HYDROSALINITY STUDIES IN THE COERNEY VALLEY

VOLUME 2: DATA COLLECTION AND METHODS OF ANALYSES

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Institute for Water Research
Rhodes University

Report to the Water Research Commission on the project "Hydrosalinity studies in the Eastern Cape"

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The Steering Committee for this project requested the author to effect several corrections and amendments to the final report before recommending its acceptance by the Water Research Commission. For several reasons this was not done. In the interest of releasing potentially valuable research results to the discerning reader, the WRC has decided to release the draft report on special request.

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EXECUTIVE SUMMARY

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1. INTRODUCTION

The main objectives of this study were to gain a better conceptual understanding of the hydrosalinity processes of the lower Sundays River valley and to select and evaluate models or components of hydrosalinity models that are appropriate to irrigation management in the study area.

In part, the initial motivation for this research was provided by the Department of Water Affairs and Forestry who wished to investigate using the channel of the Sundays River as a conduit for the supply of Orange River water to the city of Port Elizabeth. However, at an early stage of the project it was decided to upgrade the main canal system of the Sundays River Irrigation Board and to use this infrastructure to carry water from Korhaans Drift to the new Scheepters Vlakte balancing dam. A pipe line from this dam now carries water to Port Elizabeth. This reduced the need for the study to focus specifically on the main lower Sundays River valley where data collection was difficult due to the extent of the area and the lack of adequate flow monitoring sites. At the meeting of the Steering Committee in March 1990 it was agreed that the study should concentrate on the lower Coerney valley and not the entire lower Sundays River valley. This decision did not substantially alter the initial aim of the project which was to gain a better conceptual understanding of the hydrosalinity processes within the lower Sundays River valley. However, it enabled the study to carry out a more detailed study of specific aspects of the hydrosalinity phenomena as related to irrigation, and irrigation return flows in particular.

The final report for this project is presented in two volumes. Volume 1 presents the methods and results of the main research programme in which a conceptual understanding of the hydrosalinity processes and an evaluation of several hydrosalinity models are presented. Volume 2 presents a summary of the data collected for the research discussed in Volume 1 and reports on the availability of this data.

2. RESEARCH AIMS

The specific objectives of the project were not adequately defined within the project proposal other than that the research should attempt to gain a better conceptual understanding of the hydrosalinity processes within the lower Sundays River valley and to select and evaluate models or components of models that are appropriate to the study area. However, to place this research into a more clear framework the following four objectives were identified :

i. To acquire data on the 3-D processes of moisture and solute movement at various spatial and temporal scales.

ii. To investigate and conceptually describe the hydro-chemical processes within the root and delivery zones.

iii. To test components of selected root zone and ground water models at various spatial and temporal scales.

iv. To determine the impact of irrigation on the streamflow and ground water within an area of irrigation.

The decision of the March 1990 Steering Committee, that this study should concentrate on the lower Coerney River and not investigate the entire lower Sundays River valley, did not substantially altered the initial aims of the project. In essence, this modification meant a change in the spatial scale at which the study was carried out.

3. RESEARCH PROCEDURE

To meet the objectives of this research project data were collected at the micro and catchment scale. Initially, micro-plots were established within two orchards to monitor the movement of soil moisture and solutes within the soil under an area of irrigated orchard. These data were used to examine the processes of soil moisture and solute movement within the root zone. Three management and one research level root zone hydrosalinity models were assessed in terms of their ability to simulate irrigation drainage. This assessment comprised sensitivity analyses and a comparison of the respective models predicted leaching flux values with those determined using the micro-plot data. At the catchment scale, streamflow and water quality monitoring sites were established and a series of boreholes drilled. Rainfall data were collected using a rain gauge network of 5 gauges and daily evaporation data were obtained from the Dept. of Agriculture's Addo Citrus Research Station. This facet of the study also investigated the use of stable isotopes for identifying the different water sources contributing to the hydrosalinity system of the lower Coerney valley. Information collected from this multi-scale data collection programme have provided a good conceptual understanding of the hydrosalinity processes that operate within the lower Sundays River valley and in particular within the Coerney area. Information on the weekly volume of water delivered to respective irrigation units within the Coerney area were provided by the Lower Sundays Irrigation Board. This information and that gained from a land use survey of the lower Coerney valley enabled a water balance for the area to be compiled.

4. THE LOWER SUNDAYS RIVER

The lower Sundays River valley lies some 40 km north of Port Elizabeth. For the purpose of this report the lower Sundays River valley is defined as the area extending from Korhaans Drift to Addo Bridge (figure 1.1). This area comprises an extensive area of intensive irrigation that comes under the control of the Lower Sundays River Irrigation Board.

The lower Sundays River is situated near the coastal belt and therefore receives rain throughout the year. Generally precipitation is higher in spring and autumn. There are large variations in the amount of rainfall due to the topographical characteristics of the area. In the mountainous areas rainfall exceeds 1100 mm per year while nearer the coast only 400 mm are received. The rain is chiefly cyclonic and thunderstorms are rare. The lower Sundays River valley has a mean annual rainfall of approximately 400 mm. The mean minimum temperatures in the month of July is 5° C while the mean maximum temperature in the month of January is 30° C. The mean annual A-pan evaporation for the area is approximately 1750mm.

The Witteburg Series of the Cape Super Group outcrop as predominant mountainous ridges to the north and east of the lower Sundays River valley. These intensively folded, hard rocks, comprise quartzite sandstones interbedded with thin layers of shale. The Uitenhage

Group comprising marine and fluvial laid cretaceous sedimentary rocks overlie the cape system and comprise the bed rocks of the Sundays River valley. More recent alluvial deposits over-lying the cretaceous mudstones form the current valley floor which is used for irrigation farming today. The irrigated soils in the lower Sundays River valley are mainly developed on alluvial and colluvial sediments. The dominant soil forms are Dundee, Oakleaf and Valsrivier. Irrigation farming was first introduced to the valley at around 1870 and in 1877 a Mr James

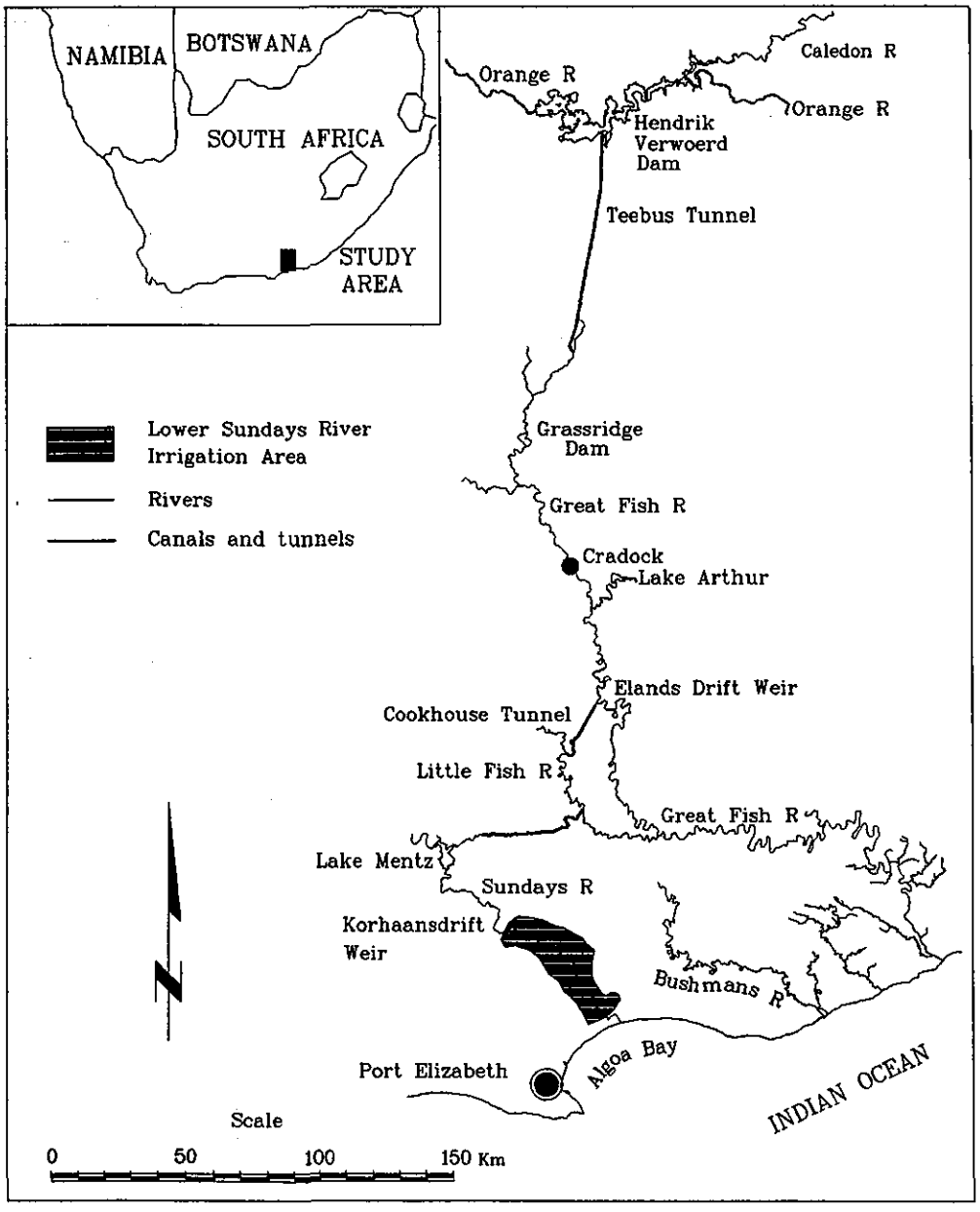

Figure 1.1 Location of the lower Sundays River irrigation area and its link to the Orange River scheme.

Kirkwood attempted to form an irrigation co-op. However, it was not until the construction of the Lake Mentz dam in 1922 that large scale irrigation began to take place within the valley. The wall of Lake Mentz dam was raised by 1.5 m in 1935 and again in 1952 by 5.8 m. However during periods of drought the valley was still subject to periodic water shortages. Areas that had been originally scheduled for irrigation, but had not been developed were therefore de-scheduled in order to create a more assured yield for the rest of the valley. In spite of these measures the valley was still subject to periods of water shortage until 1978 when Lake Mentz was linked to the Orange River Scheme (figure 1.1). The valley is now assured of an adequate water supply, although at times the salinity level has risen above normally acceptable levels.

The Sundays River valley produces mainly navel and valencia oranges, lemons and other loose skinned citrus fruit, as well as lucerne and potatoes. Other types of farming such as sheep, cattle and game farming take place to a lesser extent. In 1985, 9028 ha of farmland were scheduled for irrigation, while another 3198 ha were identified for future expansion. The regional importance of this irrigation development is clearly shown by its 1983 economic returns of R19.9 million in citrus exports and R2 million to locally markets.

5. CONCLUSIONS

Initially the study examined variations of soil moisture, and soil water and solute flux within the root zone. Data were collected at a number of micro-plots, but only that for one plot, DDM03, located in orchard M of Daisy Dell farm was used for this investigation. The most important conclusion drawn from this aspect of the study was the importance of macro-pore flow. Soil moisture flux was initially determined using a Darcian approach which is driven by the difference in matrix potential between two points in the soil profile. This method, which can only account for micro-pore flow was found to grossly underestimate the total soil water flux. A water balance approach was found to provide more realistic results, but was discarded due to its gross over estimation of negative fluxes when the evaporative term exceeded available soil moisture. The study clearly demonstrates how the water balance approach can not be implemented using a fixed crop factor for determining the evaporative term. To more successfully implement this approach one would require the knowledge needed to more accurately define the transpiration response of citrus trees to variations in the factors controlling the evaporative processes. Therefore, due to problems related to both the Darcian and the water balance methods of determining irrigation drainage a third approach based on a chloride mass balance was developed. This approach provided the most realistic estimate of soil moisture flux. The soil moisture fluxes determined by this approach were very similar to those determined by the water balance approach, but without the large negative fluxes between irrigation events.

A comparison of the soil moisture fluxes as determined using the Darcian approach, which can only account for micro-pore flow, and those determined using the mass balance approach, clearly indicated the importance of macro-pore flow as a component of irrigation drainage. The chloride mass balance approach was subsequently used to determine the solute flux within the root zone of the study orchard.

The third objective of the study was to evaluate a number of root zone models. Initially it was decided by the steering committee for this project, that this aspect of the study should

rely on the finding of a another Water Research Commission funded study which set out to evaluate a number of hydrosalinity models for the specific purpose of estimating soil water and solute movement within the root zone (Moolman, 1991). However, as the progress of that study was delayed, this project undertook a more independent approach. Also, as this study's investigation of soil moisture fluxes clearly indicated the importance of macro-pore flow, it became apparent that the models being examined by Moolman (1991) were inappropriate to the study area. In fact, from a study of the literature, it appears that most hydrosalinity models are based on the Richards equation which can only account for micro-pore flow. It was therefore decided to examine a number of hydrosalinity models, knowing full well that they would prove inappropriate to modelling irrigation drainage within the study area. The main objective being to clearly demonstrate the need for research into the development of models suitable for macro-pore flow dominated soil moisture drainage. Three management and one research type model were selected to cover the full range of model complexities. As expected the output from all four models, when compared with the soil moisture fluxes determined by the mass balance approach, were very disappointing. These results are of great significance as they clearly demonstrate the need for hydrosalinity models that are applicable in soils where macro-pore flow is the dominant form of soil moisture drainage. Within South Africa, which is faced with ever increasing water resource limitations and where over 50 percent of this resource is used for irrigation agriculture, there is an urgent need for research into, and improved management of, irrigation farming. The development of applicable hydrosalinity research and irrigation management models is an area of research that should be given a far greater priority than is currently the situation.

The forth objective of the study was to determine the impact of irrigation on both the ground water and streamflow within the study area. A number of boreholes were drilled by the Department of Water Affairs and Forestry. The level and salinity of the ground water aquifer within the alluvial deposit of the lower Coerney valley were monitored at these sites. The vertical salinity profile of the aquifer was also recorded at each borehole. These data clearly indicated a marked rise in the level of the water table in response to irrigation farming. The area of influence extended some distance up valley from irrigation development. It was also learnt that the salinity of the irrigation drainage is significantly less than that of the natural ground water within the valley. An isolated pocket of highly saline water was very clearly indicated by constructing an isoline map of electrical conductivity values recorded within the lower Coerney valley. The salinity of this water is very similar to that of the aquifer further up valley from the area influenced by irrigation. An examination of the vertical salinity profile at this point indicated that the highly saline water extended from the upper to the lower surface of the aquifer. In close proximity to this area of high salinity a shallow borehole drilled through the alluvium and into the underlying cretaceous mudstones struck artesian water. This suggests that artesian water is rising up through the underlying marine laid mudstones from the even deeper Table Mountain Sandstones. After moving up through the marine laid mudstones the relatively less saline water of the Table Mountain Sandstone has an electrical conductivity in excess of 2000 $mS.m^{-1}$. The less saline irrigation drainage water initially sits above the more dense, very saline, natural ground water. The salinity of this aquifer is therefore highly variable with both lateral and vertical gradients. This understanding clearly indicated the dangers of monitoring the surface water of an aquifer in the hope of determining its water quality characteristics.

The study also examined the discharge and salinity regimes of the lower Coerney River itself. Discharge records clearly indicate a steady rise in the base flow of the river as irrigation farming expands within the valley. Simultaneously the solute concentration of the river has decreased as the natural ground water component of the streamflow is diluted with an increasing proportion of less saline irrigation return flow. Stable isotopes were successfully used to determine the natural ground water and irrigation return flow components of both streamflow and local ground water at various locations within the study area. This technique was found to provide more useful information than conventional water quality analyses for gaining an understanding of the hydrological and hydrochemical systems of the study area.

6. RECOMMENDATIONS FOR FUTURE RESEARCH

The current study was carried out at a number of scales from micro-plot studies to an examination of the impact of irrigation on ground water and streamflow at the catchment scale. Analyses of the data collected at these scales and conclusions drawn from an assessment of several hydrosalinity models has highlighted a number of areas for future research:

i. To establish a methodology for determining the magnitude and spatial variability of macro-pore flow.

ii To carry out detailed studies of the hydrosalinity processes within the delivery zone at the plot scale rather than at the catchment scale.

iii. To gain a better understanding of the spatial variations of hydrosalinity processes at the field scale.

iv. To develop a hydrosalinity research model that considers macro-pore flow and accounts for spatial variability at the field scale.

v. To develop an irrigation systems model that permits the movement of ground water between adjacent ground water cells and allows for vertical salinity gradients within the local ground water system.

Clearly this study highlighted the importance of macro-pore flow as a dominant process in irrigation drainage. However, there is currently no sound methodology by which this component of soil water movement can be readily estimated and accounted for in hydrosalinity models. Until this aspect of hydrosalinity modelling is further understood it is difficult to foresee any significant progress in the field of irrigation management which is so desperately needed in this country of limited water resources.

Another very problematic area of salinity research lies with the lack of understanding of the processes operating within the delivery zone. This zone which connects the root zone to the ground water and surface water systems is very difficult to monitor because of its depth and also because it is often comprised of cobble and bolders which are difficult to penetrate with drilling equipment which is appropriate to research studies. Yet, being an important link for

the transfer of irrigation drainage to the ground water and streamflow systems, it is important to understand how solutes may either be accumulated and leached from this zone if the impacts of an irrigation development are to be properly assessed.

For the proper extrapolation of information gained from plot studies of the hydrosalinity processes, it is important that one gains an understanding of the spatial variability of these processes. If one can statistically define these variations it may be possible to develop more stochastic type models and reduce the data requirements of spatially distributed, deterministic type hydrosalinity models.

Currently, due to the increasing pressure on South Africa's water resources there is a great need for improved irrigation efficiency. If one considers the large volume of water currently used for irrigation, it is clear that even very small improvements in irrigation efficiency may lead to relatively large savings in water. There is also an increasing need to reduce the pollution of surface water resources by irrigation drainage. For example, the salinity of water transferred via the Orange/Fish River scheme increases in salinity from approximately 35 $mS.m^{-1}$ at Katkop (Q1M01) to over 75 $mS.m^{-1}$ at Elands Drift (Q5R0101), a distance of less than 50 km. This increase in salinity is largely attributed to saline irrigation return flow generated along this reach of the Great Fish River. The cost of this irrigation practice in terms of loss of production in the lower Sundays River irrigation area has not been estimated, but it is most probably considerable. Appropriate hydrosalinity models would provide an ideal methodology for determining more efficient irrigation strategies with the potential of saving water and reducing pollution. However, before selecting a model for this work one would need to ensure that it was appropriate to the conditions of the study area. In particular, the importance of macro-pore flow must be determined and if necessary an appropriate model developed. Currently it would appear that such a model is not available and that research into this aspect of hydrosalinity modelling is essential.

To evaluate the impact of an irrigation development on either the ground or surface water resources of an area, an appropriate irrigation management systems model is required. Such a model has been developed for the Breede River. However, as the structure of this model was developed specifically for the Breede River valley it does not facilitate the movement of ground water between adjacent cells. It also does not facilitate variations of salinity in the vertical profile of the aquifer and recharge of very saline water from an underlying artesian aquifer. It would seem that to meet these more flexible modelling requirements a finite difference type model would be required. Such a model would have wider application than the currently available model developed for the Breede River irrigation area.

Further to this list of specific hydrosalinity research requirements, it is recommended that the monitoring and analyses of data collected for the lower Coerney valley, initiated in this study, should be continued. There is now an historical record of the impact of irrigation on both the ground water and streamflow systems within the valley. There is also a good conceptual understanding of the hydrological system and methods for identifying components of this system have been established. Currently irrigation farming within the lower Coerney valley is under rapid expansion following the construction of a new higher level canal. It would therefore make a great deal of sense for at least some of the recommended areas of research, as listed above, to be carried out in this study area. It is only through continuity of clear research objectives that progress in such a problematic, yet important field as

hydrosalinity research that progress can be made.

7. REFERENCES

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LIST OF ABBREVIATIONS

For ease of presentation the water quantity and quality parameters summarise in this volume are often abbreviated with the following abbreviations.

Abbreviation	Parameter	Units
WL	Water level	m
Q	Discharge	$m^3.s$
MPot	Matric potential	kPa
pH	Concentration of H^+ ions	
EC	Electrical conductivity	$mS.m^{-1}$
TDS	Total dissolved solids	$mg.l^{-1}$
Talk	Total alkalinity ($CaCO_3$)	$mg.l^{-1}$
Cl	Chloride	$mg.l^{-1}$
Ca	Calcium	$mg.l^{-1}$
K	Potassium	$mg.l^{-1}$
Mg	Magnesium	$mg.l^{-1}$
Na	Sodium	$mg.l^{-1}$

1. INTRODUCTION

This volume is one of three that deal with the results of the Water Research Commission funded project "Hydrosalinity studies in the eastern Cape", undertaken by the Institute for Water Research at Rhodes University. The main objectives of the study were to gain a better conceptual understanding of the hydrosalinity process of the lower Sundays River valley and to select and evaluate hydrosalinity models or components of models that are appropriate to irrigation management in the study area. To place the study in a more clear framework the following four objectives were identified:

i. to acquire data on the 3-D processes of moisture and solute movement at various spatial and temporal scales,

ii. to investigate and conceptually describe the hydro-chemical processes within the root and delivery zones,

iii. to test components of selected root and ground water models at various spatial and temporal scales,

iv. to determine the impact of irrigation on the streamflow and ground water within an area of irrigation.

To satisfy these objectives it was necessary to establish a major data collection and compilation programme. This programme entailed the collection of information on the rainfall, evaporation, irrigation, soil moisture, ground water, and streamflow for both the lower Sundays and Coerney River valleys. Much of these data have been directly used in the analyses presented and discussed in Volume 1 of this report. However, to facilitate its use in further studies this Volume, a data summary, has been compiled. The main objectives of this summary are:

i. to provide a permanent record of the data collected,

ii. to provide information on the locations of respective sampling sites,

iii. to provide information on the time resolution and period for which data were collected and

iv. to provide a quick reference to representative data values and to provide information on temporal variations within the data.

For each data collection site the summary provides information on the location, site description, type of data, frequency of data collection, instrumentation, a statistical summary of the parameters collected, and a time series plot of the major parameters. This should permit prospective users to rapidly determine whether data collected as part of this study is of value to their respective research project. The data summarised in this volume may be obtained on request from the Institute for Water Research in an ASCII format.

1.1 The lower Sundays River valley

The lower Sundays River valley lies some 40 km north of Port Elizabeth. For the purpose of this report the lower Sundays River valley is defined as the area extending from Korhaans Drift to Barkly Bridge (Figure 1.1). This area comprises an extensive area of intensive irrigation that comes under the control of the Lower Sundays River Irrigation Board. The

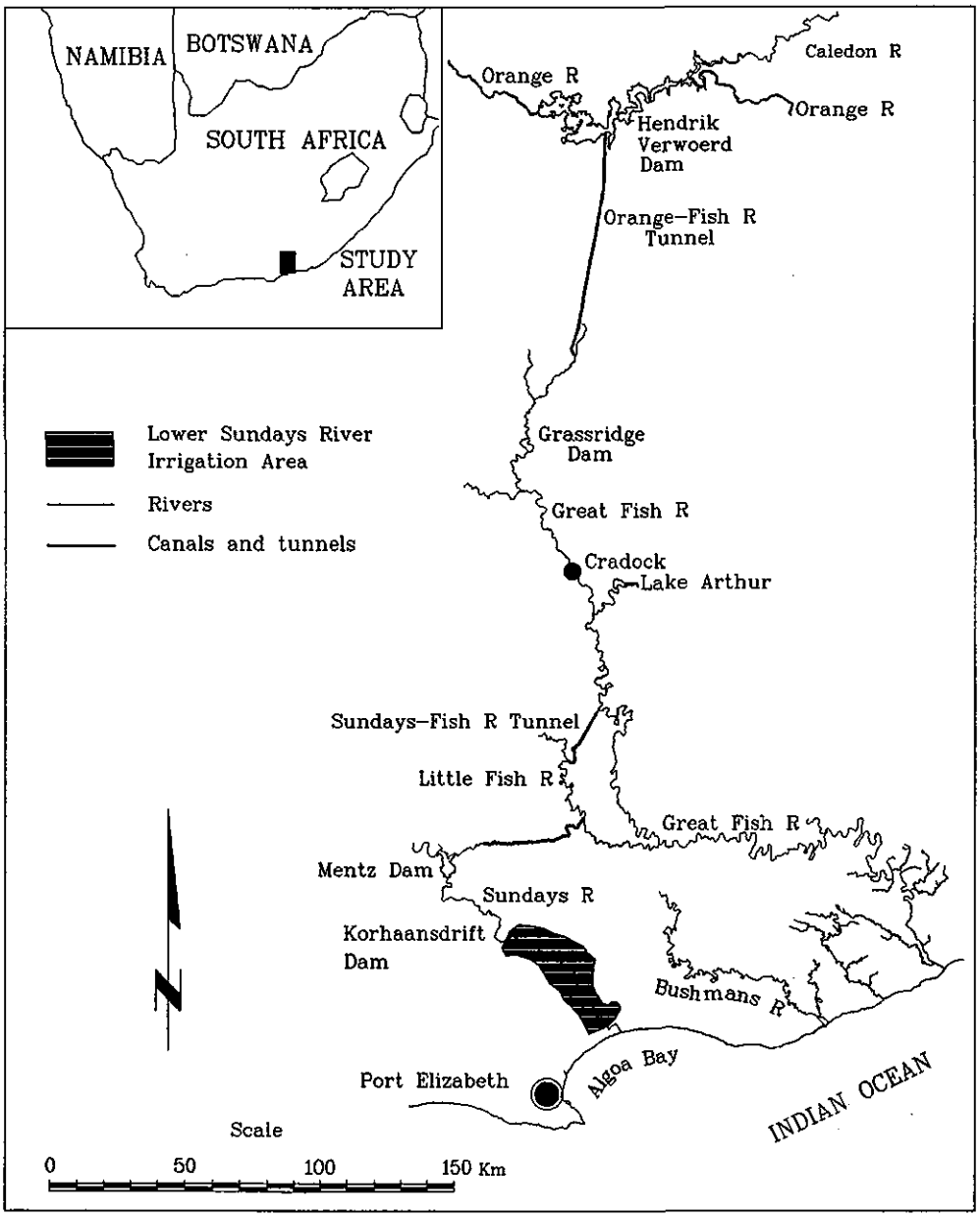

Figure 1.1 Location of the lower Sundays River valley and its link to the Orange River scheme.

lower Sundays River is situated near the coastal belt and therefore receives rain throughout the year. Generally precipitation is higher in spring and autumn. There are large variations in the amount of rainfall due to the topographic characteristics of the area. The rain is chiefly cyclonic and thunderstorms are rare. The lower Sundays River valley has a mean annual rainfall of approximately 400 mm. The mean minimum temperatures in the month of July is 5° C while the mean maximum temperature in the month of January is 30° C The mean annual A-pan evaporation for the area is 1750mm (Tylcoat 1985).

The Witteburg Series of the Cape Super Group outcrop as predominant mountainous ridges to the north and east of the lower Sundays River valley. These intensively folded hard rocks comprise sandstones and quartzite interbedded with thin layers of shale. The Uitenhage Group comprising marine and fluvial laid cretaceous sedimentary rocks overlie the cape system and comprise the bed rocks of the Sundays River valley. More recent alluvial deposits over-lying the cretaceous mudstones form the current valley floor which is used for irrigation farming today. The irrigated soils in the lower Sundays River valley are mainly developed on alluvial and colluvial sediments. The dominant soil forms are Dundee, Oakleaf and Valsrivier. A more detailed description of geology and soils within the lower Coerney valley is presented in Chapters 1 and 2 of Volume 1 of this report.

Irrigation farming was first introduced to the valley in the 1870's, but due to a lack of water did not expand significantly until after the construction of the Lake Mentz Dam in 1922. However the valley was still subject to periods of water shortage until in 1978 when Lake Mentz was linked to the Orange River Project by means of a pump station at Wellington Grove on the Little Fish River (Figure 1.1). The valley is now assured of an adequate water supply, although at times the salinity level has risen above normally acceptable levels.

The valley produces mainly navel and valencia oranges, lemons and other loose skinned citrus fruit, as well as lucerne and potatoes. Other types of farming such as sheep, cattle and game farming take place to a lesser extent. At present 9028 ha of farmland are scheduled for irrigation, while another 3198 ha have been identified for future expansion. The regional importance of this irrigation development is clearly shown by its 1983 economic returns of R19.9 million in citrus exports and R2 million to locally markets.

1.2 The lower Coerney Valley

This area comprises the catchment area of the Coerney River from its confluence with the Sundays River to where the road running between Coerney and Zuurberg crosses the river (Figure 1.2). The area was selected as a definable sub-area of the lower Sundays River valley, which is important for its current citrus production and includes a significant area planned for future irrigation development. This planned development should result in the area currently under irrigation within the lower Coerney valley increasing from approximately 792 ha to over 1700 ha during the next ten years. This increase comprises nearly a third of the increased area under irrigation within the lower Sundays River valley resulting from an upgrade of the main canal system. Therefore by establishing a hydrosalinity monitoring programme within this valley an opportunity is created possible to determine the long term impact of irrigation within the lower Sundays River valley.

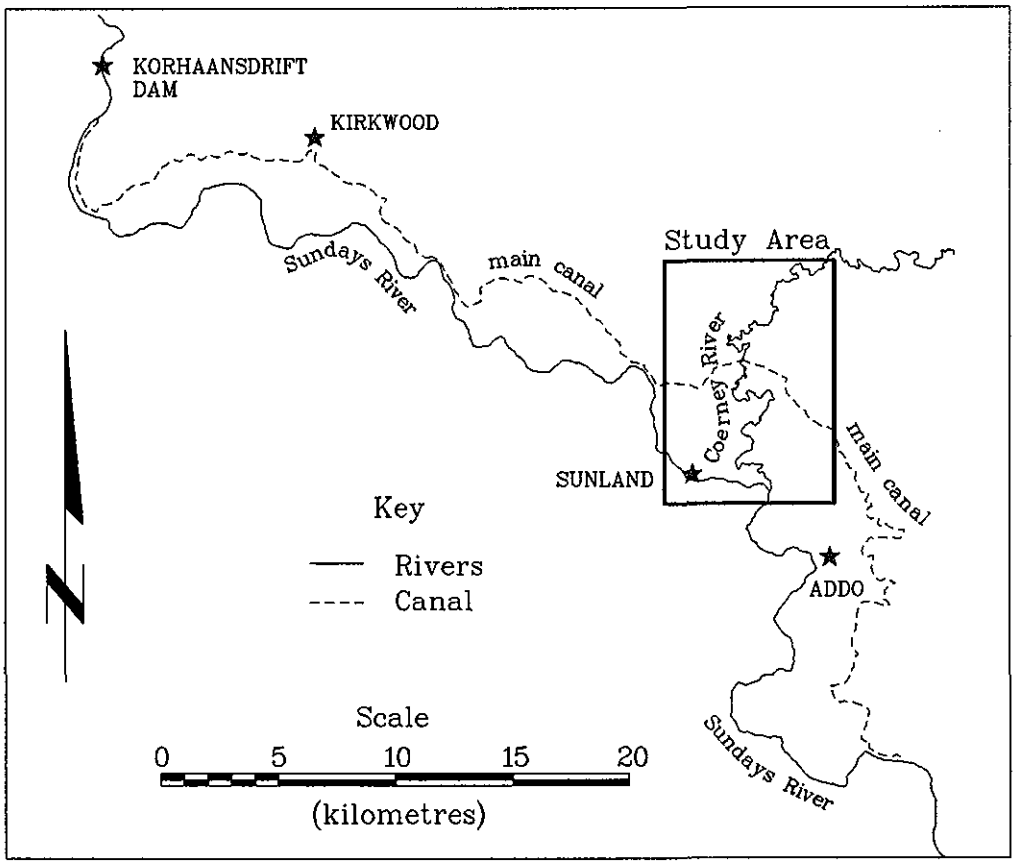

Figure 1.2 Location of the lower Coerney valley study area

2. INSTRUMENTATION

Initially the data collection programme established for this project was highly dependant upon electronic data logging equipment. However, after a great deal of frustration and loss of data some of these instruments were replaced by older mechanic analog chart recorders. Many of the problems were partially due to a lack of adequate backup support by the instrument suppliers. As there are few reports describing the experiences of researchers using this type of instrumentation within South Africa it seems appropriate to make some general comments on the reliability of the different instrumentation used for this project. It appears that within South Africa the after sales maintenance support has been somewhat limited. It is therefore suggested that it may be worthwhile for the Water Research Commission to investigate the establishment of a centralized instrument maintenance centre for the evaluation and servicing of equipment bought for projects under its control.

2.1 Electronic logging raingauges.

Five tipping bucket raingauges were installed in the lower Coerney valley for the collection of rainfall data for this project. These gauges comprise the Japanese made Ogawa Seiki tipping bucket gauge and a data logger designed and built at Rhodes University. The loggers are ROM based and designed to store intensity controlled variable time period rainfall data. These loggers were comparatively cheap to build at less than R1 000.00 per site (1987 prices) and have proved reasonably reliable. As with all raingauges it is essential to regularly clean the funnel and tipping bucket mechanism, especially in a dusty environment such as the lower Sundays River valley.

2.2 Electronic logging water level recorders

Equipment was purchased from MC Systems for the electronic logging of water level data. Unfortunately this equipment and in particular the manufacturers support for this equipment proved unsatisfactory. These loggers appear to draw more power than specified by the manufacturer such that the recommended battery power supply proved inadequate. This problem was overcome by using rechargeable batteries that are connected to solar panels. This necessitated the development and building of regulators to prevent the batteries from being over charged. There have also been many other problems with both the encoders and loggers which required frequent maintenance. One of the most frustrating problems has been the loggers shutting down for no apparent reason. At one stage the supplier acknowledged a software problem that may have caused these frequent failures of their instruments. For some reason the supplier revealed the nature of this problem to the Water Research Institute at the University of Witwatersrand at least one year before informing the Institute for Water Research (IWR) at Rhodes University. However, this new software did not solve the problem and a decision was made to replace this water level recording equipment with Ott chart recorders.

Due to the unhappy experience of the Rhodes' IWR, the data loggers and encoders supplied

by MC Systems for recording water level data can not be recommended to other potential users. However it should be noted that after some teething problems and the frustration of poor backup support by the supplier that the same loggers are now working well for the collection of rainfall data in the Bedford catchments. It should also be noted that the mechanical Ott recorders still used by the IWR in the Sundays River have proved more reliable than the water level recorders purchased from MC Systems. This is not a recommendation for the re-introduction of chart recorders, but rather a sad reflection of the data logging equipment and backup support available within South Africa.

2.3 Electronic logging of climate data

The Sundays River Project inherited one automatic weather station from the previous project in the Ecca research catchments. This instrument was supplied by ECO and is of the Campbell Scientific type. The instrument has not been installed due to an electronic problem which the supplier was unable to repair to the IWR's satisfaction. The major problem stems from the supplier subcontracting their repair work which led to a lack of direct communication between staff of the IWR and the repair technician. Although the equipment served the previous project well, the poor backup service suggests that one should be careful when buying from local agents. An automatic weather station was also purchased specifically for the Sundays River project from MC Systems. Initially there were some teething problems with the data logger but these were largely overcome. However, there are major inherent problems with the relative humidity sensor and the method used for recording wind speed and direction. It is therefore questionable whether these instruments are of value to a hydrosalinity study, such as the current project, where pan evaporation data seems more appropriate.

2.4 Automatic pump samplers

The project has five Isco pump samplers at its disposal. To date these instruments have worked well and have only failed on rare occasions due to operator error. Two of these samplers are of the new programmable type which are superior to the older model in terms of their ease of operation. However it should be noted that these pumps have one basic design fault in that the volume pumped is determined by the head to be pumped and by the diameter of the tube through which the sample is to be collected. As the head to be pumped may change significantly during major flood events one can experience problems in setting these sampler to collect the required volume of sample. This problem is not encountered when using some other brands of pump samplers which use a storage chamber and float valve to regulate the volume of sample to be collected.

2.5 Soil moisture neutron probe.

The neutron probe purchased for this project from Geoquip (model no. 503DR) has worked well and is very convenient to use in the field. The major problem experienced with the use of this equipment is in the determination of a calibration curve for which volumetric samples are essential. However this problem is inherent to the use of all soil moisture monitoring

equipment and is not a criticism of the purchased instrument. The backup service provided by the supplier has not always been satisfactory with another neutron probe supplied by the same supplier being returned a little worse for wear after a routine service.

2.6 A centralized instrumentation centre

Over the last decade there has been a strong move towards the use of electronic equipment for the collection of environmental data. Hydrological research within South Africa has followed this trend in the hope of reducing the cost of data collection and gaining an improvement in the quality of the data collected. Unfortunately the promised advantages of this new technology have not always been realized. From the experience of the Sundays River project it appears that the major factors leading to the often disappointing performance of electronic data logging devices has been the poor backup service provided by the local agents and possibly the marketing of locally produced equipment that is not yet ready for field use. Unfortunately, because of the implications of South Africa's political policies, researcher have often been faced with little choice but to purchase locally manufactured and distributed equipment. Another problem facing many researchers when purchasing and operating electronic instruments is a lack of the necessary expertise to fully understand and evaluate this type of equipment. Hydrological researchers cannot be expected to be experts in all fields.

To help overcome these problems it is suggested that the Water Research Commission should investigate the establishment of an instrumentation centre. The staff of this centre would be responsible for the evaluation, purchase and maintenance of equipment necessary to carry out research projects funded by the Water Research Commission. This should overcome the problems related to the poor backup services provided by many instrument suppliers and lead to the more cost effective use of equipment. Equipment would be loaned out to research organisations for the duration of their projects and then returned to a common pool for reallocation to other users. Such centres have been established in other parts of the world and found to be very cost effective.

3. METHODS OF WATER QUALITY ANALYSES

The water quality samples collected for the project were analysed by the staff of the Institute for Water Research at Rhodes University. The methods of analyses were all standard and as such do not warrant further discussion. However, a list of the parameters analysed and the method of analyses are now presented in table form (Table 3.1). The results of the laboratory analyses were entered into a water quality data base on the mainframe computer at Rhodes University where a number of simple checks were carried out. These included a comparison of the EC/TDS ratio, a determination of the SO_4 concentration as a residual to balance the major anions and cations and time series plots to ensure continuity of laboratory standards. Subsequent analyses of the water quality parameters was mainly carried out on PC's using the Quattro Pro spreadsheet package.

Table 3.1 Water quality parameters and methods of analyses adopted for the current study.

