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TECHNICAL PAPER NO. 42

**STREAMWATER TURBIDITIES IN
ADELONG CREEK CATCHMENT,
TUMUT SHIRE**

1983 - 1984

BY

P.M. CORNISH



FORESTRY COMMISSION OF NEW SOUTH WALES

STREAMWATER TURBIDITIES IN ADELONG CREEK CATCHMENT, TUMUT SHIRE

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Forestry Commission of New South Wales

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ABSTRACT

This report examines the turbidity of water samples from various sampling sites in Adelong Creek Catchment during part of 1983 and the whole of 1984. The upper part of the catchment, principally draining *P. radiata* plantation that had been established prior to the introduction of the current erosion mitigation measures, had slightly higher turbidity levels than an adjacent agricultural/pastoral tributary. All sampled agricultural/pastoral tributaries, except Tanyard Creek, had lower turbidity levels than Adelong Creek and effectively reduced main stream turbidity levels downstream of the *P. radiata* plantation by dilution. Pump station turbidity levels were the highest in the catchment due to inflows from Tanyard Creek, although extensive lower catchment bank erosion on Adelong Creek itself may have contributed to this.

Turbidity levels in Adelong Creek were generally high, particularly during and following periods of heavy rainfall. Turbidity levels increased with increasing area of pine plantation in the upper catchment. There is some evidence that the soils of this upper catchment area contain a more dispersive clay type.

Although the plantation layout may have been sub-optimal from a water quality production viewpoint, the fact remains that the actual layout, together with the conservative harvesting measures adopted, resulted in turbidity levels in plantation streams only slightly higher than those in streams influenced by other land uses.

INTRODUCTION

The township of Adelong (pop.1000) is supplied with domestic water from Adelong Creek. Water is pumped from an offtake weir on the creek to an offtream storage before treatment and reticulation to the township.

The residents of Adelong have complained of the quality of the water for many years to the Tumut Shire Council (the authority responsible for the supply), and to the State Government. The principal complaint has been the high turbidity levels in the water, and in 1973 The Soil Conservation Service of N.S.W. published a survey of soil erosion in the Adelong Creek catchment (Emery and McArthur 1973). This report concentrated on the upper catchment and in particular on that part of the upper catchment occupied by Green Hills State Forest, which is principally *Pinus radiata* (D. Don) plantation. The Forestry Commission of N.S.W. conducted its own investigation into soil erosion and water quality in the Adelong Catchment (Cornish 1974) and concluded that in addition to the State Forest Area, significant amounts of sediment were being supplied from deep erosion gullies in the lower catchment and from erosion of the banks of Adelong Creek itself.

In order to minimise soil erosion and water quality degradation, the Forestry Commission of N.S.W. introduced "The Standard Erosion Mitigation Conditions for Logging and Clearing in N.S.W." in 1977. These conditions had been drawn up in conjunction with the Soil Conservation Service, and were revised in 1983. In 1978 the Forestry Commission introduced a system of forest closures to logging and hauling in wet conditions with the aim of further minimising stream impacts.

In the winter of 1983 there were further complaints and ministerial representations by the residents of Adelong concerning the quality of the reticulated supply. Following public meetings the Forestry Commission of N.S.W. and the Tumut Shire Council agreed to set up a joint water quality monitoring study in the catchment of Adelong Creek in order to determine the magnitude of the problem and the principal source areas of pollution.

THE STUDY AREA

Topography and Land Use

The catchment of Adelong Creek studied here is shown in Figure 1 and varies in elevation from 770 m to 330 m. The upper catchment is hilly to steep, while the lower catchment is undulating. The total area of catchment above the pump station is approximately 15400 hectares, of which around 24% is Forestry Commission *Pinus radiata* plantation, while the remainder is principally agricultural or pastoral land.

Much of this plantation area was established prior to the introduction of the Standard Erosion Mitigation Conditions and the roading pattern consequently included a greater proportion of streamside roads than recently planted areas. In addition, buffer strips were not routinely retained beside streams in this area, although it is now current practice in plantation establishment.

Geology

Igneous rocks of Ordovician and Silurian age underlie the catchment, and the location of the principal rock types is shown in Figure 2. A band of Ordovician volcanic rocks is intruded by Silurian plutonic rocks of differing ages to the east and west (Basden 1982 and Basden [pers. comm.]). The principal rock types in Figure 2 are as follows:-

- Øn - Nacka Nacka metabasic igneous complex.
- Sgg - Green Hills Granodiorite, a coarse-grained, mainly massive, biotite granodiorite.
- Sad - Donkey Gap basic intrusives including hornblende diorite, minor gabbro and norite.
- Sge - Ellerslie Granodiorite intrudes the adjoining rocks and is dominantly a coarse-grained biotite granodiorite.
- Sgw - Wondalga Granodiorite, a medium to coarse-grained granodiorite/tonalite.

Hornblende is virtually absent from the Ellerslie and Green Hills Granodiorites which dominate the catchment above sampling site 4, while it is an important mineral (up to 75%) of the other major geological types in the Adelong Creek catchment above the pump station. (H. Basden, pers. comm.). Cornish (1974) reported that the proportion of hornblende in streamwater sediments at the pump station increased during storms, indicating that sediment was being supplied from areas downstream of the *P. radiata* plantation in greater quantities during storm periods.

Water Sampling Programme

Nine water sampling sites on Adelong Creek and major tributaries were selected initially and sampling began on 22nd June, 1983. In order to improve the detection of sediment sources in the lower catchment five additional sampling sites were added in November, 1983. Three of these were located on tributaries and two on the main stream. The catchment and sampling sites are shown in Figure 1. Samples were collected manually by the Tumut Council always beginning in

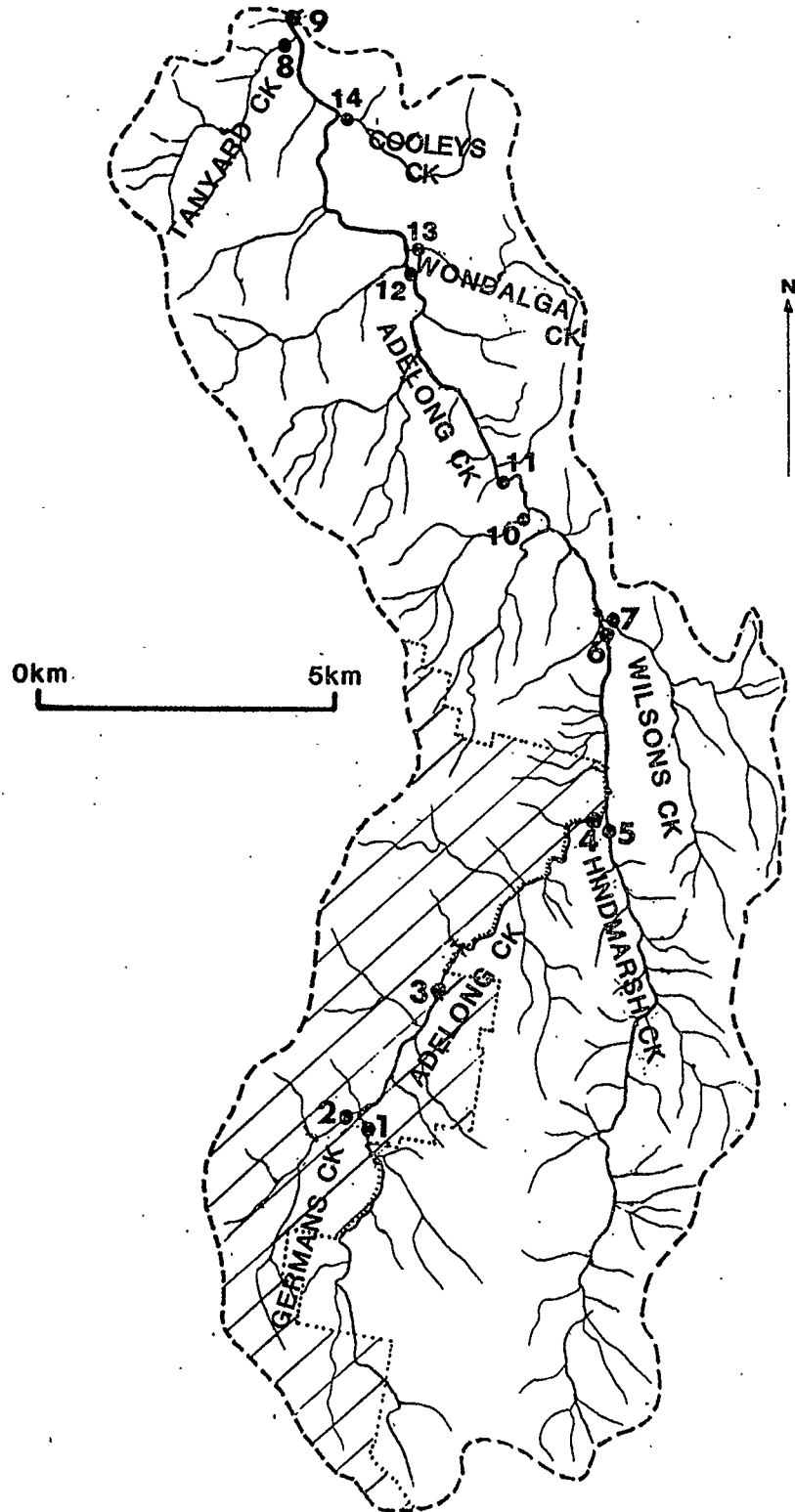


Figure 1. Catchment of Adelong Creek above the pump station at Adelong showing the location of water sampling sites. The hatched area is Forestry Commission pine plantation.

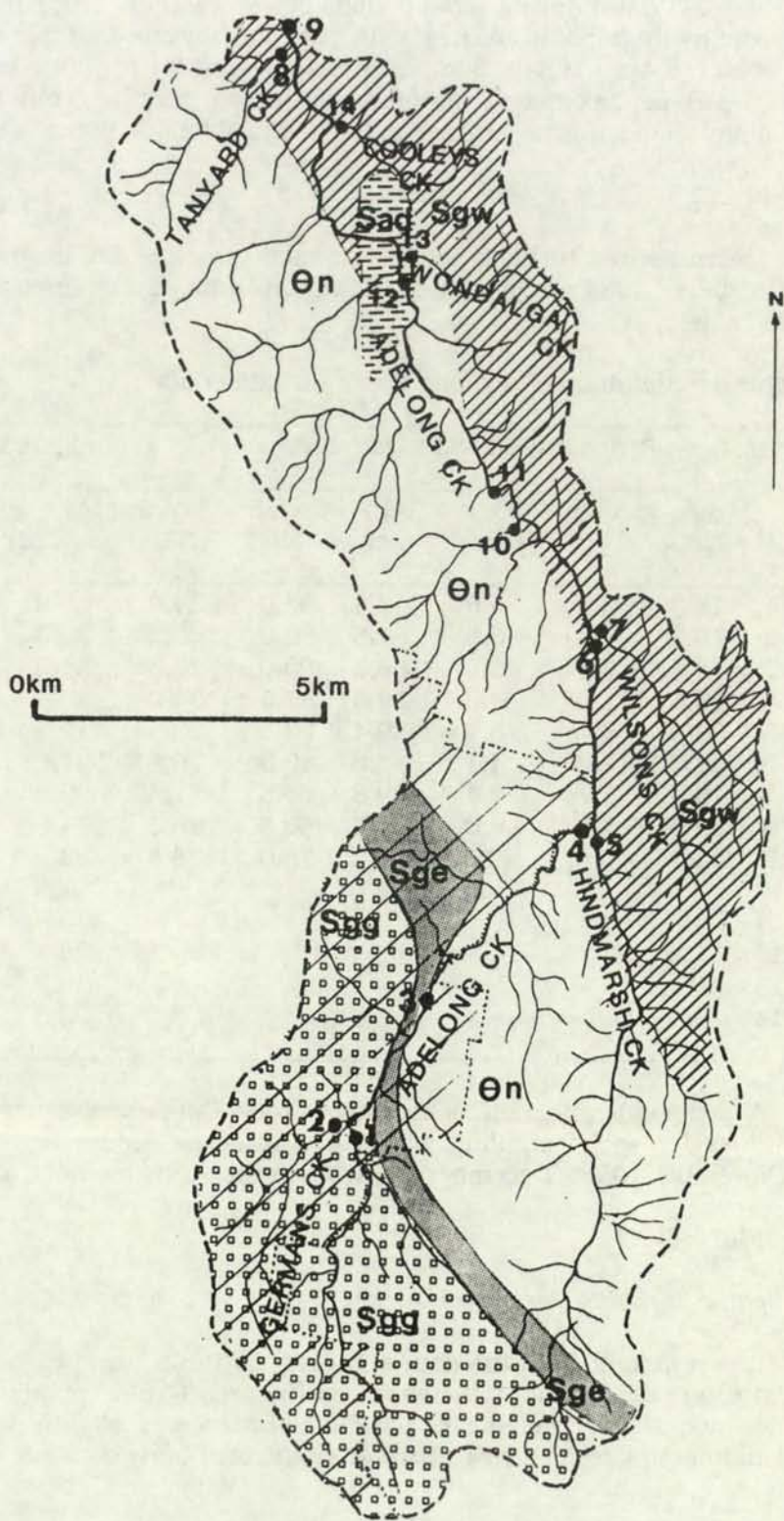


Figure 2. Geological types in Adelong Creek catchment.

the upper catchment and ending at the pump station. This always occurred on the same day over a period of two hours or so. Sampling in this way took place weekly, and more frequently (every 2-3 days) during some periods of wet weather. Sampling was generally on the same part of the hydrograph at all sites, with only one obvious example of sampling overtaking the storm runoff (18 April 1984). Samples were analysed for turbidity by the Tumut Shire Council using a HACH nephelometer. Rainfall information for the study was obtained from the Forestry Commission gauge at Ardrossan in Green Hills State Forest.

RESULTS

The measured turbidity values for each sampling site for the period 22nd June, 1983 - 19th December, 1984 are presented in the Appendix. Summaries of all turbidity data are presented in Table 1.

Table 1. Summary of Adelong Creek turbidity data.

