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1. Introduction

This report provides a review of the surface water salinity data collected at four sites in the Ovens Basin for the 2002 calendar year. A brief analysis of the data is also included.

This report contains:

- An assessment of the usefulness and accuracy of information provided by the monitoring sites, with recommendations where appropriate;
- A schedule of missing data at each site;
- Basic flow, salinity and salt load statistics at each site;
- Time series graphs for flow and salinity for each site; and
- An evaluation of statistics and graphs at possible faulty data.

This brief annual review is essential to ensure the integrity of the monitoring program and is a precursor to any full analysis of data from these monitoring sites. The collation of additional catchment data such as area, landuse and climate information may assist in the longterm understanding of salinity characteristics in these catchments.

2. Catchment Information

The Ovens River catchment (shown in Figure 2.1) covers an area of approximately 778,000 ha and is recognised as contributing approximately 14% of the total volume of water to the Murray Darling Basin system (NESWG, 1997). The four continuous flow and salinity monitoring sites that have been reviewed in this report are located in the lower reaches of the Ovens catchment. The purpose of these sites is to record the flow and salinity within these waterways over time and to assist in the assessment of dryland salinity impacts. Dryland salinity due to rising water tables in the lower part of the catchment is a recognised factor in the decline of water quality in streams.

There is a large quantity of information available regarding salt discharge sites in the Ovens Basin. An example of this is the Everton Upper area where work has been undertaken to assess the effectiveness of groundwater pumping from a fractured bedrock aquifer for the remediation of a discharge site. The valley where the salt discharge is occurring does not flow as a stream but would naturally drain to the Ovens River during wetter weather. There is potential to collate information to link washoff of salt from these areas, which can be measured by the stream gauge, with particular weather sequences.

The catchment characteristics for the selected gauging sites are summarised below.

2.1 Ovens River at Peechelba (Site 403241)

The Ovens River drains from the northern side of the Great Dividing Range and discharges to the River Murray upstream of Yarrawonga. The Ovens River monitoring site 403241 is located at Peechelba. This site is being used by the Murray Darling Basin Commission for spot flow measurements and flood forecasting and would also be an appropriate location to monitor ‘End of Valley’ targets under the Salinity and Drainage Strategy, 2000.

It should be noted that although there is also a flow monitoring site upstream of Peechelba at Wangaratta (Site 403242) the Wangaratta site does not capture any flows from the Fifteen Mile Creek system which flows into the Ovens River downstream of Wangaratta (Refer to Figure 2.1). The Peechelba site was chosen to best represent the salt load reaching the River Murray from the entire Ovens River catchment.

There is some flow regulation on the Ovens system from Lake Buffalo on the Buffalo River and Lake William Hovell on the upper King River. These storages provide irrigation, stock and domestic and urban water supply and there is some power generation at Lake William Hovell.

There is presently no Bulk Water Entitlement requirement to maintain minimum passing flows in the Ovens System. Releases may be made from the storages during late summer-autumn to supplement Murray River flows, allowing reduced releases from Lake Hume.

2.2 Three Mile Creek (Site 403249)

The Three Mile Creek drains the area west of the King River and includes the combined flows from the Fifteen Mile and One Mile Creeks. The Creek passes through Wangaratta and discharges to the Ovens River downstream of the town. The upstream catchment terrain is generally flat (Riverine plain) and extensively cleared. There are a number of known salt discharge sites in the upper catchment. Runoff in the lower parts of the catchment includes town stormwater runoff and is also influenced by industrial effluent discharges to the creek.

An artificial floodway has been constructed just upstream of the Hume Highway to redirect a portion of high flows from the One Mile Creek to the King River. This system reduces flooding along the creek in Wangaratta. No records are available on the operation of the floodway.

2.3 Black Dog Creek (Site 403247)

Black Dog Creek originates near Chiltern and flows across the Riverine Plains to the River Murray. The catchment is mainly cleared and although there is some steeper terrain in the upper reaches, the predominant land management unit is Riverine Plain Upper Terrace. There are a significant number of noted salt discharge sites in the catchment (NESWG, 1997), particularly in the Springhurst Hills area. The catchment includes a large area on the Riverine Plain (in the Reedy Creek area near Wangaratta) where surface water can pond and will not necessarily always discharge to the Black Dog Creek system. As a result, flow and salinity data may exhibit very different characteristics during wetter climatic periods. Further investigation and documentation could allow catchment boundaries for both low flow and flood flows to be more clearly defined.

2.4 Indigo Creek (Site 403248)

Indigo Creek originates amongst some steep terrain north of Yackandandah and flows across the Riverine Plain Upper Terrace to the River Murray. The catchment is mainly cleared and has been identified as having a significant number of salt discharge sites (NESWG, 1997). The discharge sites are concentrated in the middle reaches of the catchment where there is a transition from the steeper terrain to the Riverine Plains.

