BANDED STILT *CLADORHYNCHUS LEUCOCEPHALUS* RESEARCH IN WESTERN AUSTRALIA IN 1995

WATER DEPTH & WATER QUALITY MEASUREMENTS

AQUATIC INVERTEBRATE SWEEPS

FOOD AVAILABILITY, FEEDING & DRINKING OBSERVATIONS

AT LAKES BALLARD & MARMION IN 1995

RESEARCH MATERIALS CONSOLIDATION REPORT

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Cover photo: Grant Pearson & Clive Minton wading from 'Camp Island' to the main Banded Stilt nesting colony on Lake Ballard on March 15th, 1995. © JAK Lane. The 'high water mark' on Clive's shorts provides a reasonable measure of the depth (maximum) of Lake Ballard at that time.

This **Research Materials Consolidation Report** is a preliminary stage in the preparation of research reports and publications relating to the Banded Stilt breeding event on Lakes Ballard and Marmion in Western Australia in 1995.

The purpose of an RMCR is to consolidate and conserve all of the research materials relating to a research project. The material reproduced here is in its original form, with limited or no reformatting.

FUTURE WORK

The next steps to be taken in finalising this RMCR and then preparing reports and publications based on its contents should be to:

- Look in the DPaW Busselton Lab (and, if not there, at DPaW Woodvale) for the 1995 Ballard & Marmion BaSt sweep (aquatic invertebrate) samples (and gut contents samples).
- Replenish the alcohol in the 1995 Ballard & Marmion BaSt sweep (and gut) samples.
- Seek funding to sort and ID the 1995 Ballard & Marmion BaSt sweep (and gut).
- Sort and ID the 1995 Ballard & Marmion BaSt sweep (and gut) samples.
- Ask Andy Chapman (ACh) for copies of his field notes from his approx. April-May 1995 field trip to Lake Ballard with JL & ACl. Copy these to this and other relevant BaSt RMCR's. Note that JL already has ACh's field notes from his June 1995 trip to Lakes Ballard & Marmion with GBP & ACl.
- Prepare Excel spreadsheets of all water depth and water quality measurements, water sampling and results of water sample analyses, at Lakes Ballard, Marmion & Crossover Lake in 1995. Before doing so, resolve the potential overlap with the Excel spreadsheets proposed for the 'BaSt Collected in 1995' RMCR, as both sets of spreadsheets will potentially contain water depth, water quality and sweep samples data.
- See yellow highlighted text in the remainder of this RMCR summary for other Future Work needed / desirable.
- Don't finalise any report on feeding by BaSt adults and chicks at Lake Ballard in 1995 without re-viewing the ABC TV Natural History Unit's footage (uncut), as this contains many 'observations'.

Photographs

The scanned (digital) copies of all photos taken at Lakes Ballard and Marmion in 1995 by JL, GBP, most or all of those taken by ACh, and some of those taken by CDTM, are on JL's office computer and backups. Few of these relate specifically to the themes of this RMCR. Those that do have been printed (thumb prints only) in this RMCR.

Note that CDTM – and maybe ACh – could perhaps have taken some photos relating to themes of this RMCR that JL does not have copies of (e.g. the taking of sweep samples?)

Field Notes

A separate RMCR of 1995 Field Notes has been prepared containing copies of the Field Notes made by J Lane (JL), G Pearson (GBP), A Clarke (ACl) and A Chapman (ACh) in 1995 while undertaking collaborative research with C Minton (CDTM) on Banded Stilts in Western Australia. All observations, measurements, etc., relating to the themes of this RMCR have been fully extracted to this RMCR (except the June 1995 field notes of ACh, see 'Future Work' above).

NOTES ABOUT THE CONTENTS OF THIS RMCR

As its title indicates, this RMCR draws together all of the materials relating to water depth and water quality measurements, aquatic invertebrate sweeps, food availability, feeding and drinking observations at Lakes Ballard & Marmion in 1995.

It is important to note that there is considerable overlap between this RMCR and the RMCR titled 'Banded Stilt Adults & Chicks Collected at Lakes Ballard & Marmion in 1995'. This is because water depth and water quality measurements were made, and water and sweep (aquatic invertebrate) samples were taken, at each of the locations on Lakes Ballard & Marmion at which BaSt were collected. Also, the gut contents of the collected BaSt were retained for dietary analysis. It will therefore be important, when preparing reports / publications based on the contents of either of these two RMCR's, to **check both** to make sure that all relevant materials are utilised. Note also that, although this RMCR should contain all materials relevant to preparing reports / publications on its themes, it would be a good idea to re-read all field notes before finalising such reports / publications, in order that nothing of importance is missed.

Materials that are in this RMCR, and not in the 'Collected BaSt' RMCR, are those relating to water depth and water quality measurements, water level recordings (Ballard only) and water and sweep (aquatic invertebrate) samples, at each of the locations in Lakes Ballard & Marmion and Crossover Lake where BaSt *were not* collected (noting that there were no BaSt on Crossover Lake). Also, all observations of potential food (particularly Brine Shrimp *Parartemia*), 'feeding' and 'drinking' are in this RMCR and not in the 'Collected BaSt' RMCR. This RMCR also contains all observations, calculations, etc. relating to lake filling & drying and extents of inundation, and 1995 rainfall and evaporation data for the Lakes Ballard & Marmion area (note that all weather observations made by JL, GBP, *et al.*, while on the lakes are to be compiled in another, yet to be prepared, RMCR). Materials concerning existing and potential threats, particularly hydrological, to BaSt in WA are also in this RMCR. Results of water sample analyses by WA Chem Centre are in both RMCR's.

Materials that are in the 'Collected BaSt' RMCR, and not in this RMCR, are those relating to water depth and water quality measurements, and water and sweep (aquatic invertebrate) samples, at each of the locations in Lakes Ballard & Marmion where BaSt *were* collected (noting that there were no BaSt on Crossover Lake). Of course, the 'Collected BaSt' RMCR also contains all particulars of the BaSt (adults & chicks) that were collected, including details concerning the gut samples (and some observations concerning the contents of those samples). All 2003 & 2005 correspondence relating to the sorting and identification of all sweep samples (and gut samples) is also *not* in this RMCR, but is in the 'Collected BaSt' RMCR – see next page. Results of water sample analyses by WA Chem Centre are in both RMCR's.

Note that from early 1995 to the early 2000s, Jim Lane (JL) was based in Busselton and technical officers Grant Pearson (GBP) and Alan Clarke were based at Woodvale (a northern suburb of Perth) – hence the many faxes and emails between JL and GBP listed below.

CONTENTS OF THIS RMCR

See the 'Banded Stilt Adults & Chicks Collected at Lakes Ballard & Marmion in 1995' RMCR for the following documents, all of which are relevant to this RMCR.

1. *Printout (31/3/2014) of document headed 'Search (Started by JL on 30/3/2014) for Correspondence / Results of Sorting & Identification of Banded Stilt Gut Samples and Sweep Samples from Lakes Ballard & Marmion in 1995'. JL stopped this search on 31/3/1995 when he felt he had found most or all of the relevant material (which was then incorporated into this RMCR, below).*
2. *Email exchange (22/12/2005) between ACl and Stuart Halse (CALM Woodvale) with attached agreement for SH to arrange / perform $8000 of identifications on aquatic invertebrate samples '... for the potential Directory [Directory of Important Wetlands in Australia] sites'. Note that the Lakes Ballard and Marmion BaSt gut contents samples and sweep samples are NOT in the list of sites of material to be identified. This was no doubt due to the full amount of funding requested by JL ($12,000 – see below) not being provided and priority being given to the other sites. Note that Lakes Ballard and Marmion were already listed in the 'Directory'.*
3. *Email exchange (02-03/11/2005) between JL and ACl that inter alia indicates that only $8000 had been granted for aquatic invertebrate identifications ($12,000 had been requested by JL – see below) and that it might not be possible to identify all of the aquatic invertebrate material collected from potential 'Directory' sites and Lakes Ballard and Marmion (which were already listed in the 'Directory').*
4. *Email (02/11/2005) from JL to ACL with an attached copy of JL's '2005/06 Funding Application' to the Dept. of CALM 'Wetland Conservation Program' for 'Specialist identification and significance assessment of aquatic invertebrate samples from existing and prospective Directory and Ramsar wetlands in remote regions of Western Australia'. Regarding Lakes Ballard and Marmion, it reads (inter alia): 'During the 1995 Banded Stilt breeding event at Lakes Ballard and Marmion, a number of sweep and gut samples of aquatic invertebrates were collected ...' 'All samples [potential 'Directory' sites and Ballard & Marmion?] have subsequently been sorted and separated into major taxonomic groups by STO [Senior Technical Officer] Alan Clarke with guidance from CALM limnologists'.*
5. *Email exchange (04-08/03/2005) between JL and ACl with an attached report by ACh '... outlining the current situation with the DIWA ('Directory') identification and analysis of aquatic invertebrate species [and the 1995 BaSt gut contents and sweep samples from Lakes Ballard and Marmion]'.* ***The status of the 1995 BaSt samples is described in detail (current storage location, contents, curation, sorting process required [still] before identification by a taxonomist). Note that '... because the alcohol dries out quickly some samples have been lost'.*** ***Look in DPaW Busselton Lab (and if not there, at DPaW Woodvale) for the 1995 Ballard & Marmion BaSt gut contents and sweep samples.***
   A 'breakdown' [two Tables in MSWord] of the '[1995 BaSt] samples that need sorting' is attached'. These are 'BALLARDN.doc' and 'MARMIONT.doc'. ***Use these to locate all the samples*** *and perhaps as a basis for preparing a more-comprehensive Excel spreadsheet(s) of the collected materials.*
6. *Undated, annotated, earlier printouts of the two Tables in MSWord of the 1995 BaSt samples that need sorting. These are the Tables included in the email exchange of 04-08/03/2005 above.*
7. *Undated, annotated, earlier drafts of the two Tables in MSWord of the 1995 BaSt samples that need sorting. These are the Tables included in the email exchange of 04-08/03/2005 above.*
8. *Email (03/12/2003) from ACl to JL which, inter alia, indicates that, at that point in time, the 1995 BaSt gut contents and sweep samples from Lakes Ballard and Marmion had NOT been sorted (a necessary preparatory step before identification). AC seeks to 'discuss the options and timing' with JL.*

CONTENTS OF THIS RMCR – CONTINUED

This RMCR contains:

9. A one page, hand-written note (30/4/2014) by JL which indicates that copies of some 1995 BaSt water chemistry results (from WA Chem Centre) are on JL's 'Dawesville Channel Impacts' file/s (because some 1995 BaSt water samples were sent to WACC by GBP together with samples from Harvey River and elsewhere). JL thinks (03/4/2014) that the data being referred to has probably all been captured in this RMCR, but if any are missing, that would be a place to start looking for them.

10. Part of what appears to be a fax (20/2/2001) (but note that year is difficult to read) from JL to CDTM in which JL writes, inter alia: 'We will be making a start on the Ballard-Marmion sweep & gut samples in a few months time ...'

11. Faxed (on Fri 17/03/2000; from JL to GBP) copies of a 1999/2000 Budget Request and a Science Project Plan for SPP 'Breeding ecology and conservation of Banded Stilt'.

    The Budget Request refers to: 'Sorting, identification and quantification of aquatic invertebrate sweep samples from 1995 breeding event at Lake Ballard' as one of several 'Planned Achievements for 1999/2000'.

    The Science Project Plan refers to: lake hydrology, potential mining industry impacts on salt lakes, salinity, water chemistry, diet, 'conduct macroinvertebrate (standardised sweeps) to monitor food availability', 'install continuous recorder to monitor lake water level', 'sample water chemistry' and 'water depths'. 'Sorting, identification and quantification of macroinvertebrate sweep samples ...' is listed in the SPP as a 'Phase 1: (1995-2000)' milestone to be completed by Dec 1999. The SPP also says (Item 22) that 'Data from a continuous water level recorder (Lake Ballard 1995) are on a disk in a datasafe in JL's office. The 1995 macroinvertebrate samples are held and curated by A. Clarke at CALMScience Woodvale'.

12. File record (16/3/2000) by JL headed 'Calculation of Banded Stilt Funds Available as at 16 March 2000'. Inter alia this records that: 'On 26 Nov 1998 Keith Morris [CALM] sent me an email (v4 f16) saying he would provide $5,000 to enable me to employ an assistant to analyse the Banded Stilt samples ...'; that this money '... went into [a Trust Account], and that as at 16/3/2000 'There is still $5,078.80 available in [a Trust Account] to spend on analysing the BaSt invertebrate samples'. Were these funds spent?

13. Hand-written notes made by JL at 'Salt Lake Ecology Seminar' held on 07/7/1999 at the Perth Zoo Conference Centre. Reference made to:
    - Bernard Bowen (reservation of salt lakes for conservation);
    - Jacob John (characterisation of salt lakes, stratification, algae, phytoplankton, macrophytes, stratification, no fish; Lake Carey, depth, salinity, nutrients, pH);
    - Shane Chaplin (Lake Carey, aquatic invertebrates, rainfall, salinity, de-watering of mine site, salinity tolerances, biomonitoring, Nick Dunlop, 'Granny Smith (Placer)');
    - Jeremy English (*Halosarcia*, salinity and waterlogging tolerance, Hannan Lake, rehabilitation);
    - Mike Lyons (botany of Wheatbelt salt lakes, biogeography, macrophytes, conservation status);
    - Stuart Halse (aquatic invertebrates, salinity tolerances, fresh phase of salt lakes, Wheatbelt survey, conservation significance, threats, small freshwater pools around salt lakes);
    - Phil Commander (salt lake hydrology, palaeochannels, evaporation, groundwater flow, mining, dewatering and disposal of saline water, acidity, ecology, hydrological change, 'Directory of Important Wetlands in Australia');

- Jeff Turner (surface water hydrology, groundwater recharge, water shortage for mining, rainfall and runoff, water use volumes, palaeochannels, catchment characteristics and runoff);
- Brian Fowler (Lake Wannaminga, mine water discharge, 'Golden Grove Mine');
- Celeste Beavis (Lake Carey, potential impacts of mining in salt lakes);
- Greg Morris (Lake Lefroy, biodiversity, causeways, exploration, drilling, islands, dumping, site management, rehabilitation);
- Rory Lamont (Aboriginal people, Wongai, Lake Carey);
- Mark Coleman (Kathey Meney, criteria for salt water discharge to agricultural zone wetlands, evaporation rate varies 70% with salinity? and with depth, nutrients and lake bed permeability, changed ... (pH?) killed brine shrimps at Port Hedland salt works?).

See JL's office computer for a digital copy of the published Proceedings.

14. Article in 'The [WA] Naturalist News' (May 1999) by Kevin Coate reporting nesting of BaSt on Lake Goongarrie in April 1999. Refers to feeding; '... shallow water had an abundance of Brine Shrimps'; low water depth; needs follow up rain, and 'Shield Shrimp and Brine Shrimp were plentiful in ephemeral lakes ...'.

15. Article in 'Antipode AFA – News Francais et Australien – No.5 – Dec 1997' by JL describing BaSt breeding event. Refers to: 'salt-encrusted pans', Fairy Shrimp *Parartemia* and their eggs, water depth, salt water, chicks feeding, diet, aquatic invertebrates, lake filling and drying, drought resistant Fairy Shrimp eggs, French SPOT satellite system, BaSt first described by French scientist Vieillot in 1806. This article was published in French.

16. Phone message recording that Andrew Storey attempted to phone JL on 22/8/1997. See fax of 24/7/1995 below for probable reason for this call.

17. Fax (04/8/1997) from JL to GBP with a copy of the WA Chem Centre 'Report on 32 samples of water received on 4 September 1995'. It appears that this report was issued by WACC on 26/10/1995. It reports the results of analysis of samples 1-20 & 32, which were apparently collected at Lakes Marmion & Ballard (& Crossover Lake?). The results are ECond (mS/m) of 11 samples (3, 5, 13-20 & 32), and Tot N and Tot P of the remainder (10 samples 1, 2, 4 & 6-12). This fax relates to JL's email request (for collection details) to GBP earlier the same day (04/8, see below).

18. Email (04/8/1997 at 0717hrs) from JL to GBP referring to the WA Chem Centre report (to GBP) of 26/10/1995 and requesting that GBP fax to him '... collection details (date, location, etc.)' of the Lake Ballard samples. JL faxed GBP a copy of WACC's report later the same day (04/8), see above.

19. Fax (01/8/1997) from JL to CDTM saying, inter alia, 'I spent yesterday in Perth with Grant [GBP] & Alan Clarke [ACl] sorting out the water level & water quality info and organising the ... sweep (invertebrate samples). Grant did have the missing info about the [depth measuring] stick [on Lake Ballard] so the water level info now looks good'.

20. Two pages of hand-written notes (31/7/1997) by JL saying, inter alia:
    - 'Alan [ACl] to get evapn [evaporation] map ... to determine evapn rates at [Lakes] Ballard, Barlee & Marmion in 1995';
    - (Crossed out): '[GBP] thinks the [depth measuring] stake with tape we placed on south side of the island [Camp Island] on 15/3/95 wasn't there when we went looking for it';
    - (Also crossed out): 'Me look at photos [3638-39] of Grant & Clive washing on south side of Camp Island on 15/3. Is the [depth measuring] stick in the photo?' (JL checked photos on 02/4/2014. Answer is no);
    - 'Me check Harvey River [salinity profiling] reports [by WA Chem Centre] for Lake Marmion water analysis results'.

21. Fax (30/7/1997) from CDTM to JL saying, inter alia: 'My only note [about water level recordings] in my diary is the one you already have. Grant [GBP] will be able to answer you question about the [depth measuring] stick position [on Lake Ballard] I hope'. This fax was in response to JL's questions of 23/7/1997, see below.

22. Copy (29/7/1997, supplied by WA Chem Centre) '... of Report on 77 samples of water received on 26 June 1995'. See GBP's letter of 26/6/1995 to WACC (and initial, unsent copy of 24/5/1995) for details of these samples.

23. Folios 10-24 (Vol.5) of JL's BaSt files is data supplied in 1997 by Bureau of Meteorology. The data are: 1995 daily precipitation (rainfall) data for Leonora (Sites 012272, 012061, 012046, 012032), Menzies (012187, 012052, 012051, 012043, 012037) & Sandstone (012022). Note that Menzies site 012037 is 'Menzies (Jeedamya)'. The coordinates (lat long) of each station are supplied. 1995 daily evaporation data for: Meekatharra (007045), Kalgoorlie (012038). 1967-1997 monthly evaporation (and means, medians, max, min) data for Meekatharra (007045) and Kalgoorlie (012038). JL has annotated with, inter alia, calculations of total evaporation at Kalgoorlie and rainfall at Jeedamya from 1/3, 2/3 & 3/3 to 15/31995.

24. Folio 9 (Vol.5) of JL's BaSt files is an annotated copy (29/7/1997) of a graph of Lake Ballard water levels in 1995. The logger depths are continuous and are from Julian Day c.92 to c.257 (by eye), i.e. from c.02/4/1995 to c.14/9/1995. Annotations (20/8/1997) by JL say: 'Need to subtract 0.05m from all these logger depths' and 'Level on 15/3/97 [incorrect, year should be 1995] should be 0.52m'. Rainfall and evaporation were to be added to this graph.

25. 'Folio 8' (Vol.5) of JL's BaSt files. This 'folio' is actually a single plastic wallet containing a bunch of papers relating to calculation and graphing of water levels at Lake Ballard in 1995. They include,:

    - A partial printout (BALL1995.CH3) of water level data with the annotation (by JL, on 20/8/1997): 'Now need to subtract 0.05m (because originally added 0.02m when should have subtracted 0.03m) from all the final record values in the Paradox & Harvard Graphics data files' 9e.g.
    - A single hand-written page of water level calculations and source notations.
    - Annotated printouts (10/7/1997 - BAX.DB, BA.DB, BA16195X.DB) of water level values (all values and daily averages, maxs & mins) to Julian Days 160 (09/6/1995) and 161.

    TO DO: Find these data files (see below). Convert them to Excel?

26. Folio 7 (Vol.5) of JL's BaSt files is a copy (29/7/1997) of a graph labelled 'Lake Ballard 1995: Difference between daily Min & Max water levels'.

27. Printout (undated) of data from logger (water level recorder) installed at Lake Ballard. This printout appears to be all data from initial 'set up at Woodvale) to 'installed at Lake Ballard 2/4/95 [02/4/1994]' to (inferred from what appear to be Julian Days) the 10th June 1995. According to GBP's report and field notes the logger was downloaded on 9th June 1995. Why the apparent discrepancy? Probably resolved by GBP / Yvonne Winchcombe when the data was graphed (see 'graph (printed 23/7/1997)' above). Note that, according to the Science Project Plan faxed on Fri 17/03/2000 from JL to GBP (see above) 'Data from a continuous water level recorder (Lake Ballard 1995) are on a disk in a data safe in JL's office'. Also see 11/7/1997 above (and elsewhere in this RMCR) for related materials.

28. Three page draft (incomplete) document prepared (22-24/7/1997) by JL and headed **'The Following is the Makings of the "Water Depth and Quality Section" of the Final Publication on the 1995 Banded Stilt Work'.** It contains all or most observations, in chronological order, relating to Water Depth, some of Water Temperature and Water pH,

none of Water Salinity and none of Water Phosphorus (or other parameters, e.g. Nitrogen) of Lake Ballard, and no observations of Lake Marmion. It has important hand-written annotations. TO DO: Find electronic copy of this document (Found 02/4/2014 – it is 'BALLWATR.doc'). Complete all sections? Consider also doing Lake Marmion (and Crossover Lake?) the same way?

Accompanying is a graph (printed 23/7/1997) of Lake Ballard water depth comprising guesstimates of levels on 25/2/1995 (dry), 04/3, 12/3 & 15/3/1995, plus recorded levels (maxs, mins, means of logger recordings to Julian Day c.160 = 09/6), 'measurements of depth at stake on north side of Camp Island', and a single record (02/5) 'when boating about lake'. A note (20/8/1997) by JL reads: 'Need to subtract 0.05m from all these depths'. Another note reads: 'Were any depths greater than that at Camp I. found?' There should be some later (> 09/6/1995) logger recordings – see 23/7/1995 below). TO DO: Finalise this graph, the files (Paradox software?) are in JL's 'BALDEPTH' sub-folder.

29. Extract (written soon before 31/7/1997) from a 1995 Field Notebook of GBP that refers to planned meeting (see 24/7/1997 below) of JL, GBP & ACl re 1995 work. GBP has written, inter alia: 'Marmion Depth 110 {77, 88} 108 {220, 112}'. Presumably these are water depth calculations (subtractions) using measurements (in cm & mm) made by GBP at a post (posts?) at Lake Marmion in June 1995.

30. Extract from a 1995 Field Notebook of GBP that reads 'Salinity data' and 14/9/95 [14/9/1995] 88.3%. This was probably a water sample taken by GBP at Lake Ballard on that date. Is there another GBP Field Notebook (or report) referring to GBP's visit to Lake Ballard on 14/9/1995? See 29/8/1995 below. See also '23/7/1997'; 'Copy [12/2/1996] of Report ...'; and 'Folio 9 (Vol.5) of JL's BaSt files ...' below.

    JL thinks (05/4/2014) that this field notebook entry was actually made by GBP soon before 31/7/1997 as it refers to that date and is in the same biro and hand-writing as the next page of that date, see above.

31. Fax (24/7/1997) from JL (at Busselton) to GBP & ACl (at Woodvale) arranging for all three to meet at Woodvale 'next Thursday' [31/7/1997] to sort out the Ballard, Crossover lake and [Lake] Marmion invertebrate sweep samples ... [collected in 1995] ...' and to have all relevant research materials on hand '... so that we can clear up all uncertainties before discussing with Andrew Storey [UWA-associated aquatic invertebrate specialist, see phone message of 22/8/1997 above] how they are to be analysed and a price'. ACl was also to 'obtain and fax to me the monthly evaporation rates for Lake Ballard from the Met Bureau' (done, see above).

32. Fax (23/7/1997) from JL to CDTM indicating that: 'I am currently working on the water level and water quality data from Lake Ballard'. JL asks whether CDTM has any other (in addition to 14/4/1995) depth records for Ballard – in particular from the stick installed (on 15/3/1995) on the south side of Camp Island, and did CDTM visit Ballard in 1996. Note JL also writes that the logger data '... from the period 10 June [10/6/1995] to 14 September [14/9/1995] (when the recorder was retrieved [by GBP]) will be added [to the attached graph] next week.

33. Tables (faxed 22/7/1997, from ACl/GBP to JL) detailing all the gut and sweep samples collected at Lakes Ballard and Marmion (and Crossover Lake – sweep samples only) in 1995. There is also a map of Lake Ballard annotated by ACl that inter alia indicates where 'most birds [BaSt] taken [collected]' and 'Dist. between Tripod & Camp [Islands] 16km'. The Tables have many important annotations and some corrections by JL, ACl and or GBP. See further above for revised versions.

    These are the same or similar to the Tables used in 2005 (see above). The Lake Ballard Tables are the same as those first sent to JL by ACl on 30/1/1996 (see below).

34. Fax (11/7/1997) from JL to ACl & GBP asking if they ever made any water level observations using the stick that was used to mark the water's edge on the south side of

Camp Island on 15/3/1995, and for copies of the Lake Ballard (1995) water analyses (salinity and nutrients) results. Also, JL asks GBP to '... send me a copy of the data from the data logger from 9 June [1995] to when you retrieved it on (16?) September 1995'. A graph of Lake Ballard water logger data to c.09/6/1995 is attached (note that this was named and located at 'C: BANSTILT\BALDEPTH\ball1995.ch3'.

35. Fax (10/7/1997) from JL to ACl requesting him to arrange for David Cale [an aquatic invertebrate specialist] to be employed '... to sort, etc., twenty samples [sweep or gut and from where and when unspecified] at $125 per sample. Were these BaSt sweep samples (or gut samples) from Lakes Ballard and/or Marmion in 1995? Was the work arranged and done?

    Note that JL's fax was in response to a fax (attached) of the same date (10/7/1997) from ACl to him, the cover page of which reads 'For your info as requested'. Attached to this fax is a sticker in JL's handwriting inter alia calculating the cost of 20 samples at $125 / sample to be $2500. This was presumably a record of a phone conversation between JL and ACl before JL's fax of 10/7/1997. Is '$350 take away' of any assistance in working out what later transpired?

36. A list of the photos (35mm colour positive slides) used by JL for presentations about the 1995 BaSt work on (25th?) Sept 1996 (RAOU WA Group, Perth) and on 07/10/1996 (SHOC, Albany). Include are slides showing 'washing/preening/ drinking stilt (15/3) [3615] and '2 stilt drinking (15/3)' [3589]. There is also a slide of '[ACl] ... in shallow water ... in punt ... [4177]' and 'nests washed away (5.95)' [4148].

    Prints (thumbnails) of these and other photos of BaSt drinking, ACL in punt in shallow water, and nests washed away are here.

37. Two of the 'overheads' that JL projected during his presentation (on behalf of JL, CDTM *et al.*) at the 'Southern Hemisphere Ornithological Conference' (SHOC) in Albany, WA, on 07/10/1996.

    The overhead 'Lake Ballard – Main Colony, 1995 Breeding Cycle' contains, inter alia: JL's calculations / estimates of the number of days taken by each stage in the breeding cycle; an estimate that Lake Ballard's water level peaked on c.01/3/1995; an estimate of the number of days from 'lake full' to 'lake dry' (calculated to be approx. 200 days, from approx. 1st March to 16th Sept 1995.

    The overhead 'Current and Potential Conservation Issues' lists, inter alia, under 'Non-Breeding Habitats': 'salt field construction (+ve) and landscape salinisation (+ve), and under 'Breeding Habitats': increased runoff (+ve), siltation (?) (-ve), mining of lake beds (-ve), water use (mining) (-ve) and hypersaline disposal (-ve)'.

38. Two pages of hand-written notes (02/10/1996) by JL recording ACh's thoughts (conveyed by phone to JL) on 'Conservation Issues / Threats to Banded Stilt in [the] Goldfields'. Reference is made to: lake bed prospectivity for minerals; Lake Lefroy; nickel; creating islands with waste; causeways as nesting platforms for several waterbird species; Hannan's Lake; Wally Klaus; bunding and pumping; hypersaline water disposal; Lake Carey; natural freshwater recharge; aquatic invertebrates; fresh-saline transition; huge volumes of dewatering; cyanide; milling (crushing); 'King of the West' mine; Yindarlgooda and Roe palaeochannels; 'Lake Barlee – Auriferous Island – prospective' and 'Runoff – increased sedimentation – impact on processes in salt crusts'.

