SUNRISE AQUACULTURE ESTATE
SUPPLEMENTARY REPORT

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1. Introduction

This additional study has been undertaken to more accurately model the proposed pond layout and to allow for the distribution of water between the growing ponds, the harvest pond and the recirculation ponds. To more accurately model the effects of rainfall and evaporation, a daily time step was used. The model was too complicated to be implemented using a spread sheet. A computer model (programmed in Microsoft Visual C++) was developed to implement the model.

The results from the model indicate that frequency of overflow is comparable to that predicted by the earlier more simple model. The model does indicate, however that fresh water requirements to maintain growing pond levels are significantly reduced from previous estimates. This would result in reduction of offstream storage capacity by about 50%.

The proportion of catchment discharge required to be diverted to supply the initial proposed development is less than 1% over the period of record. The final requirement is estimated to be less than 10% of total discharge.

2. Prawn Ponds Model

Note from EcOz: The specific details of the ponds are of a proprietary nature and are confidential at this stage. DIPE has information on the material on which these calculations and the model were based.

Rain Factor 1.20 Evap. Factor 1.00
Start Month/Year 1/1941 End Month/Year 1/2003.

The operation of the model is as follows:
Initially input as listed above are read together with monthly evaporation values from a file "evap.dat". The "Init. Depth for each pond is also the desirable working level for that pond.

A daily water balance is then calculated as follows:

1. Daily rainfall is read from the rainfall file.

2. Rainfall and evaporation are applied to the recirculation, growing and harvest ponds to determine the change in volume of the ponds. Rainfall is applied to the maximum pond area to determine rainfall volume. The actual water area on the previous day is used to determine potential evaporation volume. Actual evaporation volume is the lesser of the potential evaporation volume and the pond volume (after rainfall, if any is added). Overflow, if any, is also calculated and is assumed to occur from the harvest pond.

3. The level of the growing ponds is then checked. If this level exceeds the initial level plus 250mm, water is transferred to the harvest pond to bring the level back to the initial (or working) level. Alternatively if the level has fallen to below initial level minus 250mm, water is transferred from the recirculating ponds. If there is insufficient water in the recirculating ponds the additional volume required is assumed to be supplied from an offstream storage. This input is recorded as the daily input.

4. The next step is to deal with any harvest pond overflow resulting directly from rainfall or from transfer from the growing ponds. If the maximum volume of the harvest pond has been exceeded the excess is first distributed to the other ponds up to their maximum capacity. If any overflow remains this is recorded as the daily overflow.

5. If there is no overflow, water is transferred from the harvest pond to the recirculation ponds if any volume is available in the recirculation ponds below their working level.

6. Finally the levels and volumes in each pond, the daily rainfall and evaporation and the daily volumes of input and overflow are output to a text file “day.out”. Daily values of rain, evaporation, input and overflow are added to monthly and overall totals. If any input or overflow occurred this is output to the appropriate file “Inputs.out” or OverFlows.out

