9. SUMMARY AND CONCLUSIONS

The primary aim of this study was to determine effective approaches for reducing receiving water degradation caused by gross pollutants carried in urban stormwater. This was achieved in three steps. Firstly, an improved understanding of the quantities and origins of urban gross pollutants was gained from two intensive monitoring programs; secondly, the performances of two promising gross pollutant trapping techniques were assessed; and thirdly, the outcomes were formulated into a decision support system to aid catchment managers determine gross pollutant trapping strategies for urban catchments (which is discussed in a companion report, Allison, 1997).

The results from the monitoring programs suggest that, although large amounts of gross pollutants are transported from urban catchments to receiving waters via the stormwater system, technologies are available to capture these pollutants from within the drainage network. However, trapping gross pollutants from within urban waterways can be expensive. With the large areas associated with urban centres in Australia, it is unlikely that gross pollutant traps will be located on all urban catchments. Waterway managers must therefore decide what are the appropriate trapping techniques and where best to locate traps within a particular drainage network.

The main research outcomes from this study can be grouped into the two areas of gross pollutant loads and gross pollutant trapping techniques. The conclusions are summarised as follows.

9.1 GROSS POLLUTANT LOADS

Despite education, awareness and street cleaning programs, large amounts of gross pollutants are reaching and degrading receiving waters. This study showed that previous estimates of the number of litter items moving through the stormwater systems are too small by orders of magnitude, and that organic material is consistently the main component of gross pollutant loads.

The results of this study indicate that urban areas contribute approximately 30 dry kg per hectare per year of gross pollutants to the stormwater system. For Melbourne, this is equivalent to 60,000 tonnes of wet gross pollutants (230,000 cubic meters) and between one and three billion items of litter annually. This quantity of material presents a large problem for waterway managers.

The results from the monitoring program indicate that about three quarters of gross pollutants are organic material (mainly leaves and twigs). This was observed consistently across different land-use types. However, despite the large amounts of organic gross pollutants transported by stormwater, they are not a major source of nutrients (TP and TN). The results indicate that nutrient loads transported by organic gross pollutants are about two orders of magnitude lower than the diffuse loads generated from other sources. Nevertheless, because of their large amounts, organic gross pollutants must be taken into account in the design of gross pollutant traps, especially where they are likely to impose physical impacts such as pipe blockages or habitat smothering.

Higher amounts of litter (mainly paper and plastics from pedestrians and motorists) are transported from commercial and light-industrial areas than from residential areas. This suggests that commercial and light-industrial areas should be targeted for reduction strategies.

Only 20 percent of the litter and less than 10 percent of the organic material transported by the flow in urban waterways are transported as floating material. This means that floating gross pollutant traps can, at best, only capture small fractions of the gross pollutants being transported. There is a need to design trapping systems which include capture of gross pollutants being transported within the flow.

Outcomes from the event monitoring program indicate that gross pollutant concentrations generally peak before the peak of the storm hydrograph. However, most of the gross pollutant load is transported during peak discharges. As such, to capture the maximum amount of gross pollutants, trapping systems should be designed to treat high discharges. This result would suggest that 'first flush' trapping systems (designed to direct the small initial portion of runoff into a treatment chamber and allow the remainder of the flow to by-pass the trap) will not treat the flow when most of the gross pollutants are transported and therefore would miss significant quantities of material, particularly for large storms.

The quantity of gross pollutants transported by storm events appeared to be correlated with the rainfall and runoff quantities. This would suggest that most of the load of gross pollutants are not flushed through the drainage network by the first part of the runoff and that the quantity of material transported is not limited by supply but rather the carrying potential of the rainfall and runoff characteristics.

Although gross pollutant loads and concentrations vary considerably during runoff events, the composition of the gross pollutants remains relatively consistent. This suggests that organic and litter materials are transported in similar ways through drainage networks during runoff events. It is therefore not possible to capture exclusively one component of gross pollutants by only treating one part of the storm hydrograph (eg. capturing most of the litter by removing the first part of the runoff is not possible).

Litter items mostly entered the drainage network from commercial areas, mainly due to the actions of pedestrians and motorists in the catchments, which contributed large quantities of plastic and paper items (especially food and drink items) and very high numbers of cigarette related items (approximately 35% of the total number of items). Organic loads of material were relatively uniform from the different land-use areas and may be attributed to near uniform coverage of vegetation in the catchment.

9.2 GROSS POLLUTANT TRAPPING TECHNIQUES

Reduction campaigns for gross pollutants in urban stormwater can be grouped into two categories, non-structural and structural. Non-structural measures are means of reducing the quantity of pollutants available for wash-off, primarily by changing the attitudes (and actions) of the community, while structural measures are constructed in-transit treatments that separate and contain pollutants. Trapping systems provide a structural method for reducing the quantities of gross pollutants that reach receiving waters and are the focus of this study. They are becoming increasingly used in Australia although there is little information available concerning their performance in trapping gross pollutants.

In this study, two promising gross pollutant traps were identified for investigation. Both techniques attempt to trap gross pollutants from different locations in the drainage network. Continuous deflective separation (CDS) devices divert incoming flow to a chamber where pollutants are separated from the flow and are retained until cleaning. They are intended to treat stormwater from catchments of residential block to whole suburb sizes. Side entry pit traps (SEPTs) are baskets that are placed inside the entrances to the drainage system from road gutters. Stormwater passes through the baskets to the drain and material larger than the mesh size is retained. They are intended to be placed on numerous drain entrances within an area.

The field monitoring in this study suggests that CDS devices are efficient gross pollutant traps. During 12 months of monitoring, practically all gross pollutants transported by the stormwater were trapped by the CDS device (ie. 100% removal rate). In addition, they appear to cause only small interference to the stormwater drain, and therefore, are suitable for most urban areas. However, they are expensive to install and require complex construction methods. Nevertheless, once constructed they have the advantage of infrequent cleaning (approximately every 3 months) from only one location in a catchment.