39. 'Rough jottings [by JL] made in preparation for talk at the 'Sthn. Hem. Orn. Congress' to be held in Albany on 07/10/1996. Includes reference to: water depths (several important measurements in Lake Ballard are listed), (water level) data logger, salinities, pH ('7.9, 7.8, 8.7'), sweep samples, evaporation rate. This single page has been scanned over two pages due to its length.

40. Abstract (copy faxed by JL to GBP on 05/8/1996) of paper to be presented by JL on behalf of JL, CDTM & GBP, at SHOC, Albany WA, on 07/10/1996. It includes

reference to: 'recently-flooded saline lakes' and 'a super-abundance of brine shrimps *Parartemia*'. A copy of the SHOC program is also included here.

41. Notice of Seminar to be held at CALM Wildlife Research Centre, Woodvale, on 17/05/1996 with JL presenting 'Banded Stilt Breeding in the Goldfields'. Abstract refers to 'recently-flooded saline lakes' and 'a super-abundance of brine shrimps *Parartemia*'.

42. Hardcopy (16/05/1996) of document 'Banded Stilt *Cladorhynchus leucocephalus* Seminar' '... compiled [by JL] 14-16 May 1996 in preparation for seminar at Woodvale [CALM's Wildlife Research Centre] on Fri 17 May [1996]. Words and sentences relating to water analysis, sweep samples, water level data logger, water depths (incl. Lake Barlee), incubating BaSt dunking belly feathers before returning to nest, BaSt drinking, lake filling, BaSt diet, salinity, nutrients, phosphorous, nitrogen, water (and air) temperatures, BaSt feeding areas, BaSt 'drank', rain, brine shrimp, water level stake / stick, pH; chicks walking, wading, running; '*artemia*', 'chicks feeding in very shallow water on minute items too small to be brine shrimp', 'water too shallow for outboard', '[Lake] Marmion – installed staff gauge', ostracods, *Parartemia*, parts of lakes dry, etc., have been highlighted (in blue, by JL on 02/4/2014). Note that this document is not a primary source.

43. A copy of 'Bobby & The Banded Stilts: Narration Draft 1' with JL's edits as faxed (13/5/1996) by JL to David Luffman of ABC TV Natural History Unit. References to brine shrimp, shrimp eggs, dormancy, fish, crustacea, salt crust, algae, bacteria, filling and drying, chicks feeding, premature drying, water depths, replenishment by rainfall, brine shrimp mating and dying are highlighted (blue).

44. JL's fax (29/4/1996) to Jeremy Hogarth with additional comments on '... the 7 one hour tapes you sent me last year and ... the 29 min 20 sec video that Mark Lamble sent me (11/4/96 version)'. Inter alia, JL refers to: BaSt washing, chick dispersal (swimming), the 'very large webbed feet' of chicks, chick 'prey' (i.e. diet), chicks feeding, BaSt drinking and salinity tolerance.

45. One page of 'Notes / Ideas' (by JL, undated, but probably late April 1996) relating to the content of (videos) Tape One to Tape Seven (all or nearly all of the ABC Natural History Unit's filming) for 'Bobby and the Banded Stilt'. Includes reference to: BaSt food supplies; salt glands; feeding during the incubation period; film of BaSt swallowing action; prey; rain maintaining water levels, food source depletion and BaSt behaviour, webbed feet and dispersal, wind and high turbidity.

46. 15 pages of notes (all by JL, undated, but probably late April 1996) referring to and describing in considerable detail the content of (videos) Tape One to Tape Seven (all or nearly all of the filming) for 'Bobby and the Banded Stilt'. Reference is made to: BaSt swimming, washing, feeding, pecking in shallows, wading, webbed feet, feeding by up-ending, lowering black belly feathers when settling on eggs, damp mud, running, walking, drinking; waves; 'aquarium footage of *Parartemia* [and other, much smaller invertebrates?] swimming about'; '*Daphnia*?'; *Parartemia* mating? shedding eggs? male/female ratio; mosquito?; etc. TO DO: Copy remaining (JL has already copied one or more of these) video tapes to DVD. Obtain DVD copy (Ian Kealley has made one) of final 'Bobby and the Banded Stilt' video.

47. Several pages from faxed (25/4/1996) copy of 'Transcription of Comments while Watching Un-Cut Rushes of Banded Stilts on Lake Ballard'. Present: CDTM, Mark Lamble, David Luffman, Jeremy Hogarth. Recorded at ABC Natural History Unit, 1995. These pages make reference to: feeding and drinking by incubating BaSt; BaSt drying by preening; BaSt don't just wade they also swim; feeding techniques and morphology, large eyes, touch; dunking, social aspects of feeding; feeding frequency; change-overs at nest; brine shrimp; diet; feeding techniques, pecking, swallowing; feeding success, bivalves;

walking, swimming; water depth; shallows, mud; wading; feeding at night; effects of wind on water depths (tilting).

48. Letter (03/3/1996) from Jeremy Hogarth to JL seeking JL's comments on an attached 'early draft' [18/10/1995] script of 'Bobby and the Banded Stilts'. Extracted [by JL on 02/4/2014] pages of script refer to: *Parartemia* eggs in the dry salt; no rivers; high nutrients; fish; lake bathymetry and hydrology; water temperature and food; food for BaSt; Brine shrimp abundance and breeding several times; BaSt feeding techniques (pecking); small eyes of BaSt; feeding by day-old chicks; dispersal and feeding; feeding depths; lake drying, salinity rising, brine shrimp mating, types of eggs, 'resting egg'.
49. Fax (27/2/1996) from Jeremy Hogarth to JL in which he states: 'Also he (Mark Lamble) has been doing some macro filming of Brine Shrimp ...'
50. 'Copy [12/2/1996] of Report on 120 samples of water received on 20 [Sept] 1995; 2 samples of water received on 21 [Sept] 1995; 1 sample of water received on 28 [Sept] 1995'. This was faxed by WA Chem Centre to GBP on the same date (12/2/1996). An annotation by WACC reads: 'original issued 30/11/95, reissued 12/2/96'.

    Four (only) of these samples were from Lake Ballard (2) and Crossover Lake (2). Results are presented for Tot P & Tot N (only). Annotations by JL suggest these four samples were collected on 14/9/1995. JL has also annotated the report with some water depth measurements, salinities, conductivities and pH values and refers to a water level logger.
51. Fax (30/1/1996) from ACl to JL (copied to GBP for info) saying: 'I have documented the Lake Ballard gut contents and sweep samples [and Crossover Lake sweep samples]. Are they clear enough? Should I ... do the same for [Lake] Marmion samples? Do you want me to discuss sorting techniques with Andrew Storey or others?' Attached are tabulations (in MSWord) detailing all the sweep and gut samples collected at Lake Ballard (only) in 1995. These are the same or similar to the Tables used on 22/7/1997 and in 2005 (see above for both). Note that some sweeps were associated with gut sampling (of collected BaSt) and some were not. This RMCR is primarily about the sweeps that were not. The 'BaSt adults & chicks collected in 1995 RMCR' is primarily about the sweeps that were.
52. Faxes (29/11 & 23/11/1995) from ACl to JL in which ACl writes that the area of Lake Marmion is 35,312 hectares and its catchment area (including the lake area) is 329,700 ha. Lake Marmion's lake bed elevation is estimated to be 354 mAHD (NW section) and 352 mAHD (SE section). ACl says the area of Lake Ballard is c.60,500 ha and its catchment area is c.1,390,000 ha.
53. Hand-written notes by JL recording a phone conversation with Jeremy Hogarth on 18/10/1995. Inter alia, JH apparently said Brenton Knott [UWA] is supervisor of Allan Savage (WA Museum??) who will do a 3yr PhD on brine shrimp. He has got funding and starts 01/01/1996'.
54. Extract (appears to be late Aug or early Sept 1995) from GBP's field notebook in which GBP writes 'Sort gut samples & retain each for ID [identification of contents]' and 'Sweeps – sort to family & retain' and 'Jim to talk to AW Storey'. Looks like GBP met with JL (& Y. Winchcombe re Vasse-Wonnerup water level loggers) in Busselton on this day and these were his notes relating to processing of BaSt gut samples and aquatic invertebrate sweep samples collected at Lakes Ballard and Marmion earlier in 1995.

    This extract has been printed from the 1995 BaSt project 'Field Notebooks' RMCR. Refer to that RMCR if context or higher quality viewing required.
55. Fax (29/8/1995) from JL to GBP in which JL writes, inter alia, 'Your suggestion that you go to Kal[goorlie] and [Lake] Ballard [after driving Perth to Esperance in the 2nd week of Sept 1995 for the routine SW wetlands monitoring run] is a good one ... As well as retrieving the logger [water level recorder on Lake Ballard] ... go (walk?) out to camp Island and do standard sweeps, water samples etc as before'.

56. First page of a fax (23/8/1995) from JL to GBP in which he writes, inter alia, 'Monday's [JL added a note on 10/1/2014 questioning whether it was 'Mon' or Tues 22/8] air survey by Andy Chapman showed that Lake Marmion will be dry in a week or so and Ballard in the next month or two'.

57. Report (undated, but must be post 22/08/1995) from ACh to JL with detailed results of aerial surveys conducted on 06/6, 14/07 & 22/8/1995 by him with others. During the 22/8/1995 survey of 'Lakes Ballard & Marmion w/- WR, PB, [in] Piper Warrior' ACh writes, inter alia, 'Ballard ... western end of lake – dry'; 'Lake Marmion – N. Arm dry'. He also writes 'We collected Argo [6 wheel drive amphibious vehicle] + gear from Lake Marmion on 10/8/95. Depth at sample point near camp was 5cm, TDS = 63,350 mg/L'.

58. Extract from Andrew Chapman (Kalgoorlie-based CALM Goldfields Region Ecologist) field notebook ('WATERFOWL #5') recording his 10/8/1995 visit to Lake Marmion with Warwick Roe (CALM Goldfields Region Wildlife Officer). He records water conductivity, water temperature and some waterbirds at 'Lake Marmion peripheral claypan' and water conductivity, TDS, temperature and depth at 'Lake Marmion sample point'.

59. Fax (29/7/1995) from CDTM to JL inter alia asking 'Thanks for message re aerial survey. ... What is water level [in Lake Ballard] like?'

60. Letter (26/6/1995 'FILE: CHEM895') from GBP to Roger Schultz (WA Chemistry Centre) requesting analysis of accompanying water samples. 32 samples are individually listed. They are numbered 1-32. Of these, numbers 1-20 & 32 are listed as being from Lake Marmion (samples 1-9, 12, 15-20), Lake Ballard (samples 10, 14, 32) or Crossover Lake (11, 13). The dates of the 3 samples from Ballard are 02/4 (presumably this one sample was overlooked when a batch was sent to Chem Centre on 24/5/1995, see below) and 09/6/1995. The 2 samples from Crossover Lake are dated 09/6/1995. The dates of the 16 samples from Marmion range from 10-13/6/1995.

    The labelling of the Marmion samples (and the 02/4/1995 Ballard sample) indicates some were associated with collected BaSt (11-12/6/1995 only), <u>while some were not.</u> Some were to be analysed for Total Phosphorus and Total Nitrogen and had already been filtered, 'using millipore 0.45 uM HA filters'. Some were to be analysed for conductivity (and TDS).

    Mysteriously, there is a copy of this 26/6/1995 request, re-dated in GBP's handwriting to 31/8/1995, and faxed from Woodvale to JL on 04/8/1997. Perhaps this batch of samples was meant to go to the Chem Centre on 26/6/1995 but was delayed until 31/8/1995 and GBP simply re-dated the covering letter by hand.

61. Letter (26/6/1995 'FILE: CHEM895') from GBP to Roger Schultz (WA Chemistry Centre) that is IDENTICAL to the letter of 24/5/1995, except for the date. It is apparent from 29/7/1997 copy of results (see above) that the samples weren't delivered to / received by WA Chem Centre until 26/6/1995 See 24/5/1995 for a description of the letter's content.

    Note that this 26/6/1995 copy has later annotations by JL relating to where some of these samples were taken, the depths that were measured at the time; some pH measurements; references to the stakes that were installed to monitor water depth, coordinates (lats & longs) and other details.

62. Faxed (19/06/1995) copy of 17/06/1995 report by GBP for JL, headed 'Report on Survey to Lake Ballard and Lake Marmion 8 June 1995 to 13 June 1995'.

    Inter alia, refers to objectives of obtaining further water chemistry data and downloading datalogger [water level recorder] on Lake Ballard and that, on 09/6/1995, GBP, ACl & ACh measured [Lake Ballard] 'Camp Island site' and 'Crossover Lake site' water depths, temperature and pH (Crossover Lake only) and collected water samples and invertebrate sweep water samples. '[Lake Ballard] Datalogger was downloaded and reset to record

every hour and average every 6 hours. Water level varies from 398 to 689 for the 70 days it was in place'.

The objectives on Lake Marmion included: 'Collect water samples [and Record depth and install depth post'. On 10/6/1995 they 'Installed depth gauge using an old survey line peg (second from camp side of shore) 770mm above water level ... depth at gauge was 220mm. Installed second marker to denote location of site only. Collected water samples and sweep. pH 7.39; [water] temp 12.0C'. They also measured depths, conductivity / salinity and pH and collected water samples and conducted invertebrate sweeps while collecting BaSt (see another RMCR) on 11/6 and 12/6/1995. On 13/6/1995 GBP & ACl 'Proceeded west across expanse of water to 52cm deep' and apparently installed a 'depth post' at the Lake Marmion BaSt breeding island as GBP writes: 'Depth post installed at colony 211mm exposed. Coordinates of colony 29.44.36, 121.29.13' (Check if deg min sec or deg min decimal min.)

63. Andrew Chapman's (Kalgoorlie-based CALM Goldfields Region Ecologist) field notes (9-12/6/1995), from his field notebook 'WATERFOWL #5', recording observations during his visit to Lakes Ballard and Marmion with GBP & ACl. On 10/6/1995, ACh inter alia recorded water conductivity / TDS & temperature in a 'Peripheral claypan' and at Lake Marmion (on same day?). On 11/6/1995 he recorded, inter alia, water conductivity, temperature and depth at particular times (but locations not indicated, except 'Collection site').

64. Extracts (parts of 08/6 - 13/6/1995) from one of GBP's field notebooks concerning field trip to Lakes Ballard and Marmion. Extracts include:

    Lake Ballard

    - Intentions to collect water ('Tot P, Sal, Turbid') & sweep samples (in alcohol) and download ('computer, tape measure') water level logger at Lake Ballard (pages 1-2).

    Crossover Lake

    - 'Xover [Crossover] Lake Depth 53cm' (page 4).

    Lake Marmion

    - 'Depth at 77 [GPS waypoint?] 22cm deep'; '2nd Peg from shore'; 'Marmion 1[?]' sweep and water ('Tot P') sample and water temperature & pH measurement on 10/6/1995 (1545-1600hrs) (page 9).
    - Depth 'peg' installation (page 10).
    - Sweep, water ('Tot P') sample and salinity & pH measurements near Lake Marmion camp site (or near collected BaSt 'family #1'?) on 11/6/1995 (page 16).
    - References to 'deeper water', 'ran behind group' on 12 & 13/6/1995 (pages 21, 35).
    - 'Depth post [where? at BaSt breeding island?] 211 exp' on 13/6/1995 (page 42).
    - References to 'feeding in shallows 5-10cm', etc. on 13/6/1995 (page 46).
    - 'Depth at post 992 [minus] 880mm [equals] 112 deep' on 13/6/1995 (page 49).
    - 'Dataflow' [after leaving Lake Marmion].

    These extracts have been printed from the 1995 BaSt project 'Field Notebooks' RMCR PDF. Refer to that RMCR if context or higher quality viewing required.

65. One page of jottings (11/6/1995) by JL recording some details of his radio telephone conversation on that day with GBP (who was camped at Lake Marmion with ACl & ACh). Includes: '[GBP et al.] collected 1 [BaSt] family. Ostracods & Parartemia'. It is not clear whether this was a reference to what GBP et al. had found in the birds' guts or in the Lake Marmion water (or both). Another jotting is: '[Lake Marmion] bed v. soft – [water] depth up to 30cm – most 10-20cm, too shallow for boat [punt]'.

66. Extract from Alan Clarke's field notes recording:
    - At Camp Island (Lake Ballard) on 09/6/1995 at 1445hrs 'depth 0.775[m] from top of stick, pH 8.67, [water] temp[erature] not working'.

- At Crossover Lake on 09/6/1995 at 1631hrs 'pH 8.76, [water] temp[erature] 12.0 [°C]'.
- At Lake Marmion on 10/6/1995 at 1600hrs 'pH 7.39, [water] temp[erature] 12.0 [°C]'.

67. A list of equipment (sent by JL to GBP on 07/6/1995) that was originally provided to ACl by GBP for ACl's trip (with JL & ACh) of 27/4/1995 – 04/5/1995 (approx) to Lake Ballard. Included is the equipment needed for collection of water samples and invertebrate sweep samples.

68. Fax (07/06/1995) from JL to GBP with a four-page 'Revised Program Lake Ballard June 1995' with instructions for GBP, ACh and ACl regarding survey and other work to be undertaken at Lake Ballard and Lake Marmion from Thurs 8th to Wed 14th June 1995.

    Inter alia, the program refers to: '... measure this lake's [Crossover Lake] depth and take water samples'; 'Boat to Camp Island [Lake Ballard]. Measure water depth, temp, pH & take water samples, do standard invertebrate sweeps near Camp Island'.

    At Lake Marmion, they were to: 'Establish depth (gauges) and on first and last days measure water depth, water temp, pH & take water samples, do standard invertebrate sweeps at a marked location (i.e. same routine as previously at [Lake] Ballard'. Water depths were also to be measured, water and sweep samples taken, etc., when collecting BaSt specimens on Lake Marmion (see other RMCR). A task to be performed at both lakes (Ballard and Marmion) was to 'record dates of definite drinking by [Banded] Stilt for comparison with salinity'.

    See JL's fax of 02/06/1995 below to CDTM for the 'draft work program'.

69. A report (06/06/1995) from Andy Chapman (ACh) to JL and GBP headed 'Banded Stilts – Lakes Ballard & Marmion'. This reports details ACh's observations, made during an aerial survey 'today' [06/6/1995], of BaSt numbers, water depth (inferred), etc., on Lake Ballard (including 'Most of the larger rafts were in the NW sector ... and would be inaccessible to dinghy with outboard').

    On Lake Marmion he referred to stilt '... standing in water E. of 'islands'' and 'The [Lake] Marmion water is very shallow – too shallow for outboard I reckon'.

    An attached map by ACh shows the locations of the 'sites with stilt chicks' on Lake Ballard. JL subsequently mapped ACh's coordinates (locations 1-5) of the 'Banded Stilts main rafts' on Lake Ballard and this map is attached.

70. Fax (02/06/1995) from JL to CDTM (also sent to ACh & GBP) with: 'draft work program for Grant [GBP] and co. to work to next week. I ... would appreciate any comments'. This copy of the draft program has subsequent annotations [by JL]. See JL's fax of 07/06/1995 above to GBP for 'Revised Program' and what was finally decided about (inter alia) measuring of water depths, collection of water samples and invertebrate sweeps, etc.

71. Fax (05/06/1995; typed 01/06/1995) message from Mark Lamble, ABC Natural History Unit, to JL with a 'rough diary' of observations he made while at Lake Ballard from 09/05 to 17/05/1995. Observations include, inter alia, '10/5/1995: ... I got approximately 15kms up [i.e. up Lake Ballard to the NE] but then water became too shallow and forced to return to camp'; 'I feel that the Adult birds [BaSt] were feeding to the east and returning to the west ...'; 'The water surrounding Camp Island appeared to contain many more brine shrimp than our previous trip ...'. '...about a four fold increase ...'. 'We also shoot footage [film] of the brine shrimp'. '... during the time at New Camp I saw very few brine shrimp in the water'. 'Interspersed with the [BaSt] chicks [near the western end of Lake Ballard] were adults that ... at any sign of a threat would lead the chicks toward deeper water or away from the threat' and 'If the birds [BaSt] saw a human form ... they would run for hundreds of metres ...'. A map of where the stilt chicks were is attached (and where they camped and the vehicular route to it).

72. A page of jottings (05/6/1995) by JL recording some of the observations detailed by Mark Lamble in his faxed message of 05/06/1995 (typed 01/06/1995). Included is reference to: '>6cm firm for Argo'; 'No *Artemia* near New Camp, v. thick around breeding island'; 'Birds marched E during day & west at night. 2-3cm depth. Chicks are wading – not swimming'. See also jottings of 18/5/1995.

73. Undated page of jottings by JL headed 'Next Ballard Trip (6/95) [June 1995]' that records some preliminary thoughts of JL about the trip to be undertaken to Lake Ballard (and Lake Marmion) by GBP, ACl & ACh in June 1995. Inter alia reads 'depth, temp, salinity, P, turbid?, etc. & sweeps'; 'photos of – water clear – turbid', and 'download depth [water level logger]'. See faxes above for draft (02/06/1995) and revised (07/06/1995) programs.

74. One page fax (01/6/1995) from JL to GBP that reads: 'I found the instrument screwdriver (and the phillips) from the Hamon [salinity measuring instrument] box in my office this morning and have mailed them ... to you. You should receive them early next week'.

75. Letter (24/5/1995 'FILE: CHEM0595') from GBP to Roger Schultz (WA Chemistry Centre) requesting analysis of accompanying water samples. 77 samples are individually listed. They are numbered 1-57, 57A, 58-76. Of these, numbers 27-57, 57A, 58-72 are listed as being from Lake Ballard (samples 27-36, 39-43, 48-49, 51-57, 57A, 58-72) or Crossover Lake (samples 37-38, 44-47, 50). The dates of the 40 samples from Lake Ballard range from 15/3 to 04/5/1995. The dates of the 7 samples from Crossover Lake range from 01/4 to 04/5/1995.

    The labelling of the Ballard samples indicates some were associated with collected BaSt (02/4, 11/4, 02/5/1995 only), while some were not. Some were to be analysed for Total Phosphorus (of these, some had already been filtered, 'using millipore 0.45 uM HA filters', and some were unfiltered). Some were to be analysed for salinity (and conductivity). Those without analysis-specific 'descripters' were presumably also to be analysed for salinity (and conductivity).

    A copy of the results was sent by WACC to GBP on 29/7/1997. Note that all 77 samples were analysed for conductivity (mS/m), Tot P and TDS (mg/L) and 3 of the 77 samples (45, 67, 72) were analysed for Tot N.

    Note also that these samples were not delivered to / received by WA Chem Centre until 26/6/1995 (see above for that copy - annotated – of this letter).

    Also see another letter of 26/6/1995 for the next (second) batch of water samples delivered to WA Chem Centre.

    A hand-written, draft list for inclusion in the letter of 24/5/1995 is also here.

76. Extract from Alan Clarke's field notes recording:
    - Planned measurements and water & sweep sampling (probably to be undertaken on 28/4/1995, as that is the next page of this notebook). Refers to 'top & bottom salinity at star picket', 'T + P + N at top', 'pH [at] star picket top, temp top + bottom', '3 x 50m sweeps @ surface', and 'depth'.
    - On 28/4/1995, at Lake Ballard: 'depth top [presumably of depth measuring stick] to water 0.89m' and 'bottom to top of water 0.54m'; 'pH top 7.89'; [water] temp top 19.0 Bottom 19.0), and an attempted calibration of pH meter.
    - Mention of 'red tape' associated with a coot nest with 4 eggs, on Crossover Lake on 28/4/1995. So keep in mind that red tape was used at this nest as well as on a depth stick on Lake Ballard (there might be some potential for confusion in cryptic field notes).
    - On 02/5/1995, at Lake Ballard: depths at sites of collected BaSt (see other RMCR).

- On 04/5/1995, at Lake Ballard: '0.97[m] depth top of stick to water' and '0.44[m] depth from bottom to water level of stick'; calibration of pH meter; pH measurement; water temperatures (top & bottom).
- On 04/5/1995, at Crossover Lake: pH; water temperature; 'salinity top & bottom' and 'Total P & N top' [presumably samples were taken as no measurements recorded]; 'depth ... from top of star picket'.
- Testing of pH calibration buffers on 17/5/1995.

77. Extracts (late April – early May 1995) from JL's field notebooks concerning water depths, samples, measurements, sweep samples, drinking, food, feeding, etc., on Lake Ballard (and Crossover Lake) during his field trip there (with ACl, ACh and others) in late April – early May 1995. These extracts include:
    - Reference to ACl's collection ['0830-0915'] of water samples ('salinity to & bottom, Total P top'), sweep samples and measurements of pH ('top') and water temperature ('top & bottom') at 'campsite [Camp Island] stake' on 28/4/1995.
    - Observations of incubating adult BaSt drinking on 28/4/1995.
    - ACl's Lake Ballard water depth ('star picket' corrected to 'wooden stake'), pH, temperature measurements of 0830-0845hrs on 28/4/1995.
    - Description of water depths while boating on 29/4/1995. Note reference to map and 'straight line course [of] 300 degrees.
    - 'Water clear to bottom. Hoards of *Parartemia*, some mating' at 1255hrs on 30/4/1995.
    - '[Coot] Nest was 20cm above water level [of Crossover Lake]'.
    - 'Crossover Lake depth and salinity' [to be measured on 02/5/1995].
    - 'Water level 9cm below bottom of tape on stick on S side of Camp Island at 0844hrs [on 03/5/1995]'.
    - Notes (from JL discussion with ACh?) referring to: Peter Hudson doing PhD at Flinders Uni, Lake Lefroy, invertebrates, salt lakes, discharge of highly saline water, Western Mining, open pits in middle of Lake Lefroy, new invertebrate in bed of Lake Barlee.

    These extracts have been printed from the 1995 BaSt project 'Field Notebooks' RMCR PDF. Refer to that RMCR if context or higher quality viewing required.

78. Map of Lake Ballard with markings by JL showing 'Camp Island' and 'Work Area' (essentially all that part of the lake around and west of Camp Island). Also shown (by JL) is the 'boat route' taken on 01/5/1995 by JL & ACl (& ACh?) and 'times [1252, 1301, 1312hrs] are those of 29/4/95' and a distance (presumably) calculation of 16.25. Compare with JL's field notes. There are also six hand-drawn circles near the north (western) shore of the lake and a straight line (indicating?). Compare calculation of 16.25 with 'Tables (faxed 22/7/1997, from ACl/GBP to JL)' where there is also a map of Lake Ballard annotated by ACl that inter alia indicates ... 'Dist. between Tripod & Camp [Islands] 16km'.

79. List of equipment that provided to ACl by GBP for ACl's trip (with JL & ACh) of 27/4/1995 – 04/5/1995 (approx) to Lake Ballard. Inter alia, the list includes 'tall clear jars' for 'gizzards + water'; 'Tot P jars'; 'Tall 250-300ml bottles salinity' and 3-4 litres neat alcohol'. Note that GBP used to refer to what others might call 'plastic pots' as 'jars'.

80. Fax (27/04/1995) from JL (at CALM Kalgoorlie) to CDTM (at BBO) detailing the observations he (JL) made '... this morning (0810-1135hrs') during an aerial survey [on 27/04/1995] of Lakes Barlee and Ballard. Inter alia he reported that: 'Water appears too

shallow here ['west of 2nd breeding island on northern side of lake, all the way to the W end of the lake'] for outboards and access difficult'.

81. Seven page fax (24/04/1995) from CDTM (at Broome Bird Observatory) to JL (at Busselton) with a cover note that reads 'Herewith 6 pages of data – some of it partly processed and/or with comments. It will give you knowledge of what we've got & what we still need!' Note that pages 2, 4 & 6 'spilled over' onto a second page for each.

    This fax indicates, inter alia, that on Lake Ballard CDTM:

    - Suspected that on 09/4/1995 (PM), '... most of the birds [incubating BaSt] had just left the nest for a [short?] time to drink, cool down & wet their feathers ...'
    - Recorded the water depth as follows: 'At marker [which?] beside island. 4pm 14/4/95. 51cm (depth of water)'.