Samp. site	Period June 1983 - Dec. 1984						Period Nov. 1983 - Dec. 1984					
	Mean (NTU)	Median	10 perc.	90 perc.	%>5 NTU	%>25 NTU	Mean (NTU)	Median	10 perc.	90 perc.	%>5 NTU	%>25 NTU
1	18.3	9.0	5.5	43.4	95.0	24.0	18.8	8.7	5.6	47.2	95.5	24.5
2	20.4	7.6	5.0	61.6	90.0	23.5	20.3	6.8	5.0	68.4	85.0	23.0
3	23.7	9.3	5.0	66.2	90.0	27.5	24.0	7.7	5.0	70.6	88.5	25.0
4	29.6	12.0	4.8	79.4	87.5	34.0	29.4	9.4	4.7	100.2	83.5	28.5
5	20.4	9.7	3.4	49.4	72.5	23.5	19.5	6.8	3.3	60.2	65.0	19.0
6	28.0	12.0	4.1	73.6	80.5	30.5	27.6	8.0	4.0	95.4	73.5	28.5
7	19.7	7.7	2.4	59.8	65.5	21.5	20.0	5.9	2.2	65.4	59.5	20.5
8	30.8	8.9	4.0	84.2	80.5	28.5	34.9	12.0	4.0	128.0	82.0	33.5
9	32.7	10.6	3.1	94.2	75.0	36.5	32.5	6.9	2.8	120.0	65.5	30.0
10							7.8	2.6	1.2	24.4	34.5	9.5
11							26.9	7.2	3.2	80.6	66.5	26.0
12							28.1	7.2	3.0	94.2	67.0	26.5
13							20.2	7.0	1.6	57.6	58.0	23.5
14							20.0	7.5	4.6	45.0	82.5	29.5

A schematic diagram of Adelong Creek Catchment showing mean and median turbidity values for each sampling site is presented as Figure 3. These values are for the period (November 1983 - December 1984) when the study included all 14 sites.

DISCUSSION

Spatial Turbidity Variations

It is apparent from the data summary in Table 1 and Figure 3 that over both the entire and latter periods turbidity increased as the area of pine plantation increased (for sites 1-4), and declined slightly (at site 6) as a consequence of slightly less turbid pastoral inflows from Hindmarsh Creek (site 5). Turbidity remained fairly constant down Adelong Creek (sites 11

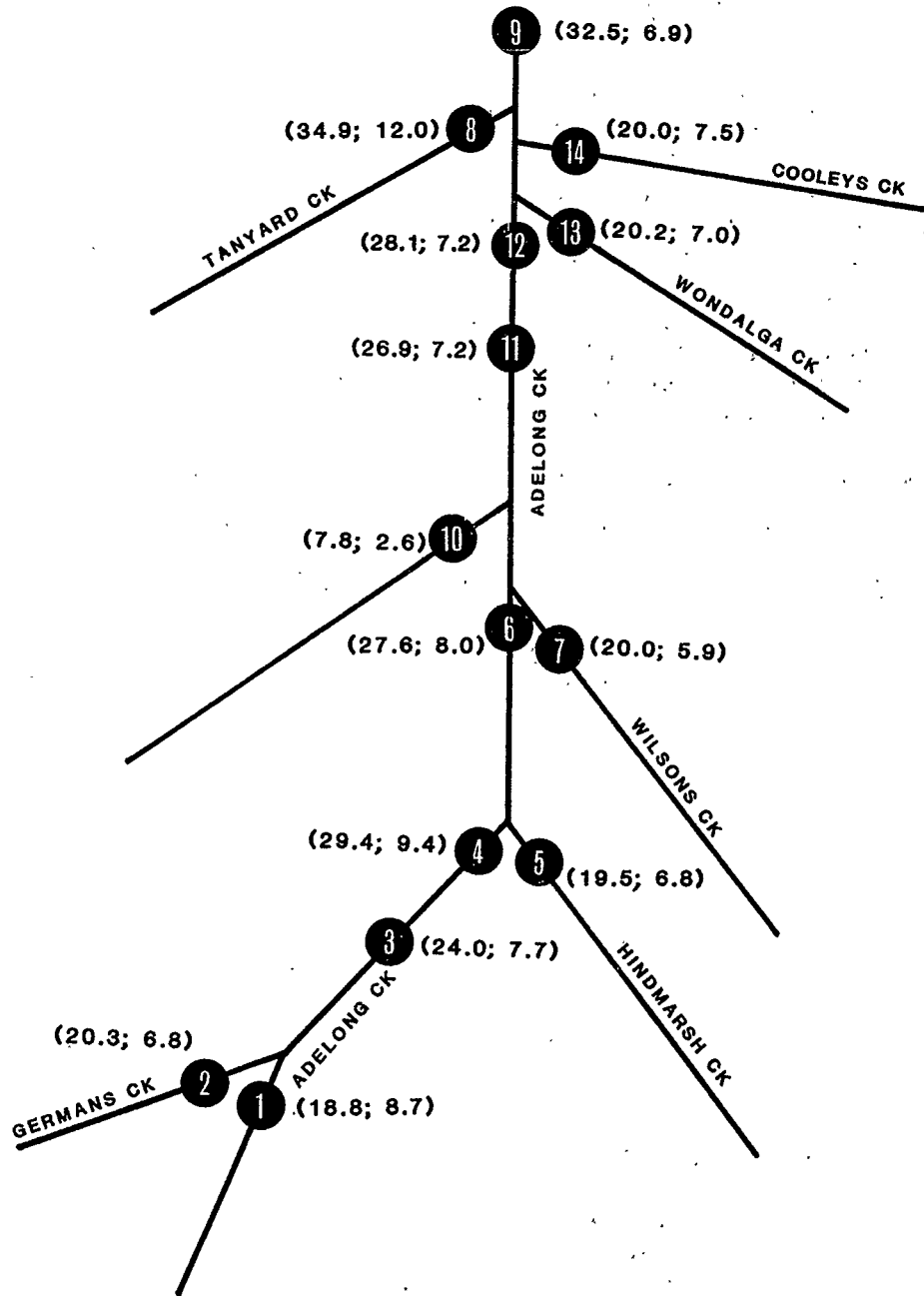


Figure 3. Schematic diagram of Adelong Creek catchment showing sampling sites and mean and median turbidity values (in brackets) for the period November 1983 - December 1984.

and 12), increasing at the pump station (site 9). Wilsons Creek. (site 7), Wondalga Creek (site 13) and Cooley's Creek (site 14) contributed water with very similar turbidity levels to those in Hindmarsh Creek, but lower than those in Adelong Creek itself. The higher levels at the pump station were in part due to the contribution from Tanyard Creek (site 8) where values were higher in 1984. The western tributary (site 10) which drains pastoral country had very much lower turbidity levels and was at least partly responsible for a small reduction in turbidity values between sites 6 and 11 on Adelong Creek. Reasons for the lower values at site 10 are not obvious but may be a consequence of better land management in that catchment.

It should be noted from Table 1 that while the proportion of samples with > 25 NTU increased down Adelong Creek between the pine plantation and pump station, the proportion of samples with >5 NTU actually decreased from site 1 to site 9. This may be due to more dispersive clays in the soils of the upper catchment. These upper soils contain illite which is more dispersive than the kaolinitic clays found in the soils of the lower catchment formed on metabasic igneous rocks that provide stabilising iron-rich minerals (P. Ryan, pers. comm.).

Median turbidity values were well above 5 NTU at all sites except site 10. The very high percentages of samples with high turbidity levels in Adelong Creek indicate the extent of the problem as far as Adelong water supply is concerned. Turbidity values greater than 25 NTU can be considered high from a town water supply viewpoint.

Table 2. T-test of means of differences between turbidity values from pairs of sampling sites.

Paired sampling sites	No. of pairs	Mean of paired differences	T	Pr > T
4 - 1	91	+ 11.5	4.78	0.0001
4 - 2	93	+ 9.1	4.70	0.0001
4 - 3	92	+ 5.9	4.11	0.0001
4 - 5	93	+ 9.1	5.19	0.0001
4 - 6	93	+ 1.6	2.06	0.0418
9 - 4	92	+ 2.9	1.29	0.1999
9 - 6	92	+ 4.5	2.18	0.0321
9 - 7	92	+ 12.8	4.46	0.0001
9 - 8	92	+ 1.9	0.72	0.4723
9 - 10	66	+ 25.1	4.53	0.0001
9 - 11	66	+ 5.9	2.58	0.0121
9 - 12	66	+ 4.7	2.62	0.0109
9 - 13	66	+ 12.9	3.69	0.0005
9 - 14	66	+ 13.1	2.50	0.0149

A t-Test performed on the means of differences between turbidity values from pairs of sampling sites (Table 2) indicates that turbidity levels at site 4 were highly significantly different from those further upstream, and from those in Hindmarsh Creek, but less significantly different from those at site 6 downstream. Turbidity levels at site 9 (pump station) were significantly different from those at all main stream sites below site 4, and all lower tributaries except Tanyard Creek. Levels at site 4 were not significantly different from those at the pump station.

The areas logged in the plantation in Adelong Creek Catchment during the study period in 1983 and 1984 are shown in Figure 4. Altogether about 1000 ha was logged in this period,

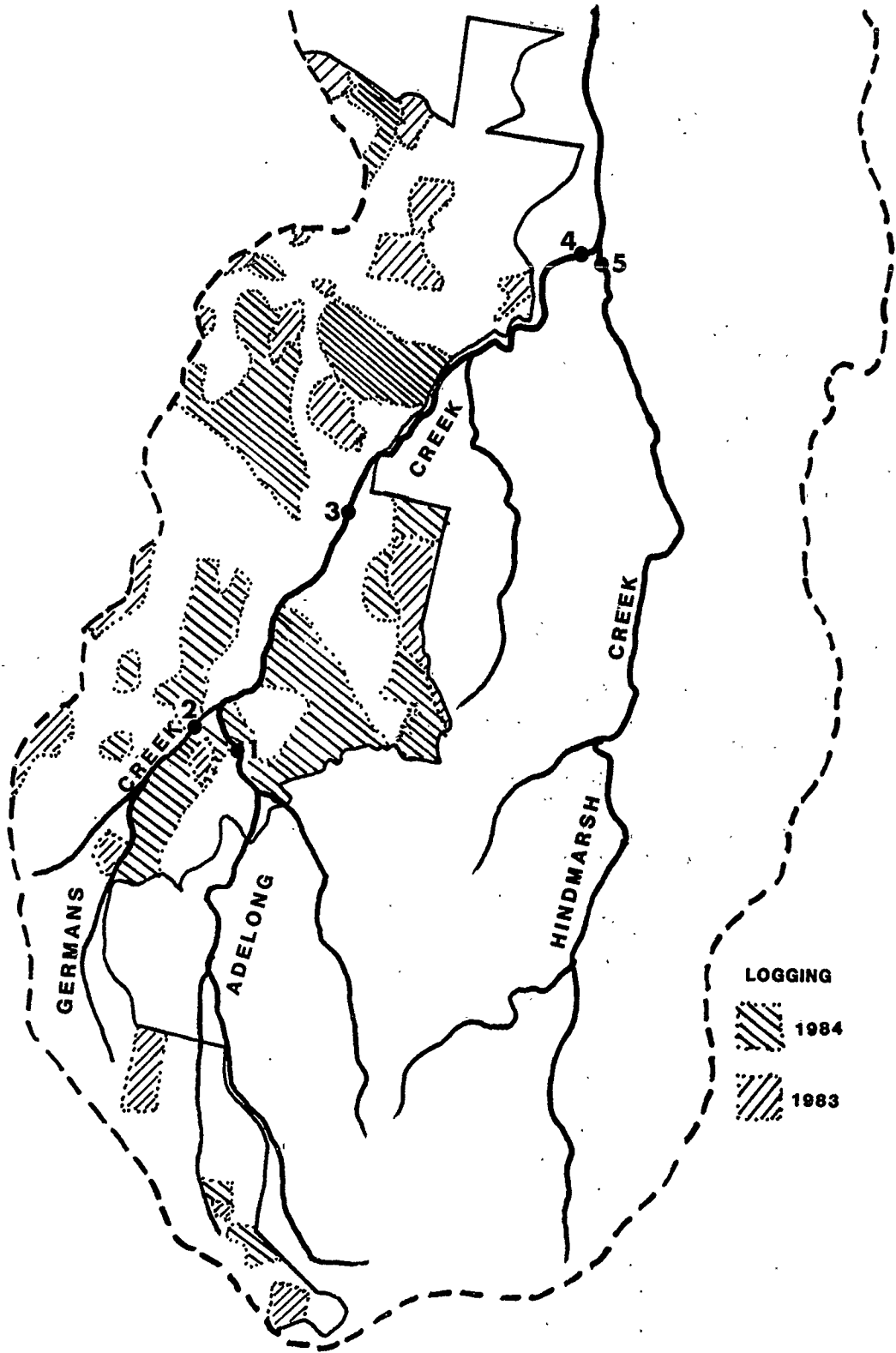


Figure 4. Upper catchment of Adelong Creek showing sampling sites 1 - 5 and areas of *Pinus radiata* plantation logged during the study in 1983 and 1984.

or about 25% of the plantation area. About half of this area is drained by streams that enter Adelong Creek between sampling sites 3 and 4, and this is reflected in the increase in turbidity values at site 4 relative to site 3.

Temporal Turbidity Variations

2183 mm of rain fell at Ardrossan during the 1983/84 period under review, with numerous daily falls over 25 mm. The effects of larger blocks of rainfall on turbidity levels are shown in Figures 5 - 15.

To investigate the relative differences in turbidity levels between sampling sites over time the following procedures were adopted. For the two sites being compared the ratio of turbidity values was calculated for each sampling day, and a three sampling moving average value determined, thus producing a filtered series which depicts trends. These moving average values were then plotted against time using the central of the three sampling dates as the plotting position in Figures 5 - 15. In addition the differences between pairs of turbidity values obtained on the same day for the same two sampling sites were determined and mean values of these differences calculated on a monthly basis. These monthly mean differences are plotted as bar graphs in Figures 5 - 15.

Turbidity levels at site 4 were more influenced by substantial blocks of rainfall than those at site 1, demonstrating the effect of greater pine areas logged above site 4. The drier periods (February - June 1984 and November - December 1984) resulted in higher turbidity levels at site 1, relative to site 4, perhaps due to a more dispersive clay type in the upper catchment (Figure 5). A similar picture emerges when site 5 is compared with site 4 (Figure 6). The greatest differences occurred during major rainfall periods but turbidity levels in Hindmarsh Creek were lower than those at site 4 for virtually the whole study period.

The major rainfall blocks resulted in higher turbidity levels at the pump station than at site 4 (Figure 7). Drier periods (with lower flows) resulted in relatively higher values in the pine plantation which may have been due to a combination of higher clay dispersibility and logging disturbance.

