CURSORY ANALYSIS

OF

TUATAPERE

WATER SUPPLY

DATA

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A Report to the Southland Regional Council's Waiau River Working Party

1. DATA

The following data was available for analysis:

1. Hours of operation of bush (ie. bore) pumps 1 & 2.
2. Hours of operation of river pumps 1 & 2.

All readings are at approximately weekly intervals; however often they are at greater intervals and sometimes at shorter intervals.

In effect the data is a summation of pump hours over each period.

River level and flow data at Tuatapere is available at 15 minute intervals.

Hours of pump operation and average river flow at Tuatapere are listed in Table 1.

2. NORMALISATION OF DATA

Because the periods of pump record were of inconsistent length it was necessary to "normalise" the data in order that comparisons could be made between periods of different length and so that analyses could be made for the full length of record.

This was achieved by converting the hourly totals for each period to "percent of time operating". For example pump operation of 99 hours in the period 19 Aug 1991 to 28 Aug 1991 equates to the pump being operational for 46% of the time (ie. 99 hours divided by 9 days x 24 hours x 100). It stands to reason that the maximum percentage of time any pump could be operational is 100.

3. ANNUAL RESULTS

Figures 1 to 7 plot bush pump activity with river level recorded at Tuatapere for each year from 1985 to 1991 inclusive. Likewise Figures 8 to 14 plot river pump activity with river level.

By and large, and as expected, the bush pumps operate predominantly at times of high river level when the river is likely to be dirty. Generally the water is sourced from the bush for quite a time after the river has peaked because it is likely that the river takes quite some time to clear.

In most years there are some quite long periods when the river has been too high for the river pumps to have been used. For example August 1986, June & October 1987, Ocober/November 1988, March-June 1989, May 1990, August and October 1991.

4. AVERAGE RESULTS

In the period from 8 October 1984 until 20 January 1992 the pumps operated for the following percentages of time:

bush pump 1	28.5%
bush pump 2	16.8%
Average	22.7%
river pump 1	2.5%
river pump 2	19.1%
Average	10.8%

Although the bush pumps operate for more than twice the length of time that the river pumps operate, they pump at an average rate of only 27 cubic metres/hour compared with the river pumps which pump at around 50 cubic metres/hour. Overall it would appear that about 53% of time water is supplied from borewater with the remainder supplied from the river.

5. PERIODS OF OPERATION

The percent of time in each recording period that the various pumps have operated is shown in Figures 15 and 16. The average river flow at Tuatapere over the corresponding periods is shown in Figure 17 (note that average flows greater than 700 cumecs are truncated).

Figure 15 shows that there are few periods in which at least one bush pump has not operated. Until mid 1988 both pumps tended to be operated but since then generally only pump 1 has been used.

Figure 16 shows that generally only one river pump was operated until mid 1990 from which time both river pumps have tended to be used.

Figure 17 shows river flows averaged over periods corresponding to the pump data. The high flows in late 1988 coincide with little pumping from the river and extensive use of bush pump no. 1.

6. CORRELATION OF PUMP ACTIVITY WITH RIVER FLOWS

Figure 18 is a scatter plot of pump activity versus river flow at Tuatapere.
In this graph percentages of pump activity in each time period are plotted for bush pump 1 and river pump 2 against average river flow in the period.

While a straightforward correlation between pump activity and river flow is not evident it is clear that at higher flows only the bush pump is operational. This of course corresponds to the information presented in the annual plots (Figures 1 to 14).

7. DISCUSSION

Tuatapere water supply bore water pumps operate on average for 22.7% of the time whereas the pumps which supply water from the river operate on average for 10.8% of the time.

Given that the river pumps can supply water at about twice the rate of the bore pumps it follows that roughly half of Tuatapere's water is supplied from the river and about half from groundwater.

While there are some long time spans when it is not possible to pump from the river there are no particularly long periods when bore water has not been pumped. This is because there are no particularly long periods when the river level is not affected by at least small freshes which increase the suspended sediment concentration.

Unfortunately negligible suspended sediment information has been collected in the lower Waiau river and consequently there is no satisfactory sediment data available for analysis in respect of the water supply operation.

8. CONCLUSION

This report serves merely to substantiate the fact that Tuatapere's water is sourced from groundwater for a large part of the time. The frequency with which groundwater is pumped will mean that the river water held in storage is also likely to be 'contaminated' by groundwater.

Given that the present supply arrangement is inadequate it is recommended that preliminary investigations be made of alternative schemes to deliver high quality water with 100% continuity of supply.

9. ACKNOWLEDGEMENTS

The raw data on pump operation for this study was extracted and tabulated from District Council records by Ngarita Dixon.

This study was funded by the Waiau River Working Party.

TABLE 1 Pump operation and average river flows

BUSH PUMP 1(hrsx100)	BUSH PUMP 2(hrsx100)	RIVER PUMP 1(hrsx100)	RIVER PUMP 2(hrsx100)	RIVER FLOW m3/s	PERIOD ENDING
0	26420	0	0	575.080	841023
0	10790	0	0	470.708	841029
3400	14500	0	0	79.066	841105
0	4000	6870	0	40.835	841112
0	0	7500	0	183.915	850422
0	47700	0	0	99.520	850520
0	2200	0	6400	67.123	850604
7500	7600	1900	9100	123.552	850611
1600	9400	0	0	111.702	850617
0	14700	0	0	96.956	850625
0	0	0	9200	50.090	850702
0	8000	0	16000	117.078	850715
0	5700	0	6300	117.410	850723
0	3000	0	6100	65.558	850729
0	0	0	7600	54.527	850805
0	0	0	7800	52.821	850812
0	400	0	7300	58.586	850819
200	9400	0	0	205.889	850827
0	0	0	7400	58.405	850902
0	400	0	8500	124.852	850909
400	1800	0	28200	67.479	850930
0	0	2900	7100	92.889	851009
0	0	0	11800	44.026	851015
1700	1700	0	6200	36.749	851021
0	0	0	12000	36.868	851030
0	0	0	6600	32.550	851104
0	0	0	10400	32.980	851111
0	0	0	12500	26.048	851118
0	8100	0	3300	76.503	851125
0	500	0	10700	46.609	851202
0	3800	0	8400	63.982	851209
1300	1400	300	10600	23.042	851216
0	5400	0	13400	48.123	851227
0	7000	0	7900	126.356	860106
200	7600	1300	16600	104.185	860120
0	2900	0	8000	37.276	860127
100	600	100	26500	33.019	860212
0	7500	300	11500	52.630	860224
300	8400	100	4300	177.877	860303
300	200	100	14300	45.193	860310
2100	0	0	6300	60.522	860318
6100	300	0	5500	50.726	860325
500	0	0	15000	56.048	860407
1600	0	0	10900	92.909	860414
200	7400	0	500	94.449	860421
1300	1600	0	11700	87.887	860429
1800	5700	0	7700	340.961	860505
0	8400	4100	2300	258.557	860512
0	0	10800	0	62.700	860519
10300	10300	0	0	76.867	860526
8300	8300	0	2300	163.522	860603
7900	7800	0	0	259.790	860609
9400	9400	0	0	333.434	860616
4100	4100	0	4700	178.305	860623

6900	6900	0	2800	159.934	860630
9800	9800	0	0	188.258	860707
10700	10800	0	0	118.388	860714
5100	5100	0	6000	87.684	860721
2700	2700	3100	5700	106.506	860728
10500	10500	0	0	322.257	860804
11300	11300	0	0	169.800	860811
11000	11000	0	0	149.059	860818
11200	11300	0	0	70.690	860825
9700	9700	0	0	68.227	860901
1600	1600	0	8100	70.042	860908
2800	2300	0	4800	86.910	860915
0	0	0	6800	53.106	860922
0	0	0	7600	70.338	860929
3100	3100	0	4900	233.434	861006
2800	2800	0	5400	161.854	861013
0	0	0	7700	62.253	861020
0	0	0	8200	53.727	861028
0	0	0	7900	49.457	861103
0	0	0	8700	47.441	861110
8000	8000	0	4000	58.166	861117
0	0	0	10400	43.720	861124
10500	10500	0	1200	196.734	861201
7400	7400	0	3700	77.772	861208
900	900	0	11300	34.560	861216
0	0	0	9300	35.448	861222
9800	9800	0	0	103.233	861229
10800	10800	0	0	96.278	870105
0	12900	0	1700	26.968	870112
0	12300	0	400	75.996	870119
0	13000	0	300	151.751	870126
5000	11700	0	1300	71.347	870202
12200	12200	0	0	235.512	870209
14300	14300	0	200	160.501	870216
8700	8800	0	3400	48.699	870223
22800	25200	0	2000	230.905	870309
8000	6800	0	0	718.912	870316
7500	7500	0	4900	115.693	870324
10700	10700	0	400	59.996	870330
11800	11800	0	1200	348.072	870406
15200	15200	0	0	285.858	870413
14900	14900	0	3800	214.403	870422
11400	11400	0	0	228.681	870427
5500	5500	0	5700	136.454	870504
500	500	0	8000	122.438	870512
900	900	0	5500	92.099	870518
8300	8300	0	1700	109.456	870525
12700	12700	0	500	190.940	870602
9300	9300	0	400	470.360	870608
10800	10800	0	0	265.749	870615
11100	11100	0	0	296.066	870622
10900	10900	0	0	165.451	870629
21600	21600	0	0	140.673	870713
10800	10800	0	800	81.026	870720
11000	5900	0	0	245.994	870727
400	0	0	9900	76.795	870803
8800	5500	0	600	148.451	870810
0	2500	0	6900	68.133	870817
0	2200	0	6100	65.183	870824
0	0	800	8600	54.431	870901

0	6500	0	3400	101.723	870907
0	8000	0	2800	127.549	870914
11400	12000	0	0	162.654	870921
12200	12200	0	0	158.846	870928
12300	12300	0	0	308.508	871005
13200	13200	0	0	728.826	871012
12600	12600	0	0	526.422	871019
31200	31300	0	0	234.681	871103
10200	10100	0	0	296.343	871109
6100	6100	0	4900	86.331	871116
0	0	0	9000	33.719	871123
0	0	0	10800	40.387	871201
0	0	0	6700	59.532	871207
7200	7200	0	3000	78.745	871214
0	0	0	8100	53.244	871221
0	0	0	7700	58.766	871229
0	0	0	7900	48.481	880106
20000	19800	0	8700	80.788	880125
0	3500	0	7400	40.262	880201
0	0	0	9900	22.860	880208
0	0	0	9800	26.075	880215
0	12800	0	700	66.540	880222
0	14200	0	1000	155.672	880229
0	4600	0	7100	71.448	880307
0	0	0	10800	19.738	880315
0	0	0	7700	32.830	880321
0	0	0	9400	28.132	880328
0	7300	0	10700	44.340	880406
0	3400	0	4400	93.189	880411
0	2100	0	8800	74.708	880418
0	0	0	10500	41.865	880426
0	0	0	7300	33.589	880502
4600	7000	0	4260	52.938	880509
4900	5000	0	5700	65.384	880516
3100	21900	0	4200	89.479	880530
0	0	0	8800	58.671	880607
0	9300	0	1200	84.976	880613
0	7100	0	4100	65.050	880620
0	7400	0	3200	125.361	880627
0	13300	0	0	210.243	880704
0	12900	0	0	161.438	880711
0	11100	0	1600	102.489	880718
0	1000	0	6800	55.585	880725
0	0	0	8700	144.289	880801
8700	3600	0	0	160.899	880808
0	0	0	8200	75.877	880815
3900	0	0	5600	143.644	880822
7800	0	0	2500	199.663	880829
6800	0	0	3100	109.073	880905
2400	0	0	5500	148.631	880912
11500	0	0	0	729.030	880919
11800	0	0	0	574.768	880926
23200	0	0	0	517.935	881010
13200	0	0	0	741.800	881018
10500	0	0	0	1119.141	881025
9300	0	0	0	1341.940	881031
11300	0	0	0	1382.586	881107
8400	3900	0	0	973.481	881114
10800	3200	0	0	656.353	881121
12800	0	0	0	439.527	881128

