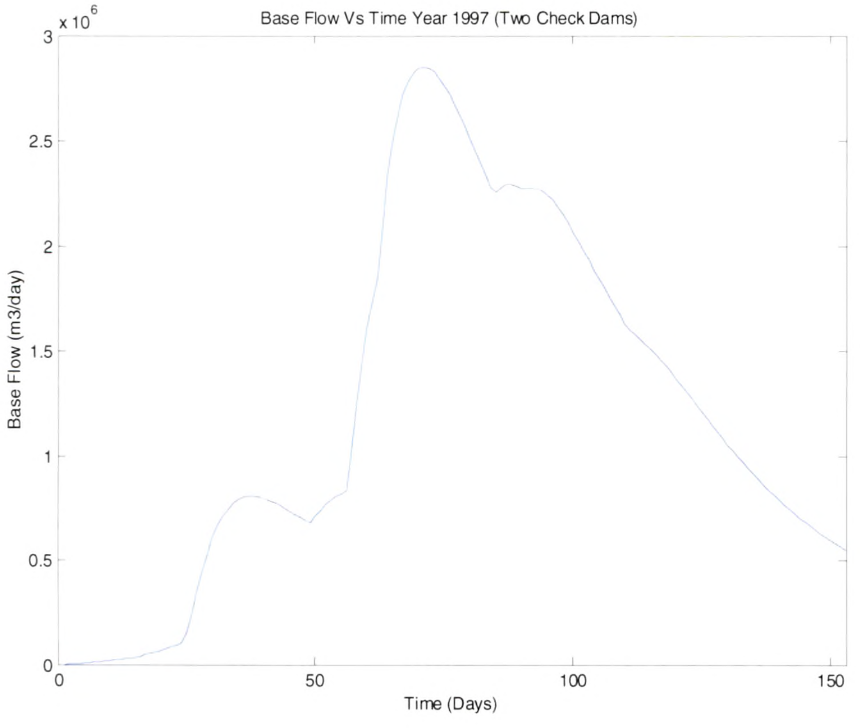
8.1.8.2 Results 1997



Graph – 8.13 Observed Runoff & Calculated Runoff Vs Time 1997

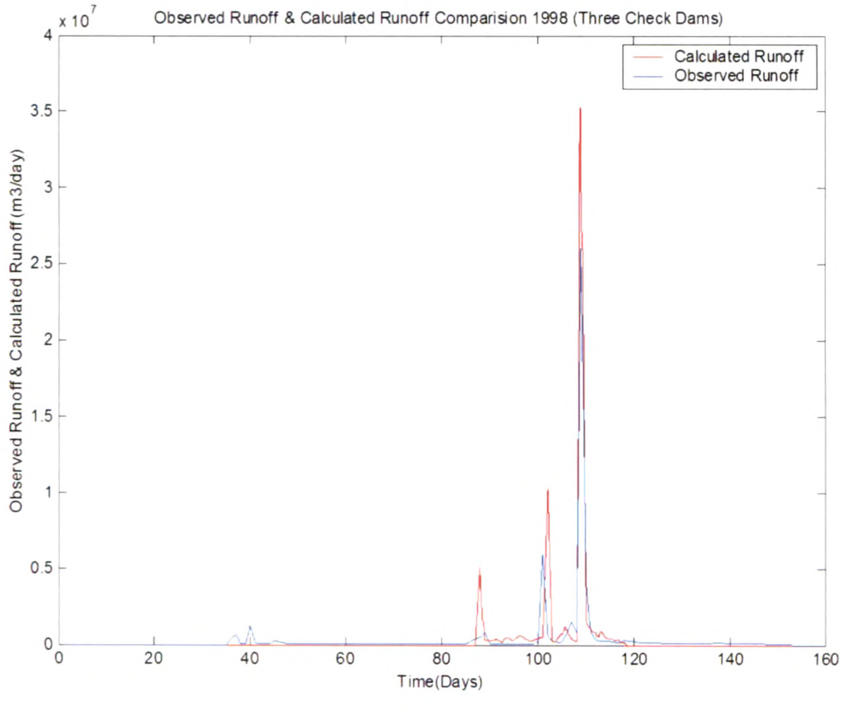


Graph – 8.14 Inter Flow Vs Time for the year 1997

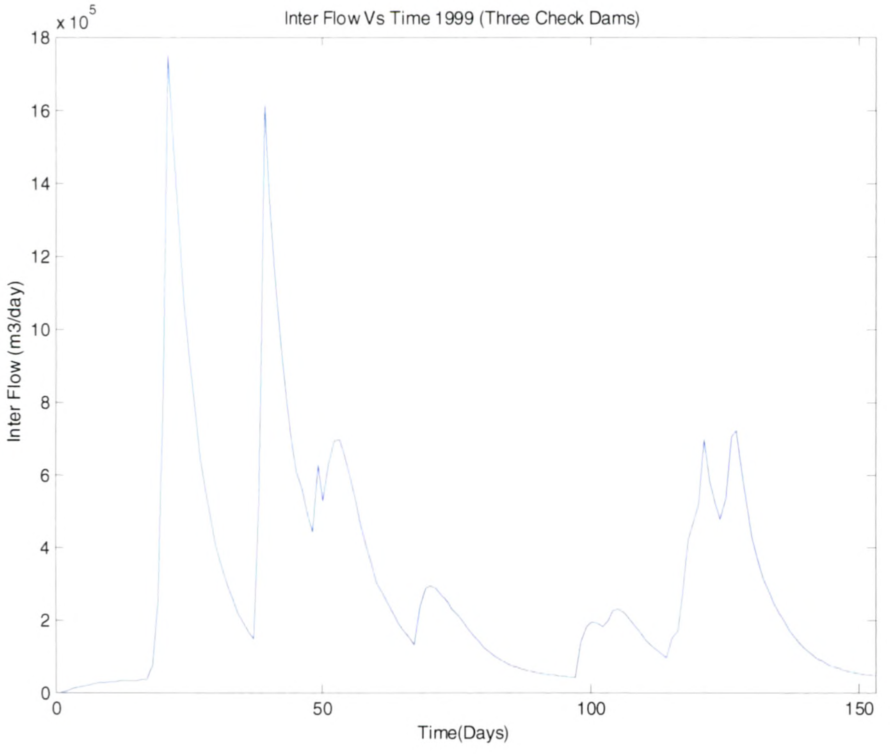


Graph – 8.15 Base Flow Vs Time for year 1997

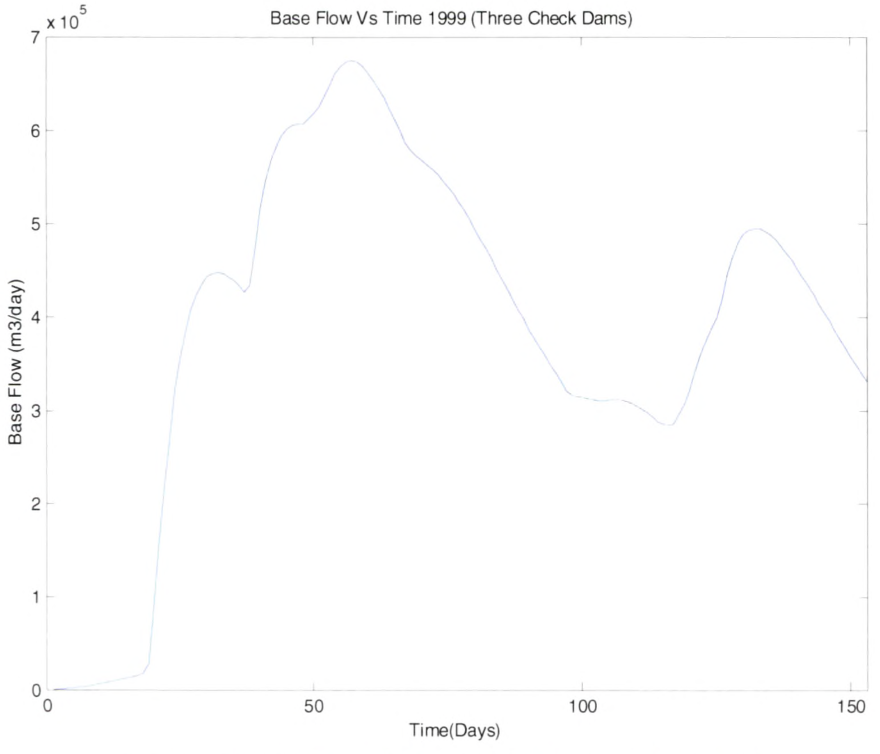
8.1.8.3 Results 1998



Graph – 8.16 Observed Runoff & Calculated Runoff Vs Time 1998