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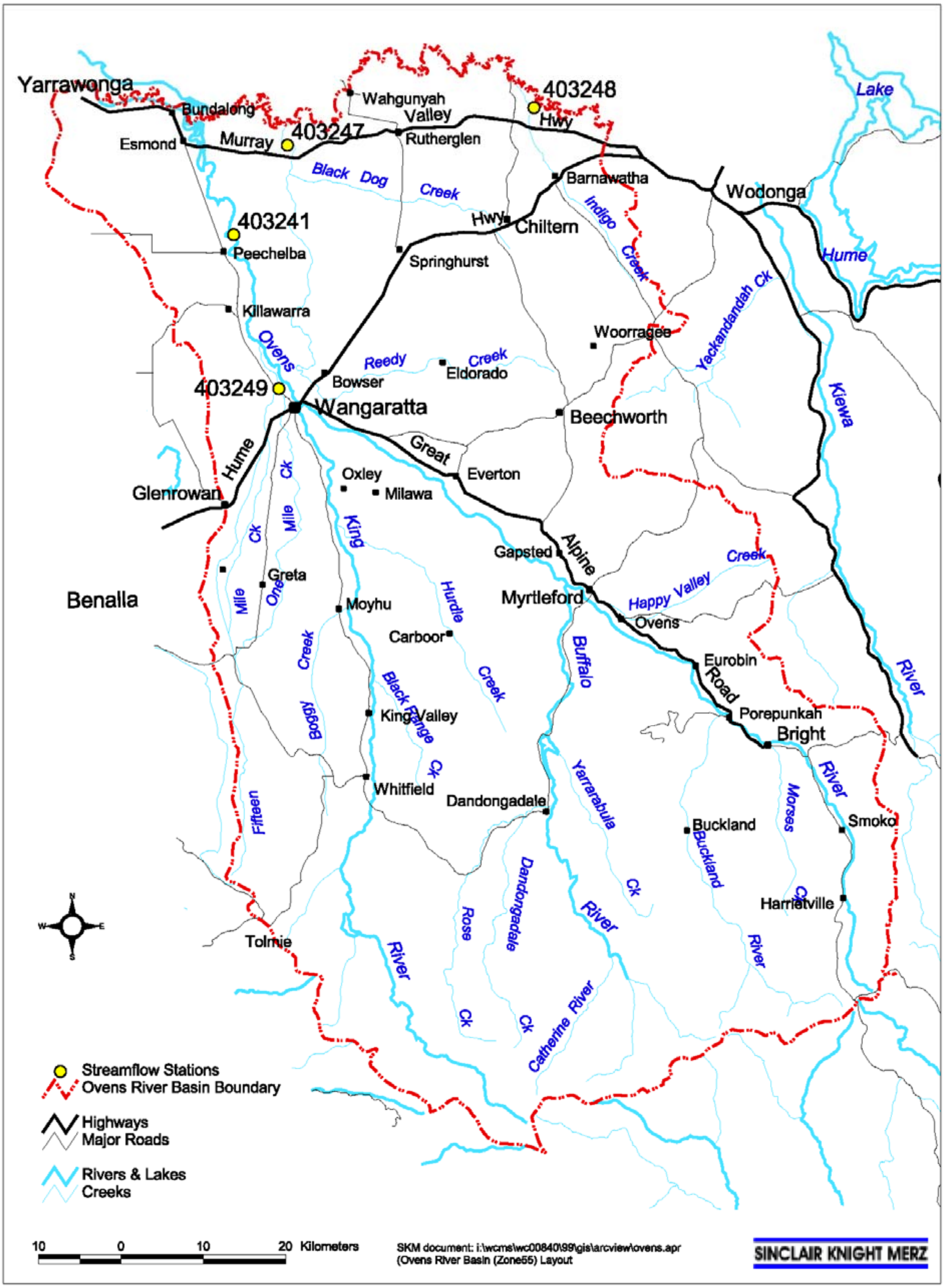
■ **Figure 2-1 Locality Plan**



3. Data Assessment

Theiss Services are contracted to monitor stream flow and salinity at the hydrographic stations. This includes basic site and equipment maintenance, the maintenance of station rating for accurate flow measurement, instrument calibration, data collection, initial quality assessment of data and data entry to the State stream monitoring database.

The process used to assess salinity data involves a number of steps. Initially, the data quality is assessed for completeness and accuracy. The assessment and documentation of problems with data collection then provides an indication of the degree to which statistics generated from the raw data represent the actual flow and salinity characteristics of the catchments during the year. The data is then infilled before salt loads are produced.

3.1 Data Availability

This report covers four hydrographic monitoring sites for the 2002 calendar year, as listed in Table 3.1 below. The table shows the total extent of data available at the sites. The North-East data collection program began in the latter part of 1998 and all data has been examined for completeness and integrity.