Water Quality Parameter	Method of Analyses
pH	Meter calibrated to pH 7.0 at room temperature
Electrical Conductivity	Meter calibrated at 141.3 $mS.m^{-1}$ .01 M KCl
Total Dissolved Solids	Filter and hot air dried for 24 hours
Total Alkalinity	Titration with 0.5 M H_2SO_4
Chlorides	Titration with 0.005 M $AgNO_3$
Calcium	Atomic absorption spectrophotometer
Potassium	Atomic absorption spectrophotometer
Magnesium	Atomic absorption spectrophotometer
Sodium	Atomic absorption spectrophotometer

4. LOWER SUNDAYS RIVER VALLEY: GROUND WATER DATA

Prior to the decision, of the March 1990 Steering Committee, that the study should focus on the lower Coerney valley, ground water depth and water quality data were collected for 15 wells located in the main lower Sundays River valley (figure 4.1). These wells were all disused with no water extraction taking place during the period of monitoring. No meaningful information on the depth of the holes or on the material into which they were dug was collected. Information on their elevations above mean sea level is also not available. Therefore, in the data summary these water levels are expressed as a depth from the ground surface. The ground water level and water samples were collected manually with all water samples being collected from the water surface. The LO coordinates presented in the data summary were estimated by extracting the digitised coordinates from the 1:50 000 topographic map series. Unfortunately no permanent bench marks for the long term monitoring of these water levels were established at these sites. However the available information does provide a useful indication of the ground water level and quality for the period of monitoring.

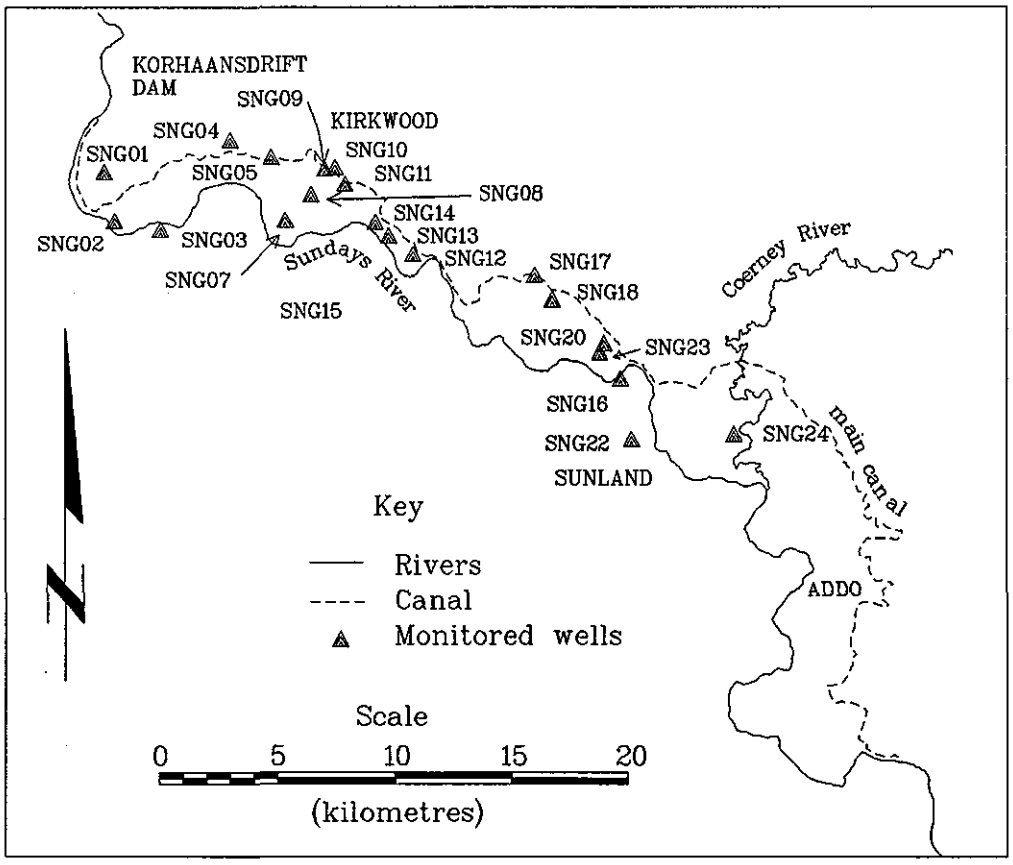

Figure 4.1 Location of ground water monitoring sites in the lower Sundays River valley.

SITE NUMBER: SNG01

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3696914 Eastings: -33324
Period of Data:	02/12/87 - 30/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	18.22	8.51	5803	919	2410	470	224	330	1480	9.60
Minimum	17.17	7.63	2803	444	106	35	91	108	629	4.00
Mean	17.72	7.94	4028	638	1411	259	140	193	983	6.04
Std. Dev.	0.17	0.28	1042	147	484	177	46	66	238	1.75

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

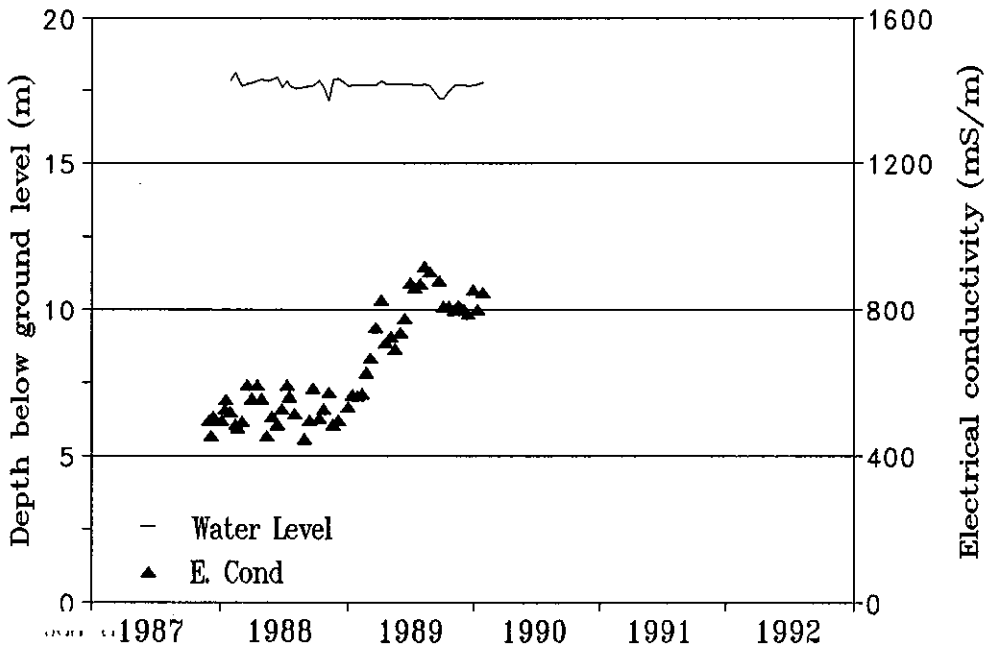

Figure 4.2 Water Level and electrical conductivity of borehole SNG01

SITE NUMBER: SNG03

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3699409 Eastings: -35716
Period of Data:	02/12/87 - 18/02/88
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	6.38	7.87	-	499	1153	485	-	-	-	-
Minimum	6.32	7.53	-	302	1053	330	-	-	-	-
Mean	6.35	7.78	-	457	1105	451	-	-	-	-
Std. Dev.	0.02	0.14	-	60	34	60	-	-	-	-

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

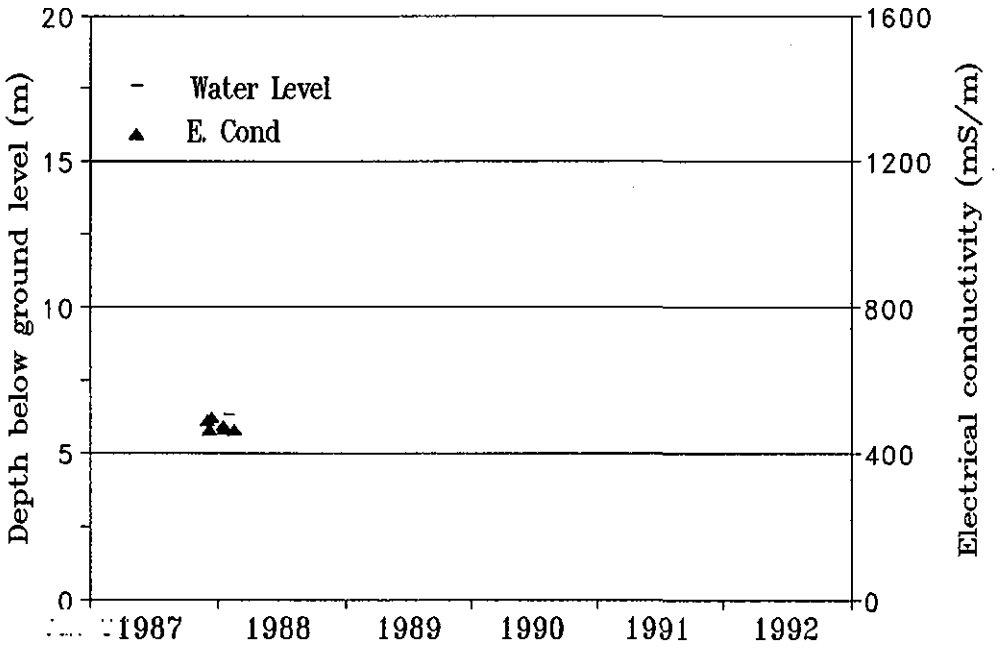

Figure 4.3 Water Level and electrical conductivity of borehole SNG03

SITE NUMBER: SNG04

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3695547 Eastings: -38671
Period of Data:	02/12/87 - 30/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	6.04	7.96	729	230	332	370	87	97	368	21.60
Minimum	3.14	6.70	462	95	175	15	25	25	97	9.00
Mean	5.17	7.37	633	110	227	108	36	36	148	14.32
Std. Dev.	0.61	0.44	68	18	31	75	17	20	73	3.56

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

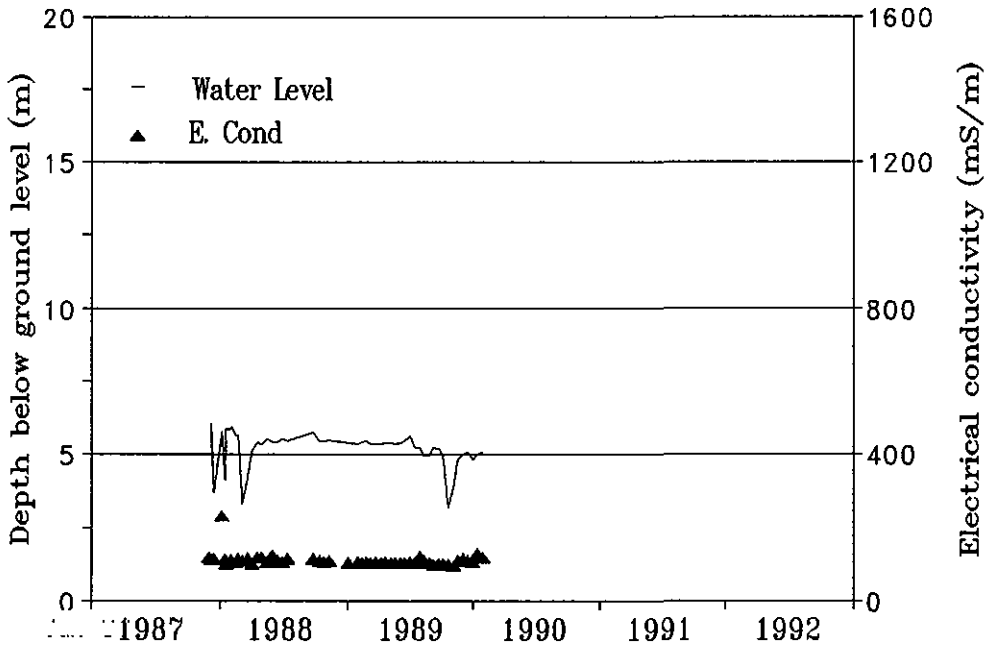

Figure 4.4 Water Level and electrical conductivity of borehole SNG04

SITE NUMBER: SNG07

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3698994 Eastings: -40996
Period of Data:	02/12/87 - 30/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	12.20	8.50	1868	377	739	-	84	96	444	7.90
Minimum	10.13	7.22	1454	228	331	-	35	71	328	2.70
Mean	10.54	7.98	1732	275	437	-	70	86	391	3.92
Std. Dev.	0.29	0.51	113	24	85	-	12	7	37	1.71

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

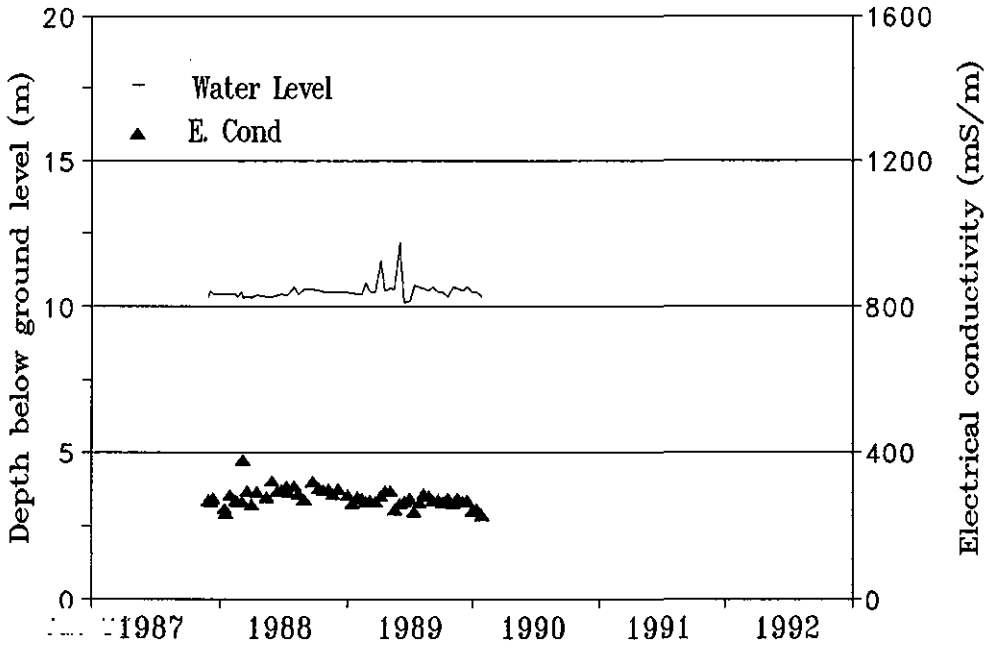

Figure 4.5 Water Level and electrical conductivity of borehole SNG07

SITE NUMBER: SNG08

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3697890 Eastings: -42068
Period of Data:	02/12/87 - 30/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	12.53	8.38	1776	325	495	463	71	-	313	2.10
Minimum	9.40	6.92	1151	171	292	33	36	-	192	1.00
Mean	10.89	7.43	1399	231	406	249	52	-	258	1.56
Std. Dev.	0.85	0.47	148	20	49	85	9	-	39	0.35

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

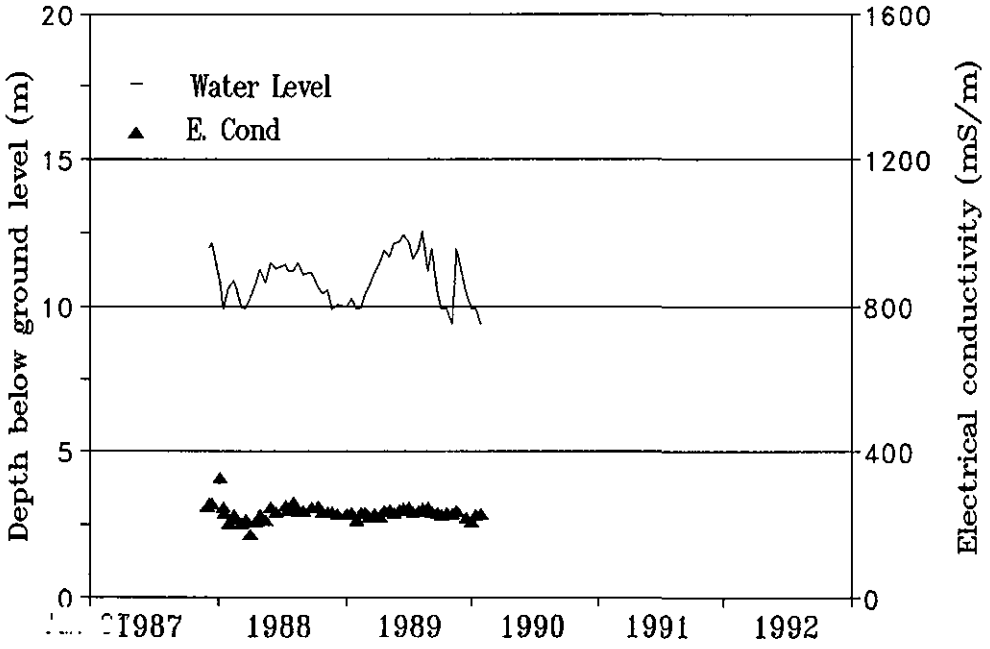

Figure 4.6 Water Level and electrical conductivity of borehole SNG08

SITE NUMBER: SNG09

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3696787 Eastings: -42650
Period of Data:	09/12/87 - 30/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	5.58	8.06	4975	176	1695	180	112	132	1330	8.90
Minimum	3.24	6.66	718	138	320	25	18	30	117	4.90
Mean	4.99	7.46	1187	156	452	115	40	50	270	7.32
Std. Dev.	0.50	0.52	1035	9	308	50	31	27	310	1.00

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

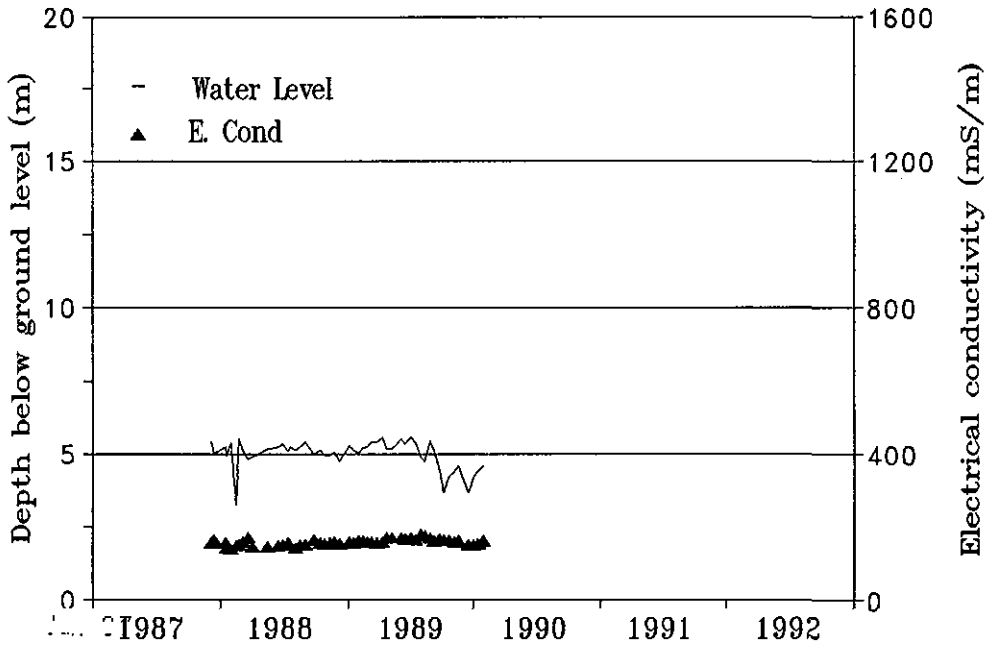

Figure 4.7 Water Level and electrical conductivity of borehole SNG09

SITE NUMBER: SNG11

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3697435 Eastings: -43526
Period of Data:	02/12/87 - 30/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	9.88	8.48	2109	375	652	533	57	92	637	2.5
Minimum	7.30	6.98	1860	277	426	435	40	78	494	0.90
Mean	8.83	7.65	2007	348	560	467	46	86	536	1.20
Std. Dev.	0.40	0.63	82	18	60	24	5	5	42	0.21

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

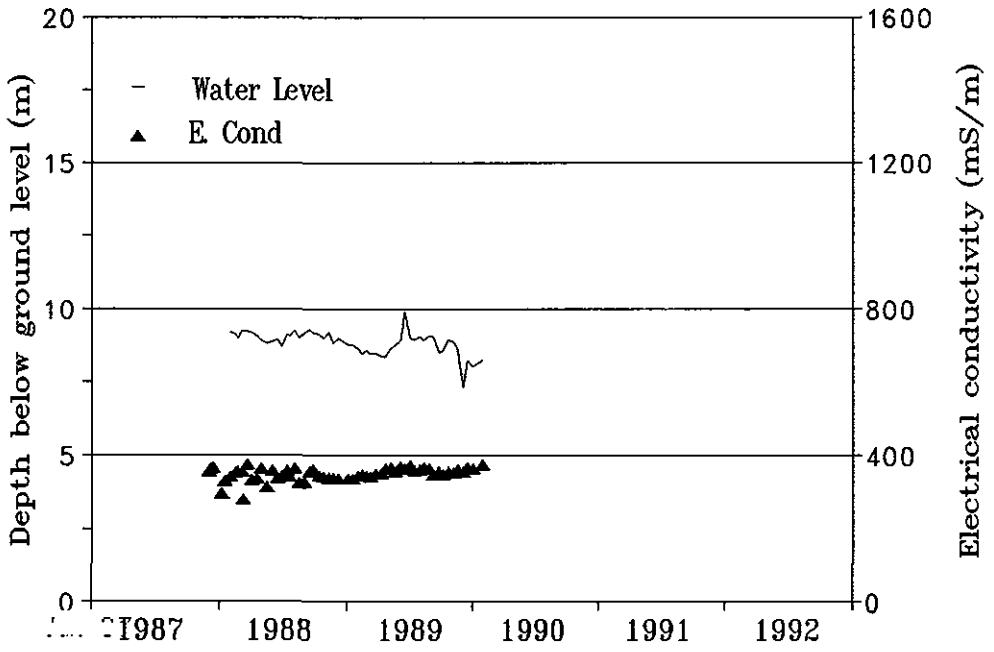

Figure 4.8 Water Level and electrical conductivity of borehole SNG11

SITE NUMBER: SNG12

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3700480 Eastings: -46424
Period of Data:	02/12/87 - 30/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	11.86	8.49	4582	718	1266	533	233	244	840	4.00
Minimum	6.51	6.64	1275	113	159	50	53	64	277	1.30
Mean	9.28	8.11	2191	319	557	297	120	113	470	2.65
Std. Dev.	0.85	0.56	734	105	271	197	43	44	135	0.62

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

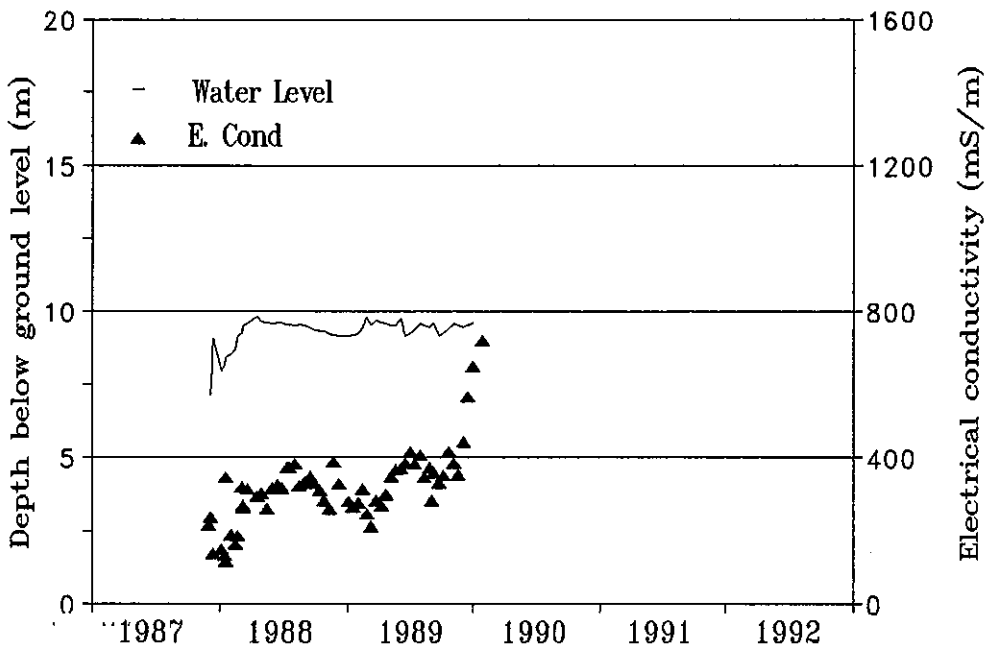

Figure 4.9 Water Level and electrical conductivity of borehole SNG12

SITE NUMBER: SNG13

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3699682 Eastings: -45374
Period of Data:	02/12/87 - 30/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	11.72	8.42	1683	347	554	490	62	57	470	10.60
Minimum	9.98	7.59	612	82	162	65	42	24	145	3.90
Mean	10.79	8.21	1181	236	393	351	48	39	353	7.12
Std. Dev.	0.26	0.36	310	62	110	131	7	8	97	2.13

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

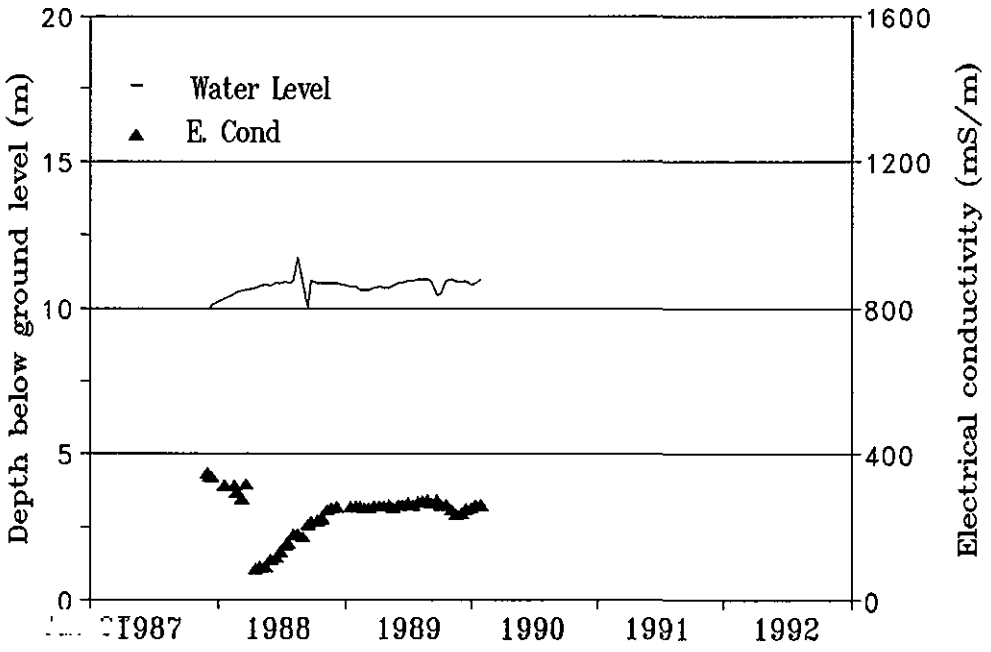

Figure 4.10 Water Level and electrical conductivity of borehole SNG13

SITE NUMBER: SNG15

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3703278 Eastings: -45579
Period of Data:	02/12/87 - 30/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	7.93	8.46	2173	469	524	633	90	73	566	6.40
Minimum	4.03	7.47	923	118	126	43	51	37	192	3.40
Mean	7.15	7.90	1519	262	326	393	73	59	364	4.64
Std. Dev.	1.44	0.38	337	61	111	187	12	11	108	0.80

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

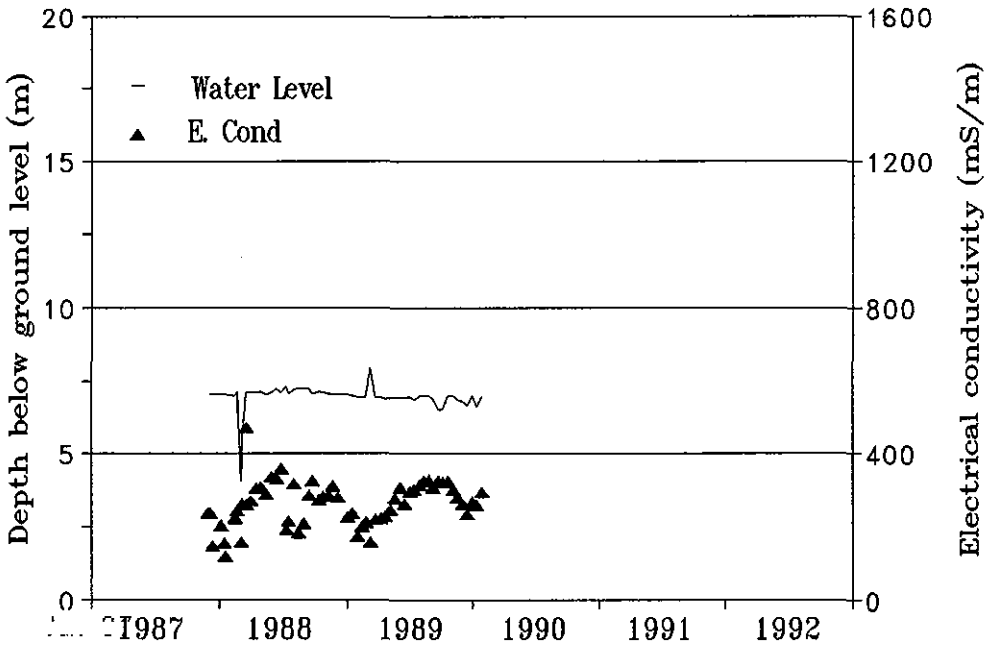

Figure 4.11 Water Level and electrical conductivity of borehole SNG15

SITE NUMBER: SNG17

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3701400 Eastings: -51672
Period of Data:	16/12/87 - 23/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	8.52	7.93	1008	251	531	258	49	82	220	11.10
Minimum	5.67	6.82	666	115	177	23	32	31	123	5.00
Mean	7.59	7.43	773	137	243	190	38	43	175	7.51
Std. Dev.	0.57	0.39	90	19	80	76	5	15	27	1.76

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

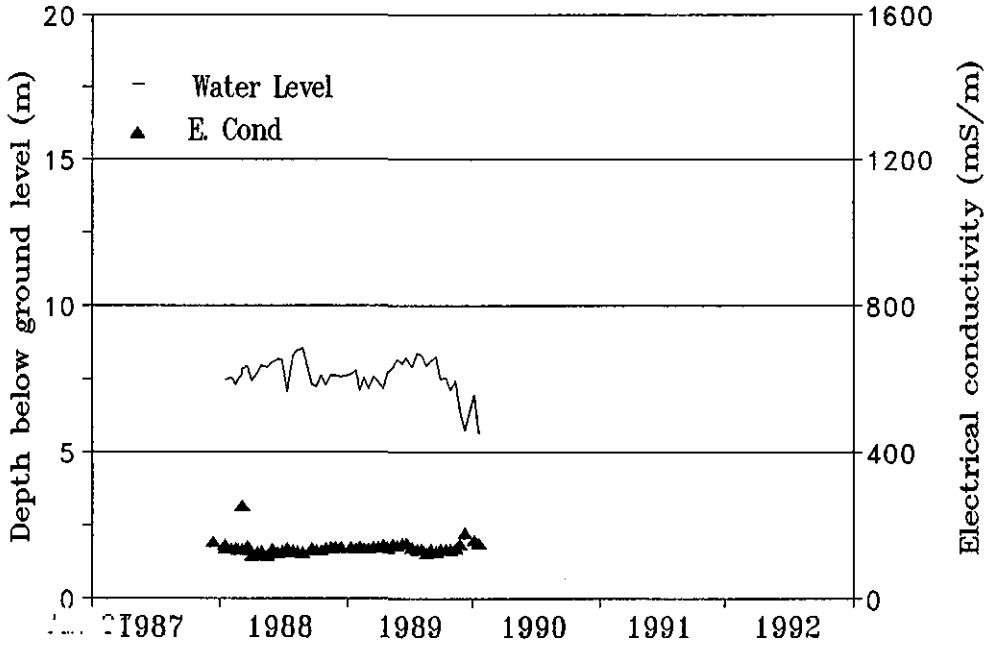

Figure 4.12 Water Level and electrical conductivity of borehole SNG17

SITE NUMBER: SNG18

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3702407 Eastings: -52416
Period of Data:	02/12/87 - 23/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	5.00	8.05	1028	197	746	500	52	59	270	7.00
Minimum	3.96	7.18	951	108	144	188	41	28	120	4.90
Mean	4.74	7.82	982	174	286	317	44	49	208	5.69
Std. Dev.	0.23	0.30	26	14	124	72	3	8	39	0.57

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

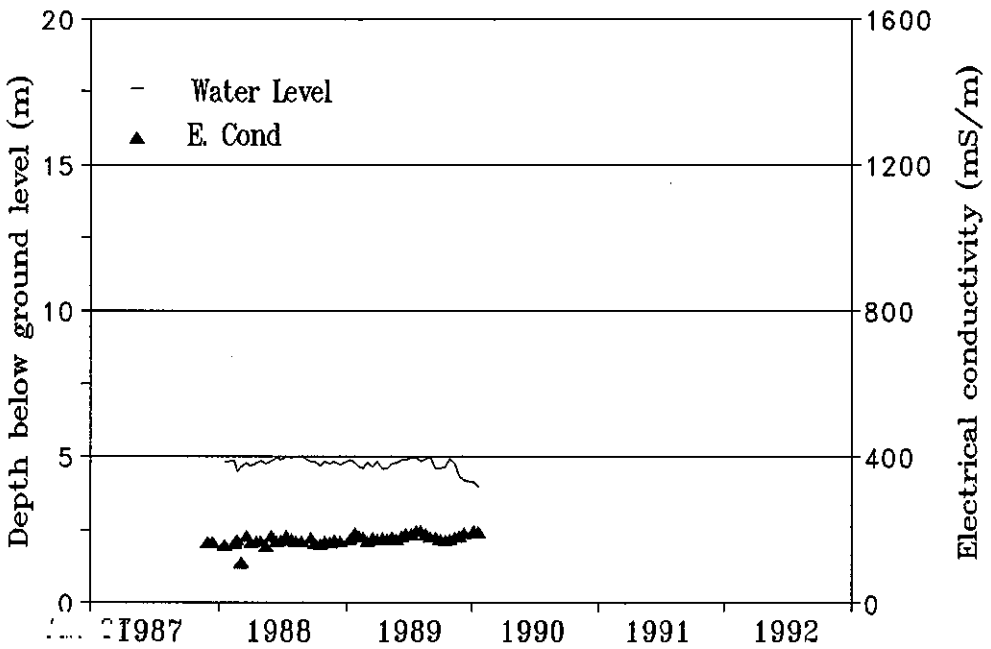

Figure 4.13 Water Level and electrical conductivity of borehole SNG18

SITE NUMBER: SNG20

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3702407 Eastings: -52416
Period of Data:	02/12/87 - 23/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	9.53	8.23	2573	444	836	578	89	-	678	8.00
Minimum	9.33	7.68	1333	145	211	197	41	-	234	1.50
Mean	9.44	7.95	1951	298	564	361	69	-	433	4.78
Std. Dev.	0.06	0.18	473	107	223	133	17	-	154	2.20

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

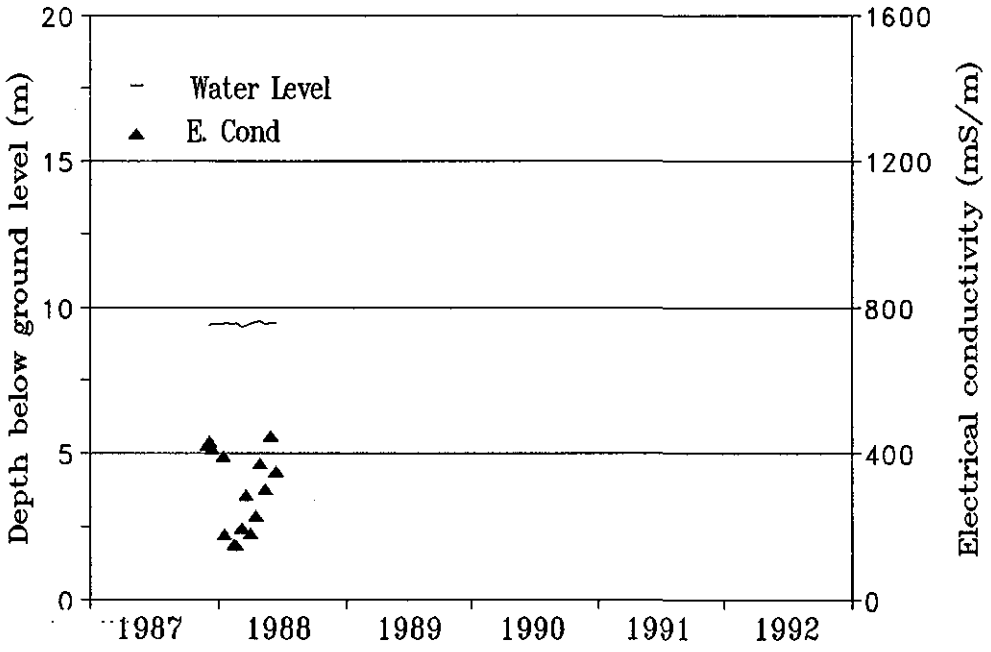

Figure 4.14 Water Level and electrical conductivity of borehole SNG20

SITE NUMBER: SNG21

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3697434 Eastings: -34728
Period of Data:	02/12/87 - 23/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	11.78	8.19	1199	215	322	440	64	69	235	26.80
Minimum	11.04	7.51	804	137	130	35	36	44	150	19.90
Mean	11.40	7.79	963	167	234	328	49	58	181	22.69
Std. Dev.	0.15	0.28	97	18	50	119	8	7	18	2.03

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

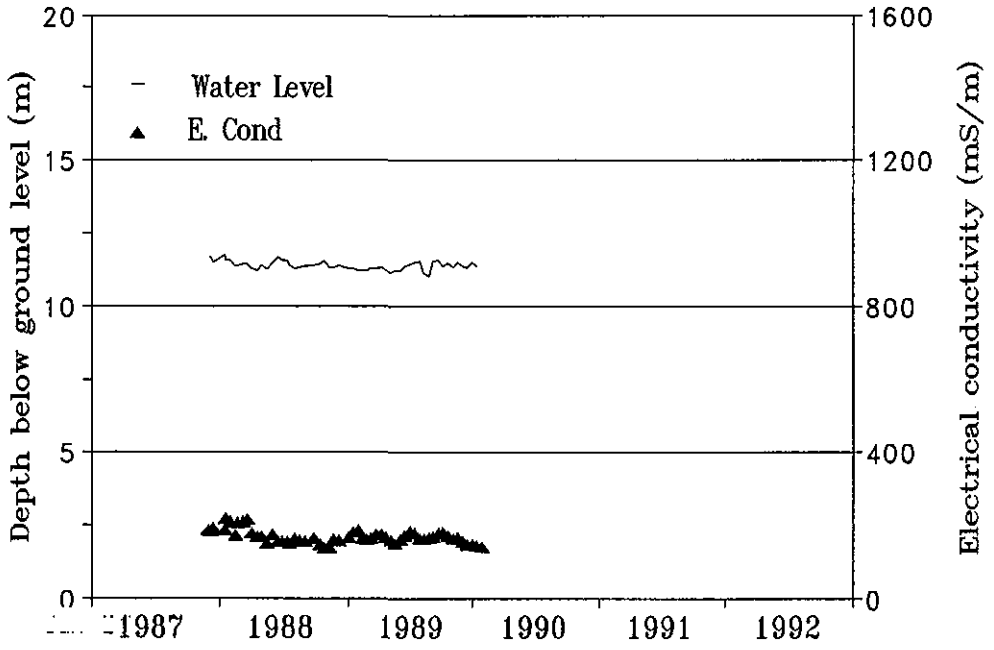

Figure 4.15 Water Level and electrical conductivity of borehole SNG21

SITE NUMBER: SNG22

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3708392 Eastings: -55823
Period of Data:	02/12/87 - 23/01/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water level and water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	5.08	8.04	1498	264	410	468	99	89	410	34.70
Minimum	4.39	7.18	592	95	118	16	48	18	112	16.70
Mean	4.81	7.51	1252	212	301	315	78	41	289	29.68
Std. Dev.	0.17	0.38	260	32	84	168	12	16	85	4.69

(Units: EC - mS/m, WL - metres below ground level, all other parameters mg/l)

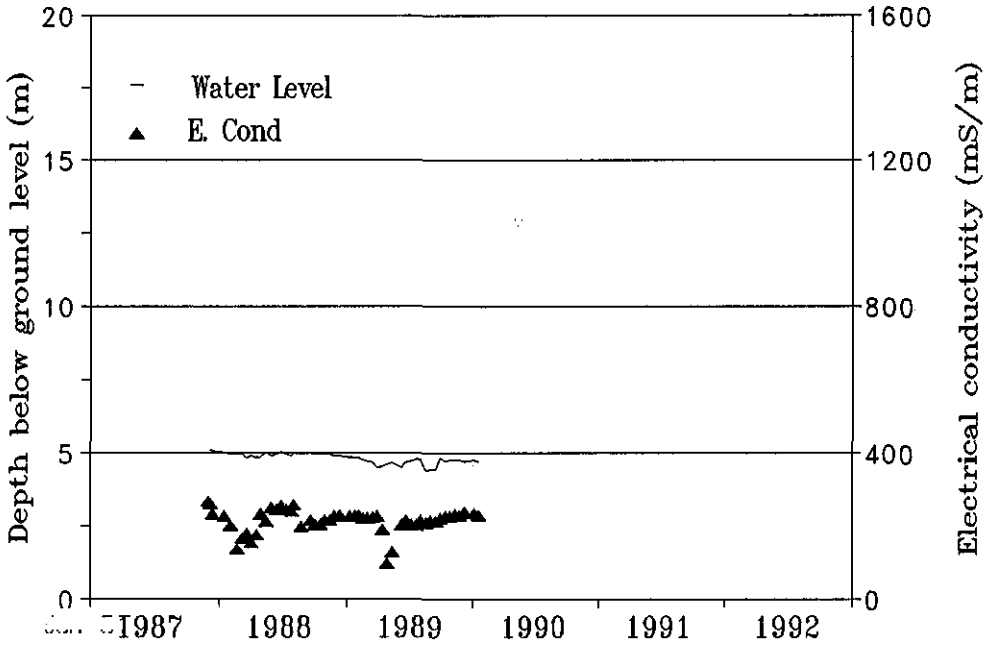

Figure 4.16 Water Level and electrical conductivity of borehole SNG22

5. LOWER SUNDAYS RIVER VALLEY: SURFACE WATER DATA

Prior to the 1990 Steering Committee decision that the study should focus on the lower Coerney valley, water level and quality of the Sundays River was monitored at 13 sites (figure 5.1). These sites included the depth and water quality in Korhaans Drift (SNQ01) and of the main Sundays River at flow monitoring sites SNQ06, SNQ08 and SNQ16 and water quality at a further 9 sites. The level of flow and water quality of a major seepage (SNQ13) entering the Sundays River was also monitored. However, as none of these sites are either ratable, due to over vegetation of the channel, or because the channel monitored does not carry the entire flow of the Sundays River, the water level records have not been converted to discharge. It was partially for these reasons that the decision was made to focus this study on the lower Coerney valley study area. Water samples were collected both manually and using automatic pump samplers. The LO coordinates presented in the data summary were estimated by extracting the digitised coordinates from the 1:50 000 topographic map series. Although discharge data is not available for these sites the water quality information does provide a clear indication of the increased salinity down the lower Sundays River due to irrigation return flow.