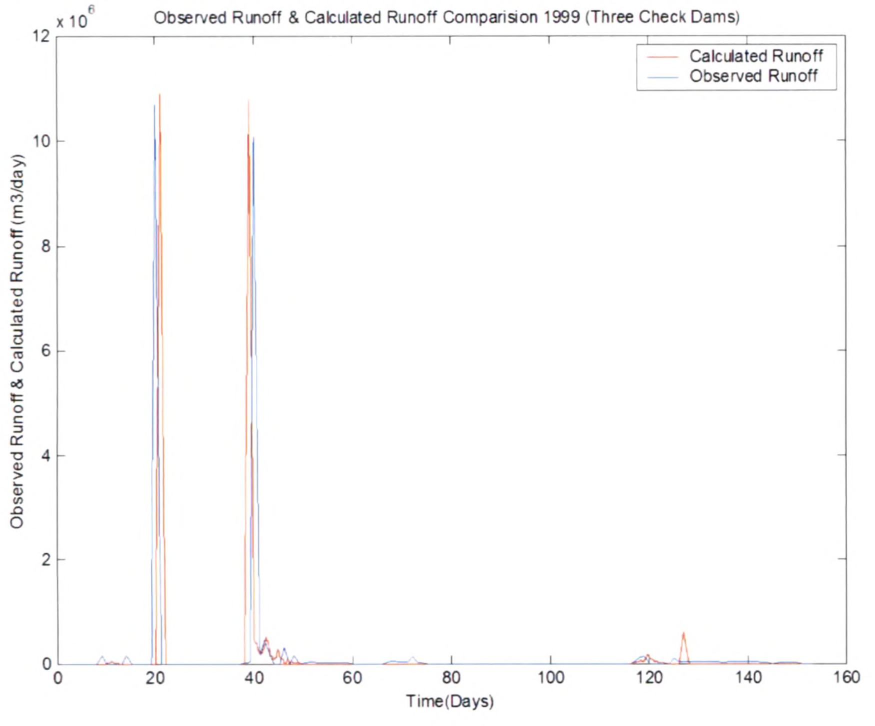


Graph – 8.17 Inter Flow Vs Time for year 1998

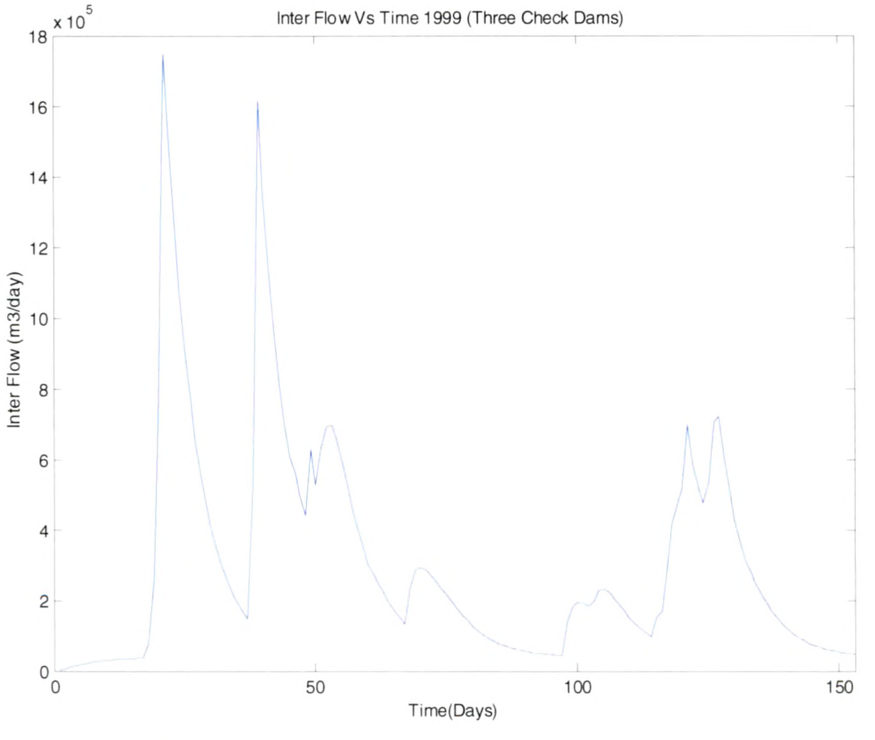


Graph – 8.18 Base Flow Vs Time for year 1998

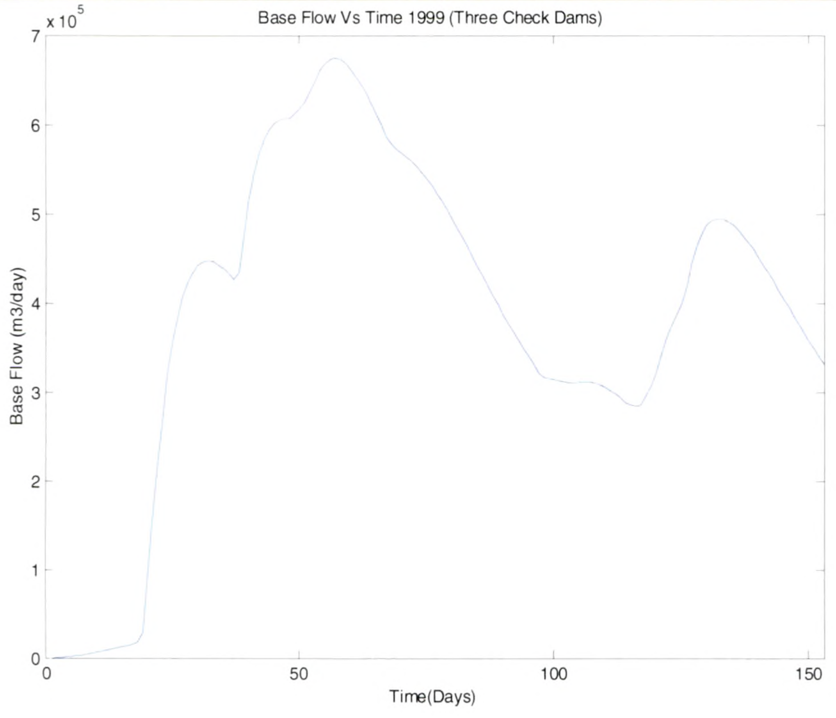
8.1.8.4 Results 1999



Graph – 8.19 Observed Runoff & Calculated Runoff Vs Time 1999

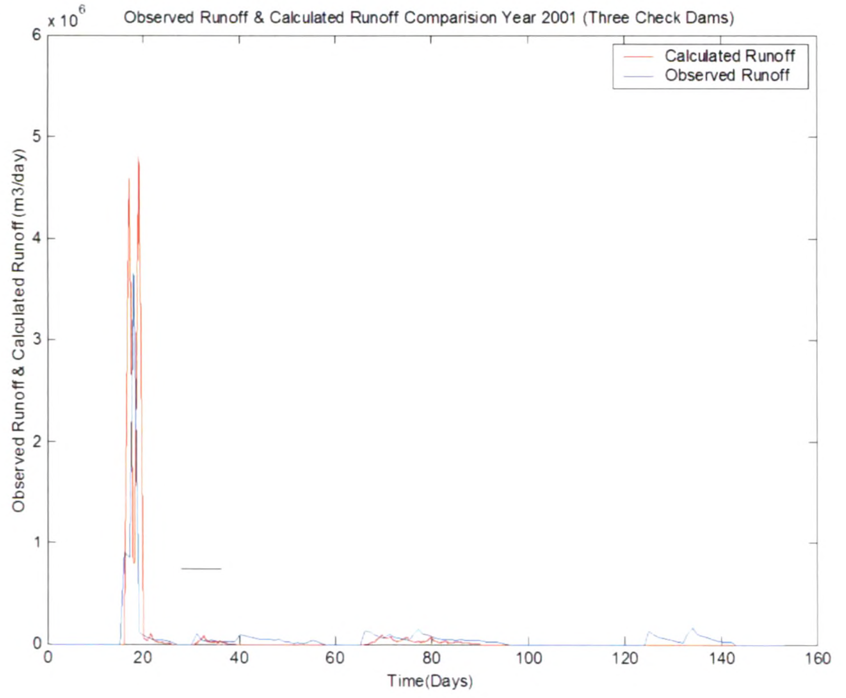


Graph – 8.20 Inter flow Vs time for the year 1999