    Note that JL's only copy of this fax has small amounts of important text missing due to cropped borders.

    See "JL's recordings (notes) of phone conversation with CDTM in April 1995 ..." below.

82. JL's records (notes) of phone conversation with CDTM in April 1995, after CDTM had left Lake Ballard for Broome. Inter alia, the notes record CDTM's observations at Lake Ballard that: '[In] PM [adult BaSt] left nest, drank etc [and] returned [to nest]', and that 'rain added 13cm (51cm [being the] water depth at stake on ... [blank] 4 days after rain)'.

    See also "Seven page fax (24/4/1995) from CDTM ... to JL ..." above

83. Fax (13/04/1995) from Ron Johnstone (WA Museum) to JL detailing the observations made during an aerial survey for breeding BaSt that he and ... [not specified in fax, but were Phil Stone and Nick Kolichis] made of Lakes Goongarrie [or Raeside? See notes of 11/04/1995 below], Marmion, Ballard and Barlee on ... [date not specified in fax, but was 07/04/1995]. Inter alia he wrote: 'I will send you details of specimen stomach contents etc. at a later date'.

84. Photocopy (2 A4 pages) of six small notepad pages of notes made by JL during phone conversation with Ron Johnstone (WA Museum) on 11/04/1995 in which RJo shared details of his aerial survey (with Phil Stone & Nick Kolichis) for breeding BaSt on 07/04/1995 and their ground visit to Lake Ballard in kayaks on 08/04/1995. Inter alia, the notes read: 'food – chicks forming small creches – 5 chicks dead, 2 just alive – others crow pecked & too smelly to retain'. It is not clear what the reference to 'food' was about.

85. Extracts (01/4 to 12/4/1995) from one of GBP's field notebooks concerning water depths, samples, measurements, sweep samples, drinking, food, feeding, etc., on Lake Ballard (and Crossover Lake) during his field trip there (with ACl, ACh and others) in late April – early May 1995. These extracts include:
    - '[On 01/4/1995] 0910[hrs] installed Peg due N of East end of Camp [Island] as Site [No.1]'. Took salinity , Tot P samples. 'Depth = 38 [cm?], 98 [cm?] exposed'. 'Installed Data logger at 0940 [hrs on 01/4/1995] #39873 ... [indecipherable] 6 hrly x 1 hour' (page '43').
    - 'Low Mel[aleuca] teretifolia? 20cm-30 above water' [on Crossover Lake on 01/4/1995] (page '45').
    - 'Pead [Pink-eared Duck] (definite) [nest] abandoned ... 25cm above water – v strange' [on Crossover Lake on 01/4/1995] (page '45').
    - 'Big lake [apparently on Crossover Lake], South end on fence, Depth 77cm, exposed 54cm [on 01/4/1995, page '47').
    - Depth measurements and sweeps at and near 'Peg' at 'Site 1'. '110 um [sweep] net' used [Lake Ballard at 1350hrs on 01/4/1995] (page '47').
    - 'Lake 1 [definitely on Crossover Lake, see a dot point below] Site 1 on south side of lake on track'. Sweeps made, depth measured, Tot P & salinity samples taken (page '49').

- 'pH Ballard after calibrating ['Hamma'?] ... 7.75'. Lake 1 Crossover Lake pH 8.24'. Looks like GBP pH-tested the water samples for 'Lake 1' and Lake Ballard when reached Camp Island (page '49').
- '[02/4/1995] water level [Lake Ballard] – 161mm from bottom of red tape at 0807' GBP has subsequently (probably in 1997 in response to query from JL) annotated with 'Yahoo!! Lake Ballard south side camp [Island] depth marker' (page '55').
- 'Collected salinity, Tot P, Depth = 10cm' written next to what appears to be a sketch of a cluster of small islands (check against an aerial photo) with a small cross at (SE?) end of one. GBP has later annotated (probably in 1997) with 'Site 1 probably'. Which 'Site 1' and was he correct? (page '61').
- 'Get Redox probe [of pH meter?] to Peter Darch [of Perth Scientific] and get him to calibrate' (page 71).
- Planning? notes referring to water and sweep samples and collecting jar / pot sizes and numbers (page 79).
- Depth (at post / peg) & pH measurements and sweep & salinity samples taken at 'Site 1 Ballard' on 09/4/1995. Also 'Visit island ... measure depth' (page '81').
- Many observations of feeding behaviour of BaSt adults and chicks on 10/4/1995 (pages '83' – '87').
- Depth (at post / peg) & pH measurements and sweep and Tot P & salinity samples taken at 'Site 1 Ballard Camp [Island]' on 11/4/1995.
- Depth at datalogger on 12/4/1995 (page '107').
- 'Crossover lake 87 [cm?] deep, 41 [cm?] exposed' (page '107').

These extracts have been printed from the 1995 BaSt project 'Field Notebooks' RMCR PDF. Refer to that RMCR if context or higher quality viewing required.

See the 'BaSt adults & chicks collected in 1995 RMCR' for water depths, water samples, sweeps, feeding behaviour (and gut contents) of / associated with birds that were collected during the above time period.

86. Two page memorandum from JL to GBP headed 'GRANT. TASKS FOR SAT 8 – TUES 11 APRIL 95 INCL'. Inter alia these tasks included:
    - 'Take a surface water sample wherever you collect a family group (or single adult) – for salinity and Total P [phosphorus] and turbidity unfiltered. Also measure water depth. Also do a standard, surface-only, invertebrate sweep at each shooting location'.
    - 'Each day, make a note of whether you see any [BaSt] adults (or chicks) drink (re [tolerance of] salinity)'.
    - 'While boating between the two breeding islands, measure depths and record positions (preferably with compass and map or [vertical aerial] photo)'.
87. Extracts (30/3 to 07/4/1995) from JL's field notebooks concerning water depths, samples, measurements, sweep samples, drinking, food, feeding, etc., on Lake Ballard (and Crossover Lake) during his field trip there (with others) in late March – early April 1995. These extracts include:
    - Crossover Lake water depth observations and depth ('>1m') and salinity ('fresh') estimates on 30/3/1995.
    - Comments re flying insect numbers (e.g. 'very few mosquitoes') next to Crossover Lake on evening of 30/3/1995.
    - Observation concerning wind strength, waves, water colour and turbidity Lake Ballard on 31/3/1995.
    - Many observations of BaSt (and one Avocet) feeding (incl. 'pecking') and several of BaSt drinking.
    - '[GBP] said many birds [BaSt] were feeding in pairs [on 02/4/1995]'.
    - Intention to 'note drinking [by BaSt]' on Monday.

- Intention to 'measure lake depths' on Wed 05/4/1995.
- JL's estimate [on 05/4/1995] that 'Lake [Ballard] presumably took 4-5 days to fill [at end of Feb 1995] to average depth of c.40cm'.
- JL's estimate [on 05/4/1995] that 'First birds [BaSt] nested on top of (highest point) of suitable island (c.1.5m above water level)'.
- Comment (on 05/4/1995) that 'Rate at which lake [Ballard] is drying is difficult to determine due to effect of wind'.
- 'Mark [Lamble] filmed (Thurs PM [06/4/1995]) adults [BaSt] at Island 1 [on Lake Ballard] flying off nest to water's edge, drinking & going straight back - at least 12 birds'. Search through video tapes for this filming.
- JL's draft list (made 07/4/1995) of tasks for GBP to perform while at Lake Ballard (JL was leaving the lake on 08/4/1995). This list included collection of water samples (salinity, Tot P), pH measurement and invertebrate sweeps '(same mesh size)'at standard location/s' and measurement of depths. See 'Two page memorandum ...' above, for finalised list.
- JL planned to measure depths between Camp Island and '2nd [BaSt breeding] colony' on 07/4/1995.

These extracts have been printed from the 1995 BaSt project 'Field Notebooks' RMCR. Refer to that RMCR if context or higher quality viewing required.

See the 'BaSt adults & chicks collected in 1995 RMCR' for water depths, water samples, sweeps, feeding behaviour (and gut contents) of / associated with birds that were collected during the above time period.

88. Extract from GBP's field notebook which indicates that, during aerial survey on 303/1995, GBP was to, inter alia, look for and record 'Where on [Lake] Ballard [BaSt] feeding groups [are and] How many in each group. Get locations'.

89. Fax (20/3/1995) from JL to GBP with a list of equipment for the upcoming trip to Lake Ballard. Inter alia, the list includes collecting equipment for aquatic invertebrates (sweep) samples, water samples and in situ water testing. It looks to JL (on 30/3/2014) that this was a typed list of GBP's, with JL having placed a 'yes', 'no' or 'maybe' against each item and some 'also's and other annotations. Equipment with a 'yes' against it includes 'formalin 10% buffered', 'alcohol neat / 70%', pH meter', 'spare [pH] meter] probe', '110um [plankton] nets', 'Total N & P filters and jars', 'salinity jars [250ml]', 'Turbidity 250ml bottles', 'Labels (adhesive)', 'tape measure' & 'depth line'. Concerning the Hamon salinity meter, JL annotated this item with 'too big – get pocket size or rely on jars' [but note email of 01/6/1995]. Regarding the list of equipment for 'Data [water level] Loggers', JL annotated 'Would be nice but probably too much gear / trouble for this trip – maybe next trip?' Fax cover note refers to kayak repair, but JL, GBP & ACl did not end up using kayaks on Lakes Ballard or Marmion in 1995.

90. One page of jottings (undated, but almost certainly on or before 20/3/1995) by JL headed 'Grant'. It appears to be some initial thoughts on equipment to take to Lake Ballard and included 'gear for daily sampling of aquatic invertebrates (near surface) in at least 3 areas'; 'Sainty – Williams [aquatic science books]', and 'Data logger?' The note 'kayak repairs' suggests these jottings were written on or prior to 20/3/1995 (see fax above of that date).

91. One page extract (undated, but probably soon after 15/3/1995 helicopter trip to Lake Ballard) from one of GBP's field notebooks. This extract appears to be some initial thoughts on arrangements and equipment for the proposed ground trip to the Lake Ballard BaSt breeding colony(ies). Inter alia, the 'list' includes 'Vials [for what?]' and 'Water Jars 250-300 ml'. Note that GBP used to refer to plastic pots as 'jars'.

92. Undated page of jottings by JL listing stuff for him to take to Lake Ballard, probably (judging on 29/3/2014 by what is in and not in the list) for the one day helicopter trip

from Kalgoorlie to Lake Ballard and return on 15/3/1995. Includes: 'water samples', plankton net' and tape measure'.

93. Fax (20/3/1995) from JL (at CALM Busselton) to Raelene [Hick] (at CALM Woodvale) with corrections (typos) to her typescript of the 'Banded Stilt Research Programme – Lake Ballard, March/April 1995' that CDTM had hand-drafted (see 14/03/1995 below).

94. Extracts (appear to have been written soon after helicopter flight of 15/3/1995) from GBP's field notebooks that refer to, inter alia: 'water quality'; Depth stake 1 ½ [inches] x 6 [ft]' & 'hammer'; 'invertebrate [sampling] gear'. These were, no doubt, early thoughts on gear to be taken on first ground visit to Lake Ballard, at end of March 1995.

95. Extracts (15/3 – c.25/3/1995) from JL's field notebook with notes made: during return helicopter flight from Lake Ballard to Kalgoorlie (including 'depth gauge' – to be installed at Lake Ballard); while waiting at Kalgoorlie Airport for return flight to Perth (reference to chicks feeding); soon afterwards ('Field guides – inverts (Williams), aquatic plants (Sainty)'; on Fri 24/3/1995 ('salinity of lake [Ballard] water last week?' – with a line through and a cross next to, perhaps indicating that no water sample (or measurement) was taken during helicopter visit on 15/3/1995); and on c.25/3/1995 (2 [sweep] nets (250-500 micron) [are] in shed on grey shelf'. 'MS [Mike Scanlon? – worked for Stuart Halse] recommends 250 micron & subsample after'.

96. Extract (undated) from GBP's field notebook with neatly written account (summary) of helicopter trip (with JL, CDTM & MR) to Lake Ballard on 15/3/1995. One observation is of BaSt male 'feeding' [?] immediately following copulation.

97. Fax (14/03/1995) from CDTM to JL with his (CDTM's) draft manuscript headed 'Banded Stilt Research Programme – Lake Ballard, March/April 1995'. Inter alia, CDTM refers to: '... when inland salt lakes become flooded by exceptional rains'; '[colonies] ... abandoned in mid breeding because of declining water levels / food supplies or at the chick stage ...';, and '... the limited 'window of opportunity' [for breeding by BaSt]'. CDTM also lists '... specific parameters which should be studied / measured / assessed', including: '(l) Food availability / water level / salinity'.

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98. Two typed pages by JL headed 'LAKE BARLEE – MON 2nd – FRI 6th NOV 1992'. This is a plan of work to be done by JL & GBP at Lake Barlee during that period. Two of the listed 'Tasks to be performed at Lake Barlee' are: '1.2. Water Depth and Quality Sampling (GP). Need: pH meter; sample containers (2 for sal; 4 for phos); tape measures (3m JL&GP; 30m JL); labels', and '1.4. Aquatic Invertebrate Collections (GP). Need: sweep net; containers; preservative; labels'.

    These pages are included in this RMCR as a link to the bird (BaSt) and gut content sampling that undertaken at Lake Barlee in 1992 by JL & GBP. Note that Lake Barlee turned out to be dry in Nov 1992, so no water or sweep samples were taken then. Note also that JL intends (03/4/2014) to prepare a separate RMCR covering the BaSt work undertaken by him & GBP at BaSt breeding locations pre (and post) 1995.

99. Two typed pages headed 'INVERTEBRATE FAUNA OF LAKE BARLEE: Survey of lake Barlee; Date July 3 1992', probably prepared by GBP for JL. The first page indicates what was found in a number of aquatic invertebrate sweep samples at various named locations on Lake Barlee on 02/7/1992.

    These pages are included in this RMCR as a link to the water and aquatic invertebrate (sweep) sampling undertaken at Lake Barlee in 1992 by JL & GBP. Note that JL intends (03/4/2014) to prepare a separate RMCR covering the BaSt work undertaken by him & GBP at BaSt breeding locations pre (and post) 1995.

A one page, hand-written note (30/4/2014) by JL which indicates that copies of some 1995 BaSt water chemistry results (from WA Chem Centre) are on JL's 'Dawesville Channel Impacts' file/s (because some 1995 BaSt water samples were sent to WACC by GBP together with samples from Harvey River and elsewhere). JL thinks (03/4/2014) that the data being referred to has probably all been captured in this RMCR, but if any are missing, that would be a place to start looking for them.

- There are some results of

Lake Ballard, Lake Moore

(and other Banded Stilt nesting lakes?)

Water chemistry analyses in

Vol 1 (and 2?) of "Renewable

Channel Impact Monitoring — Project

Data and Related Info" file (of JL).

(or originals)

- There might be copies in the Banded Stilt project box, I don't know.

30/4/2012

Part of what appears to be a fax (20/2/2001) (but note that year is difficult to read) from JL to CDTM in which JL writes, inter alia: 'We will be making a start on the Ballard-Marmion sweep & gut samples in a few months time ...'

With Compliments

Claire [illegible]

Many thanks for the material that you sent to Sue for the 3rd edition of the Directory.

Accompanying is a copy of the summary publication for your personal library.

[illegible]

I'm steadily finishing off projects that have been around too long - e.g. the Directory and W.A.'s new Reserve Site nominations (incl. data form).

We will be making a start on the Ballard - Marmion surveys & get samples in a few months time, when Saltbush Action Plan work's completed. Cheers.

[illegible]

20/2/01

Faxed (on Fri 17/03/2000; from JL to GBP) copies of a 1999/2000 Budget Request and a Science Project Plan for SPP 'Breeding ecology and conservation of Banded Stilt'.

The Budget Request refers to: 'Sorting, identification and quantification of aquatic invertebrate sweep samples from 1995 breeding event at Lake Ballard' as one of several 'Planned Achievements for 1999/2000'.

The Science Project Plan refers to: lake hydrology, potential mining industry impacts on salt lakes, salinity, water chemistry, diet, 'conduct macroinvertebrate (standardised sweeps) to monitor food availability', 'install continuous recorder to monitor lake water level', 'sample water chemistry' and 'water depths'. 'Sorting, identification and quantification of macroinvertebrate sweep samples ...' is listed in the SPP as a 'Phase 1: (1995-2000)' milestone to be completed by Dec 1999. The SPP also says (Item 22) that 'Data from a continuous water level recorder (Lake Ballard 1995) are on a disk in a datasafe in JL's office. The 1995 macroinvertebrate samples are held and curated by A. Clarke at CALMScience Woodvale'.

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
14 QUEEN STREET, BUSSELTON WA 6280
PHONE – (08) 9752 1677 FAX – (08) 9752 1432

FAXED

FACSIMILE TRANSMITTAL SHEET

TO: GRANT PEARSON
FROM: JIM L.
COMPANY:
DATE: 17/3/00
FAX NUMBER:
TOTAL NO. OF PAGES INCLUDING COVER: 9
PHONE NUMBER:
SENDER'S REFERENCE NUMBER:
RE:
YOUR REFERENCE NUMBER:
NOTES/COMMENTS: Re Monday's flight.

a) **CF (including ED / NC Division) allocation: $5,000**

b) **External allocation and source: Support to value of $2,000 provided by mining industry.**

6. **PLANNED ACHIEVEMENTS FOR 1999/2000 (5-6 dot points):**

- **Sorting, identification and quantification of aquatic invertebrate sweep samples from 1995 breeding event at Lake Ballard.**
- **Identification and quantification of Banded Stilt oesophagus contents from 1995 breeding at Ballard.**
- **Egg laying, incubation and hatching success data to be extracted from daily photographic monitoring of quadrats established in 1995 Ballard breeding colonies.**
- **Data and observations from 1995 Ballard breeding event to be prepared for publication in "Emu".**
- ***In the event that suitable rainfall occurs,* aerial surveys are proposed to determine Banded Stilt breeding locations, colony size, colony site characteristics, breeding success, etc.**
- ***In the event that suitable rainfall occurs and breeding is successful,* banding and flagging of Stilt chicks is proposed to determine movements, longevity, etc.**

7. **1999/2000 CF BUDGET REQUEST:**

BIODIVERSITY CONSERVATION GROUP

CF BUDGET REQUESTS

1999 / 2000

1. SPP TITLE: Breeding ecology and conservation of Banded Stilt

2. SPP NUMBER: Req. No. WD/0023

3. SCIENTIST: J.A.K. Lane

4. ACHIEVEMENTS IN 1998/9 (5-6 dot points):

- Aerial survey of limited number of known and potential breeding sites in Eastern Goldfields conducted in April 1999 following rainfalls from ex-tropical cyclones Elaine and Vance.
- Effectiveness of March-April 1999 rainfall in providing suitable conditions for breeding activity by Banded Stilt on Lakes Ballard, Goongarrie, Marmion and Carey determined.
- Precise location of new breeding site on Goongarrie identified.
- Mining industry support obtained for CALM Banded Stilt research.
- Potentially useful contacts established with mining industry.

5. 1998/9 BUDGET ALLOCATION:

a) CF (including ED / NC Division) allocation: $5,000

b) External allocation and source: Support to value of $2,000 provided by mining industry.

6. PLANNED ACHIEVEMENTS FOR 1999/2000 (5-6 dot points):

- Sorting, identification and quantification of aquatic invertebrate sweep samples from 1995 breeding event at Lake Ballard.
- Identification and quantification of Banded Stilt oesophagus contents from 1995 breeding at Ballard.
- Egg laying, incubation and hatching success data to be extracted from daily photographic monitoring of quadrats established in 1995 Ballard breeding colonies.
- Data and observations from 1995 Ballard breeding event to be prepared for publication in "Emu".
- *In the event that suitable rainfall occurs,* aerial surveys are proposed to determine Banded Stilt breeding locations, colony size, colony site characteristics, breeding success, etc.
- *In the event that suitable rainfall occurs and breeding is successful,* banding and flagging of Stilt chicks is proposed to determine movements, longevity, etc.

7. 1999/2000 CF BUDGET REQUEST:

a) Operating (including requests for ED / NC Division funding):
$3,000 See special note at Item 10 below.

b) Chemistry Centre:
$0

8. EXTERNAL FUNDING RECEIVED OR EXPECTED TO RECEIVE, AND SOURCE:

There is a strong possibility of significant, external, in-kind support ($1,000s) being provided by the mining industry and/or other sources in the event that suitable rainfall occurs in 1999/2000 or subsequent years.

9. COMPLETION DATE FOR THIS WORK (mm/yy):

Depends upon timing of rainfall events and level of funding and in-kind support obtained. Rainfall events suitable for successful breeding appear to occur once in 3-10 years.

10. ANY OTHER INFORMATION RELEVANT TO BUDGET REQUEST:

CALMScience funding ($3,000) is being sought for 1999/2000 to enable a *rapid response* in the event (<50% probability) that a potentially-suitable rainfall event occurs. These funds would be used for an initial aerial survey. External funds would be sought to support follow-up work in the event that breeding colonies with a high likelihood of success are located.

11. ENDORSEMENT BY PROJECT LEADER:

a) Operating (including requests for ED / NC Division funding):
$3,000 See special note at Item 10 below.

b) Chemistry Centre:
$0

8. EXTERNAL FUNDING RECEIVED OR EXPECTED TO RECEIVE, AND SOURCE:

There is a strong possibility of significant, external, in-kind support ($1,000s) being provided by the mining industry and/or other sources in the event that suitable rainfall occurs in 1999/2000 or subsequent years.

9. COMPLETION DATE FOR THIS WORK (mm/yy):

Depends upon timing of rainfall events and level of funding and in-kind support obtained. Rainfall events suitable for successful breeding appear to occur once in 3-10 years.

10. ANY OTHER INFORMATION RELEVANT TO BUDGET REQUEST:

CALMScience funding ($3,000) is being sought for 1999/2000 to enable a *rapid response* in the event (<50% probability) that a potentially-suitable rainfall event occurs. These funds would be used for an initial aerial survey. External funds would be sought to support follow-up work in the event that breeding colonies with a high likelihood of success are located.

11. ENDORSEMENT BY PROJECT LEADER:

Department of Conservation and Land Management

CALM**Science** Division

Science Project Plan

(Page 1)

Important: Refer to the *Explanatory Notes* (Staff Guideline No. 7) when preparing an SPP.

PART A Title and Location

SPP Number: [allocated by D/AA]
Request No: [allocated by WASPP] WD/0023
Concept Plan No: [allocated by D/AA]

1. Project Title: Breeding ecology and conservation of the Banded Stilt

2. CALM**Science** Group: Project Team:
   Biodiversity Conservation Aquatic Ecosystems

3. Staff [Names and estimates of percentage of time]:

Supervising Scientist:	J. Lane (15% in 1999/00)
Other Scientists:	
Technical Officers:	G. Pearson (2% in 1999/00)
	A. Clarke (10% in 1999/00)
External Collaborators:	Dr C. Minton (Australian Wader Study Group)
Volunteer(s):	A. Chapman

4. a) Departmental Program(s): Nature Conservation

   b) Land Tenure(s): Vacant crown land, pastoral lease, CALM-managed land.

   c) CALM Region(s): Goldfields, Wheatbelt, Pilbara

   d) CALM District(s): All within above regions.

   e) Location of plots/transects [Name] : Not applicable

5. Related SPPs: WD/0024 (*A Directory of Important Wetlands In Australia*)

6. Proposed commencement date: Phase 1: 1995 Phase 2: 1999

7. Proposed completion dates: Phase 1: 2001 Phase 2: 2005

8. Date of submission of this Plan and signature of Supervising Scientist:

PART B Endorsements

9. List the relevant District Manager(s), Business Unit Manager(s), and/or Regional Manager(s) whom you have consulted about the SPP. If the SPP relates to all Regions, you should confer with the Director of Regional Services:

   Goldfields Regional Manager (Ian Keally)

10. Biometrician:
   Return comments to D/AA

11. Animal Ethics Committee:
   Return comments to D/AA

12. Project Team Leader:
   Return comments to D/AA

13. Group Manager:
   Science Group Manager to forward to D/AA

14. Divisional Administrative Assistant (D/AA):
   Divisional Admin. Assistant to manage approval process, load approved SPP on WASPP, arrange filing at SOHQ, publish in CALMScience News, send photocopy of completed SPP to Supervising Scientist and notify Biometrician of SPP No., copy cover sheet to Regional Manager, District Manager and relevant Program Manager (for their information)

PART C Relevance and Outcomes

15. Background: The Banded Stilt *Cladorhynchus leucocephalus* is an Australian endemic. It nests in large colonies (up to 100,000+ pairs) on small islands (about 1-5 ha) on huge (100+ km^2) claypan lakes of inland Western (mainly) and South Australia following exceptional rainfall events (c. 3-7 year intervals). Its breeding biology has been little studied, due mainly to the difficulty of finding and gaining access to breeding colonies. Nesting attempts fail spectacularly if lakes dry prematurely during breeding attempts. Few known nesting locations are within conservation reserves, and these only partly. The mining industry is showing substantial interest in mining the beds of claypan lakes and utilising them for storage / disposal of wastes and for water supply. Without an improved knowledge of Banded Stilt breeding biology and environmental requirements, CALM is not well placed to ensure conservation of the species.

16. Project aims:
- Determine the principal breeding locations of Banded Stilt in Western Australia and their relative importance.
- Develop an improved understanding of their breeding biology.
- Quantify key environmental factors (e.g. hydrological regime, salinity) governing breeding success;
- Identify any significant human-induced threats to nesting colonies and habitats.
- Obtain and disseminate knowledge needed to ensure conservation of the species.

17. Anticipated project outcome(s): Scientific and other publications that will provide information necessary to ensure that the principal breeding sites and habitats of the Banded Stilt can be adequately conserved and wisely managed.

18. Anticipated users of the knowledge to be gained and technology transfer strategy: CALM, Department of Environmental Protection, Environmental Protection Authority, Department of Minerals & Energy, mining and tourism industries, conservation groups. Results of Phase 1 have been transferred through articles in the media, popular and ornithological magazines, an ABC television documentary, presentation at Southern Hemisphere Ornithological Conference. Scientific publication is also proposed.

19. Milestones [Describe tasks and when they will be completed]:

Phase 1: (1995-2000)

• Aerial survey to locate Banded Stilt breeding colonies in Eastern Goldfields following passage of Cyclone Bobby.	Mar 1995
• Establishment of base camp to study Lake Ballard breeding colony	Apr 1995
• Collection of data on breeding colony characteristics, timing of nesting, clutch size, incubation period, hatching & fledging success, fledging period, lake filling / drying cycle, water chemistry.	Jun1995
• Collection of stilt adults and chicks for gut content analysis.	Jun 1995
• Leg banding and flagging of chicks on Lakes Ballard and Marmion.	Jun 1995
• Sorting, identification and quantification of macroinvertebrate sweep samples and stilt gut contents.	Dec 1999
• Extraction of clutch size, incubation period, hatching success data from photograhic monitoring of 1995 Ballard nesting event.	Dec 1999
• Preparation and write-up of 1995 breeding event data and observations for scientific publication.	Apr 2000
• Publication of 1995 breeding event results in journal *Emu.*	2001

Phase 2: (1999-2005)

• Monitor rainfall reports from Eastern Goldfields and Wheatbelt.	2004
• *In the event that exceptional rainfall occurs (annual probability low),* conduct aerial surveys to locate and photograph breeding colonies.	2004

- *In the event that exceptional rainfall occurs and breeding colonies become established,* conduct aerial (& possibly ground) monitoring to determine colony success and major limiting factors. 2004
- *In the event that successful fledging of chicks appears probable,* conduct banding and leg flagging of chicks. 2004
- Prepare and write-up of data and observations for publication. end 2004
- Publish in *Emu* or other scientific journal. 2005

PART D Study Design

20. Method [including statistical analysis]: Phase 1 (1995-2000): Conduct aerial survey of Lakes Barlee & Ballard following Cyclone Bobby (Feb 1995) to locate breeding colonies. Establish base camp on Lake Ballard. Establish quadrats in nesting areas for daily monitoring (photographs) to determine laying rate, clutch size, incubation period and hatching success. Collect adults and chicks to determine diet. Conduct macro-invertebrate (standardised sweeps) to monitor food availability. Install continuous recorder to monitor lake water level. Sample water chemistry. Develop safe method of catching chicks. Band / leg flag chicks. Conduct additional aerial surveys to monitor fledging success. Analyse results. Prepare for publication. Publish.