SEPTs can also trap significant quantities of gross pollutants. They are cheap, simple to install and can be used to target specific areas because they can be installed on individual drainage entrances. Although they cannot remove all gross pollutants from the drainage network, they can capture up to 85% of the litter load and up to 75% of the total gross pollutant load entering the drainage system, if placed on all public road entrances. However, regular maintenance (monthly) to clean traps implies that putting traps on all feasible entrances (ie. 100% coverage of road entrances) is unlikely. It is therefore imperative to choose the entrances that contribute the most loads to the drainage system when locating SEPTs.

Analyses of different entrances in the experimental catchment reveal that side entry pits and side entry pits with grates deliver more gross pollutants to the drainage system than grates, and therefore should be targeted. With selective entrances fitted with SEPTs it is possible to locate SEPTs on 50% of the drainage entrances and capture approximately 65% of the litter and about 50% of the total gross pollutant load (litter and organic material).

In addition to CDS devices and SEPTs, there are many other gross pollutant traps available in Australia. Many of these are currently being used and several others are being developed. Information on the performances and costs of some of these traps have been collated in this study, but none of the data sets are as extensive as those established for the two traps examined here. The choice of traps that suit the different conditions in urban catchments depends on the resources available, the layout of the drainage system and the types of gross pollutants that are of most concern to the waterway manager.

The results of this study were incorporated into a decision support system (DSS). The DSS estimates gross pollutant loads from rainfall data and land-use type information, and the trapping performances and costs associated with alternative trapping strategies. The DSS provides a simple aid for urban waterway managers considering appropriate gross pollutant reduction strategies for given resources and management needs, based on our current understanding of gross pollutant movement and trapping.

9.3 AREAS OF POTENTIAL FUTURE WORK

There are three main areas of potential future work following this study.

<u>Gross pollutant characteristics</u>

A considerable amount of data on gross pollutant characteristics and loads from different land-use types and different rainfall conditions were gathered from the field work in this study. However, the data were from only one location, Coburg, Victoria. Although this location is typical of inner city suburbs in Australia, more gross pollutant data are required to improve our understanding of the influences on gross pollutant loads. In particular, data for different Australian cities, different seasons and land-use types other than those examined in this study would be useful. Methodologies for evaluating gross pollutant characteristics have been demonstrated as part of this study and can be used to collect the information from these areas.

<u>Gross pollutant trapping systems</u>

Detailed trapping performance data are only available for the two traps investigated in this study (CDS devices and SEPTs). There is a range of gross pollutant traps becoming available (eg. Diston Purifications, Baramy Engineering traps) for which there are no performance data. Evaluating the performance of trapping techniques not covered in this study would improve our understanding of their performance and allow catchment managers to assess their feasibility for installation.

<u>Catchment management techniques</u>

This study only considered structural means of reducing gross pollutant impacts. There is also a range of non-structural measures, such as education and awareness campaigns, which can be used to reduce the quantities of gross pollutants in urban waterways. Research is needed to quantify the effectiveness of these approaches to enable waterway managers to determine the feasibility of their use. For example, large amounts of resources are spent on street cleaning in Australia despite almost no knowledge of its effectiveness for improving stormwater quality. Research into understanding the effectiveness of street cleaning would either justify current expenditure or potentially lead to a changed role for street cleaning plant and resources in Australia. Other aspects which could influence gross pollutant loads that could be investigated include collection bin densities and cleaning frequencies, education and awareness campaigns (for different target audiences, eg. domestic or commercial), and legislative changes.

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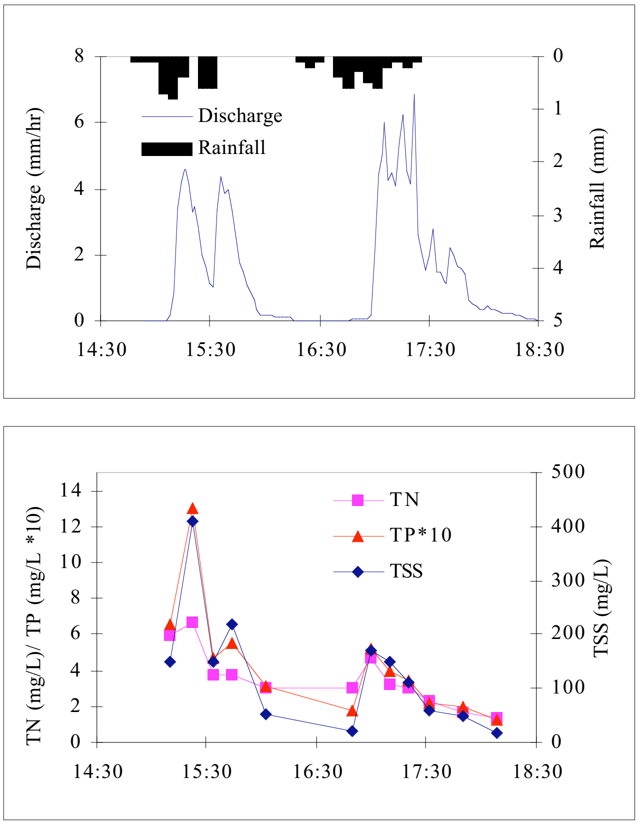
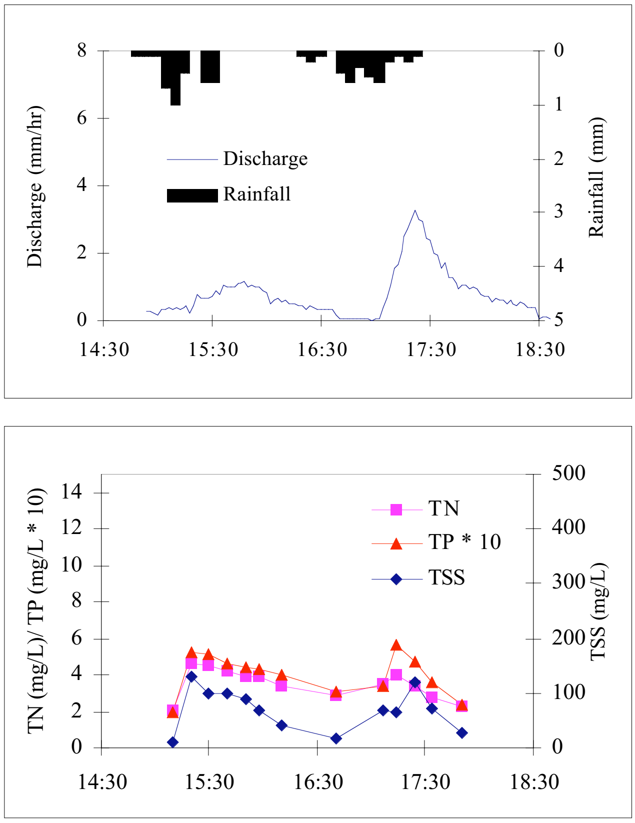