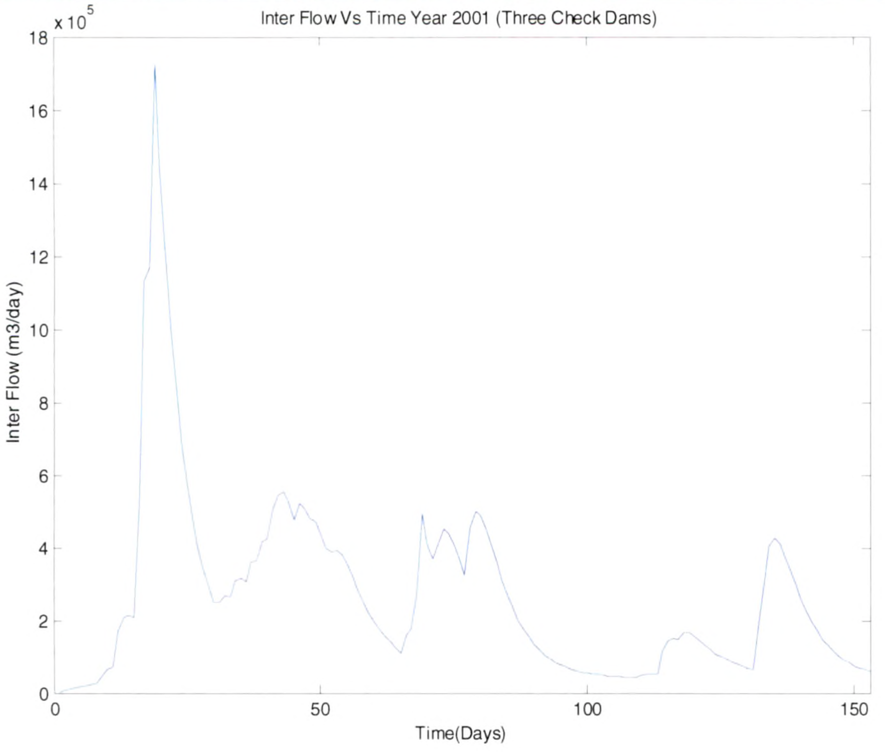


Graph – 8.21 Base Flow vs. Time for the year 1999

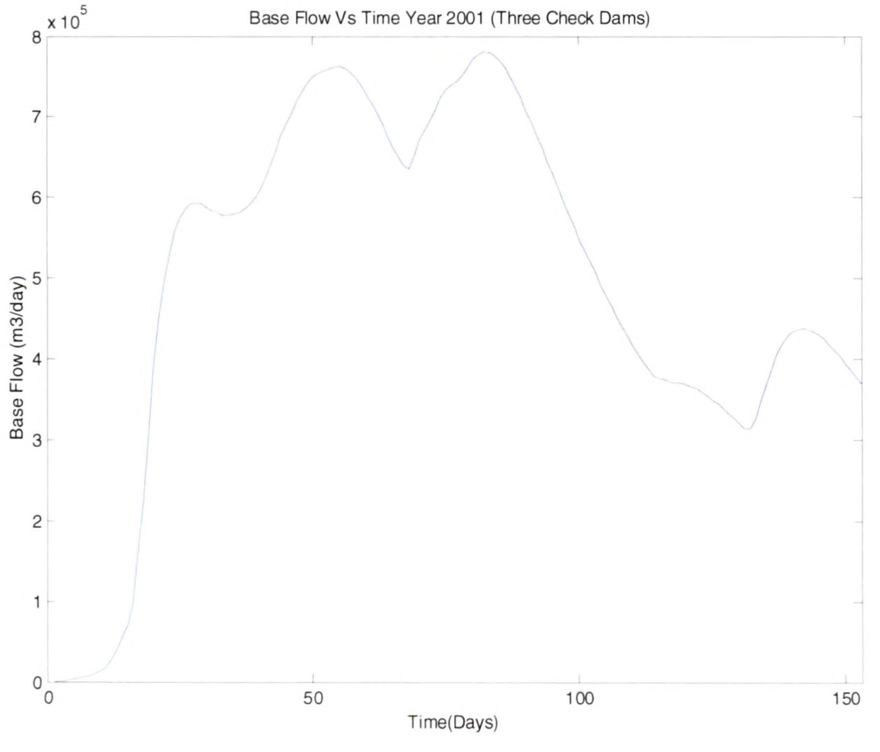
8.1.8.5 Results 2001



Graph – 8.22 Observed Runoff & Calculated Runoff Vs Time 2001

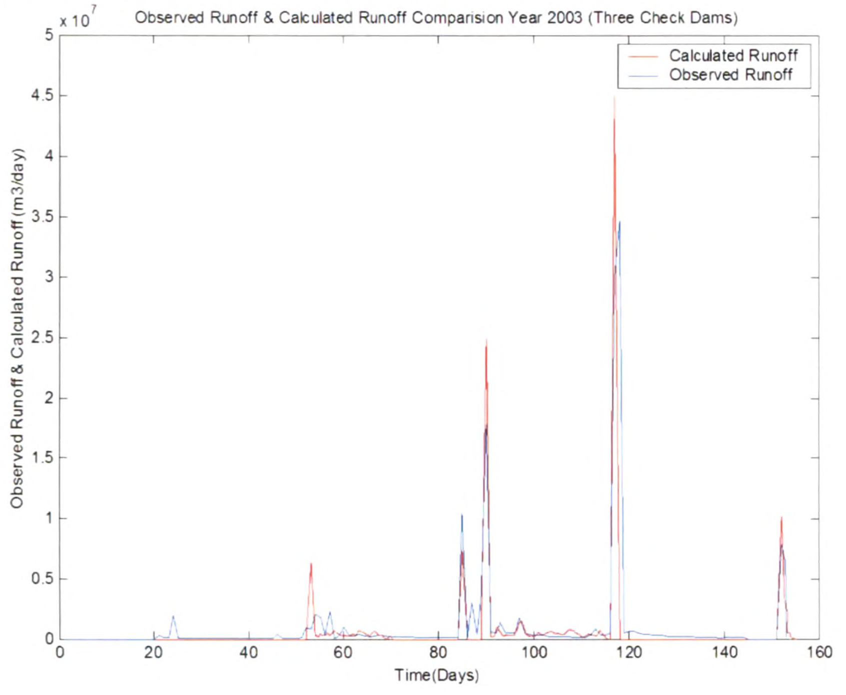


Graph – 8.23 Inter flow Vs time for the year 2001

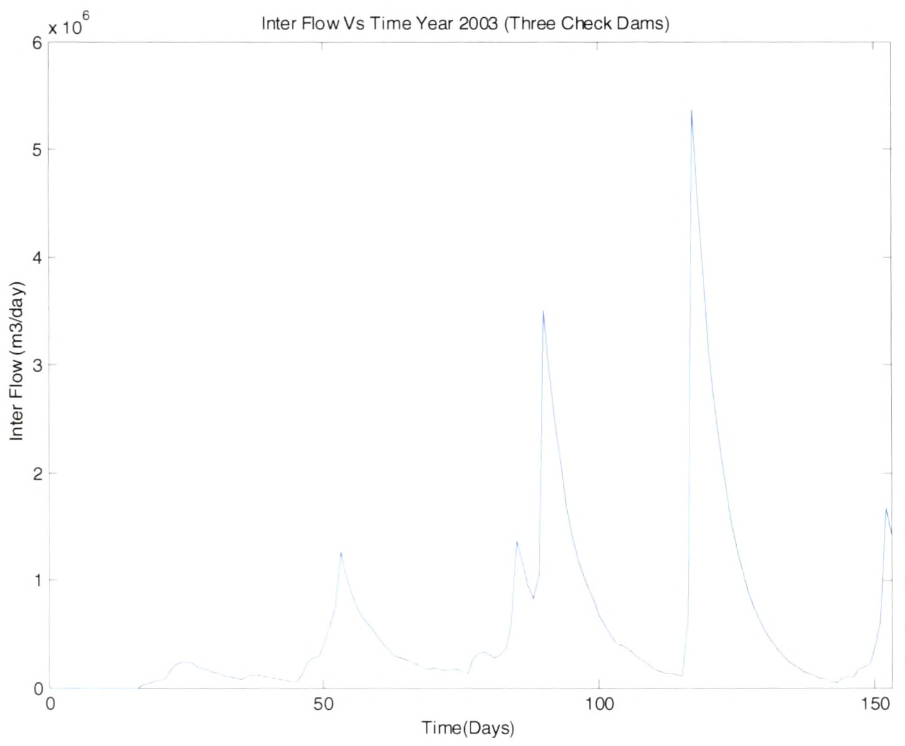


Graph – 8.24 Base Flow vs. Time for the year 2001