Turbidity levels were generally slightly higher at site 4 than at site 6 downstream (Figure 8) due to cleaner inflows from Hindmarsh Creek. Site 6 had lower turbidity values than the pump station except during low flow periods (Figure 9).

Turbidity levels in Tanyard Creek (site 8) were generally below those at the pump station during 1983, but increased considerably from January 1984 (Figure 10). Inspection revealed an extensive network of deep erosion gullies in this catchment and active erosion may have been initiated by the storms in January, 1984. This catchment was a significant contributor of turbidity (and probably suspended sediment) to Adelong pump station.

The unnamed tributary (site 10) drains pastoral country and exhibited by far the lowest turbidity levels of any stream in the study. An inspection failed to reveal the reason for the better water quality, although pasture cover, stocking levels and catchment condition during 1984 must have all played a part. There was a tendency for turbidity levels to rise relative to those in Adelong Creek during 1984 (Figure 11), but only during low flows.

Sites 11 and 12 on Adelong Creek both displayed similar turbidity fluctuations relative to turbidity levels at the pump station downstream (Figures 12 and 13). Apart from the drier periods turbidity levels were lower than those at site 9.

Site 1 - Site 4

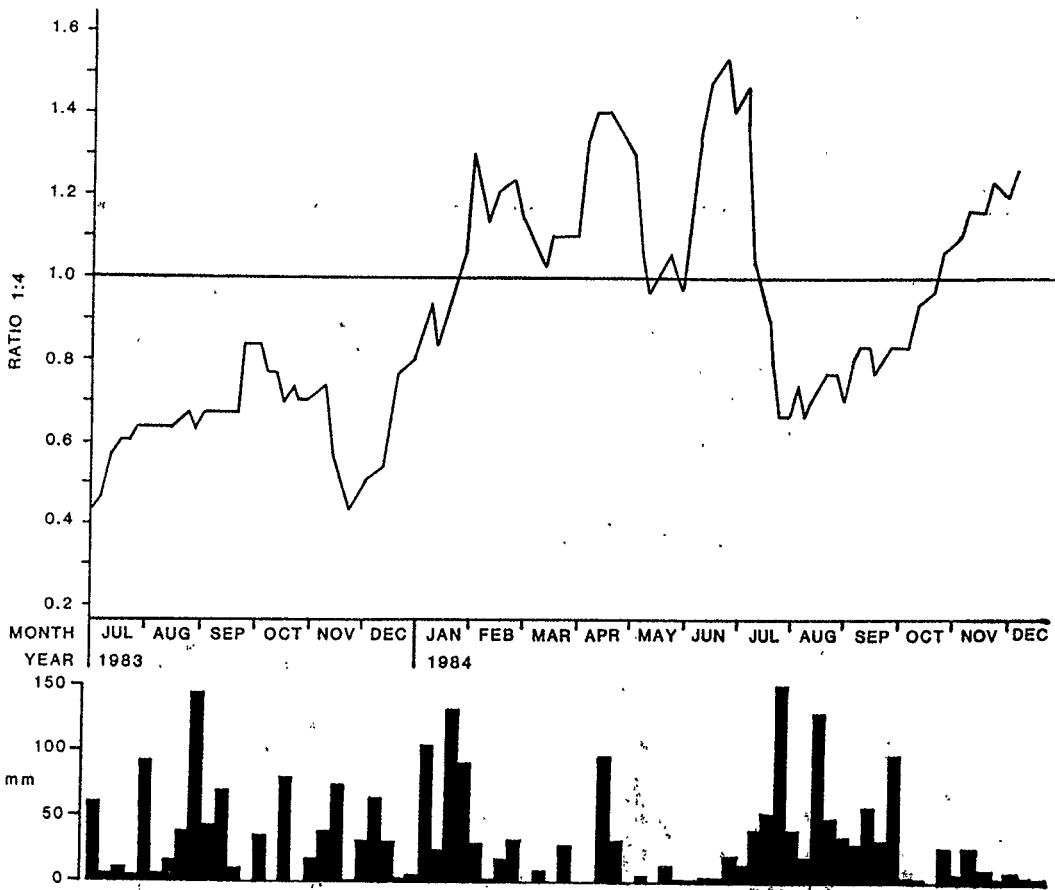
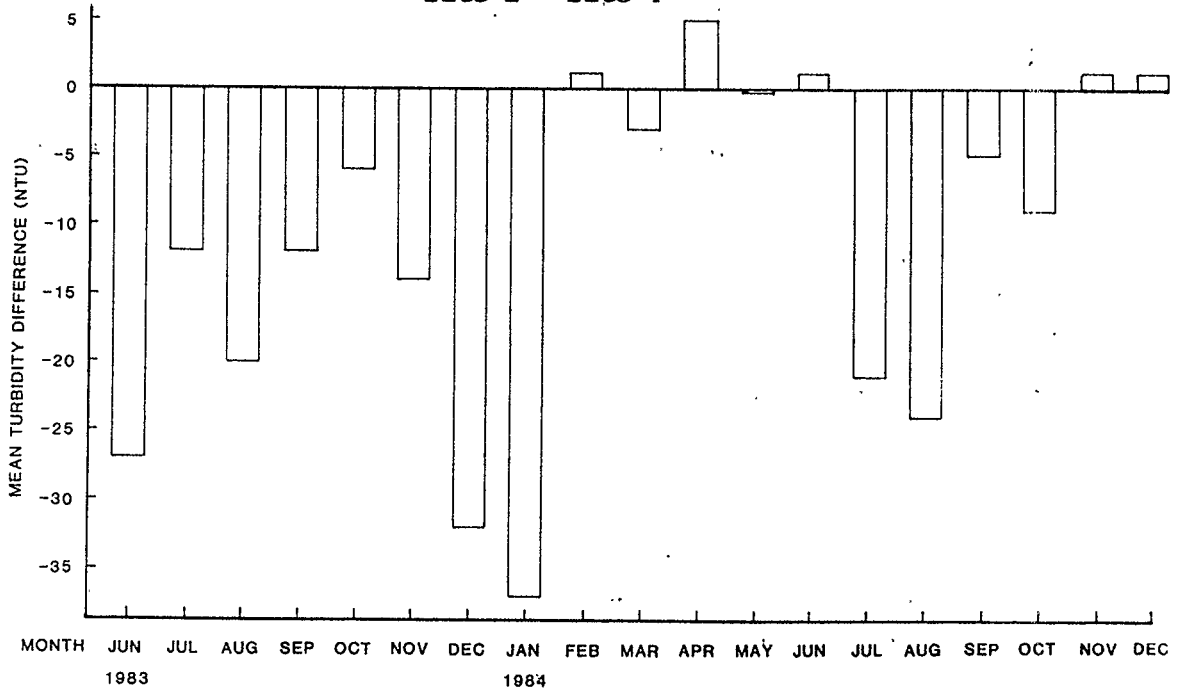


Figure 5. Time series comparison of turbidity values at sampling sites 1 and 4 showing weekly rainfalls.

Site 5 - Site 4

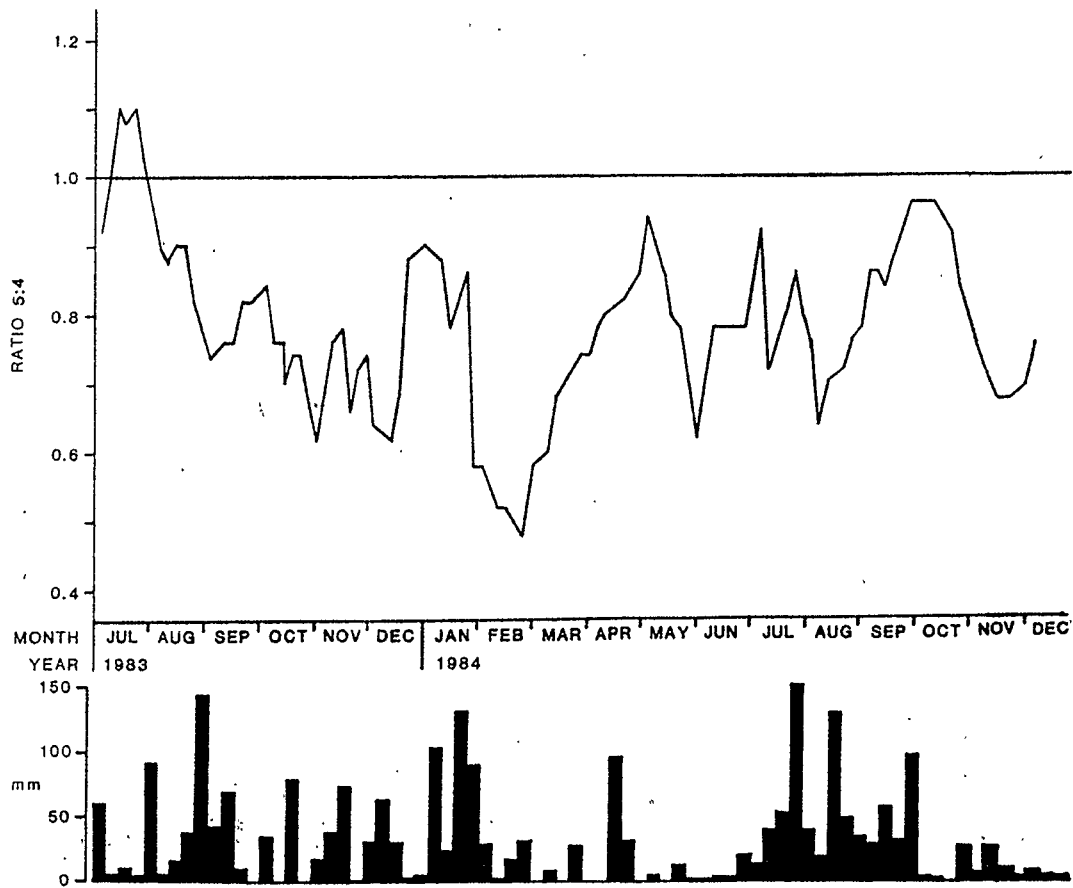
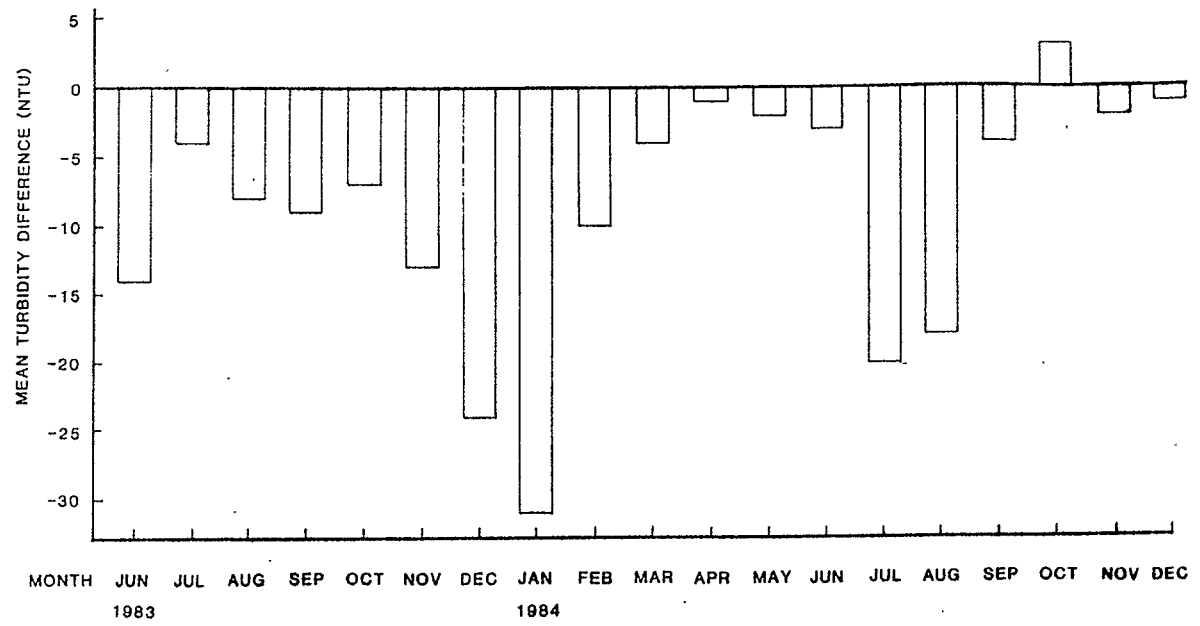


Figure 6. Time series comparison of turbidity values at sampling sites 5 and 4 showing weekly rainfalls.