Phase 2 (1999-2005): Rainfall in the main breeding range of the Banded Stilt (in WA) will be monitored using daily rainfall data obtained by the Bureau of Meteorology. Following exceptional rainfall events (approx 3-7 year intervals) and reports of flooding, aerial surveys will be conducted to locate and monitor breeding colonies. Colonies will be photographed from the air and, if feasible, visited on the ground to determine number of breeding pairs, nesting and fledging success, water depths, water chemistry and food availability. Chicks will be banded and leg-flagged to obtain information on movements and longevity. Standard statistical techniques will be used where appropriate.

PART E Data Management and Budget

21. Voucher specimens [how many are anticipated to be collected and where will they be lodged?]: Voucher specimens (at least) from macroinvertebrate samples will be retained and curated at CALMScience Woodvale.

22. Data management [how and where are data being archived/maintained?]: The original data (field note books, other papers) and nest monitoring photographs are held by J.Lane at CALM Busselton. Data from a continuous water level recorder (Lake Ballard 1995) are on disk in a datasafe in JL's office. The 1995 macroinvertabrate samples are held and curated by A.Clarke at CALMScience Woodvale. Data to be collected (Phase 2) will be held by JL at Busselton.

23. Budget Estimate [anticipated expenditure]:

Consolidated Funds (CALM)

	Year 1 (94/95)	Year 5 (98/99)	Year 6 (99/00)
FTEs - Scientist	0.2	0.02	0.15
FTEs - Technical	0.5	0.03	0.12
Equipment	0	0	200
Vehicle	0	0	500
Travel	0	0	500
Other	0	5 000	1 800
TOTAL	0	5 000	3 000*

	Years 7 to 10 (00/01 to 03/04)	Year 11 (2004/05)	
FTEs - Scientist	0.05	0.1	
FTEs - Technical	0.1	0.05	
Equipment	200	200	
Vehicle	500		
Travel	500		
Other	1 800	800	
TOTAL	3 000*	1 000	

External Funds

	Year 1 (94/95)	Year 5 (98/99)	Year 6 (99/00)
Salaries/Wages/Overtime			
Overheads			
Equipment			
Vehicle			
Travel			
Other			
TOTAL	10 000**	1 200**	**

	Years 7 to 10 (00/01 to 03/04)	Year 11 (2004/05)	
Salaries/Wages/Overtime			
Overheads			
Equipment			
Vehicle			
Travel			
Other			
TOTAL	**	**	

* CALMScience funding ($3,000 each year) is being sought from 1999/00 to 2003/04 to enable a *rapid response* in the event (<50% probability) that potentially-suitable rainfall events occur. These funds will be used for aerial surveys. External funds will be sought to support follow-up work in the event that breeding colonies with a high likelihood of success are located. In years when potentially-suitable rains do not occur (by end of April), *the funds could be reallocated* to other projects.

** There is a strong possibility of significant, external, in-kind support ($1,000s) being provided (as occurred in 1994/95 & 1998/99) to this project by the mining industry and other sources in the event that suitable rainfall events occur in 1999/2000 and subsequent years.

24 Budget Actual [to be updated at the end of each financial year by D/AA and local AA]:

Consolidated Funds (CALM)

	Year 1 (94/95)	Year 5 (98/99)	Year 6 (99/00)
FTEs - Scientist	0.2	0.02	
FTEs - Technical	0.5	0.03	
Equipment	0	0	

Vehicle	0	0	
Travel	0	0	
Other	0	0	
TOTAL	0	0	

	Years 7 to 10 (00/01 to 03/04)	**Year 11 (2004/05)**	
FTEs - Scientist			
FTEs - Technical			
Equipment			
Vehicle			
Travel			
Other			
TOTAL			

External Funds

	Year 1 (94/95)	**Year 5 (98/99)**	**Year 6 (99/00)**
Salaries/Wages/Overtime			
Overheads			
Equipment			
Vehicle			
Travel			
Other			
TOTAL	10 000**	2 000**	

	Years 7 to 10 (00/01 to 03/04)	**Year 11 (2004/05)**	
Salaries/Wages/Overtime			
Overheads			
Equipment			
Vehicle			
Travel			
Other			
TOTAL	**	**	

25 Account code(s) for this SPP [allocated by Group AA]:

26 Latitude and longitude of plots/transects: Not applicable (no permanent plots/transects)

File record (16/3/2000) by JL headed 'Calculation of Banded Stilt Funds Available as at 16 March 2000'. Inter alia this records that: 'On 26 Nov 1998 Keith Morris [CALM] sent me an email (v4 f16) saying he would provide $5,000 to enable me to employ an assistant to analyse the Banded Stilt samples ...'; that this money '... went into [a Trust Account], and that as at 16/3/2000 'There is still $5,078.80 available in [a Trust Account] to spend on analysing the BaSt invertebrate samples'. Were these funds spent?

CALCULATION OF BANDED STILT FUNDS AVAILABLE AS AT 16 MARCH 2000

1. On 26 Nov 1998 Keith Morris sent me an email (v4 f16) saying he would provide $5,000 to enable me to employ an assistant to analyse the banded Stilt samples and that he would put the funds in my RAOU account.

2. On 28 Nov 1998 Keith Morris emailed (v3 f...) to Rod Mell (copied to me) a request to transfer $5,000 from one of his accounts to my RAOU account for analysing BaSt samples.

3. External Funds summary provided by Rod Mell on 5 march 1999 (v3 f ...) says (as at Fri 5 March 1999)

L29	**RAOU Trip**	**Opening Balance**	**Expenditure**	**Revenue**	**Closing Balance**
		105.80	27.00	0.00	78.80

4. I calculated cost of BaSt air survey at $2,068 around 30 April 1999 (v3 f...)

5. On 13 May 1999, following my appraisal in Nov 1998, I sent an email (v4 f17) to Rod Mell saying that the $5,000 promised by keith Morris for bandede Stilt work had not appeared in Job L29 (RAOU Trip) report of 2 march 1999 and asking if it had been transferred since. No reply (until 21 May, see below).

6. On 21 May 1999, I sent an e-mail to Keith Morris saying he had agreed to "transfer $5,000 into my RAOU account (Job L29) to enable me to employ a consultant to analyse the banded Stilt samples" but that the transfer had not happened yet (v4 f18, 30, 58). Folios 30, 59 have discussion of what would be done and reason for holdup. Keith emailed on 22 may 1999 (f59) indicating the $5,000 would be transfered "this financial year" (1998/99).

7. On 21 May 1999 Rod Mell emailed me (v4 f31) saying he had processed the paperwork for the transfer but it would take a few days to be processed..

8. 1999/2000 CRF budget allocation summary page (v4 f133, 131) indicates as follows:

SPP No.	**Account**	**Project**	**Request**	**Received 99/00**	**Alloc. 99/00**
(WD/0023)	535AE516M	Breeding ecology and conservation of BaStilt	3,000	5,000	2,000

The $2,000 for 99/00 was allocated to 535AE516M by 20 Sep 1999 (see v4 f127).
Which account did the $5,000 allocated in 98/99 go in to? It went into Trust Account L29 (see v4 f143; this folio shows a credit (negative expenditure) of $4,973 for 98/99, this was the credit of $5,000 minus the expenditure in 98/99 of $27).

9. (as at Tues 16 November 2000) (v4 f172)

L29	**RAOU Trip**	**Opening Balance**	**Expenditure**	**Revenue**	**Closing Balance**
		5,078.80	0.00	0.00	5,078.80

Note that $5,078.80 was also the balance at the end of the 1998/99 financial year (v4 f143 & 142).
Note that Job L29 has account codes 535GL29M etc.

10. (as at Tues 7 March 2000)

WASPP 99/0013		**Budget**	**Expend**	**Availabl**
535AE516M	Materials - Breeding ecology and conservation of the Banded Stilt	2,000	10.75	1,989.25

(Note that nothing had been spent from this account as at)

CONCLUSIONS

1. There is $1,989.25 available in CRF account 535AE516M to spend in 1999/2000 on BaST air survey following flooding.
2. There is still $5,078.80 available in Trust Account L29 to spend on analysing the BaST invertebrate samples.

J. Lane
16 March 2000

Hand-written notes made by JL at 'Salt Lake Ecology Seminar' held on 07/7/1999 at the Perth Zoo Conference Centre. Reference made to:

- **Bernard Bowen (reservation of salt lakes for conservation);**
- **Jacob John (characterisation of salt lakes, stratification, algae, phytoplankton, macrophytes, stratification, no fish; Lake Carey, depth, salinity, nutrients, pH);**
- **Shane Chaplin (Lake Carey, aquatic invertebrates, rainfall, salinity, de-watering of mine site, salinity tolerances, biomonitoring, Nick Dunlop, 'Granny Smith (Placer)');**
- **Jeremy English (*Halosarcia*, salinity and waterlogging tolerance, Hannan Lake, rehabilitation);**
- **Mike Lyons (botany of Wheatbelt salt lakes, biogeography, macrophytes, conservation status);**
- **Stuart Halse (aquatic invertebrates, salinity tolerances, fresh phase of salt lakes, Wheatbelt survey, conservation significance, threats, small freshwater pools around salt lakes);**
- **Phil Commander (salt lake hydrology, palaeochannels, evaporation, groundwater flow, mining, dewatering and disposal of saline water, acidity, ecology, hydrological change, 'Directory of Important Wetlands in Australia');**
- **Jeff Turner (surface water hydrology, groundwater recharge, water shortage for mining, rainfall and runoff, water use volumes, palaeochannels, catchment characteristics and runoff);**
- **Brian Fowler (Lake Wannaminga, mine water discharge, 'Golden Grove Mine');**
- **Celeste Beavis (Lake Carey, potential impacts of mining in salt lakes);**
- **Greg Morris (Lake Lefroy, biodiversity, causeways, exploration, drilling, islands, dumping, site management, rehabilitation);**
- **Rory Lamont (Aboriginal people, Wongai, Lake Carey);**
- **Mark Coleman (Kathey Meney, criteria for salt water discharge to agricultural zone wetlands, evaporation rate varies 70% with salinity? and with depth, nutrients and lake bed permeability, changed ... (pH?) killed brine shrimps at Port Hedland salt works?).**

See JL's office computer for a digital copy of the published Proceedings.

J. Lane 125.

PROCEEDINGS OF THE SALT LAKE ECOLOGY SEMINAR

Wednesday, 7 July 1999
Perth Zoo Conference Centre

Organised by the Centre for Land Rehabilitation
on behalf of the
Salt Lake Ecology Working Group

THE CHAMBER OF MINERALS AND ENERGY OF WESTERN AUSTRALIA INC

The University of Western Australia
CENTRE FOR LAND REHABILITATION

(T)

124.

Salt Lake Ecology Seminar

Wed 7 Jan? 1999

0835 - 0850

Bernard Bowen - emphasised need to identify salt lakes most suitable for inclusion in State's conservation reserve system - at present these ecosystems are weakly represented in reserve system. Workshop is important step in effort to gain the knowledge to identify the most significant lakes.

Jacob John - 0850 →

1. Shallow & well mixed
2. algal mats
3. low phytoplankton
4. low macrophytes
5. v. little invertebrates
6. no fish

Characteristics of hypersaline lakes.

Lake Cowey - Jacob John & Shane Chaplin studied the limnology of the lake - 1998 and March 1999.

Jacob's main interest was algal mats. Sediment was full of cyanobacteria & diatoms. Cond '98 sampled for 4 weeks measured depth & salinity pH + DO at 14 sites (depth of "standing water") Max depth was 16 cm. Salinity went as high as 287 ppt. Monitored nutrients (+ carbon). Discovered it was not a nutrient (phosphate + nitrate) poor environment after 1st week. Chlorophyll of standing water is low.

Lake Cowey was | Oligotrophic in terms of chlorophyll
| Meso-eutrophic in terms of nutrients

Lake Cowey: pH 7 → 9.3 Depth - up to 16 cm Jan 1999
" " 25 cm August 1998

There were 30 sp. of cyanobacteria, green algae and diatoms - they are universal saline species. (found around the world)

(2) 123.

7 July, 1999.

(Ecology) contd.

Shane Chaplin – Lake Carey invertebrates
sampled crustaceans & aquatic insects

Results (crustaceans only)

March 99 – 77 mm rainfall – Lake Carey catchment – from 2 cyclones (Vance + Elaine)

Sampled – 1 week after rains fell
14 sites – 12 inundated.
4 main taxa groups – ① Anostracans (eg Parartemia
prob in excess of 10-15 species – WA)
(eg Branchinella)

② Ostracods – collected 4 spp in Lake Carey.

③ – Copepods (?)

④ – Cladocerans – restricted to less saline sites.

Salinity range was 46 – 96 ppt initially
130 – 300 ppt at end

Inflow areas were fresher – max diversity + most abundance of crustacea were in these inflow (natural) areas

De-watering (mine site) area
– higher salinity (225 initially – 285 at end)
– loss in crustacea (species + abundance) – probably because initial salinity was too high ‖ *

Different species have diff salinity tolerances (+
Brine shrimp 45 – 297 Copepods ≤ 130 ppt

Shane contd

Cladocera ≤ 45 μm.

Ostracods – 45μ – with different salinity ranges.

Ostracods most suitable for biomonitoring.

They are 1 – ubiquitous in system
2 – high abundance (for statistics)
3 – easy to identify
4 – preserved in sediments (historical record).

Conclusions – high abundance + diversity where low salinity water present, presence of lake periphery – high diversity.
– low diversity at de-watering sites, some recovery at old dewatering site (grading)

Rick Dimlop instituted the study – Jenny Smith (Placer) supported the study.

Jenny English 0930 –

"A comparison of salt + waterlogging tolerance in 3 spp of Halosarcia"

ARC SPIRT grant for Halosarcia research at Centre for Land + Water Rehab at UWA – JE, Kelly Shepherd, David Howe, Andrew English, supervised by Dave Bennett and Tim Colmer. –

7/7/99 cont'd

Halosarcia generally the 1st vascular plant above the waterline on salt lakes in arid Australia,
– published knowledge on physiology + ecology is limited.

His project – compare H. pergranulata, indica, doleiformis
+ H. sp. Angel Fish Island (B. Davy 4)
His field site is at Hannan Lake, near Kalgoorlie

Halosarcia pergranulata forms
→ "adventitious rooting" – grows at (and above) stem root junction, not from other roots

propose continued monitoring of soil moisture + salinity to identify "window of opportunity" at which germination occurs.
Maxime referred to use "TDR" (?)

One of his sites at Hannan Lake is a "rehab" site.

Mike Lyons – 0958 hrs →
"Botany of Wheatbelt Salt Lakes"

- background, flora, biogeographic patterns, current surveys (SAP).

The Salt Lake Flora – c 1000 spp – 80 families – 300 genera
(not all obligates)
① – Aquatic macrophytes
(Lepilaena + Ruppia)
② – Major families/genera — c 20 spp – Wheatbelt
- Chenopodiaceae (Halosarcia, Sclerostegia, Tecticornia)
- Frankeniaceae
- Aizoaceae
- Asteraceae
- Myrtaceae

③ Rare + priority flora
④ Undescribed taxa
⑤ Introduced taxa.

(5) 120.

7/7/99 contd.

Mike Lyons contd:

~~[illegible]~~ c20+
64 + spp of Rare + Priority flora
(of many families) around Wheatbelt
salt lakes

- "In some places, 20% of the flora of the lake was only located on the gypsum dunes."

Stuart Halse: ~~[illegible]~~ 1050 →

Types of invertebrates in salt lakes
Brine shrimps
Ostracods
Copepods.
] — easy to identify on the characteristics of the salt lakes. main groups.
Dipterans (Cladocera)
Rotifers ← 4th major group
Haloniscus (Isopods)
Beetles
Dipteran larvae (ceratopogonids, chironomids, ephydrids)

- Narrow tolerance freshwater (<c3 ppt)
salt tolerant freshwater (to c15 ppt)
Halophilous – to 50 ppt
Halobiont – 50-300 ppt
] major groupings

(6) 119.

7/7/99

Inverts in saline playa lakes

20-30 spp.

- fresh phase playa lakes probably support ~~1000s~~ of spp.

- sp. composition changes as lake become more saline (lakes drying)

- species composition varies annually according to rainfall

SAP survey. (of salt tolerant species)
- approx 500 species in central wheatbelt.
- 59 species are halobionts (> 50 ppt)

Can only expect to get 3-4 species - salt lake when ~~species~~ salinity is around 200 ppt.

∴ WA is centre for crustacean radiation
- huge proportion of salt tolerant species
- many endemic salt-lake species have a limited distribution.
- many undescribed species.
- survey results may be difficult to interpret.
- salt lakes often significant for a species.

Even if species number in a lake is low, eg 3-4, they should be considered as having an "intact fauna" and therefore of conservation value.

Threats: "changed inundation & salinity regime"

Important Issue: "small pools (around large playa lakes) often harbour fresher species

needs management focus also

7/7/99 contd.

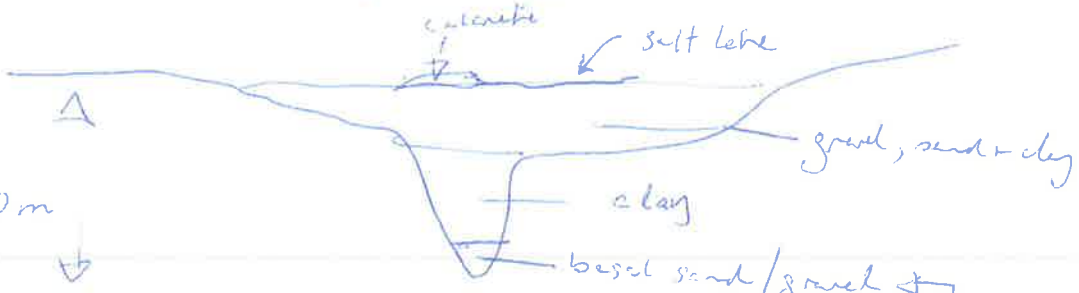
Phil Commders 1105 hrs →

(the large lakes)
— WA salt lakes have some distinct characteristics

① they are surface expressions of groundwater systems
② " intimately connected with the ancient drainage systems — they are connected and form an integrated system.

(the lakes)

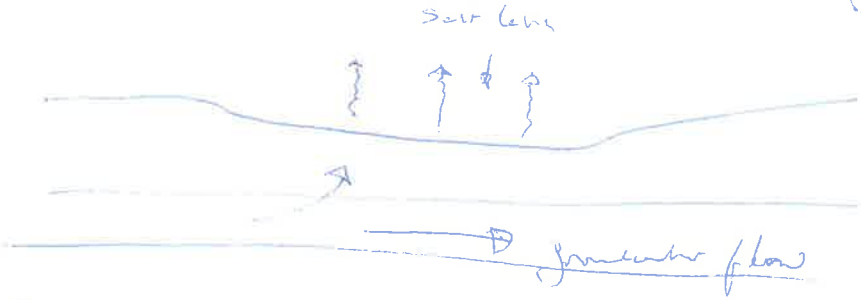
③



most permeable unit
(this is what many salinity is using)

The salt lakes are often "offset" i.e. not directly over the palaeochannel aquifers

These are the groundwater "drains" of the region.



Evaporation salt lakes causes an increase in salinity of groundwater flow.

It may 10,000's years for water to pass under a salt lake

" 99.9 % of groundwater outflow is down (via) the salt lakes " ! (by evaporation)

7 July 99 contd

Phil Commander contd

- Mining issues.

normally. these lakes fill with fresh water

- major ~~issue~~ is disposal of saline dewatering from mines into salt lakes. This water is often highly acidic also.

WRC doesn't have it own policy.

- suggestion is — dewatering disposal to salt lakes is to be a last resort
— need to better understand the ecology

change from ephemeral wetlands to permanent hypersaline lakes.

- there are few salt lakes in the conservation estate
— but Directory identifies some that are important. — suggests studies on the hydrogeology of these lakes as none have been conducted to date.

Jeff Turner (CSIRO) 1130 hr →

"Surface Water Hydrology of Salt Lake Systems": Potential water resource for industry.

— "Capture & use of surface water for enhanced recharge of groundwater.

7 July 98.

Jeff Turner contd

years 2010 – 2020 there will be a significant shortage of groundwater for many industry (regional)

There are some local shortages already.

~~Rainfall events > 25 mm per~~
1 hrs a

30–40% probability that these sort of rainfall events will occur 1–2 x per year.

(that will produce runoff to playa lakes)

Showed Table of summary of cloud free images from 1980 → 1998 (Landsat)
to study look at flooding / drying cycle of playa lakes of the region (eastern goldfields)

$25 \times 10^6\ m^3$ of palaeochannel water is used in the Kalgoorlie region each year

~~[illegible]~~ Not looking at catchment characteristics and relationships with flow. (rainfall)

10
115

Brian Fowler + Darrel 1200hr →

Golden Grove Mine 250 km inland from Geraldton.

Mine water discharge to Lake Wannamonga.

27 km pipeline

"Basemetals" mine (not a goldmine).

Celeste Beavis 1230 →

"The Lake Carey [illegible] Group"

- Reps from mining companies of this area (5+ companies)

Potential Impacts

- [illegible] [illegible] [illegible] on [illegible] [illegible]
- [illegible] discharges
- open pits
- waste dumps
- cumulative impacts (on hydrogeology / hydrology)

Greg Morris WMC 1.30pm →

Lake Lefroy: has a "well developed halite crust"

- some permanent pools
- low biodiversity

- Aim to minimise causeway construction — used to build crossings for exploration (drilling) tracks.

- All causeways > 500 m long will have culvert installed

- sequence pit development to minimise backfilling opportunities - ⇒ including pits in lakes

• maintain the integrity of natural (existing) islands

• minimise disturbance to foreshore areas (by shifting dumps onto lake!) - create artificial islands (mimicking natural islands)

• species selection from islands.

• remove causeways to lake bed at condition

Rory Lemmon (Placer - Granny Smith) 2pm →

Aboriginal people in Lake Carey area are "Wongai"

Mark Coleman 2.30pm →

He & Kelly [illegible] developed environmental criteria for discharge of saline water into wetlands (eg [illegible]) for DEP.

Pursue

"Evaporation varies by 70% with salinity ? ?
~ ~ ~ other factors - eg depth.

(12) 113.

increased nutrients increases permeability of the bed of the seabed

? Changed -- (pit?) and tackled all the brine ... — Port Hedland Salt Works?

3pm ———

Mark Coleman —

Article in 'The [WA] Naturalist News' (May 1999) by Kevin Coate reporting nesting of BaSt on Lake Goongarrie in April 1999. Refers to feeding; '... shallow water had an abundance of Brine Shrimps'; low water depth; needs follow up rain, and 'Shield Shrimp and Brine Shrimp were plentiful in ephemeral lakes ...'.

cemented laterite pebbles somewhat reminiscent of the Pinnacles. There was little evidence left of the Cobb & Co Staging Post which had been built nearby. The Main Road through the area had skirted the western side of the Valley.

We lunched in a pleasant Eucalypt woodland down by the Lake. Several of our party left leaving six to return to base and home on Tuesday.

Of course the botanists and the birdoes had their eyes open on all the outings. Several birds sighted were not on the Station or Park lists and also several plant species. 32 flowering plant specimens were collected, most yet to be identified. Many Euros were sighted. Dragon lizards were everywhere and tadpoles and frogs were evident around the soak areas. The wet conditions had brought up a lot of fungi even including mushrooms at the mallee fowl mound. Kevin will tell you about the birds including his adventures on Lake Goongarrie, in a separate account.

In spite of the disappointing Mallee fowl mound sweep, the excursion was most successful. The recent heavy rain had filled many scenic lakes providing us with opportunities to observe many species of waterbirds. The country has its fascination with its Acacia, Mallee and mixed woodlands, Eremophilas and other shrubs in flower dotted here and there, the compact shapes, colours and textures of the Gimlets and many Casuarina cristata (Black oak) and the almost exotic appearance of the occasional Brachychiton gregorii and Callitris preisii ssp. verrucosa. These generally reflect the underlying soil types, red loam flats, pinkish residual granitic sandy country including sand ridges, breakaways with many colours and forms, the lakes and clay pans, the granite outcrops and the soaks. Thanks to Daphne for a well organised Excursion and to CALM for the use of their excellent facilities.

Gilbert Marsh

"The Naturalist News"
May 1999

BIRD NOTES FOR THE EASTER CAMPOUT AT GOONGARRIE STATION.

Some Club members travelled directly to Goongarrie Station, while others with more time took alternative routes. On the Mt Jackson road Lake Deborah and small ephemeral lakes were full and attracting all kinds of waterfowl, including Pink-eared Duck and Australian Shoveller. Several Australian Shelduck and Maned Wood Duck were seen in forested areas, obviously seeking nesting hollows. Two Major Mitchell Cockatoo were seen 30kms north of Lake Deborah.

On the 2nd April 1999, Banded Stilt were discovered breeding on a very isolated low island in Lake Goongarrie by following their distant sounds carried on a strong easterly wind. Initially it was thought the breeding colony at a conservative estimate, consisted of about 3,000 birds with about the same number feeding out in the lake away from the breeding area. (The shallow water had an abundance of Brine Shrimps.) However, after looking at photographs taken at the time, it is possible there could be up to 10,000 birds.

It appeared as if they had all suddenly gone down to nest after Cyclone Elaine. During Cyclone Vance in March thousands of eggs were abandoned after being covered with sand, blown into piles or washed down the slope into the lake.

Since Cyclone Vance the colony has restructured and breeding is continuing with many fresh scrapes and newly laid eggs. It is expected that the breeding colony of Stilt will increase rapidly over following weeks as hundreds of copulating pairs were to be seen on the lake. However, the depth of water covering the lake was low and unless there is more follow up rain in the area within the next month, it could well be that the colony will be abandoned. Due to the isolated nature and difficult access to areas where these birds breed, there have been less than 25 breeding records in Australia since white settlement.

Shield Shrimp and Brine Shrimp were plentiful in ephemeral lakes close to Goongarrie Station homestead and others we visited on the way to Goongarrie National Park. Black Swan, Hoary-headed Grebe, Australian Shelduck, Grey Teal (up to 96 on one lake), a single Australian Shoveller, Red-necked Avocet and White-faced Heron were recorded.

On our early morning bird walks from the homestead, interesting birdlife included about six Hooded Robin. Red-capped Robin were reasonably plentiful and there was a lot of courting behaviour going on between pairs. Splendid Wrens, Southern Whiteface, Chestnut and Yellow-rumped Thornbill were also reasonably common. Horsfield's Bronze-Cuckoo were seen and heard. Spiny-cheeked Honeyeater were common and Crested Bell Bird heard often. The Owlet Nightjar calling at dawn near the shed close to the homestead possibly had a roost there. After our unsuccessful hot walk in formation along grid lines to monitor Mallee Fowl, it was gratifying next day to find distinctive fresh tracks near an unused nest mound not far from the grid line area. While doing this walk Shy Heath Wren, Mulga Parrot, White-fronted Honeyeater and White-eared Honeyeater were seen.

On Lake Wangine near Siberia, there were considerable numbers of Black Swan, Grey Teal, Australian Shelduck and Eurasion Coot to be seen. Returning to Perth, near Northam we stopped to view a Barn Owl sitting on a road sign.

Kevin Coate

YOUNG NATURALISTS EXCUR

A BUGS LIFE

And it certainly was a bug's life. Rather unwittingly, over thirty junior and senior Naturalists ventured into a world of assassins and poisons of adventure.... and cockroaches. Saturday, 7th March a heated morning on Wireless Hill, Applecross was the scene, Eric McCrum our man. While the main focus was insects, we were still able to view the swift and deadly accurate male Darter, and a magnificent sparrow hawk, showing her beauty from high in the sky. Also, the celebrity reptile of the day - a Bobtail Skink found by David and its attached ticks that completed the pack. At 38cm in length and 810g this bobtail provided the group with a chance to touch, hold and watch her devour a supply of apple. The ticks were extracted from the earhole and back region, and we were able to view these squeamishly fascinating arachnids from a close range.

Article in 'Antipode AFA – News Francais et Australien – No.5 – Dec 1997' by JL describing BaSt breeding event. Refers to: 'salt-encrusted pans', Fairy Shrimp *Parartemia* and their eggs, water depth, salt water, chicks feeding, diet, aquatic invertebrates, lake filling and drying, drought resistant Fairy Shrimp eggs, French SPOT satellite system, BaSt first described by French scientist Vieillot in 1806. This article was published in French.