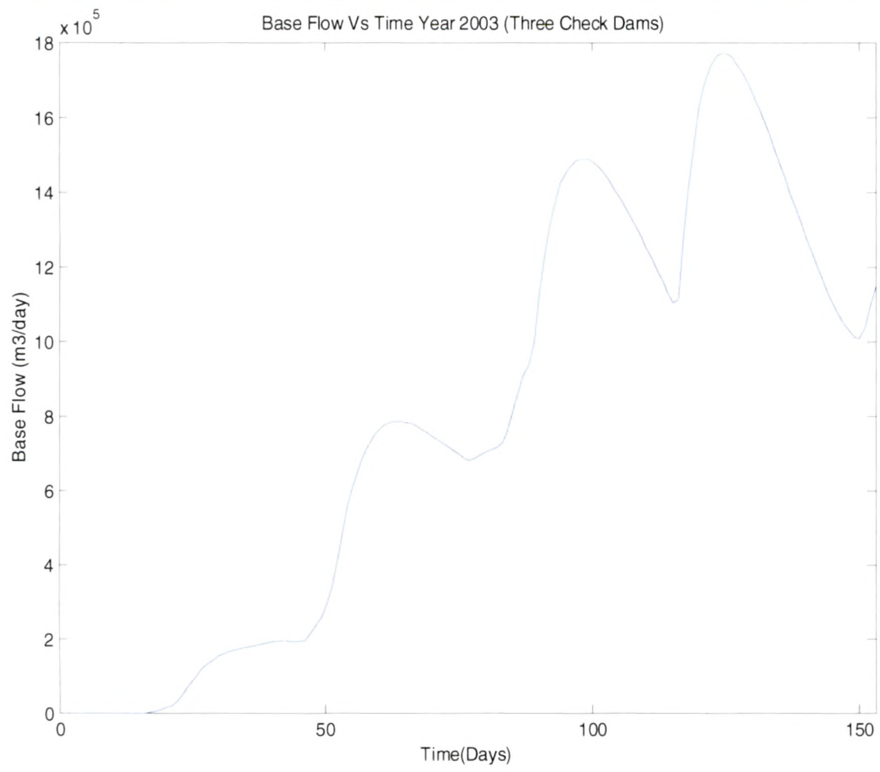
8.1.8.6 Results 2003



Graph – 8.25 Observed Runoff & Calculated Runoff Vs Time 2003

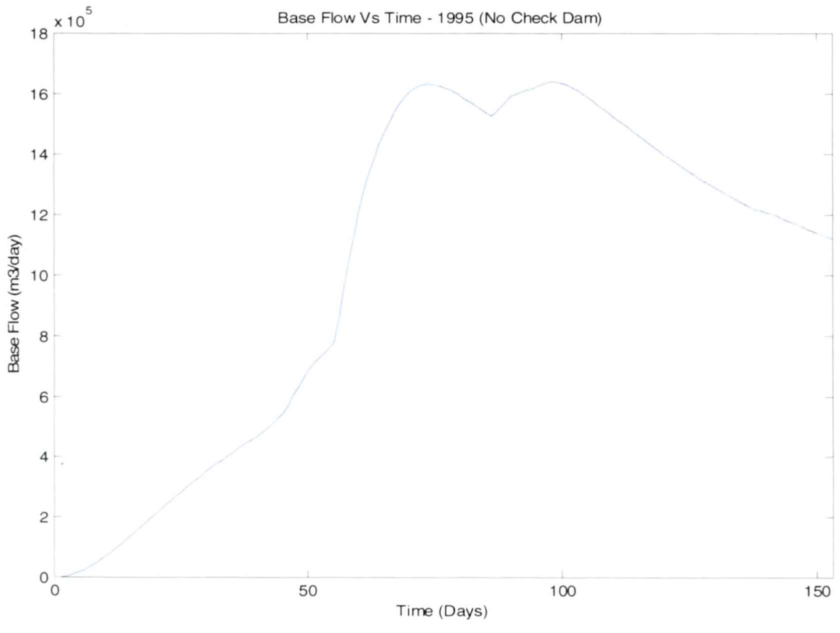


Graph – 8.26 Inter flow Vs time for the year 2003

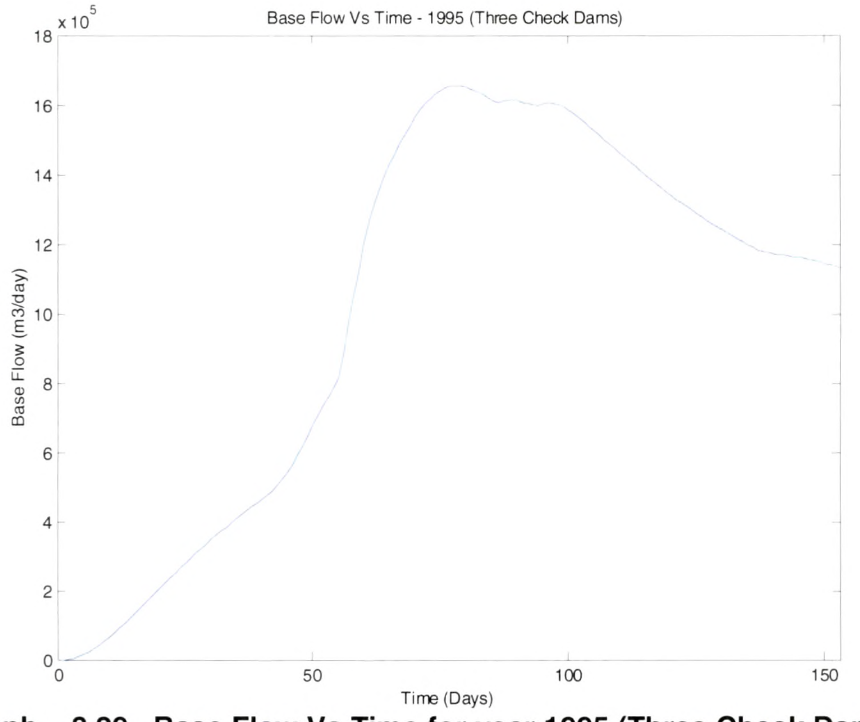


Graph – 8.27 Base Flow Vs Time for the year 2003

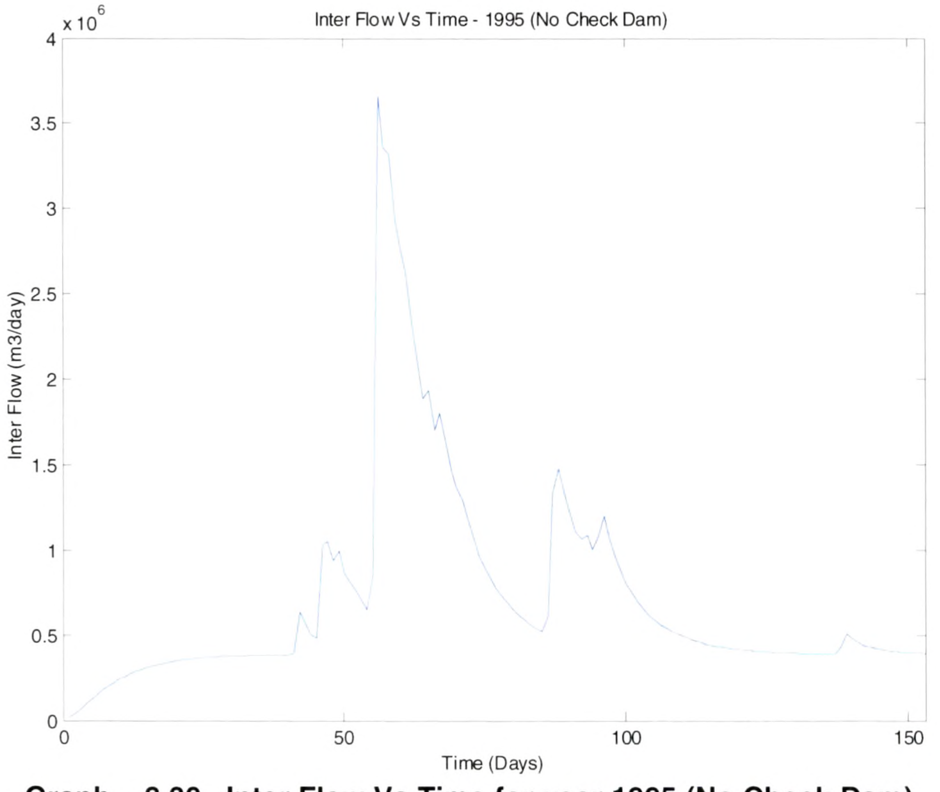
8.1.9 Specimen Results of Base Flow and Inter Flow with Different Number Check Dams