7400	0	0	6300	266.781	881205
2300	0	0	7700	207.500	881212
11300	11600	0	4000	386.111	881219
6000	0	0	11100	252.988	881228
7200	5900	0	500	194.557	890104
13000	0	0	0	199.944	890111
11800	0	0	0	133.861	890118
7800	0	0	0	64.205	890123
9700	0	0	3300	42.673	890130
7700	0	0	6000	95.889	890207
7000	0	0	2900	51.369	890213
0	0	0	8600	28.968	890220
11200	400	0	2100	135.494	890227
13200	0	0	0	48.183	890306
13600	0	0	0	35.807	890313
13000	0	0	0	78.764	890320
16900	0	0	0	117.534	890329
9300	0	0	0	249.543	890403
12900	0	0	0	50.107	890410
14000	0	0	0	50.126	890417
13100	0	0	0	72.416	890424
13400	0	0	0	48.899	890501
13500	0	0	0	70.153	890508
14000	0	0	0	50.008	890515
14100	0	0	0	77.507	890522
14500	0	0	0	65.913	890529
15900	0	0	0	91.455	890606
11400	0	0	200	242.252	890612
14000	0	0	0	225.169	890619
11900	0	0	0	256.849	890626
12400	0	0	0	104.560	890703
22900	0	0	0	113.853	890717
11400	0	0	0	63.762	890724
300	0	0	8000	41.844	890731
7500	0	0	2400	68.570	890807
3000	0	0	5600	47.151	890814
3700	0	0	4600	35.921	890821
0	0	0	6900	30.010	890828
800	0	0	6500	28.817	890904
4600	0	0	4200	37.107	890911
4400	0	0	4300	33.071	890918
4700	0	0	3900	43.847	890925
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1300	0	0	6600	31.277	891016
1300	0	0	7500	35.622	891024
3600	0	0	4400	32.932	891030
3800	0	0	8200	34.789	891108
8000	0	0	1500	87.377	891113
300	0	0	9300	48.949	891120
3900	3500	0	6300	49.548	891127
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200	0	0	9300	21.701	891211
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30900	0	0	9700	47.594	900115
8700	0	0	2300	74.236	900122
0	0	0	9000	24.018	900129
2000	0	0	8800	18.345	900205
4200	0	0	5400	21.548	900212
2700	0	0	6700	17.352	900219

5500	0	0	4300	15.709	900226
3200	0	0	4600	22.537	900305
5800	0	0	3400	60.911	900312
3700	0	0	5300	37.758	900320
1600	0	0	18300	19.469	900409
400	0	0	6000	11.001	900417
7600	0	0	500	65.442	900423
1200	0	0	4700	43.184	900430
5700	0	2200	0	77.054	900507
8800	0	0	0	202.415	900514
9400	0	0	0	327.072	900521
8900	0	0	0	455.206	900528
10400	0	0	0	305.347	900605
7700	0	0	0	106.455	900611
2700	0	4900	0	67.113	900618
9100	0	0	0	177.759	900625
9300	0	0	0	198.833	900702
6000	0	3000	0	143.442	900709
9000	0	0	0	239.704	900716
2900	0	0	3900	121.618	900723
3500	0	3600	0	104.204	900730
2700	0	0	3900	46.492	900806
0	500	5200	0	48.590	900813
3100	0	3500	0	33.605	900820
1100	0	0	4700	28.435	900827
3500	0	3600	0	33.904	900903
3800	0	0	3800	31.748	900910
4200	0	2800	0	37.329	900917
0	0	0	6000	33.821	900924
0	0	5700	0	31.004	901001
1600	1700	0	5200	94.153	901008
9900	0	0	1800	144.666	901018
5900	400	0	0	62.227	901023
4100	0	0	2800	42.178	901029
3800	0	3000	0	44.637	901105
3100	0	0	4800	29.774	901112
3400	0	4000	0	31.309	901119
0	0	0	6400	29.806	901126
2300	0	5100	0	24.371	901203
9100	900	0	1300	19.299	901210
8500	0	500	0	249.056	901217
9400	0	0	0	336.678	901224
16300	0	1000	0	261.799	910107
9200	0	0	0	549.719	910114
10300	0	0	0	269.641	910121
1300	0	8700	0	34.774	910128
5300	0	0	5100	91.507	910204
12600	0	0	0	246.964	910211
12600	0	0	0	339.879	910218
11600	4000	0	0	598.807	910225
12800	0	0	0	231.788	910304
3200	500	6300	0	71.280	910311
2300	0	0	6200	31.414	910318
2900	0	200	5800	17.462	910325
1600	0	7200	0	20.300	910403
0	0	3600	0	59.922	910408
8400	300	700	0	107.983	910415
8100	0	0	1000	99.501	910422
9500	0	700	0	115.344	910430
4700	2800	2600	0	79.336	910506

11100	0	200	0	76.513	910513
9400	200	0	0	128.828	910520
8900	0	0	0	60.774	910527
10200	0	0	0	78.438	910604
10400	0	0	0	73.057	910612
0	0	0	3900	43.210	910617
6000	0	1800	0	59.848	910624
3400	0	0	2800	56.862	910701
8000	0	0	0	45.202	910708
0	0	5100	0	45.471	910715
0	0	0	4800	37.048	910722
7400	0	0	0	73.746	910729
13000	0	0	1500	151.040	910812
7600	0	0	0	658.520	910819
9900	0	0	0	332.813	910828
5900	0	0	0	106.871	910902
0	0	0	5400	75.771	910909
5000	0	2600	0	187.328	910916
8900	0	0	0	83.102	910923
8200	0	700	0	71.886	910930
8800	0	0	600	77.635	911007
1100	0	5500	0	95.268	911014
0	9800	0	0	458.648	911021
8300	4800	0	0	438.034	911030
11100	0	0	0	294.783	911106
7800	0	0	0	56.969	911111
9700	0	0	0	83.902	911118
2700	0	4200	0	71.587	911125
1600	0	4900	0	62.052	911202
4800	0	3500	0	61.174	911209
3700	0	0	4100	59.908	911216
0	0	0	7800	36.534	911223
0	0	7900	0	31.258	911230
0	0	0	10600	26.286	920108
0	0	5200	0	23.024	920113
0	0	0	6900	38.658	920120

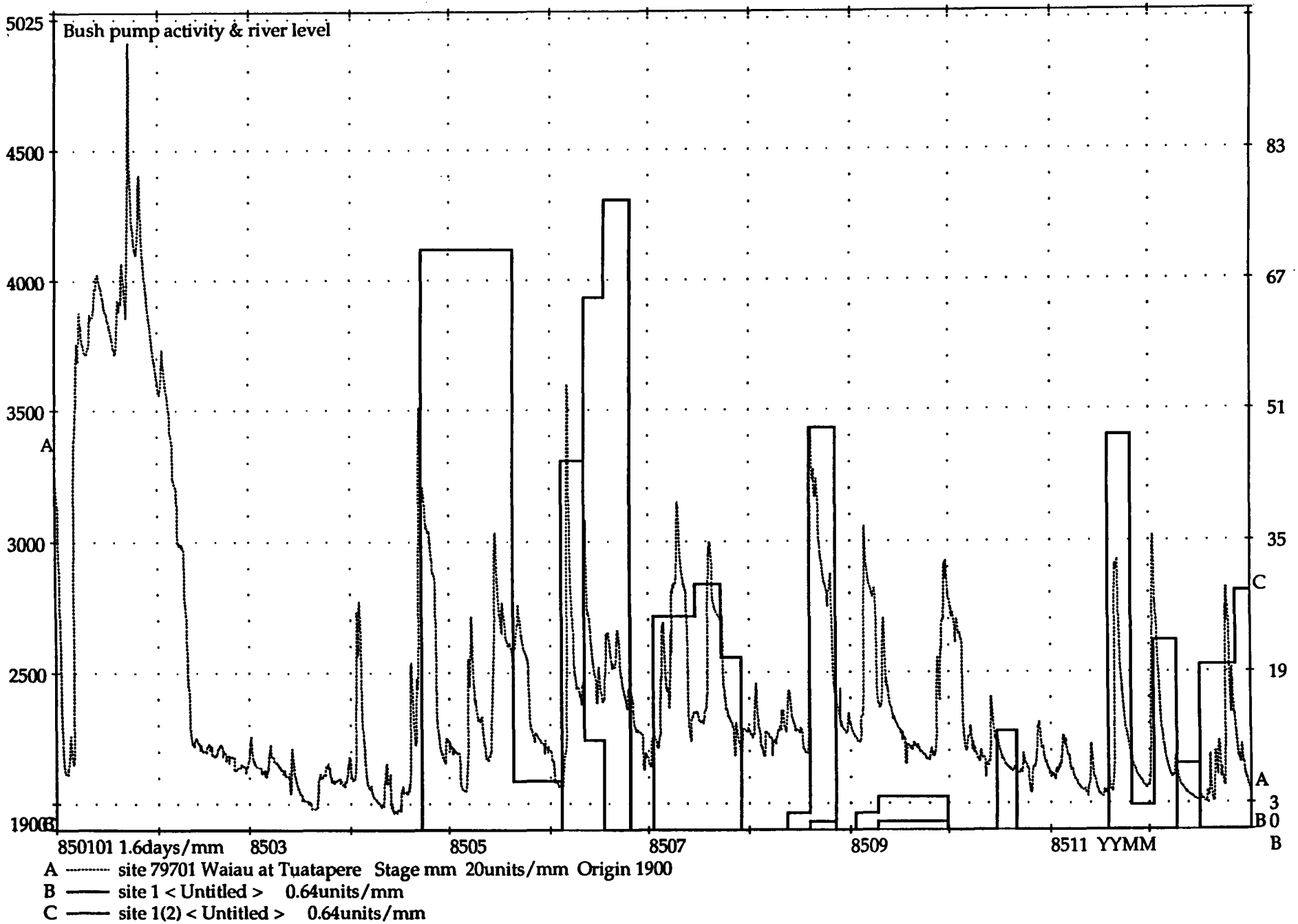

Bush pump activity & river level
5025
4500
4000
3500
3000
2500
1900
A
B
83
67
51
35
19
3
0
C
A
B
850101 1.6days/mm
8503
8505
8507
8509
8511 YYMM
A ····· site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1 < Untitled > 0.64units/mm
C —— site 1(2) < Untitled > 0.64units/mm