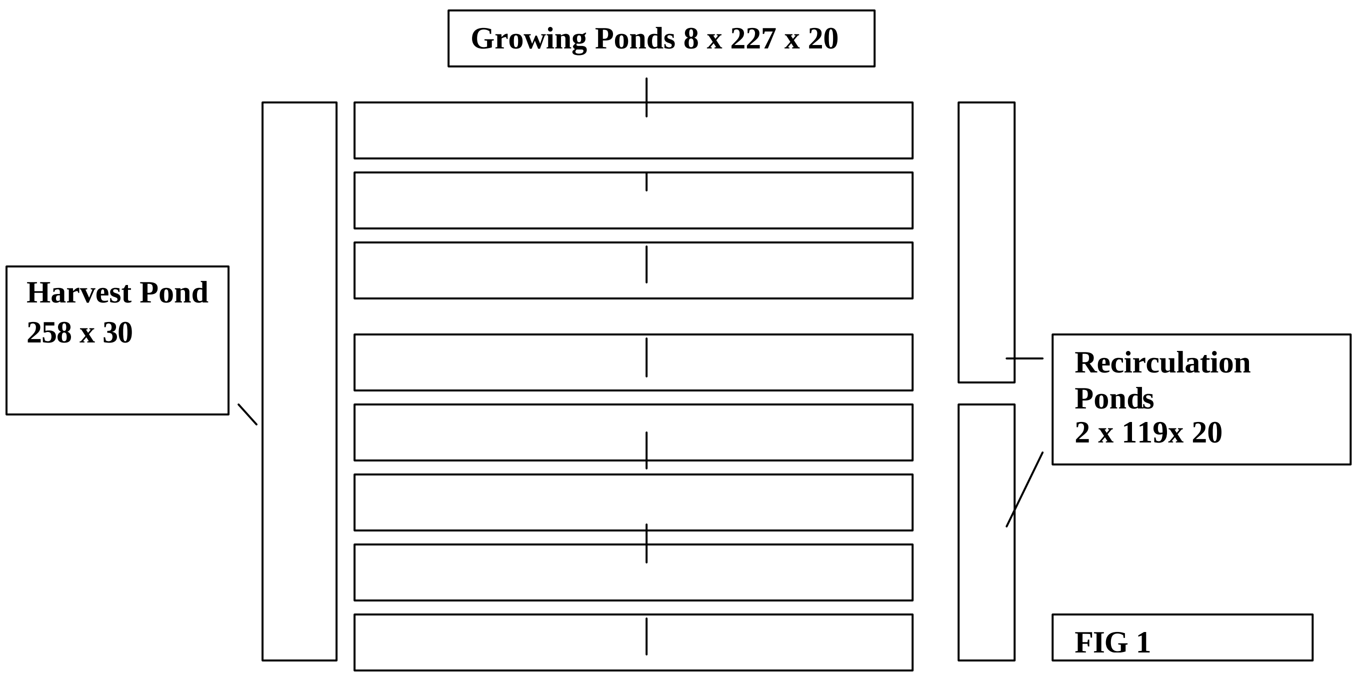
At the end of each month, monthly levels, volumes etc are output to a “Month.out” file. At the end of the run a “Summary.out” file is output containing the input information together with initial total volume, total rainfall, total evaporation, total inputs and overflows together with final volume. This information was included to ensure that the model was carrying out an accurate water balance. The number of years in which overflow occurred is also shown. A typical Summary.out file is shown below.

Note from EcOz: The specific details of the ponds are of a proprietary nature and are confidential at this stage. DIPE has information on the material on which these calculations and the model were based.

Rain Factor 1.20 Evap. Factor 1.00

Initial Volume	66097
Plus Total Rain	9926149
Plus Total Input	757074
Minus Total Evap	10520304
Minus Total Oflow	157735
Total	71281
Final Vol	71282
No. of Overflow Years	9

Schematic Layout of Ponds



The other output files are too big to be printed. Typical output is only is shown. The full files will be made available electronically.

1. Month.out

PRAWN PONDS MONTHLY OUTPUT

Month	Recirc. Depth m	Recirc. Vol. kL	Growing Depth m	Growing Vol. kL	Harvest Depth m	Harvest Vol. kL	Rain mm	Evap. mm	Input kL	OverFlow kL
Jan 1941	2.41	20832	1.33	55554	2.21	20002	508.4	263.0	0	0
Feb 1941	2.98	26803	1.43	59954	2.78	26034	371.9	269.0	0	0
Mar 1941	3.00	27072	1.66	71514	2.80	26304	304.3	233.0	0	0

Jul 1942	1.70	13873	1.04	42097	0.00	0	0.0	177.0	0	0
Aug 1942	0.11	824	1.07	43615	0.00	0	0.0	217.0	0	0
Sep 1942	0.27	1965	1.25	51696	0.00	0	108.1	236.0	11511	0