(a) Mixed commercial residential area (27-1-95)



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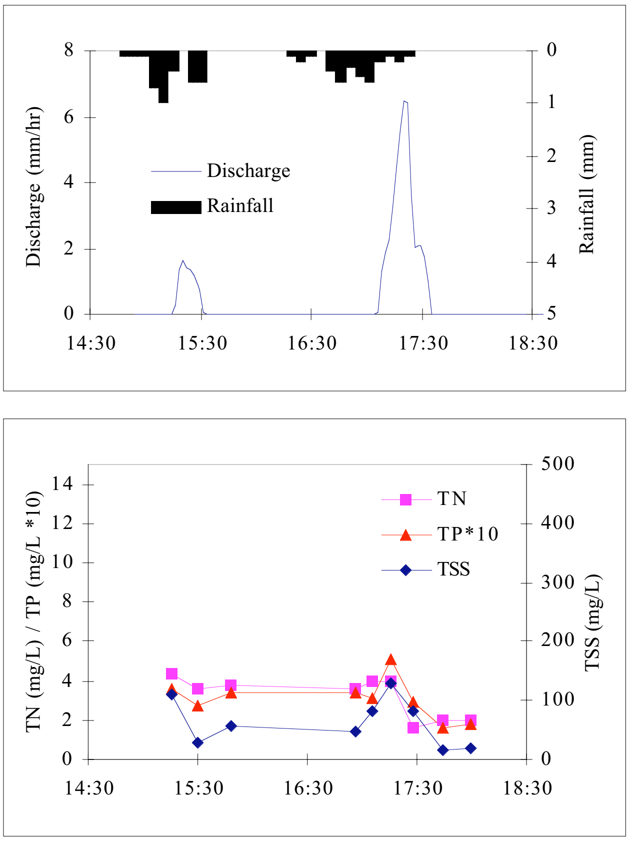

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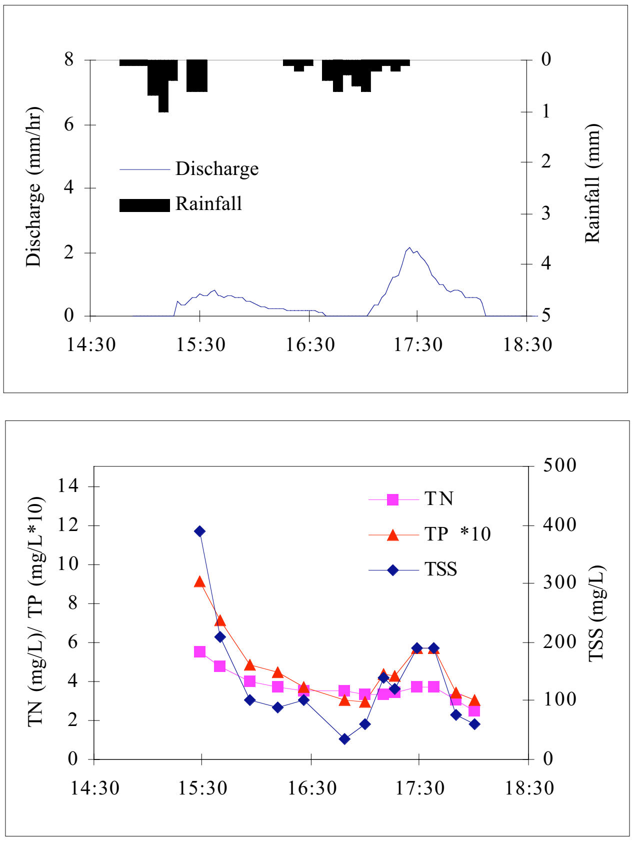
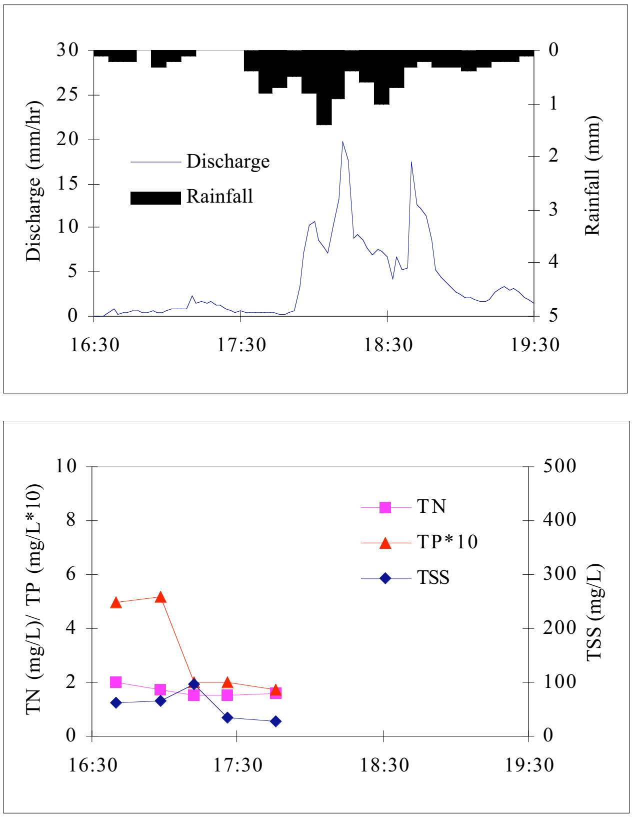
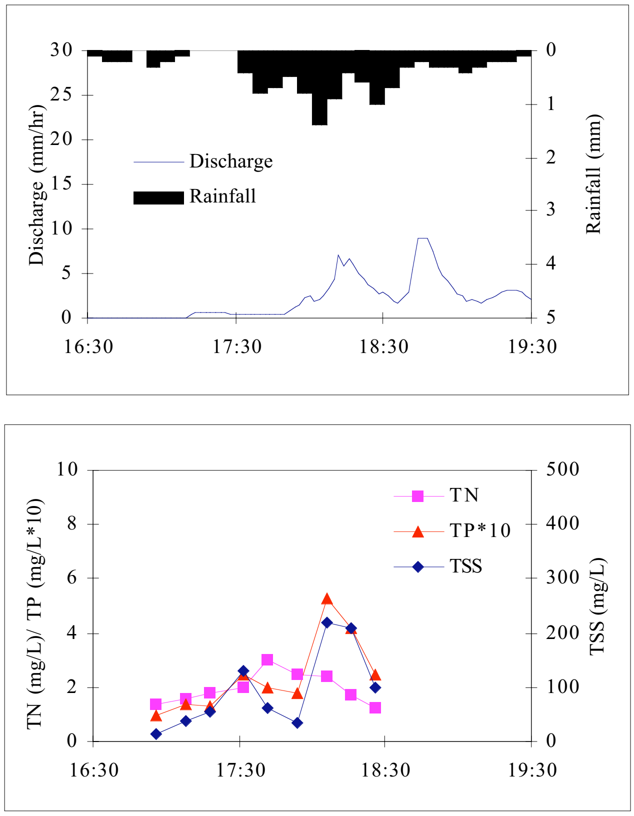