FIGURE 1

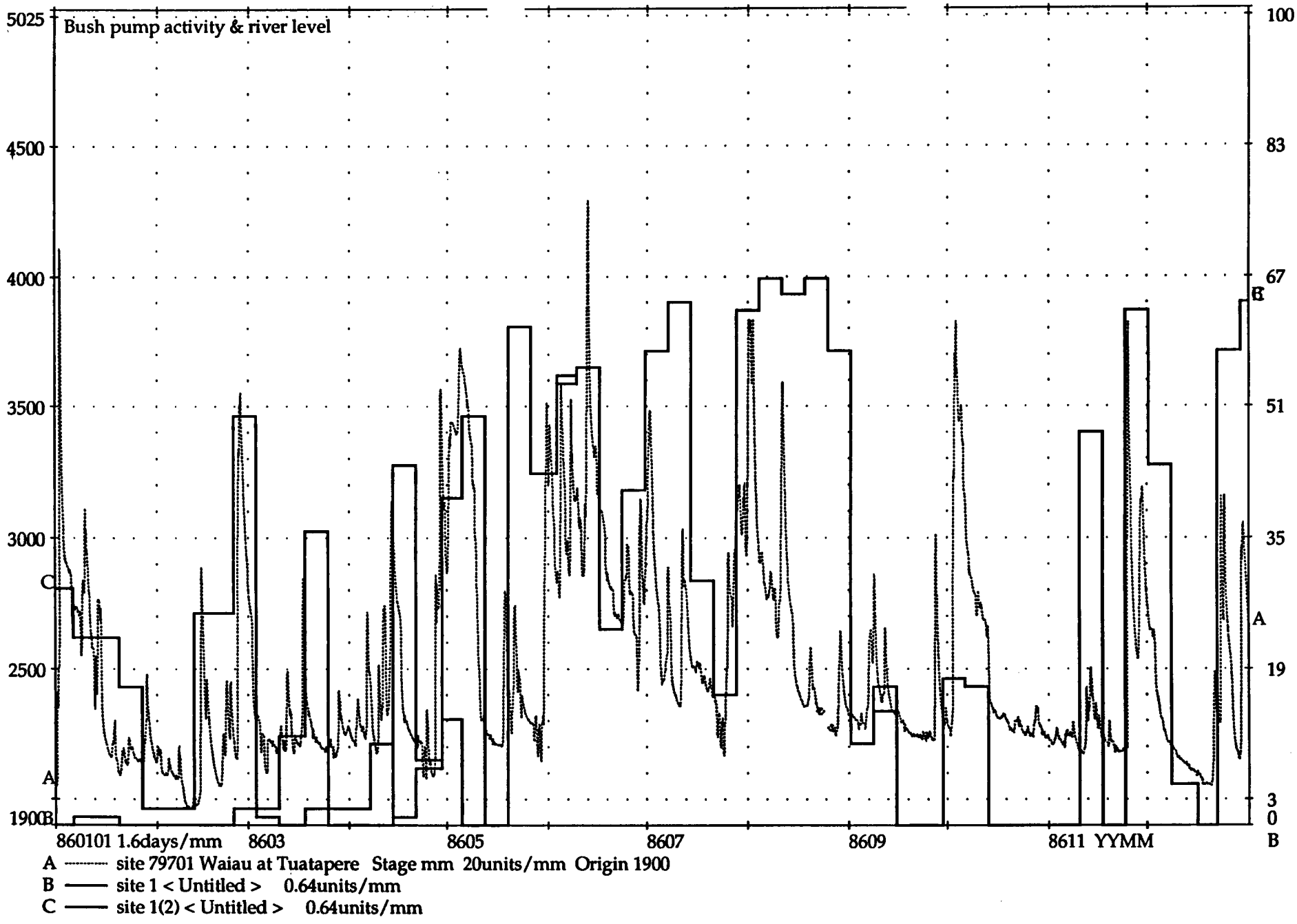

Bush pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
3
0
C
A
B
860101 1.6days/mm
8603
8605
8607
8609
8611 YYMM
A ---------- site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1 < Untitled > 0.64units/mm
C —— site 1(2) < Untitled > 0.64units/mm

FIGURE 2

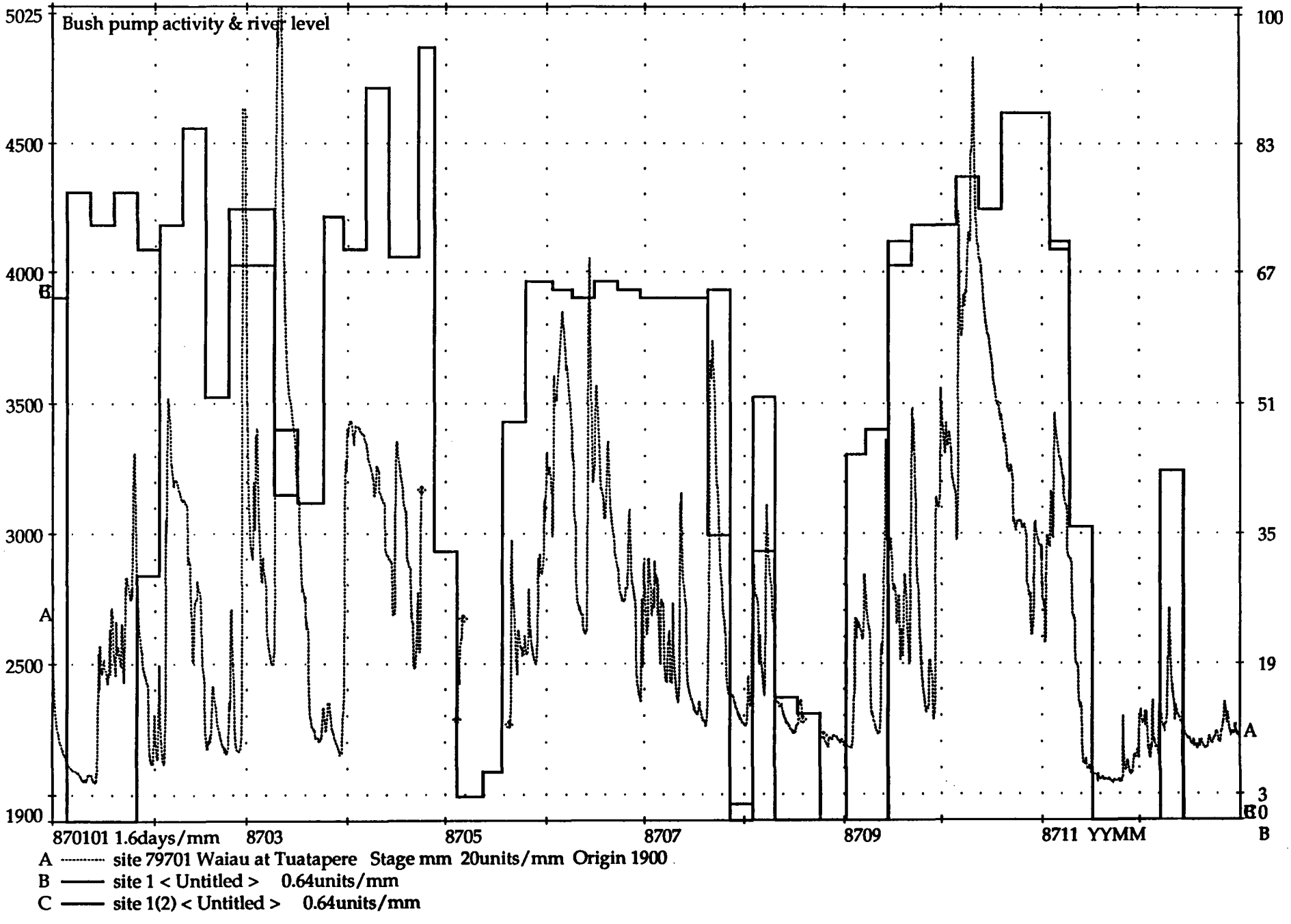

Bush pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
3
0
A
B
870101 1.6days/mm
8703
8705
8707
8709
8711 YYMM
A ····· site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1 < Untitled > 0.64units/mm
C —— site 1(2) < Untitled > 0.64units/mm

FIGURE 3

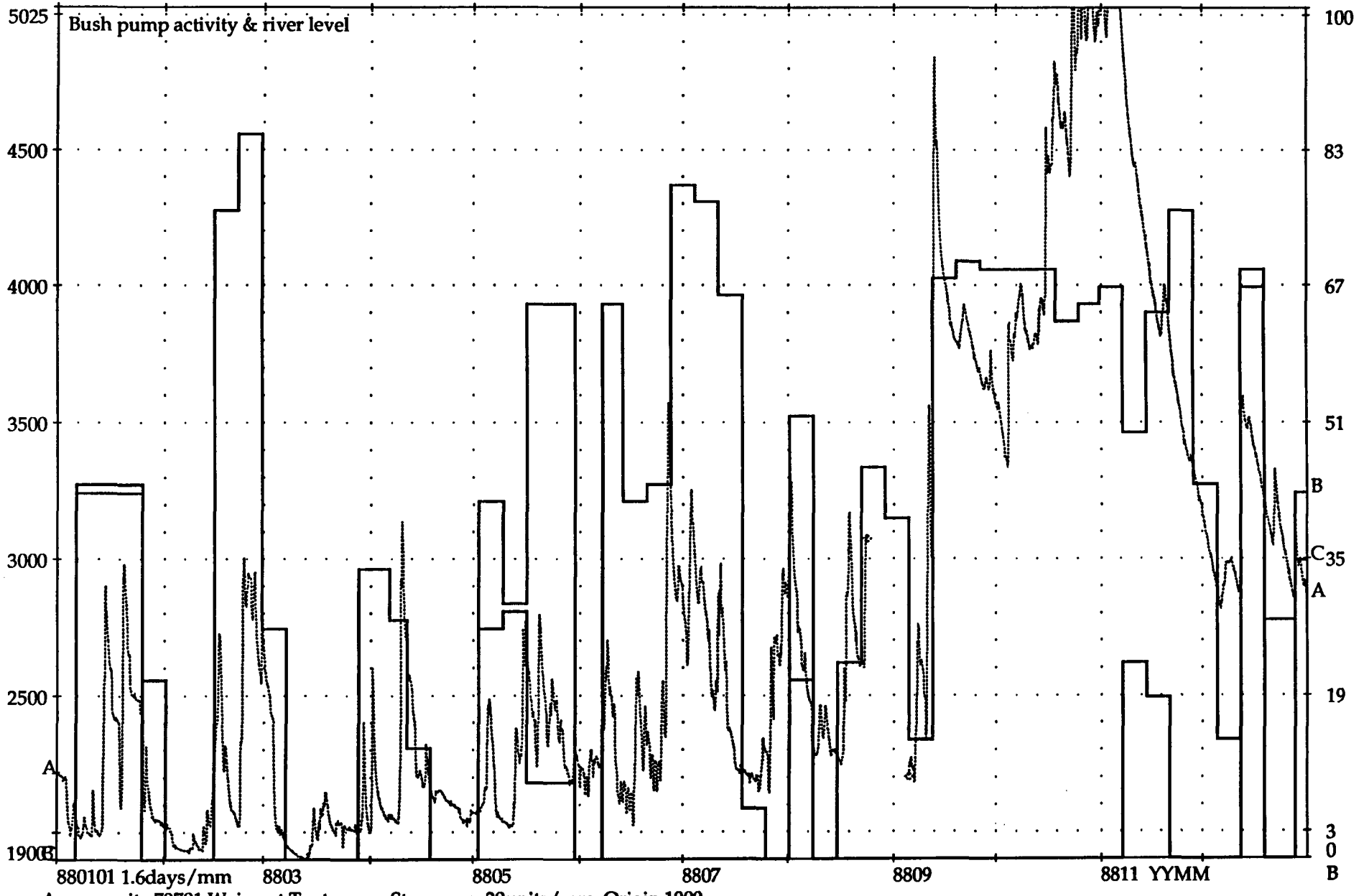

Bush pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
3
0
A
B
C
880101 1.6days/mm
8803
8805
8807
8809
8811 YYMM
A ····· site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1 < Untitled > 0.64units/mm
C —— site 1(2) < Untitled > 0.64units/mm