2. day.out

20/03/1977	3.00	27072	2.22	100510	2.80	26304	23.6	7.5	0	0
21/03/1977	3.00	27072	2.40	110521	2.80	26304	174.6	7.5	0	5764
22/03/1977	3.00	27072	2.40	110521	2.80	26304	72.8	7.5	0	6230
23/03/1977	3.00	27072	2.40	110521	2.80	26304	41.4	7.5	0	3289

3/10/1979	0.00	0	0.95	38146	0.00	0	0.6	7.6	0	0
4/10/1979	0.00	0	1.20	49348	0.00	0	0.0	7.6	11538	0
5/10/1979	0.00	0	1.19	48997	0.00	0	0.0	7.6	0	0

3. Input and OverFlow files show the same information as the day.out file but only for days that overflow or input occurred.

3. Results of Modelling

Overflows

The model was run for a number of different pond sizes and depths to determine the best arrangement to minimise overflow. In general it was found that if a rainfall factor of 1.2 is used it is almost impossible to prevent overflow in particularly wet years. For the inputs in the "Summary.out" file shown, overflows occurred in 9 years of the 62 on record. These were 1975, 1976, 1977, 1991, 1995, 1997, 1998, 1999 and 2000. If the rainfall factor is reduced to 1.1, overflow occurs only in 1977, 1997 1998 and 1999. If unfactored Darwin rainfall is used, overflow occurs only in 1998. This demonstrates that a relatively small increase in rainfall has a significant effect on overflows. In my previous report I recommended that a factor of 1.2 be used based on comparisons of short term local rainfalls with Darwin records. This is still considered to be a reasonable assumption. If over flow is to be a significant problem it may be worthwhile to seek expert meteorological advice as to whether rainfalls at the Suntay site would be expected to be greater than at Darwin and by how much.

It has been suggested that overflow could be further minimised by utilising surplus capacity in offstream storages. This is not considered to be a practical option. To be efficient Offstream storages should be kept full when ever practicable as future rainfall cannot be predicted. Significant storage would have to be available as significant volumes of overflow can occur in a short period. For the 1.2 rainfall factor case, over 30,000 kL was discharged from 1st to 5th of March 1998 with 20,000kL discharged in one day.

In many years volumes of overflow are very much less than those mentioned above. The following Table 2 shows daily overflows (in kL) together with the estimated dilution ratio. This was calculated by assuming 80% runoff from the 17.5km2 dam catchment.