(d) Catchment outlet (27-195)

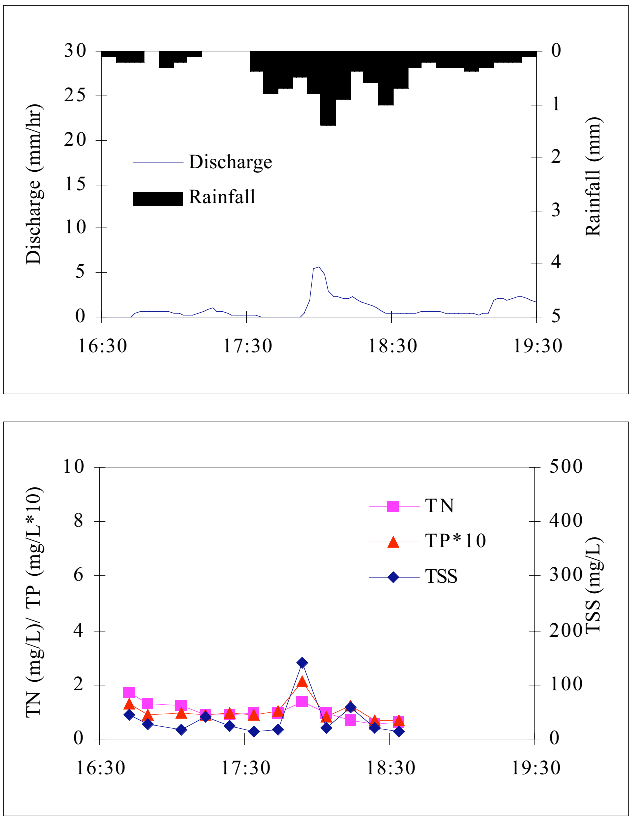
Appendix A (i) Water quality results for different land-use types (27-1-95)



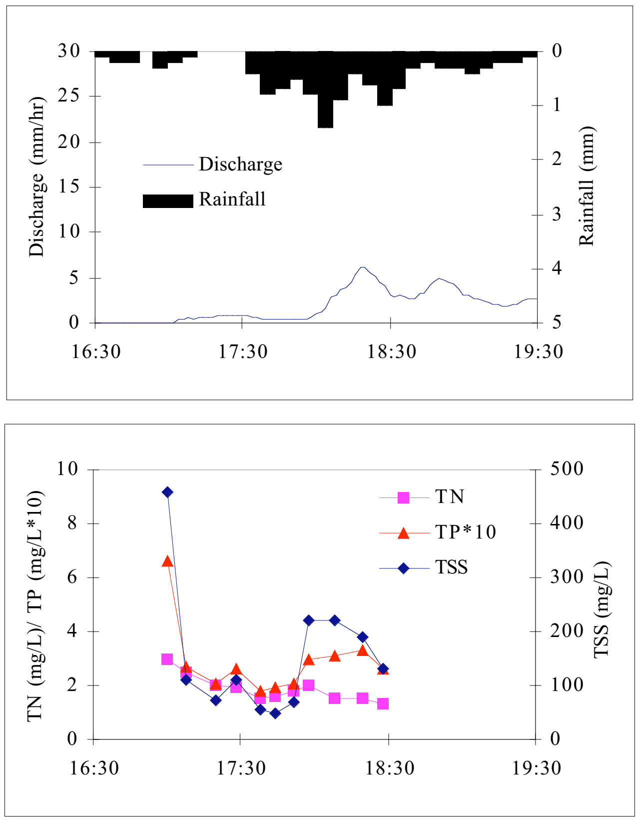
(a) Mixed commercial residential area (6-4-95)



(b) Residential area (6-4-95)