FIGURE 4

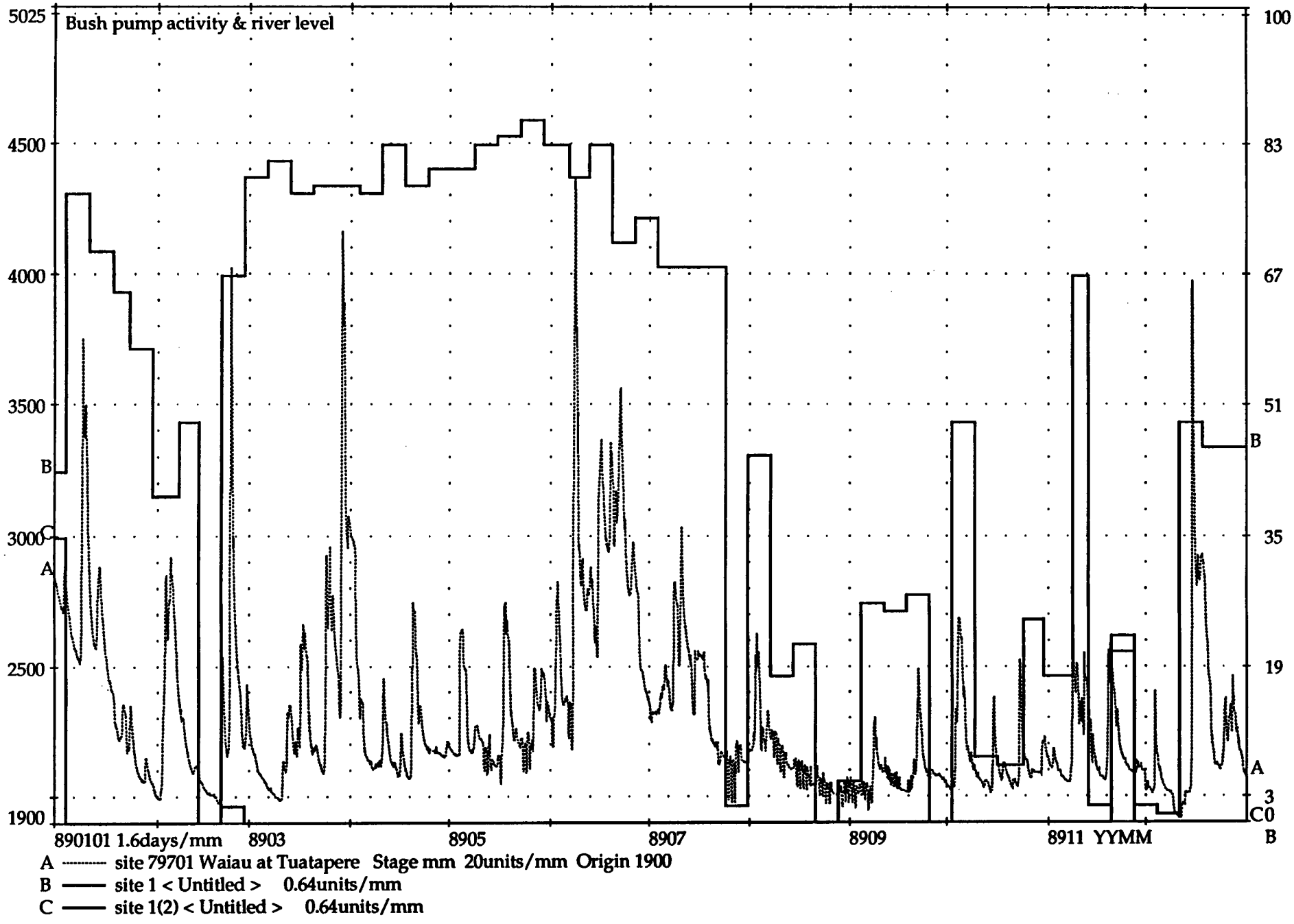

Bush pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
3
0
B
C
A
890101 1.6days/mm
8903
8905
8907
8909
8911 YYMM
A ---------- site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1 < Untitled > 0.64units/mm
C —— site 1(2) < Untitled > 0.64units/mm

FIGURE 5

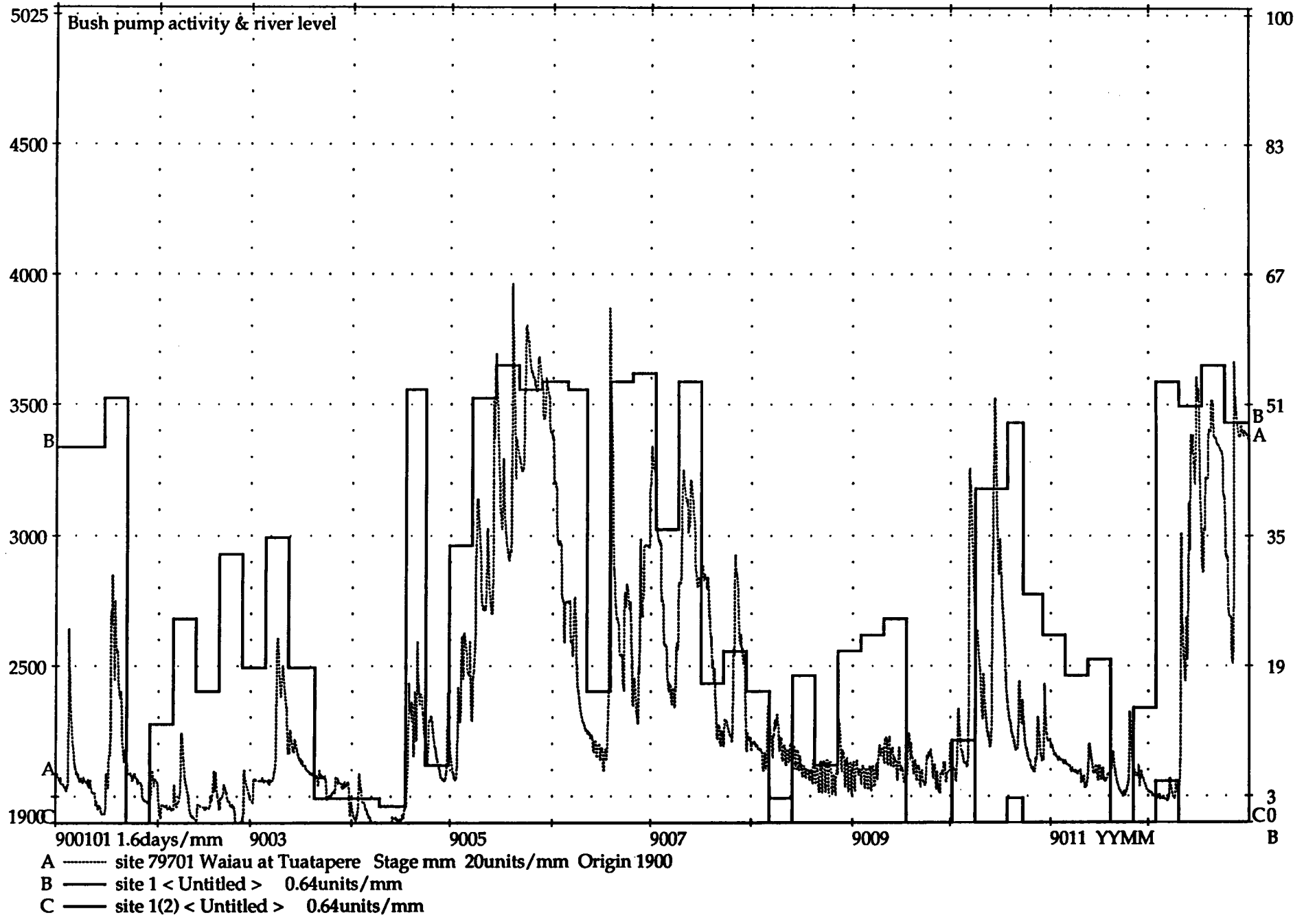

Bush pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
3
0
B
A
C
900101 1.6days/mm
9003
9005
9007
9009
9011 YYMM
A ····· site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1 < Untitled > 0.64units/mm
C —— site 1(2) < Untitled > 0.64units/mm

FIGURE 6

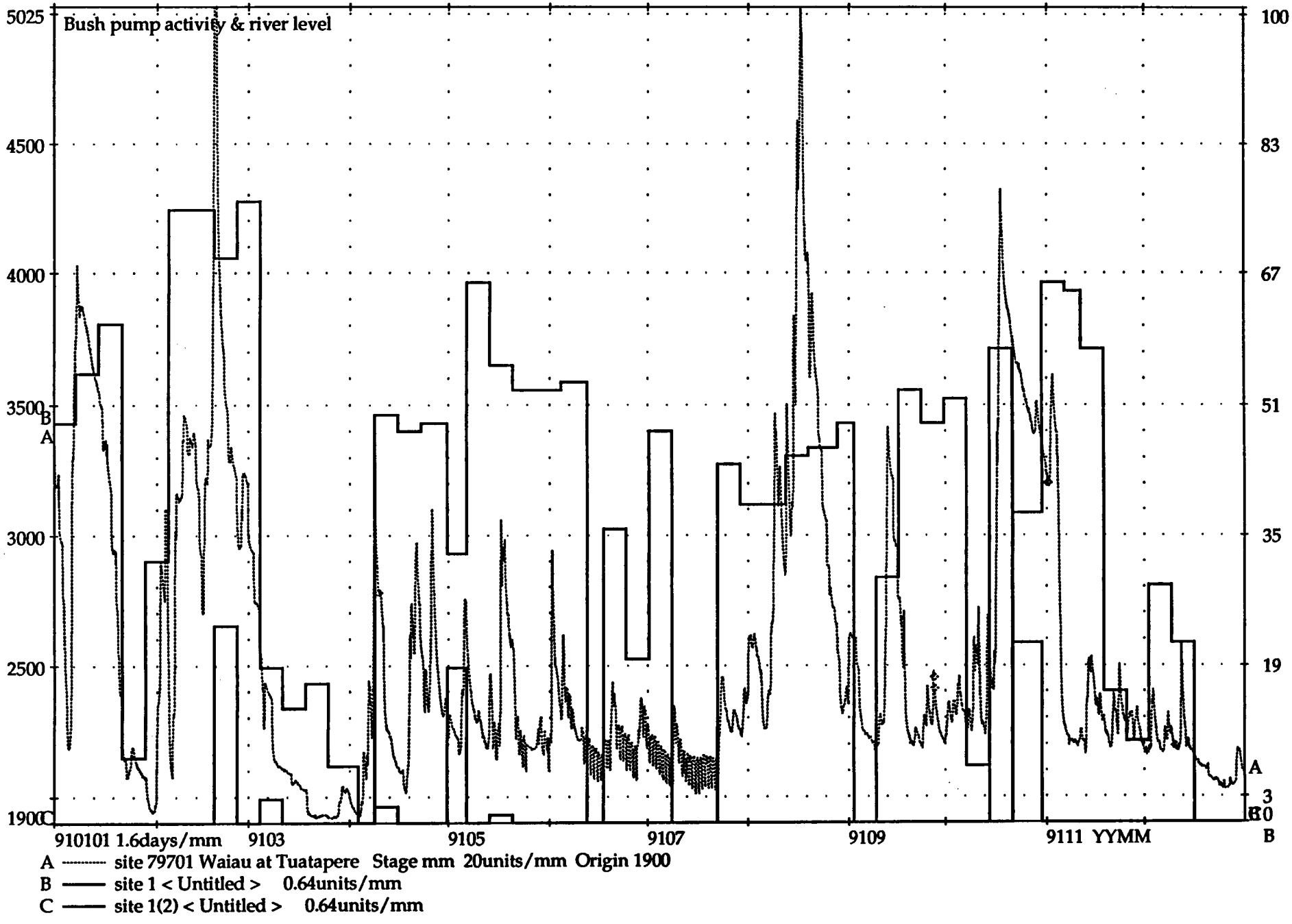

Bush pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
3
B
A
910101 1.6days/mm
9103
9105
9107
9109
9111 YYMM
A ---------- site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1 < Untitled > 0.64units/mm
C —— site 1(2) < Untitled > 0.64units/mm