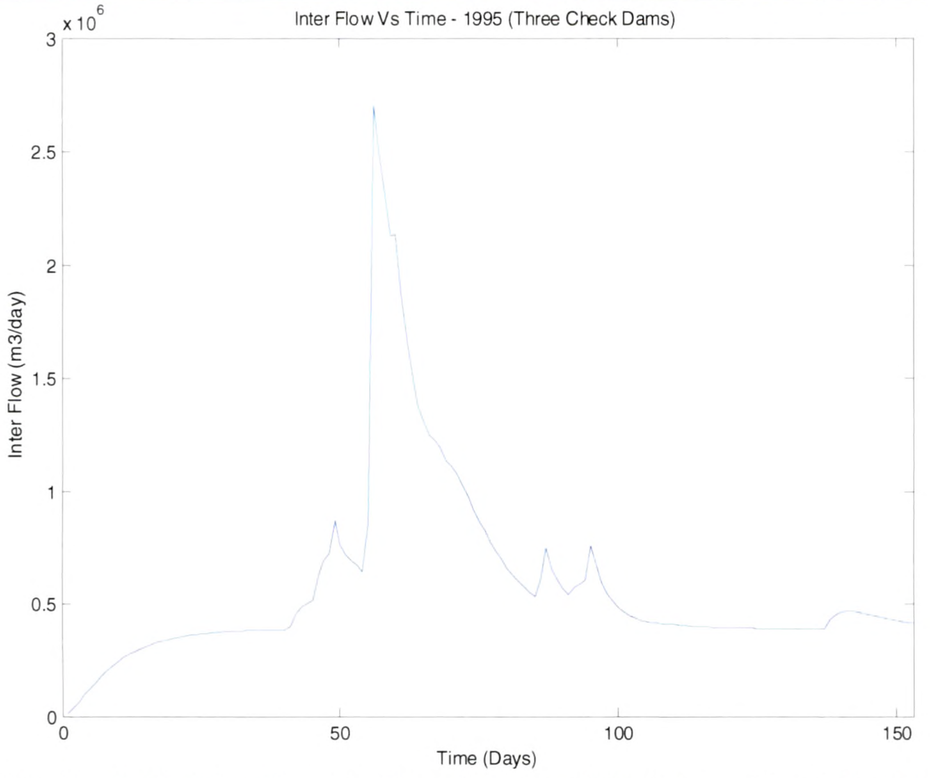
Graph – 8.28 Base Flow Vs Time for year 1995 (No Check Dam)



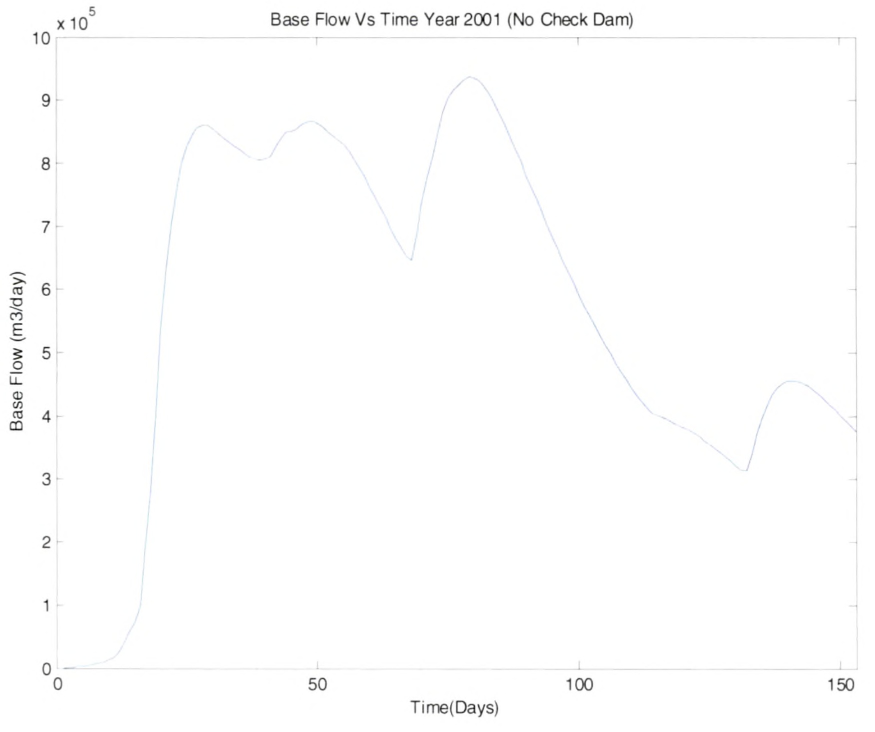
Graph – 8.29 Base Flow Vs Time for year 1995 (Three Check Dams)



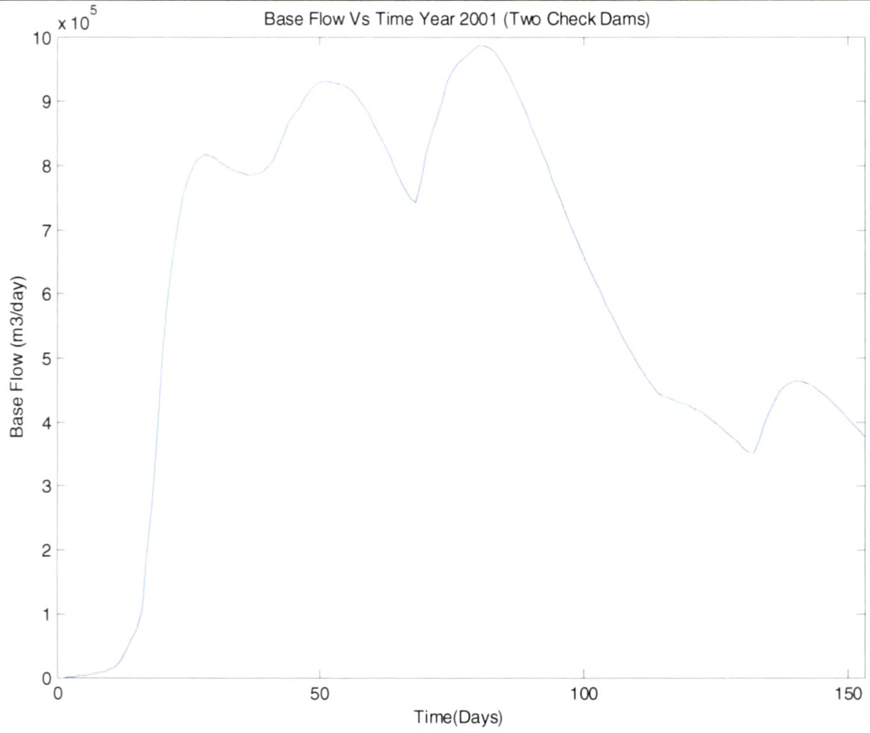
Graph – 8.30 Inter Flow Vs Time for year 1995 (No Check Dam)



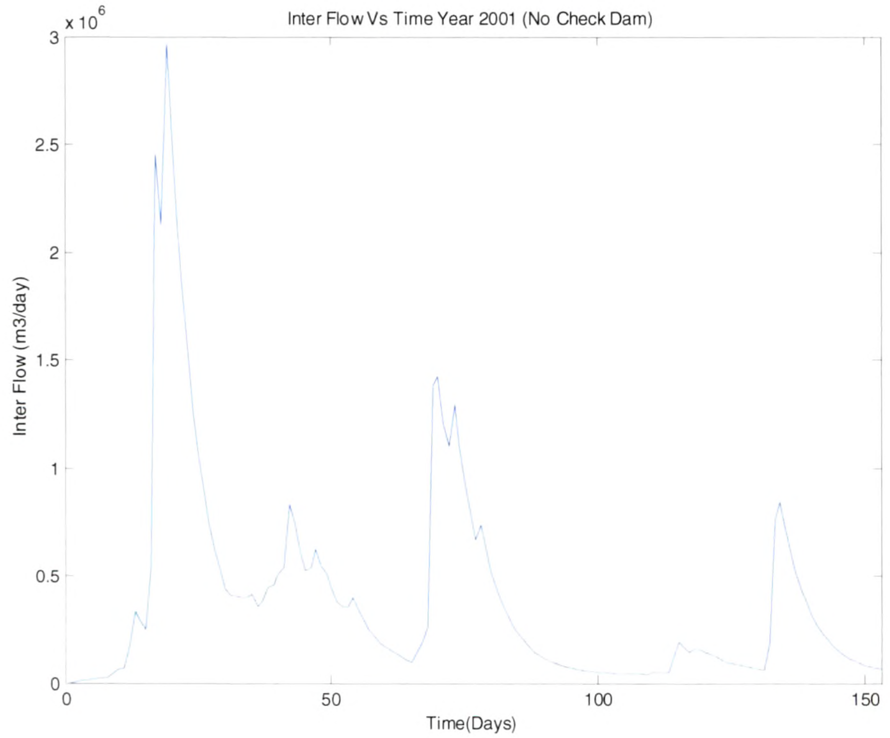
Graph – 8.31 Inter Flow Vs Time for year 1995 (Three Check Dams)