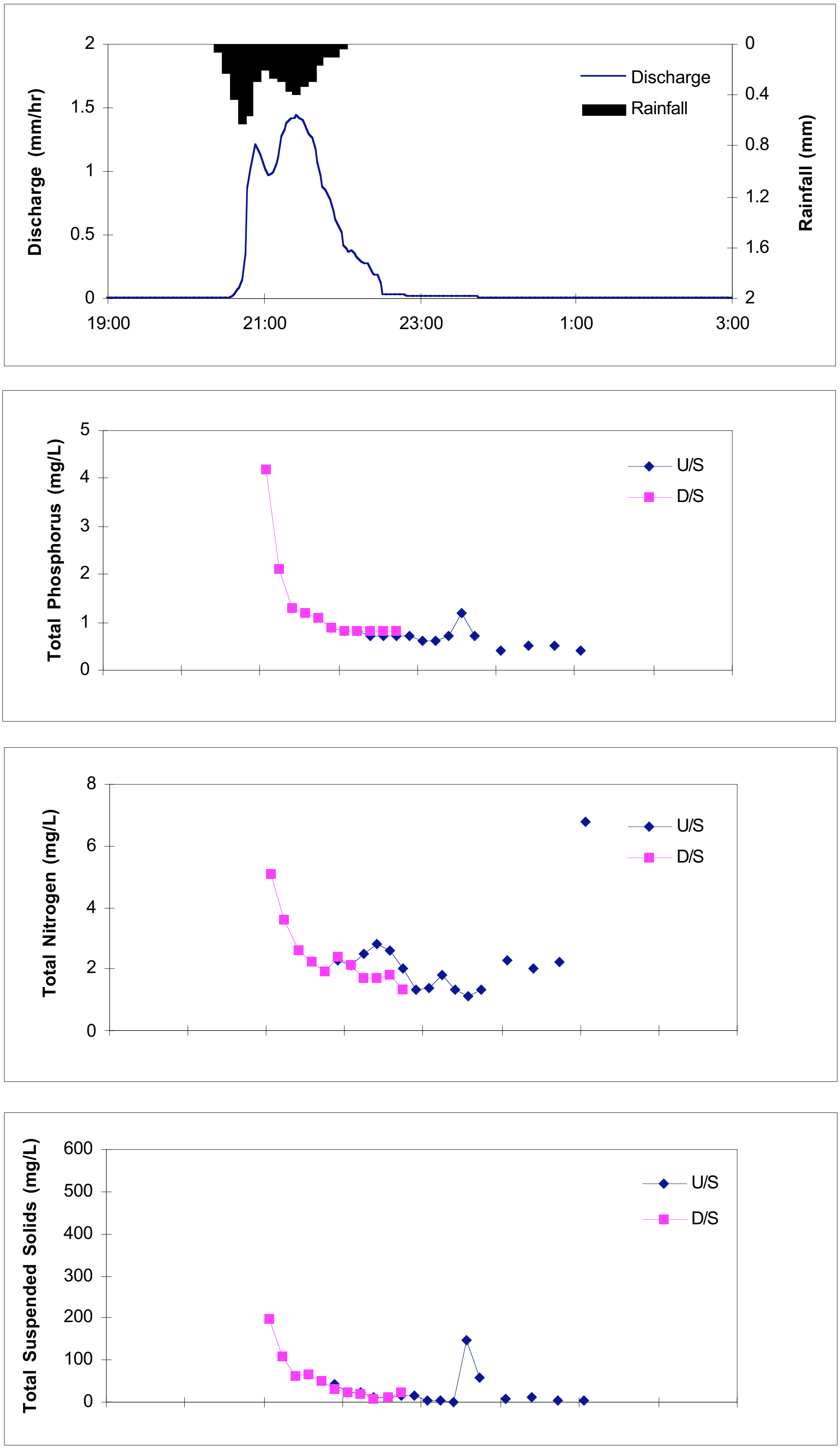


(c) Light-industrial area (6-4-95)

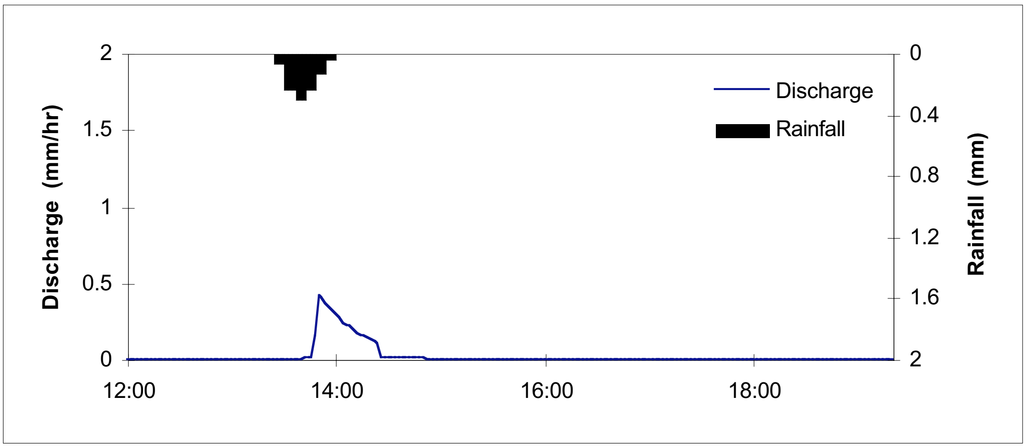


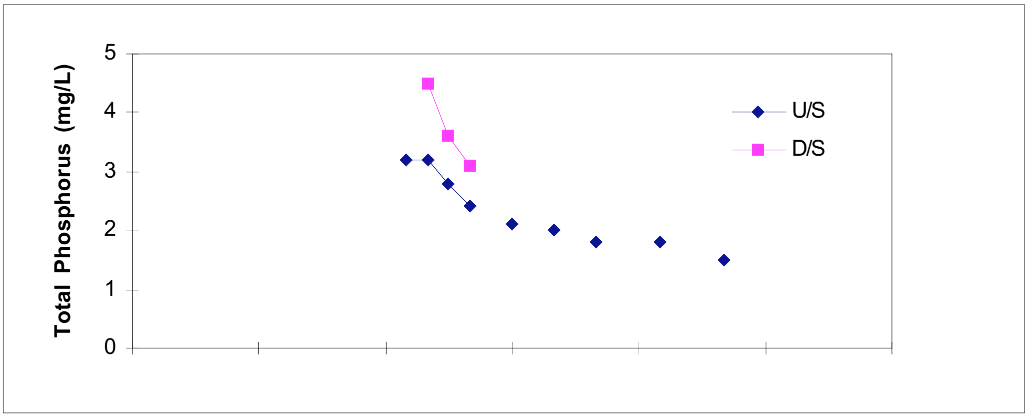
(d) Catchment outlet (6-4-95)