WESTERN AUSTRALIA'S DESERT LAKES

A glance at a map of Western Australia shows many large lakes in the interior, particularly in the southern half of the State. Of course anyone familiar with this most-arid land, knows that these "lakes" are actually vast, dry, salt-encrusted pans, unbearably hot in summer, freezing cold in winter and totally devoid of life.

Or, at least, that is how they used to be regarded. Recently it has been discovered that, once or twice each decade, these enormous salt pans (up to 1800 km^2 in area) fill to the brim and for a few short months support a rich abundance of aquatic life.

In most years, little rain falls in the Australian outback. But when it does, it comes down in buckets. Each summer, tropical cyclones develop off the north-west coast. Normally they dissipate soon after reaching land. On occasions, however, they evolve into rain-bearing depressions and travel across the continent in a south-easterly direction. Heavy rains result; continuous downpours of 300-400 millimetres in three or four days. The land is deluged. Long-dry salt pans are transformed into vast inland seas.

As the pans fill, they explode with life. Myriads of tiny eggs lying dormant in the sediments swell and hatch. Within a week, the half metre deep waters are swarming with Fairy Shrimp *Pararartemia*, 5 cm long aquatic crustaceans with a penchant for saline, ephemeral waters.

Simultaneously, an even more remarkable event occurs. Within days of the salt pans filling, thousands of Banded Stilt *Cladorhynchus leucocephalus* fly in from permanent waters near the coast, some 500-1100 km distant. These stately birds, first described in 1806 by French scientist Vieillot, come to mate and lay their eggs and raise their young on the super-abundant shrimp. Two weeks after the rains have finished, the stilts have formed island colonies of 20 000 or more nests, each 30 cm apart and containing 2-3 eggs.

Three weeks of incubation follow and the stilt eggs begin to hatch. Within a day, the chicks are led from their nests to the waters' edge where they peck at unsuspecting shrimp. Small parties leave the island, paddling downwind, feeding as they go. Tens of thousands gather in the shallows at the end of the lake, 50 km or more distant from their nests. Here the young birds grow rapidly as they gorge on the abundant invertebrates.

Seven weeks later the chicks are fully feathered and ready for the long flight to the coast. The entire breeding event takes less than four months. It's just as well because the evaporation rate in this part of Australia is extreme. The lakes usually dry within six months of filling and the young birds must leave before the water becomes too saline and all the shrimp die.

The Fairy Shrimp have their own strategy for surviving the long dry period between fills. As the lakes dry, the shrimp lay drought-resistant eggs. These will hatch with the next flooding rains. The Banded Stilt fly to the coast to begin their long wait - perhaps five or ten years - for the next opportunity to breed. Only another flood will bring these two superbly-adapted species together again.

Jim Lane
Principal Research Scientist
Western Australian Department of Conservation and Land Management

Note : Much remains to be learnt about the Banded Stilt. Not all breeding localities have been found and searches for colonies by conventional means are prohibitively expensive because of the huge areas involved. Given that the species was first discovered by a French expedition, it is perhaps not surprising that French technology - imagery from the SPOT satellite system - offers one of the most promising means of learning more about this unique Australian waterbird.

Phone message recording that Andrew Storey attempted to phone JL on 22/8/1997. See fax of 24/7/1995 below for probable reason for this call.

OFFICE / TELEPHONE MESSAGE

31.

30.

TO: Jim Lane

TIME 2:25

FROM: Andrew Storey.

Callers telephone Number:- 9380 1482

Telephoned ✓ | Will call you back | Returned your call

Please call ✓ | Called to see you | Urgent

Message:-

SOVER LAKE

of samples were taken

heck GP's notes

contents dried out

Message received by:- JW

Date: 22/08/97

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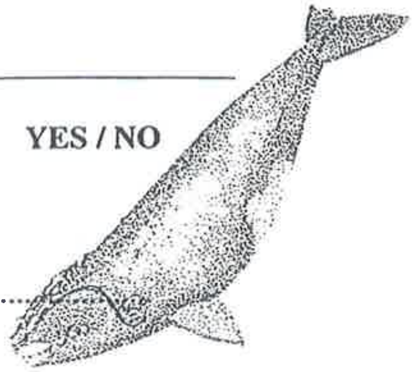
		2	1	
		3	1	
11/04/95		1	1	
		2	1	
		3	1	
28/04/95		1	2	
		2	2	
		3	2	
04/05/95		1	2	
		2	1	2nd vial damaged
		3	2	
09/06/95		1	2	
		2	2	
		3	2	
09/06/95	Crossover lake	1	4	

Fax (04/8/1997) from JL to GBP with a copy of the WA Chem Centre 'Report on 32 samples of water received on 4 September 1995'. It appears that this report was issued by WACC on 26/10/1995. It reports the results of analysis of samples 1-20 & 32, which were apparently collected at Lakes Marmion & Ballard (& Crossover Lake?). The results are ECond (mS/m) of 11 samples (3, 5, 13-20 & 32), and Tot N and Tot P of the remainder (10 samples 1, 2, 4 & 6-12). This fax relates to JL's email request (for collection details) to GBP earlier the same day (04/8, see below).

5.

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
BUSSELTON DISTRICT
FAX NO: (097) 521 432



TO: GBP .... URGENT: YES / NO

FAXED

AT: ....

.... Fax No. ....

FROM: JL ....

DATE: 4/8/97

Your Ref: ....
Local Ref: ....

No. of pages inc. this page: 3

Please call us on (097) 521 677 if this message was incomplete or illegible

95E0315/008	8	13/06/95	0.62	0.01	-	-
95E0315/009	9	10/06/95	0.73	0.02	-	-
95E0315/010	10	09/06/95	0.90	0.08	-	-
95E0315/011	11	09/06/95	0.71	0.03	-	-
95E0315/012	12	11/06/95	0.98	0.09	-	-
95E0315/013	13	09/06/95	-	-	33.5	-
95E0315/014	14	09/06/95	-	-	5480	-
95E0315/015	15	11/06/95	-	-	9120	-
95E0315/016	16	10/06/95	-	-	9260	-
95E0315/017	17	12/06/95	-	-	8920	-
95E0315/018	18	12/06/95	-	-	9520	-
95E0315/019	19	13/06/95	-	-	9160	-
95E0315/020	20	13/06/95	-	-	9280	-
95E0315/021	32	02/04/95	-	-	3580	-
95E0315/022	21	30/08/95	-	-	4080	29000
95E0315/023	22	30/08/95	-	-	666	4000
95E0315/024	23	30/08/95	-	-	839	4870
95E0315/025	24	30/08/95	-	-	806	4750
95E0315/026	25	30/08/95	-	-	907	5330
95E0315/027	26	30/08/95	-	-	807	3470
95E0315/028	27	30/08/95	-	-	2920	19800
95E0315/029	28	30/08/95	-	-	55.8	331
95E0315/030	29	20/06/95	-	-	4050	29100

(27)

1/2

95E0315
26 October 1995

Chemistry Centre (WA)

125 Hay Street, East Perth, Western Australia 6004 Phone (09) 222 3177, Facsimile (09) 325 7767

CHEMISTRY CENTRE

Your Ref :
Our Ref : FILE: CHEM895/95E0315; 3.1.9
Enquiries to :
Telephone :

Research Centre Manager
Department of Conservation and Land Management
Woodvale Reasearch Centre
Ocean Reef Road
WOODVALE WA 6065
Attention : G Pearson

Report on:

32 samples of water received on 4 September 1995

Analyte / Unit			N_total mg/L	P_total mg/L	ECond mS/m	TDS_180C mg/L
CCWA ID	Client ID	Sampled				
95E0315/001	1	12/06/95	0.59	0.02	-	-
95E0315/002	2	12/06/95	1.2	0.26	-	-
95E0315/003	3	12/06/95	-	-	9470	-
95E0315/004	4	12/06/95	0.79	0.05	-	-
95E0315/005	5	12/06/95	-	-	9470	-
95E0315/006	6	12/06/95	0.76	0.09	-	-
95E0315/007	7	13/06/95	0.72	0.03	-	-
95E0315/008	8	13/06/95	0.62	0.01	-	-
95E0315/009	9	10/06/95	0.73	0.02	-	-
95E0315/010	10	09/06/95	0.90	0.08	-	-
95E0315/011	11	09/06/95	0.71	0.03	-	-
95E0315/012	12	11/06/95	0.98	0.09	-	-
95E0315/013	13	09/06/95	-	-	33.5	-
95E0315/014	14	09/06/95	-	-	5480	-
95E0315/015	15	11/06/95	-	-	9120	-
95E0315/016	16	10/06/95	-	-	9260	-
95E0315/017	17	12/06/95	-	-	8920	-
95E0315/018	18	12/06/95	-	-	9520	-
95E0315/019	19	13/06/95	-	-	9160	-
95E0315/020	20	13/06/95	-	-	9280	-
95E0315/021	32	02/04/95	-	-	3580	-
95E0315/022	21	30/08/95	-	-	4080	29000
95E0315/023	22	30/08/95	-	-	668	4000
95E0315/024	23	30/08/95	-	-	839	4870
95E0315/025	24	30/08/95	-	-	808	4750
95E0315/026	25	30/08/95	-	-	907	5330
95E0315/027	26	30/08/95	-	-	607	3470
95E0315/028	27	30/08/95	-	-	2920	19800
95E0315/029	28	30/08/95	-	-	55.8	331
95E0315/030	29	20/06/95	-	-	4050	29100

(29)

1/2

95E0315
26 October 1995

Chemistry Centre (WA)
125 Hay Street, East Perth, Western Australia 6004 Phone (09) 222 3177, Facsimile (09) 325 7767

FILE: CHEM895 31/08/95 Page 2

3.

8/13

GP's file (CHEM895.doc)

Harvey Estuary samples for analysis for conductivity and salinity in PPT by evaporation.

21	30/8/95	Harvey Est. site 1	Cond.& salinity
22	30/8/95	Harvey Est. 2	Cond & salinity
23	30/8	Harvey Est. 3	Cond & salinity
24	30/8	Harvey Est 4	Cond & salinity
25	30/8	Harvey Est 5	Cond & salinity
26	30/8	Harvey Est 6	Cond & salinity
27	30/8	Harvey Est. 7	Cond &salinity
28	30/8	Harvey River Depth Post	Cond & salinity
29	29/6	Harvey Est site 4	Cond. & salinity
30	29/6	Harvey Est site 6	Cond & salinity
31	02/6	Harvey Est site 4	Cond & salinity

Email (04/8/1997 at 0717hrs) from JL to GBP referring to the WA Chem Centre report (to GBP) of 26/10/1995 and requesting that GBP fax to him '... collection details (date, location, etc.)' of the Lake Ballard samples. JL faxed GBP a copy of WACC's report later the same day (04/8), see above.

To: Grant Pearson@WOOD.SID@CALM
From: Jim Lane@buss.sid@CALM
Certify: Y
Subject: Chem centre results, Ballard etc.
Date: Monday, August 4, 1997 at 7:17:20 am WST
Attached: None

26

The Chem Centre report to you dated 26 October 1995 has Ballard, Marmion & possibly Crossover results - along with Harvey Estuary & River results. According to your notation in the margin, samples ("client IDs") 1 to 20 and 32 are Ballard etc.

I think you will find the collection details (date, location etc.) on your file CHEM895 (if that doesn't work, try CHEM0895). Please fax these details to me as I don't have them.

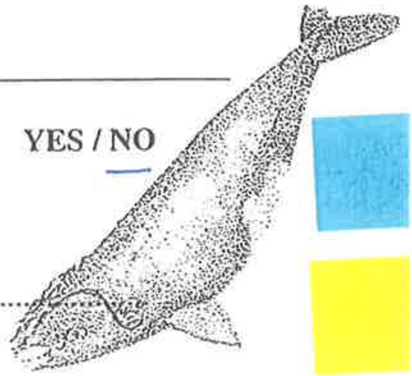
Jim
4/8/97

Bast

(+ Harvey River)

Fax (01/8/1997) from JL to CDTM saying, inter alia, 'I spent yesterday in Perth with Grant [GBP] & Alan Clarke [ACl] sorting out the water level & water quality info and organising the ... sweep (invertebrate samples). Grant did have the missing info about the [depth measuring] stick [on Lake Ballard] so the water level info now looks good'.

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
BUSSELTON DISTRICT
FAX NO: (097) 521 432



FAXED

TO: CLIVE MESTON **URGENT:** YES / NO

AT:

Fax No.

FROM: JIM LANE

DATE: 1/8/97 **Your Ref:**
Local Ref:

Thanks for the fast comments + info. I spent yesterday in Perth with Grant + Glen Clarke sorting out the water level + water quality info and organising the put and sweep (invertebrate samples). Grant did have the missing info about the stick so the water level info now looks good. Cheers.

No. of pages inc. this page: 1

specifically asked to make recordings. My only note in my diary is the one you already have, Grant will be able to answer your question about the stick position I hope.

I did not get back to Ballard in 1996.

I look forward to seeing draft sections in due course, and I'll lead on some later in the year.

Best wishes,

Clive 03-9589-4901

Two pages of hand-written notes (31/7/1997) by JL saying, inter alia:

- **'Alan [ACl] to get evapn [evaporation] map ... to determine evapn rates at [Lakes] Ballard, Barlee & Marmion in 1995';**
- **(Crossed out): '[GBP] thinks the [depth measuring] stake with tape we placed on south side of the island [Camp Island] on 15/3/95 wasn't there when we went looking for it';**
- **(Also crossed out): 'Me look at photos [3638-39] of Grant & Clive washing on south side of Camp Island on 15/3. Is the [depth measuring] stick in the photo?' (JL checked photos on 02/4/2014. Answer is no);**
- **'Me check Harvey River [salinity profiling] reports [by WA Chem Centre] for Lake Marmion water analysis results'.**

31/7/97

- Glen to get evap maps that will enable us to determine evap rates at Bellevue, Banker & Marmion in 1995.

- Grant thinks the stake with tape we placed on south side of the island on 15/3/95 wasn't there when we went looking for it.

- Me look at photos of Grant & Clive searching for south side of Carnac Island on 15/3 ... Is the stick in the photo.

- Glen didn't use a camera on any trips.

- Grant has Bellevue & Marmion photos. He needs to label them (particularly dates). I need to go thru & get copies of some for my collection.

- Me to go thru GP's 12/3/97 photos – get in sequence – renumber.

- Grant to correctly sequence, renumber & label all his photos.

- Glen to get long term averages (month? annual?) for Wel & Meekatharra
  1968–74 average – for Jan, April, July, October for whole of

Glen has arranged to receive & will send me.

- me check Henry River reports for Lake Mannum water analysis results.

Fax (30/7/1997) from CDTM to JL saying, inter alia: 'My only note [about water level recordings] in my diary is the one you already have. Grant [GBP] will be able to answer you question about the [depth measuring] stick position [on Lake Ballard] I hope'. This fax was in response to JL's questions of 23/7/1997, see below.

Fax to Jim Lane 08-97-521432 (30/7/97)

I'm delighted you are picking up the Banded Stilt ball and are going to lead the running on it! My decks are now clearing & I'll be able to input too over the next few months.

Re your specific questions on water levels, I left this entirely to Grant except where I was specifically asked to make recordings. My only note in my diary is the one you already have. Grant will be able to answer your question about the stick position I hope.

I did not get back to Ballard in 1996.

I look forward to seeing draft sections in due course, and I'll lead on some later in the year.

Best wishes,

Clive 03-9589-4901

Copy (29/7/1997, supplied by WA Chem Centre) '... of Report on 77 samples of water received on 26 June 1995'. See GBP's letter of 26/6/1995 to WACC (and initial, unsent copy of 24/5/1995) for details of these samples.

178.

CHEMISTRY CENTRE

Water Analyses, File: CHEM0595/
Your Ref : 94E2471; 3.1.9
Our Ref : Roger Schulz
Enquiries to :
Telephone :

Research Centre Manager
Department of Conservation and Land Management
Woodvale Reasearch Centre
Ocean Reef Road
WOODVALE WA 6065
Attention : G Pearson

A copy to also on vol 4 (29/7/97)

Copy of Report on:

77 samples of water received on 26 June 1995

Analyte Unit			ECond mS/m	P_total mg/L	TDS_180C mg/L	N_total mg/L
CCWA ID	**Client ID**	**Sampled**				
94E2471/001	1	09/03/95	47	0.15	300	-
94E2471/002	2	09/03/95	424	0.16	2400	-
94E2471/003	3	09/03/95	6670	0.13	49000	-
94E2471/004	4	09/03/95	6640	0.12	51000	-
94E2471/005	5	09/03/95	6530	0.12	50000	-
94E2471/006	6	09/03/95	6740	0.07	52000	-
94E2471/007	7	21/03/95	65	0.22	380	-
94E2471/008	8	21/03/95	6470	0.13	49000	-
94E2471/009	9	21/03/95	6680	0.05	51000	-
94E2471/010	10	06/04/95	6620	0.06	51000	-
94E2471/011	11	06/04/95	6410	0.14	48000	-
94E2471/012	12	06/04/95	2530	0.19	17000	-
94E2471/013	13	06/04/95	55	0.19	350	-
94E2471/014	14	21/04/95	6420	0.07	48000	-
94E2471/015	15	21/04/95	6380	0.06	47000	-
94E2471/016	16	21/04/95	6430	0.06	47000	-
94E2471/017	17	21/04/95	6300	0.05	47000	-
94E2471/018	18	21/04/95	6310	0.08	47000	-
94E2471/019	19	21/04/95	6440	0.10	47000	-
94E2471/020	20	21/04/95	134	0.16	760	-
94E2471/021	21	17/05/95	5750	0.11	43000	-
94E2471/022	22	17/05/95	5710	0.08	41000	-
94E2471/023	23	17/05/95	5740	0.13	42000	-
94E2471/024	24	17/05/95	5530	0.06	39000	-
94E2471/025	25	17/11/94	4480	0.08	31000	-
94E2471/026	26	17/11/94	99	0.21	580	-
94E2471/027	27	15/03/95	2340	0.03	16000	-
94E2471/028	28	11/04/95	3480	0.05	24000	-
94E2471/029	29	11/04/95	3460	0.04	24000	-
94E2471/030	30	11/04/95	3600	0.05	25000	-

Chemistry Centre (WA)

CHEMISTRY CENTRE (WESTERN AUSTRALIA)
ENVIRONMENTAL CHEMISTRY LABORATORY

REPORT OF EXAMINATION

Analyte			ECond	P_total	TDS_180C	N_total
Unit			mS/m	mg/L	mg/L	mg/L
CCWA ID	Client ID	Sampled				
94E2471/031	31	11/04/95	3490	0.06	24000	-
94E2471/032	32	11/04/95	3440	0.04	24000	-
94E2471/033	33	11/04/95	3620	0.07	26000	-
94E2471/034	34	01/04/95	3300	0.22	23000	-
94E2471/035	35	01/04/95	3300	0.02	23000	-
94E2471/036	36	01/04/95	3290	0.19	23000	-
94E2471/037	37	01/04/95	31	0.12	220	-
94E2471/038	38	01/04/95	41	0.19	260	-
94E2471/039	39	02/04/95	3550	0.07	26000	-
94E2471/040	40	02/04/95	3490	0.11	25000	-
94E2471/041	41	02/04/95	3430	0.06	25000	-
94E2471/042	42	09/04/95	3860	0.20	28000	-
94E2471/043	43	11/04/95	3380	0.06	25000	-
94E2471/044	44	02/04/95	30	0.11	510	-
94E2471/045	45	04/05/95	30	0.08	180	1.0
94E2471/046	46	04/05/95	31	0.09	170	-
94E2471/047	47	04/05/95	30	0.06	180	-
94E2471/048	48	01/04/95	3260	0.25	24000	-
94E2471/049	49	01/04/95	3250	0.47	25000	-
94E2471/050	50	01/04/95	29	0.09	140	-
94E2471/051	51	02/04/95	3550	0.08	26000	-
94E2471/052	52	02/04/95	3550	0.06	26000	-
94E2471/053	53	02/04/95	3500	0.11	26000	-
94E2471/054	54	02/04/95	3460	0.09	24000	-
94E2471/055	55	09/04/95	3880	0.21	28000	-
94E2471/056	56	09/04/95	3870	0.27	28000	-
94E2471/057	57	11/04/95	3390	0.06	23000	-
94E2471/058	57A	11/04/95	3420	0.10	24000	-
94E2471/059	58	02/05/95	4180	0.06	29000	-
94E2471/060	59	02/05/95	5320	0.05	39000	-
94E2471/061	60	02/05/95	5140	0.05	37000	-
94E2471/062	61	02/05/95	5450	0.07	40000	-
94E2471/063	62	02/05/95	5450	0.07	40000	-
94E2471/064	63	04/05/95	4120	0.12	29000	-
94E2471/065	64	28/04/95	4220	0.02	29000	-
94E2471/066	65	28/04/95	4200	0.02	31000	-
94E2471/067	66	28/04/95	4190	0.03	31000	-
94E2471/068	67	04/05/95	4130	0.13	30000	1.1
94E2471/069	68	02/05/95	4140	0.06	29000	-
94E2471/070	69	02/05/95	5290	0.08	39000	-
94E2471/071	70	02/05/95	5420	0.06	40000	-
94E2471/072	71	02/05/95	5490	0.06	41000	-
94E2471/073	72	02/05/95	5170	0.09	38000	0.88
94E2471/074	73	14/02/95	1710	0.24	11000	-
94E2471/075	74	14/02/95	70	0.05	440	-
94E2471/076	75	14/02/95	1140	0.01	7100	-
94E2471/077	76	14/02/95	466	0.08	2700	-

CHEMISTRY CENTRE (WESTERN AUSTRALIA)
ENVIRONMENTAL CHEMISTRY LABORATORY

REPORT OF EXAMINATION

Analyte	Method	Description
ECond	iEC1WZSE	Electrical Conductivity, 25 degrees celcius.
P_total	iPP1WTCO	Phosphorus, persulphate total.
TDS_180C	iSOL1WDGR	Total dissolved solids, <0.45um.
N_total	iNP1WTAA	Nitrogen, persulphate total.

These results apply only to the sample(s) as received.

The TDS for sample 94E2471/044 appears anamolous in comparison with the conductivity value. The conductivity has been confirmed but there was insufficient sample to repeat the TDS.

Jenny McGuire
Acting Principal Chemist
ENVIRONMENTAL CHEMISTRY LABORATORY

29 July 1997 Re issued 29/7/97

CHEMISTRY CENTRE

Water Analyses, File: CHEM0595/
Your Ref : 94E2471; 3.1.9
Our Ref : Roger Schulz
Enquiries to
Telephone :

Research Centre Manager
Department of Conservation and Land Management
Woodvale Reasearch Centre
Ocean Reef Road
WOODVALE WA 6065
Attention : G Pearson

Copy of Report on:

77 samples of water received on 26 June 1995

Analyte Unit			ECond mS/m	P_total mg/L	TDS_180C mg/L	N_total mg/L
CCWA ID	**Client ID**	**Sampled**				
94E2471/001	1	09/03/95	47	0.15	300	-
94E2471/002	2	09/03/95	424	0.16	2400	-
94E2471/003	3	09/03/95	6670	0.13	49000	-
94E2471/004	4	09/03/95	6640	0.12	51000	-
94E2471/005	5	09/03/95	6530	0.12	50000	-
94E2471/006	6	09/03/95	6740	0.07	52000	-
94E2471/007	7	21/03/95	65	0.22	380	-
94E2471/008	8	21/03/95	6470	0.13	49000	-
94E2471/009	9	21/03/95	6680	0.05	51000	-
94E2471/010	10	06/04/95	6620	0.06	51000	-
94E2471/011	11	06/04/95	6410	0.14	48000	-
94E2471/012	12	06/04/95	2530	0.19	17000	-
94E2471/013	13	06/04/95	55	0.19	350	-
94E2471/014	14	21/04/95	6420	0.07	48000	-
94E2471/015	15	21/04/95	6380	0.06	47000	-
94E2471/016	16	21/04/95	6430	0.06	47000	-
94E2471/017	17	21/04/95	6300	0.05	47000	-
94E2471/018	18	21/04/95	6310	0.08	47000	-
94E2471/019	19	21/04/95	6440	0.10	47000	-
94E2471/020	20	21/04/95	134	0.16	760	-
94E2471/021	21	17/05/95	5750	0.11	43000	-
94E2471/022	22	17/05/95	5710	0.08	41000	-
94E2471/023	23	17/05/95	5740	0.13	42000	-
94E2471/024	24	17/05/95	5530	0.06	39000	-
94E2471/025	25	17/11/94	4480	0.08	31000	-
94E2471/026	26	17/11/94	99	0.21	580	-
94E2471/027	27	15/03/95	2340	0.03	16000	-
94E2471/028	28	11/04/95	3480	0.05	24000	-
94E2471/029	29	11/04/95	3460	0.04	24000	-
94E2471/030	30	11/04/95	3600	0.05	25000	-

94E2471
29 July 1997

CHEMISTRY CENTRE (WESTERN AUSTRALIA)
ENVIRONMENTAL CHEMISTRY LABORATORY

REPORT OF EXAMINATION

Analyte			ECond	P_total	TDS_180C	N_total
Unit			mS/m	mg/L	mg/L	mg/L
CCWA ID	**Client ID**	**Sampled**				
94E2471/031	31	11/04/95	3490	0.06	24000	-
94E2471/032	32	11/04/95	3440	0.04	24000	-
94E2471/033	33	11/04/95	3620	0.07	26000	-
94E2471/034	34	01/04/95	3300	0.22	23000	-
94E2471/035	35	01/04/95	3300	0.02	23000	-
94E2471/036	36	01/04/95	3290	0.19	23000	-
94E2471/037	37	01/04/95	31	0.12	220	-
94E2471/038	38	01/04/95	41	0.19	260	-
94E2471/039	39	02/04/95	3550	0.07	26000	-
94E2471/040	40	02/04/95	3490	0.11	25000	-
94E2471/041	41	02/04/95	3430	0.06	25000	-
94E2471/042	42	09/04/95	3860	0.20	28000	-
94E2471/043	43	11/04/95	3380	0.06	25000	-
94E2471/044	44	02/04/95	30	0.11	510	-
94E2471/045	45	04/05/95	30	0.08	180	1.0
94E2471/046	46	04/05/95	31	0.09	170	-
94E2471/047	47	04/05/95	30	0.06	180	-
94E2471/048	48	01/04/95	3260	0.25	24000	-
94E2471/049	49	01/04/95	3250	0.47	25000	-
94E2471/050	50	01/04/95	29	0.09	140	-
94E2471/051	51	02/04/95	3550	0.08	26000	-
94E2471/052	52	02/04/95	3550	0.06	26000	-
94E2471/053	53	02/04/95	3500	0.11	26000	-
94E2471/054	54	02/04/95	3460	0.09	24000	-
94E2471/055	55	09/04/95	3880	0.21	28000	-
94E2471/056	56	09/04/95	3870	0.27	28000	-
94E2471/057	57	11/04/95	3390	0.06	23000	-
94E2471/058	57A	11/04/95	3420	0.10	24000	-
94E2471/059	58	02/05/95	4180	0.06	29000	-
94E2471/060	59	02/05/95	5320	0.05	39000	-
94E2471/061	60	02/05/95	5140	0.05	37000	-
94E2471/062	61	02/05/95	5450	0.07	40000	-
94E2471/063	62	02/05/95	5450	0.07	40000	-
94E2471/064	63	04/05/95	4120	0.12	29000	-
94E2471/065	64	28/04/95	4220	0.02	29000	-
94E2471/066	65	28/04/95	4200	0.02	31000	-
94E2471/067	66	28/04/95	4190	0.03	31000	-
94E2471/068	67	04/05/95	4130	0.13	30000	1.1
94E2471/069	68	02/05/95	4140	0.06	29000	-
94E2471/070	69	02/05/95	5290	0.08	39000	-
94E2471/071	70	02/05/95	5420	0.06	40000	-
94E2471/072	71	02/05/95	5490	0.06	41000	-
94E2471/073	72	02/05/95	5170	0.09	38000	0.88
94E2471/074	73	14/02/95	1710	0.24	11000	-
94E2471/075	74	14/02/95	70	0.05	440	-
94E2471/076	75	14/02/95	1140	0.01	7100	-
94E2471/077	76	14/02/95	466	0.08	2700	-

80 b

CHEMISTRY CENTRE (WESTERN AUSTRALIA)
ENVIRONMENTAL CHEMISTRY LABORATORY

REPORT OF EXAMINATION

Analyte	Method	Description
ECond	iEC1WZSE	Electrical Conductivity, 25 degrees celcius.
P_total	iPP1WTCO	Phosphorus, persulphate total.
TDS_180C	iSOL1WDGR	Total dissolved solids, <0.45um.
N_total	iNP1WTAA	Nitrogen, persulphate total.