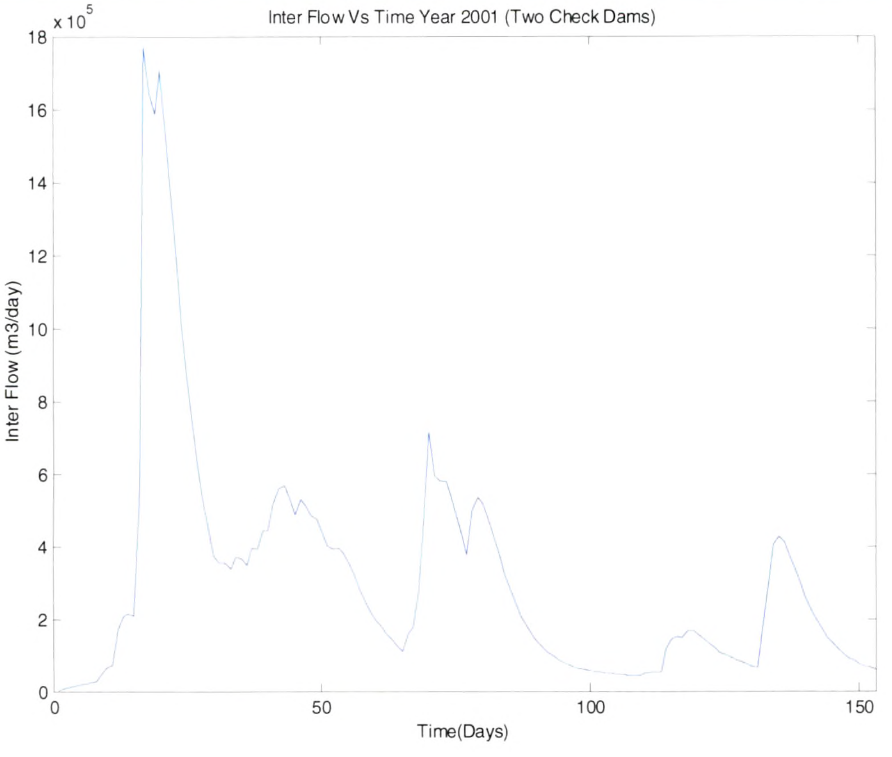
Graph – 8.32 Base Flow Vs Time for year 2001 (No Check Dam)



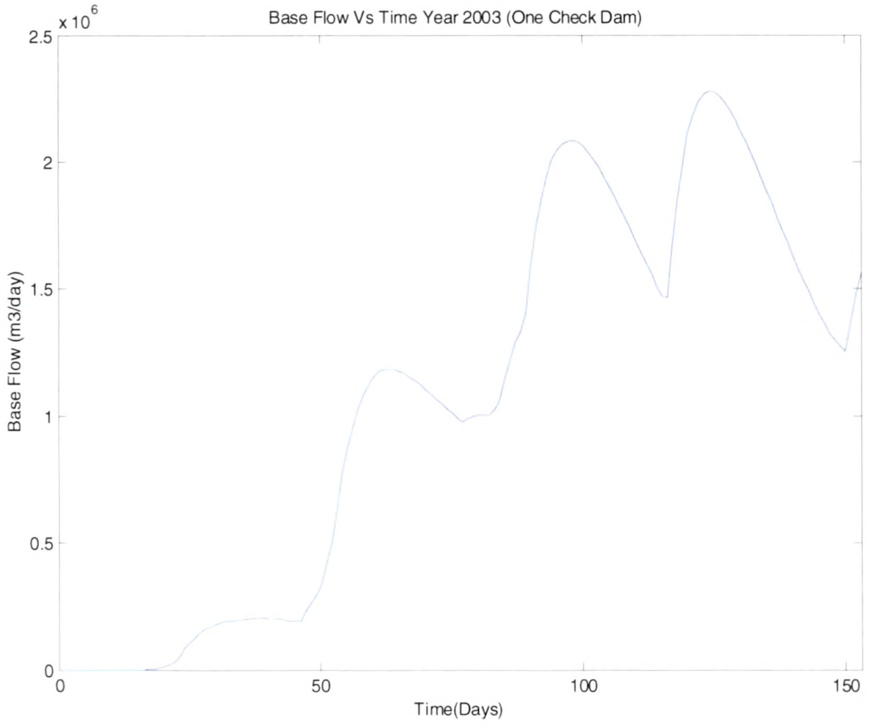
Graph – 8.33 Base Flow Vs Time for year 2001 (Two Check Dams)



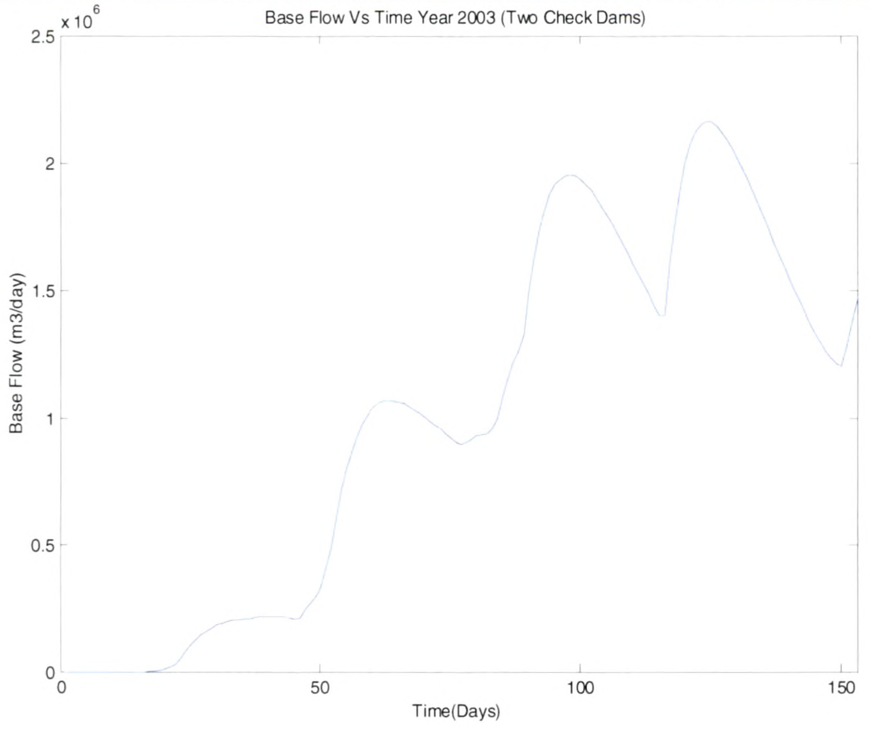
Graph – 8.34 Inter Flow Vs Time for year 2001 (No Check Dam)



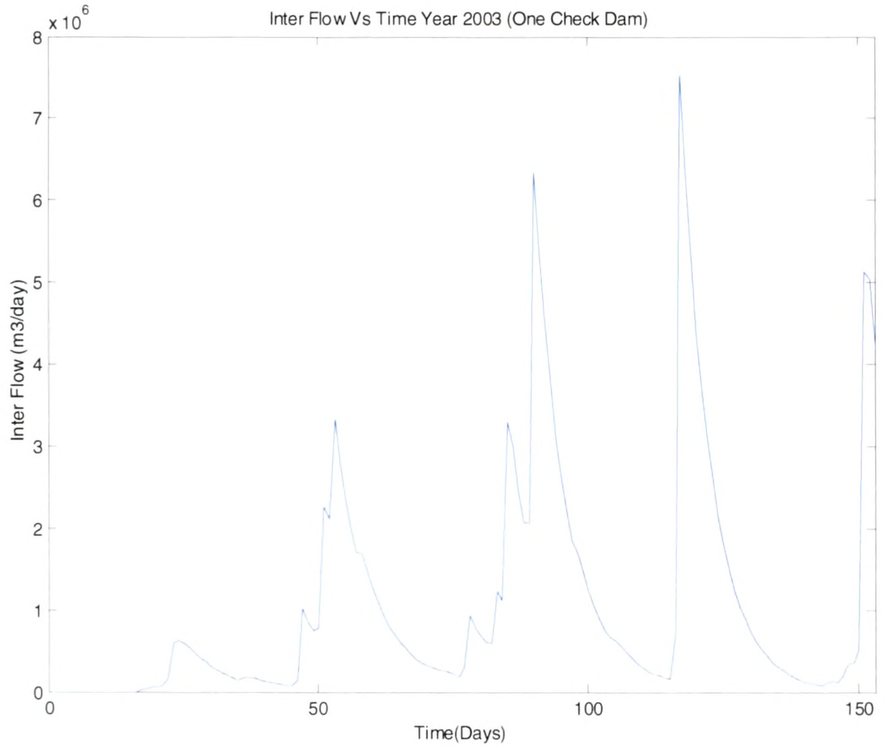
Graph – 8.35 Inter Flow Vs Time for year 2001 (Two Check Dams)