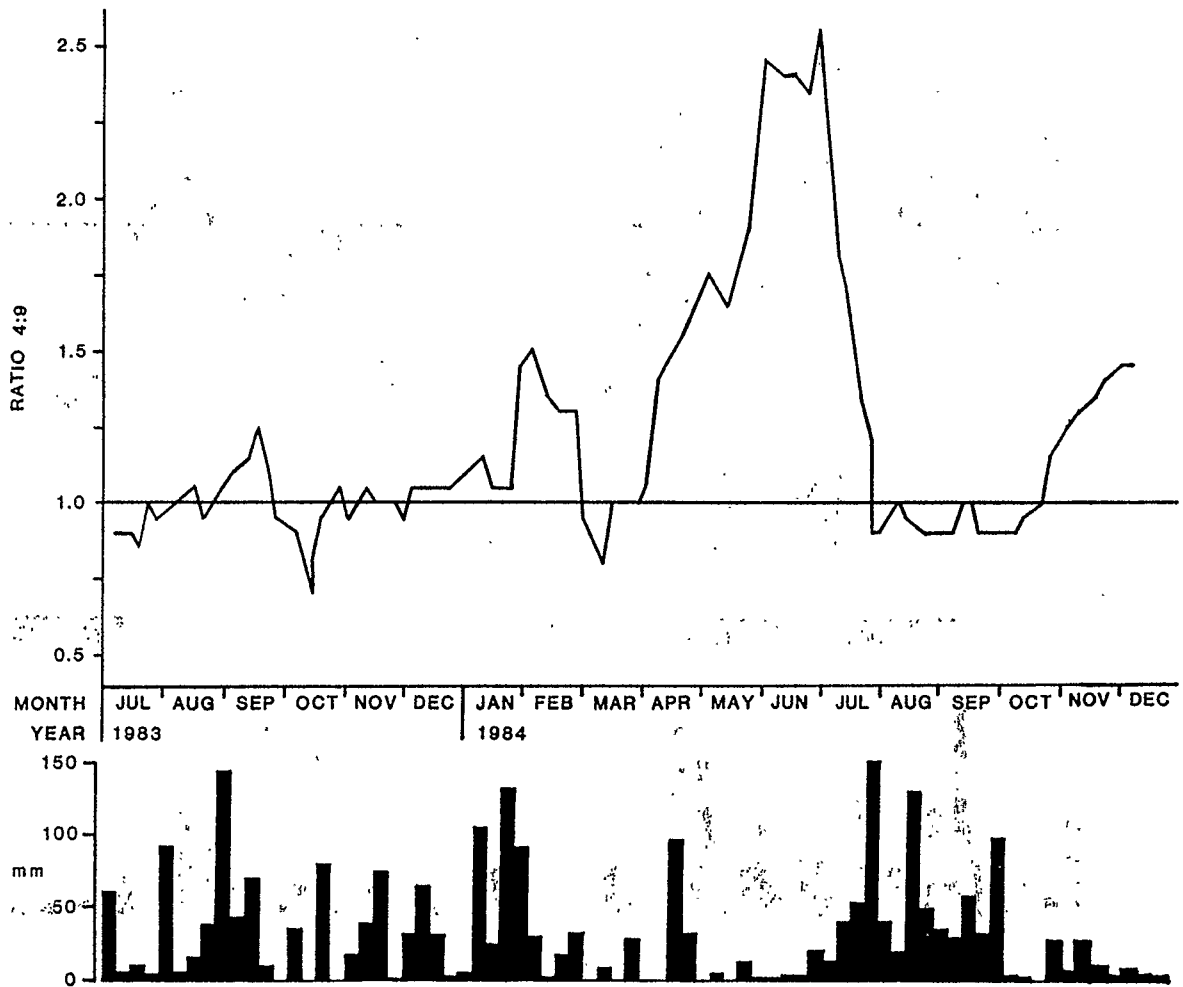
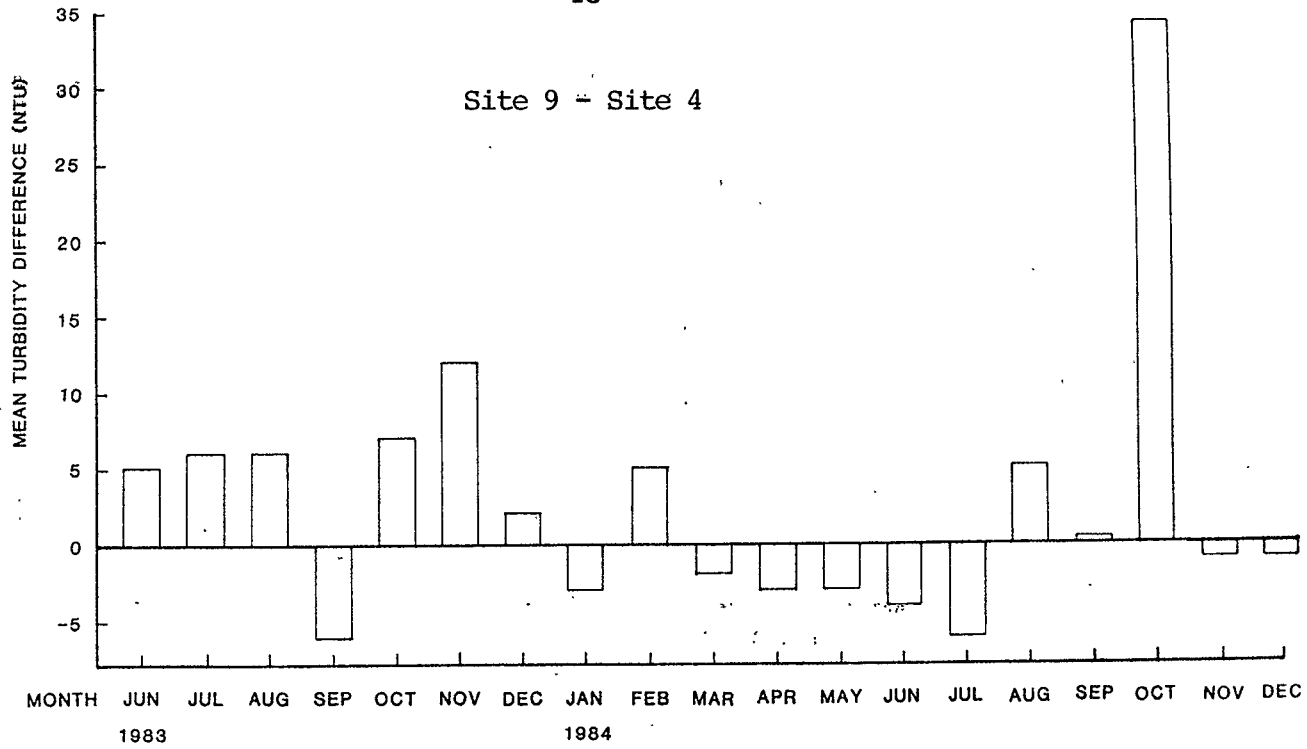


Figure 7. Time series comparison of turbidity values at sampling sites 9 and 4 showing weekly rainfalls.

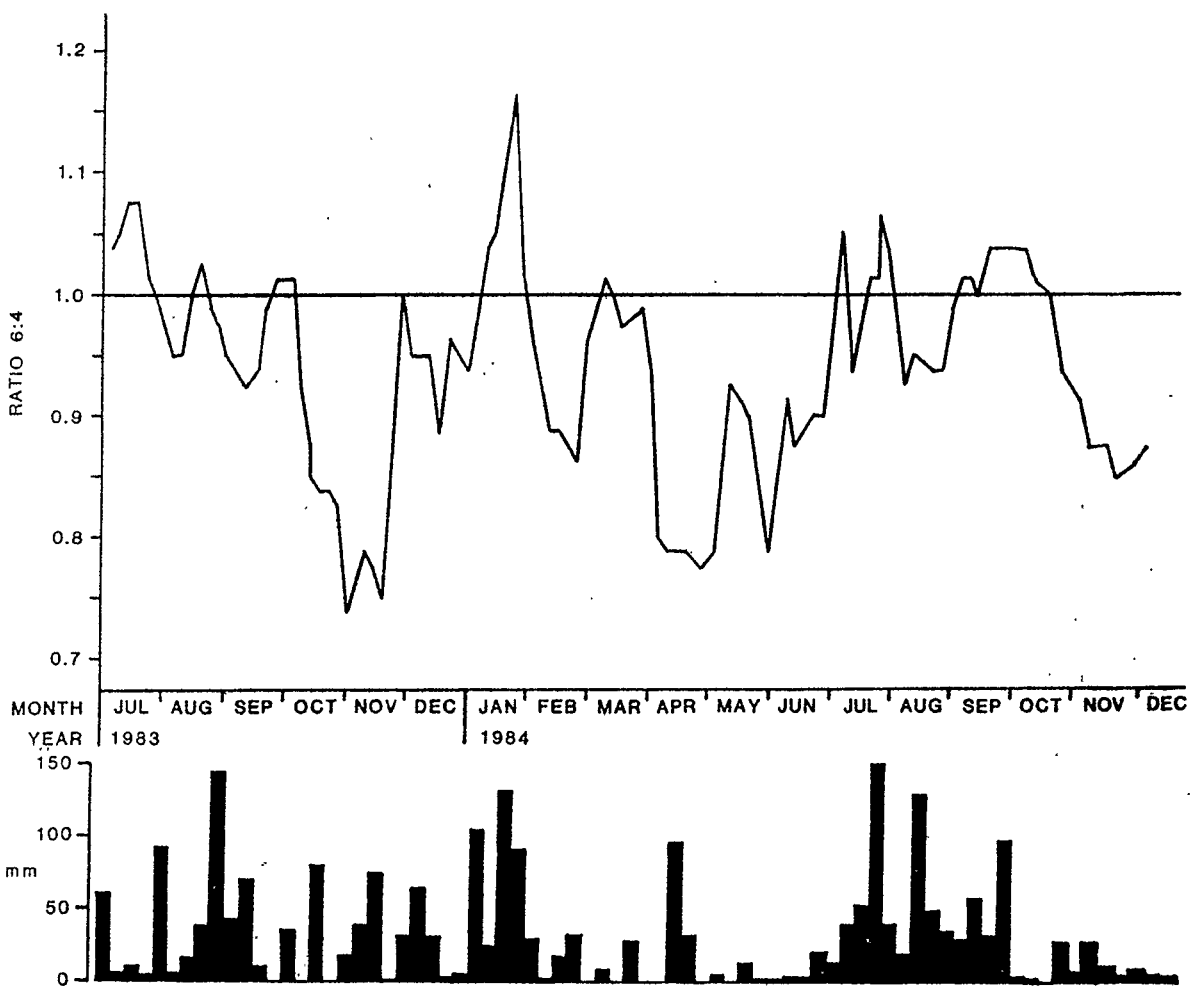
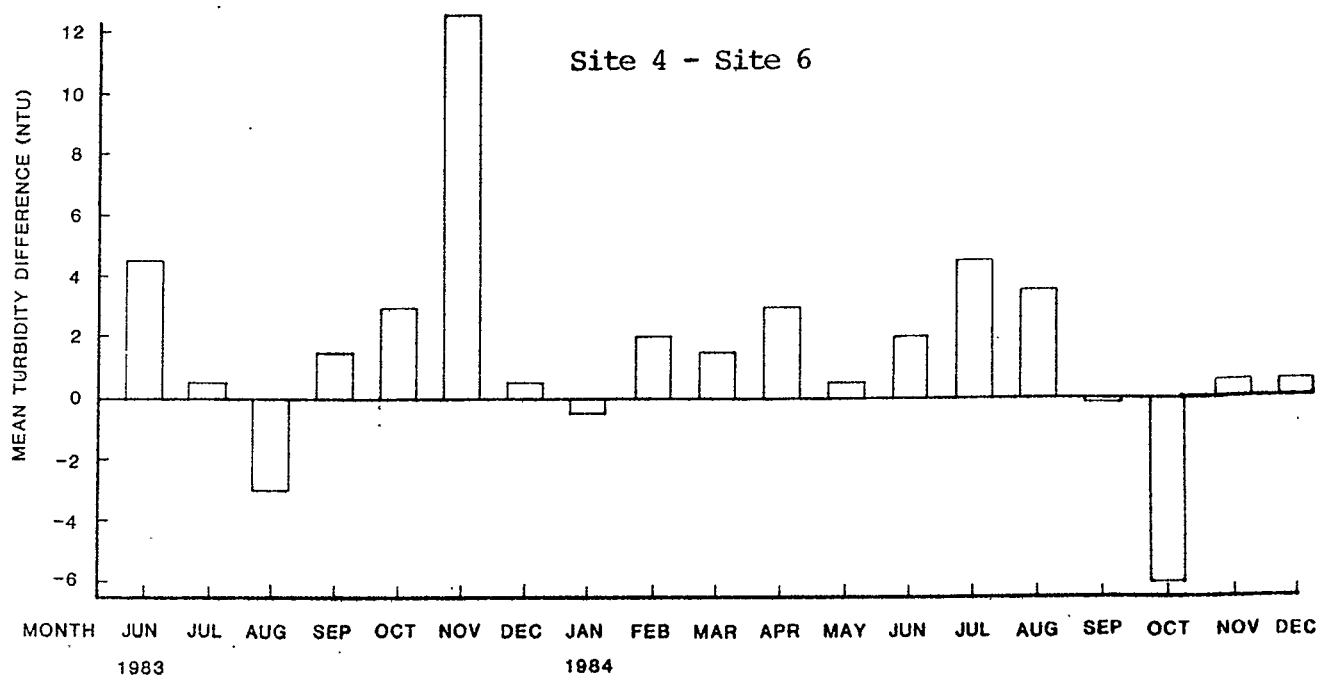


Figure 8. Time series comparison of turbidity values at sampling sites 4 and 6 showing weekly rainfalls.