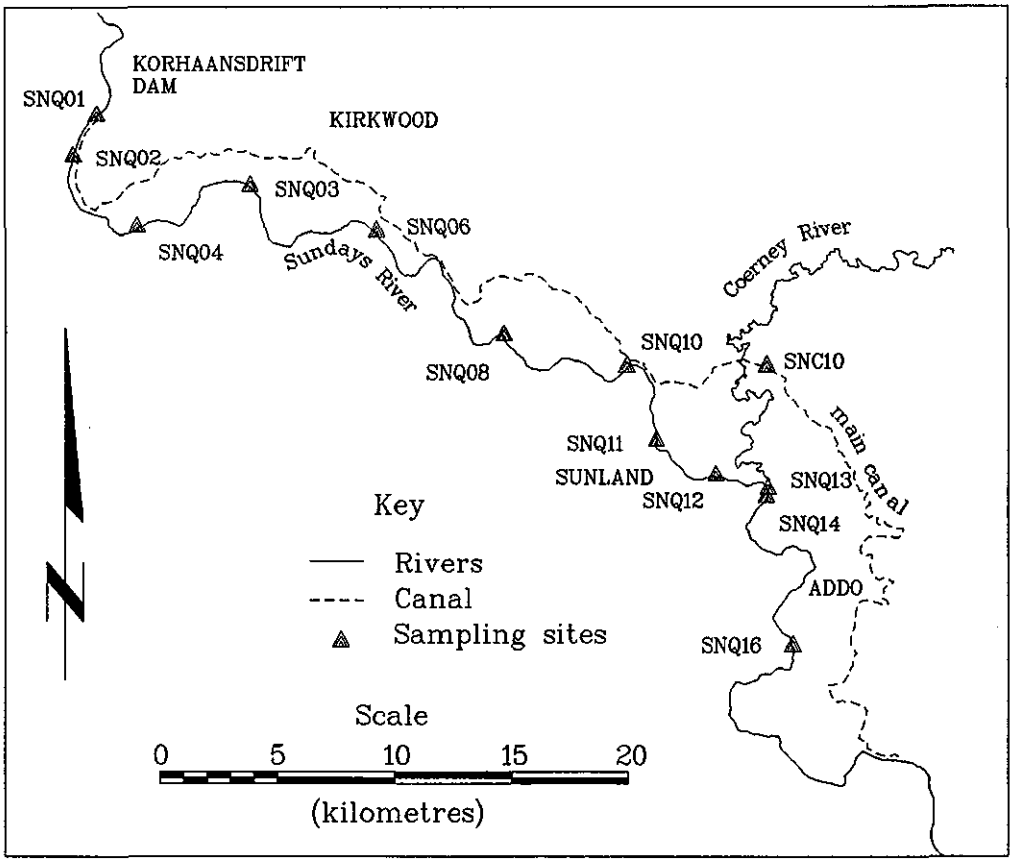

Figure 5.1 Location of surface water monitoring sites in the lower Sundays River valley.

SITE NUMBER: SNQ01

1. Site Information

Site Description:	Sundays River at Korhaansdrift
Site Location (est.):	Lo: 25 Southings: 3694462 Eastings: -33033
Period of Data:	01/07/87 - 13/02/90
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.65	1078	180	331	317	105	80	250	11.30
Minimum	-	8.10	254	36	50	10	12	14	36	3.80
Mean	-	8.16	638	104	165	226	41	32	158	6.00
Std. Dev.	-	0.87	133	133	65	71	14	9	47	2.00

(Units: EC - mS/m, all other parameters mg/l)

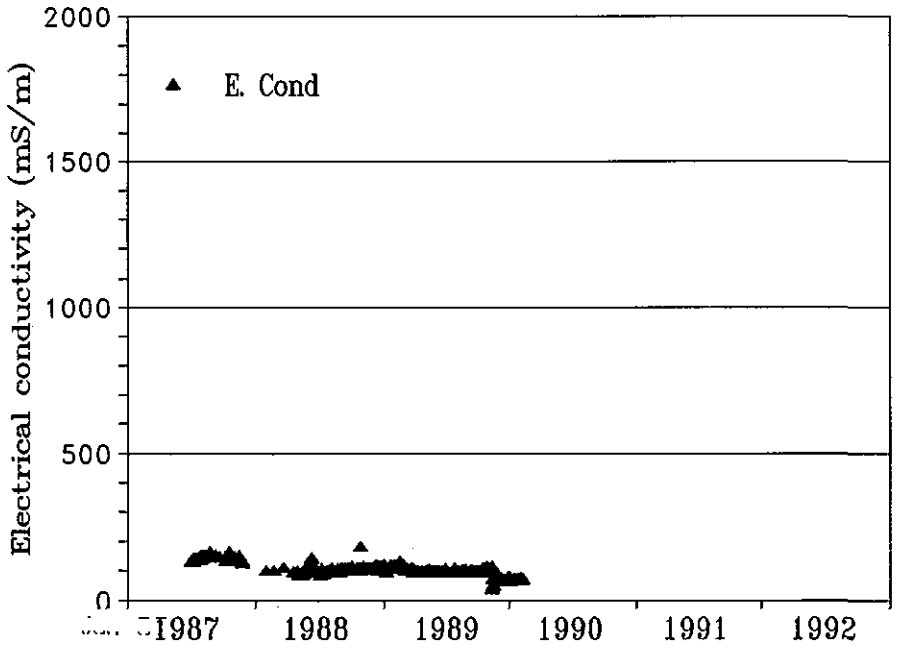

Figure 5.2 Electrical conductivity of borehole SNQ01

SITE NUMBER: SNQ02

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3696217 Eastings: -32067
Period of Data:	22/03/88 - 31/05/88
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	-	-	117	-	-	-	-	-	-
Minimum	-	-	-	77	-	-	-	-	-	-
Mean	-	-	-	99	-	-	-	-	-	-
Std. Dev.	-	-	-	13	-	-	-	-	-	-

(Units: EC - mS/m, all other parameters mg/l)

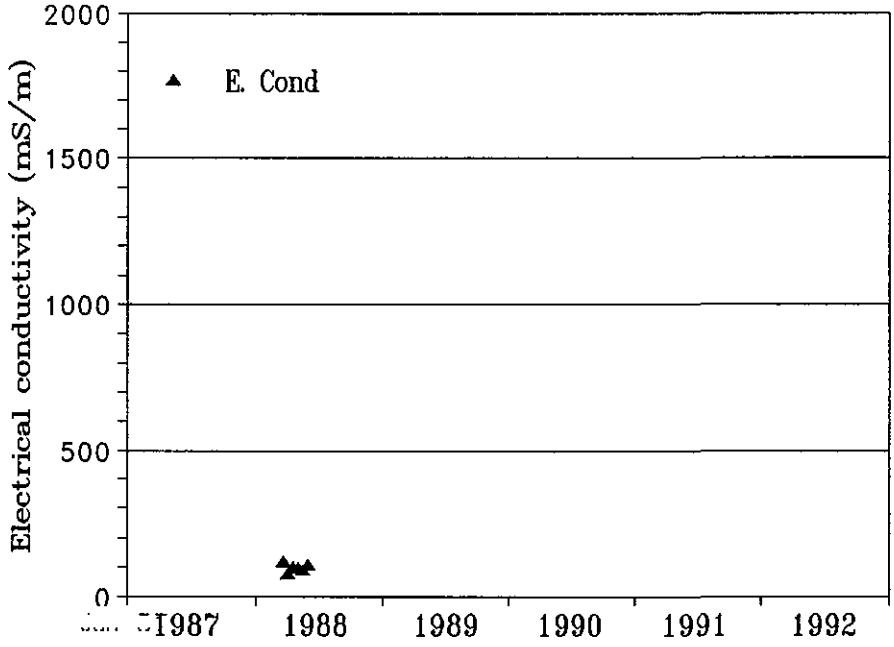

Figure 5.3 Electrical conductivity of borehole SNQ02

SITE NUMBER: SNQ03

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3697497 Eastings: -39527
Period of Data:	22/03/88 - 31/05/88
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	-	997	272	277	275	51	45	196	5.60
Minimum	-	-	997	161	277	275	51	45	196	5.60
Mean	-	-	997	197	277	275	51	45	196	5.60
Std. Dev.	-	-	0	39	0	0	0	0	0	0.00

(Units: EC - mS/m, all other parameters mg/l)

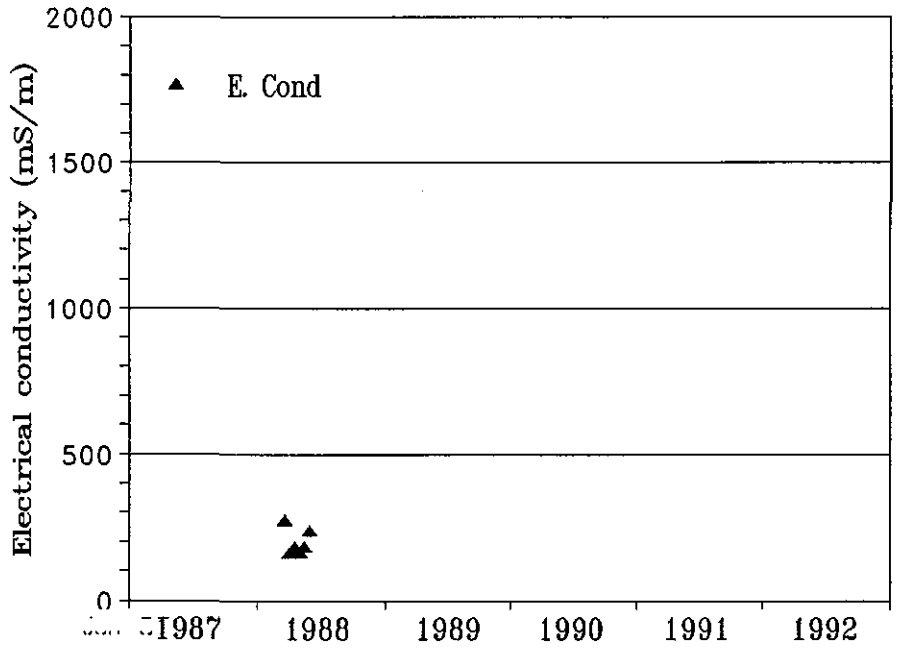

Figure 5.4 Electrical conductivity of borehole SNQ03

SITE NUMBER: SNQ04

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3699262 Eastings: -34710
Period of Data:	22/03/88 - 31/01/88
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	-	1651	288	558	505	101	82	328	10.10
Minimum	-	-	438	71	135	10	26	25	83	4.00
Mean	-	-	1011	169	163	163	58	50	224	5.28
Std. Dev.	-	-	327	55	119	157	20	17	73	1.51

(Units: EC - mS/m, all other parameters mg/l)

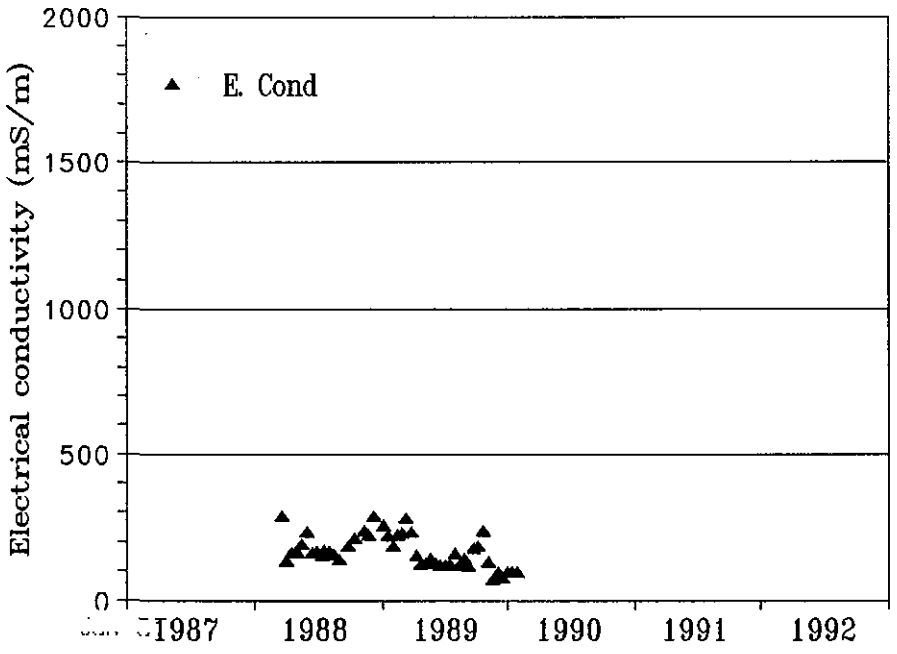

Figure 5.5 Electrical conductivity of borehole SNQ04

SITE NUMBER: SNQ05

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3700010 Eastings: -41223
Period of Data:	01/07/88 - 01/06/90
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	-	1272	297	333	305	63	57	239	5.90
Minimum	-	-	1272	195	333	305	63	57	239	5.90
Mean	-	-	1272	232	333	305	63	57	239	5.90
Std. Dev.	-	-	0	36	0	0	0	0	0	0.00

(Units: EC - mS/m, all other parameters mg/l)

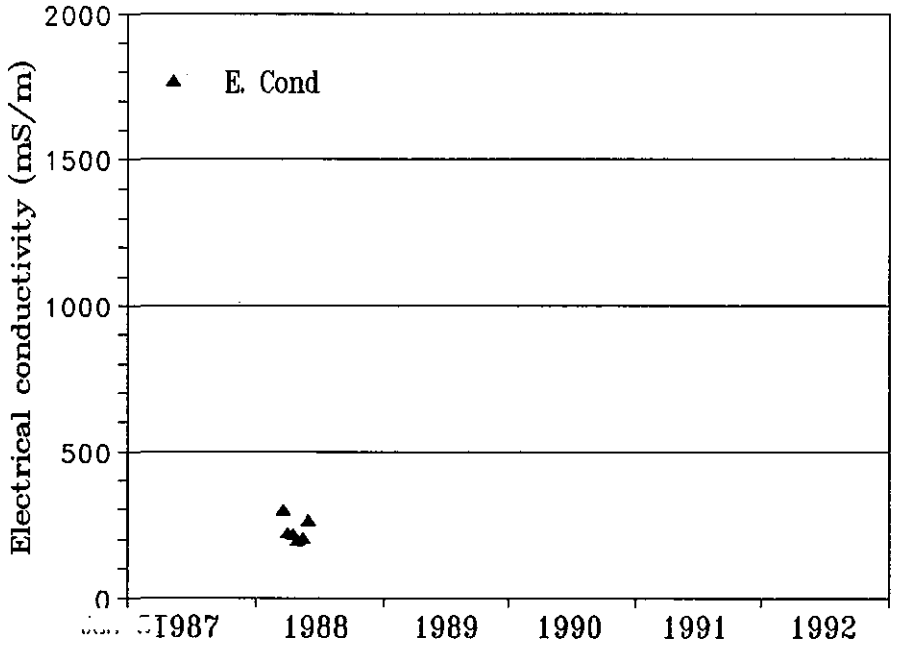

Figure 5.6 Electrical conductivity of borehole SNQ05

SITE NUMBER: SNQ06

1. Site Information

Site Description:	Sundays River at Cleveland
Site Location (est.):	Lo: 25 Southings: 3699433 Eastings: -44864
Period of Data:	02/07/87 - 01/05/90
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Automatic sampling using Isco pump sampler

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.51	1856	314	930	1850	113	99	600	7.90
Minimum	-	7.32	889	71	148	33	23	29	182	3.80
Mean	-	7.99	1407	231	395	367	58	65	363	5.65
Std. Dev.	-	0.23	181	38	107	200	18	13	93	1.10

(Units: EC - mS/m, all other parameters mg/l)

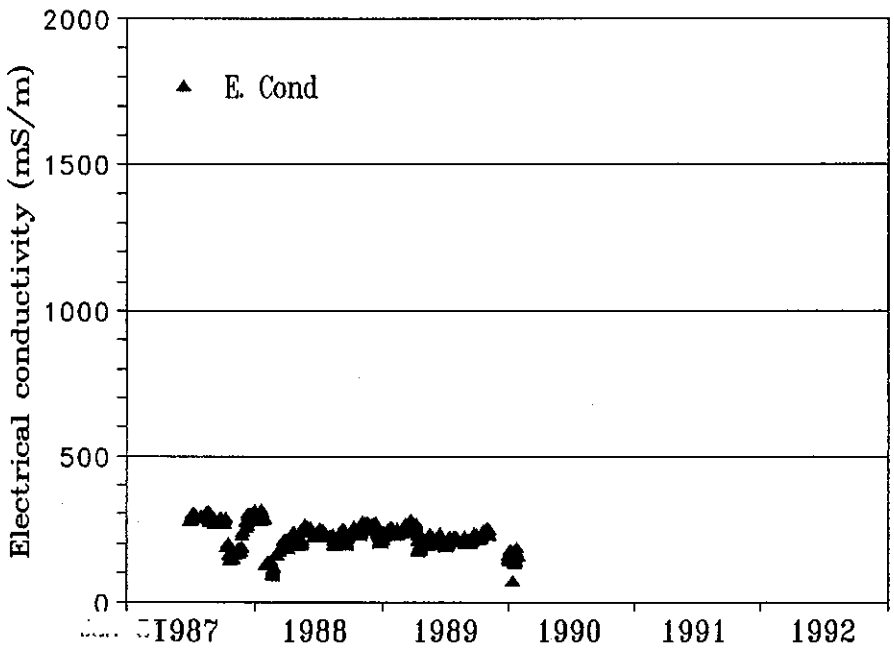

Figure 5.7 Electrical conductivity of borehole SNQ06

SITE NUMBER: SNQ08

1. Site Information

Site Description:	Sundays River at Dunbrody
Site Location (est.):	Lo: 25 Southings: 3703886 Eastings: -50318
Period of Data:	01/07/87 - 30/01/90
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Automatic sampling using Isco pump sampler

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	11.34	9.06	1777	427	1282	698	169	144	670	14.30
Minimum	0.19	6.51	176	52	8	13	21	16	30	2.20
Mean	1.93	8.07	1394	257	459	351	53	65	368	5.56
Std. Dev.	1.06	0.33	346	46	153	146	19	19	127	1.32

(Units: EC - mS/m, all other parameters mg/l)

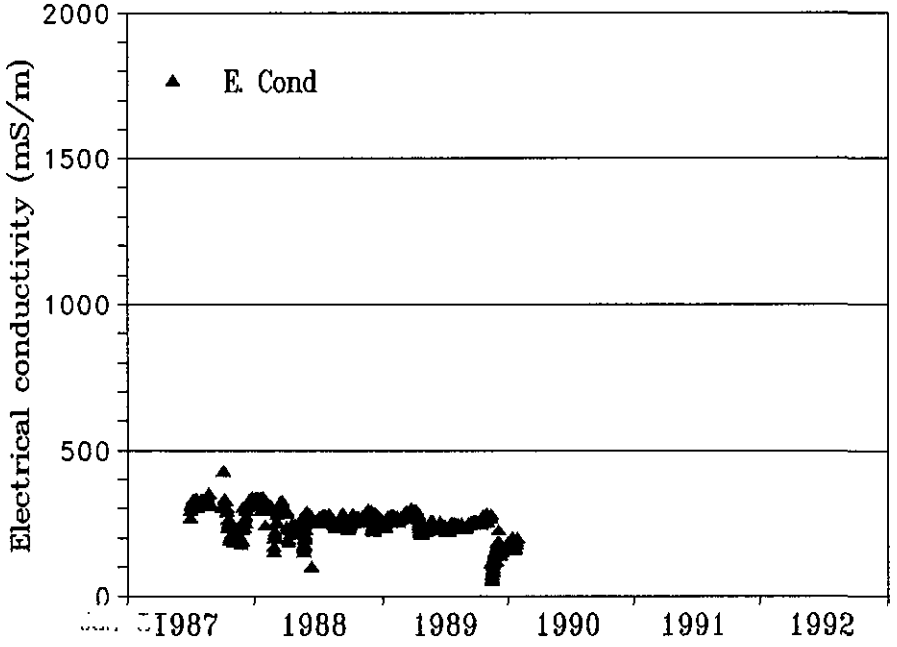

Figure 5.8 Electrical conductivity of borehole SNQ08

SITE NUMBER: SNQ10

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3785214 Eastings: -55583
Period of Data:	01/07/87 - 01/06/90
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	-	1810	329	471	453	74	77	450	6.20
Minimum	-	-	1357	125	35	50	43	57	334	2.90
Mean	-	-	1545	264	369	216	61	67	402	4.83
Std. Dev.	-	-	142	37	141	191	10	6	39	0.97

(Units: EC - mS/m, all other parameters mg/l)

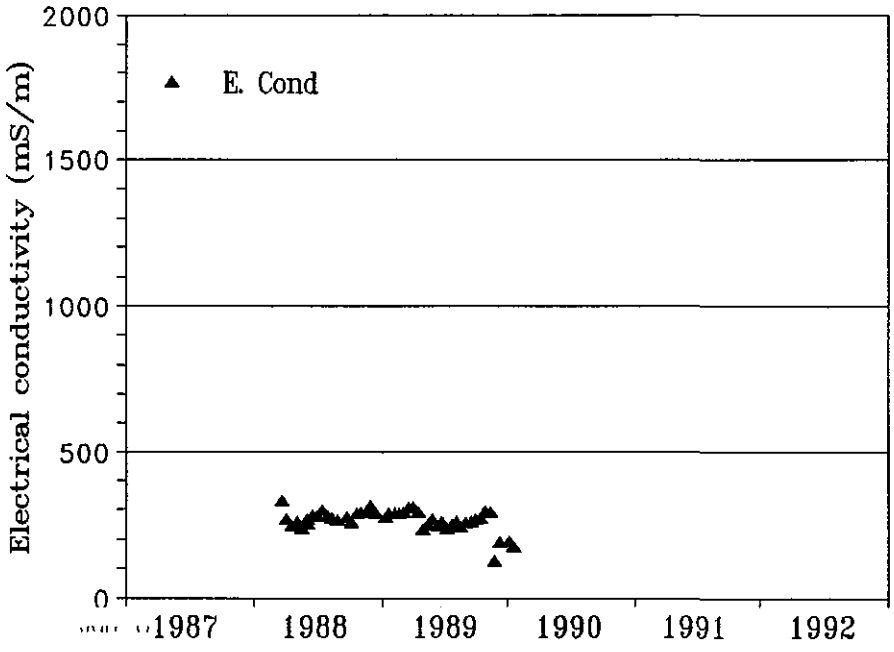

Figure 5.9 Electrical conductivity of borehole SNQ10

SITE NUMBER: SNQ11

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3708350 Eastings: -56857
Period of Data:	01/07/87 - 01/06/90
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	-	1863	378	696	465	87	87	-	8.10
Minimum	-	-	1400	130	241	48	37	63	-	5.30
Mean	-	-	1696	276	469	245	64	75	-	6.25
Std. Dev.	-	-	169	41	142	196	18	8	-	0.97

(Units: EC - mS/m, all other parameters mg/l)

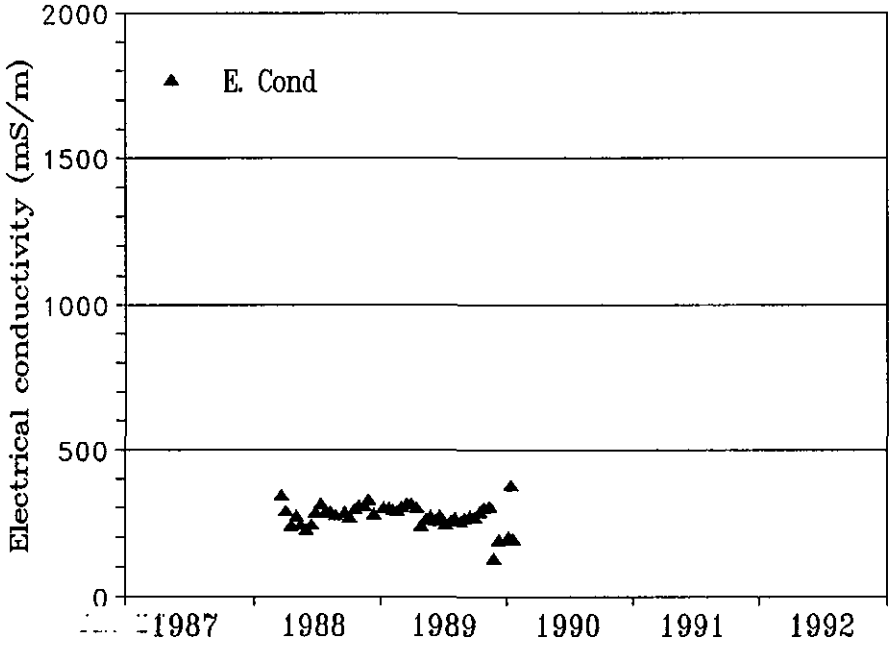

Figure 5.10 Electrical conductivity of borehole SNQ11

SITE NUMBER: SNQ12

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3709867 Eastings: -56379
Period of Data:	01/07/87 - 01/06/90
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	-	1838	352	510	495	92	84	538	6.50
Minimum	-	-	1519	194	21	50	51	64	388	3.40
Mean	-	-	1718	293	414	246	64	72	478	5.40
Std. Dev.	-	-	104	34	144	214	13	7	52	1.00

(Units: EC - mS/m, all other parameters mg/l)

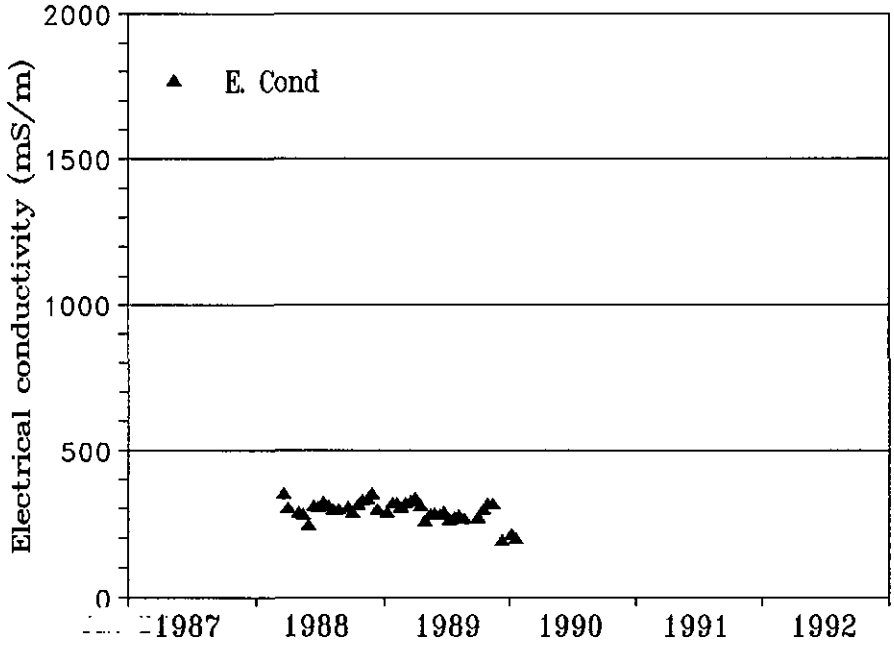

Figure 5.11 Electrical conductivity of borehole SNQ12

SITE NUMBER: SNQ13

1. Site Information

Site Description:	Sundays River
Site Location (est.):	Lo: 25 Southings: 3710431 Eastings: -61597
Period of Data:	01/07/87 - 01/06/90
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.50	2275	802	2348	725	82	91	-	12.00
Minimum	-	7.86	1724	37	62	10	16	13	-	3.70
Mean	-	8.07	2060	597	1719	499	64	71	-	7.18
Std. Dev.	-	0.12	169	219	624	260	18	23	-	2.64

(Units: EC - mS/m, all other parameters mg/l)

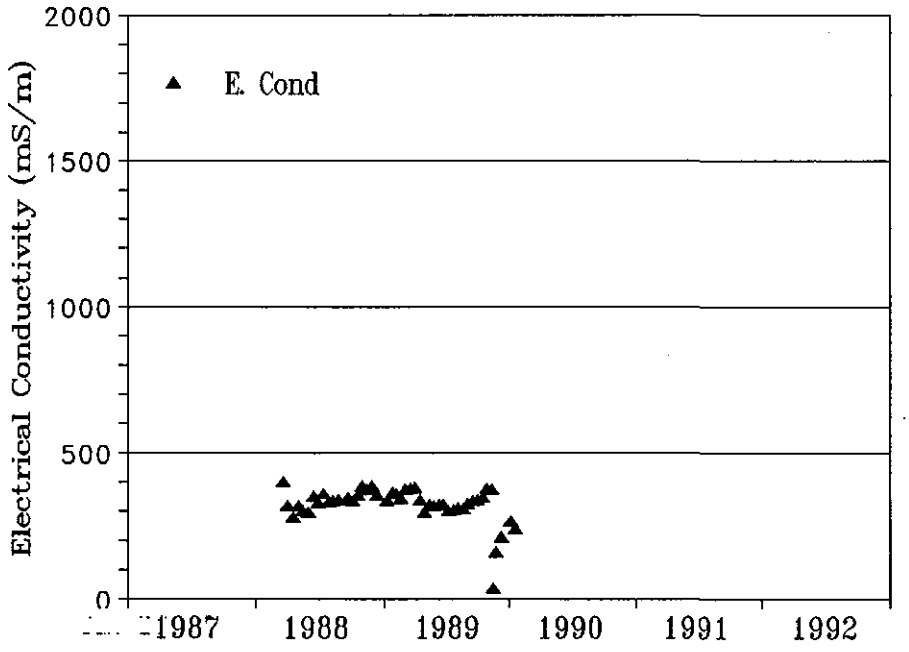

Figure 5.12 Electrical conductivity of borehole SNQ13

SITE NUMBER: SNQ14

1. Site Information

Site Description:	Bank Seepage into Sundays River
Site Location (est.):	Lo: 25 Southings: 3710781 Eastings: -61539
Period of Data:	01/07/87 - 01/06/90
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	7.94	5704	894	3583	815	172	194	1626	7.30
Minimum	-	7.35	729	228	830	60	12	74	157	2.70
Mean	-	7.62	4023	679	1490	386	98	129	1138	5.65
Std. Dev.	-	0.14	1151	137	487	259	36	34	294	0.96

(Units: EC - mS/m, all other parameters mg/l)

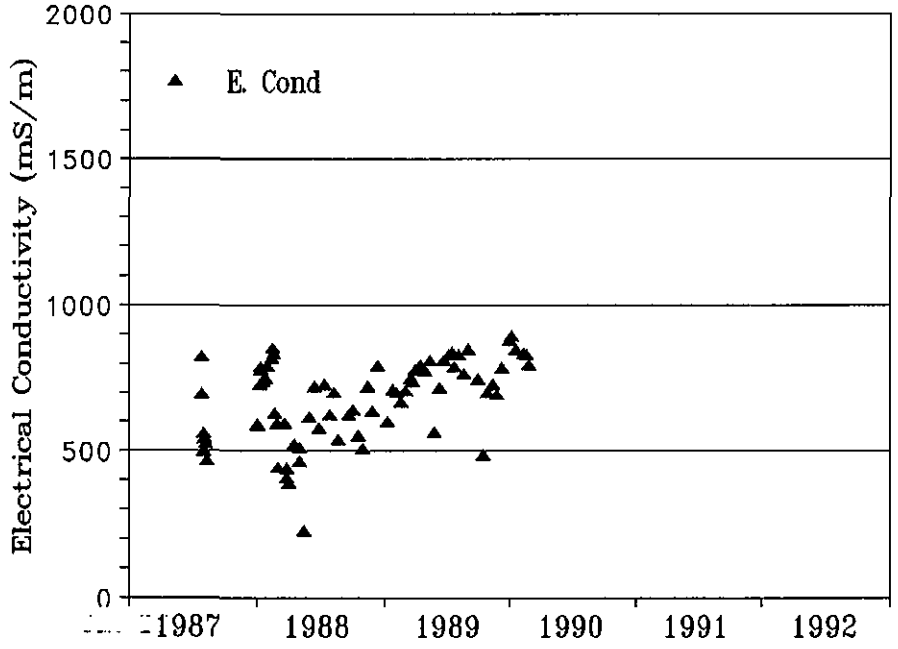

Figure 5.13 Electrical conductivity of borehole SNQ14

SITE NUMBER: SNQ16

1. Site Information

Site Description:	Sundays River at Addo Bridge
Site Location (est.):	Lo: 25 Southings: 3717144 Eastings: -62652
Period of Data:	01/07/87 - 01/06/90
Data Type:	Water quality
Data Interval:	Daily
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.66	2956	527	77	650	107	164	960	62.00
Minimum	-	7.93	739	53	4608	18	25	20	110	3.00
Mean	-	8.25	2267	397	848	434	63	89	658	7.47
Std. Dev.	-	0.14	408	69	447	177	15	21	175	6.92

(Units: EC - mS/m, all other parameters mg/l)

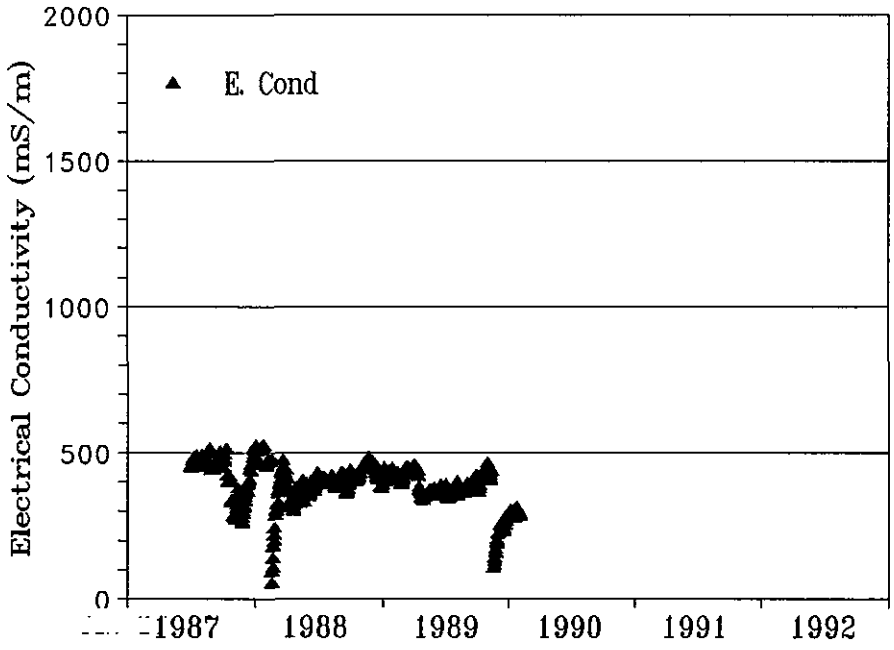

Figure 5.14 Electrical conductivity of borehole SNQ16

6. LOWER COERNEY RIVER VALLEY: GROUND WATER DATA

To provide information on the period of the level and quality of ground water within the lower Coerney valley the Department of Water Affair and Forestry drilled a number of

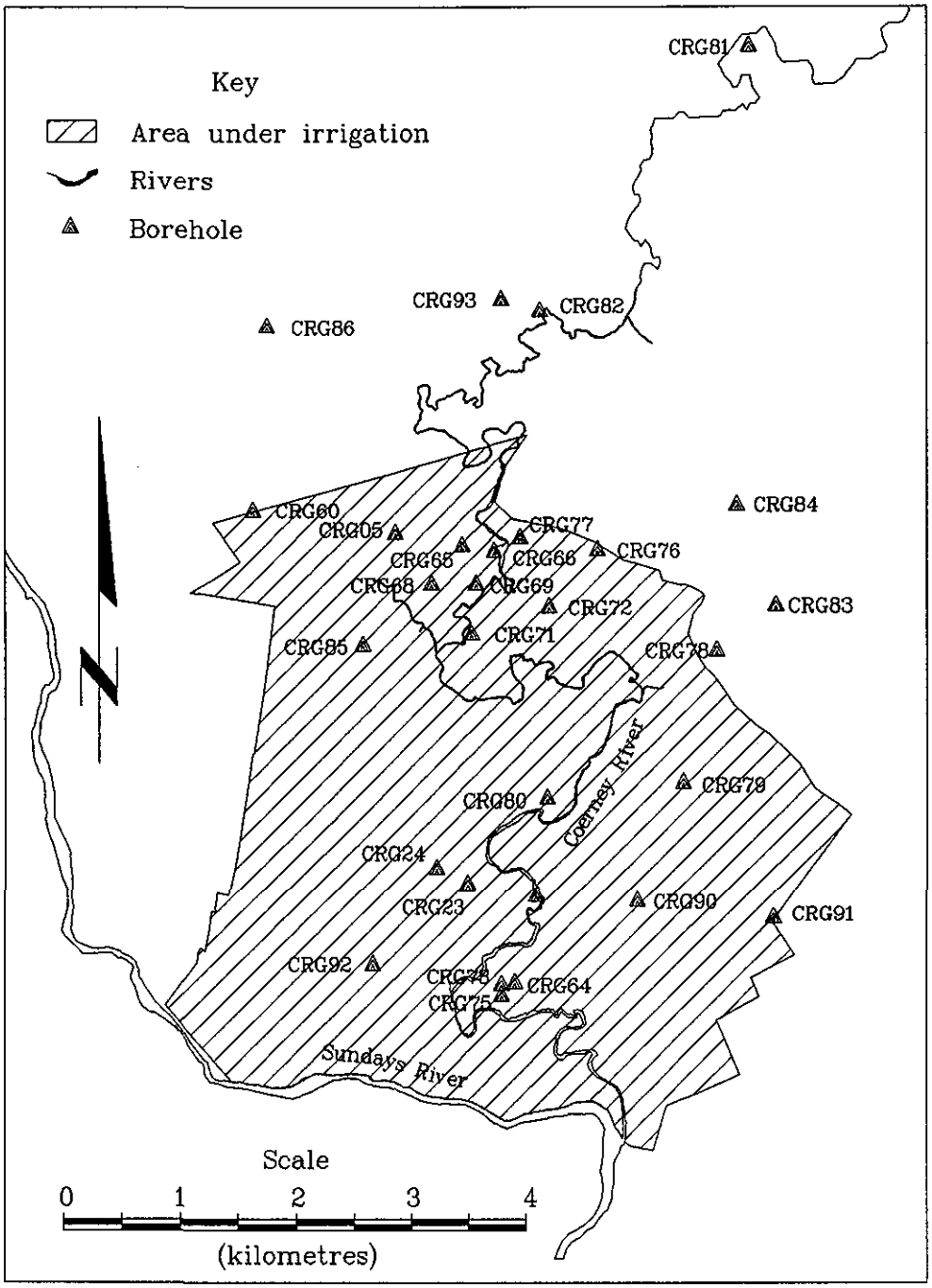

Figure 6.1 Location of ground water monitoring sites in the lower Coerney valley.

boreholes through the alluvium and just penetrating the underlying mudstones. These holes were screened with perforated PVC pipe backfilled with small stone ship. Initially an attempt was made to log the water levels of selected boreholes using MC data loggers. However after repeated unexplained logger failures all borehole monitoring was carried out manually at either weekly of monthly intervals. Surveyors of the Dept of Water Affairs and Forestry determined the location and elevation of all but two of the boreholes in the lower Coerney valley. The locations of the unsurveyed holes was determined by extracting the digitised coordinates from the 1:5 000 scale maps of the lower Sundays River irrigation area.