These results apply only to the sample(s) as received.

The TDS for sample 94E2471/044 appears anamolous in comparison with the conductivity value. The conductivity has been confirmed but there was insufficient sample to repeat the TDS.

Jenny McGuire
Acting Principal Chemist
ENVIRONMENTAL CHEMISTRY LABORATORY

29 July 1997 Re issued 29/7/97

Folios 10-24 (Vol.5) of JL's BaSt files is data supplied in 1997 by Bureau of Meteorology. The data are:

- **1995 daily precipitation (rainfall) data for Leonora (Sites 012272, 012061, 012046, 012032), Menzies (012187, 012052, 012051, 012043, 012037) & Sandstone (012022). Note that Menzies site 012037 is 'Menzies (Jeedamya)'. The coordinates (lat long) of each station are supplied.**
- **1995 daily evaporation data for: Meekatharra (007045), Kalgoorlie (012038).**
- **1967-1997 monthly evaporation (and means, medians, max, min) data for Meekatharra (007045) and Kalgoorlie (012038). JL has annotated with, inter alia, calculations of total evaporation at Kalgoorlie and rainfall at Jeedamya from 1/3, 2/3 & 3/3 to 15/31995.**

Monthly Data for KALGOORLIE (KALGOORLIE-BOULDER AMO)

Site Number 012038 Latitude 30°47'07"S Longitude 121°27'08"E Elevation 365 metres Opened Feb 1939 Still Open

Mean Daily Evaporation (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
1966												13.2	
1967	12.7	10.9	9.2	6.1	3.7	3.4	3.1	3.8	6.8	9.6	11.8	13.6	7.9
1968	15.3	12.0	8.8	5.6	3.5	2.2	2.4	3.6	5.8	8.6	10.0	11.0	7.4
1969	13.3	11.2	9.0	6.5	3.3	2.8	3.0	4.2	5.0	8.3	11.8	12.7	7.6
1970	13.2	11.8	9.7	5.9	3.7	3.1	3.0	4.1	5.2	8.4	10.4	14.0	7.7
1971	13.0	12.3	9.0	6.6	4.3	3.0	3.1	3.9	5.9	8.7	9.6	12.6	7.7
1972	13.2	11.8	8.6	7.3	5.2	3.1	2.7	3.8	6.6	9.3	10.1	14.7	8.0
1973	12.4	13.1	10.3	5.6	4.1	2.1	2.5	2.9	4.7	7.1	8.3	12.1	7.1
1974	12.3	10.6	6.8	3.5	3.3	2.3	2.4	3.4	4.2	7.5	9.2	11.8	6.4
1975	12.4	9.7	6.4	4.5	2.6	2.4	2.3	3.1	5.2	5.5	9.3	11.3	6.2
1976	11.6	9.9		5.8	4.6	2.4	3.4	4.7	6.7	7.2	10.0	14.5	
1977	15.3	13.6	10.5	6.6	3.3	3.2	3.6	4.7	6.0	9.9	10.6	13.1	8.4
1978	12.3	10.4	9.1	7.0	4.7	3.0	2.5	3.2	5.8	9.1	11.5	12.9	7.6
1979	13.8	11.7	10.4	6.5	3.4	3.0	3.9	3.5	5.0	9.3	11.0	13.6	7.9
1980	13.9	10.5	11.0	6.8	3.2	2.2	2.1	3.7	6.2	7.9	11.5	12.8	7.7
1981	11.3	9.7	8.7	7.0	3.5	2.5	2.9	3.6	6.6	9.7	8.6	10.5	7.1
1982	12.1	12.6	7.5	5.9	3.4	2.5	2.9	4.8	5.7	6.9	9.7	11.0	7.1
1983	12.7	11.9	7.6	5.6	4.5	3.0	3.0	4.3	6.3	8.7	10.0	9.9	7.3
1984	11.9	11.6	6.8	5.6	3.5	2.9	2.2	3.4	5.0	7.8	10.6	11.8	6.9
1985	13.7	10.7	9.9	6.5	3.1	3.3	2.9	3.2	6.4	9.0	10.4	13.3	7.7
1986	13.7	10.8	10.6	6.8	3.3	1.9	2.0	3.1	5.0	7.6	10.5	11.8	7.3
1987	11.4	10.1	7.5	5.7	3.2	2.3	2.7	3.5	5.6	7.7	9.3	11.4	6.7
1988	12.3	9.8	9.6	5.3	2.6	3.0	2.8	3.9	6.4	9.2	10.8	8.7	7.0
1989	10.9	10.9	7.8	5.8	2.9	1.6	2.3	4.0	6.8	8.7	10.6	13.0	7.1
1990	9.6		9.4	6.0	4.2	2.4	2.3	3.7	5.7	7.4	11.3	11.9	
1991	13.1	13.0	9.1	6.8	3.8	2.2	2.5	3.7	6.2	9.2	10.4	11.4	7.6
1992	11.9	9.1	7.8	3.2	2.4	1.8	2.1	2.4	3.2	6.2	9.1	10.4	5.8
1993	12.4	10.0	7.9	5.2	2.2	1.9	2.4	3.1	5.1	7.9	8.5	11.2	6.5
1994	13.5	10.5	9.0	6.7	4.9	2.5	4.1	4.0	6.2	8.9	10.3	11.6	7.7
1995	12.7	9.8	6.1	3.8	2.7	2.3	2.2	4.1	5.6	8.3	10.5	10.8	6.6
1996	13.1	12.4	9.3	5.3	4.3	2.5	2.7	3.3	6.2	8.5	11.4	12.0	7.6
1997	13.1	11.6	9.0	5.0	2.3	2.5							

Summary of Mean Daily Evaporation using available data between 1966 and 1997

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
Mean	12.7	11.1	8.7	5.8	3.5	2.6	2.7	3.7	5.7	8.3	10.2	12.1	7.3
Median	12.7	10.9	9.0	5.9	3.4	2.5	2.7	3.7	5.8	8.4	10.4	11.9	7.3
Highest	15.3	13.6	11.0	7.3	5.2	3.4	4.1	4.8	6.8	9.9	11.8	14.7	8.4
Lowest	9.6	9.1	6.1	3.2	2.2	1.6	2.0	2.4	3.2	5.5	8.3	8.7	5.8
Number	31	30	30	31	31	31	30	30	30	30	30	31	28

Monthly Data for MEEKATHARRA (MEEKATHARRA A.M.O.)

23.

Site Number 007045 Latitude 26°36'40"S Longitude 118°32'41"E Elevation 517 metres Opened Jan 1944 Still Open

Mean Daily Evaporation (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
1967	16.6	15.6	14.4	11.7	6.6	4.7	5.1	6.9	10.9	15.4	17.1	16.5	11.8
1968	19.6	17.2	11.3	7.3	5.6	3.9	4.4	5.5	8.7	12.1	15.5	16.6	10.6
1969	18.9	15.4	13.9	9.9	6.0	4.2	5.2	6.9	9.4	13.2	16.4	16.0	11.3
1970	17.1	16.3	14.3	8.7	5.1	3.6	5.3	7.8	7.7	14.0	16.5	17.8	11.2
1971	17.0	15.2	12.8	10.5	6.4	3.5	4.5	4.7	8.4	11.0	13.4	16.6	10.3
1972	17.0	15.9	13.4	10.3	7.8	4.3	3.7	4.8	9.0	12.2	15.5	17.9	11.0
1973	16.9	17.6	14.4	7.9	5.2	3.0	3.0	4.4	7.7	11.3	13.0	14.4	9.9
1974	18.5	15.1	11.8	7.9	5.2	4.2	3.1	4.5	7.6	10.0	14.0	16.7	9.9
1975	17.9	13.1	9.8	6.9	5.6	4.0	3.7	5.6	8.0	7.9	10.9	14.7	9.0
1976	16.7	16.1	11.6	9.0	6.5	4.9	4.9	6.3	8.2	10.6	13.8	18.0	10.6
1977	18.0	18.9	14.0	10.9	5.4	5.1	5.2	6.0	8.6	12.2	14.3	15.4	11.2
1978	17.5	12.0	13.3	10.3	6.5	4.1	3.5	5.6	7.2	11.5	15.0	15.3	10.2
1979	19.4	16.5	13.8	7.9	5.3	4.8	5.1	4.9	8.0	12.5	14.7	16.7	10.8
1980	17.3	14.3	15.8	7.8	4.6	2.8	2.7	4.8	8.2	10.0	13.5	16.7	9.9
1981	16.9	13.8	12.4	10.4	6.2	3.5	4.0	5.2	9.5	13.0	14.0	16.4	10.4
1982	13.9	15.5	10.9	9.4	5.0	3.0	4.2	5.9	7.7	10.9	13.2	14.1	9.5
1983	16.6	15.3	12.4	8.6	6.7	4.3	4.6	6.0	8.8	12.5	12.2	13.2	10.1
1984	16.6	17.6	10.0	9.2	3.8	3.9	3.3	4.4	6.8	10.2	12.8	14.5	9.4
1985	17.2	13.9	13.7	8.9	4.6	4.1	3.8	4.7	8.4	10.6	12.8	14.0	9.7
1986	15.9	12.9	11.5	9.3	5.9	3.1	2.6	4.3	6.6	8.8	13.8	15.6	9.2
1987	13.7	12.6	10.9	8.3	4.7	3.0	4.2	5.5	8.7	10.8	12.6	14.7	9.1
1988	16.1	15.2	13.4	8.0	4.5	4.0	4.3	5.2	8.5	11.5	12.8	12.6	9.7
1989	13.9	13.8	12.2	8.3	5.0	2.7	3.1	5.8	7.8	10.2	12.6	15.7	9.3
1990	12.8	11.3	12.3	9.1	6.0	4.3	3.9	4.8	8.4	10.2	14.0	15.8	9.4
1991	17.2	18.5	12.9	9.1	6.5	2.8	3.4	5.8	8.0	11.3	12.9	14.5	10.2
1992	15.3	14.3	10.3	6.2	3.2	2.3	3.4	4.1	6.5	10.2	12.3	14.4	8.5
1993	16.7	13.8	11.1	8.2	4.4	3.3	3.5	4.8	7.1	10.1	11.9	14.4	9.1
1994	17.4	13.1	12.8	9.9	6.7	3.9	4.8	6.8	9.5	11.3	14.0	15.2	10.5
1995	16.6	10.3	9.0	4.8	4.5	3.8	3.5	5.8	8.1	11.3	12.3	14.7	8.7
1996	17.5	16.2	12.2	6.8	6.7	2.3	2.7	4.0	7.2	11.1	14.6	12.9	9.5
1997	15.3	9.6	11.6	6.3	4.5	3.4							

Summary of Mean Daily Evaporation using available data between 1967 and 1997

Mean	16.7	14.7	12.4	8.6	5.5	3.7	4.0	5.4	8.2	11.3	13.7	15.4	10.0
Median	16.9	15.2	12.4	8.7	5.4	3.9	3.9	5.4	8.1	11.2	13.7	15.4	9.9
Highest	19.6	18.9	15.8	11.7	7.8	5.1	5.3	7.8	10.9	15.4	17.1	18.0	11.8
Lowest	12.8	9.6	9.0	4.8	3.2	2.3	2.6	4.0	6.5	7.9	10.9	12.6	8.5
Number	31	31	31	31	31	31	30	30	30	30	30	30	30

Daily Data for KALGOORLIE (KALGOORLIE-BOULDER AMO)

Site Number 012038 Latitude 30°47'07"S Longitude 121°27'08"E Elevation 365 metres Opened Feb 1939 Still Open

Evaporation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jan 1995	15.2	19.4	17.0	12.0	12.0	12.4	15.0	13.2	12.8	12.2	13.8	13.2	13.6	4.4	12.8	11.0	15.2	16.0	14.8	16.0	13.2	14.2	16.8	8.4	5.8	6.2	5.0	12.8	16.0	9.8	13.4	12.7	19.4	4.4	393.6	31
Feb 1995	9.2	9.4	9.4	12.8	11.6	8.0	10.6	13.8	12.0	11.4	11.8	12.0	10.4	4.2	9.4	10.8	11.8	13.8	10.2	7.8	8.0	10.8	13.2	12.8	13.4	2.0	1.6	1.4				9.8	13.8	1.4	273.6	28
Mar 1995	1.6	2.4	3.0	2.6	4.8	6.8	6.8	6.2	6.4	7.0	6.4	7.2	7.0	8.4	7.2	7.6	6.6	9.0	5.6	6.4	7.2	7.4	5.4	6.0	4.4	5.2	8.2	9.2	6.0	6.8	4.0	6.1	9.2	1.6	188.8	31
Apr 1995	3.2	5.2	6.2	6.0	6.2	5.6	5.8	4.8	2.6	4.2	1.4	3.6	2.4	2.8	4.8	5.0	3.2	2.4	2.4	2.0	2.8	4.6	3.2	2.2	5.8	2.8	3.2	4.0	2.6	3.4		3.8	6.2	1.4	114.4	30
May 1995	0.8	1.2	4.2	1.8	4.0	3.0	2.2	2.4	6.4	1.0	4.0	3.8	4.0	1.2	1.4	3.6	2.2	3.8	5.4	2.2	2.6	2.0	3.2	3.0	2.0	1.2	2.4	2.0	2.4	2.2	0.8	2.7	6.4	0.8	82.4	31
Jun 1995	0.8	1.8	2.4	2.0	2.6	0.0	5.0	5.0	4.6	2.2	1.0	1.0	2.4	1.8	1.6	0.8	2.4	1.8	2.4	3.6	2.8	2.2	0.4	2.0	1.4	3.0	3.0	2.8	2.8	3.0		2.3	5.0	0.0	68.6	30
Jul 1995	1.0	1.0	1.6	3.4	1.8	4.6	1.4	3.4	4.8	2.4	1.8	1.6	1.6	1.6	0.4	1.6	1.2	1.6	3.0	4.0	3.4	1.6	1.4	2.4	3.8	2.0	1.8	1.8	3.4	2.2	2.0	2.2	4.8	0.4	69.6	31
Aug 1995	3.0	1.2	1.4	2.6	2.4	3.0	3.2	5.2	5.6	4.0	4.0	2.0	6.8	4.0	4.6	3.4	5.4	6.4	4.0	6.6	3.0	5.0	4.0	4.6	2.4	4.0	2.4	4.2	7.8	6.6	4.0	4.1	7.8	1.2	126.8	31
Sep 1995	3.4	3.0	5.0	6.8	3.0	5.2	4.6	3.6	6.4	3.6	5.2	7.8	7.6	2.6	3.4	5.4	8.8	8.4	6.4	6.0	6.8	5.4	5.4	7.2	7.2	7.6	7.8	5.0	3.6	6.4		5.6	8.8	2.6	168.6	30
Oct 1995	3.4	6.0	5.4	7.0	5.4	6.4	6.6	6.4	10.2	4.2	7.8	11.0	7.6	7.4	12.0	13.0	12.6	6.4	6.6	7.8	7.8	7.0	9.2	6.4	7.6	11.0	10.6	9.2	11.6	11.6	13.0	8.3	13.0	3.4	258.2	31
Nov 1995	10.0	9.2	9.8	8.0	9.8	12.6	11.4	12.8	10.4	7.0	8.4	8.8	10.8	9.4	12.0	10.2	11.6	5.2	6.8	6.2	9.6	12.0	18.4	7.6	11.2	15.2	12.0	12.8	14.2	11.2		10.5	18.4	5.2	314.6	30
Dec 1995	10.6	11.6	19.8	7.8	12.0	11.6	17.0	17.2	9.2	13.4	11.2	13.8	10.0	0.8	1.2	12.0	12.8	12.2	13.0	18.5	12.4	10.6	10.8	10.6	5.4	9.0	9.0	8.8	10.2	4.6	9.2	10.8	19.8	0.8	336.3	31

Total evaporation at Kals from 9am on 15/3 back to 9am on 3/3 = 76.8 mm

" " " " " " " 2/3 = 79.8 mm

" " " " " " " 1/3 = 82.2 mm

Total rain at Jeedamya since period

= 0 mm

= 0 mm

= 0.8 mm

Convert to estimated evaps at Jeedamya.

Range in daily evaps. = 0.0 → 19.8 mm

22.

Daily Data for MEEKATHARRA (MEEKATHARRA A.M.O.)

Site Number 007045 Latitude 26°36'40"S Longitude 118°32'41"E Elevation 517 metres Opened Jan 1944 Still Open

Evaporation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jan 1995	18.8	19.4	20.8	19.4	18.6	17.6	17.0	16.2	17.6	15.8	18.8	20.0	17.2	15.4	9.6	12.8	14.0	15.6	19.2	17.2	19.0	17.6	18.6	15.6	13.4	12.8	14.4	14.8	16.0	19.4	13.4	16.6	20.8	9.6	516.0	31
Feb 1995	8.4	13.6	11.0	12.8	16.0	17.2	16.0	16.0	21.0	16.0	1.6	7.0	10.6	6.0	10.2	12.0	10.6	11.6	4.0	4.2	4.2	9.0	11.4	13.2	7.0	2.6		4.8				10.3	21.0	1.6	278.0	27
Mar 1995	2.2	6.2	5.8	6.4	12.0	5.8	14.4	10.0	10.4	8.0	11.4	11.2	11.0	12.0	12.8	12.8	12.6	13.0	13.4	13.0	11.8	6.4	7.6	6.4	6.0	5.6	9.0	6.0	7.0	6.0	3.6	9.0	14.4	2.2	280.0	31
Apr 1995	9.2	8.0	7.8	2.2	7.2	2.8	4.8	6.2	2.2	2.0	1.8	4.4	4.0	4.6	5.8	5.6	3.8	5.6	3.8	4.2	4.6	2.0	5.0	7.4	6.0	6.4	5.4	5.6	4.2	0.2		4.8	9.2	0.2	142.8	30
May 1995	5.2	5.8	7.4	6.8	5.2	5.4	4.0	6.0	5.4	4.4	6.6	3.0	3.6	3.8	6.0	3.6	6.4	4.8	4.0	4.6	4.6	0.4	3.4	4.2	3.0	3.0	3.6	3.6	3.2	3.6	6.0	4.5	7.4	0.4	140.6	31
Jun 1995	5.6	5.0	3.8	4.0	4.8	2.4	3.8	4.2	3.0	2.8	4.0	1.6	3.2	3.2	3.8	4.0	4.8	3.6	6.0	7.6	1.8	4.0	4.0	3.8	3.2	3.8	2.6	2.4	4.0	4.0		3.8	7.6	1.6	114.8	30
Jul 1995	3.8	3.8	4.0	4.6	6.6	6.4	2.8	6.2	5.4	3.6	3.2	2.8	2.8	1.0	2.4	2.6	2.8	3.0	3.0	3.2	2.2	3.0	2.0	3.2	3.2	3.8	2.4	3.8	5.8	1.2	2.6	3.5	6.6	1.0	107.2	31
Aug 1995	3.4	3.2	4.0	6.8	7.6	6.8	5.8	5.4	8.0	3.0	4.2	4.8	6.8	5.4	6.0	2.8	6.6	4.0	5.2	6.4	6.2	6.6	5.6	7.2	5.0	4.8	7.2	8.4	5.4	9.8	8.0	5.8	9.8	2.8	180.4	31
Sep 1995	7.4	5.0	7.0	6.8	5.2	7.0	6.0	5.6	4.2	6.8	7.0	10.2	8.6	8.0	8.0	9.6	9.4	7.2	5.8	10.6	8.0	9.4	9.2	11.4	8.0	8.0	10.4	16.0	11.2	7.2		8.1	16.0	4.2	244.2	30
Oct 1995	8.6	5.2	9.4	9.8	12.0	8.0	9.4	11.4	12.0	10.8	9.2	8.0	11.6	13.0	12.0	11.6	15.0	13.6	11.2	13.8	13.4	13.2	10.4	11.6	11.2	12.0	10.4	12.6	12.6	13.0	13.6	11.3	15.0	5.2	349.6	31
Nov 1995	11.6	11.6	9.6	12.6	14.2	16.0	11.4	12.2	5.8	11.4	12.8	16.0	8.0	12.0	10.6	10.0	8.0	12.0	10.0	15.8	12.0	12.0	14.2	16.0	16.0	16.0	14.2	9.4	13.2	13.2		12.3	16.0	5.8	367.8	30
Dec 1995	16.0	16.0	20.0	20.0	16.0	16.0	16.0	20.0	16.6	9.4	9.6	16.0	11.6	7.2	9.4	16.0		31.0	8.6	13.2	12.6	14.2	11.2	14.4	15.6	14.0	13.6	16.8	20.0	17.0	16.6	15.2	31.0	7.2	454.6	30

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	Name	Site No	Latitude	Longitude	Start	End
	SANDSTONE (CASHMERE	012022	-28.9706	119.5669	01-01-1919	
	LEONARA (GLENORN)	012032	-29.0894	121.6744	01-01-1922	
	MENZIES (JEEDAMYA)	012037	-29.4033	121.2736	01-01-1925	
	MENZIES (KOOKYNIE)	012043	-29.3419	121.4897	01-01-1902	
	LEONORA (LEONORA POS	012046	-28.8847	121.3289	01-01-1898	
	MENZIES (MENANGINA)	012051	-29.8286	121.9147	01-01-1927	
	MENZIES (MENZIES)	012052	-29.6925	121.0286	01-05-1896	
	LEONORA (MINARA)	012061	-28.9189	121.7961	01-01-1898	
	MENZIES (YERILLA)	012187	-29.4722	121.8261	01-01-1897	
	MENZIES (DIEMALS)	012242	-29.6694	119.3031	01-01-1970	- N/A.
	LEONORA (MINARA DING	012272	-28.8789	121.5969	01-01-1973	
*	MENZIES (WALLING ROC	012318	-29.3497	120.4000	01-05-1995	not used.

12 rows selected.

Search area. 28° - 30° S, 119° - 122° E.

Daily Data for SANDSTONE (CASHMERE DOWNS)

Site Number 012022 Latitude 28°58'14"S Longitude 119°34'01"E Elevation 450 metres Opened Jan 1919 Still Open

Precipitation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jan 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.8	0.0	0.0	0.4	0.0	11.2	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.4	11.2	0.0	13.6	31
Feb 1995	34.8	0.2	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	6.6	8.0	0.0	0.0	0.0	0.0	0.4	0.0	0.2	0.0	0.0	0.0	65.4	94.4	149.8	3.2				13.1	149.8	0.0	367.6	28
Mar 1995	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	16.8	0.0	0.2	1.0	0.0	0.6	16.8	0.0	18.6	31
Apr 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	14.8	6.8	1.4	0.2	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	14.4	0.0	0.0	0.0	0.0	0.0	3.2	7.4	0.0		1.7	14.8	0.0	51.8	30
May 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.2	0.0	0.0	0.0	0.6	0.0	0.0	1.2	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	4.2	0.0	6.8	31
Jun 1995	0.0	0.0	0.0	0.0	0.2	1.0	5.4	13.4	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	3.8	2.4	0.2	0.0	0.8	0.0	0.0	0.0	0.0		1.2	13.4	0.0	34.8	30
Jul 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.4	1.6	13.4	0.0	0.0	2.0	8.2	0.0	0.0	0.0	3.8	0.8	1.4	0.0	0.0	10.8	0.0	0.0	0.0	1.0	5.2	0.0	1.6	13.4	0.0	50.2	31
Aug 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.6	31
Sep 1995	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.6	0.4		0.9	22.6	0.0	26.6	30
Oct 1995	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	1.4	31
Nov 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.2	6.2	0.0	6.4	30
Dec 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	12.8	0.0	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	12.8	0.0	26.8	31

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Daily Data for LEONARA (GLENORN)

Site Number 012032 Latitude 29°05'22"S Longitude 121°40'28"E Elevation 360 metres Opened Jan 1922 Still Open

Precipitation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jan 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	3.4	17.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	17.2	0.0	27.4	31
Feb 1995	19.0	2.6	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	26.6	0.0	0.0	0.0	0.0	0.0	30.4	42.0	79.8	74.4				10.1	79.8	0.0	282.4	28
Mar 1995	3.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	8.0	0.0	11.0	31
Apr 1995	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	12.0	10.8	2.0	0.0	0.0	0.0	0.0	0.0	0.0	8.8	0.0	0.0	0.0	12.6	0.0	0.0	0.0	0.0	0.0	6.4	2.0	0.0		1.9	12.6	0.0	55.6	30
May 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	2.4	0.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.4	0.0	4.6	31
Jun 1995	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	7.2	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.4	7.2	0.0	12.6	30
Jul 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	1.0	0.0	1.0	9.0	0.0	0.0	0.0	3.0	1.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.4	5.2	0.0	1.4	20.0	0.0	44.6	31
Aug 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31
Sep 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	3.0	1.0		0.4	5.0	0.0	11.0	30
Oct 1995	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	4.4	0.0	9.0	31
Nov 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	30
Dec 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	8.6	0.0	0.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.8	8.6	0.0	25.2	31

Daily Data for MENZIES (JEEDAMYA)

Site Number 012037 Latitude 29°24'12"S Longitude 121°16'25"E Elevation 434 metres Opened Jan 1925 Still Open

Precipitation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jan 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	11.0	0.0	14.8	31
Feb 1995	37.4	1.5	0.0	52.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	15.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	87.4	60.2	138.0	51.8				15.9	138.0	0.0	445.7	28
Mar 1995	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.8	0.0	1.6	31
Apr 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	8.2	53.8	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	7.0	1.2	0.0	0.0	0.0	0.0	0.0	35.0	0.6		3.8	53.8	0.0	112.8	30
May 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	1.4	31
Jun 1995	0.0	0.0	0.0	0.0	0.0	1.8	4.6	6.8	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.7	6.8	0.0	21.1	30
Jul 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	17.3	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	3.0	0.0	3.2	0.0	0.0	0.0	0.0	7.2	0.0	1.3	17.3	0.0	38.9	31
Aug 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31
Sep 1995	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	11.4	0.0		0.7	11.4	0.0	19.6	30
Oct 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	3.8	0.0	5.8	31
Nov 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.3	5.6	0.0	7.8	30
Dec 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.0	98.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	3.9	98.0	0.0	119.8	31

Daily Range in daily rainfall = 0 → 138.0

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Daily Data for MENZIES (KOOKYNIE)

Site Number 012043 Latitude 29°20'31"S Longitude 121°29'23"E Elevation 423 metres Opened Jan 1902 Still Open

Precipitation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jun 1995	0.0	0.0	0.0	0.0	0.0	0.0	3.0	6.4	3.2	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.8	10.0	0.0	24.0	30
Jul 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	17.6	0.0	0.0	3.0	1.4	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	1.0	17.6	0.0	31.8	31

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Daily Data for LEONORA (LEONORA POST OFFICE)

Site Number 012046 Latitude 28°53'05"S Longitude 121°19'44"E Elevation 379 metres Opened Jan 1898 Still Open

Precipitation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jan 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	1.2	14.0	0.0	1.2	0.0	0.0	0.0	0.4	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	14.0	0.0	19.0	31
Feb 1995	13.6	0.0	0.8	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.2	0.0	0.0	0.0	0.0	23.4	0.0	0.0	0.0	0.0	0.0	16.6	45.3	105.9	65.0				10.2	105.9	0.0	284.6	28
Mar 1995	0.0	0.8	0.0	10.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	10.6	0.0	13.4	31
Apr 1995	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.2	14.4	4.0	1.4	0.0	0.0	0.0	0.0	0.0	1.4	1.4	0.0	0.0	2.2	4.2	0.0	0.0	0.0	0.0	0.0	2.4	5.4	0.0		1.3	14.4	0.0	38.6	30
May 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.4	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.4	0.0	2.8	31
Jun 1995	0.0	0.0	0.0	0.0	0.0	1.4	0.0	1.4	4.6	0.0	0.0	0.0	0.0	1.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0		0.3	4.6	0.0	10.0	30
Jul 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	14.0	0.0	0.0	3.0	3.0	0.0	0.0	0.0	3.0	2.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.8	8.0	0.0	1.3	14.0	0.0	39.8	31
Aug 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.4	31
Sep 1995	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	1.4	0.0		0.2	2.2	0.0	6.4	30
Oct 1995	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.0	0.0	2.0	31
Nov 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.1	1.0	0.0	3.4	30
Dec 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	6.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	6.0	0.2	0.0	0.0	0.0	5.0	0.0	0.0	0.7	6.0	0.0	20.8	31