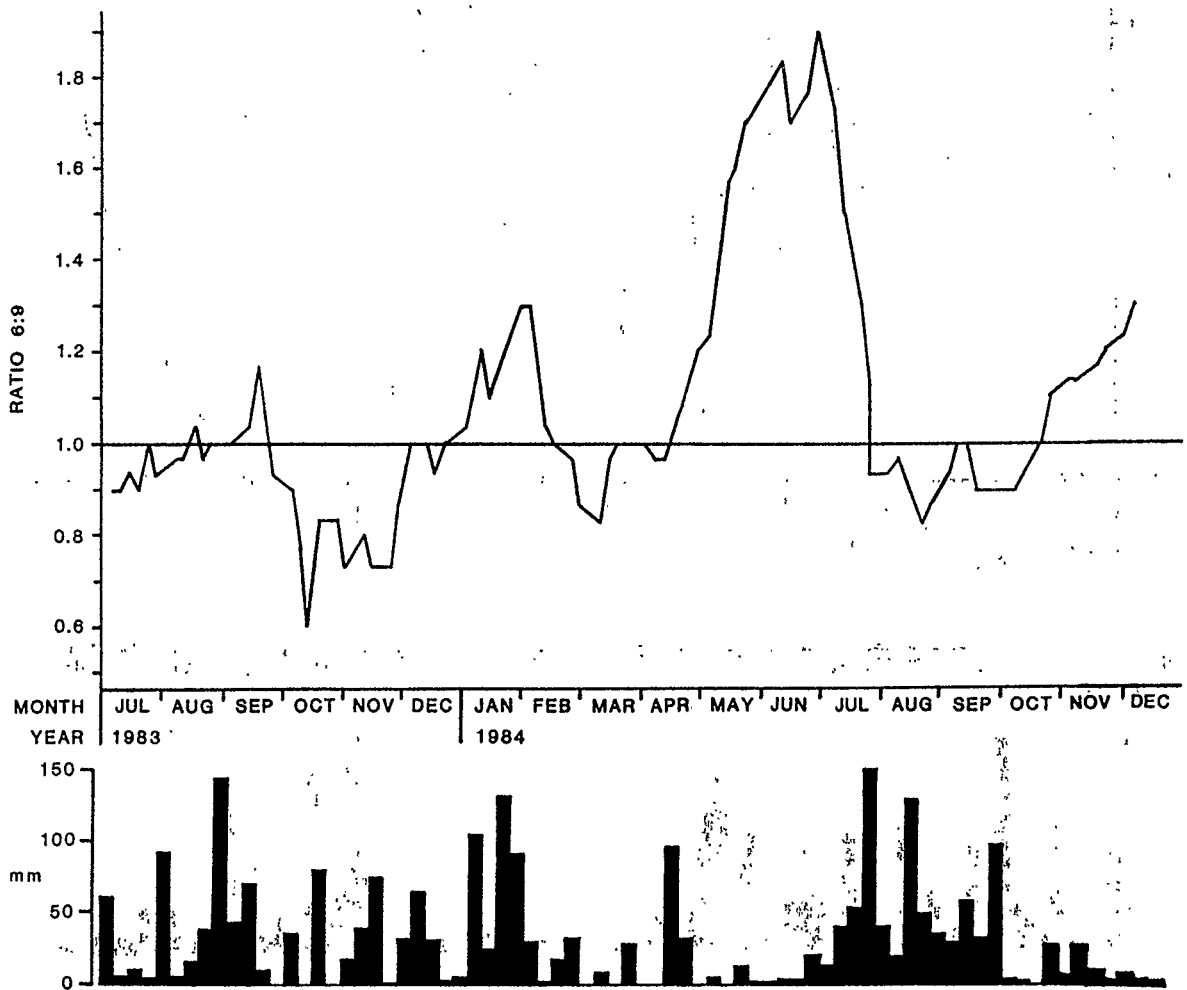
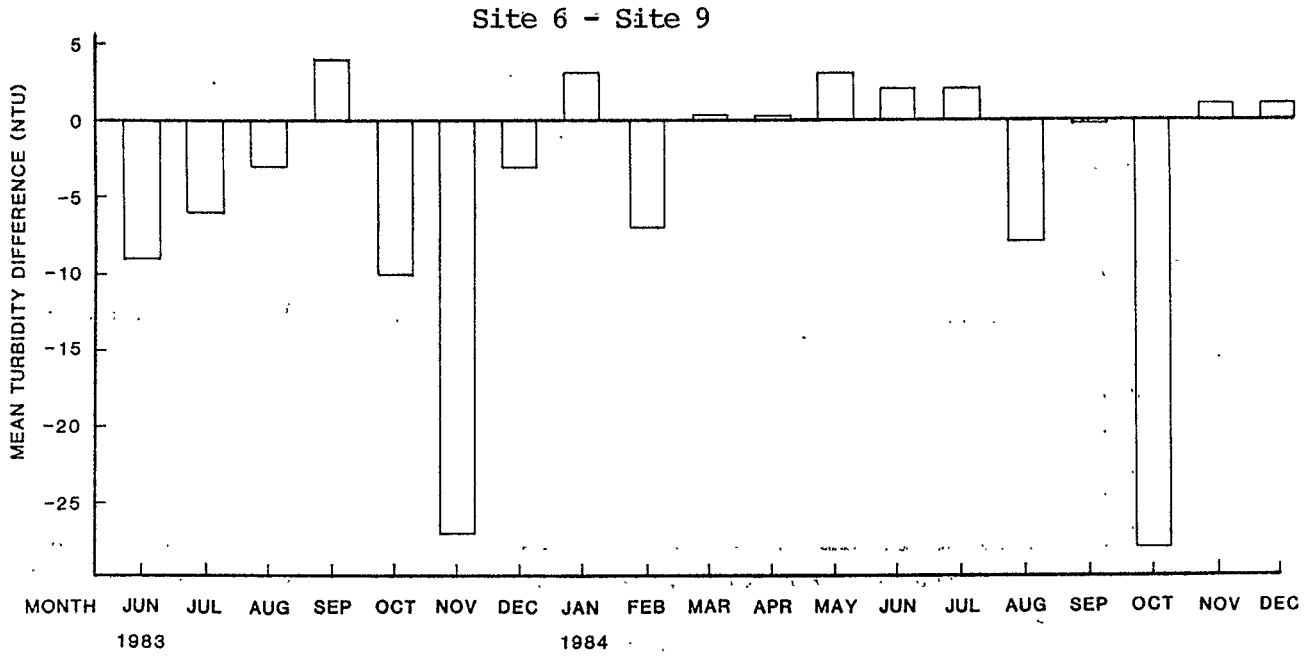


Figure 9. Time series comparisons of turbidity values at sampling sites 6 and 9 showing weekly rainfalls.

Site 8 - Site 9

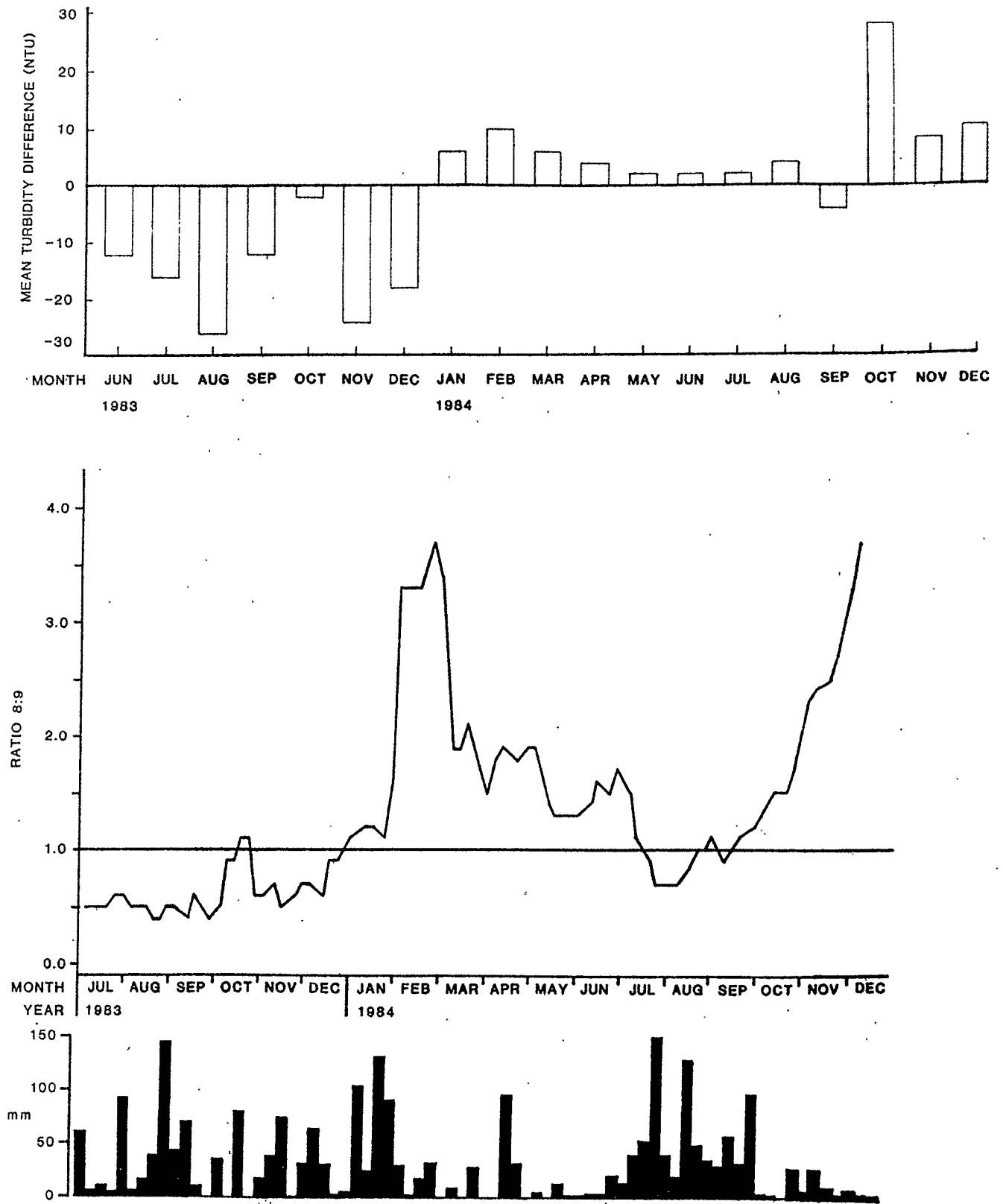


Figure 10. Time series comparisons of turbidity values at sampling sites 8 and 9 showing weekly rainfalls.

Site 10 - Site 9

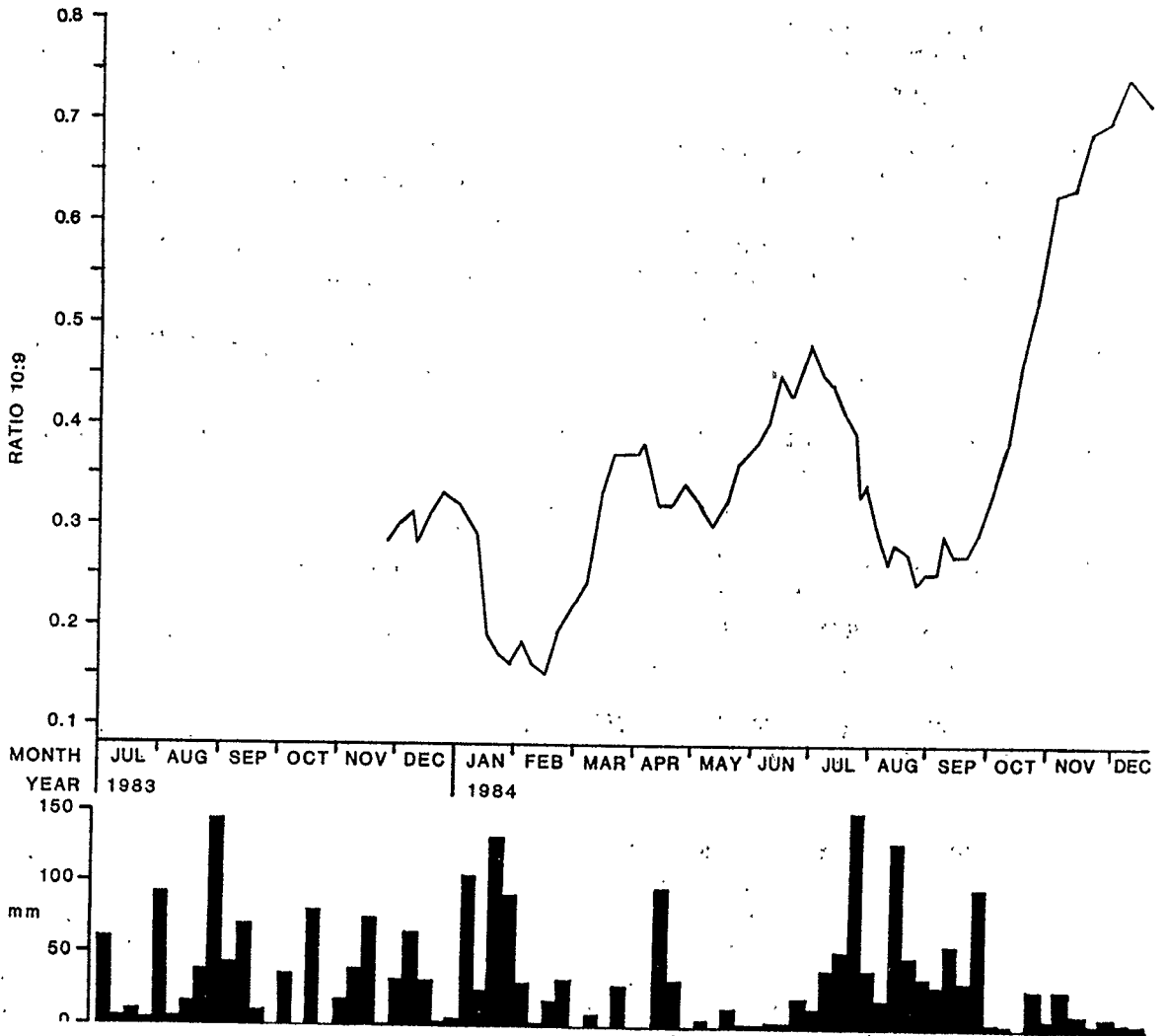
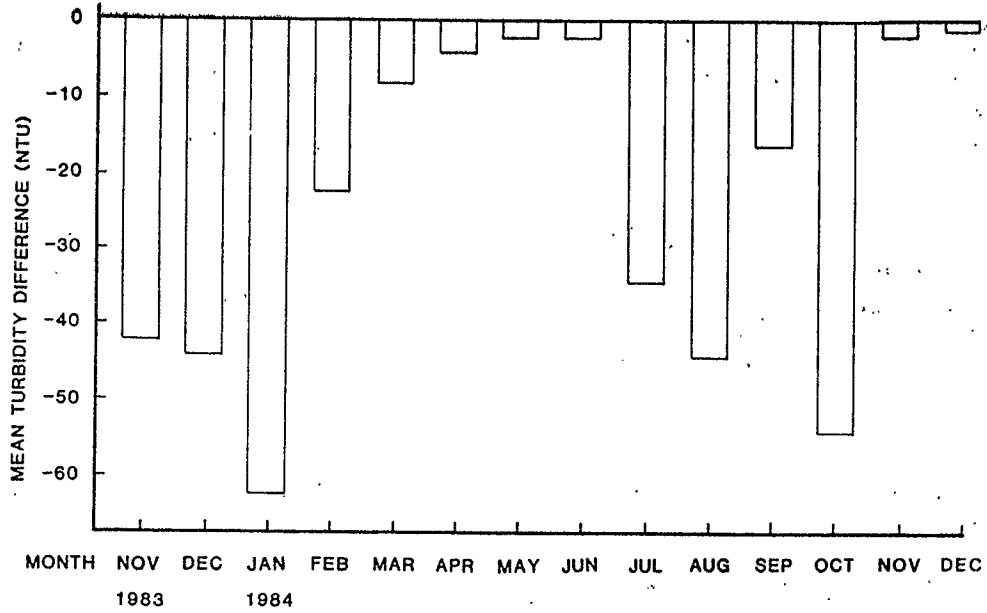


Figure 11. Time series comparison of turbidity value at sampling sites 10 and 9 showing weekly rainfalls.

Turbidity levels at sites 13 (Wondalga Creek) and 14 (Cooley's Creek) increased relative to those at the pump station during 1984 (Figures 14 and 15). In Wondalga Creek turbidity levels were markedly lower in drier periods, while in Cooley's Creek levels were at or above those in Adelong Creek for most of 1984, perhaps due to different agricultural/pastoral practices in this catchment.

Figures 16 and 17 show mean monthly turbidity differences between pairs of adjacent sites. Monthly differences between sites 1 and 2 probably reflect periods of logging, while site 3 generally had higher values than site 2, particularly in wet periods. Except in dry periods values at site 3 were lower than those at site 4. Adelong Creek at site 6 had generally higher turbidity levels than those in Wilsons Creek (site 7), particularly at higher flows.