FIGURE 7

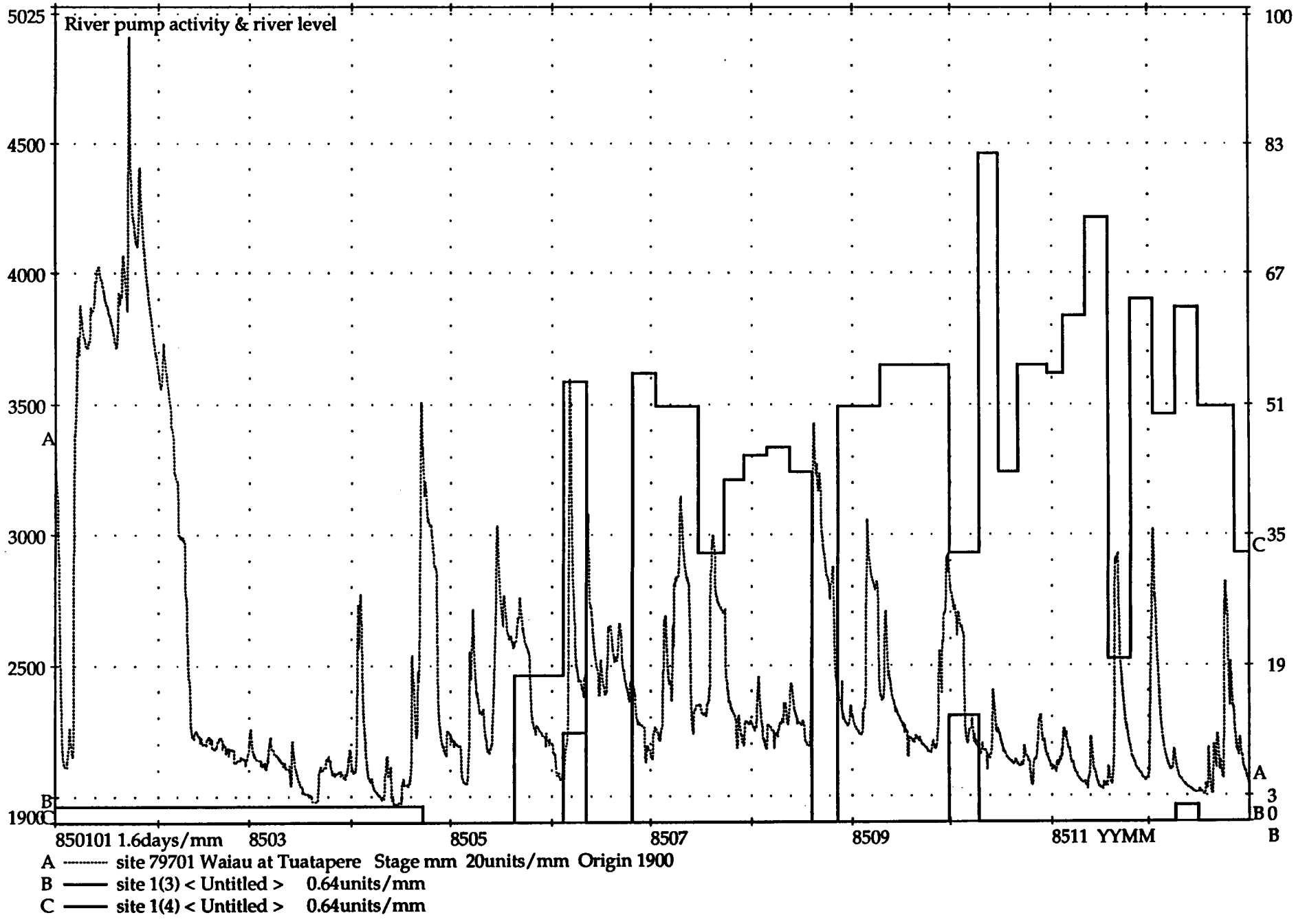

River pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
3
0
A
B
C
850101 1.6days/mm
8503
8505
8507
8509
8511 YYMM
A ····· site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1(3) < Untitled > 0.64units/mm
C —— site 1(4) < Untitled > 0.64units/mm

FIGURE 8

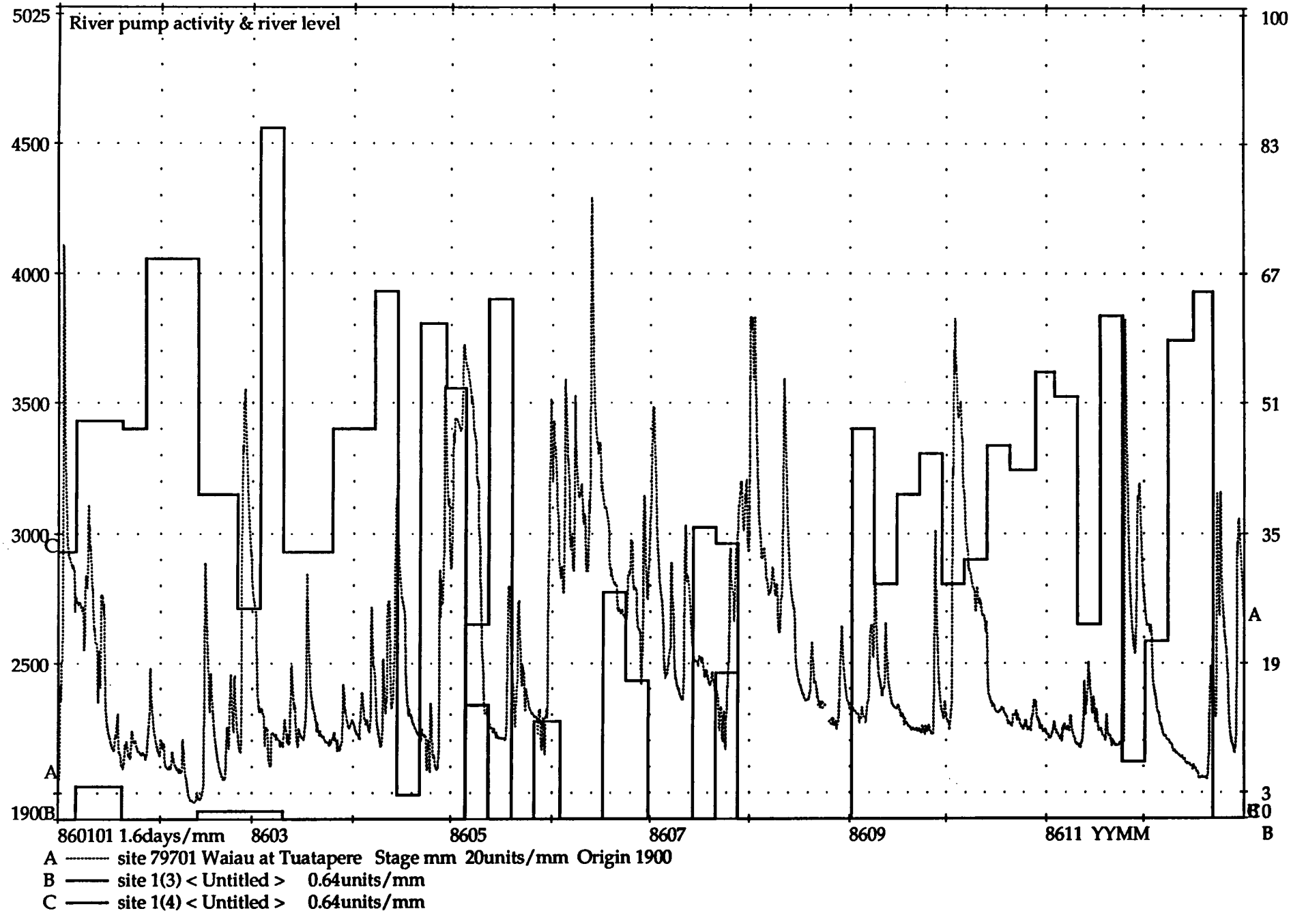

River pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
3
0
A
B
C
860101 1.6days/mm
8603
8605
8607
8609
8611 YYMM
A ····· site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1(3) < Untitled > 0.64units/mm
C —— site 1(4) < Untitled > 0.64units/mm

FIGURE 9

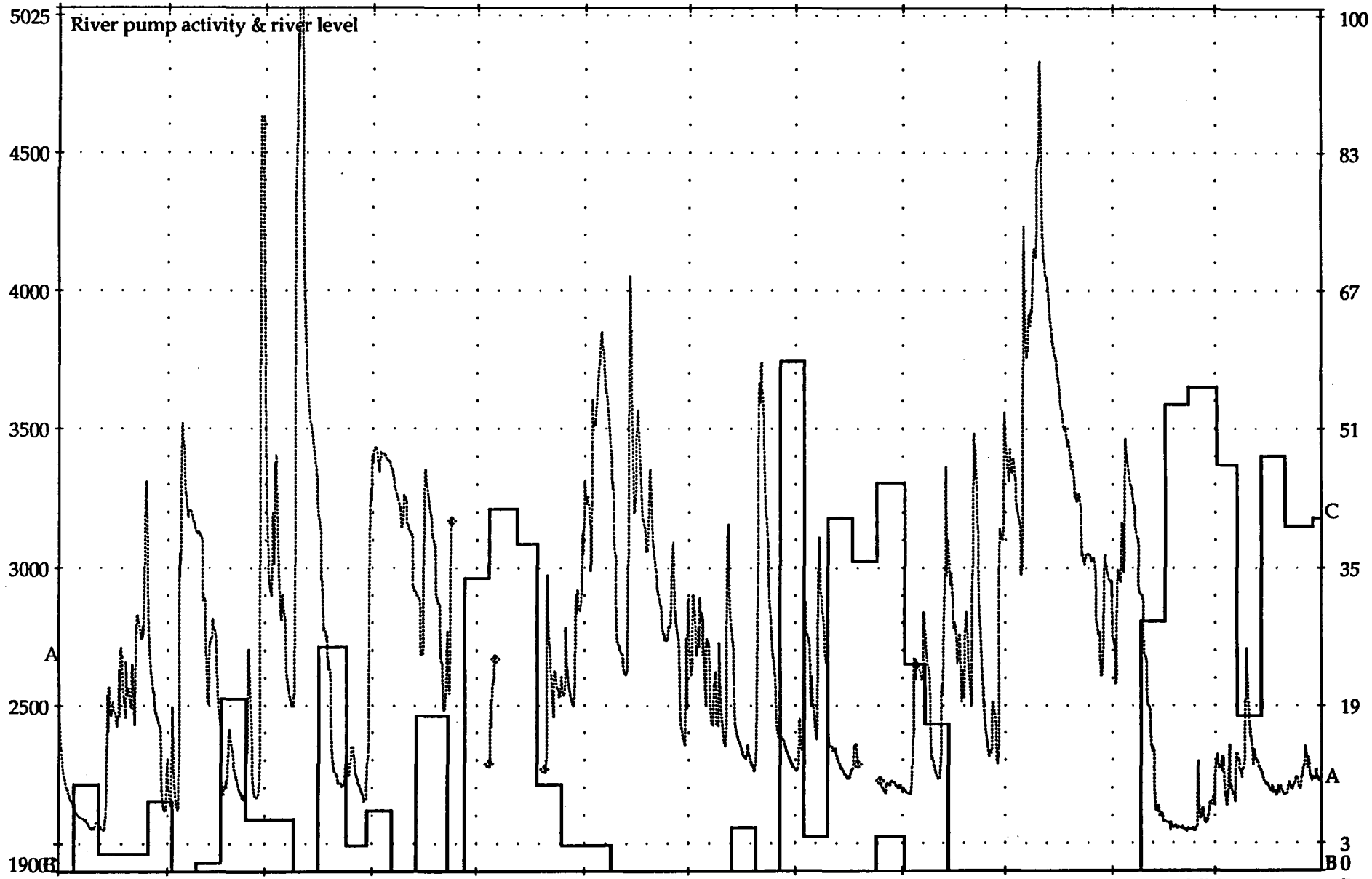

River pump activity & river level
5025
4500
4000
3500
3000
A
2500
1900
B
100
83
67
51
C
35
19
A
3
B 0
B
870101 1.6days/mm
8703
8705
8707
8709
8711 YYMM
A ····· site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1(3) < Untitled > 0.64units/mm
C —— site 1(4) < Untitled > 0.64units/mm