■ **Table 3.1: Data Available**

Station	Number	Parameter	Frequency	Start Date	End Date
Ovens River @ Peechelba	403241	Flow Salinity	Continuous Continuous	22/9/1998 22/9/1998	Ongoing Ongoing
Black Dog Creek	403247	Flow Salinity	Continuous Continuous	22/8/1998 22/8/1998	Ongoing Ongoing
Indigo Creek	403248	Flow Salinity	Continuous Continuous	24/6/1999 24/6/1999	Ongoing Ongoing
Three Mile Creek	403249	Flow Salinity	Continuous Continuous	2/6/2000 2/6/2000	Ongoing Ongoing

3.2 Data Collation During 2002

The raw data collected during 2002 has been plotted, with tables included in **Appendix A** for reference. Overall the data collected during 2002 was of a good quality with relatively few data gaps.

There were 60 days for which the quality code for flow was higher than 3 (ie. some editing required), whilst there were no days where the salinity code was greater than 3, excluding high quality codes associated with no flow. There was no missing data during 2002. Stations 403247 and 403248 had some flow data with the quality code 15, but this is considered to be good quality data that is estimated by Theiss. Stations 403247 and 403248 had periods where there was no flow and hence there was no salinity reading. There was therefore no estimation of data required during these periods.

A summary of the data collection problems is presented below:

- Some minor editing of the flow data was undertaken by Thiess.
- Stations 403247 and 403248 had significant periods with no flow due to drought conditions which resulted in high quality codes for the salinity data. This is not considered as a data error.

3.3 Proposed Additional Monitoring

One of the recommendations of the North East Salinity Strategy (NESWG, 1997) was that new flow and water quality monitoring sites should be established at a number of nominated locations within the Ovens Basin. The final location nominated for monitoring, which has not yet been established, is the Buffalo River near the Ovens River junction. It was also recommended that water quality monitoring should be re-established on the Ovens River at Wangaratta and Reedy Creek in Wangaratta North. These are yet to be established, although flow is currently monitored at these two sites.

Funding is yet to be made available for nutrient monitoring at any of the existing monitoring sites, as proposed in the salinity management strategy.

4. Flow and Salinity Statistics

4.1 Explanation of Statistics

The statistical analysis is based on available raw data for the monitoring sites listed in Table 3.1. Flow and salinity statistics for 2002 are presented in Table 4.1 and Table 4.2. The following statistics have been derived from the available data:

MEAN DAILY - the average value of all measurements on a specified day.

MEDIAN - the value above (or below) which half the data set falls. The median gives an indication of the 'most usual' flow or salinity in the stream.

UPPER QUARTILE - the value below which three quarters of the data set falls, giving an indication of how high the flow and salinity can ordinarily get without being influenced by extreme events.

LOWER QUARTILE - the value below which one quarter of the data set falls, giving an indication of how low the flow and salinity ordinarily falls without being influenced by extreme events.

MAXIMUM - the highest value recorded. It is generally not a good indication of the flow or salinity of the stream because such a high value may be rare. However it is sometimes useful to be aware of extreme values.

MINIMUM - the lowest value recorded. It is generally not a good indication of the flow or salinity of the stream because such a low value may be rare.

SALT LOADS – a measure of the total quantity of salt transported by a stream, measured in tonnes. The figures quoted in this report are based on mean daily values, which have been calculated by averaging the instantaneous salt loads throughout the day. The figures quoted (tonnes per month) represent the sum of daily values within a month. The instantaneous salt load is calculated as follows:

$$\textbf{Salt Load} = \textbf{Flow (ML/day)} \times \textbf{EC } (\mu\textbf{s/cm}) \times (0.6/1000)$$

FLOW WEIGHTED SALINITY (FWS) - a measure of the average salinity for a defined period. This measure is of particular relevance to downstream interests. In many Australian streams the salinity during average to high flow events is much lower than the salinity during low flow periods. The FWS is derived by dividing the total salt load for a study period by the total flow for the same period (which produces a salinity in tonnes/megalitre) then dividing by (0.6/1000) to express the result in the more familiar EC units.

4.2 Flow Statistics

The key flow statistics as described in the previous section are presented below in Table 4.1. Time series plots of the raw flow data are included in Appendix A. Note that there are no time series plots available for Black Dog Creek (Station 403247) as this station had no flow for 2002.