CONCLUSIONS

- (a) Turbidity levels in Adelong Creek catchment during the period of the study were generally high.
- (b) Turbidity levels at all sites rose considerably during periods of heavy rainfall.
- (c) The turbidity levels at the sampling sites in the *Pinus* plantation in Green Hills State Forest increased with increasing plantation area and proportional area logged during the period.
- (d) Adelong Creek at site 4, which drains *P. radiata* plantation, had higher turbidity levels than nearby Hindmarsh Creek which drains agricultural/pastoral land.
- (e) All pastoral/agricultural tributaries (with the exception of Tanyard Creek) generally had lower streamwater turbidity levels than Adelong Creek.
- (f) The tributary at sampling site 10 had much lower turbidity levels than all other streams in the catchment, although the reason for this was unclear.
- (g) Tanyard Creek had the highest turbidity levels in the catchment in 1984, possibly because of the initiation of active gully erosion in this catchment by the storms of January, 1984.
- (h) While streamwater turbidity levels in Adelong Creek were lower between sampling sites 6 and 12 than at site 4 due to tributary dilution effects, those at the pump station were relatively higher due to the inflows from Tanyard Creek and also possibly due to the extensive bank erosion occurring on Adelong Creek below site 12.
- (i) The proportion of samples >5 NTU decreased down Adelong Creek from site 1 to the pump station. This suggests a more dispersive clay type in the soils of the upper catchment.
- (j) Although these results suggest that the *P. radiata* plantation has supplied more turbid water to Adelong Creek than nearby pastoral/agricultural land, it should not be overlooked that most of the plantation within this catchment was established prior to the introduction of erosion mitigation measures. Consequently plantation layout, road location and streamside protection may have been sub-optimal from a water quality production viewpoint. However erosion mitigation and wet weather closure procedures were followed during harvesting operations in 1983 and 1984 and these measures have certainly prevented massive increases in turbidity levels in plantation streams.

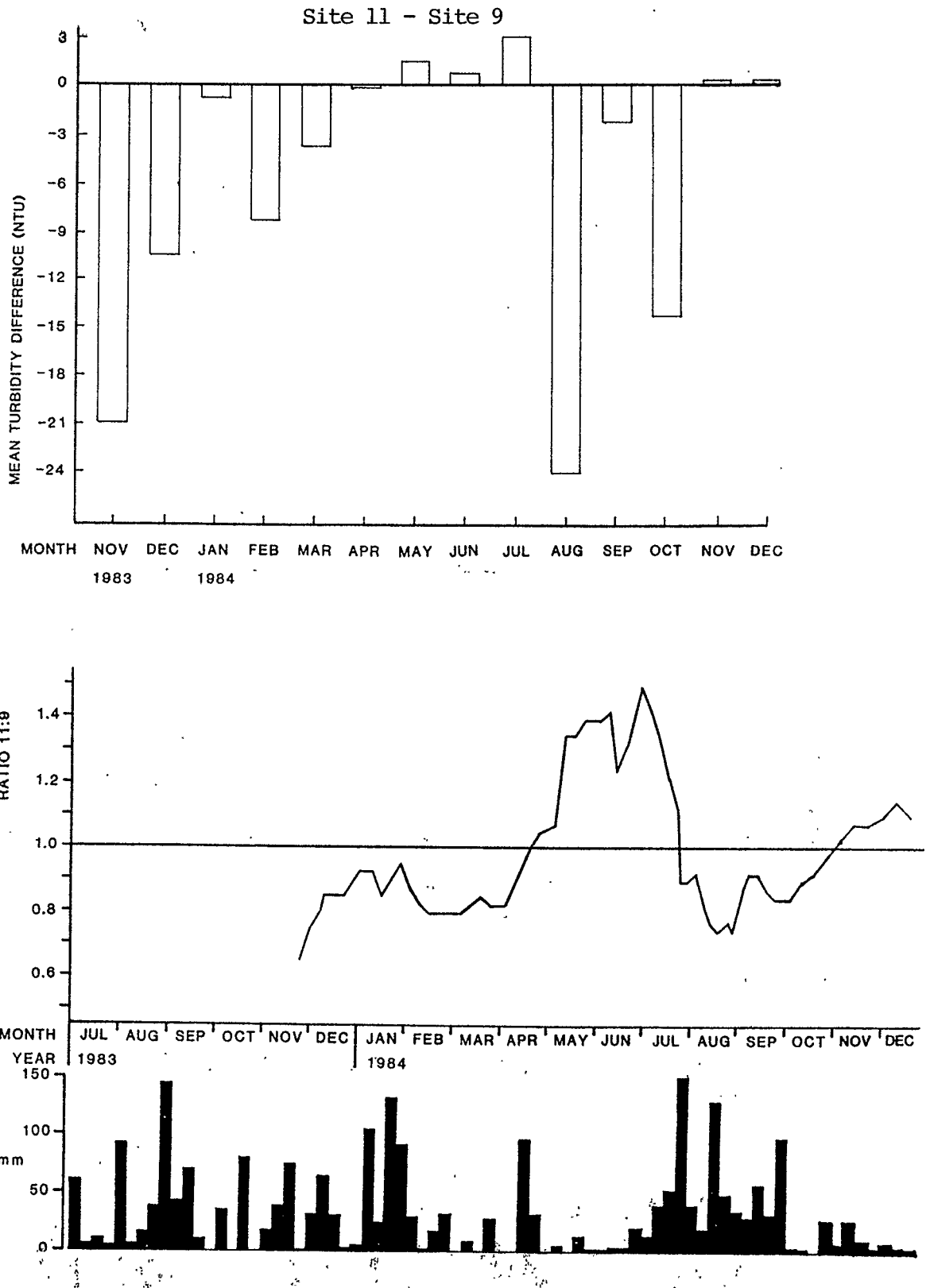


Figure 12. Time series comparison of turbidity value at sampling sites 11 and 9 showing weekly rainfalls.

Site 12 - Site 9

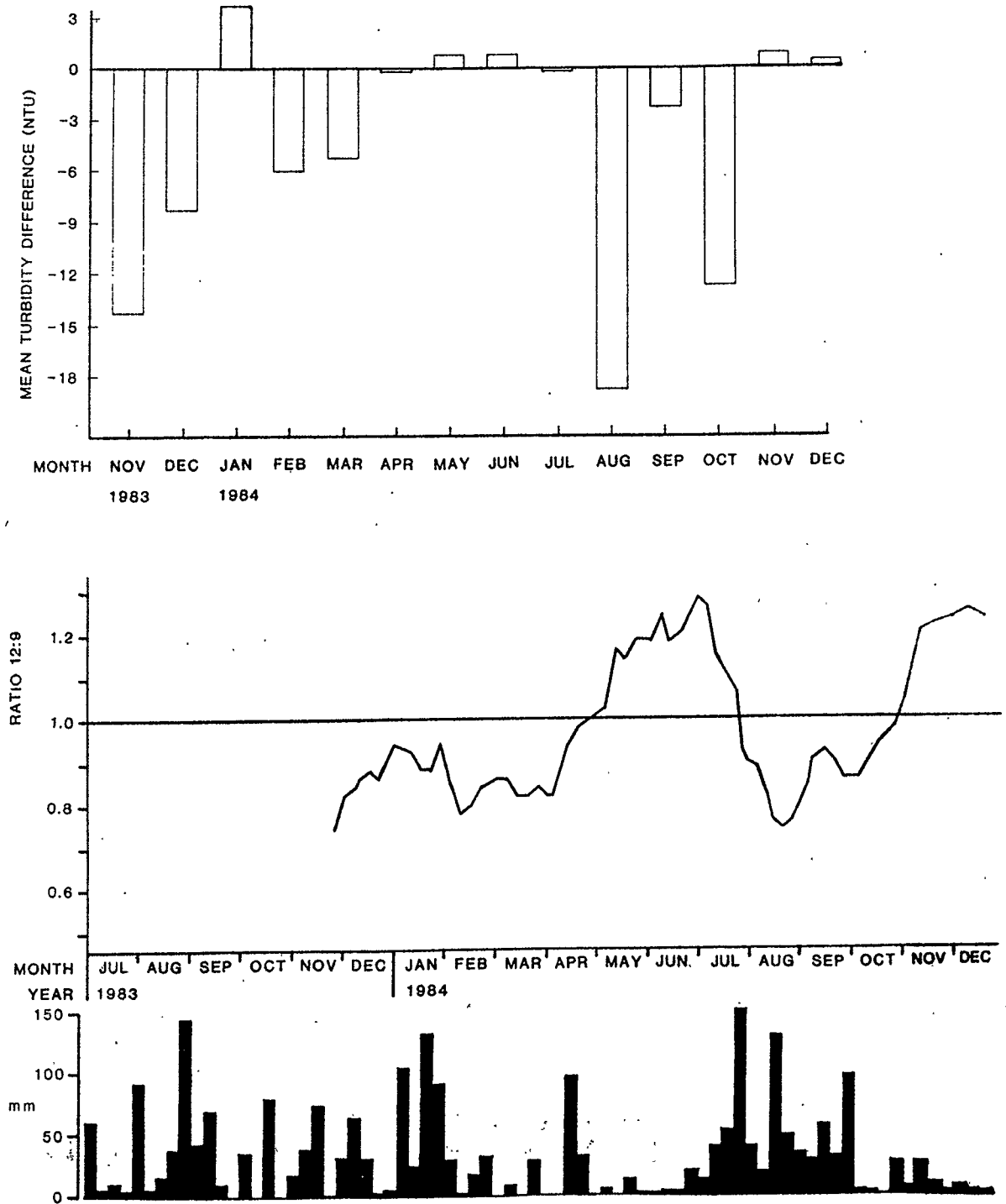


Figure 13. Time series comparison of turbidity values at sampling sites 12 and 9 showing weekly rainfalls.

Site 13 - Site 9

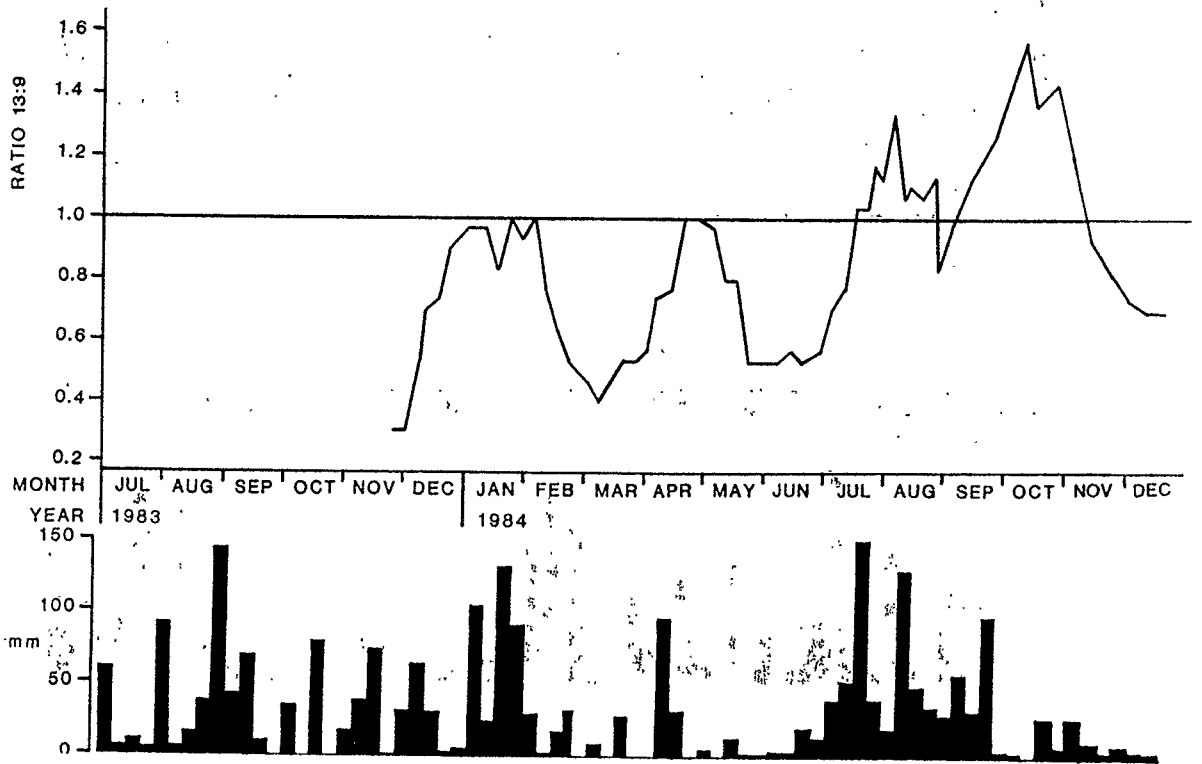
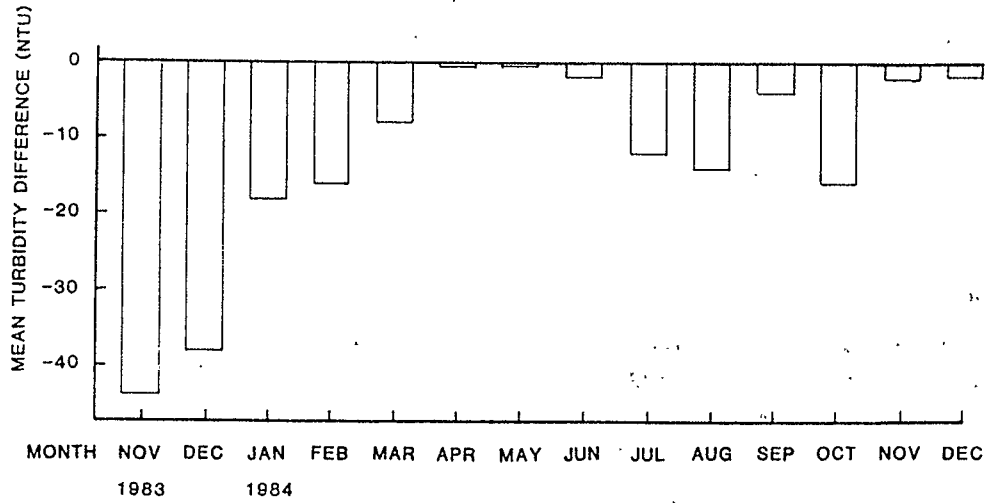


Figure 14. Time series comparison of turbidity values at sampling sites 13 and 9 showing weekly rainfalls.