FIGURE 10

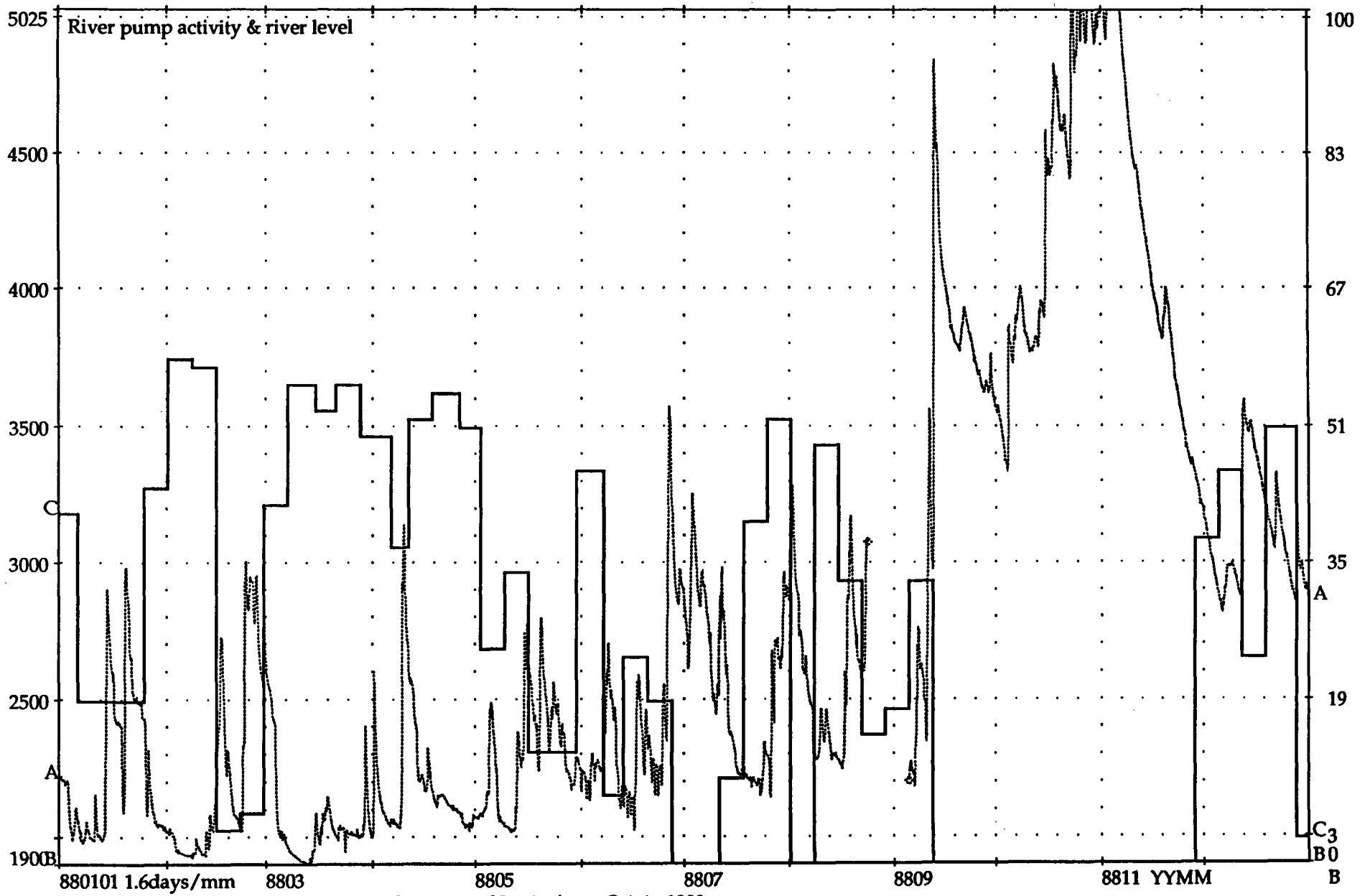

River pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
0
C
A
B
880101 1.6days/mm
8803
8805
8807
8809
8811 YYMM
A ---------- site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1(3) < Untitled > 0.64units/mm
C —— site 1(4) < Untitled > 0.64units/mm

FIGURE 11

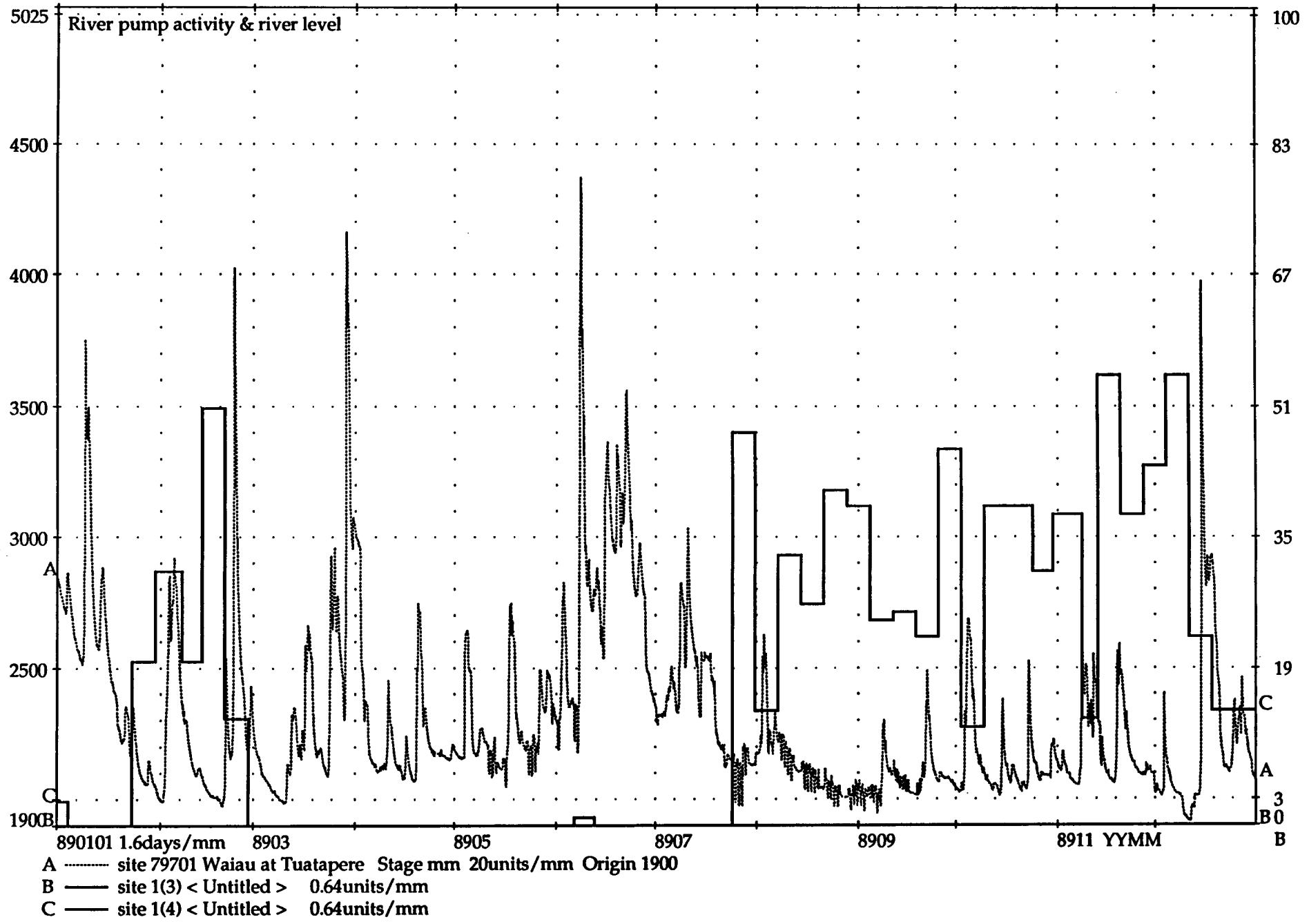

River pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
3
0
A
C
B
890101 1.6days/mm
8903
8905
8907
8909
8911 YYMM
A ····· site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1(3) < Untitled > 0.64units/mm
C —— site 1(4) < Untitled > 0.64units/mm

FIGURE 12

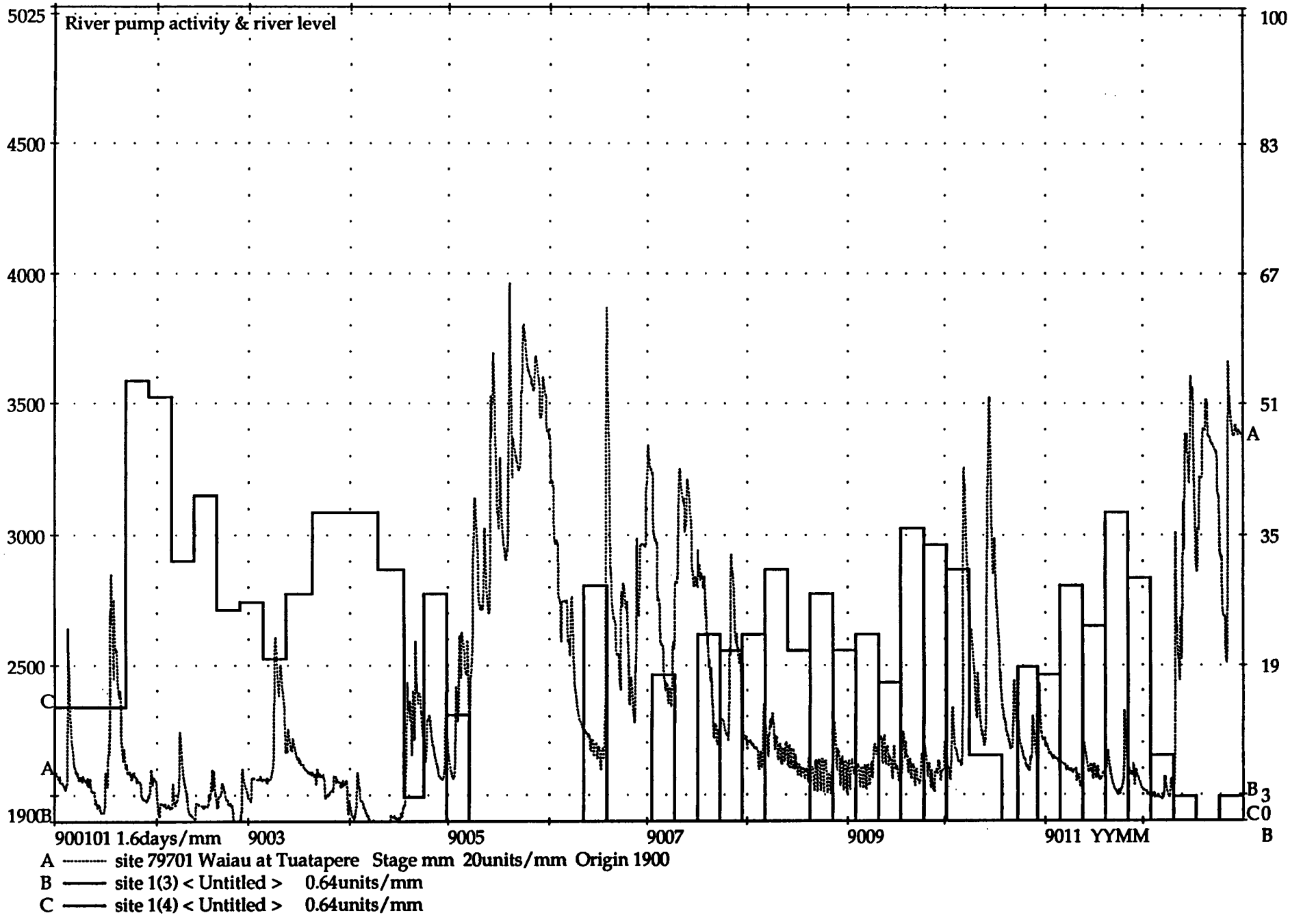

River pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
3
0
A
B
C
900101 1.6days/mm
9003
9005
9007
9009
9011 YYMM
A ····· site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1(3) < Untitled > 0.64units/mm
C —— site 1(4) < Untitled > 0.64units/mm