- **Table 4.1: Statistical Analysis of Flow (ML/day)**

Station Name	Station Number	Period of Analysis	Mean Daily	Median	Upper Quartile	Lower Quartile	Max	Min
Ovens River @ Peechelba	403241	1/1/2002 – 31/12/2002	1,111	475	1,576	326	6,074	56
		22/9/1998 – 31/12/2002	3,558	1,270	3,862	443	95,667	56
Black Dog Creek @ Parris Rd, Brimin	403247	1/1/2002 – 31/12/2002	0	0	0	0	0	0
		22/8/1998 – 31/12/2002	29	0	8	0	1,695	0
Indigo Creek	403248	1/1/2002 – 31/12/2002	1	0	3	0	15	0
		24/6/1999 – 31/12/2002	29	6	15	2	2,284	0
Three Mile Creek	403249	1/1/2002 – 31/12/2002	26	9	40	3	283	0
		2/6/2000 – 31/12/2002	88	33	84	8	1,456	0

Dry conditions prevailed during 2002 and no flow was recorded in Black Dog Creek. The upper quartile for Black Dog Creek is low due to the large number of zero flow events. Three Mile Creek has retained flow throughout most of 2002 whereas Indigo Creek flow largely occurred from late Autumn to mid spring. The reason for this is not clear.

4.3 Salinity Statistics

The salinity statistics presented in this report are all quoted in Electrical Conductivity (EC) units of microsiemens per centimetre (µs/cm) at 25^0C. The key salinity statistics are presented in Table 4.2 and time series plots of the raw data, other than Black Dog Creek, are included in Appendix A.

A number of observations can be made from this information:

- Salinity concentrations in 2002 have increased compared to 2001 data, as presented in the 2001 SKM report, which is to be expected as the climate has been drier due to the drought.
- There is a distinct flow pattern observed for each catchment which may influence the salinity statistics:
  - The Ovens River gauge shows a distinct low flow period from January to May 2002. The corresponding salinity measurements are high compared to the rest of the record. The latter part of the year is opposite, with higher flows and a lower salinity pattern. Large short term peaks in salinity during low flow periods tend to follow high salinity events in Three Mile Creek. The three peaks occur in late March, mid April and late November.
  - The Black Dog Creek had no flow for the year and therefore no salinity analysis can be undertaken.
  - The Indigo Creek gauge shows no flow from mid-January to mid-May 2002. Therefore there are no corresponding salinity measurements for that period.

As in 2001, salinity statistics for 2002 at Three Mile Creek indicate that the salt generation characteristics are different to the other catchments. This is evident from the large difference between mean daily salinity and flow weighted salinity compared to the difference in these statistics at the other sites. In addition, cyclic changes in salinity may suggest cyclic releases from a point source.

- **Table 4.2: Statistical Analysis of Salinity (µs/cm)**

Station	Number	Period of Analysis	Flow Weighted Salinity	Mean Daily	Upper Quartile	Median	Lower Quartile	Max	Min
Ovens River @ Peechelba	403241	1/1/2002 – 31/12/2002	61	76	88	78	62	175	42
		22/9/1998 – 31/12/2002	53	74	88	69	54	175	36
Black Dog Creek @ Parris Rd, Brimin	403247	1/1/2002 – 31/12/2002	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		22/8/1998 – 31/12/2002	134	189	224	184	156	327	70
Indigo Creek	403248	1/1/2002 – 31/12/2002	580	615	623	576	547	988	432
		24/6/1999 – 31/12/2002	189	442	568	447	321	988	77
Three Mile Creek	403249	1/1/2002 – 31/12/2002	293	766	1387	475	236	2,027	88
		2/6/2000 – 31/12/2002	131	528	811	249	115	2,069	55

Note: N/A Data not available due to no flows for the year

4.4 Salt Loads

Salt loads have been calculated on a daily basis as described in Section 4.1. There were no sites that required an examination for missing flow data and therefore there was no infilling of data. A summary of monthly salt loads and corresponding flow weighted salinities is presented below in Table 4.3.

■ **Table 4.3: Monthly Salt Loads, 2002**

Month	Monitoring Station											
	Ovens River at Peechelba 403241			**Three Mile Creek 403249**			**Black Dog Creek 403247**			**Indigo Creek 403248**		
	Flow (ML/mth)	Salt Load (t/mth)	FWS (µs/cm)	Flow (ML/mth)	Salt Load (t/mth)	FWS (µs/cm)	Flow (ML/mth)	Salt Load (t/mth)	FWS (µs/cm)	Flow (ML/mth)	Salt Load (t/mth)	FWS (µs/cm)
January	12,138	610	84	113	31	458	0	0	na	3	2	761
February	9,431	528	93	150	70	783	0	0	na	0	0	na
March	10,070	532	88	205	120	976	0	0	na	0	0	na
April	10,428	543	87	138	111	1,337	0	0	na	0	0	na
May	13,772	725	88	270	148	911	0	0	na	17	10	947
June	45,003	1,637	61	1,374	183	222	0	0	na	94	38	677
July	88,390	2,679	51	1,670	186	186	0	0	na	131	44	563
August	71,136	2,311	54	1,830	204	186	0	0	na	119	39	547
September	74,807	2,491	56	2,105	236	187	0	0	na	131	41	526
October	49,643	1,768	59	1,068	179	279	0	0	na	33	10	499
November	14,345	673	78	395	122	516	0	0	na	0	0	na
December	6,530	378	97	74	58	1,314	0	0	na	na	na	na
Total	405,692	14,874	61	9,391	1,648	293	0	0	na	529	184	580