SITE NUMBER: CRG05

1. Site Information

Site Description:	Borehole on Sun Orange Farm
Site Location (est.):	Lo: 25 Southings: 3705131 Eastings: -59661
Period of Data:	21/01/88 - 08/01/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	59.80	-	6300	1005	2606	1630	313	151	1650	72.00
Minimum	57.80	-	2113	357	590	45	72	34	630	5.00
Mean	58.45	-	3543	567	1080	665	156	72	976	44.00
Std. Dev.	0.21	-	1002	180	475	410	49	31	272	13.00

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

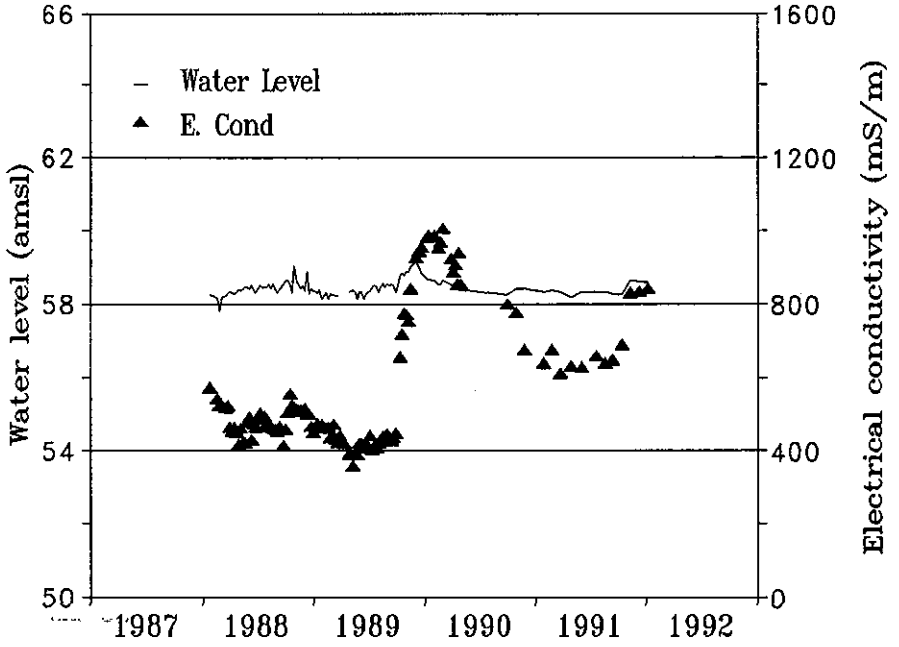

Figure 6.2 Water Level and electrical conductivity of borehole CRG05

SITE NUMBER: CRG23

1. Site Information

Site Description:	Borehole on Good Hope Farm
Site Location (est.):	Lo: 25 Southings: 3708030 Eastings: -60017
Period of Data:	12/09/88 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	43.82	-	6004	580	1865	905	80	72	1100	18.30
Minimum	42.35	-	1698	255	446	33	23	42	351	2.10
Mean	42.65	-	2823	420	830	553	44	56	882	6.50
Std. Dev.	0.32	-	625	75	210	341	14	7	177	4.71

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

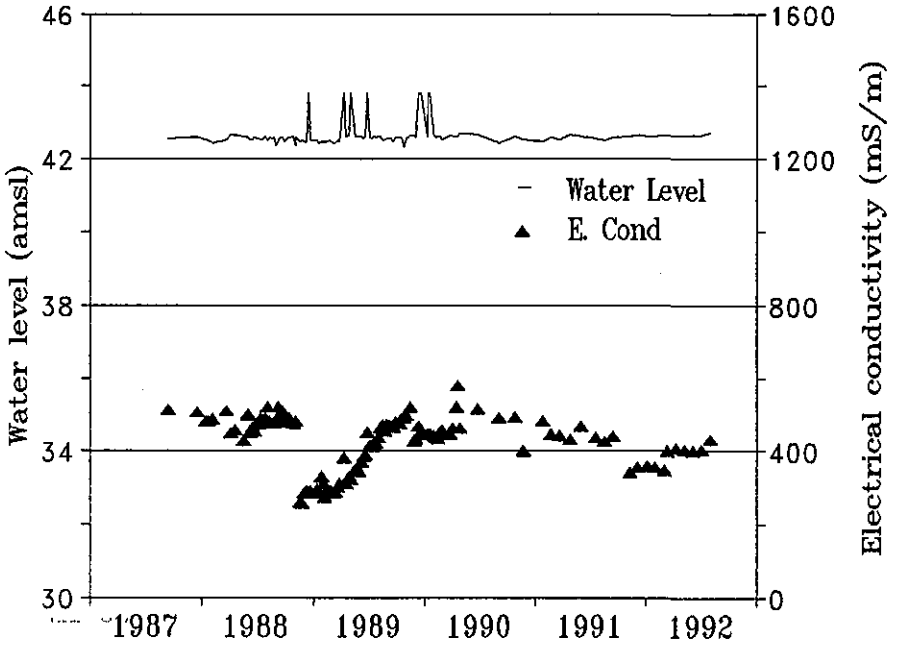

Figure 6.3 Water level and electrical conductivity of borehole CRG23

SITE NUMBER: CRG24

1. Site Information

Site Description:	Borehole on Good Hope Farm
Site Location (est.):	Lo: 25 Southings: 3708170 Eastings: -60291
Period of Data:	17/02/88 - 30/10/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	42.34	8.26	12469	1586	5116	1660	230	230	3590	32.00
Minimum	41.58	7.85	7610	1080	2532	130	90	126	2390	19.00
Mean	42.08	7.99	8653	1263	3175	1257	133	159	2731	25.00
Std. Dev.	0.12	0.16	1470	135	647	522	35	30	326	3.00

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

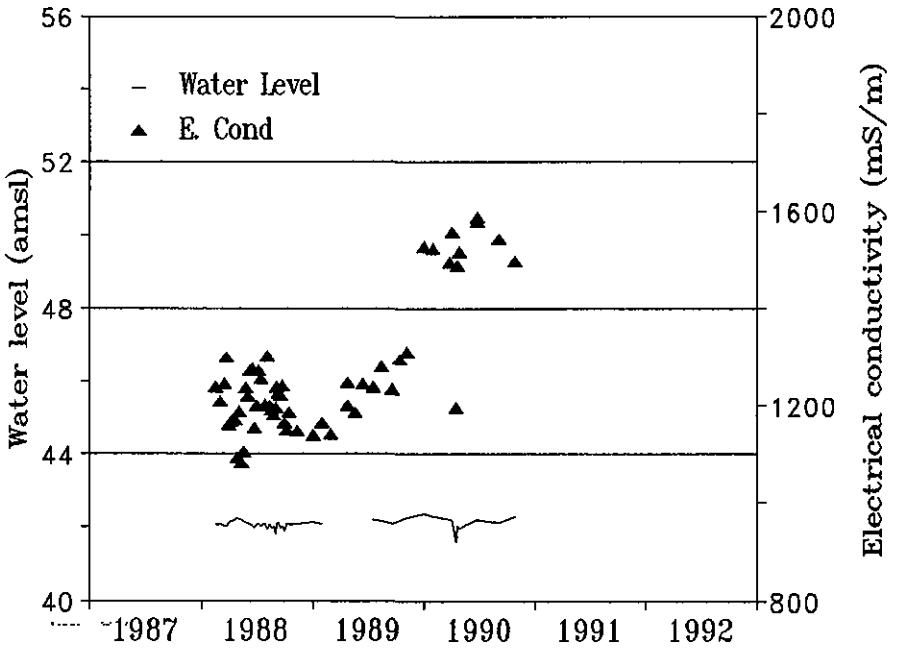

Figure 6.4 Water level and electrical conductivity of borehole CRG24

SITE NUMBER: CRG60

1. Site Information

Site Description:	Borehole on Trenley Farm
Site Location (est.):	Lo: 25 Southings: 3704923 Eastings: -58427
Period of Data:	16/04/88 - 05/08/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	65.02	-	18883	2480	9734	815	660	730	5360	170.00
Minimum	62.79	-	8035	1176	3404	55	122	171	2400	37.70
Mean	63.59	-	12850	1659	5960	493	318	364	3550	83.45
Std. Dev.	0.50	-	4490	375	1873	223	152	162	784	26.54

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

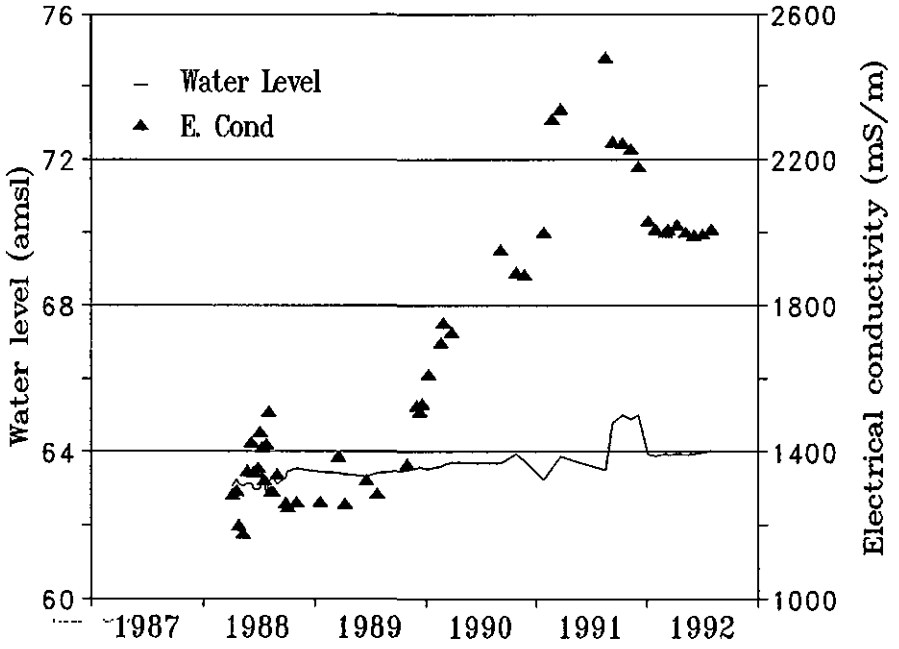

Figure 6.5 Water level and electrical conductivity of borehole CRG60

SITE NUMBER: CRG61

1. Site Information

Site Description:	Borehole on Carlton Farm
Site Location (est.):	Lo: 25 Southings: 3709194 Eastings: -60670
Period of Data:	02/03/88 - 08/01/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	34.34	-	5795	713	2301	915	165	172	1340	14.50
Minimum	33.53	-	2404	386	325	85	76	80	610	3.7
Mean	33.78	-	3605	558	1206	664	121	124	984	7.82
Std. Dev.	0.14	-	760	89	385	260	22	27	197	2.94

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

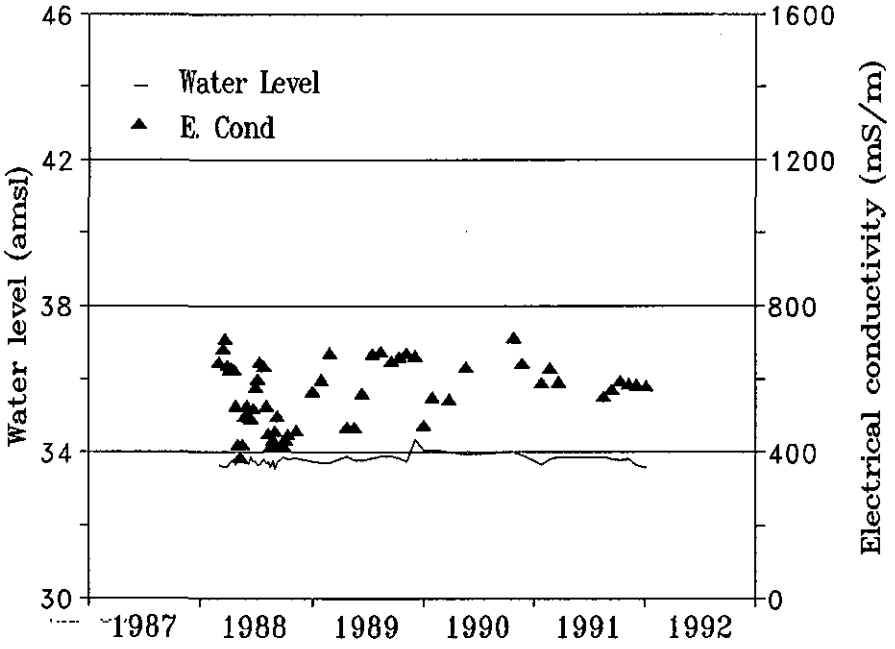

Figure 6.6 Water level and electrical conductivity of borehole CRG61

SITE NUMBER: CRG62

1. Site Information

Site Description:	Borehole on Carlton Farm
Site Location (est.):	Lo: 25 Southings: 3709285 Eastings: -60654
Period of Data:	02/03/88 - 25/05/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	34.90	-	5646	854	2532	825	249	190	1410	4.10
Minimum	33.46	-	3172	506	983	85	30	82	865	7.30
Mean	33.65	-	3476	567	1178	694	106	103	989	5.75
Std. Dev.	0.22	-	506	50	350	193	41	22	115	0.73

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

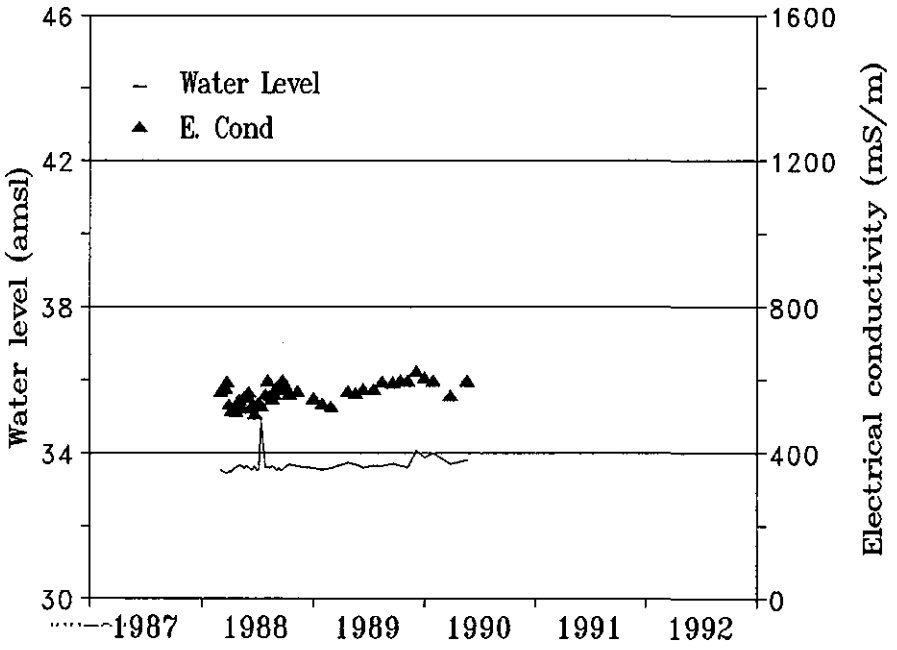

Figure 6.7 Water level and electrical conductivity of borehole CRG62

SITE NUMBER: CRG63

1. Site Information

Site Description:	Borehole on Carlton Farm
Site Location (est.):	Lo: 25 Southings: Eastings:
Period of Data:	02/03/88 - 05/06/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	34.38	8.83	4132	734	1085	520	59	133	1400	18.80
Minimum	33.13	8.83	3537	564	1594	38	12	89	1040	10.6
Mean	33.75	8.83	3879	672	1594	269	26	112	1219	13.36
Std. Dev.	0.19	0.00	145	30	196	173	10	11	91	2.47

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

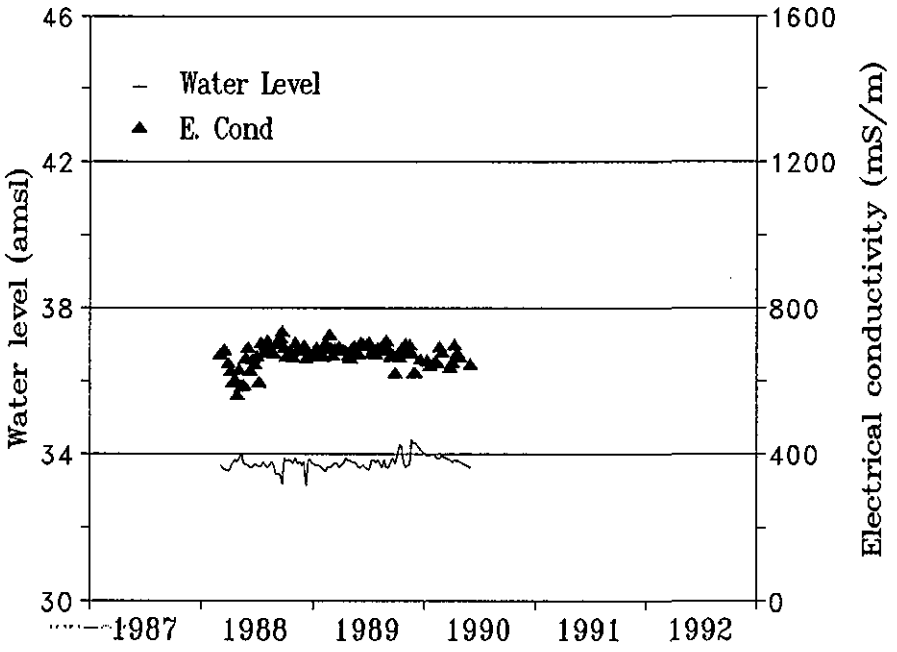

Figure 6.8 Water level and electrical conductivity of borehole CRG63

SITE NUMBER: CRG64

1. Site Information

Site Description:	Borehole on Carlton Farm
Site Location (est.):	Lo: 25 Southings: 3709026 Eastings: -60700
Period of Data:	02/03/88 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	36.86	-	17517	1989	8896	865	890	750	1500	21.00
Minimum	34.52	-	888	91	202	18	70	39	218	4.30
Mean	35.53	-	13518	1583	6020	202	651	444	2572	13.24
Std. Dev.	0.81	-	3477	510	1778	127	170	125	682	3.46

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

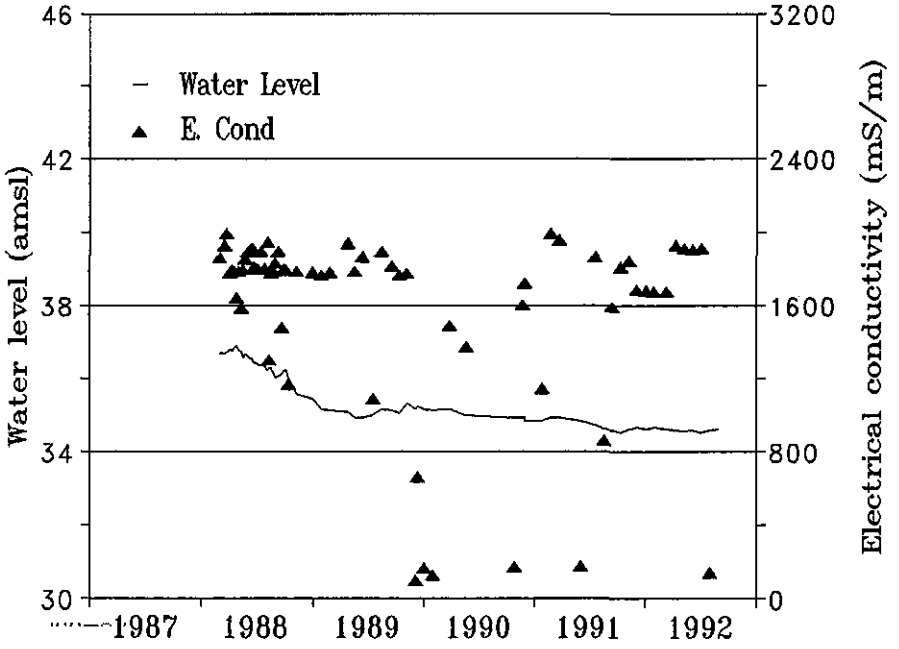

Figure 6.9 Water level and electrical conductivity of borehole CRG64

SITE NUMBER: CRG65

1. Site Information

Site Description:	Borehole on Trenley Farm
Site Location (est.):	Lo: 25 Southings: 3705235 Eastings: -60244
Period of Data:	02/03/88 - 27/11/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	57.72	8.15	1817	315	804	440	66	79	580	6.90
Minimum	55.79	7.00	1259	193	354	50	40	44	275	0.80
Mean	57.10	7.55	1442	245	469	377	51	58	396	2.25
Std. Dev.	0.29	0.47	173	30	111	84	8	8	89	1.78

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

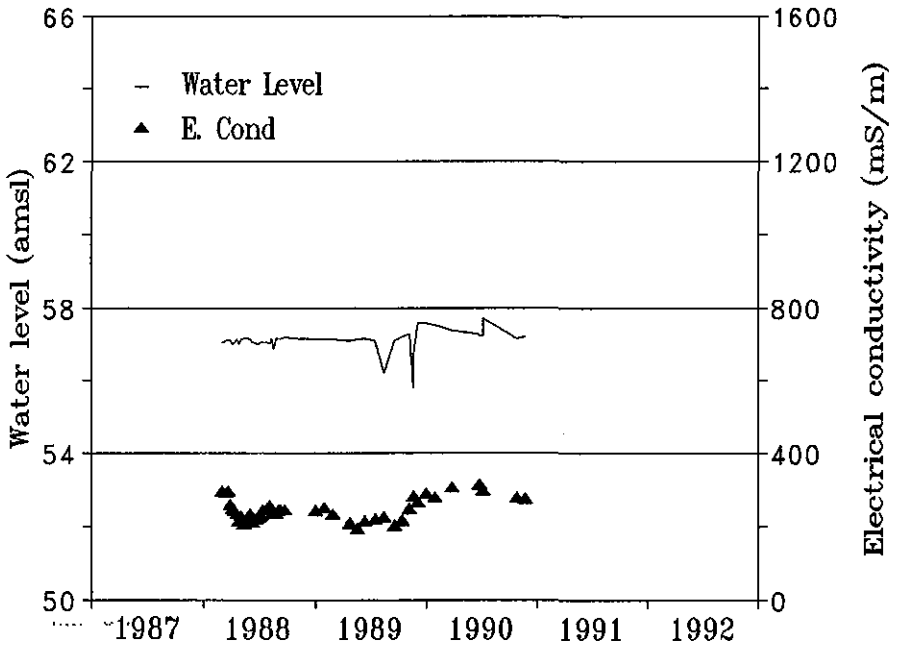

Figure 6.10 Water level and electrical conductivity of borehole CRG65

SITE NUMBER: CRG66

1. Site Information

Site Description:	Borehole on Trenley Farm
Site Location (est.):	Lo: 25 Southings: 3705287 Eastings: -60520
Period of Data:	16/03/88 - 27/11/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	58.55	-	4822	822	2215	545	91	128	1440	13.00
Minimum	55.80	-	581	102	190	26	20	12	105	1.00
Mean	56.51	-	3476	612	1439	284	67	92	1074	5.08
Std. Dev.	0.40	-	1019	138	465	204	16	28	313	3.21

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

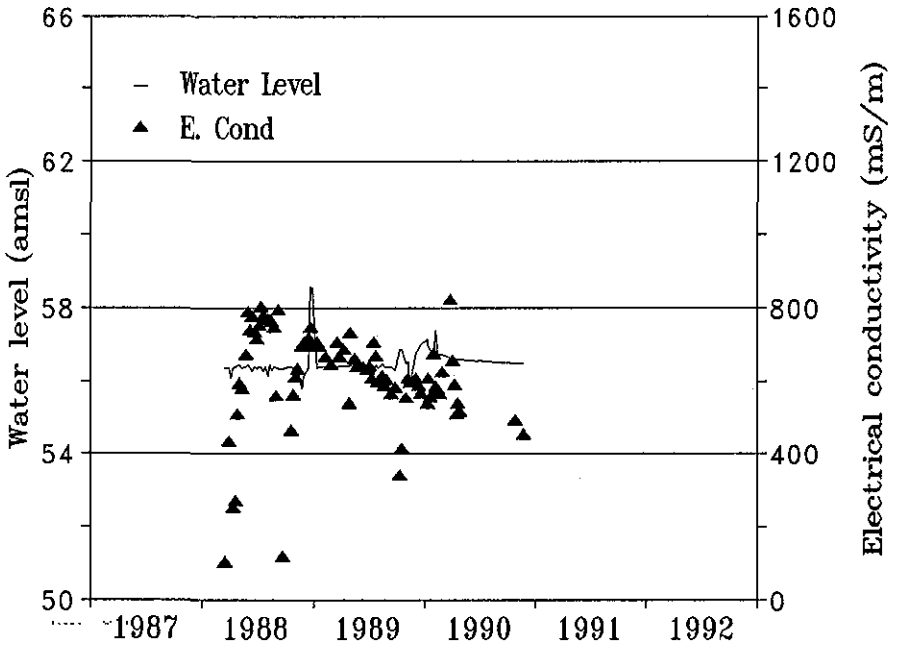

Figure 6.11 Water level and electrical conductivity of borehole CRG66

SITE NUMBER: CRG68

1. Site Information

Site Description:	Borehole on Trenley Farm
Site Location (est.):	Lo: 25 Southings: 3705575 Eastings: -59971
Period of Data:	02/03/88 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	57.83	-	9914	1483	4486	1075	304	298	2650	50.00
Minimum	56.95	-	1111	149	218	60	52	30	225	12.00
Mean	57.21	-	5297	845	1875	547	151	162	1447	29.30
Std. Dev.	0.16	-	2799	439	1342	312	82	90	747	10.12

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

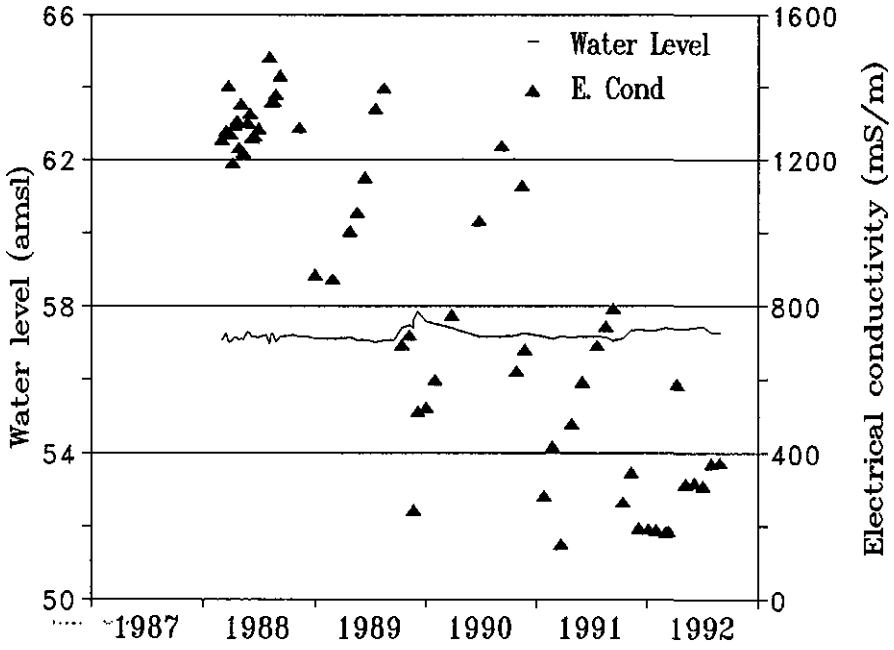

Figure 6.12 Water level and electrical conductivity of borehole CRG68

SITE NUMBER: CRG69

1. Site Information

Site Description:	Borehole on Trenley Farm
Site Location (est.):	Lo: 25 Southings: 3705572 Eastings: -60364
Period of Data:	02/03/88 - 08/01/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	56.77	-	9956	1468	5303	655	325	350	3040	89.00
Minimum	55.87	-	121	729	417	50	101	138	1290	6.00
Mean	56.29	-	7069	1239	3724	437	186	259	2347	11.00
Std. Dev.	0.16	-	3093	131	906	174	42	58	322	12.00

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

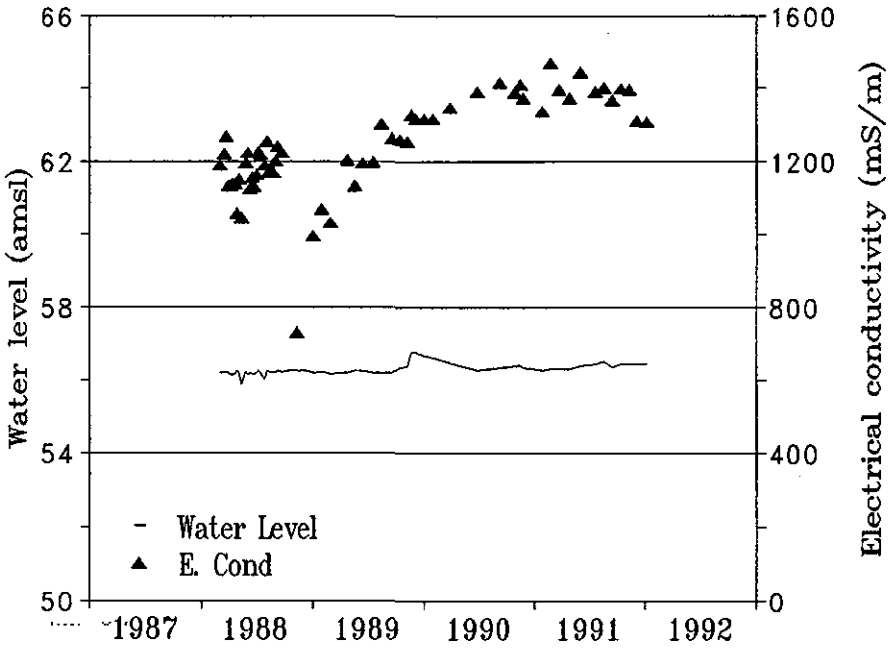

Figure 6.13 Water level and electrical conductivity of borehole CRG69

SITE NUMBER: CRG71

1. Site Information

Site Description:	Borehole on Cheltenham Farm
Site Location (est.):	Lo: 25 Southings: 3706002 Eastings: -60318
Period of Data:	02/03/88 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	52.24	-	22358	2810	12190	475	1010	1020	6990	170.00
Minimum	53.58	-	1387	57	91	5	30	10	65	10.00
Mean	53.03	-	17691	2171	8131	322	618	701	3948	23.00
Std. Dev.	0.20	-	5462	664	3080	144	230	256	1546	22.00

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

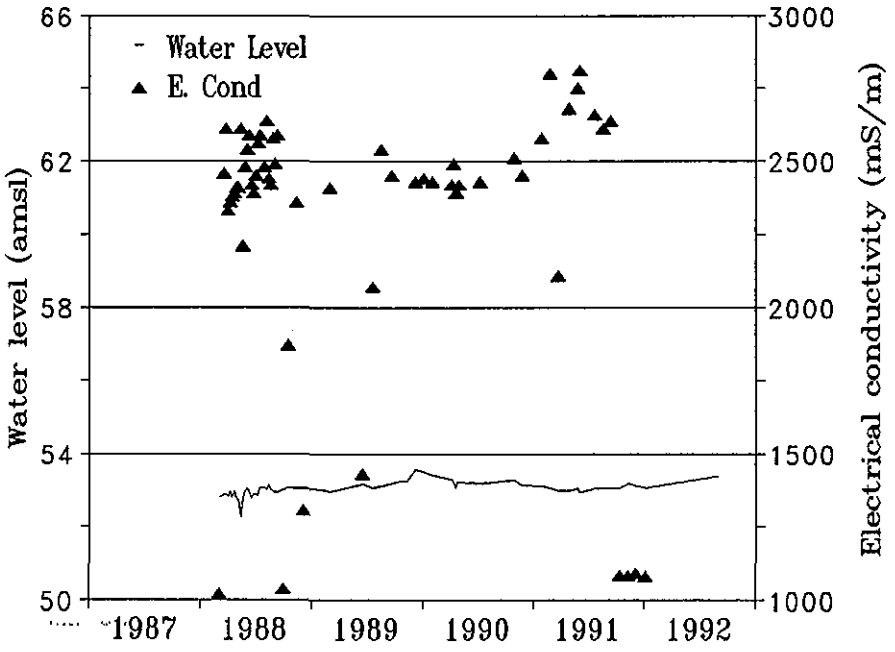

Figure 6.14 Water level and electrical conductivity of borehole CRG71

SITE NUMBER: CRG72

1. Site Information

Site Description:	Borehole on Cheltenham Farm
Site Location (est.):	Lo: 25 Southings: 3705761 Eastings: -60687
Period of Data:	02/03/88 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	54.63	-	10479	1488	6123	400	291	399	2840	34.00
Minimum	53.40	-	1629	682	2116	30	48	178	1110	8.00
Mean	43.89	-	8238	1245	4166	200	145	244	2287	17.00
Std. Dev.	0.28	-	1405	127	775	92	56	40	408	4.00

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

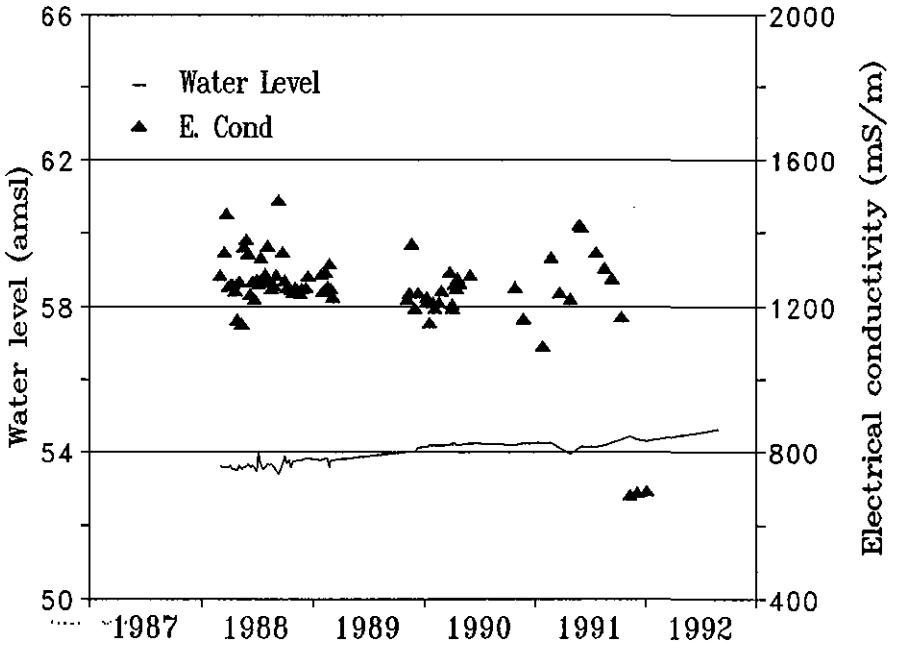

Figure 6.15 Water level and electrical conductivity of borehole CRG72

SITE NUMBER: CRG73

1. Site Information

Site Description:	Borehole on Carlton Farm
Site Location (est.):	Lo: 25 Southings: 3709134 Eastings: -60589
Period of Data:	02/03/88 - 30/10/90
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	34.43	-	9021	1106	984	1020	146	213	1994	18.00
Minimum	33.35	-	717	110	138	4	36	21	140	2.00
Mean	33.78	-	2271	339	512	549	77	77	522	8.00
Std. Dev.	0.45	-	1756	143	218	341	35	35	325	4.00