Site 14 - Site 9

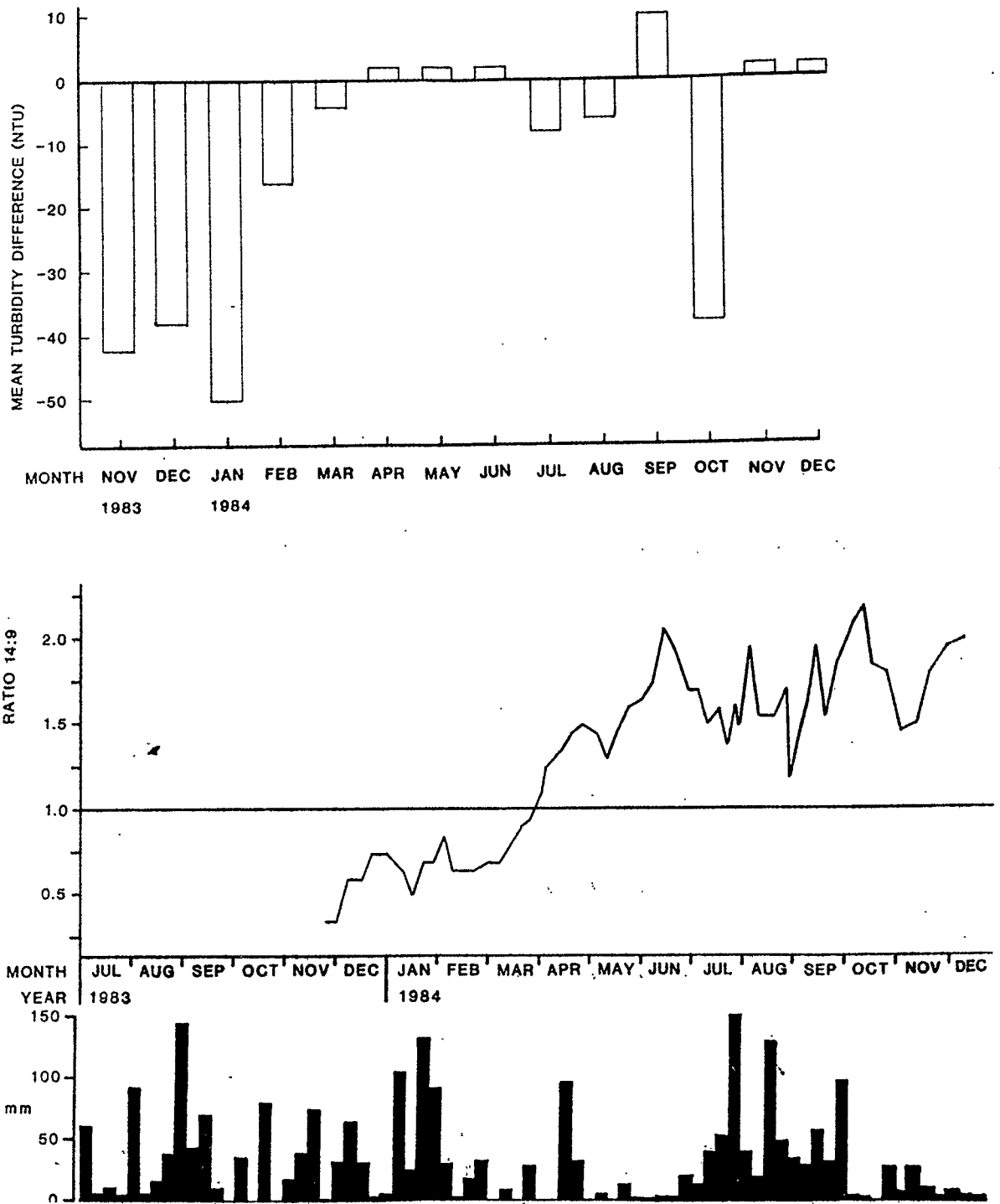


Figure 15. Time series comparison of turbidity value at sampling sites 14 and 9 showing weekly rainfalls.

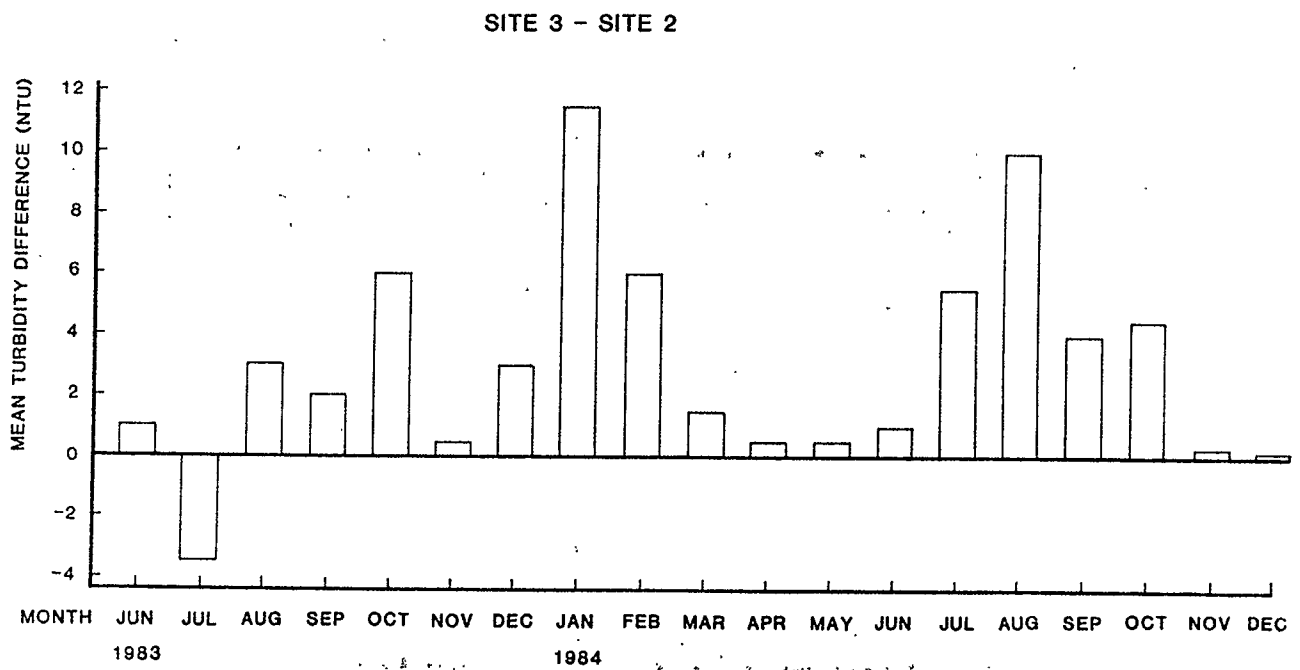
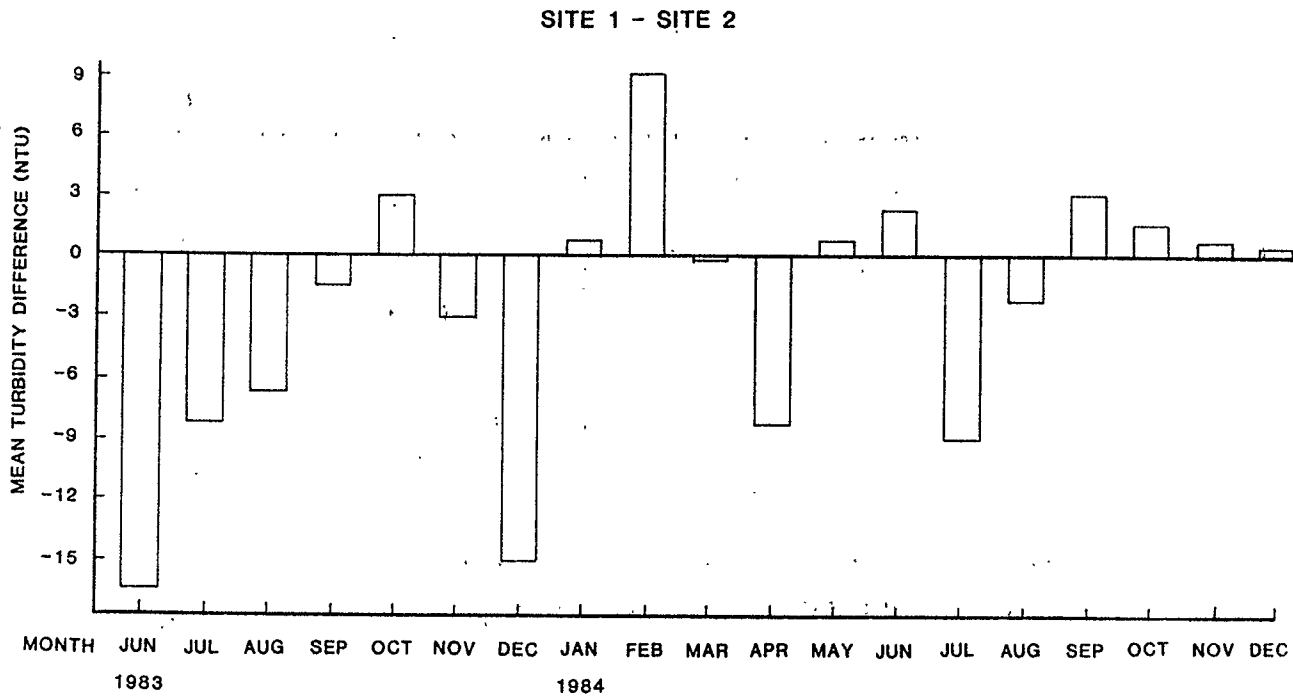
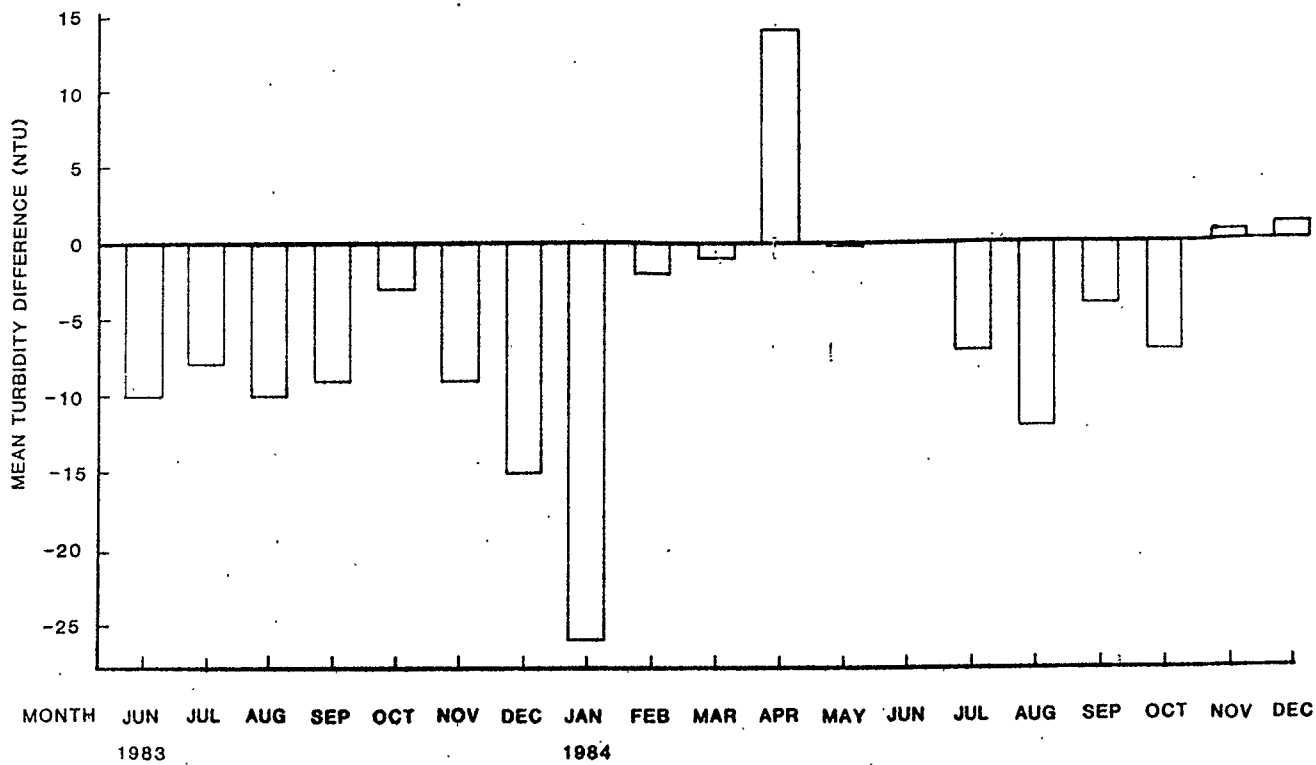


Figure 16. Time series of mean monthly turbidity differences between sites 1 and 2 and 3 and 2.