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Daily Data for MENZIES (MENANGINA)

Site Number 012051 Latitude 29°49'43"S Longitude 121°54'53"E Elevation 450 metres Opened Jan 1927 Still Open

Precipitation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jan 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	2.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.1	0.0	2.4	31
Feb 1995	8.2	16.0	0.5	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	76.5	55.0	87.0	58.5				11.4	87.0	0.0	319.2	28
Mar 1995	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	5.0	0.0	7.5	31
Apr 1995	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	1.0	47.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.0	0.0	0.0	0.0	0.0	0.0	4.0	12.5	4.0		3.1	47.0	0.0	94.0	30
May 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.5	0.0	2.5	31
Jun 1995	0.0	0.0	0.0	0.0	0.0	0.0	3.2	6.5	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		1.0	18.0	0.0	30.2	30
Jul 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	8.0	0.0	0.7	8.0	0.0	20.9	31
Aug 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31
Sep 1995	0.0	0.0	0.0	0.0	0.0	1.0	1.5	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0		0.7	12.5	0.0	19.5	30
Oct 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	6.8	0.0	10.3	31
Nov 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.5	10.5	0.0	14.0	30
Dec 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.0	0.0	0.0	0.0	0.0	0.0	5.5	0.0	0.0	4.5	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	1.6	35.0	0.0	50.2	31

Daily Data for MENZIES (MENZIES)

Site Number 012052 Latitude 29°41'33"S Longitude 121°01'43"E Elevation 426 metres Opened May 1896 Still Open

Precipitation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jan 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	6.8	1.2	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	7.0	0.0	18.6	31
Feb 1995	16.2	0.0	0.0	27.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.0	31.4	168.4	19.0				12.5	168.4	0.0	351.0	28
Mar 1995	0.0	1.2	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.8	0.0	3.6	31
Apr 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	6.0	39.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.2	1.2	0.0	0.0	0.0	0.0	4.6	12.6	0.0		3.7	39.0	0.0	110.6	30
May 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.6	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	6.2	0.0	11.2	31
Jun 1995	0.0	0.0	0.0	0.0	0.0	1.4	10.0	6.0	13.4	0.4	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.2	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0		1.3	13.4	0.0	37.8	30
Jul 1995	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	5.4	1.0	0.0	19.4	0.4	0.0	2.4	5.8	0.0	0.0	0.0	4.2	0.8	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.4	4.4	0.0	1.8	19.4	0.0	54.8	31
Aug 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	1.2	31
Sep 1995	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.2	23.0	0.0		1.5	23.0	0.0	46.4	30
Oct 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	5.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	5.2	0.0	9.6	31
Nov 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6			11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.5	11.8	0.0	13.4	28
Dec 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	50.4	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	1.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	50.4	0.0	63.6	31

Daily Data for LEONORA (MINARA)

Site Number 012061 Latitude 28°55'08"S Longitude 121°47'46"E Elevation 480 metres Opened Jan 1898 Still Open

Precipitation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jan 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	17.0	0.0	22.2	31
Feb 1995	76.4	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	5.8	0.0	0.0	0.0	30.8	0.4	0.2	0.0	0.0	0.0	0.0	13.3	44.0	25.2	47.0				9.1	76.4	0.0	256.1	28
Mar 1995	2.0	1.0	0.0	4.6	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.4	5.0	0.0	13.6	31
Apr 1995	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	9.6	5.4	0.0	0.0	0.0	0.0	0.0	0.0	12.0	4.8	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	4.2	0.2	0.0		1.4	12.0	0.0	41.0	30
May 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	6.2	0.0	8.2	31
Jun 1995	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.8	3.2	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.2	3.2	0.0	6.6	30
Jul 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	11.0	0.0	0.0	4.6	5.4	0.0	0.0	0.0	4.0	1.6	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	8.6	0.0	1.3	11.0	0.0	38.8	31
Aug 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.8	31
Sep 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	2.6	0.0		0.3	3.0	0.0	8.2	30
Oct 1995	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	4.2	0.0	4.2	31
Nov 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.3	6.6	0.0	9.6	30
Dec 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	3.6	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.5	6.0	0.0	14.0	31

Daily Data for MENZIES (YERILLA)

Site Number 012187 Latitude 29°28'20"S Longitude 121°49'34"E Elevation 381 metres Opened Jan 1897 Still Open

Precipitation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jan 1995	0.0	0.0	0.0	0.0	0.0	0.0	2.0	11.2	0.0	0.0	0.0	0.0	0.2	13.0	0.0	0.0	0.0	0.0	0.0	5.8	0.0	0.0	1.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	13.0	0.0	34.4	31
Feb 1995	22.6	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.4	0.0	0.0	0.0	0.0	0.4	0.6	0.0	0.0	0.0	0.0	50.4	43.0	97.8	58.8				10.1	97.8	0.0	282.2	28
Mar 1995	3.0	1.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	3.2	0.0	8.2	31
Apr 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	12.2	49.6	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	11.4	0.2	0.0	0.0	0.0	0.0	3.6	3.8	0.0		2.9	49.6	0.0	87.4	30
May 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0	0.0	3.0	31
Jun 1995	0.0	0.0	0.0	0.0	0.0	1.0	0.0	3.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.2	0.0	0.0	0.4	0.0	0.0	0.0	0.0		0.4	5.4	0.0	13.2	30
Jul 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	17.0	0.0	0.0	0.0	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	5.6	0.0	1.3	17.0	0.0	38.8	31
Aug 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31
Sep 1995	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.4	13.0	0.0		0.8	13.0	0.0	22.8	30
Oct 1995	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0	0.0	2.0	31
Nov 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.6	0.0	0.6	30
Dec 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	50.0	0.0	0.0	0.0	0.0	0.0	14.2	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.2	0.4	0.0	2.3	50.0	0.0	72.2	31

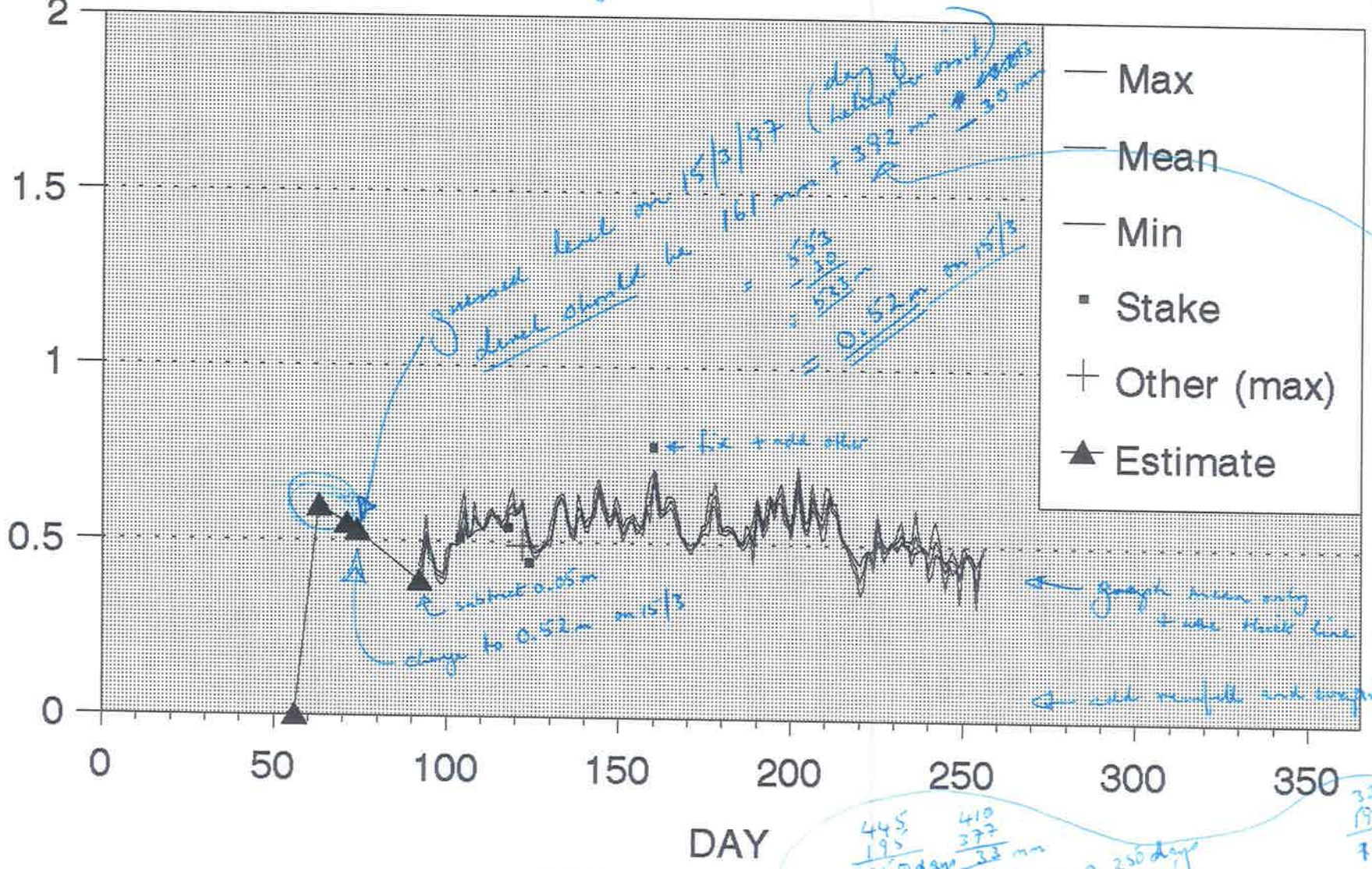
Daily Data for LEONORA (MINARA DINGO O.S.)

Site Number 012272 Latitude 28°52'44"S Longitude 121°35'49"E Elevation 450 metres Opened Jan 1973 Still Open

Precipitation to 9am (mm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg	Max	Min	Total	Nbr
Jan 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	19.0	0.0	27.4	31
Feb 1995	14.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	176.0				8.6	176.0	0.0	240.5	28
Mar 1995	0.0	3.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	7.6	0.0	10.6	31
Apr 1995	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6	0.0	0.0		1.5	20.4	0.0	44.4	30
May 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	8.2	0.0	8.2	31
Jun 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.3	8.0	0.0	8.0	30
Jul 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	10.8	0.0	1.3	25.0	0.0	39.8	31
Aug 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.6	31
Sep 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	0.0		0.3	7.0	0.0	8.4	30
Oct 1995	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.0	0.0	3.0	31
Nov 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.1	2.0	0.0	2.6	30
Dec 1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.1	1.4	0.0	1.8	31

Folio 9 (Vol.5) of JL's BaSt files is an annotated copy (29/7/1997) of a graph of Lake Ballard water levels in 1995. The logger depths are continuous and are from Julian Day c.92 to c.257 (by eye), i.e. from c.02/4/1995 to c.14/9/1995. Annotations (20/8/1997) by JL say: 'Need to subtract 0.05m from all these logger depths' and 'Level on 15/3/97 [incorrect, year should be 1995] should be 0.52m'. Rainfall and evaporation were to be added to this graph.



LAKE BALLARD 1995: Depth, salinity, etc.

'Folio 8' (Vol.5) of JL's BaSt files. This 'folio' is actually a single plastic wallet containing a bunch of papers relating to calculation and graphing of water levels at Lake Ballard in 1995. They include:

- **A partial printout (BALL1995.CH3) of water level data with the annotation (by JL, on 20/8/1997): 'Now need to subtract 0.05m (because originally added 0.02m when should have subtracted 0.03m) from all the final record values in the Paradox & Harvard Graphics data files' 9e.g.**
- **A single hand-written page of water level calculations and source notations.**
- **Annotated printouts (10/7/1997 - BAX.DB, BA.DB, BA16195X.DB) of water level values (all values and daily averages, maxs & mins) to Julian Days 160 (09/6/1995) and 161.**

TO DO: Find these data files (see below). Convert them to Excel?

" Folio 8. "

H3
enu

XY Chart

F2-Show chart F4-Draw F5-Mark
F7-Spell/Text F8-Options F9-XY data F10-Continue

X Axis Numeric	1 Max	2 Mean	3 Min	4 Series 4
	409.794	389.6205	375.889	
	447.089	411.6585	375.889	
	551.516	506.9313	481.672	
	476.247	448.7843	429.458	
	434.883	425.729	419.965	
	399.622	385.382	375.889	
	388.773	377.7535	358.936	
	386.738	376.2275	356.902	

~~[illegible]~~ Now need to subtract 0.05 m ~~[illegible]~~ (because originally ~~deducted~~ added 0.02m when should have ~~add~~ subtracted 0.03m) from all the first records values in the Penetrator + Harvest graphics data files

[signature] 20/8/97

2.35

BALL1995.CH3 XY Chart ▸▴▾

F1-Help F2-Show chart F4-Draw F5-Mark

F6-Main Menu F7-Spell/Text F8-Options F9-XY data F10-Continue

Title:
Subtitle:
Footnote:

Data Pt	X Axis Numeric	1 Max	2 Mean	3 Min	4 Series 4
89	88				
90	89				
91	90				
92	91				
93	92	409.794	389.6205	375.889	
94	93	447.089	411.6585	375.889	
95	94	551.516	506.9313	481.672	
96	95	476.247	448.7843	429.458	
97	96	434.883	425.729	419.965	
98	97	399.622	385.382	375.889	
99	98	388.773	377.7535	358.936	
100	99	386.738	376.2275	356.902	

Now need to subtract 0.05 m from (because originally ~~deducted~~ added 0.02m when should have ~~added~~ subtracted 0.03m) from all the first records values in the [illegible] + Harvard graphics data files.

[signature] 20/8/97

• Water level estimated (when?) at c.50cm on 15/3

LAKE BALLARD

• Established water level logger on or about 31/3/95 Julian day 90

• "Water depth at marker beside island. 4pm 14/4/95. 51cm (depth of water)" Julian Day 104

(Source CDTM. Folio 88 Vol 1)

• "Depth top → water 0.89m, bottom → top of water 0.54m (total = 1.43)
(on 28/4/95 at 8.30) Julian Day 118 (Source AC. Folio 106. Vol 1)

• Depth top of stick → water 0.97m, bottom to water level of stick 0.44m (total = 1.41)
(on 4/5/95 at unknown time) Julian Day 124 (Source AC. Folio 109. Vol 1)

(other depths recorded on 2/5/95 (Julian Day 122) around the lake by AC were
0.47m @ 10.30am, 0.48m @ 11.45am, 0.49m @ 12.40pm, 0.33m @ 1.50pm
and 0.31m @ 2.20pm)

• Depth was "775mm" at Camp I. on 9/6/95 (JDay 160). (Source GDP. Folio 154 Vol 1)
(Data logger downloaded and reset to record every hour and average every 6 hours) ("levels had varied from 398 to 689 mm to for the 70 days the logger was in place")
← ie since JDay 90 = 31/3/95. OK
true? where from? (~~approx both?~~)

• Data logger retrieved ~~[illegible]~~ between 9th + 17th Sep 95 by GDP. Exact date? time? depth?
14/9/95 315mm at logger

BAX.DB (corrected date (time) Summary (max, mean, min only)

10-Jul-97 Standard Report Page 1

Year	J_date	Average of Level	Min of Level	Max of Level	
1995	82	61	61	62	
1995	83	62	62	63	
1995	84	62	61	63	
1995	85	62	61	63	
1995	86	61	61	63	
1995	87	62	61	63	
1995	88	63	62	63	
1995	89	64	62	70	
1995	90	65	63	67	
1995	91	280	78	399	
1995	92	390	376	410	
1995	93	412	376	447	
1995	94	507	482	552	
1995	95	449	429	476	
1995	96	426	420	435	
1995	97	385	376	400	
1995	98	378	359	389	
1995	99	376	357	387	
1995	100	412	375	456	
1995	101	468	465	473	
1995	102	473	472	473	
1995	103	471	469	473	
1995	104	498	472	552	0.51 m at 4pm.
1995	105	576	527	625	
1995	106	496	488	514	
1995	107	497	495	498	
1995	108	552	506	591	
1995	109	529	513	540	
1995	110	517	514	519	
1995	111	517	512	524	
1995	112	550	538	565	
1995	113	569	558	576	
1995	114	549	546	552	
1995	115	546	533	556	
1995	116	524	521	528	
1995	117	523	505	554	
1995	118	569	557	591	0.54m at 8.30 am.
1995	119	592	561	632	
1995	120	559	554	564	
1995	121	569	564	581	
1995	122	592	587	599	
1995	123	529	509	547	
1995	124	477	467	489	0.44m.
1995	125	453	442	468	
1995	126	448	431	455	
1995	127	455	449	459	
1995	128	470	465	476	
1995	129	476	474	478	
1995	130	489	469	536	
1995	131	543	526	576	

1995	132	590	577	607
1995	133	609	604	617
1995	134	599	590	619
1995	135	538	529	550
1995	136	506	498	524

Year	J_date	Average of Level	Min of Level	Max of Level
1995	137	497	488	509
1995	138	580	546	617
1995	139	572	562	585
1995	140	523	515	536
1995	141	526	509	550
1995	142	552	549	554
1995	143	585	555	632
1995	144	646	629	661
1995	145	603	579	630
1995	146	574	558	592
1995	147	537	526	556
1995	148	545	535	558
1995	149	584	568	612
1995	150	549	533	590
1995	151	505	487	526
1995	152	527	508	550
1995	153	547	541	556
1995	154	552	540	563
1995	155	522	505	549
1995	156	519	512	524
1995	157	524	504	539
1995	158	590	579	620
1995	159	590	541	664
1995	160	686	682	689

BA. DB
(all records)

Clock installation date. → 23 March 95

date corrected

clock on downloading computer was out by 0.9 – .66 of a day.

sheet

(A) ← rounded to nearest mm. by Paradox.

Year	J_date	J_time	Level
1995	82	70001	61
1995	82	195001	61
1995	82	445001	61
1995	82	695001	62
1995	82	945001	62
1995	83	195001	62
1995	83	445001	63
1995	83	695001	63
1995	83	945001	62
1995	84	195001	61
1995	84	445001	63
1995	84	695001	63
1995	84	945001	61
1995	85	195001	61
1995	85	445001	62
1995	85	695001	63
1995	85	945001	61
1995	86	195001	61
1995	86	445001	61
1995	86	695001	63
1995	86	945001	62
1995	87	195001	61
1995	87	445001	62
1995	87	695001	63
1995	87	945001	62
1995	88	195001	62
1995	88	445001	63
1995	88	695001	63
1995	88	945001	63
1995	89	195001	62
1995	89	445001	63
1995	89	695001	70
1995	89	945001	63
1995	90	195001	63
1995	90	445001	65
1995	90	695001	65
1995	90	945001	67
1995	91	195001	78
1995	91	445001	248
1995	91	695001	399
1995	91	945001	396
1995	92	195001	410
1995	92	445001	377
1995	92	695001	396
1995	92	945001	376
1995	93	195001	404
1995	93	445001	420
1995	93	695001	376
1995	93	945001	447
1995	94	195001	513

Margin notes beside J_date: Fri 24/3; Sat 25/3; 26/3 drove from Perth; 27/3 arriving at Ballard; 28/3/95 reached Ballard; 29/3/95; 1/4/95.

maybe turned on in Perth??

unit stuck on S. side of island.

(1) get all Grant & Alans depths from stake (& my depths from my notebooks)

(2) get rainfall & wind data

(3) get rest of data (2nd download) from Grant.

total of 32 cm increase in 12 hrs ??

17 cm increase in 6 hours – combination of wind? + rain?

13 cm decrease in next 6 hrs?

(B) 0.38m at ... hrs (A)-(B) = +0.02m

Four "manual" measurements taken, (see following pages)

A - B = +0.02 m (day 91)
−0.02 m (day 104)
+0.02 m (day 118)
+0.03 m (day 124)
+0.04 m (day 160)

Σx = +0.09m
$\bar{x}$ = +0.02m

⇒ subtract 0.03 m from all of the records from logger to get depth at stake on S side of Long I. 1/7/97

at 0807 hrs on 2/4/95 (i.e. at JDay 92.338) the lake water level was 161 mm from bottom of top of stick of 15/3/97.

1995	94	445001	552
1995	94	695001	482
1995	94	945001	482
1995	95	195001	476
1995	95	445001	451

(A)

Year	J_date	J_time	Level (mm)
1995	95	695001	429
1995	95	945001	438
1995	96	195001	420
1995	96	445001	435
1995	96	695001	423
1995	96	945001	425
1995	97	195001	400
1995	97	445001	385
1995	97	695001	381
1995	97	945001	376
1995	98	195001	359
1995	98	445001	377
1995	98	695001	386
1995	98	945001	389
1995	99	195001	387
1995	99	445001	381
1995	99	695001	357
1995	99	945001	380
1995	100	195001	375
1995	100	445001	387
1995	100	695001	429
1995	100	945001	456
1995	101	195001	465
1995	101	445001	466
1995	101	695001	469
1995	101	945001	473
1995	102	195001	473
1995	102	445001	473
1995	102	695001	472
1995	102	945001	472
1995	103	195001	469
1995	103	445001	469
1995	103	695001	473
1995	103	945001	473
1995	104	195001	472
1995	104	445001	476
1995	104	695001	494
1995	104	945001	552
1995	105	195001	625
1995	105	445001	599
1995	105	695001	552
1995	105	945001	527
1995	106	195001	514
1995	106	445001	488
1995	106	695001	490
1995	106	945001	491
1995	107	195001	495
1995	107	445001	498
1995	107	695001	497
1995	107	945001	498
1995	108	195001	574

(B)

(CD:M)

← 0.51m at 4pm = J. time of 0.6666...

(A) − (B) = −0.02 m

↑ rounded

1995	108	445001	591
1995	108	695001	538
1995	108	945001	506
1995	109	195001	513
1995	109	445001	540

(A)

Year	J_date	J_time	Level (mm)
1995	109	695001	524
1995	109	945001	538
1995	110	195001	514
1995	110	445001	516
1995	110	695001	518
1995	110	945001	519
1995	111	195001	514
1995	111	445001	512
1995	111	695001	524
1995	111	945001	519
1995	112	195001	538
1995	112	445001	549
1995	112	695001	547
1995	112	945001	565
1995	113	195001	568
1995	113	445001	576
1995	113	695001	558
1995	113	945001	573
1995	114	195001	548
1995	114	445001	552
1995	114	695001	550
1995	114	945001	546
1995	115	195001	533
1995	115	445001	552
1995	115	695001	556
1995	115	945001	545
1995	116	195001	523
1995	116	445001	521
1995	116	695001	528
1995	116	945001	525
1995	117	195001	518
1995	117	445001	505
1995	117	695001	514
1995	117	945001	554
1995	118	195001	557
1995	118	445001	564
1995	118	695001	591
1995	118	945001	562
1995	119	195001	632
1995	119	445001	612
1995	119	695001	561
1995	119	945001	562
1995	120	195001	554
1995	120	445001	558
1995	120	695001	561
1995	120	945001	564
1995	121	195001	566
1995	121	445001	566
1995	121	695001	564
1995	121	945001	581
1995	122	195001	599

28/4/95

(B) (Alan Clarke)

0.54 m at J.time 0.3542

A - B = +0.02 m

1995	122	445001	593	] depths of
1995	122	695001	587	recorded
1995	122	945001	587	around the lake
1995	123	195001	547	
1995	123	445001	519	

2/3/97

(A)

Year	J_date	J_time	Level (mm)
1995	123	695001	539
1995	123	945001	509
1995	124	195001	489
1995	124	445001	476
1995	124	695001	467
1995	124	945001	474
1995	125	195001	468
1995	125	445001	442
1995	125	695001	444
1995	125	945001	456
1995	126	195001	431
1995	126	445001	455
1995	126	695001	453
1995	126	945001	455
1995	127	195001	456
1995	127	445001	454
1995	127	695001	449
1995	127	945001	459
1995	128	195001	465
1995	128	445001	474
1995	128	695001	467
1995	128	945001	476
1995	129	195001	478
1995	129	445001	476
1995	129	695001	474
1995	129	945001	476
1995	130	195001	475
1995	130	445001	469
1995	130	695001	478
1995	130	945001	536
1995	131	195001	541
1995	131	445001	530
1995	131	695001	526
1995	131	945001	576
1995	132	195001	577
1995	132	445001	581
1995	132	695001	594
1995	132	945001	607
1995	133	195001	604
1995	133	445001	606
1995	133	695001	608
1995	133	945001	617
1995	134	195001	619
1995	134	445001	590
1995	134	695001	592
1995	134	945001	594
1995	135	195001	550
1995	135	445001	529
1995	135	695001	537
1995	135	945001	535
1995	136	195001	524

4/5/95

(B) (Alan Clarke)

0.44 m at minimum tide

(A−B) = 0.47 − 0.44 = + 0.03 m ~~0.43~~

1995	136	445001	503
1995	136	695001	499
1995	136	945001	498
1995	137	195001	496
1995	137	445001	488

Year	J_date	J_time	Level
1995	137	695001	493
1995	137	945001	509
1995	138	195001	546
1995	138	445001	575
1995	138	695001	584
1995	138	945001	617
1995	139	195001	585
1995	139	445001	572
1995	139	695001	566
1995	139	945001	562
1995	140	195001	536
1995	140	445001	515
1995	140	695001	516
1995	140	945001	525
1995	141	195001	520
1995	141	445001	509
1995	141	695001	526
1995	141	945001	550
1995	142	195001	552
1995	142	445001	552
1995	142	695001	549
1995	142	945001	554
1995	143	195001	555
1995	143	445001	563
1995	143	695001	588
1995	143	945001	632
1995	144	195001	646
1995	144	445001	650
1995	144	695001	661
1995	144	945001	629
1995	145	195001	619
1995	145	445001	630
1995	145	695001	585
1995	145	945001	579
1995	146	195001	592
1995	146	445001	585
1995	146	695001	558
1995	146	945001	561
1995	147	195001	556
1995	147	445001	534
1995	147	695001	526
1995	147	945001	533
1995	148	195001	535
1995	148	445001	545
1995	148	695001	543
1995	148	945001	558
1995	149	195001	568
1995	149	445001	570
1995	149	695001	587
1995	149	945001	612
1995	150	195001	590

1995	150	445001	537
1995	150	695001	533
1995	150	945001	537
1995	151	195001	526
1995	151	445001	510

(A)

Year	J_date	J_time	Level (mm)
1995	151	695001	487
1995	151	945001	495
1995	152	195001	513
1995	152	445001	508
1995	152	695001	535
1995	152	945001	550
1995	153	195001	541
1995	153	445001	545
1995	153	695001	548
1995	153	945001	556
1995	154	195001	563
1995	154	445001	556
1995	154	695001	540
1995	154	945001	550
1995	155	195001	549
1995	155	445001	523
1995	155	695001	505
1995	155	945001	508
1995	156	195001	512
1995	156	445001	516
1995	156	695001	524
1995	156	945001	523
1995	157	195001	539
1995	157	445001	522
1995	157	695001	504
1995	157	945001	533
1995	158	195001	579
1995	158	445001	579
1995	158	695001	581
1995	158	945001	620
1995	159	195001	541
1995	159	445001	541
1995	159	695001	613
1995	159	945001	664
1995	160	195001	682
1995	160	445001	689

GP's measurement of total length of Shelve (on JDay 91) is 136 cm. If use this figure, depth of water at shelve on JDay 160 was 136 − 77.5 = 58.5 cm

OR

AC's measurement of total length (on JDays 118 and 124) were 143 cm and 141 cm). If use average (142 cm) depth of water at shelve on JDay 160 was 142 − 77.5 = 64.5 cm

use

(A) − (B) = 0.689 m − 0.645 = +0.044 m

A − B = 0.69 − 0.77 = −0.08 m.