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

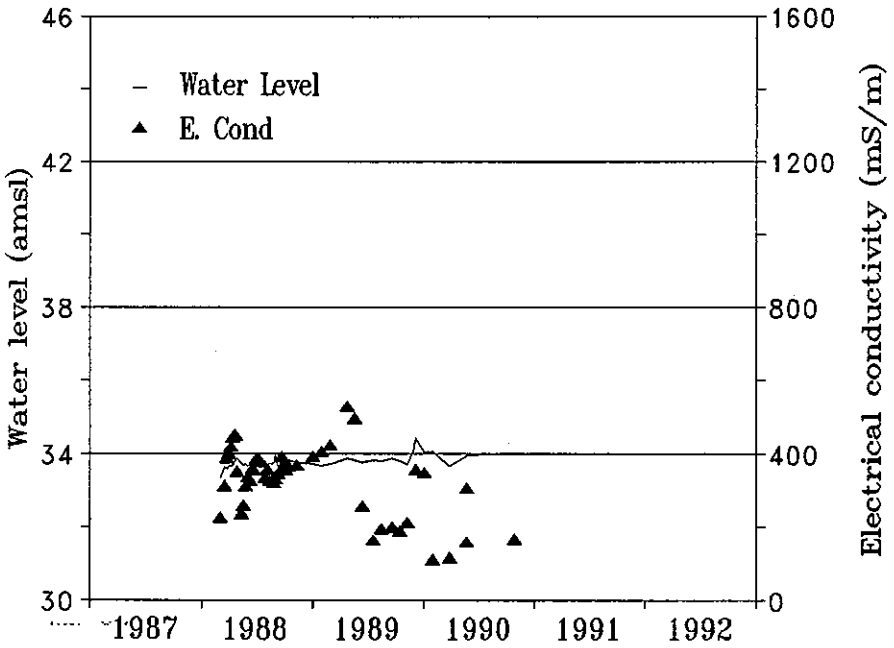

Figure 6.16 Water level and electrical conductivity of borehole CRG73

SITE NUMBER: CRG76

1. Site Information

Site Description:	Borehole on Carlton Farm
Site Location (est.):	Lo: 25 Southings: 3709131 Eastings: -60588
Period of Data:	04/05/88 - 02/05/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	33.25	-	3653	730	10057	730	96	146	1150	9.00
Minimum	32.78	-	1066	135	218	285	16	54	320	3.00
Mean	32.98	-	2535	469	1534	639	33	99	810	5.00
Std. Dev.	0.13	-	600	155	2223	117	20	23	211	2.00

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

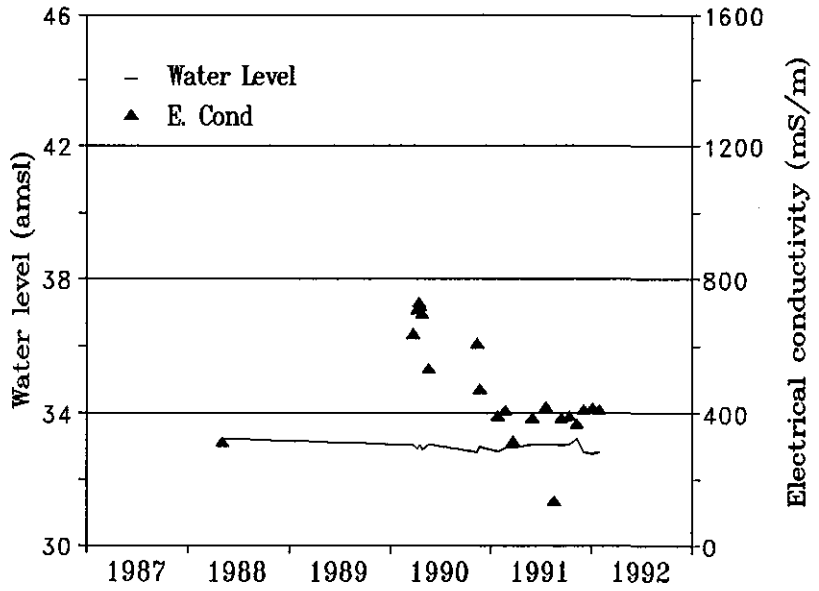

Figure 6.17 Water level and electrical conductivity of borehole CRG75

SITE NUMBER: CRG75

1. Site Information

Site Description:	Borehole on Sun Orange Farm
Site Location (est.):	Lo: 25 Southings: 3705128 Eastings: -61418
Period of Data:	22/01/88 - 08/01/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	56.80	-	7569	1729	9030	970	187	232	2530	33.00
Minimum	55.21	-	2591	442	978	50	49	63	743	3.00
Mean	55.89	-	5715	944	2537	573	103	161	1751	24.00
Std. Dev.	0.37	-	1095	147	1009	316	29	36	349	6.00

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

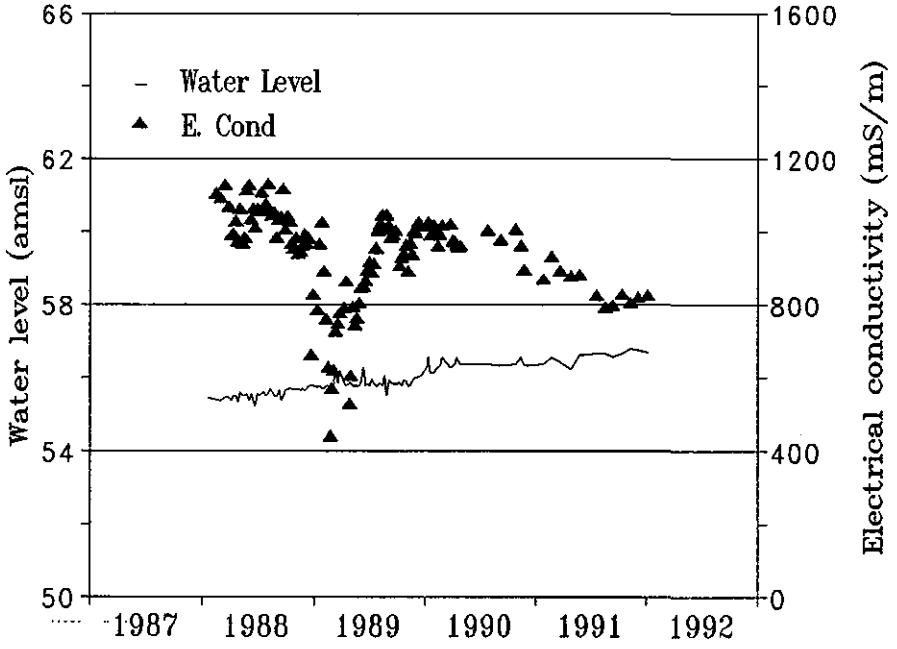

Figure 6.18 Water level and electrical conductivity of borehole CRG76

SITE NUMBER: CRG77

1. Site Information

Site Description:	Borehole on Sun Orange Farm
Site Location (est.):	Lo: 25 Southings: 3705168 Eastings: -60746
Period of Data:	22/01/88 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	55.95	-	14608	1721	6422	735	369	500	3500	17.90
Minimum	54.45	-	5459	951	2421	8	73	138	1770	1.00
Mean	54.91	-	9415	1363	4373	450	194	304	2605	6.22
Std. Dev.	0.34	-	1966	167	1086	279	57	94	421	4.18

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

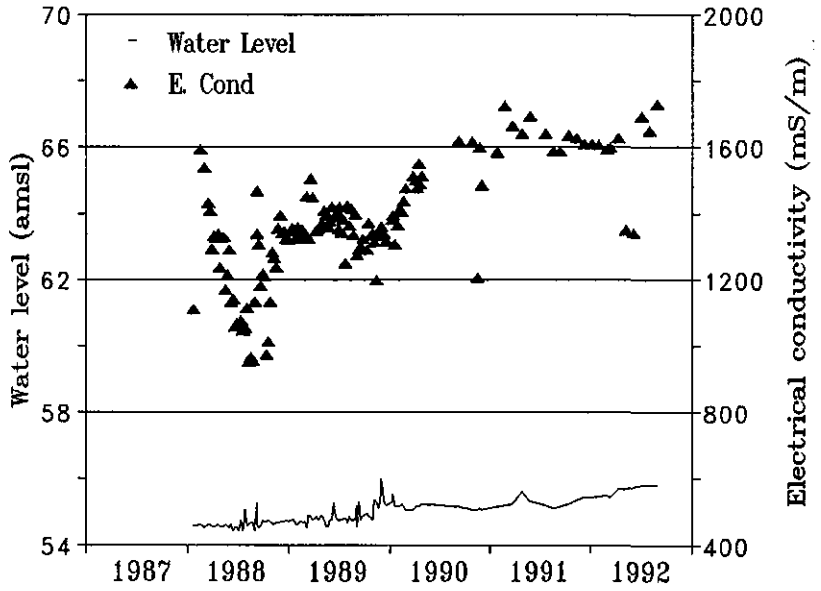

Figure 6.19 Water level and electrical conductivity of borehole CRG77

SITE NUMBER: CRG78

1. Site Information

Site Description:	Borehole on Roodedrift Farm
Site Location (est.):	Lo: 25 Southings: 3706196 Eastings: -61700
Period of Data:	10/04/90 - 08/01/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	54.39	-	6723	1044	2913	770	79	116	2460	26.00
Minimum	53.85	-	4595	734	1873	545	36	72	1680	14.00
Mean	54.09	-	5681	897	2319	685	51	92	1998	20.00
Std. Dev.	0.20	-	650	104	332	59	13	13	231	3.00

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

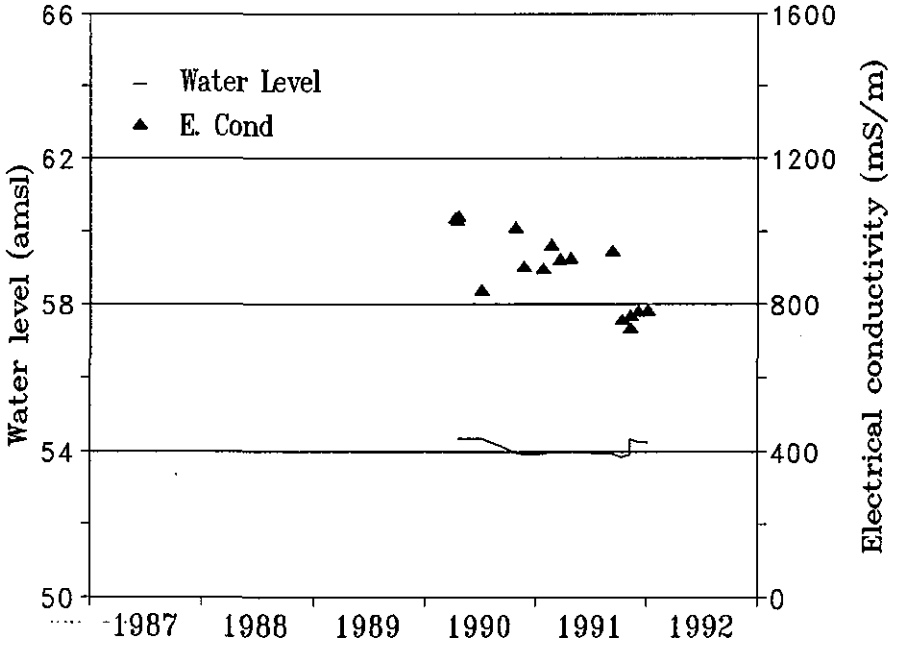

Figure 6.20 Water level and electrical conductivity of borehole CRG78

SITE NUMBER: CRG79

1. Site Information

Site Description:	Borehole on Irrigation Board Farm
Site Location (est.):	Lo: 25 Southings: 3707289 Eastings: -62169
Period of Data:	02/03/88 - 08/01/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	46.78	-	11705	1420	4975	845	243	260	3080	45.00
Minimum	44.67	-	2547	919	1808	75	60	60	1820	4.00
Mean	45.82	-	7990	1219	3319	512	117	117	2481	8.00
Std. Dev.	0.40	-	1349	113	592	292	33	33	276	5.00

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

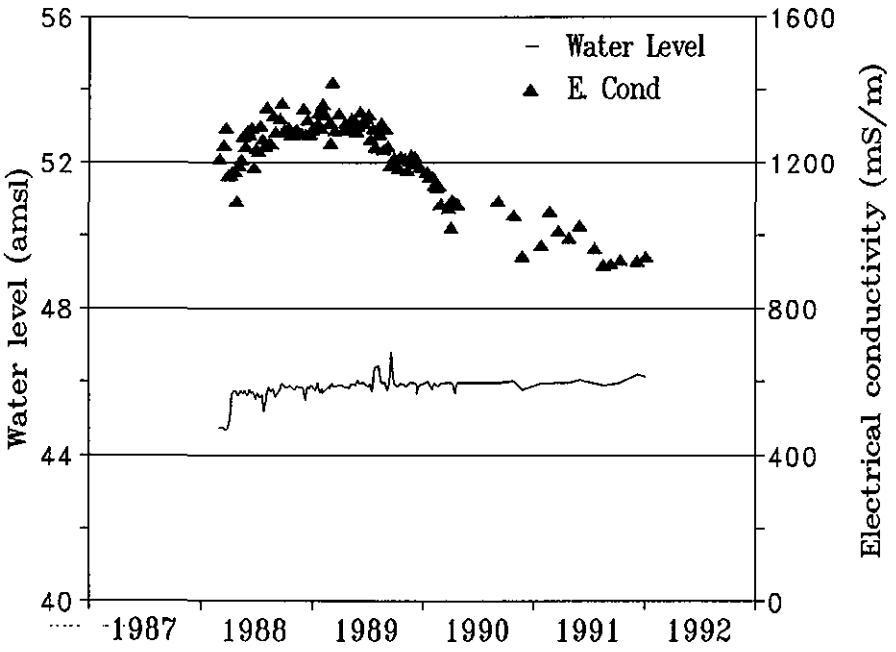

Figure 6.21 Water level and electrical conductivity of borehole CRG79

SITE NUMBER: CRG80

1. Site Information

Site Description:	Borehole on Irrigation Board Farm
Site Location (est.):	Lo: 25 Southings: 3707420 Eastings: -60982
Period of Data:	02/03/88 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	45.82	-	7499	1080	4879	740	196	220	2250	19.00
Minimum	43.91	-	667	155	155	15	27	20	109	8.00
Mean	44.29	-	5600	901	2434	531	132	170	1604	14.99
Std. Dev.	0.11	-	1398	165	658	269	32	42	435	2.01

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

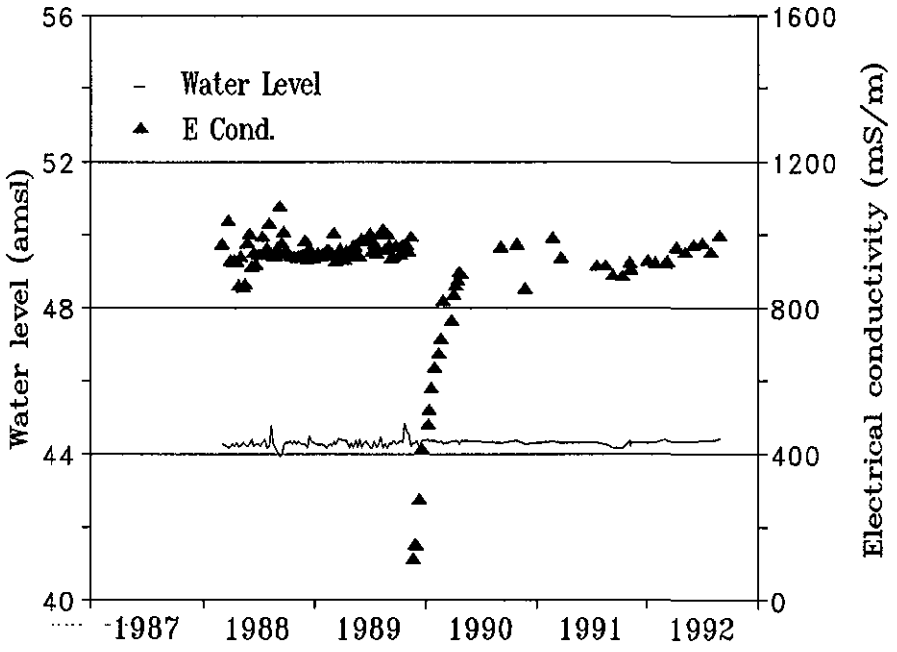

Figure 6.22 Water level and electrical conductivity of borehole CRG80

SITE NUMBER: CRG81

1. Site Information

Site Description:	Borehole on Dr Bunton's Farm
Site Location (est.):	Lo: 25 Southings: 3700805 Eastings: -62556
Period of Data:	16/05/90 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	73.27	-	23204	2770	11069	-	930	1040	5470	8.50
Minimum	72.66	-	17113	2210	7090	-	410	480	3620	3.00
Mean	72.89	-	20353	2466	9464	-	663	763	4189	4.65
Std. Dev.	0.17	-	1774	153	1250	-	156	175	508	1.53

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

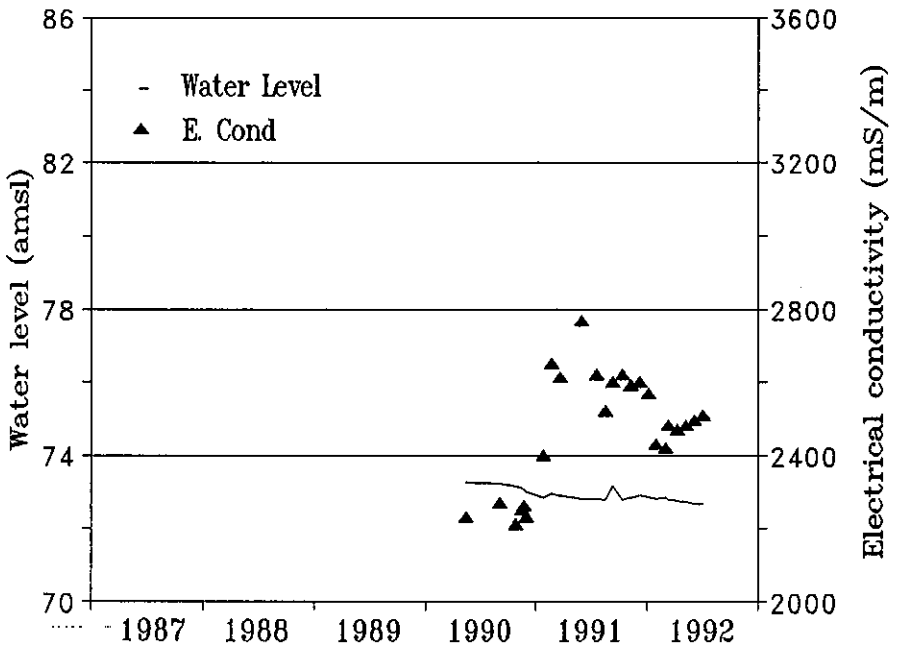

Figure 6.23 Water level and electrical conductivity of borehole CRG81

SITE NUMBER: CRG82

1. Site Information

Site Description:	Borehole on Disco Farm
Site Location (est.):	Lo: 25 Southings: 3703178 Eastings: -60923
Period of Data:	31/10/90 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	62.81	-	14686	1980	8145	470	580	610	3600	13.00
Minimum	62.32	-	12460	1645	5149	350	290	403	2890	3.00
Mean	62.53	-	13725	1816	6755	422	393	467	3310	8.57
Std. Dev.	0.11	-	695	88	807	36	93	48	210	3.17

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

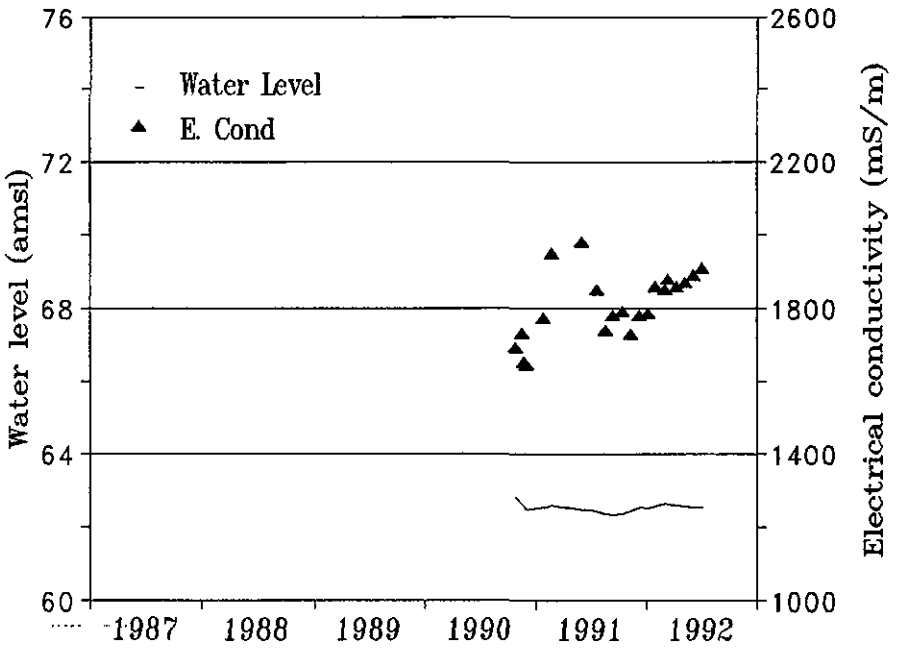

Figure 6.24 Water level and electrical conductivity of borehole CRG82

SITE NUMBER: CRG83

1. Site Information

Site Description:	Borehole on Dr Bunton's Farm
Site Location (est.):	Lo: 25 Southings: 3705756 Eastings: -62961
Period of Data:	01/10/90 - 29/01/91
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	73.58	-	6373	985	2994	930	179	201	2090	24.9
Minimum	73.29	-	6250	900	2562	710	102	130	1770	14.5
Mean	73.43	-	6312	943	2778	820	141	166	1930	19.7
Std. Dev.	0.12	-	62	43	216	110	39	36	160	5.2

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

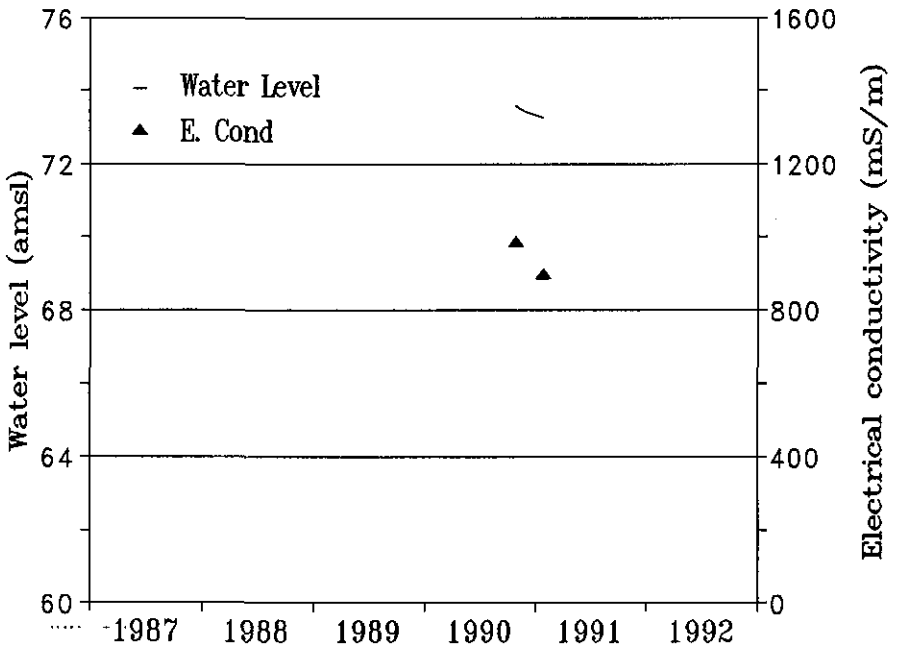

Figure 6.25 Water level and electrical conductivity of borehole CRG83

SITE NUMBER: CRG84

1. Site Information

Site Description:	Borehole on Dr Bunton's Farm
Site Location (est.):	Lo: 25 Southings: 3704881 Eastings: -62624
Period of Data:	06/09/90 - 08/07/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	69.19	-	30905	3870	15092	400	720	990	9300	59.00
Minimum	68.98	-	28676	3170	13901	365	480	800	6300	42.00
Mean	69.06	-	30364	3473	14628	383	627	883	7782	47.43
Std. Dev.	0.05	-	746	234	439	18	82	64	1061	5.92

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

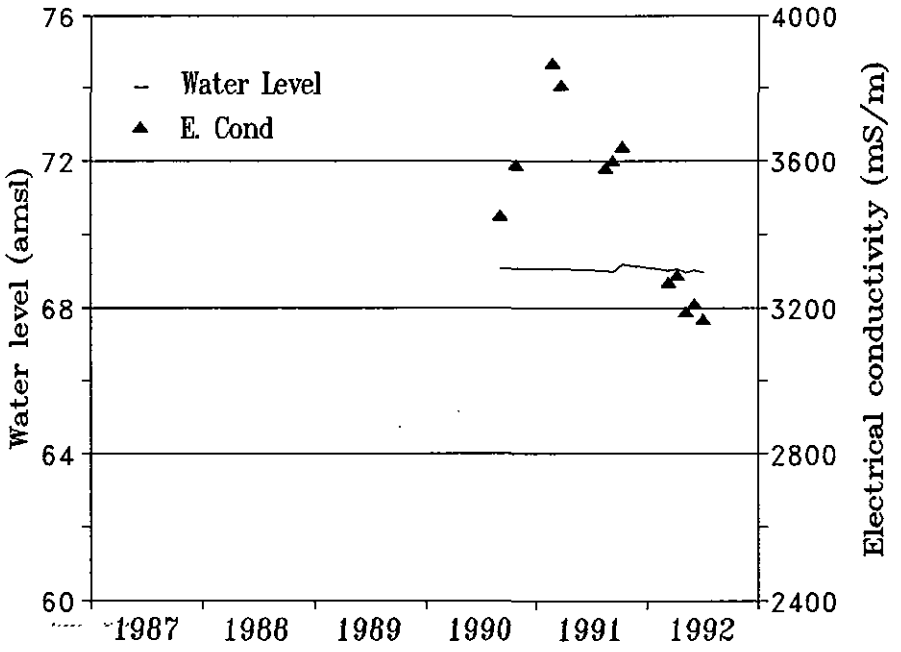

Figure 6.26 Water level and electrical conductivity of borehole CRG84

SITE NUMBER: CRG85

1. Site Information

Site Description:	Borehole on Trenley Farm
Site Location (est.):	Lo: 25 Southings: 3705967 Eastings: -59100
Period of Data:	17/09/90 - 08/01/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	61.77	-	2094	275	549	490	52	60	780	40.00
Minimum	61.57	-	1896	236	371	355	40	35	402	3.00
Mean	61.65	-	1992	263	456	439	46	48	628	17.00
Std. Dev.	0.08	-	81	14	73	49	4	9	135	17.00

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

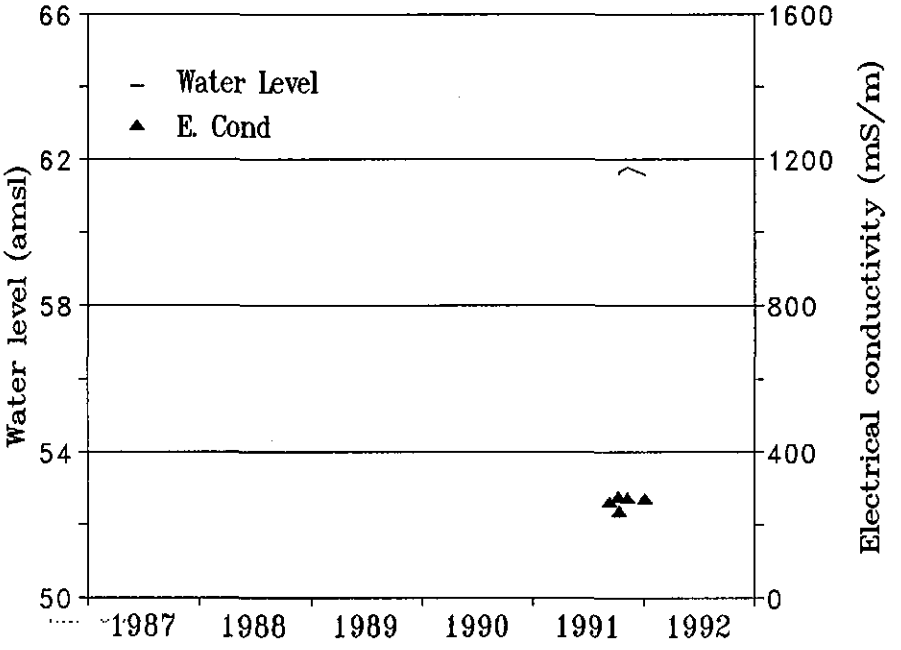

Figure 6.27 Water level and electrical conductivity of borehole CRG85

SITE NUMBER: CRG87

1. Site Information

Site Description:	Borehole on Sunland Farm
Site Location (est.):	Lo: 25 Southings: 3707735 Eastings: -58312
Period of Data:	29/05/90 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	45.14	-	4268	583	1307	895	82	110	1220	13.00
Minimum	44.81	-	2836	471	931	340	42	75	868	8.00
Mean	45.05	-	3593	546	1162	824	62	99	1094	10.88
Std. Dev.	0.08	-	317	31	94	148	9	9	78	1.49

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

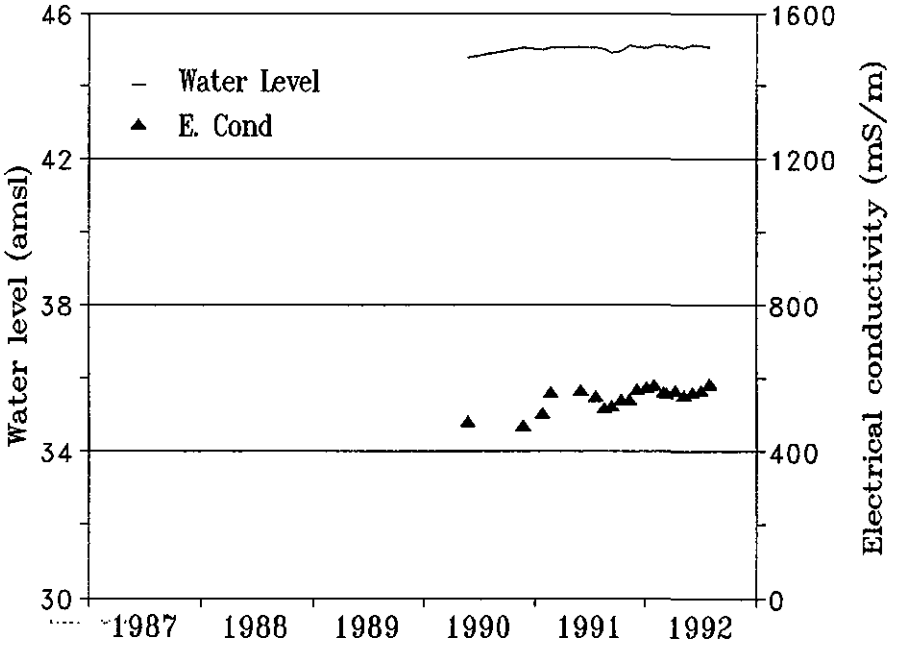

Figure 6.28 Water level and electrical conductivity of borehole CRG87

SITE NUMBER: CRG90

1. Site Information

Site Description:	Borehole on Kondoa Farm
Site Location (est.):	Lo: 25 Southings: 3708295 Eastings: -61771
Period of Data:	30/10/90 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	42.25	-	9132	1185	3722	845	292	319	2640	12.00
Minimum	41.57	-	2792	413	1007	323	80	107	780	3.00
Mean	42.01	-	5941	872	2411	739	133	173	1824	5.65
Std. Dev.	0.17	-	1591	202	747	131	52	52	494	2.27

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

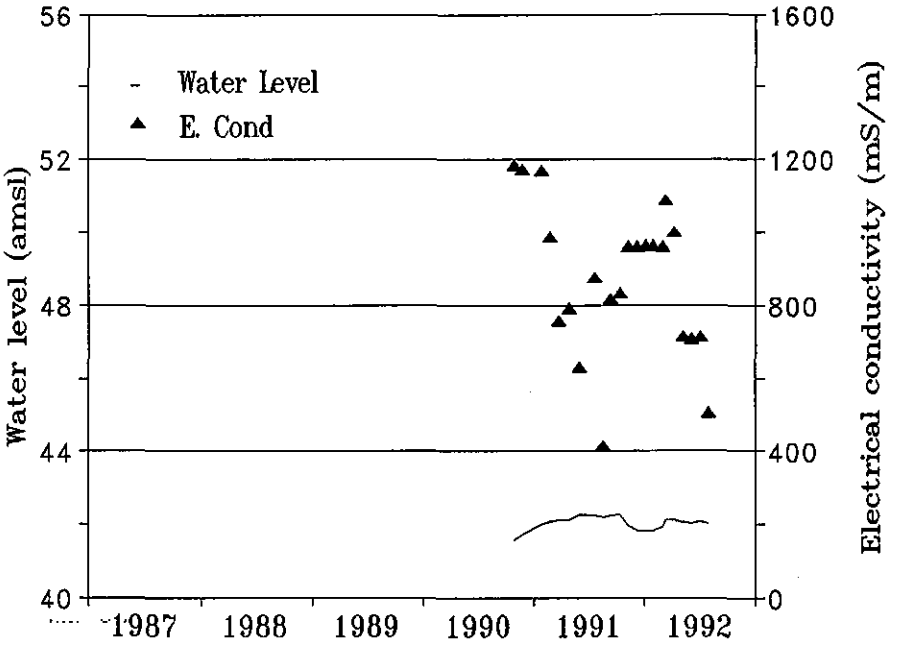

Figure 6.29 Water level and electrical conductivity of borehole CRG90

SITE NUMBER: CRG91

1. Site Information

Site Description:	Borehole on Pennyhome Farm
Site Location (est.):	Lo: 25 Southings: 3708434 Eastings: -62924
Period of Data:	19/06/90 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	45.33	-	3444	398	804	690	50	50	900	26.40
Minimum	44.45	-	2258	261	503	610	14	28	760	4.60
Mean	44.89	-	2455	350	628	651	27	35	827	9.76
Std. Dev.	0.31	-	290	26	69	18	9	6	45	4.97

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

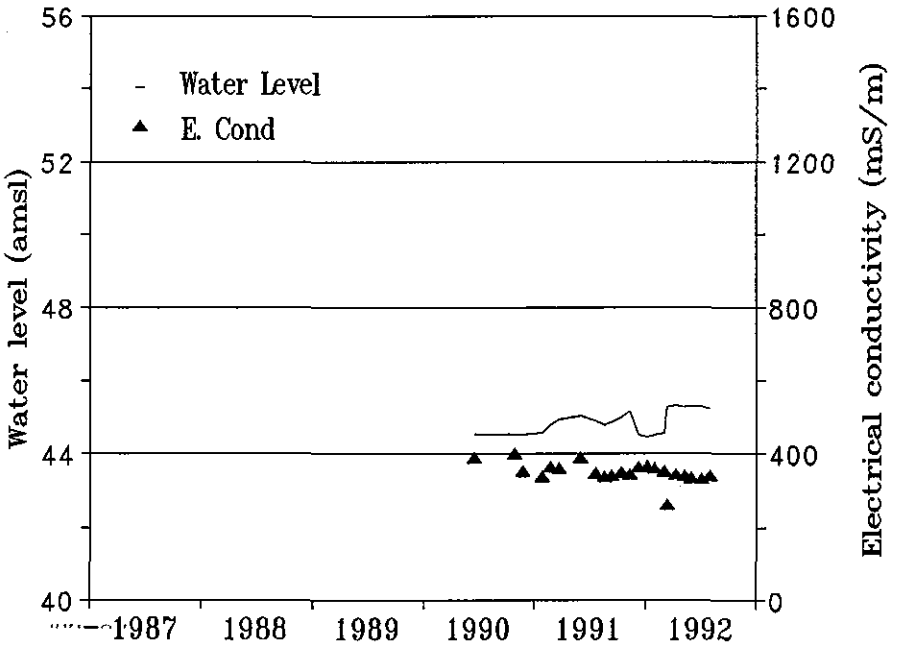

Figure 6.30 Water level and electrical conductivity of borehole CRG91

SITE NUMBER: CRG92

1. Site Information

Site Description:	Borehole on Oakfield Farm
Site Location (est.):	Lo: 25 Southings: 3708853 Eastings: -59415
Period of Data:	31/10/90 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	36.47	-	3233	415	836	715	58	69	890	3.30
Minimum	36.17	-	2261	333	579	645	25	42	610	1.00
Mean	36.27	-	2523	381	707	678	41	55	785	2.40
Std. Dev.	0.08	-	286	23	73	23	8	9	76	0.65

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

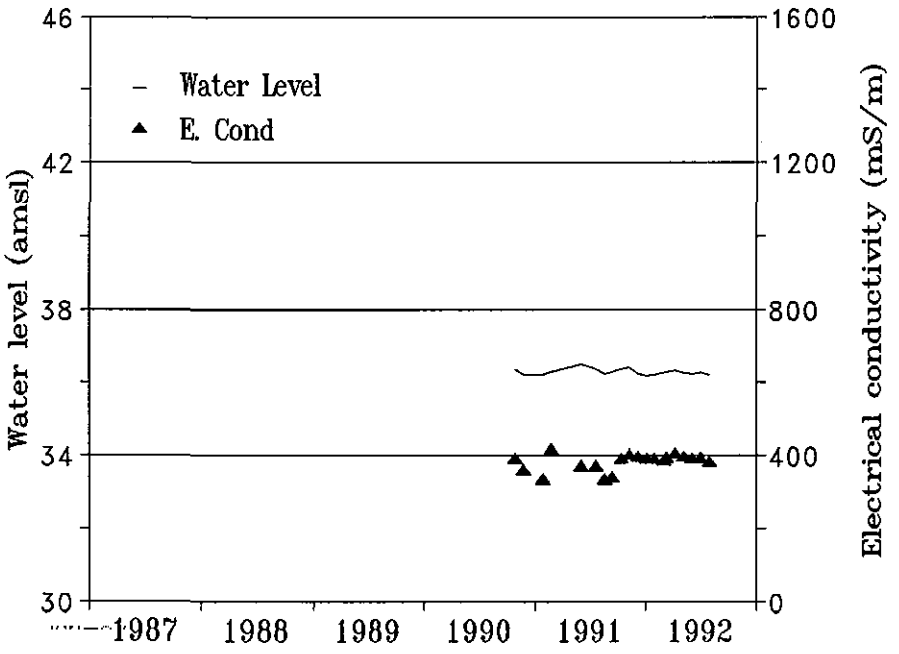

Figure 6.31 Water level and electrical conductivity of borehole CRG92

SITE NUMBER: CRG93

1. Site Information

Site Description:	Borehole on Disco Farm
Site Location (est.):	Lo: 25 Southings: 3703105 Eastings: -60580
Period of Data:	20/11/90 - 08/01/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	70.97	-	1120	188	417	320	30	50	450	7.00
Minimum	68.97	-	136	90	181	105	8	6	170	1.00
Mean	68.95	-	603	147	279	249	15	14	338	2.09
Std. Dev.	0.60	-	387	36	73	83	6	11	105	1.50