4.4.1 Salt Generation Processes

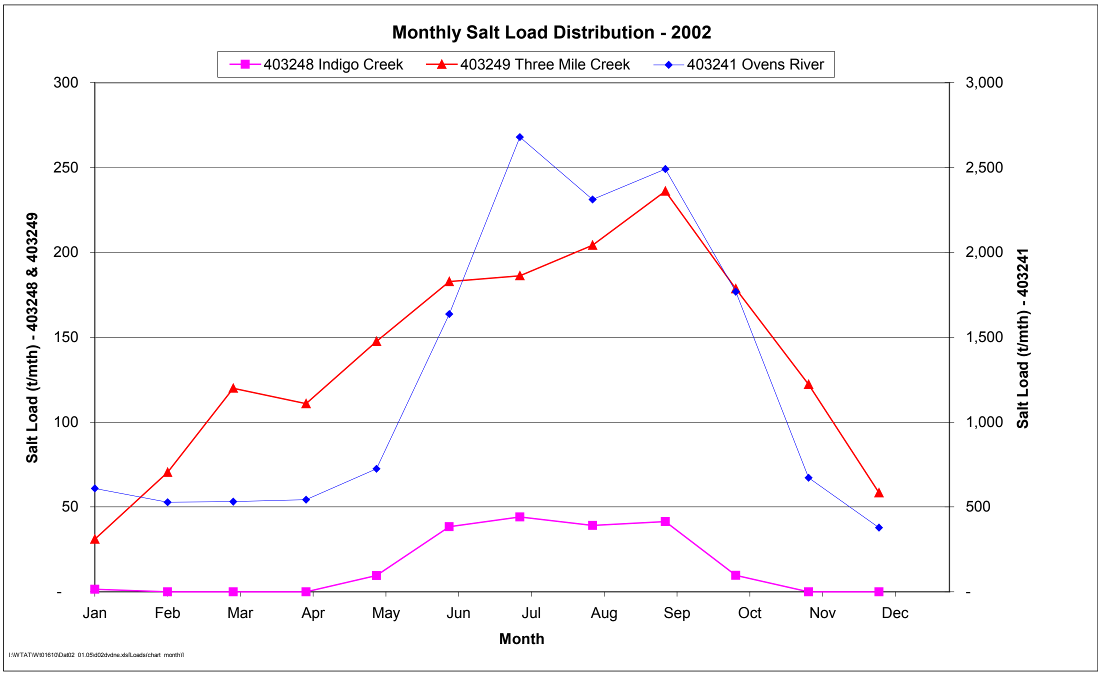
The salt generation processes for each catchment can be examined at a number of different levels using catchment parameters. Some of the catchment information available for the north-east region includes:

- Digital Elevation Model (DEM)
- Land systems
- Landuse
- Salinity discharge sites
- Geology and soil data

In future, these could be used with the stream monitoring information to help identify the salt generation processes in catchments (and potential solutions). Further work is also required to map the low flow and high flow catchment boundaries (ie. identify areas where gauged areas may differ due to events such as floods) and to better determine the areas contributing to flow. Until this work is done, analysis will be reasonably simple.

The monthly breakdown of salt loads for all stations is shown in Figure 4-1. This plot shows that the higher salt loads were generated during winter when higher rainfall resulted in higher runoff to streams and rivers. The relative rise in salt load is most noticeable in the Three Mile Creek catchment, which indicates that the salt generation processes may be different between catchments. Further investigation may provide a better understanding of the processes that cause these types of observations.

- **Figure 4-1 Monthly Salt Loads**



Note: Ovens River follows a similar pattern to Indigo Creek but loads are significantly larger. Black Dog Creek has not been shown due to no flow for 2002.

5. Conclusions

The following conclusions are drawn from the monitoring information collected during 2002 and the 2002 data analysis:

- The North East stream monitoring data for the year 2002 was of good quality.
- There were no gaps in the records.
- During 2002, flow and salt loads were significantly reduced from previous years due to the drought conditions.
- The following catchment information is currently available from NRE:
  - Digital Elevation Model (DEM)
  - Land systems
  - Landuse
  - Salinity discharge sites
  - Geology and soil data

  This information could be used to examine salt generation processes and possibly target areas of higher salt load contribution for assessment of remedial options.