FIGURE 13

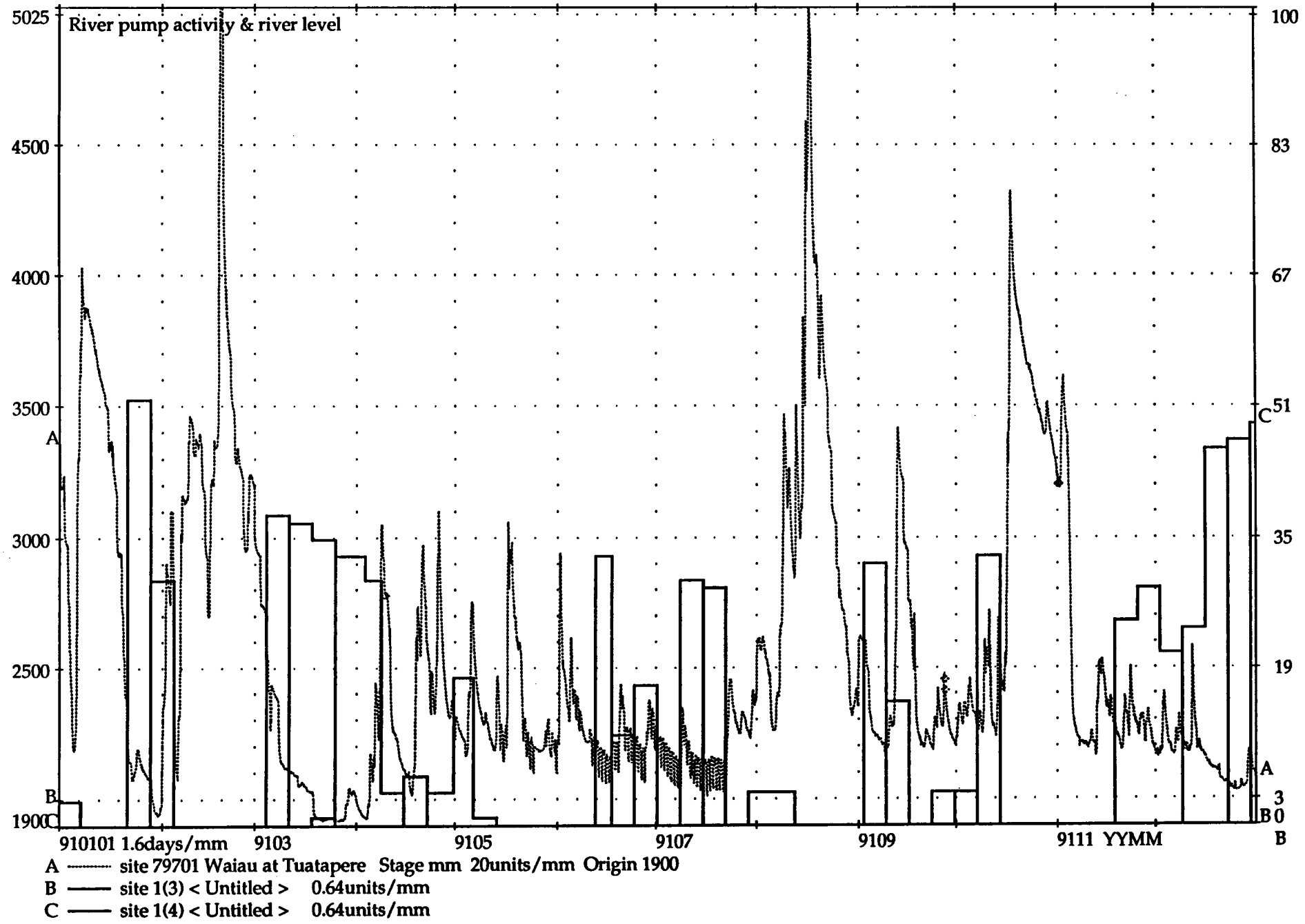

River pump activity & river level
5025
4500
4000
3500
3000
2500
1900
100
83
67
51
35
19
3
0
A
B
C
910101 1.6days/mm
9103
9105
9107
9109
9111 YYMM
A ····· site 79701 Waiau at Tuatapere Stage mm 20units/mm Origin 1900
B —— site 1(3) < Untitled > 0.64units/mm
C —— site 1(4) < Untitled > 0.64units/mm

FIGURE 14

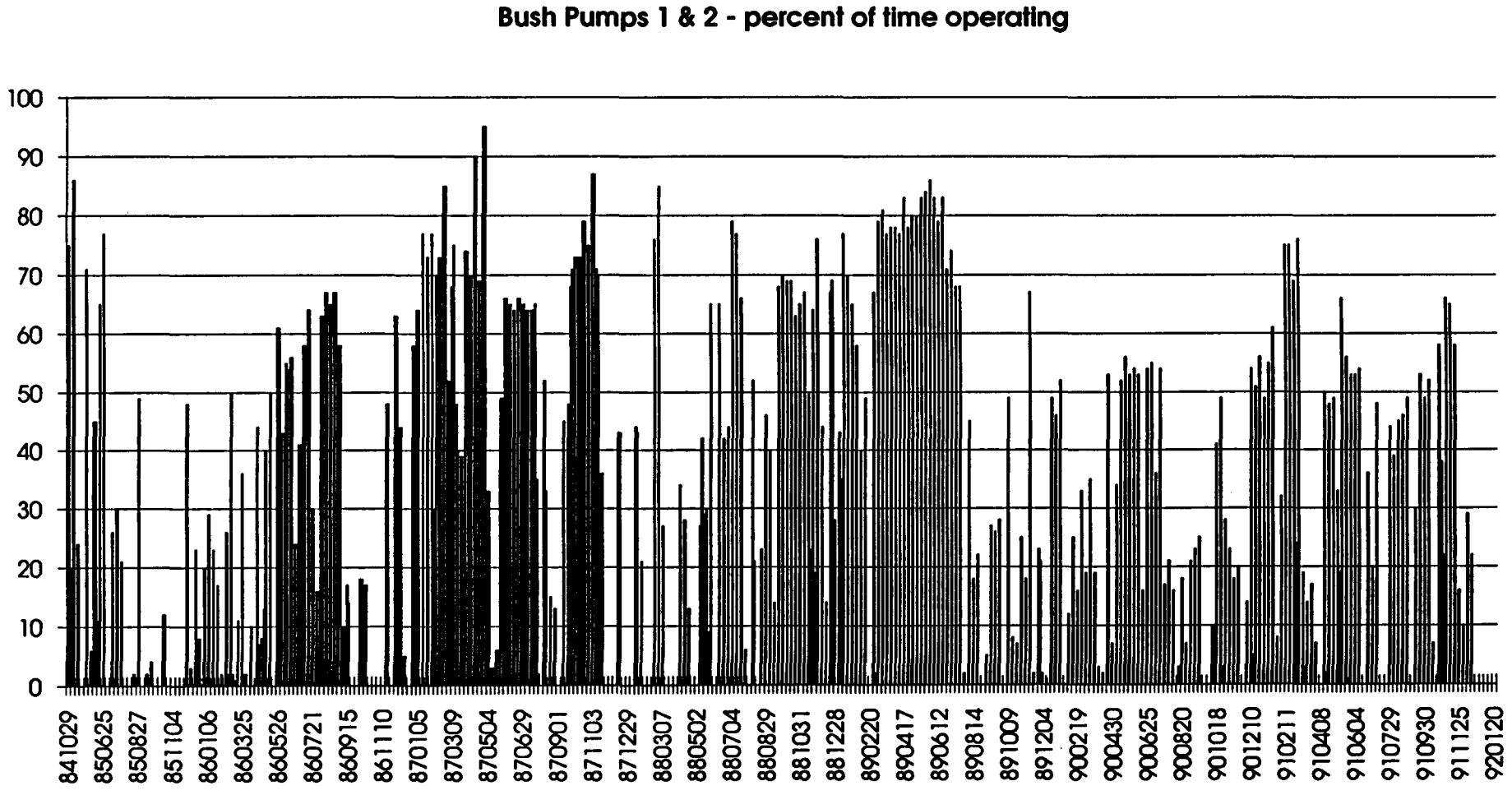

Bush Pumps 1 & 2 - percent of time operating
100
90
80
70
60
50
40
30
20
10
0
841029
850625
850827
851104
860106
860325
860526
860721
860915
861110
870105
870309
870504
870629
870901
871103
871229
880307
880502
880704
880829
881031
881228
890220
890417
890612
890814
891009
891204
900219
900430
900625
900820
901018
901210
910211
910408
910604
910729
910930
911125
920120