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

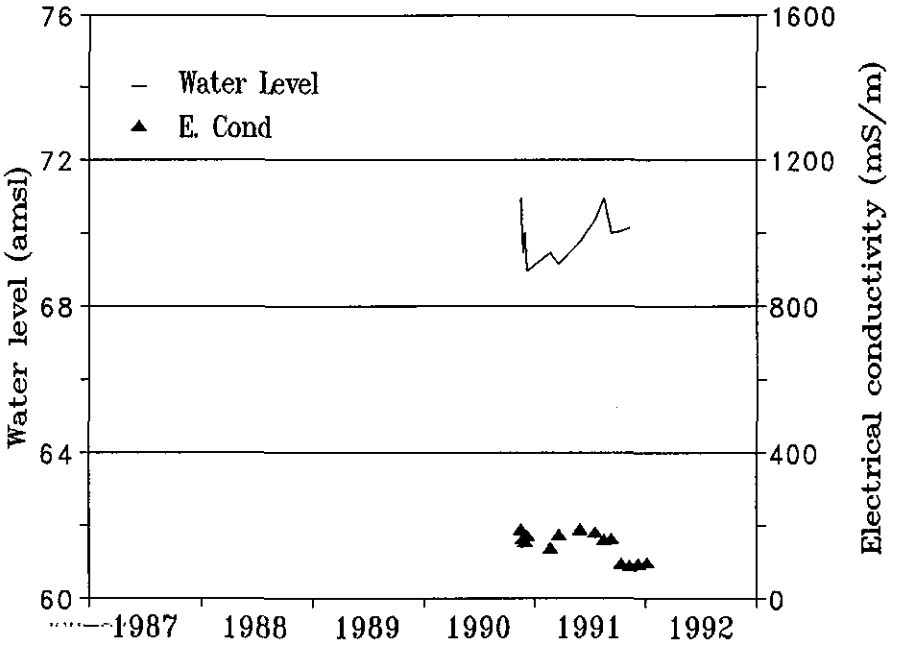

Figure 6.32 Water level and electrical conductivity of borehole CRG93

SITE NUMBER: DDG01

1. Site Information

Site Description:	Borehole on Daisy Dell Farm
Site Location (est.):	Orchard M on Daisy Dell Farm
Period of Data:	25/09/90 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	48.60	-	5088	692	1825	840	92	134	1530	18.10
Minimum	47.36	-	2156	443	1077	400	25	80	1080	7.20
Mean	47.88	-	3830	614	1579	557	58	102	1264	10.44
Std. Dev.	0.16	-	433	46	152	81	14	12	116	2.32

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

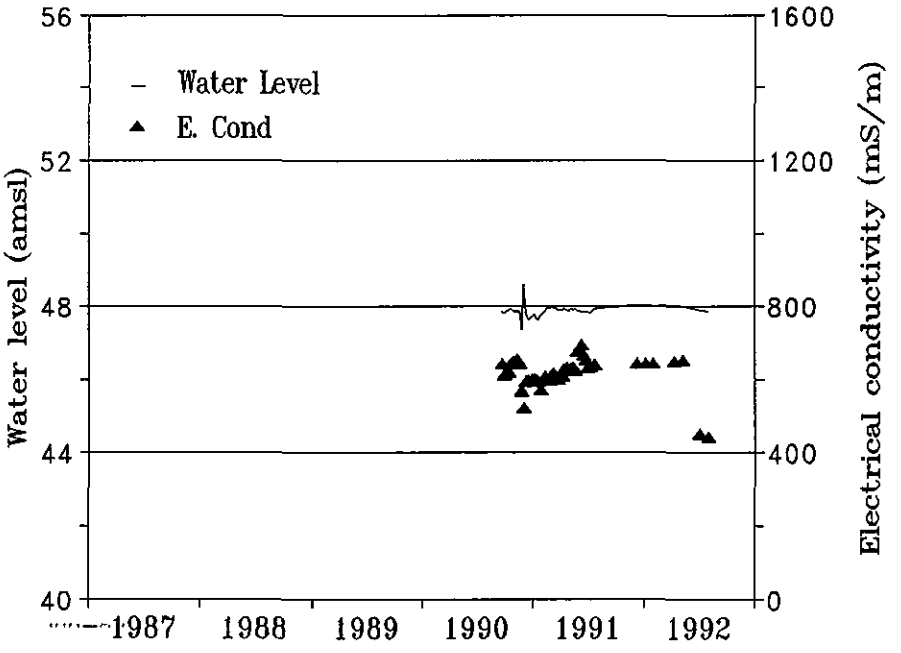

Figure 6.33 Water level and electrical conductivity of borehole DDG01

SITE NUMBER: DDG02

1. Site Information

Site Description:	Borehole on Daisy Dell Farm
Site Location (est.):	Orchard M on Daisy Dell Farm
Period of Data:	06/09/90 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	47.72	-	5831	708	1939	980	146	142	1610	18.30
Minimum	47.31	-	3614	488	1216	510	31	88	1090	4.00
Mean	47.57	-	4023	624	1618	600	64	103	1288	8.47
Std. Dev.	0.09	-	440	42	166	80	17	12	121	2.69

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

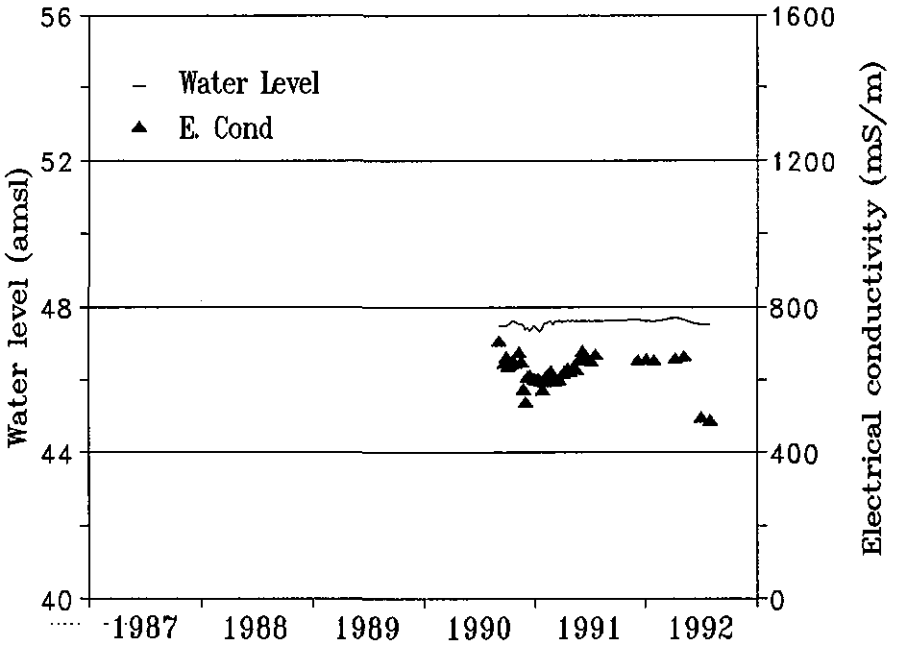

Figure 6.34 Water level and electrical conductivity of borehole DDG02

SITE NUMBER: DDG03

1. Site Information

Site Description:	Borehole on Daisy Dell Farm
Site Location (est.):	Orchard M on Daisy Dell Farm
Period of Data:	06/09/90 - 08/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	*Water level and water quality samples collected manually*

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	47.58	-	5662	782	2070	745	119	150	1630	13.70
Minimum	47.20	-	2805	615	1555	560	36	105	1170	3.10
Mean	47.48	-	4459	696	1767	640	72	127	1432	7.67
Std. Dev.	0.10	-	467	29	92	50	16	10	110	2.05

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

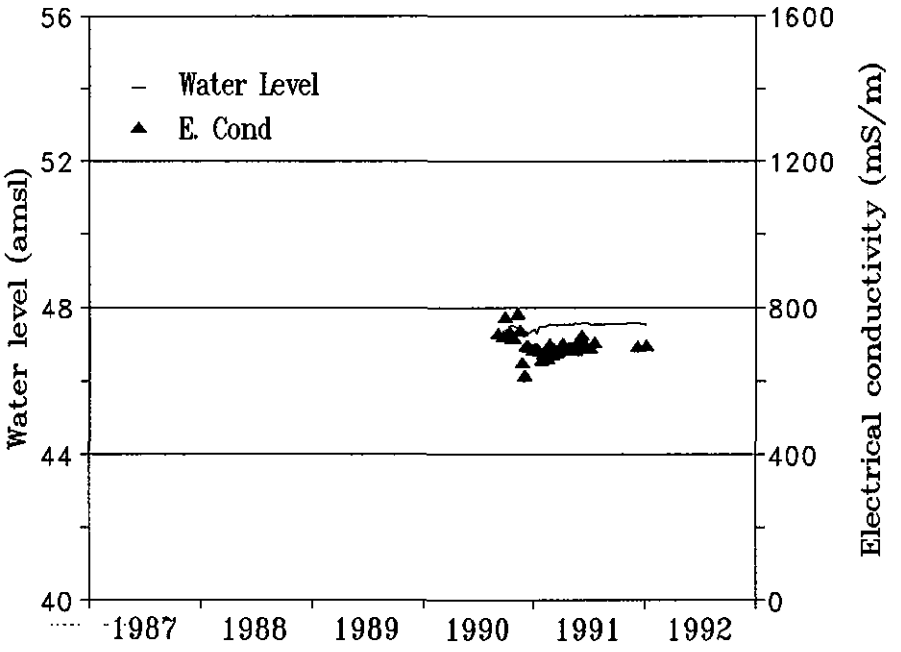

Figure 6.35 Water level and electrical conductivity of borehole DDG03

SITE NUMBER: DDG04

1. Site Information

Site Description:	Borehole on Daisy Dell Farm
Site Location (est.):	Orchard M on Daisy Dell Farm
Period of Data:	12/11/90 - 08/01/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	52.81	-	5110	651	1836	595	65	115	1495	7.00
Minimum	52.80	-	4441	646	1820	594	60	109	1490	6.00
Mean	52.80	-	4776	649	1828	594	63	112	1493	6.50
Std. Dev.	0.00	-	335	3	8	1	3	3	3	0.50

(Units: EC - mS/m, WL - metres above sea level, all other parameters mg/l)

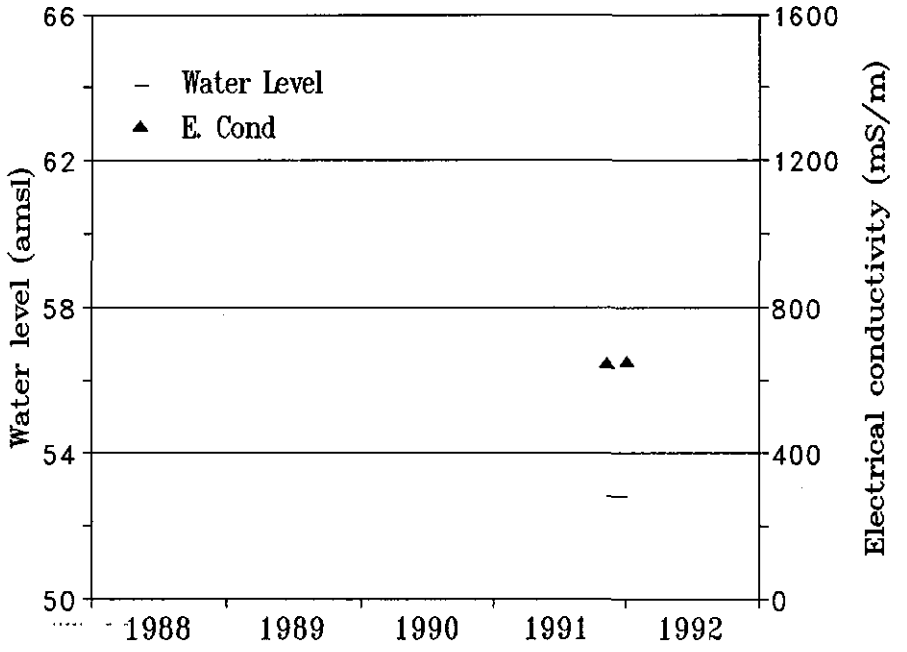

Figure 6.36 Water level and electrical conductivity of borehole DDG04

SITE NUMBER: DDG06

1. Site Information

Site Description:	Borehole on Daisy Dell Farm
Site Location (est.):	Orchard M on Daisy Dell Farm
Period of Data:	02/10/90 - 01/09/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	47.39	-	4885	733	1895	695	99	134	1620	15.00
Minimum	47.06	-	3761	478	1062	555	40	94	1120	7.40
Mean	47.28	-	4141	648	1636	600	77	111	1338	10.86
Std. Dev.	0.07	-	243	51	167	34	14	11	125	2.02

(Unit EC - mS/m, WL - metres above sea level, all other parameters mg/l)

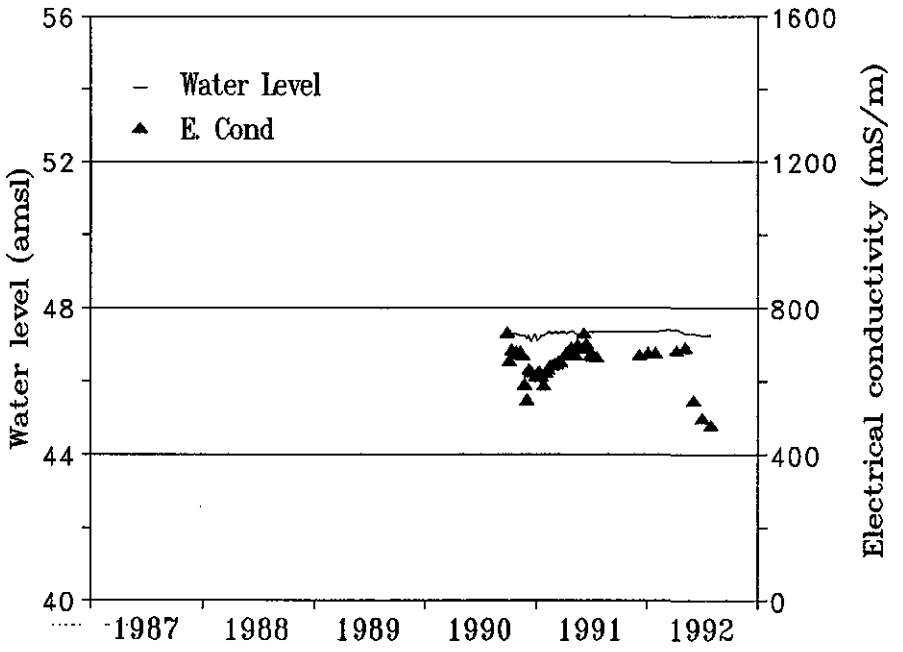

Figure 6.37 Water level and electrical conductivity of borehole DDG06

SITE NUMBER: DDG07

1. Site Information

Site Description:	Borehole on Daisy Dell Farm
Site Location (est.):	Orchard D on Daisy Dell Farm
Period of Data:	23/10/90 - 08/01/92
Data Type:	Water level and water quality
Data Interval:	Monthly
Method of Measurement:	Water level and water quality samples collected manually

2. Summary of water quality parameters

	WL	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	50.39	-	21057	1645	5754	1705	313	385	3470	38.50
Minimum	49.74	-	3425	501	1583	290	100	103	910	3.00
Mean	49.99	-	9854	1358	4372	741	215	309	2726	9.95
Std. Dev.	0.15	-	2534	195	790	280	42	54	432	7.52

(Unit EC - mS/m, WL - metres above sea level, all other parameters mg/l)

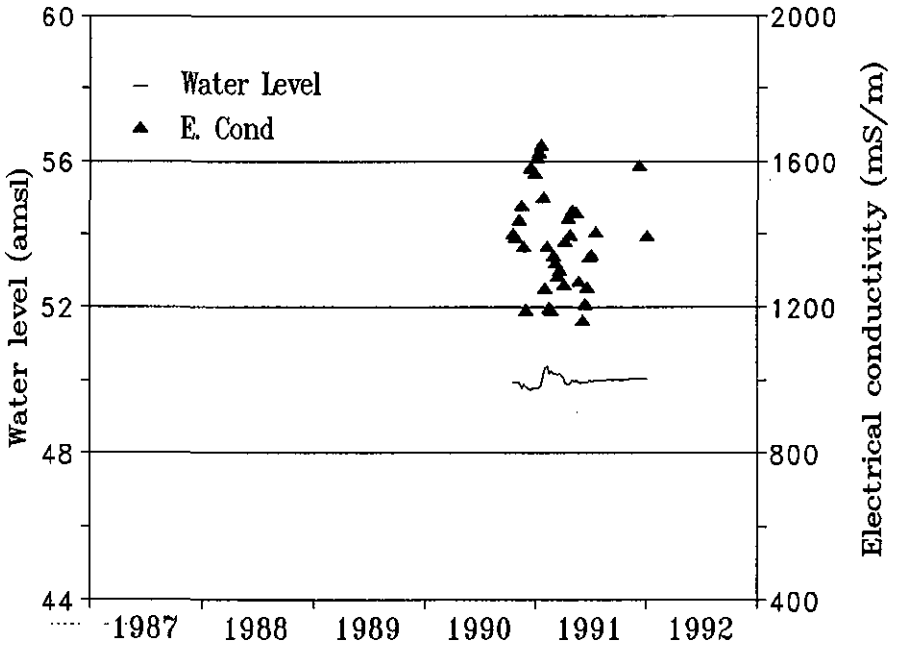

Figure 6.38 Water level and electrical conductivity of borehole DDG07

7. LOWER COERNEY RIVER: SURFACE WATER DATA

To monitor discharge and water quality of the Coerney River, three crump weirs (CRQ03, CRQ08 and CRQ11) were built by the Department of Water Affairs and Forestry.

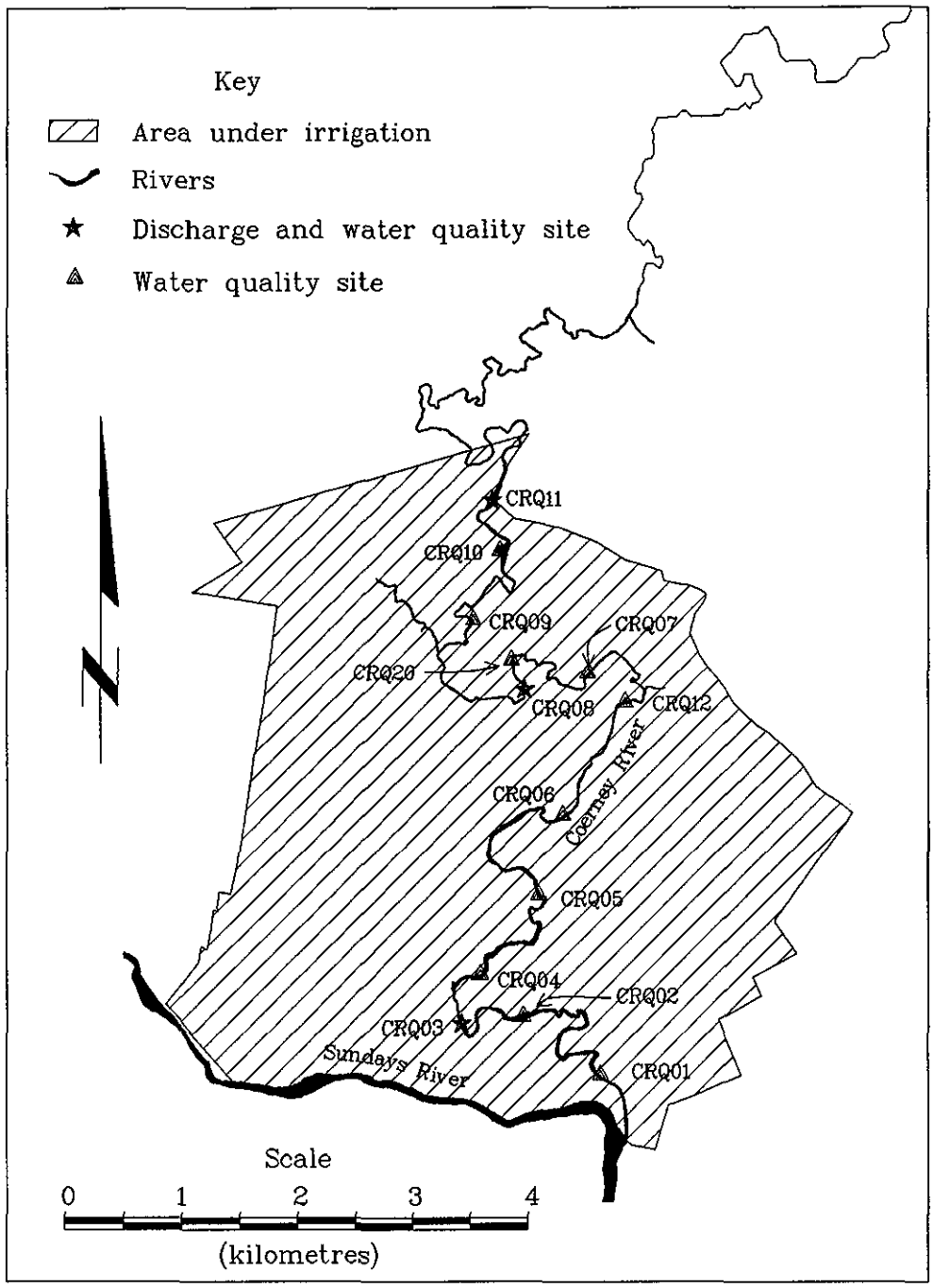

Figure 7.1 Location of surface water monitoring sites in the lower Coerney valley.

At these sites water level is recorded continuously using Ott chart recorders and water samples are collected on a daily basis using ISCO automatic pump samplers. Water samples were also collected manually at a further 12 sites to obtain more detailed information on the downstream salinity profile of the river. The location and elevation of these sites were surveyed by the Department of Water Affairs and Forestry. It should be noted that during the study period the Coerney River at CRQ11 has experienced flow only during the storm event of November 1989. Unfortunately the recorder at this site failed during the first three days of this event, a period when it was impossible to service the site due to high flood waters. The period of recession flow monitored is available but has not been included in the following data summary.

SITE NUMBER: SNC10

1. Site Information

Site Description:	Lower Sundays River Irrigation Board main canal
Site Location (est.):	Lo: 25 Southings: 3705187 Eastings: -61537
Period of Data:	19/03/88 - 18/08/92
Data Type:	Water quality
Data Interval:	Weekly
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.61	1221	175	322	520	90	71	390	7.00
Minimum	-	7.03	592	76	108	20	30	27	114	2.00
Mean	-	7.84	842	110	163	239	46	40	210	4.32
Std. Dev.	-	0.56	170	11	29	70	10	9	57	1.08

(Units: EC - mS/m, all other parameters mg/l)

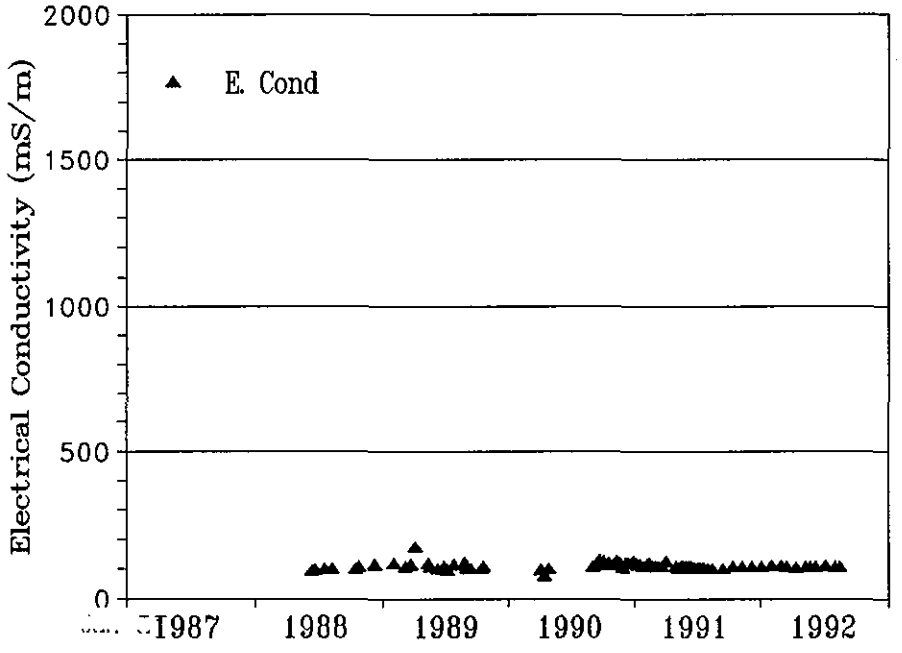

Figure 7.2 Electrical conductivity of irrigation water at SNC10

SITE NUMBER: CRQ01

1. Site Information

Site Description:	Coerney River; at road bridge
Site Location (est.):	Lo: 25 Southings: 3709814 Eastings: -61430
Period of Data:	21/07/87 - 21/03/92
Data Type:	Water quality
Data Interval:	Weekly
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.40	5720	861	2406	790	150	161	1750	11.40
Minimum	-	7.00	965	166	399	8	30	39	224	5.00
Mean	-	7.80	4319	738	1711	577	87	128	1328	8.70
Std. Dev.	-	0.20	655	84	312	244	23	18	251	1.40

(Units: EC - mS/m, all other parameters mg/l)

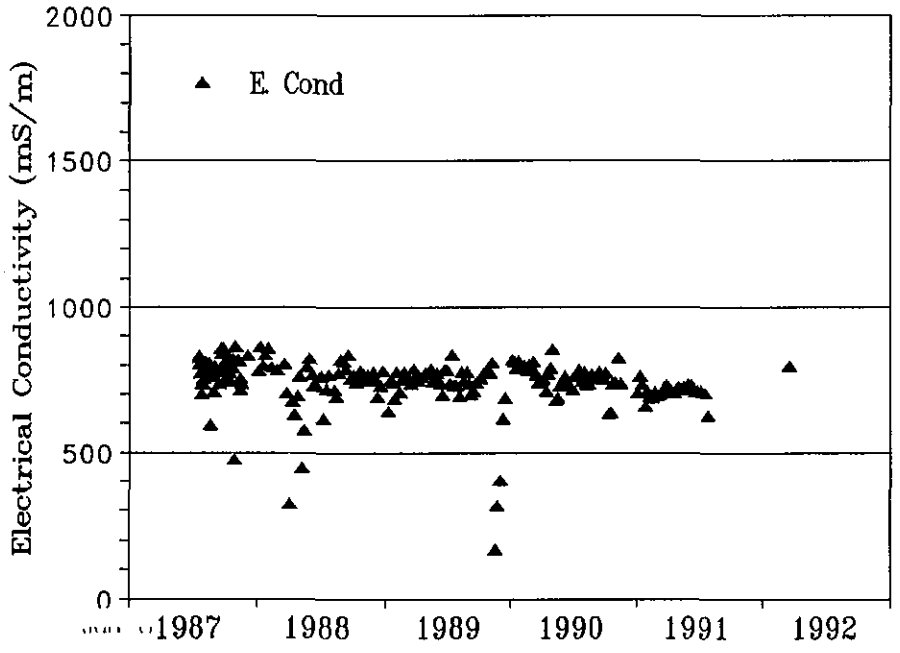

Figure 7.3 Electrical conductivity of Coerney River at CRQ01

SITE NUMBER: CRQ02

1. Site Information

Site Description:	Coerney River; at drift
Site Location (est.):	Lo: 25 Southings: 3709313 Eastings: -60755
Period of Data:	21/02/87 - 21/03/92
Data Type:	Water quality
Data Interval:	Weekly
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	-	5467	878	2276	780	144	214	1900	13.90
Minimum	-	-	922	160	379	10	36	39	200	6.00
Mean	-	-	4372	732	1695	597	90	131	1326	9.80
Std. Dev.	-	-	640	100	280	199	23	22	256	1.50

(Units: EC - mS/m, all other parameters mg/l)

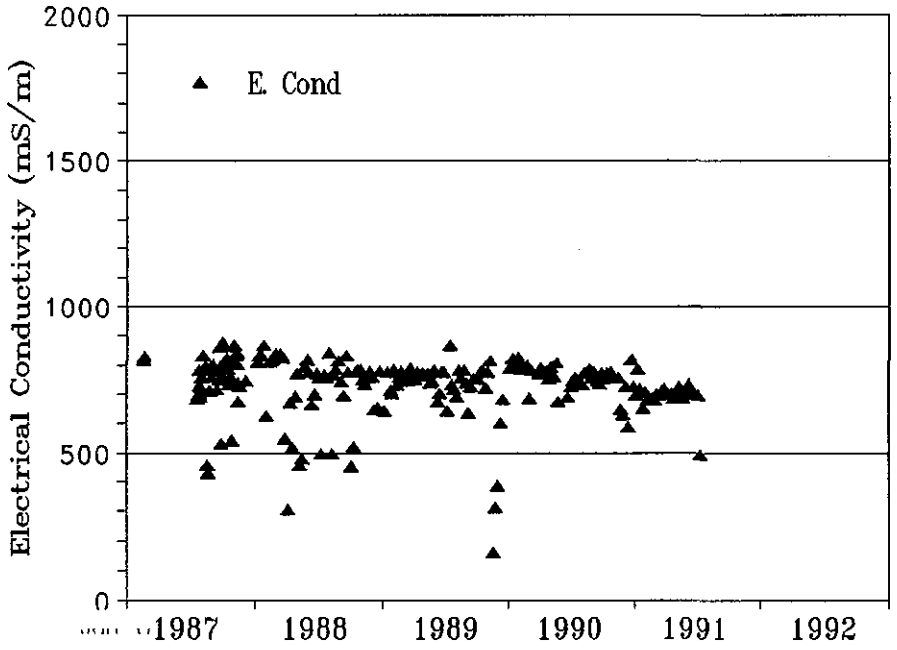

Figure 7.4 Electrical conductivity of Coerney River at CRQ02

SITE NUMBER: CRQ03

1. Site Information

Site Description:	Coerney River; crump weir on Carlton farm
Site Location (est.):	Lo: 25 Southings: 3709380 Eastings: -60219
Period of Data:	01/07/87 - 31/05/92
Data Type:	Discharge and Water quality
Data Interval:	Daily
Method of Measurement:	Ott chart recorder and Isco pump sampler

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	32.00	8.63	5887	951	2869	1250	156	198	1790	15.70
Minimum	0.02	6.98	356	34	64	3	11	30	165	3.80
Mean	0.07	8.11	4381	726	1774	562	85	130	1341	9.57
Std. Dev.	0.81	0.23	729	92	307	229	25	20	230	1.70

(Units: EC - mS/m, all other parameters mg/l)

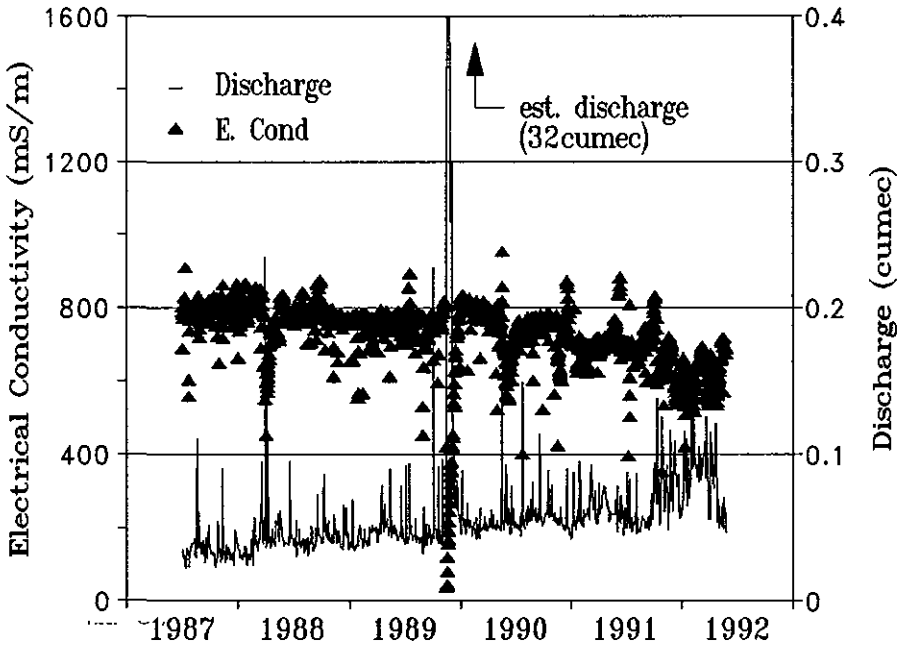

Figure 7.5 Electrical conductivity and discharge of Coerney River at CRQ03

SITE NUMBER: CRQ04

1. Site Information

Site Description:	Coerney River; at road bridge
Site Location (est.):	Lo: 25 Southings: 3708959 Eastings: -60389
Period of Data:	21/07/87 - 24/07/91
Data Type:	Water quality
Data Interval:	Weekly
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.30	5290	940	2332	900	158	180	1710	14.60
Minimum	-	7.00	877	159	359	10	32	41	214	5.10
Mean	-	8.00	4482	748	1747	588	97	133	1345	9.60
Std. Dev.	-	0.20	587	101	300	227	22	19	229	1.70

(Units: EC - mS/m, all other parameters mg/l)

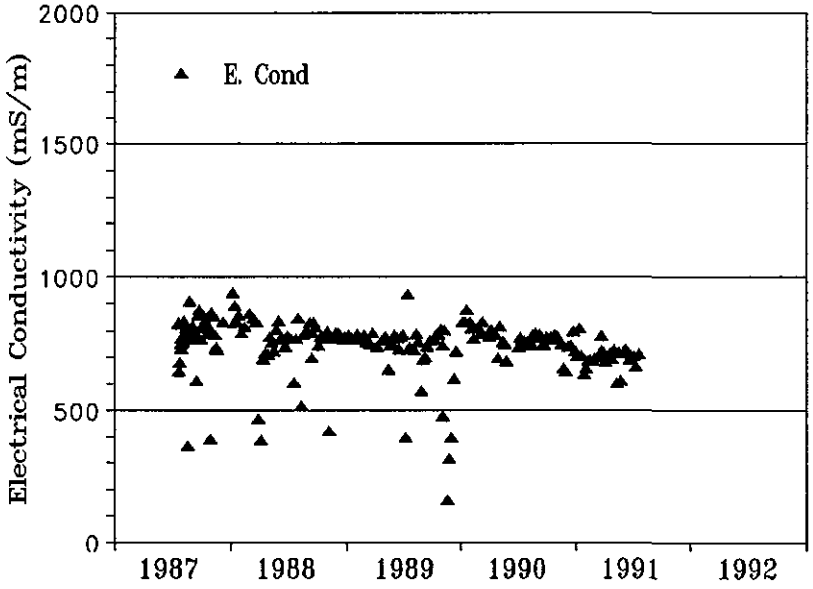

Figure 7.6 Electrical conductivity of Coerney River at CRQ04

SITE NUMBER: CRQ05

1. Site Information

Site Description:	Coerney River; at road bridge
Site Location (est.):	Lo: 25 Southings: 3708264 Eastings: -60892
Period of Data:	22/02/87 - 22/10/91
Data Type:	Water quality
Data Interval:	Weekly
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.70	6812	1185	2927	832	227	274	2044	15.00
Minimum	-	7.04	851	150	359	13	37	40	197	4.40
Mean	-	8.00	5166	838	2095	619	105	151	1564	10.80
Std. Dev.	-	0.20	653	92	336	218	28	24	230	1.70

(Units: EC - mS/m, all other parameters mg/l)

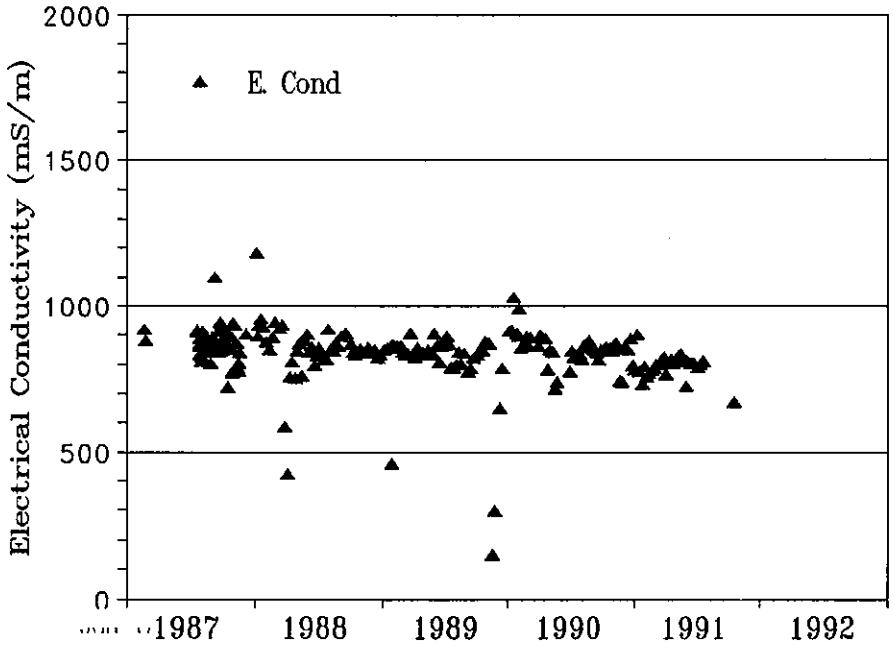

Figure 7.7 Electrical conductivity of Coerney River at CRQ05

SITE NUMBER: CRQ06

1. Site Information

Site Description:	Coerney River; at road bridge
Site Location (est.):	Lo: 25 Southings: 3707569 Eastings: -61098
Period of Data:	22/02/87 - 30/10/91
Data Type:	Water quality
Data Interval:	Weekly
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.70	9233	1333	4260	813	205	287	2580	16.00
Minimum	-	7.00	625	102	239	10	21	26	115	3.80
Mean	-	8.00	6754	1068	3022	530	125	220	2001	10.50
Std. Dev.	-	0.20	1349	173	581	242	32	45	427	2.10

(Units: EC - mS/m, all other parameters mg/l)