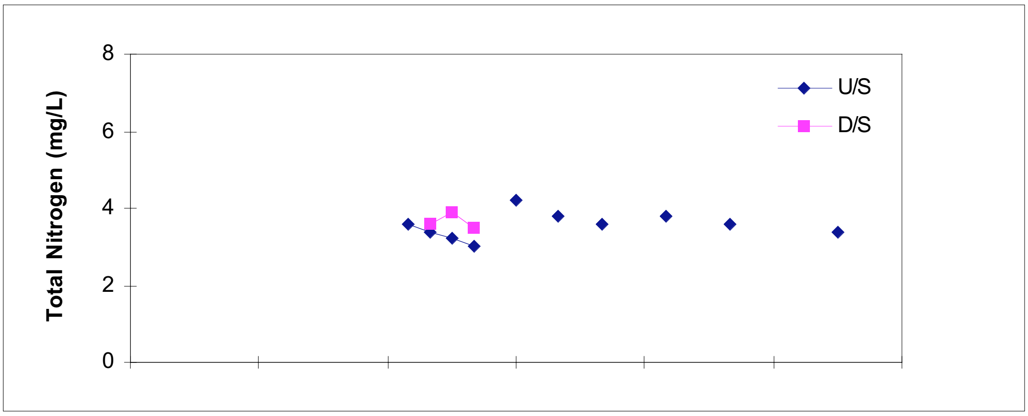
Appendix A (ii) Water quality results for different land-use types (6-4-95)

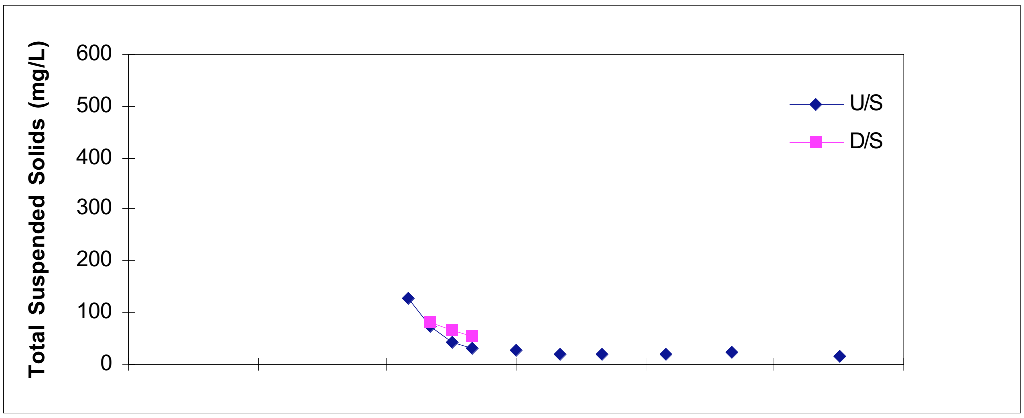


Appendix B (i) Storm event water quality u/s and d/s of the CDS trap (2 Nov. 1996)