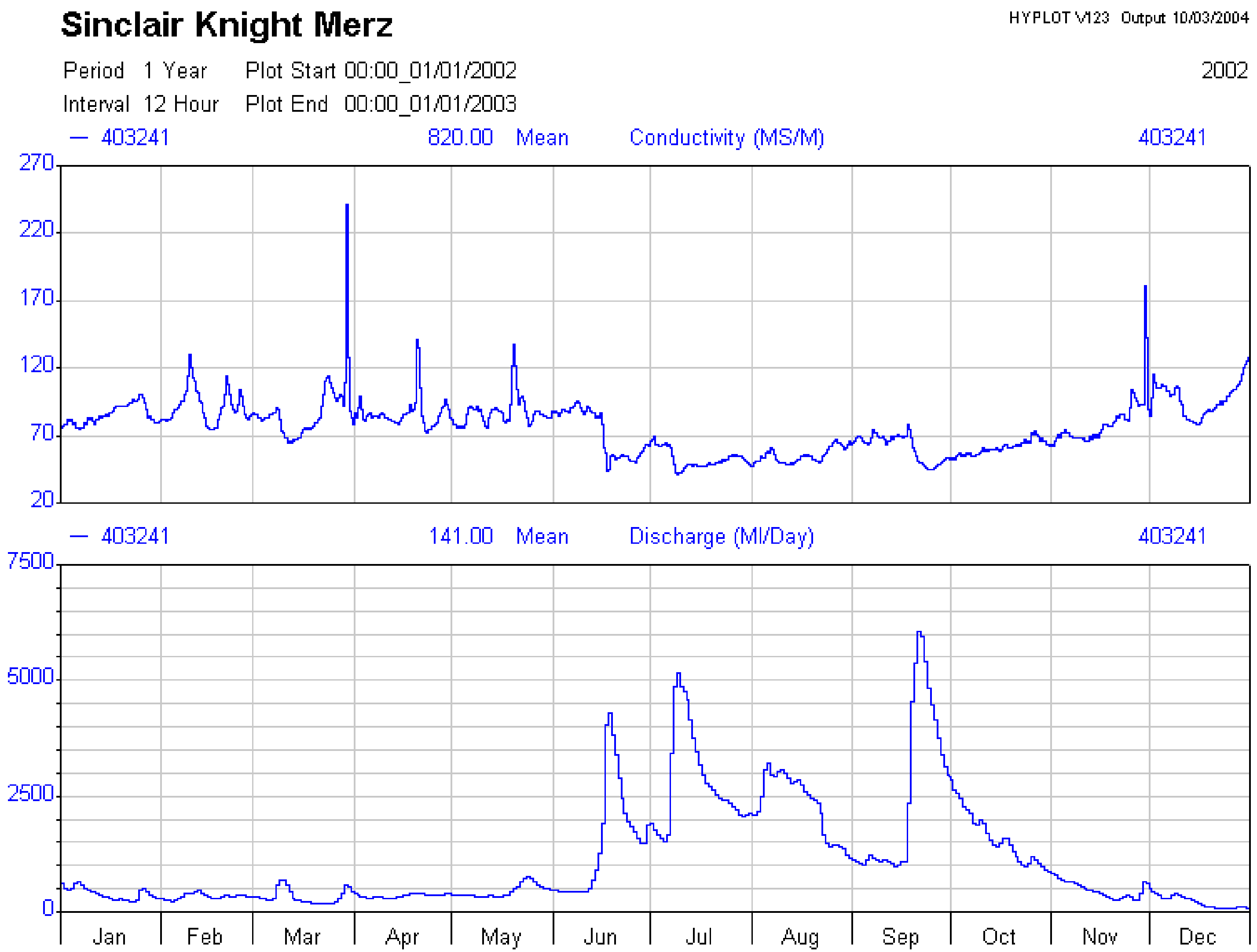
6. Recommendations

The recommendations from this report are:

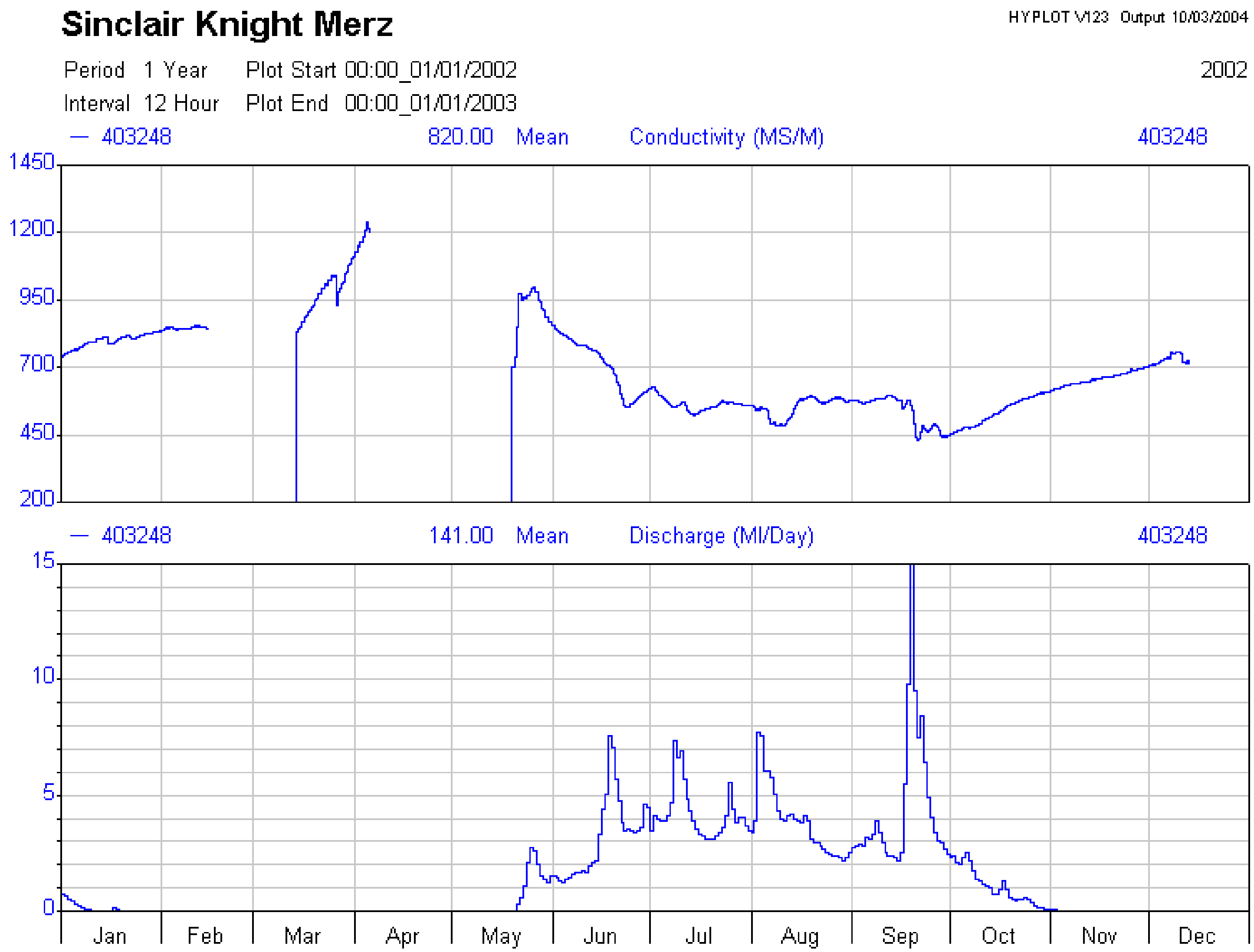
- Data collection at the four locations included in this study should continue in order to provide an on-going record of flow and salinity parameters in the Ovens catchment.
- Consideration should be given to the continued development of more detailed catchment and climate information (based on the monitoring data available) that will assist with the future evaluation of the North-East Salinity Strategy. This process has been initiated and should be formally coordinated to ensure efficient utilisation of resources.
- Further investigations are required to deal with water quality issues in Three Mile Creek.
- Catchment boundaries should be defined for both low flow and high flow conditions to enable better understanding of salt load generation.