(B) "77.5 cm exposed" at this minimum (GBP)

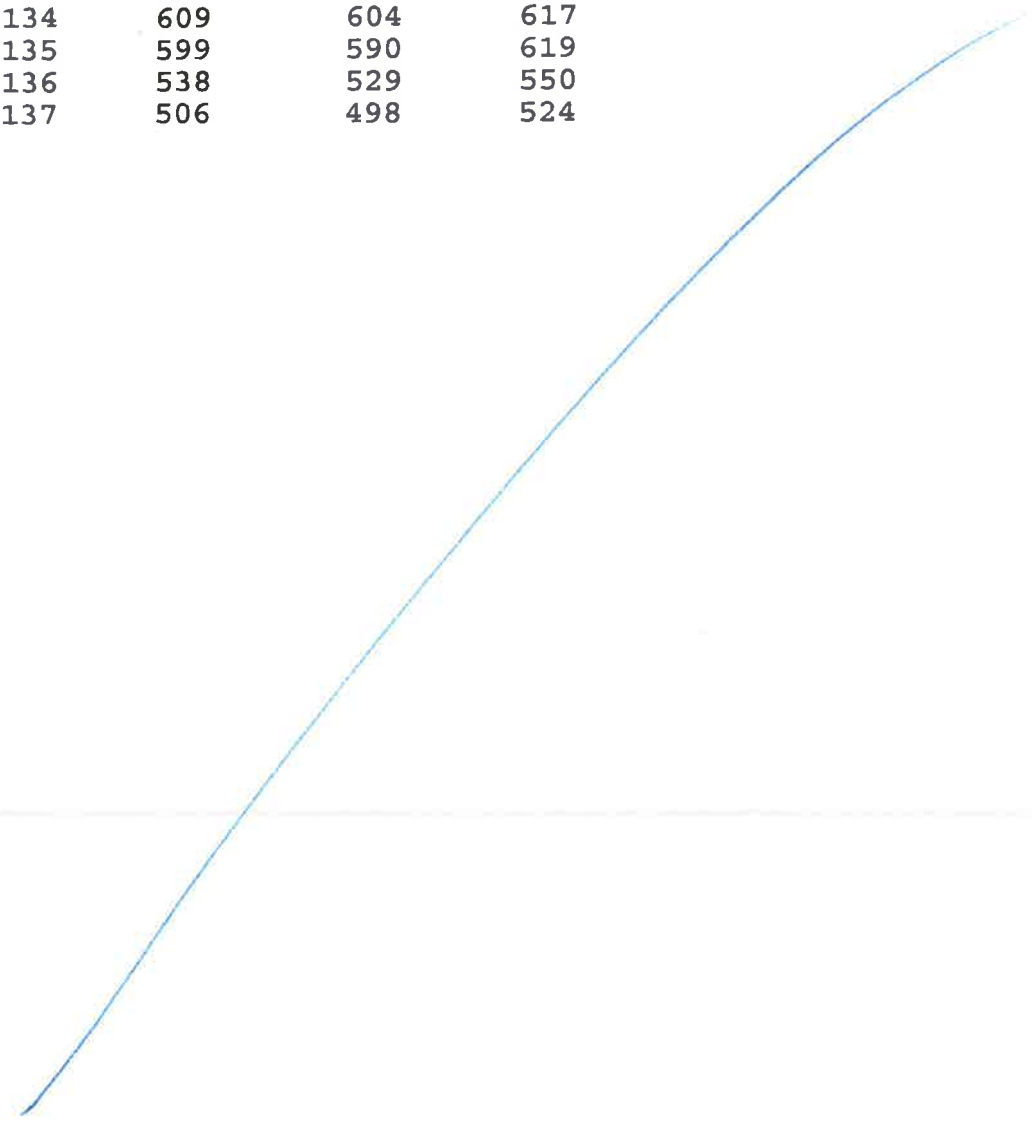
9 June 95

This is the maximum depth recorded on this file (JDay 82 → 160)

Year	J_date	Mean_lev	Min_lev	Max_lev
1995	138	497	488	509
1995	139	580	546	617
1995	140	572	562	585
1995	141	523	515	536
1995	142	526	509	550
1995	143	552	549	554
1995	144	585	555	632
1995	145	646	629	661
1995	146	603	579	630
1995	147	574	558	592
1995	148	537	526	556
1995	149	545	535	558
1995	150	584	568	612
1995	151	549	533	590
1995	152	505	487	526
1995	153	527	508	550
1995	154	547	541	556
1995	155	552	540	563
1995	156	522	505	549
1995	157	519	512	524
1995	158	524	504	539
1995	159	590	579	620
1995	160	590	541	664
1995	161	686	682	689

— "775m" — time unknown.

1995	133	590	577	607
1995	134	609	604	617
1995	135	599	590	619
1995	136	538	529	550
1995	137	506	498	524



BA16195X.DB

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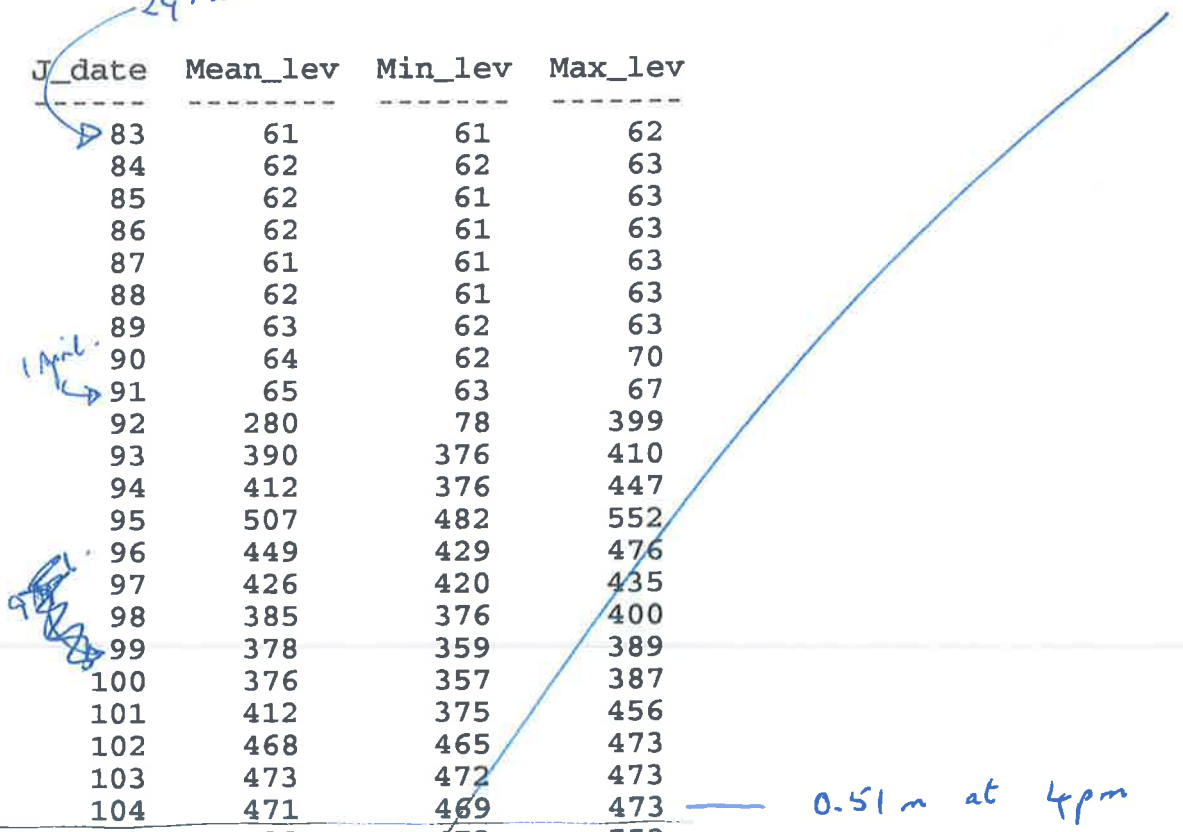
24 March 95

Year	J_date	Mean_lev	Min_lev	Max_lev
1995	83	61	61	62
1995	84	62	62	63
1995	85	62	61	63
1995	86	62	61	63
1995	87	61	61	63
1995	88	62	61	63
1995	89	63	62	63
1995	90	64	62	70
1995	91	65	63	67
1995	92	280	78	399
1995	93	390	376	410
1995	94	412	376	447
1995	95	507	482	552
1995	96	449	429	476
1995	97	426	420	435
1995	98	385	376	400
1995	99	378	359	389
1995	100	376	357	387
1995	101	412	375	456
1995	102	468	465	473
1995	103	473	472	473
1995	104	471	469	473
1995	105	498	472	552
1995	106	576	527	625
1995	107	496	488	514
1995	108	497	495	498
1995	109	552	506	591
1995	110	529	513	540
1995	111	517	514	519
1995	112	517	512	524
1995	113	550	538	565
1995	114	569	558	576
1995	115	549	546	552
1995	116	546	533	556
1995	117	524	521	528
1995	118	523	505	554
1995	119	569	557	591
1995	120	592	561	632
1995	121	559	554	564
1995	122	569	564	581
1995	123	592	587	599
1995	124	529	509	547
1995	125	477	467	489
1995	126	453	442	468
1995	127	448	431	455
1995	128	455	449	459
1995	129	470	465	476
1995	130	476	474	478
1995	131	489	469	536
1995	132	543	526	576

1 April

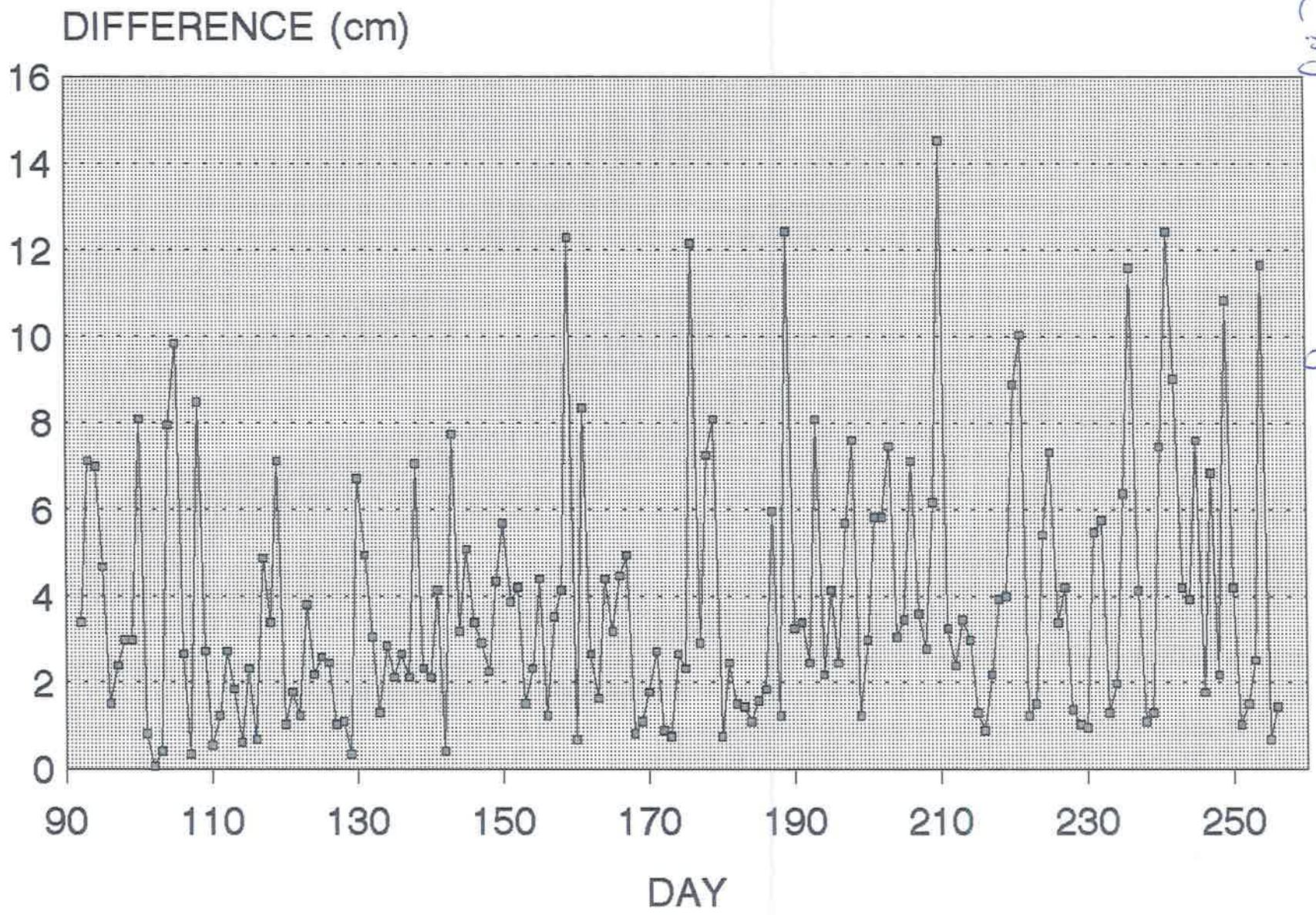


0.51m at 4pm

0.54m at 8.30am

0.44m at unknown time

Folio 7 (Vol.5) of JL's BaSt files is a copy (29/7/1997) of a graph labelled 'Lake Ballard 1995: Difference between daily Min & Max water levels'.



LAKE BALLARD 1995: Difference between daily Min & Max water levels

Printout (undated) of data from logger (water level recorder) installed at Lake Ballard. This printout appears to be all data from initial 'set up at Woodvale) to 'installed at Lake Ballard 2/4/95 [02/4/1994]' to (inferred from what appear to be Julian Days) the 10th June 1995. According to GBP's report and field notes the logger was downloaded on 9th June 1995. Why the apparent discrepancy? Probably resolved by GBP / Yvonne Winchcombe when the data was graphed (see 'graph (printed 23/7/1997)' above). Note that, according to the Science Project Plan faxed on Fri 17/03/2000 from JL to GBP (see above) 'Data from a continuous water level recorder (Lake Ballard 1995) are on a disk in a data safe in JL's office'. Also see 11/7/1997 above (and elsewhere in this RMCR) for related materials.

Lake Ballard. March 95 →

①

Set up at [illegible]

Should be 0

[illegible]

4577144

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84.416667 , 62.607 ,
84.666667 , 63.285 ,
84.916667 , 61.929 ,
85.166667 , 61.251 ,
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87.416667 , 60.573 ,
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87.916667 , 61.929 ,
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Julian Day 092

03/4/2014

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99.916667 , 388.773 ,
100.166667 , 386.738 ,
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160.416667 , 541.345 ,
160.666667 , 613.223 ,
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161.166667 , 682.389 ,
161.416667 , 689.170 ,
□

Data logger was downloaded on 09/6/1995 by GBO and they left for Tsedanya at 0955 hrs on 10/6/1995.

03/4/2014.

Julian Day 161 is 10/6 (ie 10th June)

03/4/2014.

10/6/1995 [illegible] WRONG

03/4/2014

Three page draft (incomplete) document prepared (22-24/7/1997) by JL and headed 'The Following is the Makings of the "Water Depth and Quality Section" of the Final Publication on the 1995 Banded Stilt Work'. It contains all or most observations, in chronological order, relating to Water Depth, some of Water Temperature and Water pH, none of Water Salinity and none of Water Phosphorus (or other parameters, e.g. Nitrogen) of Lake Ballard, and no observations of Lake Marmion. It has important hand-written annotations. TO DO: Find electronic copy of this document (Found 02/4/2014 – it is 'BALLWATR.doc'). Complete all sections? Consider also doing Lake Marmion (and Crossover Lake?) the same way?

Accompanying is a graph (printed 23/7/1997) of Lake Ballard water depth comprising guesstimates of levels on 25/2/1995 (dry), 04/3, 12/3 & 15/3/1995, plus recorded levels (maxs, mins, means of logger recordings to Julian Day c.160 = 09/6), 'measurements of depth at stake on north side of Camp Island', and a single record (02/5) 'when boating about lake'. A note (20/8/1997) by JL reads: 'Need to subtract 0.05m from all these depths'. Another note reads: 'Were any depths greater than that at Camp I. found?' There should be some later (> 09/6/1995) logger recordings – see 23/7/1995 below). TO DO: Finalise this graph, the files (Paradox software?) are in JL's 'BALDEPTH' sub-folder.

THE FOLLOWING IS THE MAKINGS OF THE "WATER DEPTH AND QUALITY SECTION" OF THE FINAL PUBLICATION ON THE 1995 BANDED STILT WORK

PREPARED 22-24/7/97

The following is a compilation of all data and observations relevant to this section of the report. When this has been completed, prepare a draft of the text for publication.

Water Depth of Ballard (observations in chronological order)

- Lake Ballard was dry when rain began to fall on 25 February (check) (JDay 56) 1995.
- Judging by rainfall records for (locations), Lake Ballard had been dry since at least (month/year).
- Rain from Cyclone Bobby began to fall on (date), and fell continuously for .. days, by which time a total of .. mm had fallen.
- Rain between then and 15 March (time of first ground visit (by helicopter) to lake) was ... mm.
- I could use my photos (ground) to estimate the maximum flood level (as well as the water level at the time of the photos (e.g. 12 & 15 /3/95), which should be evident on the islands.
- An article by CM, GP & JL in The Tattler (April 95) says "Marj Reni, Grant and Clive did a 4.5 hour aerial survey from Kalgoorlie on 12 March. They covered lakes Marmion, Barlee and Ballard ... All of the lakes were full .."
- Photos were presumably taken by GP and CM which could be used to estimate water level at time of first aerial inspection (12 March) (J_Day 71)..
- A stick with tape around it was used (by JL, GP & CM) to mark the water's edge (shoreline) on the south side of Camp Island on Wed 15 March (J_Day 74).
- If no further observations were made of water level in relation to stick (above) I could use my photos (need to go through my slides, and the prints in the BaSt box) from this day and subsequent days to calculate water level of 15/3. I took air photos of colony on 15/3 (see folios 14-16 of V1 for tracings), did I take photos of colony on subsequent air survey?
- Some "rough jottings" made (when?) in preparation for talk at SHOC held on 7/10/96 say water depth **"estimate c. 50cm - on 15/3".** Source? This may have been (probably was) an estimate by me at the time of doing the jottings, based on the other depths I jotted on same sheet.
- On 15 March photos were taken (by JL at least) on the ground and from the helicopter) that could be used to estimate water level at that time.
- **Grant installed a continuous water level recorder on 1 April 95 (JDay 91)** (date by deduction from logger records).
- A "stake" (wooden stake - see my notebook entry (2nd) of 28/4/95) was installed on N side of Camp Island on .. (date - on or before 28/4).
- The first Wingspan article (June 1995, p15) says "And, who knows, a further round of the breeding cycle may be aided by an unexpected 70 mm "top up" of **rainfall on 10 April (J_Day 100), which restored the gradually drying lake almost to its maximum level**". Can Clive supply supporting data?
- My rough notes on file (folio 80) have CM telling me by telephone on .. April 95 (after he was on the island - calling from Broome Bird Observatory) that **"rain added 13 cm (51 cm water depth at stake on .. 4 days after rain)".** Folio 88 (see below) indicates the missing date was 14/4/95. Therefore the water level before the rain was 51-13= **38 cm on 10/4/95 (prior to the rain on 10/4).**
- CM's fax to JL on 24 April 95 (folio 88) says **"Water depth at marker beside island. 4pm 14/4/95** (JDay 104)**. 51cm (depth of water)"**
- JL flew Ballard on 27/4/95 and observed (folio 97) "Many family parties ... all the way to the W end of the lake. Water appears too shallow for outboards here and access difficult"
- Folio 106 (photocopy from ACl notebook) says **"28/4/95** (JDay 118) **8.30 (am).** depth top -> water 0.89m. **bottom to top of water 0.54"** (also gives pH and temp readings). This data collected at gauge post on N side of Camp Island.

- Depths taken by ACl on **2/5/95** (J_Day 122) when he, JL and ACh shot adults and chicks were
  "1st shoot. 10.30am. 1km south of 2nd island. Depth **0.47m**"
  "Adult 2. 11.45am. Depth **0.48m**"
  "Adult 3. 12.10am. Depth **0.49m**"
  "Adult 4. 1.50pm. Depth **0.33m**"
  "Adult 5. 2.20pm. Depth **0.31m**"
- (folio 109; photocopy from ACl ? notebook) **4/5/95** (JDay 124) 0.97 depth top of stick to water. **0.44 depth from bottom to water level of stick** (temp and pH also read)
- Mark Lamble and Cam were further west (see map on folio 129 - also shows boat limit due to too shallow) on 16th & 17th May (folio 131). They filmed chicks "Birds marched E during day & west at night. 2-3cm depth. Chicks were wading not swimming (folio 119)."
- ACh flew Ballard on 6/6/95, five rafts of flight-capable stilt there, "Most of the larger rafts were in the NW sector .. and would be inaccessible to dinghy with outboard" (folios 138-140a). Definitely no flightless chicks or signs of further nesting. Grey Teal in 1000s, Shel in 100s.
- Grant downloaded logger data on **9 June 95** (J_Day 160) and "reset to record every hour and average every 6 hours" (folio 154). "Water levels varied from 398 (units) to 689 for the 70 days it was in place".
- GP's memo (folio 154) says "Camp Isd (**9 June 95**, JDay 160) .. Depth **775mm**".
- ACh flew over Ballard (and Marmion) on Fri 14/7/95. "He did 4 passes over Ballard - 6-7000 BaSt all flying - no further nesting" (folio .. V2). See later folios for full report. The traverses were all E to W or W to E.
- ACh also flew over Ballard (and Marmion) on **22/8/95**. Did four traverses. **"western end of lake - dry".** Counted 11,000 BaSt. Also Grey Teal, Shelduck, Avocet. Flock of 1,500 BaSt at "eastern end of lake". Some avocet and teal were around camp Island.
- JL memo of 23/8/95 to GP says "Monday's air survey by Andy Chapman showed that Lake Marmion will be dry in a week or so and Ballard in the next month or two". (folio .. V2).
- JL memo of 29/8/95 to GP says "Your suggestion that you go to Kal and Ballard is a good one .. As well as retrieving the logger, I would like you to go (walk?) out to Camp Island and do standard sweeps, water samples etc, as before". (folio .. , V2).
- GP **retrieved water level recorder on 14 Sep 95** (J_Day 257). **Depth of water at the logger** was 315mm (i.e. still high!). He didn't go out to Camp Island.
- Did Andy C or anyone else from Kalgoorlie fly over Ballard subsequently and see it dry? When?. Get satellite imagery to work out when dried (on 23/7/97 I asked GP to get Ballard "quick looks" for Jan 95 or pre 25th Feb 95, and Sep - Dec 95). Get evaporation rate data for individul months Sep to Dec (actual for 95?) (also get Feb-April data to provide another method of estimating maximum flood level in March 1995). Use with rainfall data for same period. Did Clive Minton walk out to the colony at Camp Island at end of June 1996 (as he suggested he might)?

Water Temperature of Ballard

- Folio 106 (photocopy from GP or AC notebook) says **"28/4/95 8.30. ... Temp top 19.0. Bottom 19.0** (also gives depth and pH data). This data collected at gauge post on N side of Camp Island.
- Folio 109 (photocopy from ACl notebook) says **"4/5/95. ... temp top 12.6 bottom 12.6"** This data collected at gauge post on N side of Camp Island.
- GP's memo (folio 154) says "Camp Isd (**9 June**).. Temp?NA" But hand note by me says "yet, (Alan has)".

Water pH of Ballard

- Folio 106 (photocopy from GP or AC notebook) says **"28/4/95 8.30. ... pH Top 7.89.** Calibration - Solution 7.01 read 6.95. Solution 10.01 read 9.78. Tried to calibrate, meter read E4". This data collected at gauge post on N side of Camp Island.
- Folio 109 (photocopy from ACl notebook) says **"4/5/95. ... Standardisation - buffer 7.01 read 6.99, buffer 10.01 read 9.75. pH at surface 7.78".** This data collected at gauge post on N side of Camp Island.

- GP's memo (folio 154) says "Camp Isd **(9 June)** .. **pH 8.67**". ✓ 2222

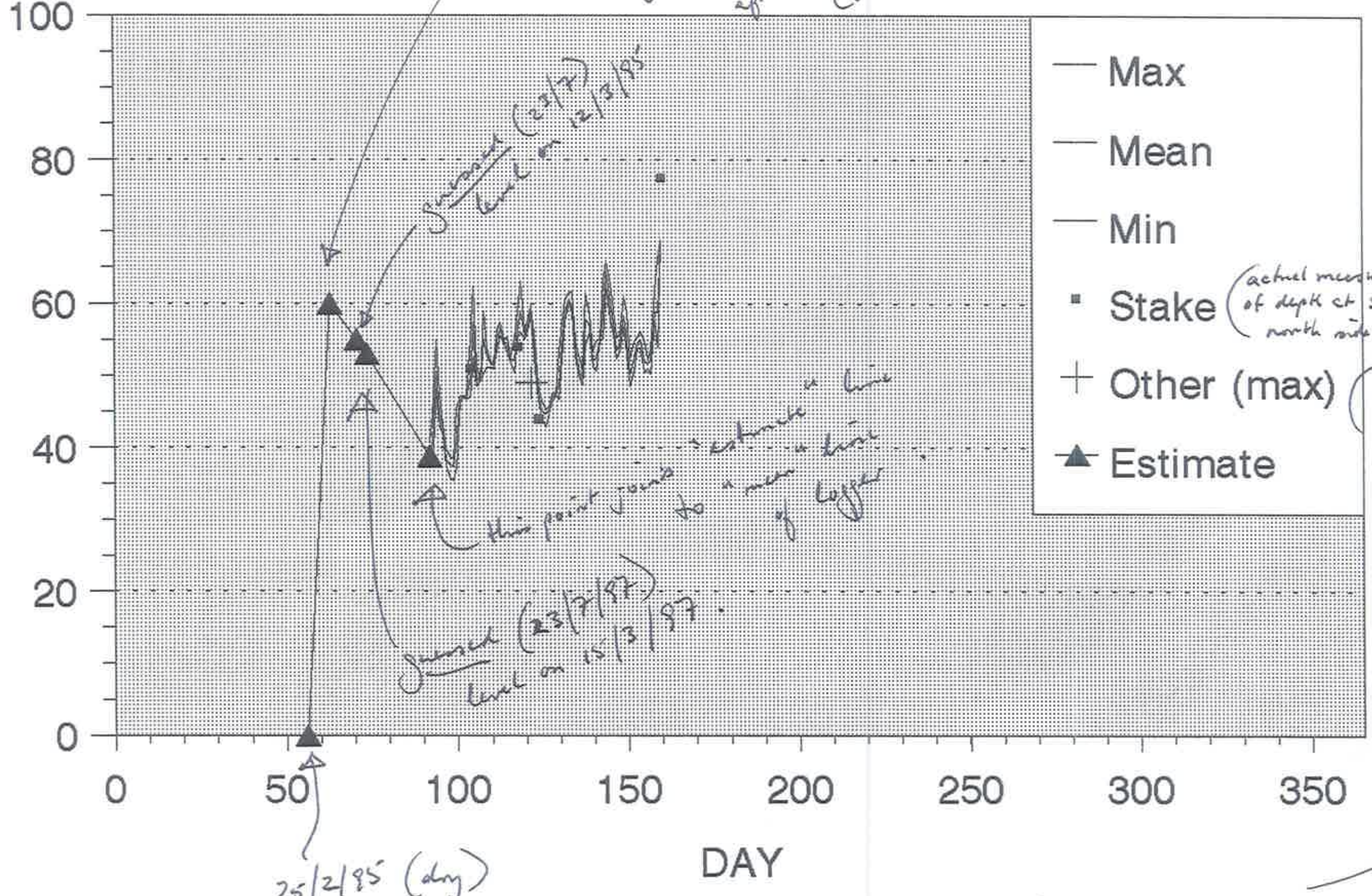
Water Salinity of Ballard
Observations of drinking by adults and chicks?

Water Phosphorus of Ballard

Need to subtract 0.05 m from all these depths. JK 20/8/87

This printout on 23/7/87

Guessed (23/7/87) that depth might have been around 60 cm one week (7 Day?) after rain started (i.e. on 4 March)



LAKE BALLARD 1995: Depth, salinity, etc.

Were any depths greater than that at Camp I. found? GBP?

Folio 71