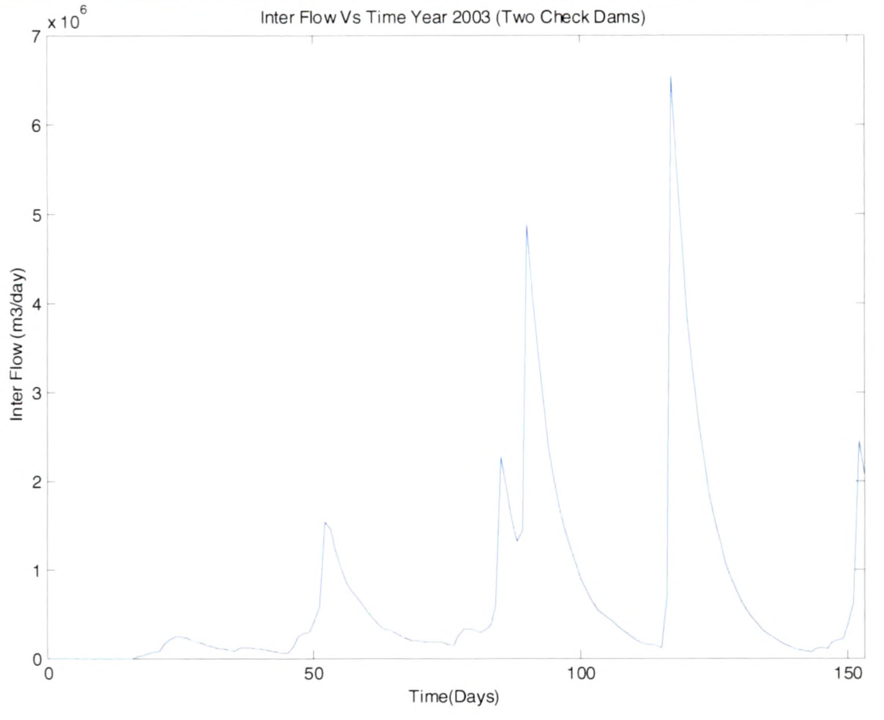
Graph – 8.36 Base Flow Vs Time for year 2003 (One Check Dam)



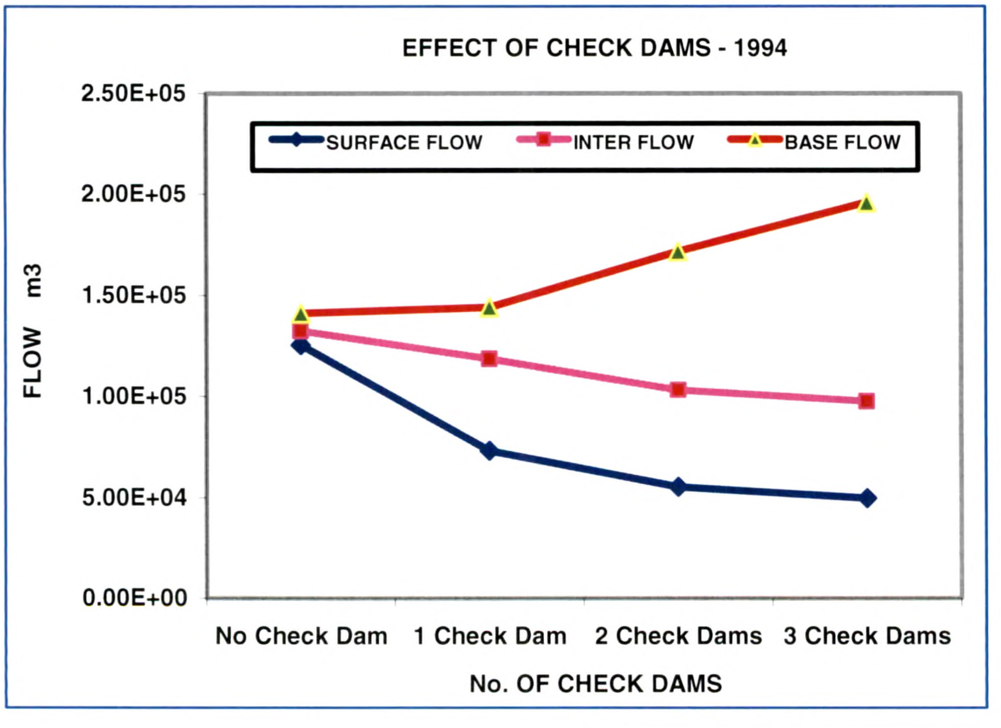
Graph – 8.37 Base Flow Vs Time for year 2003 (Two Check Dams)



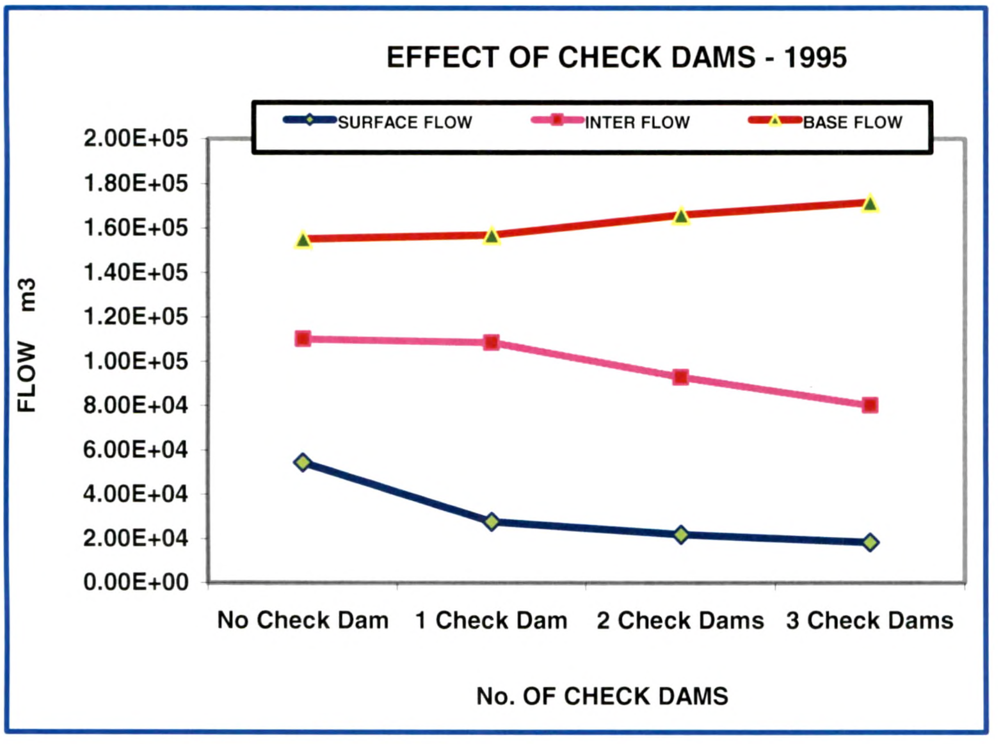
Graph – 8.38 Inter Flow Vs Time for year 2003 (One Check Dam)