Appendix A Raw Data Plots

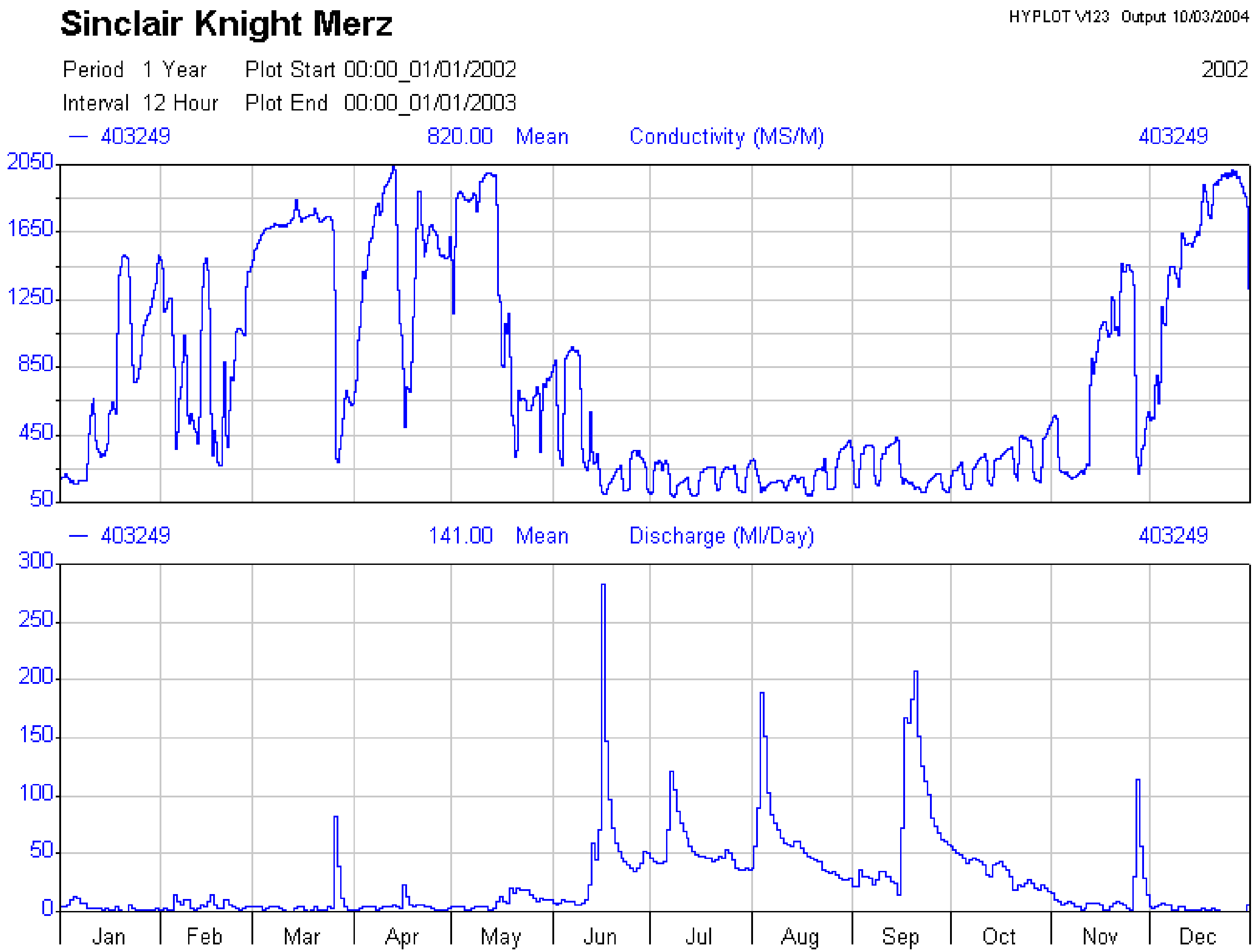
■ **Figure 6-1 Ovens River – Station 403241 Flow and Salinity 2002**



- **Figure 6-2 Indigo Creek – Station 403248 Flow and Salinity 2002**



■ **Figure 6-3 Three Mile Creek – Station 403249 Flow and Salinity 2002**



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Appendix B Missing Data

- **Table 6-1 Missing Data Summary - 2002**

Station Name	Station Number	Parameter Measured	Raw Data Missing (1)	Estimated During Processing (2)	Final Data Missing (3)	Comment
Ovens River @ Peechelba	403241	Flow	0	0	0	-
		Salinity	0	0	0	-
Black Dog Creek @ Parris Rd, Brimin	403247	Flow	0	0	0	-
		Salinity	0	0	365	Due to no flow
Indigo Creek	403248	Flow	0	0	0	-
		Salinity	0	0	185	Due to no flow
Three Mile Creek	403249	Flow	0	0	0	-
		Salinity	0	0	6	Due to no flow

Note : Missing salinity data during periods of no flow were not included in the above table, as salinity data is not expected in a dry stream.

(1) Raw data missing - is classed as the data obtained directly from the on site logger.

(2) Estimated during processing - is classed as the data which has been estimated by Thiess during initial processing.

(3) Final data missing - is classed as the data which cannot easily be estimated and is classed as missing.

The following data is not classed as missing from the raw data set:
Estimated data with a quality code of 15* or less is considered good quality data.

Appendix C Estimated Data

- **Table 6-2 Estimated Data Summary**

Station Name	Station Number	Parameter	Code				Flow QC 1-99	Flow QC 100-150	Salinity QC 1-99	Salinity QC 100-150
			1	2	15	150				
Ovens River @ Peechelba	403241	Flow	0	365	0	0	365	0	-	-
		Salinity	0	365	0	0	-	-	365	0
Black Dog Creek @ Parris Rd, Brimin	403247	Flow	0	348	17	0	365	0	-	-
		Salinity	0	0	0	0	-	-	0	0
Indigo Creek	403248	Flow	45	277	43	0	365	0	-	-
		Salinity		180	0	0	-	-	180	0
Three Mile Creek	403249	Flow		365	0	0	365	0	-	-
		Salinity		359	0	0	-	-	359	0

1 Good continuous data
2 Good quality edited data
15 Minor Editing of record
150 Rating extrapolated due to insufficient gaugings

Comments

The quality code (QC) is used to represent the accuracy of the data. The higher the QC the less accurate the data is. QC's between 1 and 99 are classed as good reliable data with QC's from 100 to 150 classed as estimated data of less accuracy. Users need to be aware that data with quality codes higher than 99 should be re-examined before use in any important study.

The following comments are made regarding the estimated data presented in Table 6-2:

- A quality code of 150 indicates that insufficient measurements at high flows have been taken. Although this is the best estimate of flow at present, further high flow measurements will improve the accuracy of high flow records.