SITE 3 - SITE 4



SITE 7 - SITE 6

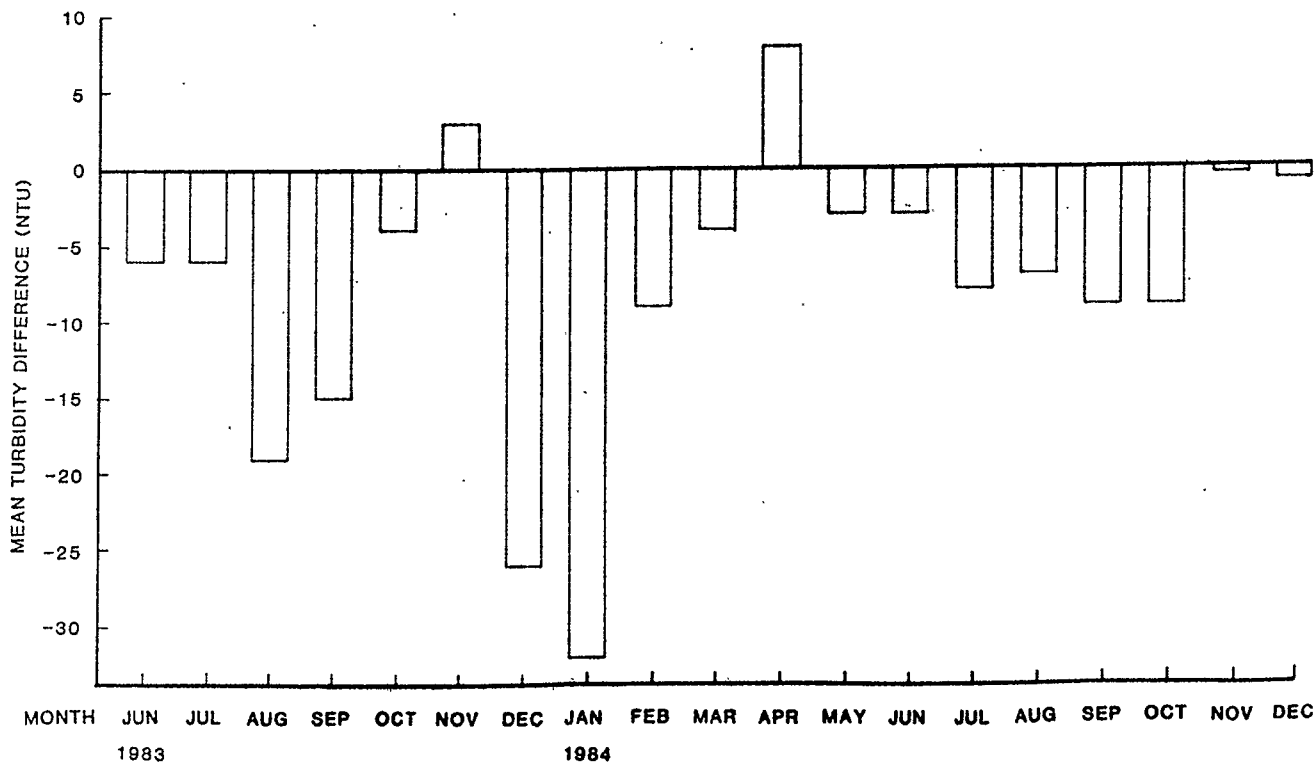


Figure 17. Time series of mean monthly turbidity differences between sites 3 and 4 and sites 7 and 6.

ACKNOWLEDGEMENTS

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TURBIDITY FOR SAMPLE SITE :

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
220683	6.40	13.00	8.60	11.00	11.00	12.50	7.50	2.50	16.00					
290683	24.00	50.00	56.00	74.00	47.00	64.00	58.00	66.00	78.00					
060783	14.00	20.00	19.00	38.00	32.00	35.00	16.00	27.00	40.00					
110783	9.20	13.00	13.00	20.00	14.00	23.00	33.00	5.50	32.00	5.60	24.00	25.00	1.80	5.80
130783	5.50	6.40	6.00	11.00	16.00	12.00	7.40	4.00	9.40					
220783	4.50	6.10	5.70	7.10	9.60	8.60	9.00	4.20	10.00					
280783	5.10	5.60	5.00	5.90	7.00	5.90	7.90	6.10	5.80					
290783	26.00	64.00	44.00	56.00	38.00	50.00	24.00	29.00	76.00					
030883	8.60	12.00	12.00	17.00	14.00	15.00	11.00	6.60	13.00					
100883	7.50	8.90	8.10	10.30	10.40	10.20	10.00	4.40	10.10					
180883	17.00	22.00	21.00	29.00	24.00	28.00	12.00	10.00	28.00					
230883	6.80	6.50	6.70	8.40	8.80	8.70	7.70	5.20	8.30					
270883	86.00	110.00	126.00	160.00	126.00	178.00	105.00	92.00	193.00					
010983		12.00		30.00	25.00	30.00	13.00	5.00	33.00					
060983	24.00	29.00	30.00	39.00	23.00	32.00	12.00	19.00	30.00					
100983	28.00	36.00	40.00	47.00	30.00	42.00	18.00	22.00	38.00					
140983	12.00	9.00	11.00	16.00	13.00	15.00	10.00	6.20	14.00					
220983	8.80	9.20	8.60	10.10	9.70	9.80	6.90	4.00	9.40					

APPENDIX

TURBIDITY FOR SAMPLE SITE :

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
280983	26.00	24.00	28.00	49.00	37.00	53.00	34.00	29.00	33.00					
051083	8.60	9.30	11.00	13.00	12.00	14.00	13.00	7.00	25.00					
121083	22.00	5.00	11.00	16.00	11.00	16.00	4.60	5.60	38.00					
131083	7.00	5.50	8.60	9.10	7.50	8.30	4.10	5.40	9.60					
141083	14.00	19.00	32.00	32.00	20.00	17.00	26.00	108.00	45.00					
191083	6.40	6.80	8.20	11.00	8.40	9.70	6.80	8.80	12.00					
201083	38.00	32.00	49.00	56.00	32.00	52.00	36.00	44.00	56.00					
281083	6.00	5.20	5.10	6.20	5.70	5.70	4.00	4.50	4.90					
021183	6.30	6.20	6.20	6.70	5.60	6.30	4.20	3.90	6.80					
091183	11.00	18.00	14.00	37.00	12.00	16.00	10.00	5.80	38.00	2.90	18.00	23.00	5.30	6.70
151183	44.00	48.00	54.00	73.00	34.00	33.00	61.00	55.00	120.00	32.00	77.00	93.00	23.00	29.00
231183	.	5.50	6.00	4.90	6.30	5.70	3.90							
241183	5.30	6.00	5.00	6.50	6.60	5.80	3.90	6.10	5.00	4.10	4.40	4.60	3.60	4.00
011283	12.00	43.00	62.00	62.00	13.00	52.00	12.00	8.30	56.00	3.00	25.00	29.00	10.00	18.00
071283	46.00	74.00	73.00	135.00	83.00	140.00	65.00	135.00	150.00	26.00	125.00	130.00	43.00	37.00
111283	32.00	58.00	60.00	83.00	46.00	88.00	46.00	52.00	90.00	15.00	86.00	89.00	12.00	10.00
141283	7.50	8.60	7.30	9.50	7.60	8.80	7.20	6.10	9.20	3.00	7.80	8.70	12.00	13.00
211283	5.70	7.00	5.40	6.00	5.50	5.50	5.00	4.00	4.50	3.00	5.00	4.60	7.00	4.50

APPENDIX (cont.)

TURBIDITY FOR SAMPLE SITE :

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
281283	3.00	4.00	4.00	4.80	2.50	2.40	5.20	5.70	4.60	1.00	2.20	2.50	1.50	1.20
110184	6.20	6.00	5.00	5.70	9.20	8.00	3.60	8.20	6.30	1.70	5.70	4.90	7.20	5.40
170184	78.00	82.00	110.00	155.00	97.00	150.00	85.00	170.00	120.00	17.00	150.00	165.00	68.00	29.00
250184	15.00	10.00	9.60	10.00	6.80	14.00	4.80	8.80	8.40	1.50	7.00	7.20	11.00	8.50
260184	50.00	48.00	68.00	125.00	60.00	125.00	77.00	125.00	150.00	20.00	120.00	122.00	127.00	38.00
010284	20.00	6.80	14.00	15.00	14.00	16.00	7.20	13.00	15.00	2.00	11.00	9.00	16.00	17.00
080284	32.00	4.80	21.00	20.00	4.60	12.00	3.30	28.00	7.00	1.50	7.70	7.10	6.30	6.10
150284	14.00	5.00	9.00	8.40	4.60	6.30	2.80	5.20	5.40	1.40	5.20	4.70	4.90	5.00
220284	14.00	16.00	17.00	21.00	8.70	21.00	15.00	45.00	45.00	3.00	21.00	27.00	5.90	6.00
280284	22.00	23.00	25.00	31.00	15.00	31.00	11.00	38.00	50.00	4.10	35.00	46.00	9.80	6.40
070384	8.30	5.80	6.00	5.70	4.00	5.50	4.00	21.00	6.30	2.00	5.20	4.90	3.80	8.00
140384	7.80	6.50	7.00	6.50	4.60	7.00	5.20	14.00	6.00	2.20	6.40	6.90	3.40	6.50
210384	7.20	5.00	6.10	5.80	4.20	6.10	5.80	13.00	5.60	2.00	5.00	4.60	3.10	4.50
250384	30.00	38.00	43.00	50.00	40.00	44.00	26.00	36.00	40.00	22.00	26.00	18.00	16.00	24.00
290384	7.60	7.30	7.00	7.40	4.30	6.50	7.10	15.00	9.30	2.30	7.20	8.40	5.80	6.60
040484	6.60	6.10	5.60	4.60	4.30	4.70	2.50	7.50	5.40	1.80	4.30	4.70	3.20	8.00
110484	5.70	5.20	4.70	4.60	3.00	4.00	2.30	5.00	3.40	1.30	3.60	3.60	2.40	6.30
180484	32.00	67.00	70.00	14.00	13.00	4.60	39.00	18.00	5.00	2.00	4.30	4.00	6.80	8.60

APPENDIX (cont.)

TURBIDITY FOR SAMPLE SITE :

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
270484	6.70	5.90	6.70	6.60	6.00	5.50	5.60	6.90	4.80	1.20	5.70	5.30	2.80	5.20
070584	5.50	4.80	5.20	5.40	3.90	4.80	3.70	4.50	3.90	1.00	4.20	4.10	7.00	4.80
090584	5.90	5.40	5.10	5.50	5.80	5.30	3.10	6.30	3.60	1.40	4.00	3.60	2.00	5.70
160584	5.80	5.20	5.10	5.30	5.70	5.00	3.00	6.10	3.40	1.00	3.90	3.80	2.10	5.60
230584	9.00	9.50	12.00	13.00	7.00	13.00	6.70	3.30	5.30	1.60	12.00	8.00	2.00	5.30
300584	6.20	5.10	5.60	5.30	3.10	4.00	1.80	3.80	2.80	1.00	3.20	3.00	1.60	4.70
060684	6.40	5.40	5.20	4.80	3.00	4.00	1.80	2.80	2.40	1.10	3.10	2.80	1.40	5.00
130684	6.80	5.30	5.70	12.00	3.60	4.70	1.80	4.40	2.70	1.30	3.20	2.90	1.40	5.30
200684	7.90	4.60	7.80	2.80	5.10	4.50	2.00	5.20	2.40	1.00	2.90	3.40	1.50	4.90
270684	8.00	5.00	6.40	5.50	3.40	4.20	1.70	4.00	2.30	1.20	3.20	2.60	1.40	5.50
040784	12.00	7.60	7.70	8.00	4.30	7.40	5.00	3.70	4.50	1.30	6.90	5.40	1.60	5.50
160784	65.00	110.00	90.00	94.00	61.00	78.00	67.00	63.00	33.00	23.00	71.00	53.00	23.00	26.00
180784	12.00	12.00	13.00	14.00	14.00	16.00	19.00	12.00	18.00	5.50	16.00	17.00	23.00	37.00
230784	27.00	27.00	35.00	46.00	36.00	48.00	58.00	30.00	61.00	25.00	48.00	52.00	54.00	70.00
260784	12.00	11.00	13.00	15.00	16.00	17.00	26.00	15.00	23.00	8.00	18.00	21.00	43.00	62.00
290784	76.00	89.00	130.00	155.00	80.00	140.00	86.00	182.00	156.00	26.00	154.00	148.00	76.00	44.00
010884	20.00	18.00	26.00	36.00	32.00	40.00	25.00	15.00	30.00	13.00	30.00	29.00	40.00	54.00
080884	27.00	22.00	23.00	28.00	21.00	28.00	20.00	18.00	30.00	10.00	27.00	25.00	33.00	45.00

APPENDIX (cont.)

TURBIDITY FOR SAMPLE SITE :

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
160884	12.00	5.00	13.00	13.00	7.00	10.00	12.00	4.90	13.00	2.00	12.00	10.00	25.00	45.00
190884	59.00	90.00	126.00	160.00	86.00	138.00	154.00	160.00	162.00	36.00	60.00	96.00	82.00	105.00
220884	41.00	38.00	46.00	67.00	51.00	67.00	34.00	140.00	96.00	24.00	61.00	63.00	63.00	35.00
280884	16.00	15.00	15.00	17.00	17.00	18.00	13.00	33.00	19.00	7.00	17.00	16.00	23.00	32.00
030984	12.00	7.20	10.00	13.00	12.00	13.00	12.00	8.00	13.00	2.80	13.00	12.00	18.00	32.00
050984	26.00	28.00	32.00	40.00	28.00	40.00	19.00	30.00	43.00	8.20	38.00	37.00	18.00	32.00
120984	16.00	10.00	15.00	18.00	16.00	18.00	12.00	7.80	17.00	4.00	16.00	16.00	19.00	32.00
180984	23.00	17.00	24.00	30.00	24.00	31.00	17.00	33.00	30.00	13.00	27.00	28.00	24.00	37.00
260984	7.50	5.50	7.00	8.50	7.80	8.20	7.40	17.00	8.40	2.30	7.70	7.70	17.00	29.00
031084	115.00	110.00	130.00	160.00	180.00	190.00	150.00	460.00	330.00	75.00	260.00	270.00	230.00	110.00
101084	7.80	6.60	7.10	9.40	10.00	9.60	9.00	12.00	11.00	3.00	8.00	7.90	18.00	27.00
171084	6.60	5.90	6.20	6.80	5.80	6.50	5.60	9.60	6.00	3.00	5.30	5.50	12.00	18.00
241084	6.50	5.20	5.50	5.40	4.30	4.90	4.20	6.20	4.00	2.50	4.70	4.50	5.80	7.50
311084	5.70	5.10	5.30	5.50	4.00	5.00	4.40	9.00	4.30	2.80	4.50	4.70	4.70	6.30
071184	6.50	5.20	5.70	4.90	3.80	4.40	5.40	7.70	4.00	2.20	4.00	4.00	3.70	4.60
141184	6.30	7.50	6.50	6.80	4.20	6.00	5.90	26.00	5.90	4.70	6.00	7.00	3.50	4.60
211184	6.00	5.00	4.50	4.70	3.00	3.80	2.50	7.00	3.10	1.90	3.50	5.00	2.00	6.00
281184	6.30	5.50	5.80	4.80	3.30	4.10	2.60	6.00	3.10	2.60	3.70	3.80	2.50	6.80

APPENDIX (cont.)

TURBIDITY FOR SAMPLE SITE :

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
051284	5.40	4.70	4.80	4.20	3.00	3.50	2.20	8.20	2.70	2.00	3.00	3.30	2.00	5.80
121284	5.10	5.00	4.80	4.20	3.40	4.00	2.40	14.00	2.90	2.00	3.80	3.00	2.20	6.40
191284	4.60	4.30	4.10	3.50	3.30	3.30	2.00	17.00	2.70	1.90	2.10	2.90	1.50	3.60

APPENDIX (cont.)