FIGURE 15

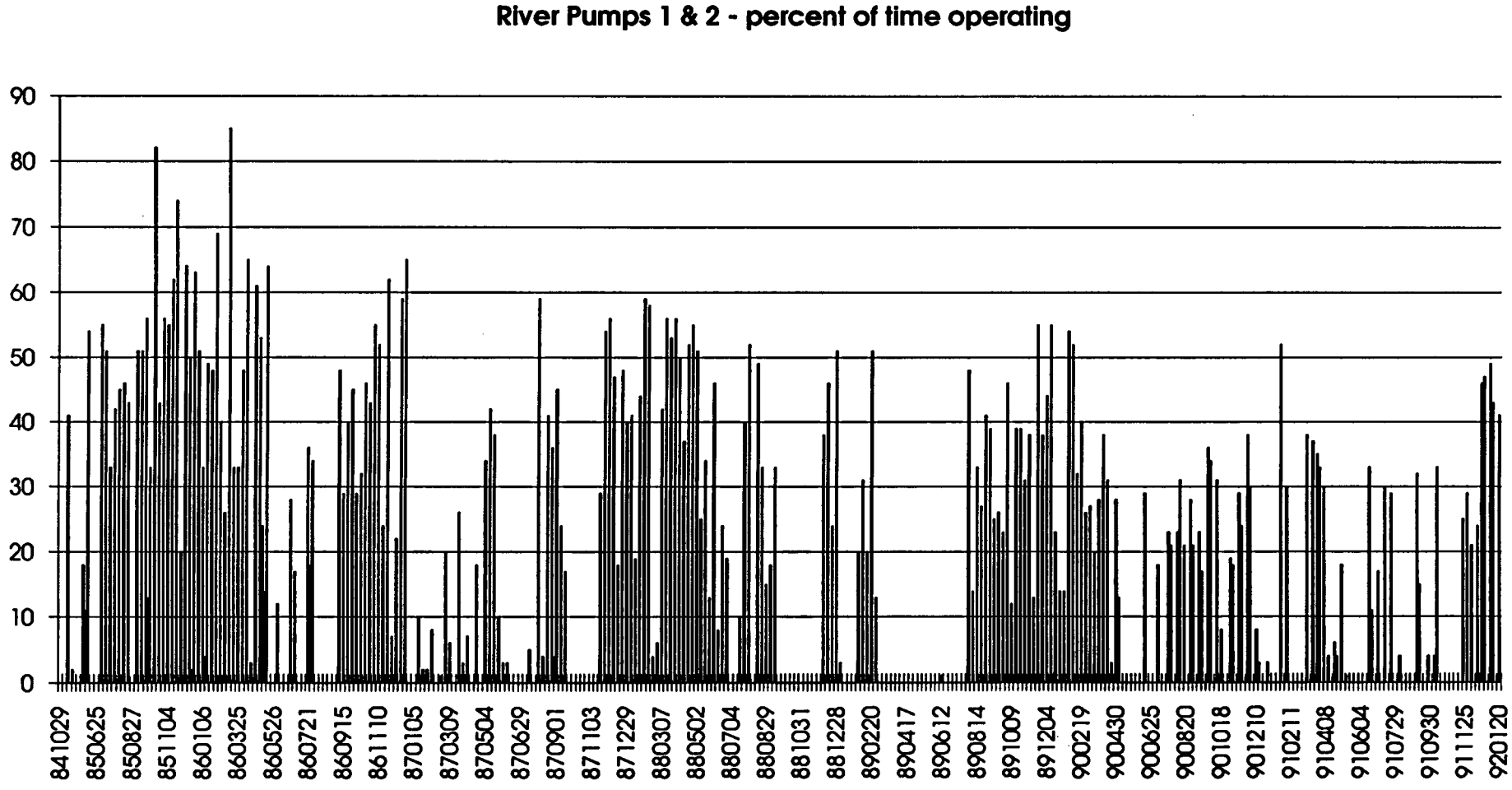

River Pumps 1 & 2 - percent of time operating
90
80
70
60
50
40
30
20
10
0
841029
850625
850827
851104
860106
860325
860526
860721
860915
861110
870105
870309
870504
870629
870901
871103
871229
880307
880502
880704
880829
881031
881228
890220
890417
890612
890814
891009
891204
900219
900430
900625
900820
901018
901210
910211
910408
910604
910729
910930
911125
920120

FIGURE 16

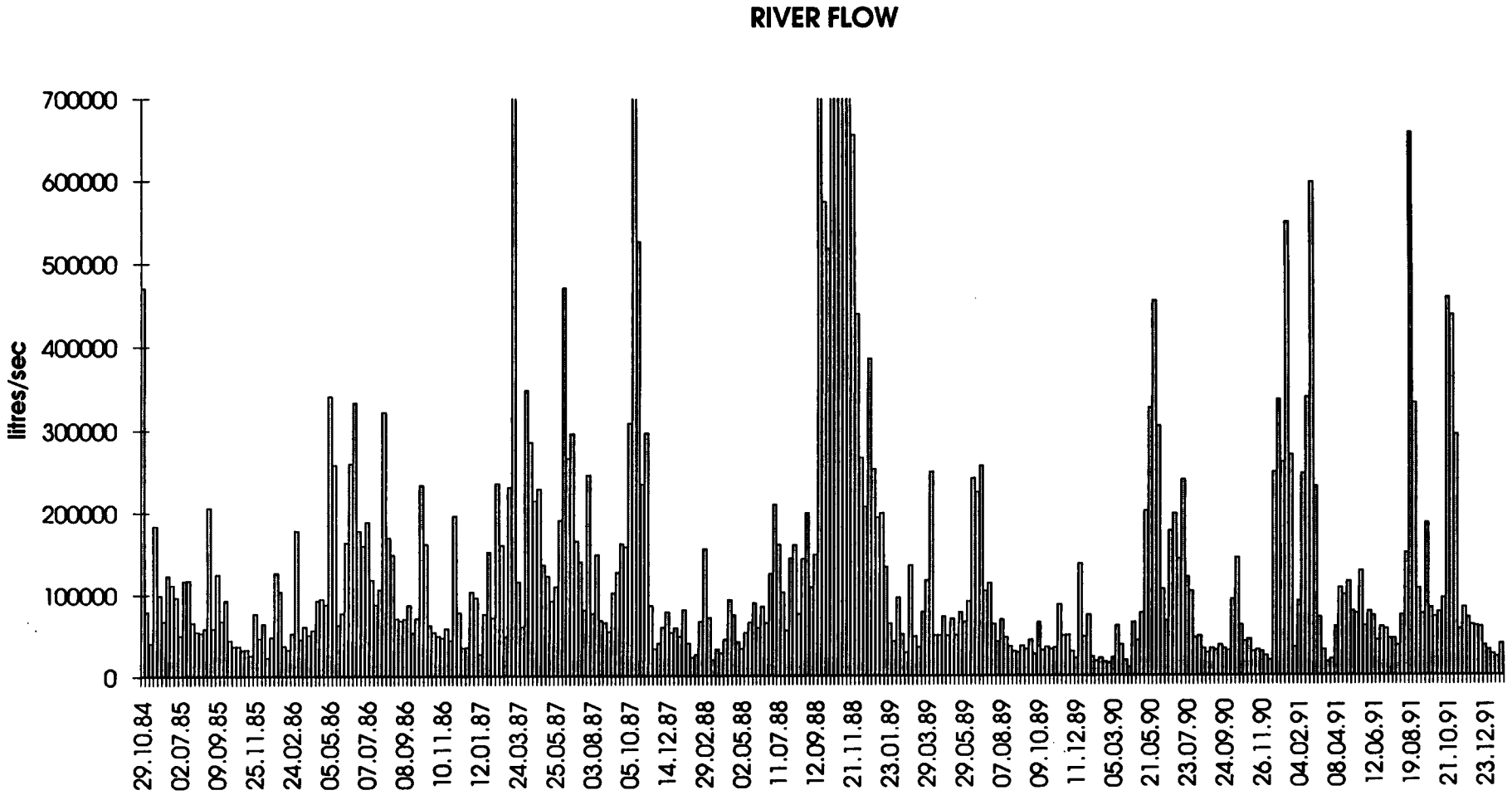
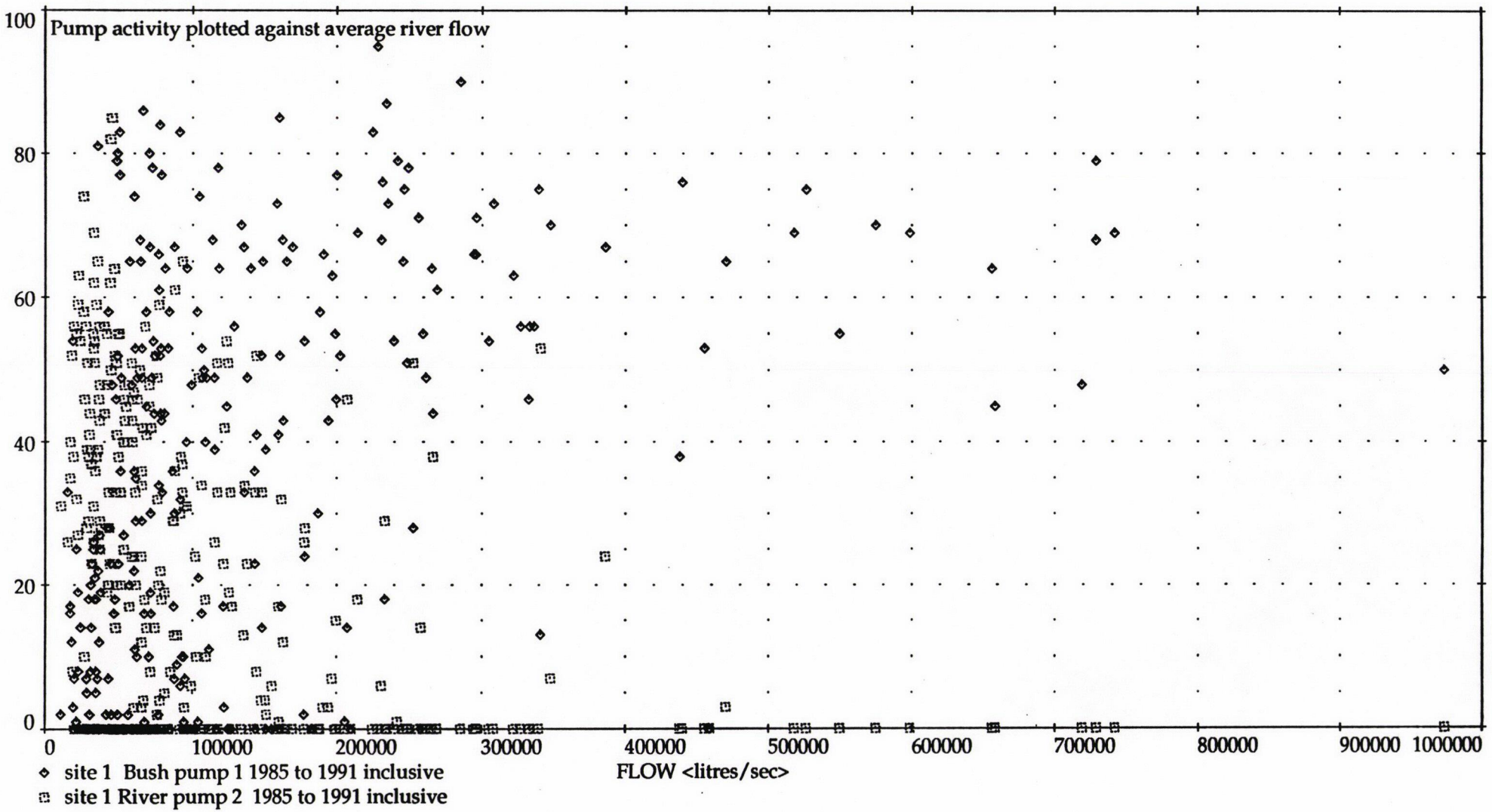

RIVER FLOW
litres/sec
700000
600000
500000
400000
300000
200000
100000
0
29.10.84
02.07.85
09.09.85
25.11.85
24.02.86
05.05.86
07.07.86
08.09.86
10.11.86
12.01.87
24.03.87
25.05.87
03.08.87
05.10.87
14.12.87
29.02.88
02.05.88
11.07.88
12.09.88
21.11.88
23.01.89
29.03.89
29.05.89
07.08.89
09.10.89
11.12.89
05.03.90
21.05.90
23.07.90
24.09.90
26.11.90
04.02.91
08.04.91
12.06.91
19.08.91
21.10.91
23.12.91

FIGURE 17


Pump activity plotted against average river flow
100
80
60
40
20
0
0
100000
200000
300000
400000
500000
600000
700000
800000
900000
1000000
FLOW <litres/sec>
site 1 Bush pump 1 1985 to 1991 inclusive
site 1 River pump 2 1985 to 1991 inclusive