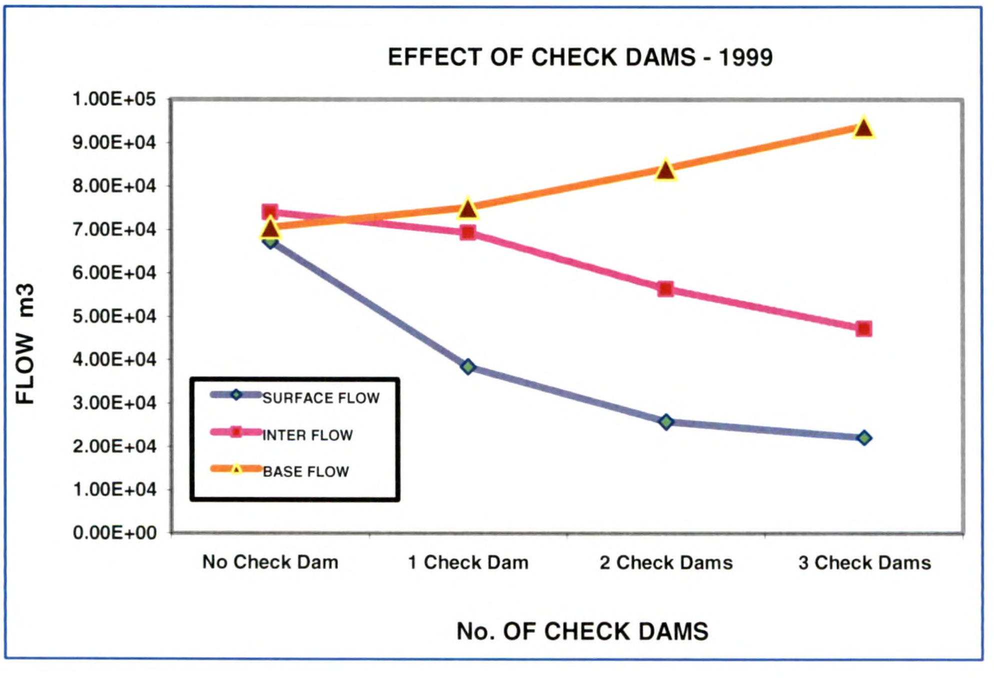
Graph – 8.39 Inter Flow Vs Time for year 2003 (Two Check Dams)



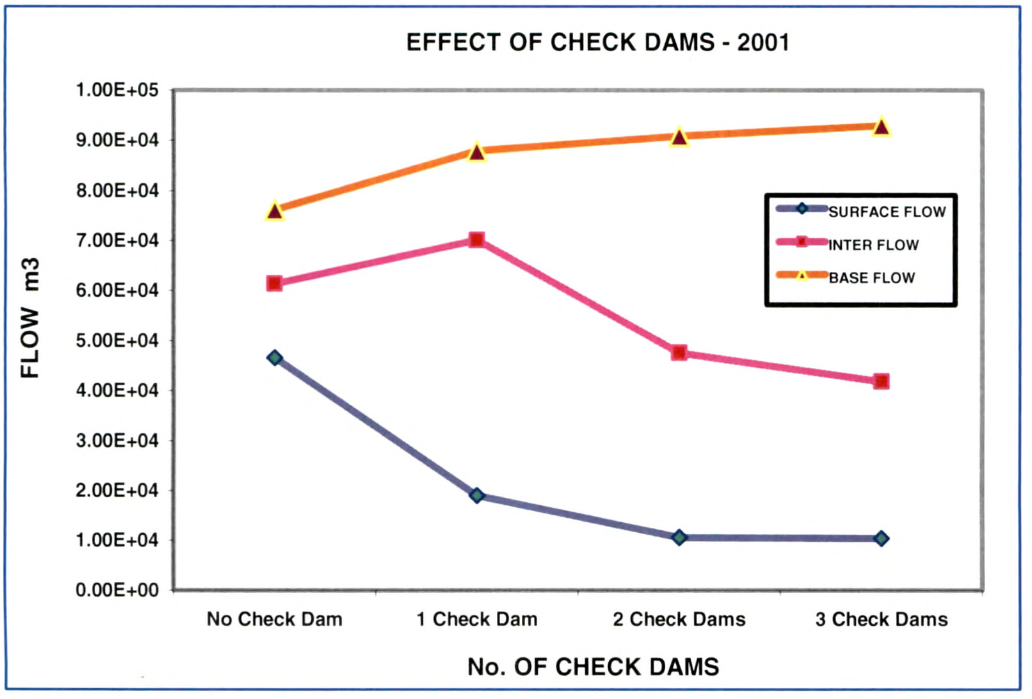
Graph – 8.40 Effect of Different Number of Check Dams - 1994



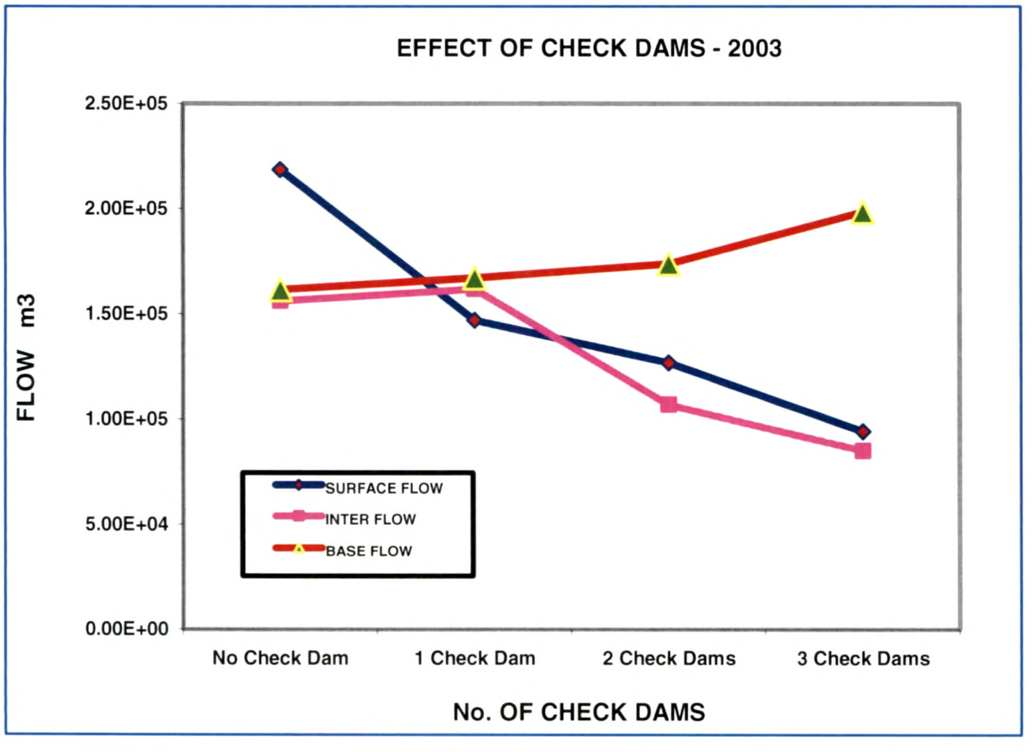
Graph – 8.41 Effect of Different Number of Check Dams - 1995



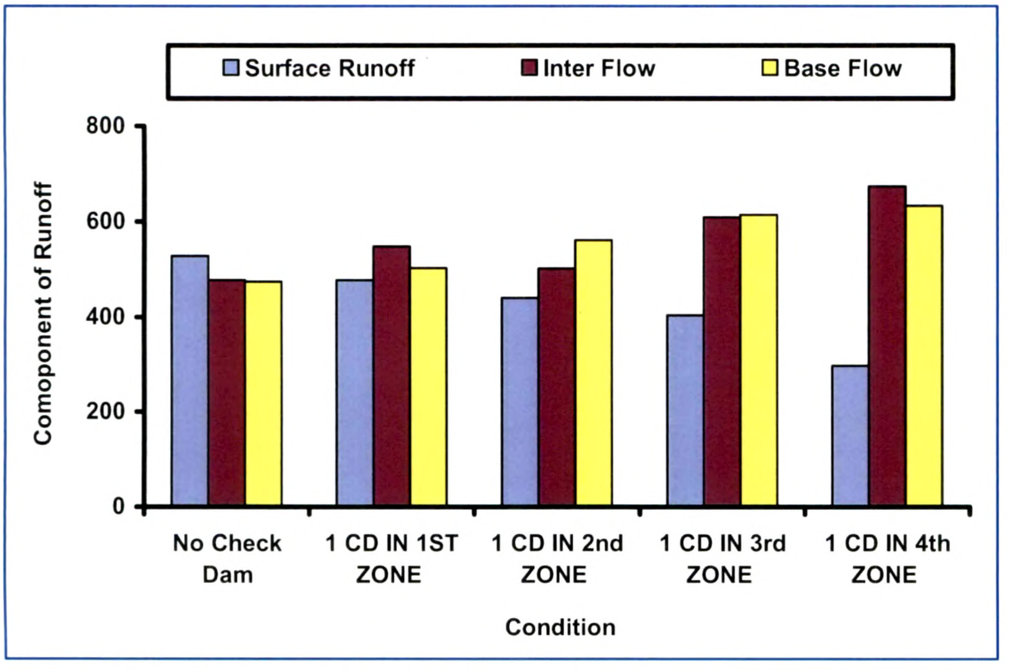
Graph – 8.42 Effect of Different Number of Check Dams - 1999



Graph – 8.43 Effect of Different Number of Check Dams - 2001



Graph – 8.44 Effect of Different Number of Check Dams - 2003



Graph 8.45 Comparison of Effect of One Check Dam in Different Zone