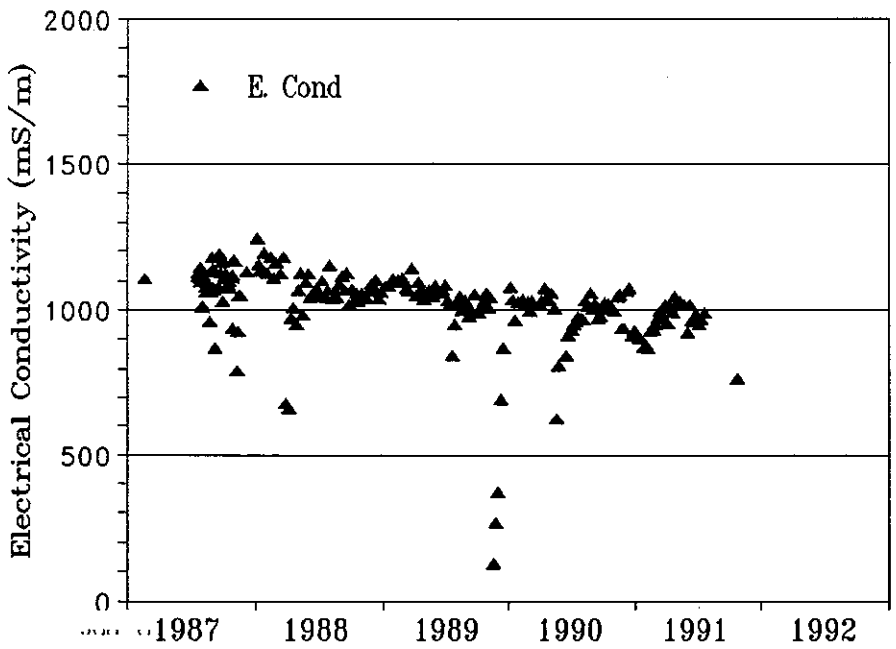

Figure 7.8 Electrical conductivity of Coerney River at CRQ06

SITE NUMBER: CRQ07

1. Site Information

Site Description:	Coerney River; at road bridge
Site Location (est.):	Lo: 25 Southings: 3706260 Eastings: -61318
Period of Data:	08/06/88 - 05/08/92
Data Type:	Water quality
Data Interval:	Weekly
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.70	9233	1333	4260	813	205	287	2580	16.00
Minimum	-	7.00	1025	102	239	10	21	26	115	3.80
Mean	-	8.00	6754	1068	3022	530	125	220	2001	10.50
Std. Dev.	-	0.20	1349	173	581	242	32	45	427	2.10

(Units: EC - mS/m, all other parameters mg/l)

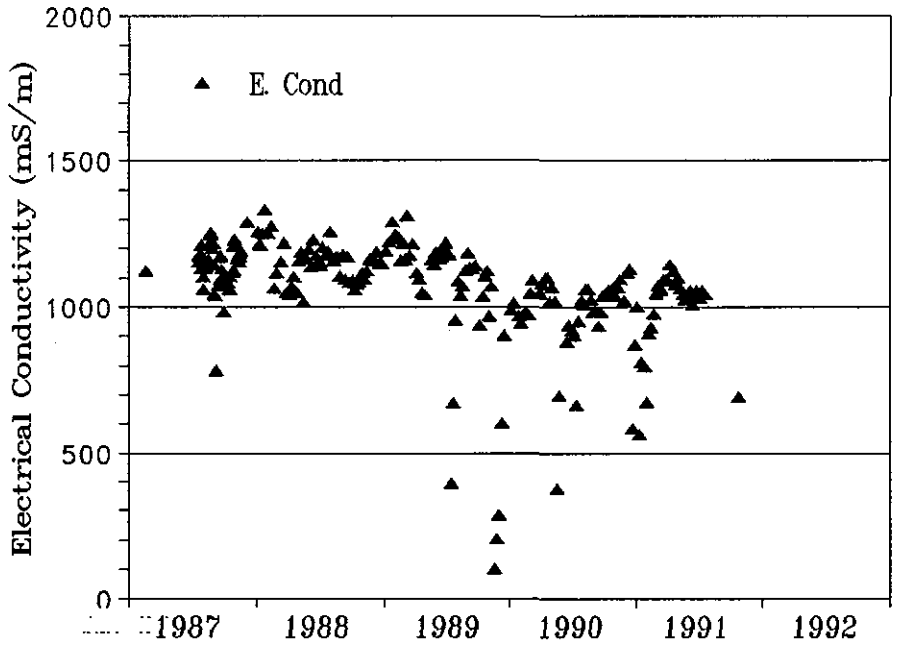

Figure 7.9 Electrical conductivity of Coerney River at CRQ07

SITE NUMBER: CRQ08

1. Site Information

Site Description:	Coerney River; crump weir on Daisy Dell farm
Site Location (est.):	Lo: 25 Southings: 3706476 Eastings: -60772
Period of Data:	21/07/87 - 31/05/92
Data Type:	Discharge and water quality
Data Interval:	Daily
Method of Measurement:	Ott chart recorder and Isco pump sampler

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	38.00	8.55	9125	1172	4603	725	200	267	2380	16.00
Minimum	0.00	6.99	864	28	59	3	10	13	37	3.00
Mean	0.07	8.16	4741	698	2012	329	90	151	1364	8.98
Std. Dev.	1.27	0.44	1859	271	941	187	28	57	540	3.04

(Units: EC - mS/m, discharge - cumec, all other parameters mg/l)

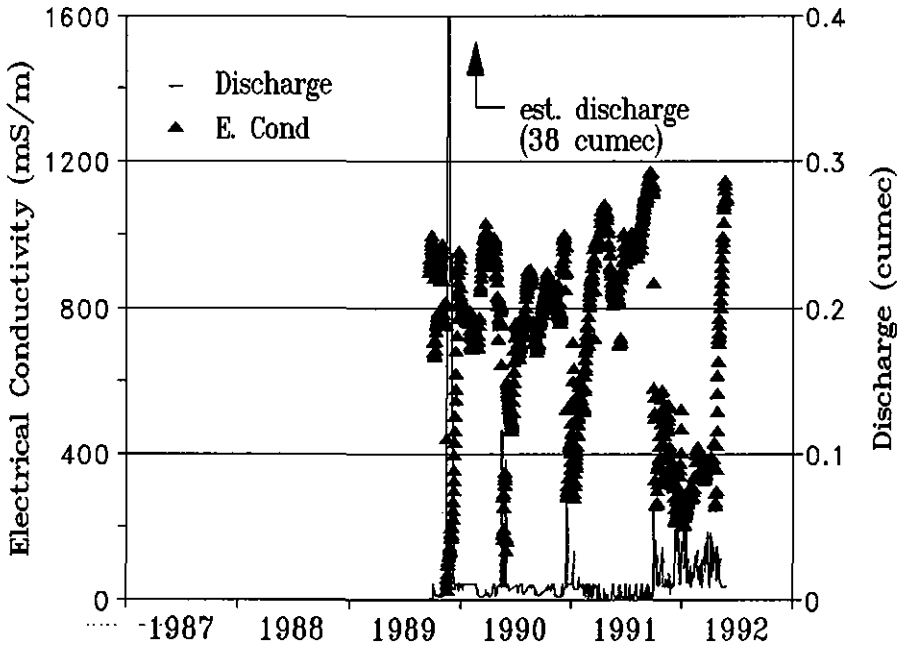

Figure 7.10 Electrical conductivity and discharge of Coerney River at CRQ08

SITE NUMBER: CRQ09

1. Site Information

Site Description:	Coerney River; between Daisy Dell and Cheltenham farms
Site Location (est.):	Lo: 25 Southings: 3705877 Eastings: -60322
Period of Data:	08/06/88 - 24/07/91
Data Type:	Water quality
Data Interval:	Weekly
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.20	9519	1351	3785	685	184	336	2760	13.00
Minimum	-	7.00	729	135	215	35	41	30	195	2.40
Mean	-	7.90	5111	795	2176	477	115	175	1475	3.57
Std. Dev.	-	0.33	1322	178	592	168	26	45	395	1.60

(Units: EC - mS/m, all other parameters mg/l)

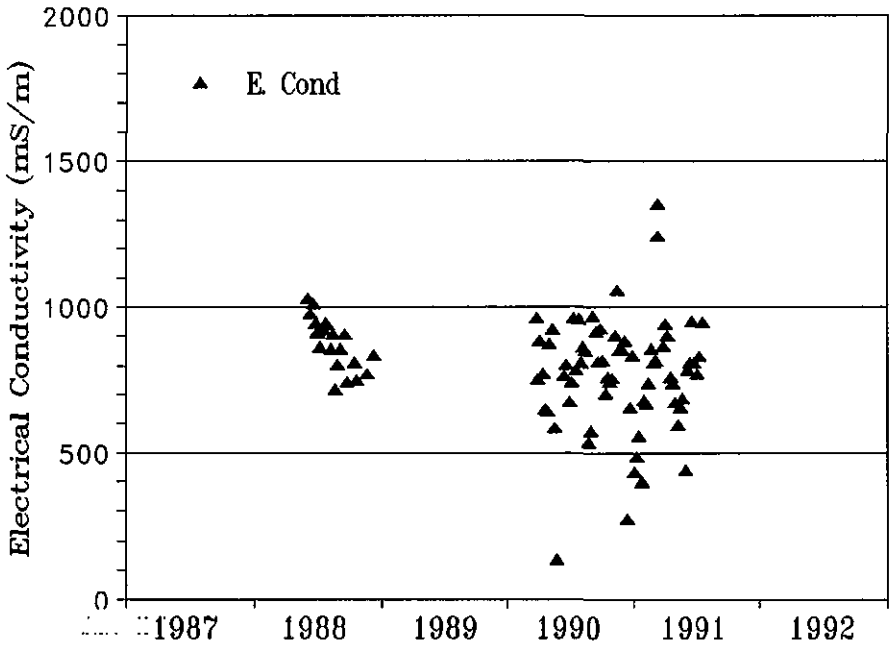

Figure 7.11 Electrical conductivity of Coerney River at CRQ09

SITE NUMBER: CRQ10

1. Site Information

Site Description:	Coerney River; at road bridge
Site Location (est.):	Lo: 25 Southings: 3705276 Eastings: -60556
Period of Data:	07/09/88 - 05/02/92
Data Type:	Water quality
Data Interval:	Weekly
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.40	2603	699	1193	340	102	87	683	5.70
Minimum	-	7.03	553	90	137	30	37	25	138	3.60
Mean	-	7.98	1523	270	574	323	65	64	412	4.86
Std. Dev.	-	0.46	420	90	240	111	17	15	116	0.56

(Units: EC - mS/m, all other parameters mg/l)

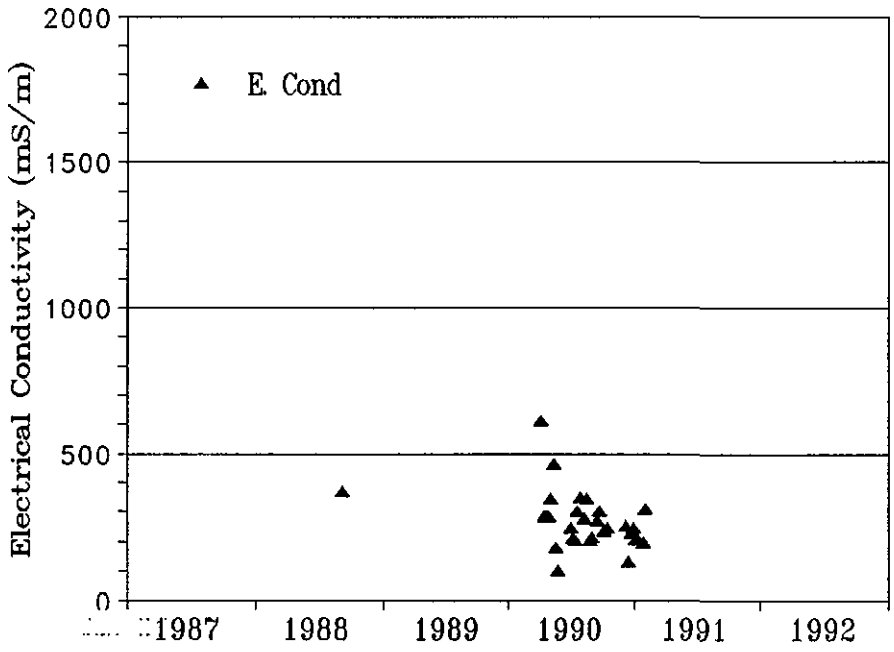

Figure 7.12 Electrical conductivity of irrigation water at CRQ10

SITE NUMBER: CRQ12

1. Site Information

Site Description:	Coerney River; pipe under farm track
Site Location (est.):	Lo: 25 Southings: 3706581 Eastings: -61643
Period of Data:	08/05/90 - 24/07/91
Data Type:	Water quality
Data Interval:	Weekly
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.51	10544	1356	4766	740	169	269	3120	28.00
Minimum	-	7.04	3504	587	2588	50	41	102	1096	8.00
Mean	-	8.12	7750	1142	3474	616	106	209	2375	21.00
Std. Dev.	-	0.40	1199	132	517	151	28	34	425	4.10

(Units: EC - mS/m, all other parameters mg/l)

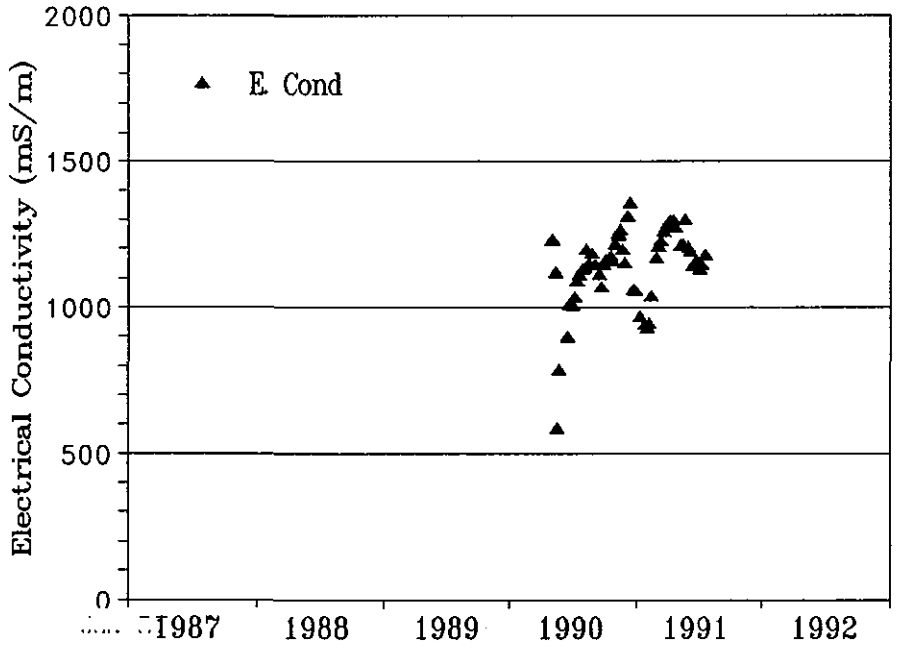

Figure 7.13 Electrical conductivity of irrigation water at CRQ12

SITE NUMBER: CRQ20

1. Site Information

Site Description:	Left bank seapage into Coerney River 250 m downstream from CRQ08 on Daisy Dell farm
Site Location (est.):	Lo: 25 Southings: 3706222 Eastings: -60650
Period of Data:	19/03/91 - 16/07/91
Data Type:	Water quality
Data Interval:	Weekly
Method of Measurement:	Water samples collected manually

2. Summary of water quality parameters

	Q	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	-	12034	1568	9651	880	530	780	6000	8.31
Minimum	-	-	19148	1980	5768	45	130	340	3300	1.90
Mean	-	-	14433	1865	6927	571	277	472	4134	2.96
Std. Dev.	-	-	1382	80	859	319	76	75	541	0.99

(Units: EC - mS/m, all other parameters mg/l)

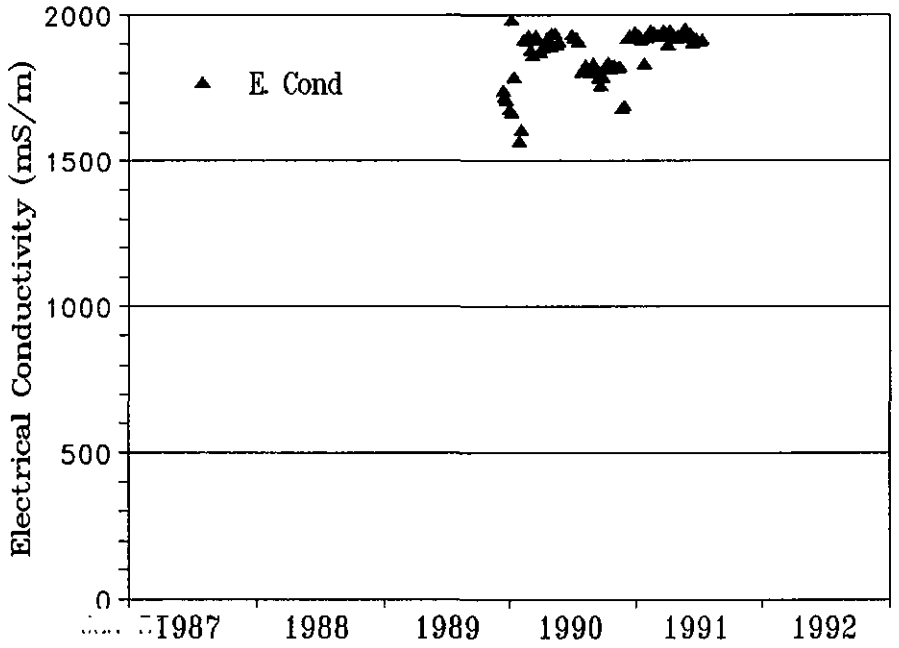

Figure 7.14 Electrical conductivity of irrigation water at CRQ20

8. MICRO-PLOT SOIL WATER DATA:

To obtain information on the 3-D processes of moisture and solute movement a number of micro-plots were established. At these plots, matrix potentials were measured using a bank of tensiometers at depths of 30, 60, 90 and 120 cm depths and soil water samples were collected using in situ soil moisture samplers at depths of 15, 30, 60, 90 and 120 cm. The in situ soil moisture samplers comprised a PVC tube fitted with a porous cup at one end and a bung at the other. To collect samples a vacuum of 80 kPa was created in the samplers using a converted portable battery operated electric tire pump. The volumetric soil moisture content of soil samples was determined gravimetrically to construct a matric potential/soil moisture rating curve for micro-plot DDM03.

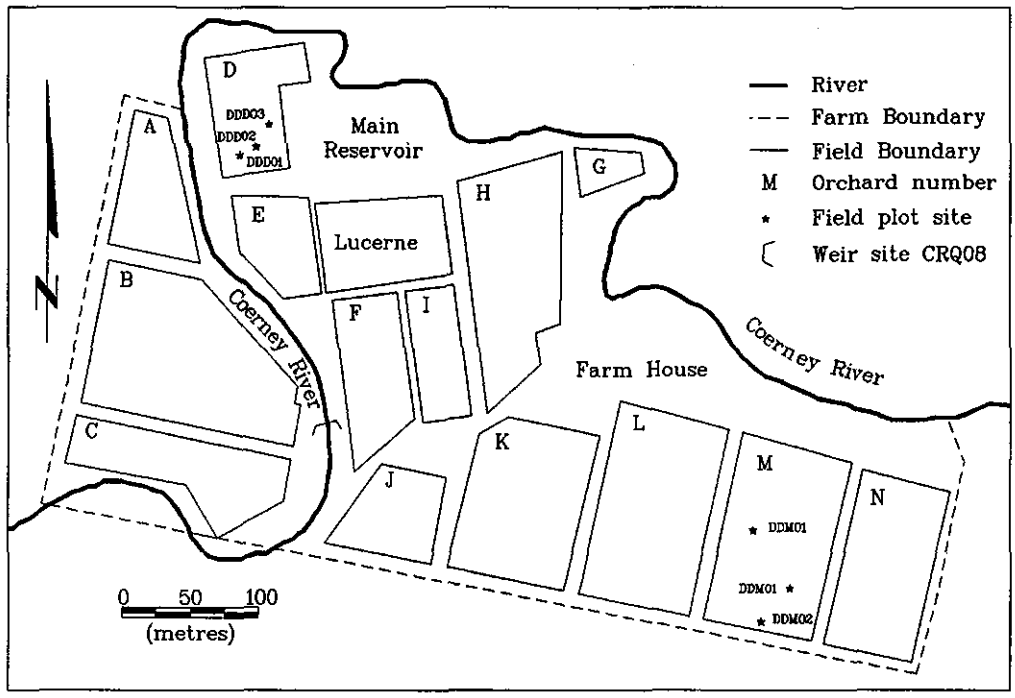

Figure 8.1 Location of micro plots on Daisy Dell farm

SITE NUMBER: DDD01

1. Site Information

Site Description:	Micro plot in orchard D on Daisy Dell farm
Site Location (est.):	Orchard D on Daisy Dell farm
Period of Data:	07/06/89 - 18/09/90
Data Type:	Soil moisture and water quality
Data Interval:	Daily matrix potential, weekly soil water samples.
Depth Interval:	Matrix potential - 15, 30, 60, 90 and 120 cm depths. Soil water samples - 15, 30, 60, 90 and 120 cm depths.
Method of Measurement:	- Matrix potential determined using in situ tensionmeters - Soil water samples collected using in situ porous cup with vacuum at 80 kPa.

2. Summary of matrix potential and water quality parameters

DDD01 at 15 cm depth

	MPot	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.05	2278	757	651	390	234	145	230	120.00
Minimum	-	6.97	930	137	55	20	87	36	115	7.30
Mean	-	7.68	1543	288	190	109	169	92	161	59.84
Std. Dev.	-	0.42	557	128	123	133	46	29	33	38.75

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

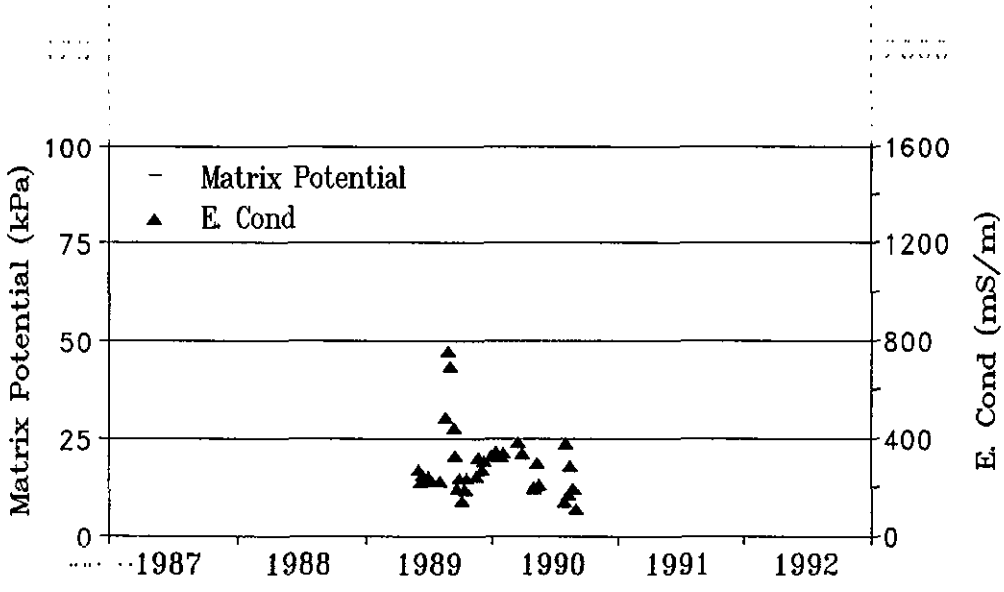

Figure 8.2 Matrix potential and electrical conductivity at 15 cm

DDD01 at 90 cm depth

	MPot	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	82.00	8.40	2247	502	389	435	275	122	277	83.00
Minimum	3.00	6.75	1174	73	68	15	34	21	91	4.00
Mean	31.80	7.56	1526	240	148	143	131	67	167	39.85
Std. Dev.	23.40	0.43	336	100	61	147	36	18	40	24.78

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

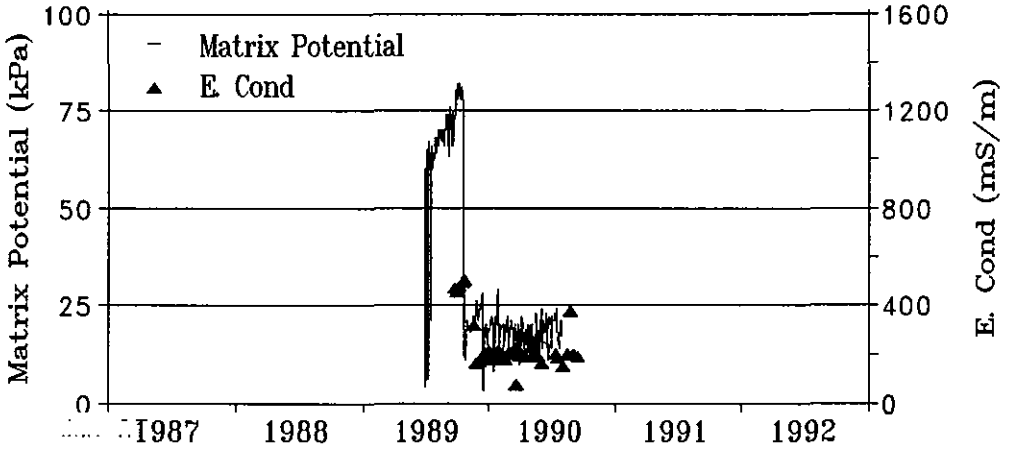

Figure 8.3 Matrix potential and electrical conductivity at 90 cm

DDD01 at 120 cm depth

	MPot	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	54.00	8.25	2079	816	302	445	282	109	247	75.40
Minimum	5.00	7.02	1068	75	74	20	36	19	28	3.50
Mean	24.77	7.57	1314	251	141	131	124	58	171	29.87
Std. Dev.	10.09	0.35	297	161	44	132	42	17	47	21.35

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

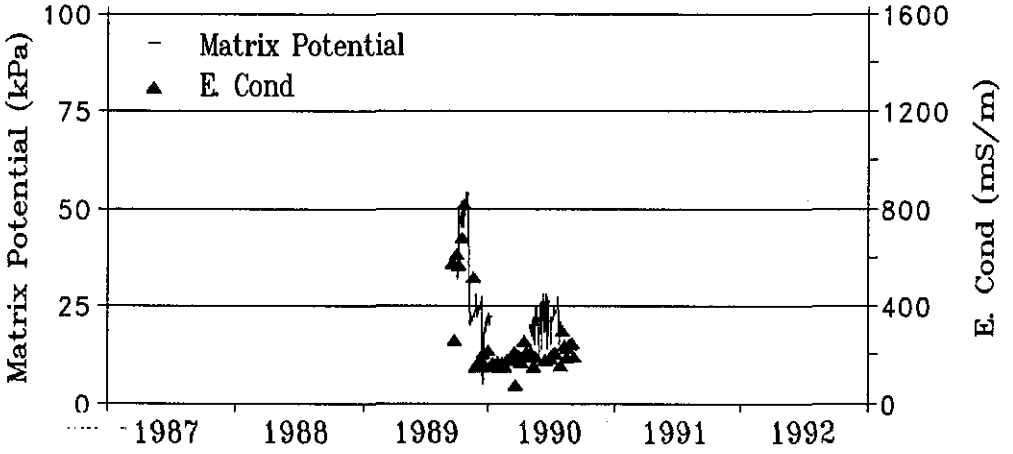

Figure 8.4 Matrix potential and electrical conductivity at 120 cm

SITE NUMBER: DDD02

1. Site Information

Site Description:	Micro plot in orchard D on Daisy Dell farm
Site Location (est.):	Orchard D on Daisy Dell farm
Period of Data:	07/06/89 - 24/04/90
Data Type:	Soil moisture and water quality
Data Interval:	Daily matrix potential, weekly soil water samples.
Depth Interval:	Matrix potential - 15, 30, 60, 90 and 120 cm depths. Soil water samples - 15, 30, 60, 90 and 120 cm depths.
Method of Measurement:	- Matrix potential determined using in situ tensionmeters - Soil water samples collected using in situ porous cup with vacuum at 80 kPa.

2. Summary of matrix potential and water quality parameters

DDD02 at 15 cm depth

	MPot	EC
Maximum	-	423
Minimum	-	110
Mean	-	239
Std. Dev.	-	62

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

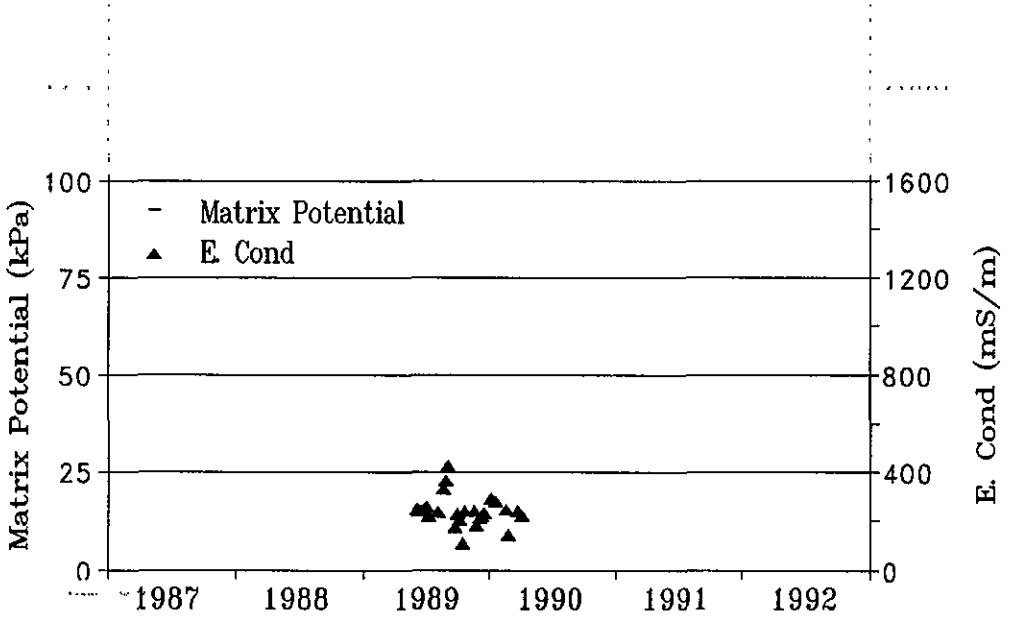

Figure 8.5 Matrix potential and electrical conductivity at 15 cm

DDD02 at 30 cm depth

	MPot	EC
Maximum	82.00	489
Minimum	0.00	124
Mean	18.44	358
Std. Dev.	14.81	85

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

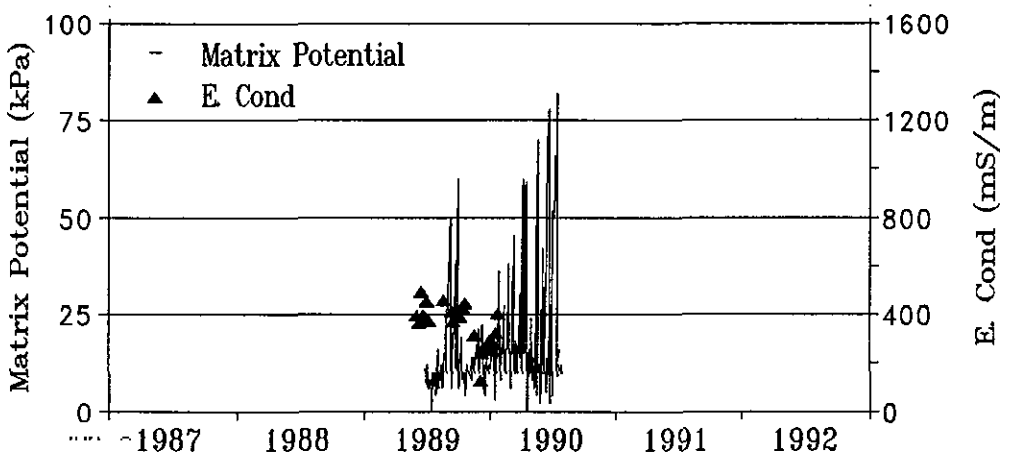

Figure 8.6 Matrix potential and electrical conductivity at 30 cm

DDD02 at 60 cm depth

	MPot	EC
Maximum	34.00	625
Minimum	0.00	236
Mean	13.45	390
Std. Dev.	4.97	132

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

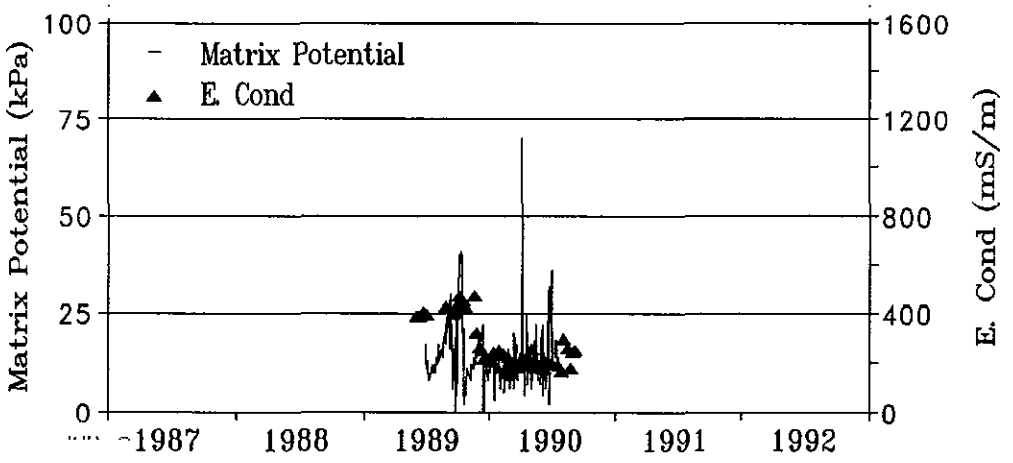

Figure 8.7 Matrix potential and electrical conductivity at 60 cm

DDD02 at 90 cm depth

	MPot	EC
Maximum	67.00	918
Minimum	4.00	143
Mean	23.92	276
Std. Dev.	12.43	108

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

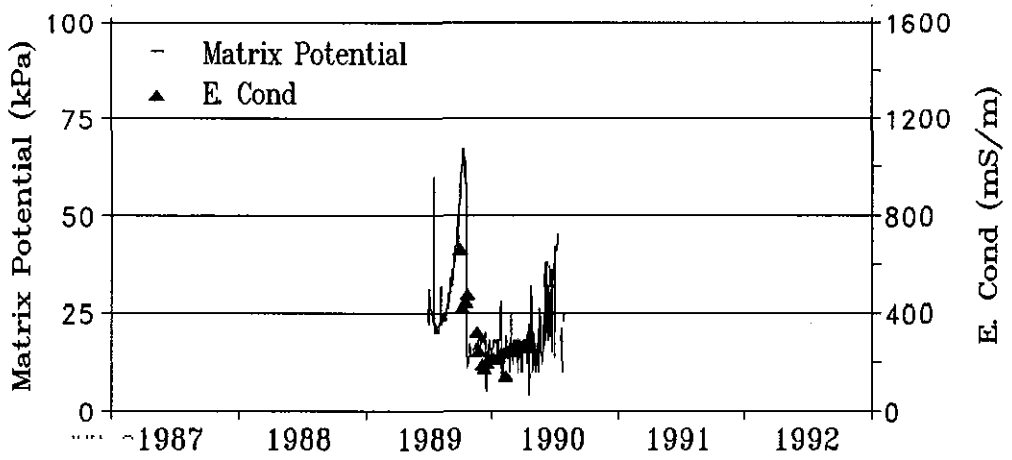

Figure 8.8 Matrix potential and electrical conductivity at 90 cm

DDD02 at 60 cm depth

	MPot	EC
Maximum	34.00	625
Minimum	0.00	236
Mean	13.45	390
Std. Dev.	4.97	132

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

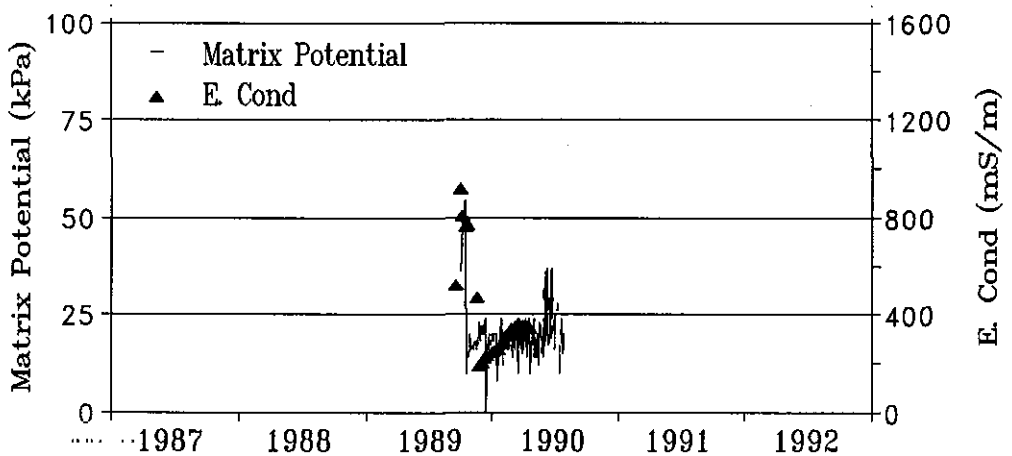

Figure 8.9 Matrix potential and electrical conductivity at 120 cm

SITE NUMBER: DDD03

1. Site Information

Site Description:	Micro plot in orchard D on Daisy Dell farm
Site Location (est.):	Orchard D on Daisy Dell farm
Period of Data:	07/06/89 - 24/04/90
Data Type:	Soil moisture and water quality
Data Interval:	Daily matrix potential, weekly soil water samples.
Depth Interval:	Matrix potential - 15, 30, 60, 90 and 120 cm depths. Soil water samples - 15, 30, 60, 90 and 120 cm depths.
Method of Measurement:	- Matrix potential determined using in situ tensionmeters - Soil water samples collected using in situ porous cup with vacuum at 80 kPa.