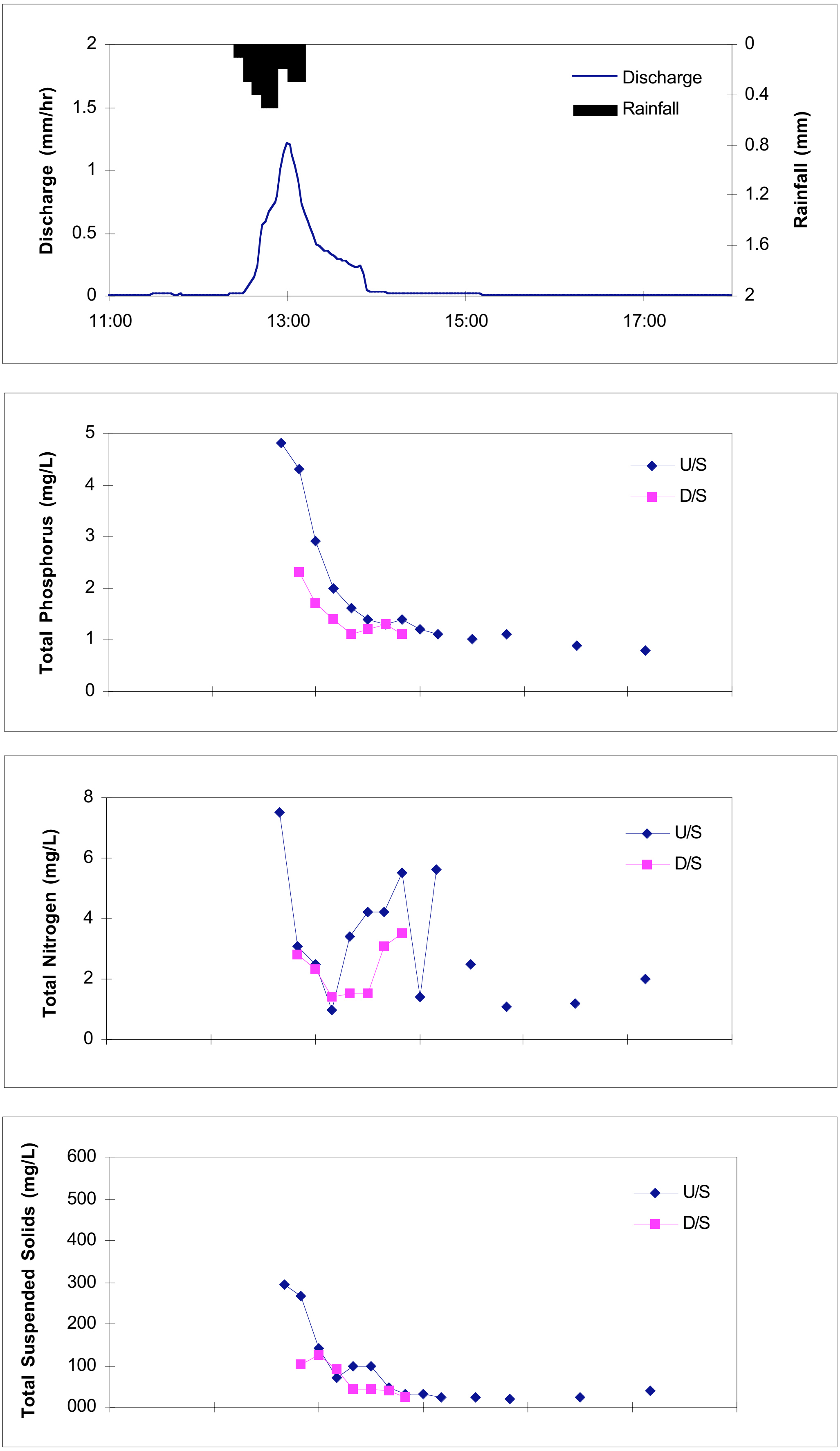




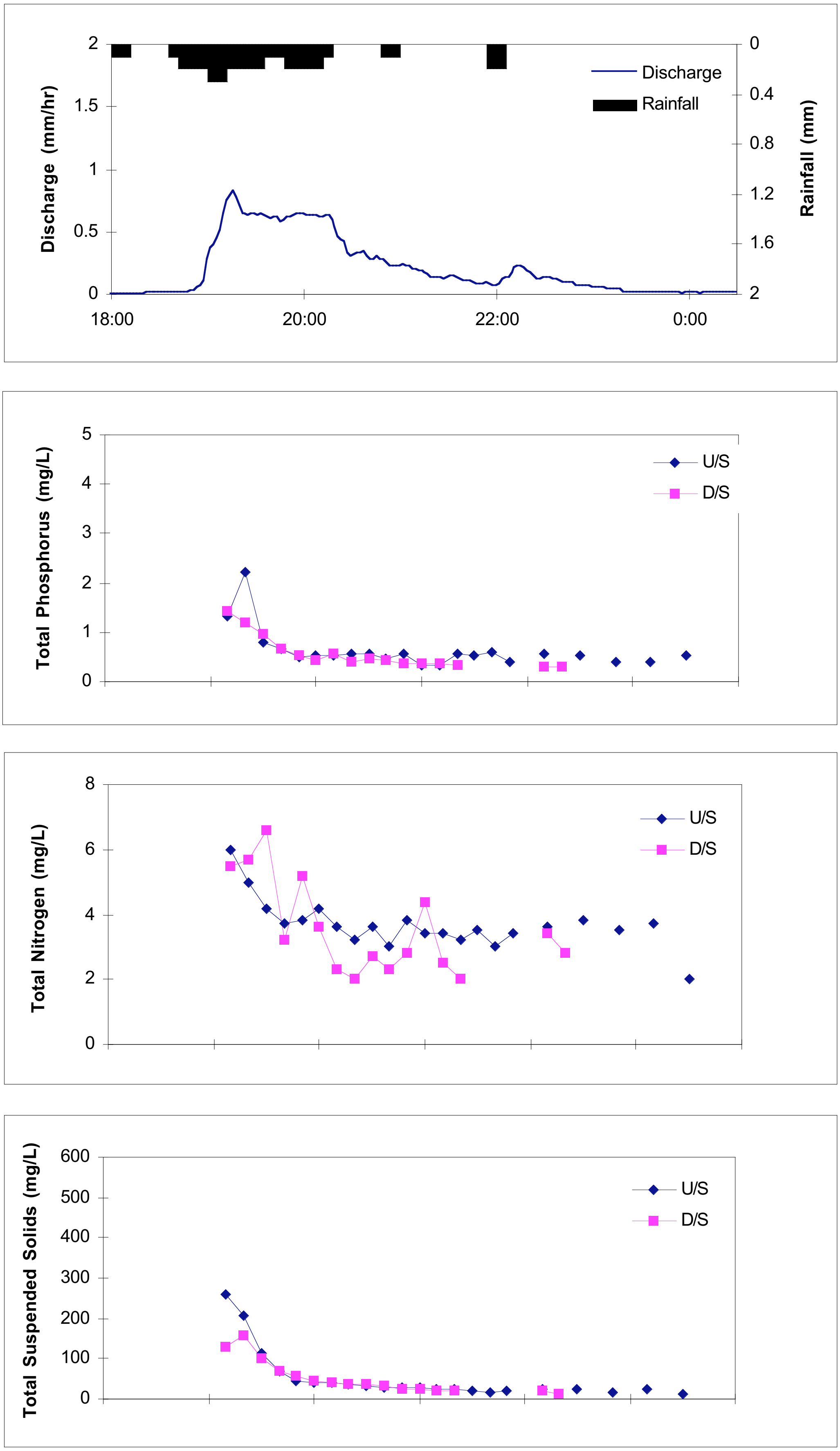




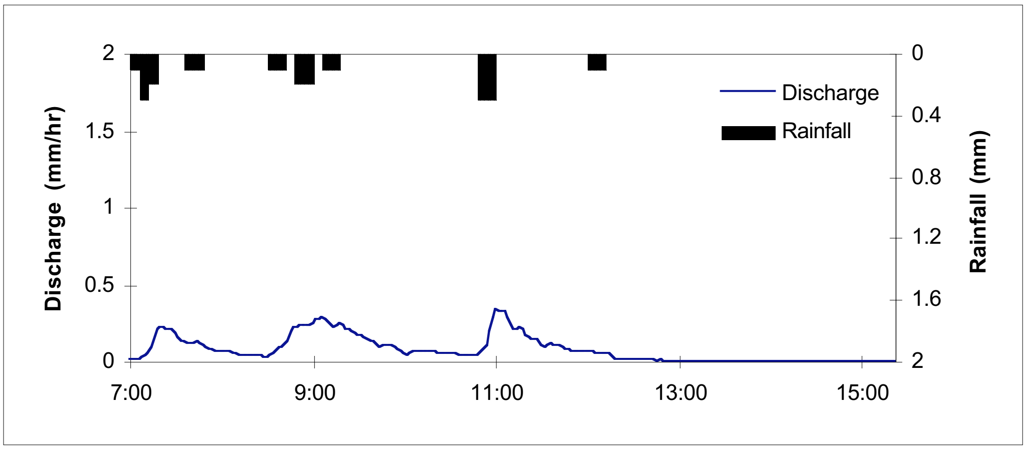
Appendix B (ii) Storm event water quality u/s and d/s of the CDS trap (16 Nov. 1996)

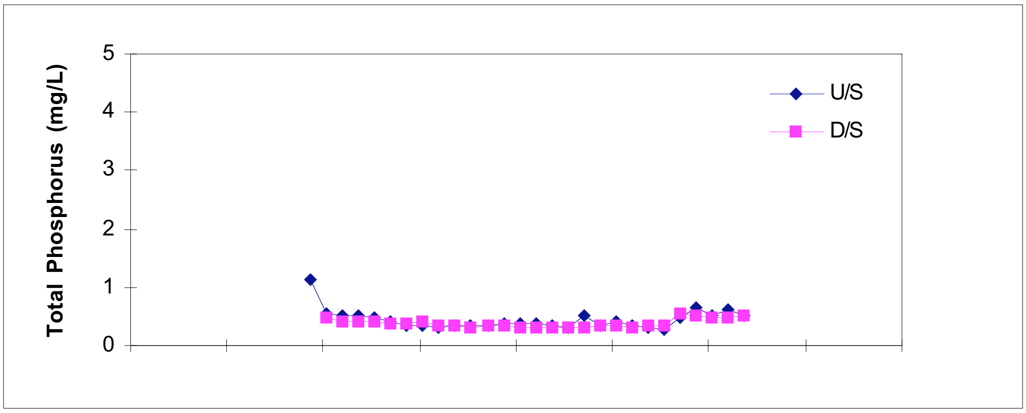


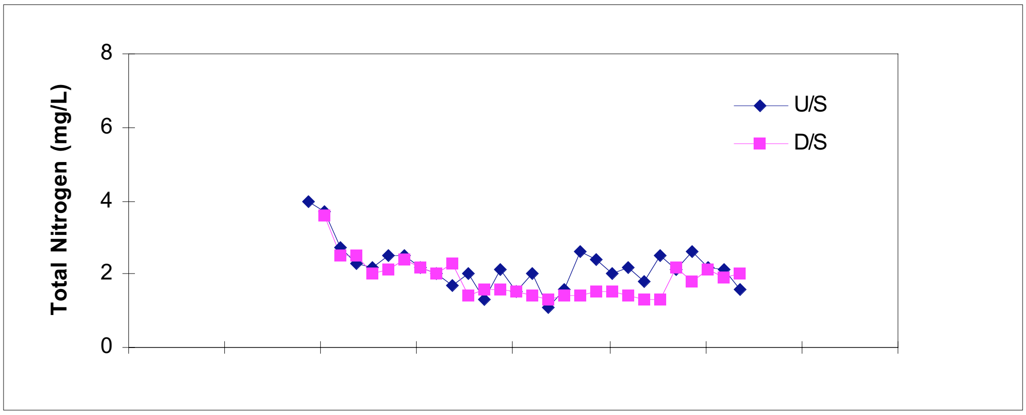
Appendix B (iii) Storm event water quality u/s and d/s of the CDS trap (27 Jan. 1997)

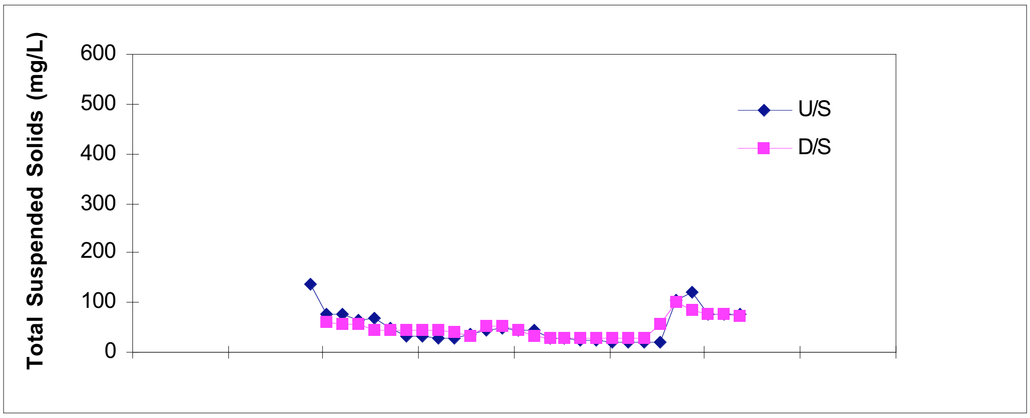


Appendix B (iv) Storm event water quality u/s and d/s of the CDS trap (21 Apr 1997)









Appendix B (v) Storm event water quality u/s and d/s of the CDS trap (26 May 1997)

The Cooperative Research Centre for Catchment Hydrology
is a cooperative venture formed under the Commonwealth CRC Program between:

Bureau of Meteorology

CSIRO Land and Water

Department of Land and Water Conservation, NSW

Department of Natural Resources and Environment, Vic

Goulburn-Murray Water

Melbourne Water

Monash University

Murray-Darling Basin Commission

Southern Rural Water

The University of Melbourne

Wimmera-Mallee Water

Associates

Department of Natural Resources, Qld

Hydro-Electric Corporation, Tas

State Forests of NSW

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