2. Summary of matrix potential and water quality parameters

DDD03 at 15 cm depth

	MPot	EC
Maximum	-	465
Minimum	-	96
Mean	-	213
Std. Dev.	-	101

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

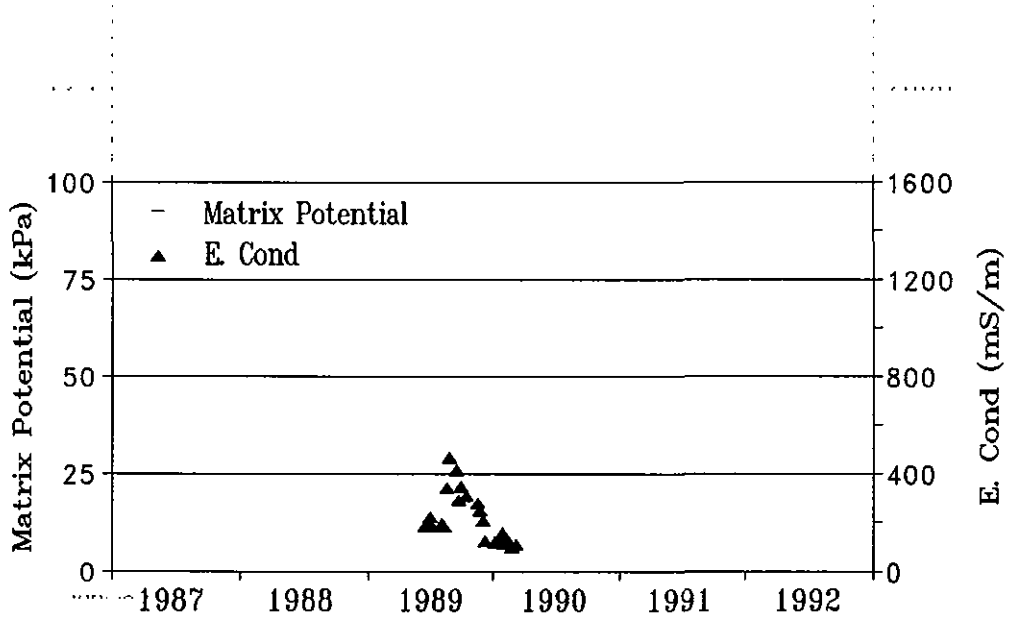

Figure 8.10 Matrix potential and electrical conductivity at 15 cm

DDD03 at 30 cm depth

	MPot	EC
Maximum	43.00	319
Minimum	0.00	107
Mean	7.89	189
Std. Dev.	7.44	50

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

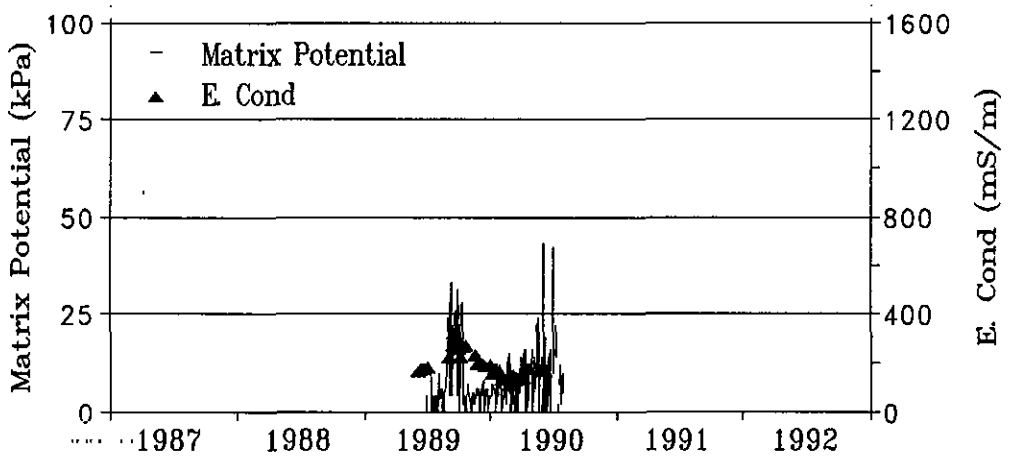

Figure 8.11 Matrix potential and electrical conductivity at 30 cm

DDD03 at 60 cm depth

	MPot	EC
Maximum	80.00	549
Minimum	4.00	193
Mean	22.81	296
Std. Dev.	19.36	93

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

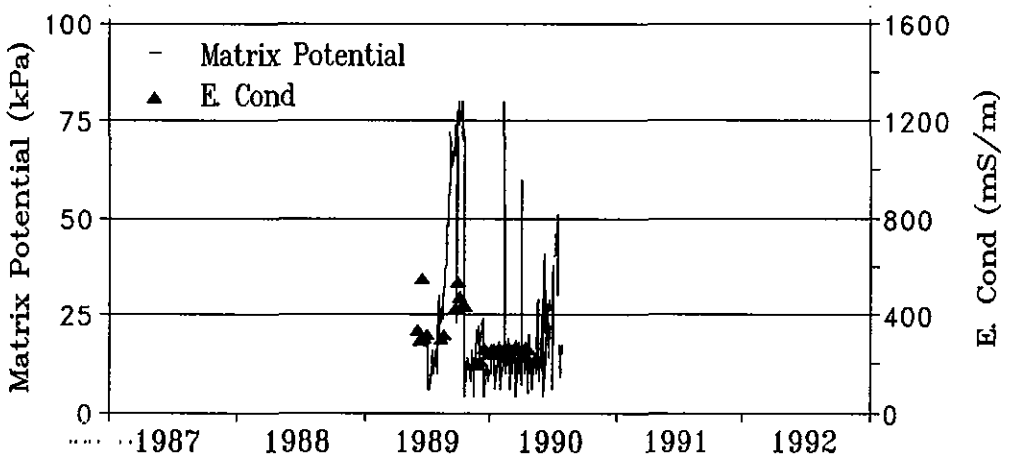

Figure 8.12 Matrix potential and electrical conductivity at 60 cm

DDD03 at 90 cm depth

	MPot	EC
Maximum	38.00	314
Minimum	3.00	175
Mean	14.70	216
Std. Dev.	5.05	32

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

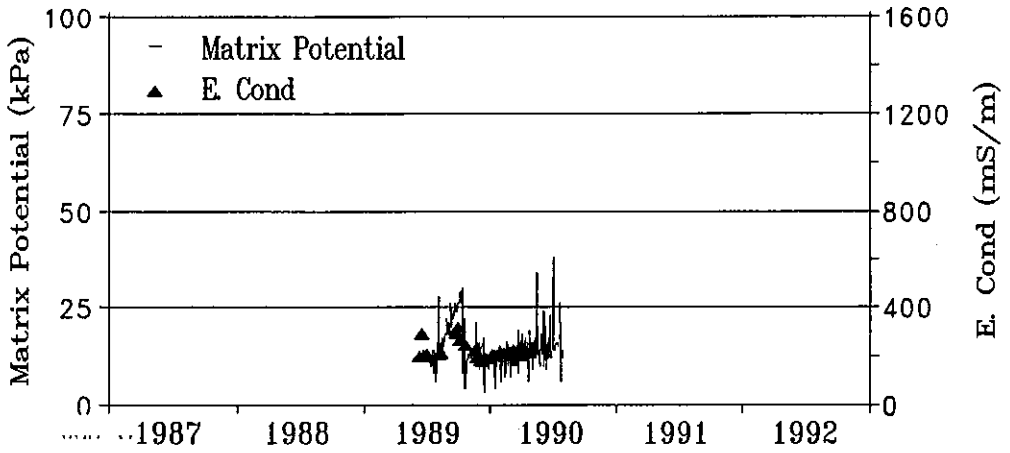

Figure 8.13 Matrix potential and electrical conductivity at 90 cm

DDD03 at 120 cm depth

	MPot	EC
Maximum	39.00	271
Minimum	0.00	89
Mean	16.00	214
Std. Dev.	6.00	37

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

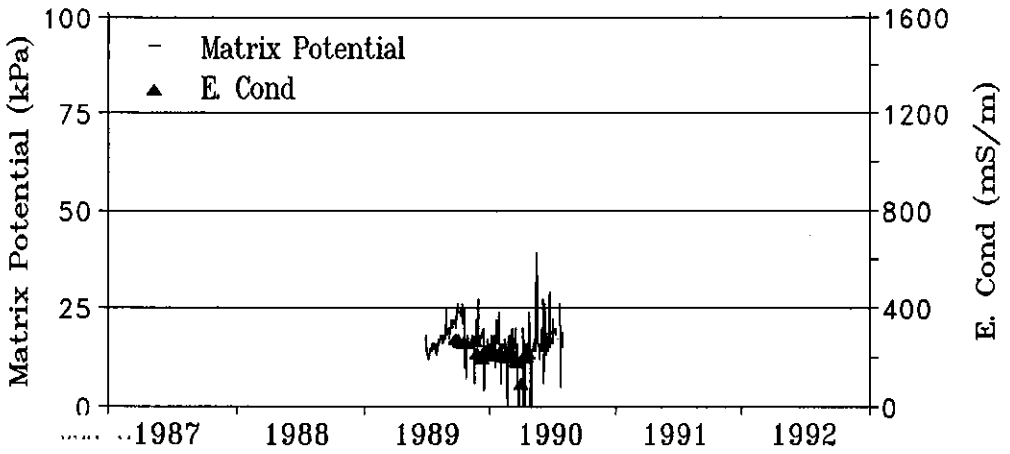

Figure 8.14 Matrix potential and electrical conductivity at 120 cm

SITE NUMBER: DDM01

1. Site Information

Site Description:	Micro plot in orchard D on Daisy Dell farm
Site Location (est.):	Orchard M on Daisy Dell farm
Period of Data:	07/06/89 - 17/04/90
Data Type:	Soil moisture and water quality
Data Interval:	Daily matrix potential, weekly soil water samples.
Depth Interval:	Matrix potential - 15, 30, 60, 90 and 120 cm depths. Soil water samples - 15, 30, 60, 90 and 120 cm depths.
Method of Measurement:	- Matrix potential determined using in situ tensionmeters - Soil water samples collected using in situ porous cup with vacuum at 80 kPa.

2. Summary of matrix potential and water quality parameters

DDD03 at 15 cm depth

	MPot	EC
Maximum	-	282
Minimum	-	129
Mean	-	180
Std. Dev.	-	45

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

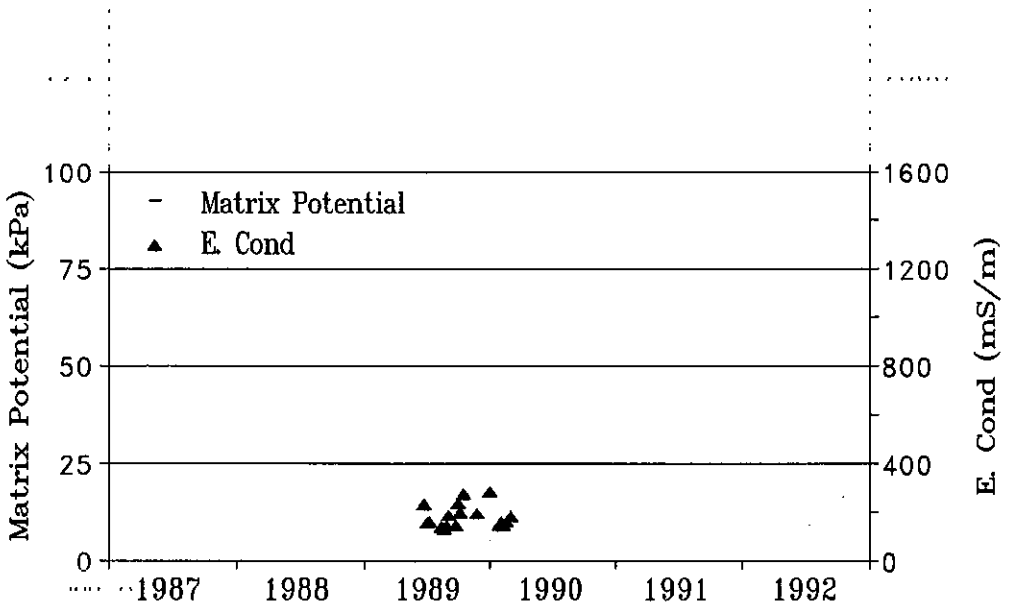

Figure 8.15 Matrix potential and electrical conductivity at 15 cm

DDM01 at 30 cm depth

	MPot	EC
Maximum	90.00	374
Minimum	0.00	155
Mean	48.55	213
Std. Dev.	31.83	49

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

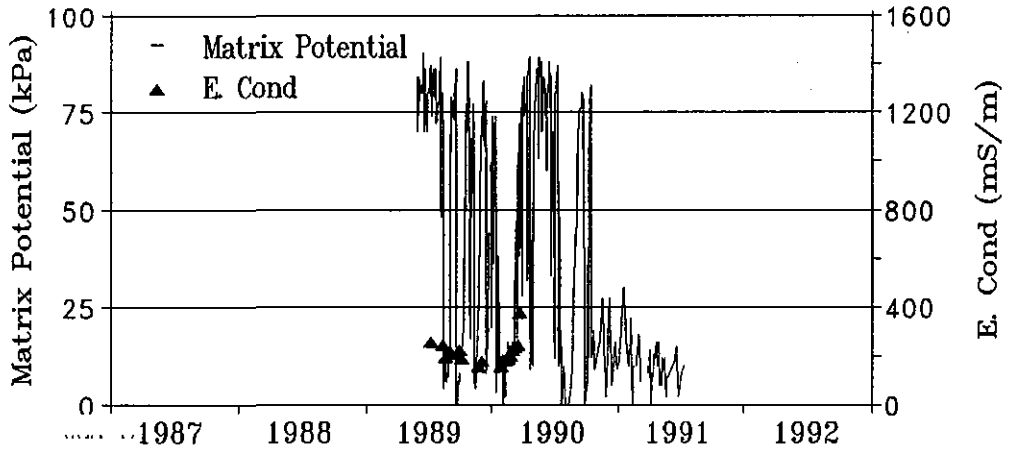

Figure 8.16 Matrix potential and electrical conductivity at 30 cm

DDM01 at 60 cm depth

	MPot	EC
Maximum	89.00	941
Minimum	0.00	175
Mean	48.55	506
Std. Dev.	25.30	229

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

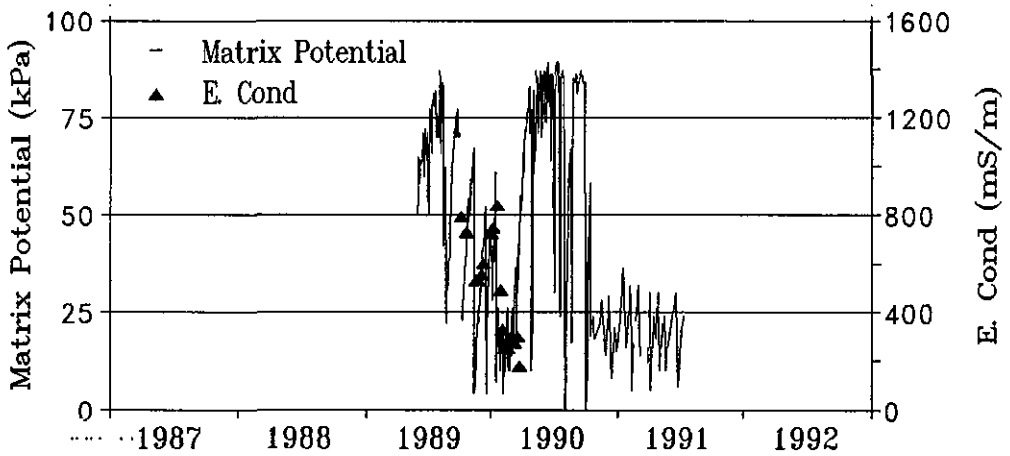

Figure 8.17 Matrix potential and electrical conductivity at 60 cm

DDM01 at 90 cm depth

	MPot	EC
Maximum	89.00	520
Minimum	0.00	219
Mean	41.89	308
Std. Dev.	21.35	96

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

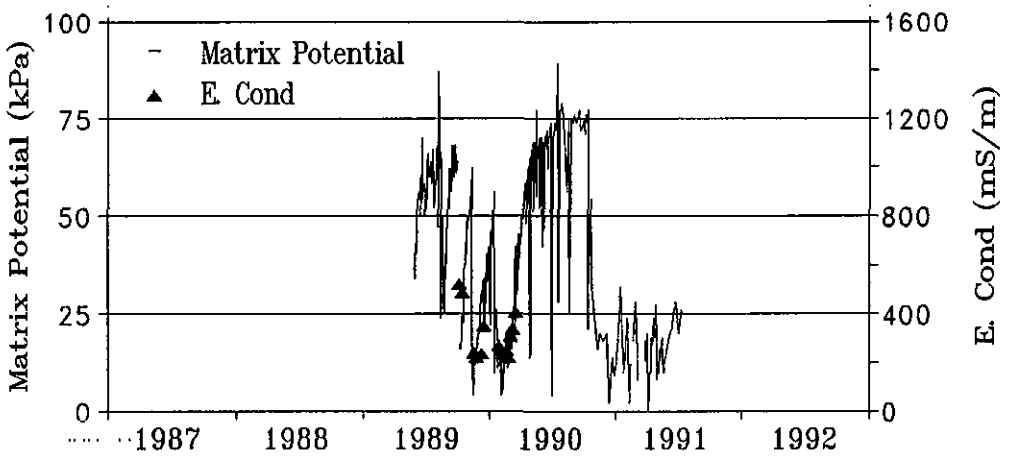

Figure 8.18 Matrix potential and electrical conductivity at 90 cm

DDM01 at 120 cm depth

	MPot	EC
Maximum	90.00	1335
Minimum	0.00	76
Mean	47.45	861
Std. Dev.	19.84	309

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

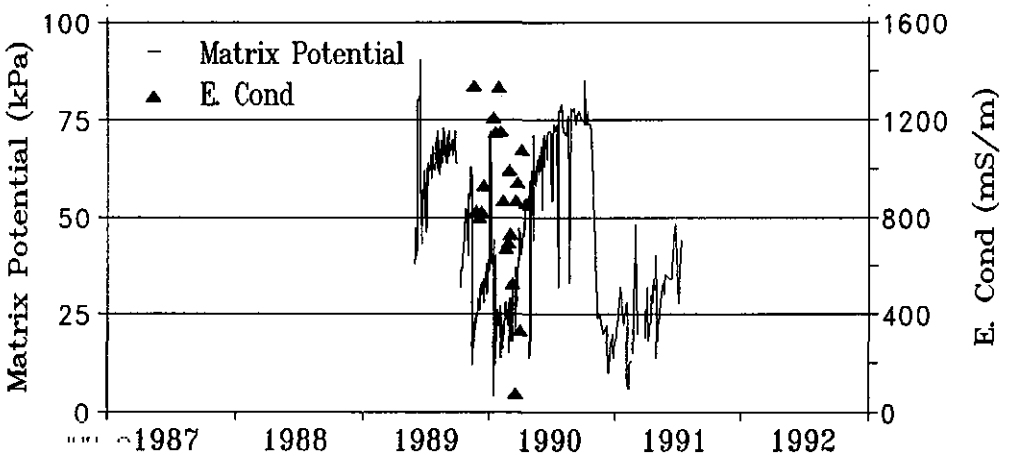

Figure 8.19 Matrix potential and electrical conductivity at 120 cm

SITE NUMBER: DDM02

1. Site Information

Site Description:	Micro plot in orchard D on Daisy Dell farm
Site Location (est.):	Orchard M on Daisy Dell farm
Period of Data:	20/06/89 - 24/04/90
Data Type:	Soil moisture and water quality
Data Interval:	Daily matrix potential, weekly soil water samples.
Depth Interval:	Matrix potential - 15, 30, 60, 90 and 120 cm depths. Soil water samples - 15, 30, 60, 90 and 120 cm depths.
Method of Measurement:	- Matrix potential determined using in situ tensionmeters - Soil water samples collected using in situ porous cup with vacuum at 80 kPa.

2. Summary of matrix potential and water quality parameters

DDM02 at 15 cm depth

	MPot	EC
Maximum	-	276
Minimum	-	144
Mean	-	192
Std. Dev.	-	37

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

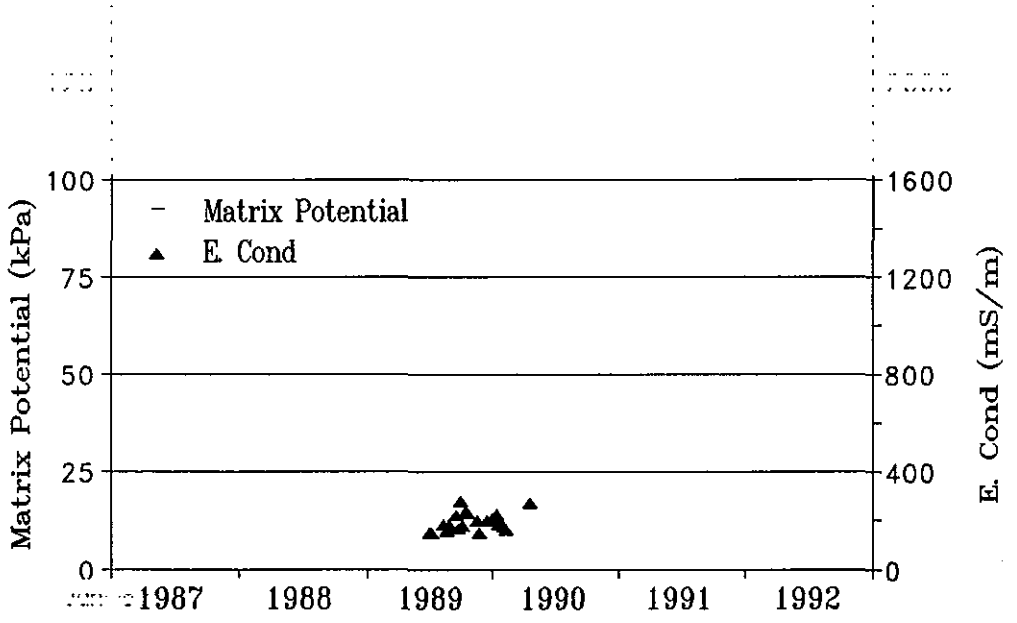

Figure 8.20 Matrix potential and electrical conductivity at 15 cm

DDM02 at 30 cm depth

	MPot	EC
Maximum	84.00	345
Minimum	0.00	154
Mean	21.47	239
Std. Dev.	20.53	57

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

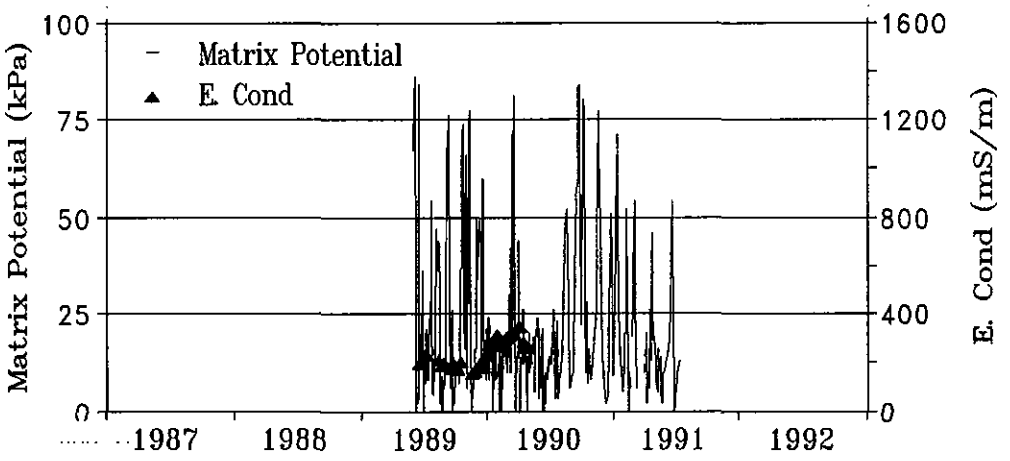

Figure 8.21 Matrix potential and electrical conductivity at 30 cm

DDM02 at 60 cm depth

	MPot	EC
Maximum	84.00	354
Minimum	0.00	163
Mean	13.24	252
Std. Dev.	7.02	60

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

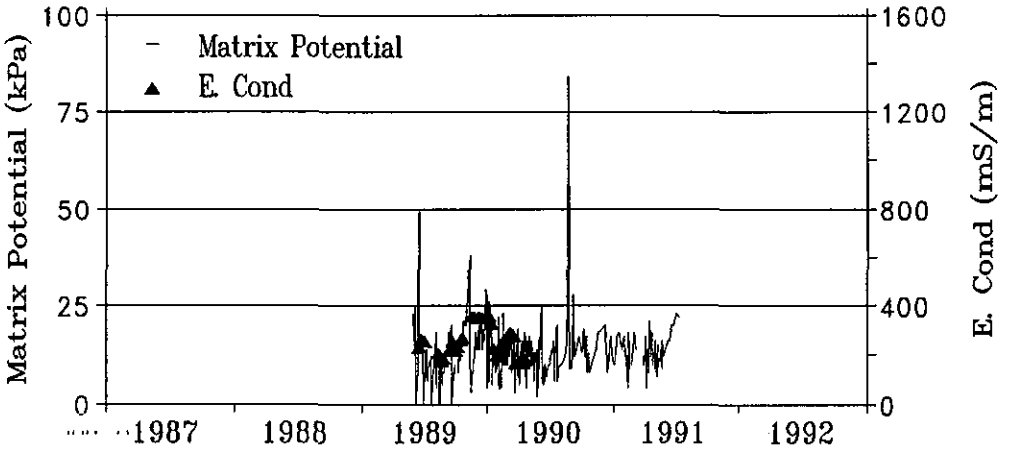

Figure 8.22 Matrix potential and electrical conductivity at 60 cm

DDM02 at 90 cm depth

	MPot	EC
Maximum	77.00	965
Minimum	0.00	286
Mean	17.60	431
Std. Dev.	7.41	130

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

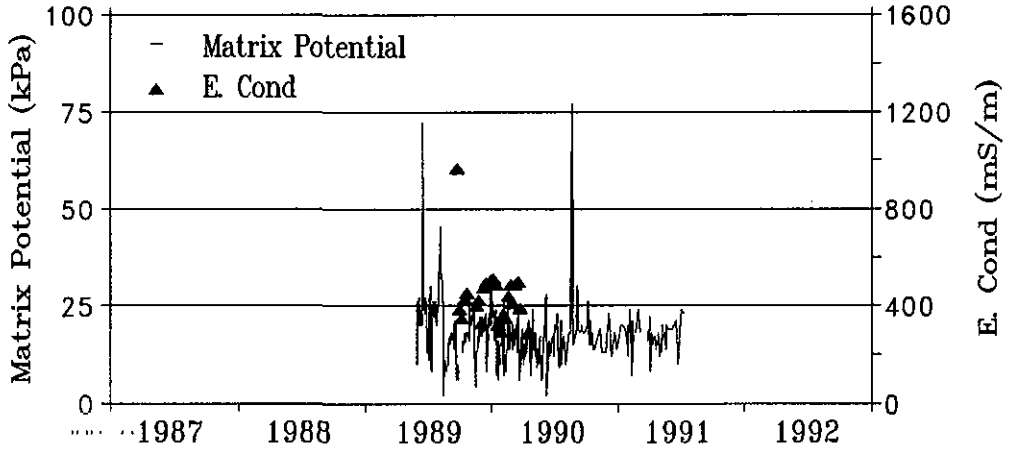

Figure 8.23 Matrix potential and electrical conductivity at 90 cm

DDM02 at 120 cm depth

	MPot	EC
Maximum	78.00	1031
Minimum	0.00	390
Mean	23.27	619
Std. Dev.	8.38	146

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

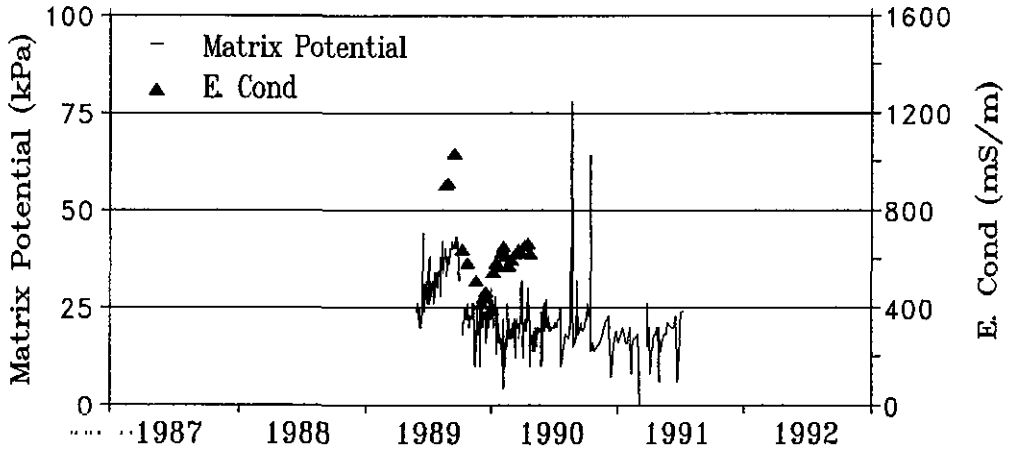

Figure 8.24 Matrix potential and electrical conductivity at 120 cm

SITE NUMBER: DDM03

1. Site Information

Site Description:	Micro plot in orchard D on Daisy Dell farm
Site Location (est.):	Orchard M on Daisy Dell farm
Period of Data:	11/07/89 - 09/07/90
Data Type:	Soil moisture and water quality
Data Interval:	Daily matrix potential, weekly soil water samples.
Depth Interval:	Matrix potential - 15, 30, 60, 90 and 120 cm depths. Soil water samples - 15, 30, 60, 90 and 120 cm depths.
Method of Measurement:	- Matrix potential determined using in situ tensionmeters - Soil water samples collected using in situ porous cup with vacuum at 80 kPa.

2. Summary of matrix potential and water quality parameters

DDM03 at 15 cm depth

	MPot	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	-	8.95	1370	1070	1874	620	338	180	2000	63.00
Minimum	-	7.52	945	121	61	30	83	38	77	9.10
Mean	-	8.10	1111	244	265	238	139	70	290	21.42
Std. Dev.	-	0.40	187	196	375	190	69	40	431	10.30

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

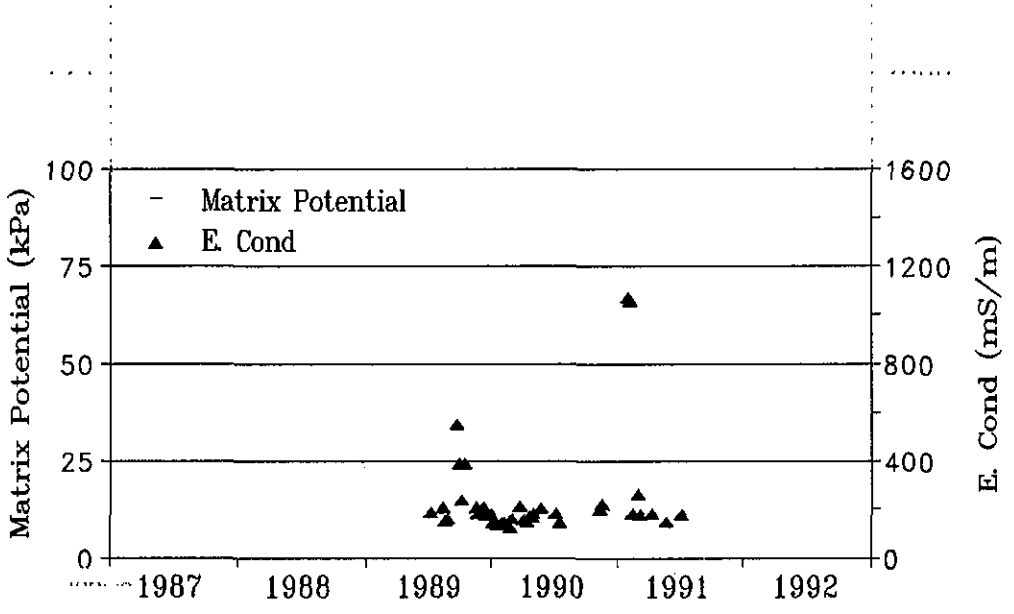

Figure 8.25 Matrix potential and electrical conductivity at 15 cm

DDM03 at 30 cm depth

	MPot	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	92.00	8.30	4557	1171	998	800	174	102	1450	46.40
Minimum	0.00	6.98	906	135	89	30	51	38	115	3.50
Mean	30.29	7.83	1338	220	206	259	107	61	243	30.64
Std. Dev.	26.77	0.36	766	146	150	176	31	18	235	10.55

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

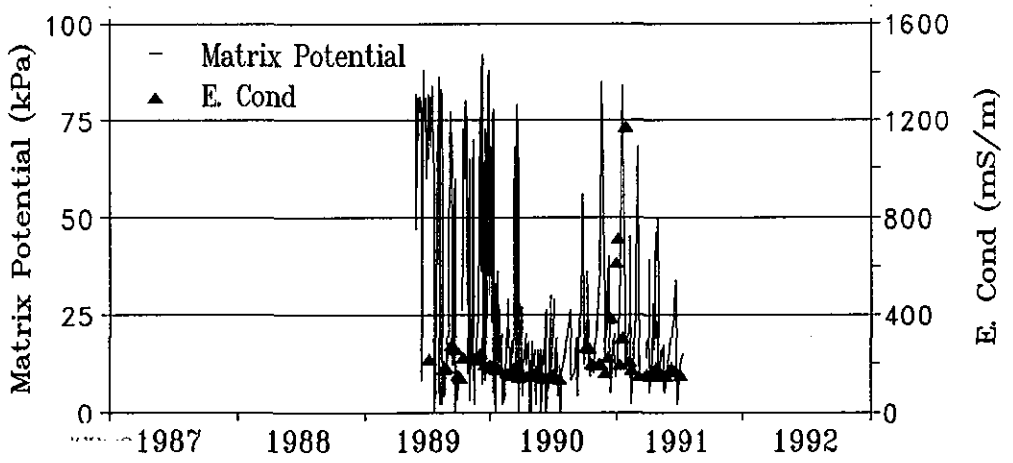

Figure 8.26 Matrix potential and electrical conductivity at 30 cm

DDM03 at 60 cm depth

	MPot	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	80.00	8.58	3276	808	1146	750	380	213	1590	112.80
Minimum	0.00	7.02	1111	160	35	45	52	47	151	4.90
Mean	34.21	7.84	1623	287	243	194	146	87	294	55.54
Std. Dev.	19.66	0.38	592	131	150	159	68	38	194	21.72

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

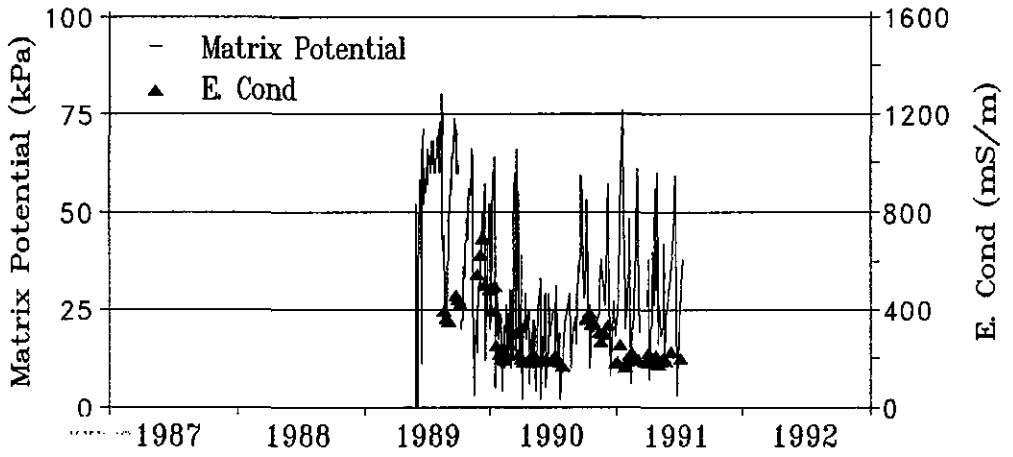

Figure 8.27 Matrix potential and electrical conductivity at 60 cm

DDM03 at 90 cm depth

	MPot	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	84.00	8.95	1956	589	659	715	167	914	67.00	
Minimum	0.00	7.01	1756	174	106	58	42	206	5.70	
Mean	41.89	7.97	1826	308	319	448	93	487	26.06	
Std. Dev.	20.58	0.47	92	99	129	219	28	171	14.76	

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

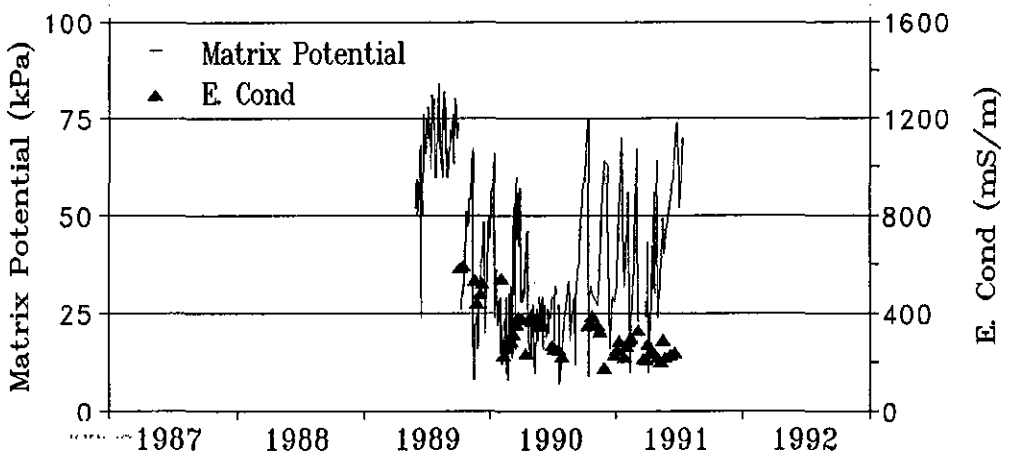

Figure 8.28 Matrix potential and electrical conductivity at 90 cm

DDM03 at 120 cm depth

	MPot	pH	TDS	EC	Cl	Talk	Ca	Mg	Na	K
Maximum	86.00	8.50	7354	1445	2351	1265	629	355	2400	89.00
Minimum	0.00	6.75	1444	206	139	80	36	28	250	2.90
Mean	38.78	7.91	3512	573	621	646	135	87	979	15.38
Std. Dev.	15.34	0.52	2009	315	437	332	103	56	558	14.17

(Units: EC - mS/m, matrix potential - kPa, all other parameters mg/l)

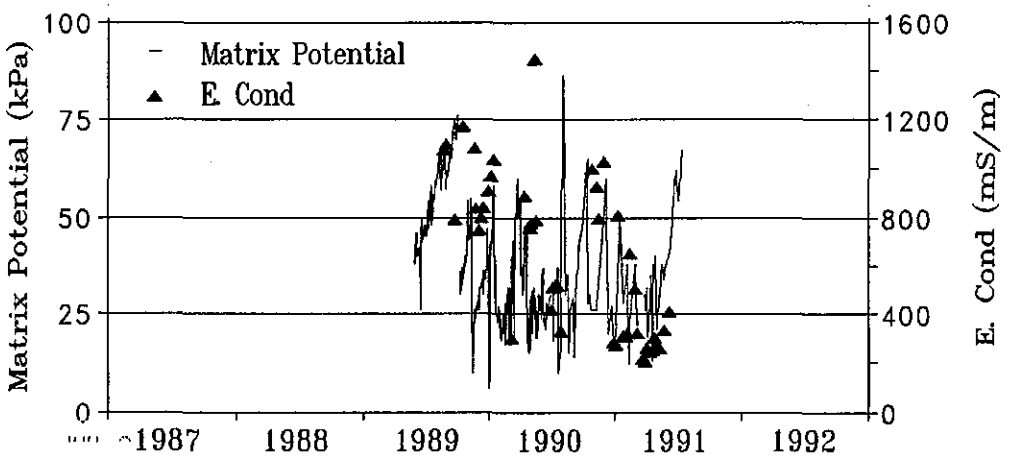

Figure 8.29 Matrix potential and electrical conductivity at 120 cm

9. REFERENCES

Tylcoat, C.D. 1985. The effects of land use on the flow and salinity of the lower Sundays River. Department of Water Affairs Scientific Services, Hydrological Research Institute.

Herald, J.R. 1992 Hydrosalinity studies in the Coerney valley, Volume 1. Final report to the Water Research Commission for the project "Hydrosalinity studies in the eastern Cape".