Table 2

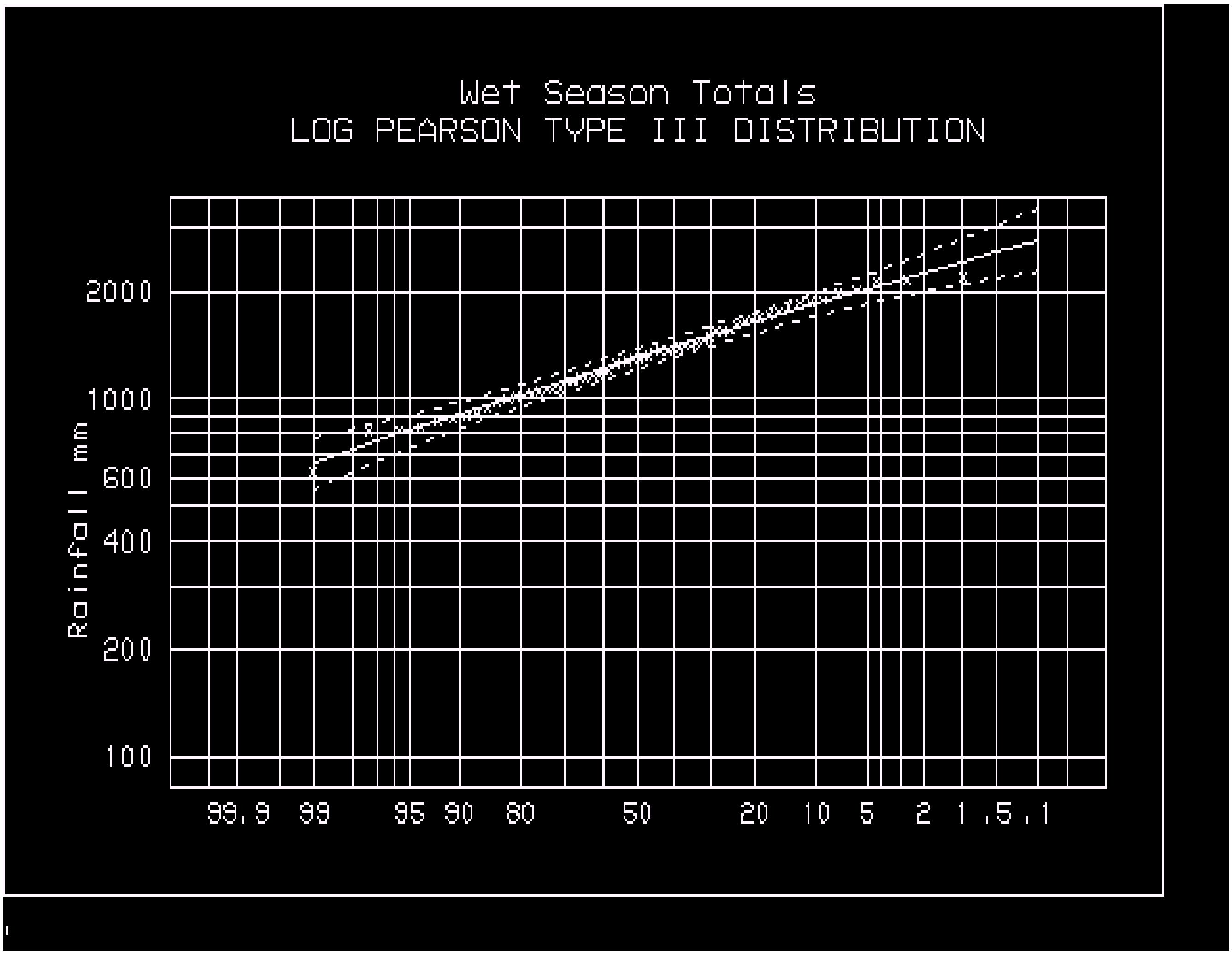
Date	Rain	O'Flow kL	Dilution Ratio
2/03/1975	38.6	2113	255750
3/03/1975	79.6	6867	162283
4/03/1975	8	161	695652
2/03/1975	21.4	1136	263732
3/03/1975	7.8	143	763636
4/03/1975	12.8	611	293290
5/03/1975	12.6	592	297973
9/03/1976	49.8	3616	192810
5/03/1976	19.6	939	292226
1/03/1977	174.6	5764	424080
2/03/1977	72.8	6230	163596
3/03/1977	41.4	3289	176224
6/04/1977	90	2480	508065
8/02/1991	47.2	335	1972537
1/03/1991	64.4	5443	165644
4/03/1991	25.6	1067	335895
6/03/1991	26.8	1410	266099
3/03/1991	27.4	357	1074510
6/03/1995	83	5082	228650
7/03/1995	32.6	2465	185152
8/03/1995	77	6623	162766
0/03/1995	24.8	1186	292749
5/04/1995	68	3627	262476
6/04/1995	8.8	232	531034
4/03/1997	94.6	4075	325006
5/03/1997	131.4	11717	157003
6/03/1997	11.2	461	340130
1/03/1998	24.4	1148	297561
2/03/1998	224.6	20446	153790
3/03/1998	82.2	7110	161857
4/03/1998	23.8	1641	203047
5/03/1998	21.4	1416	211582
2/03/1998	112	7715	203240
6/03/1998	45.8	2766	231815
7/03/1998	49.8	4076	171050
9/03/1999	41	2116	271267
3/03/1999	34.6	2185	221693
/03/1999	14.2	742	267925
7/03/1999	23.6	973	339568
8/03/1999	37.2	2896	179834
0/03/1999	8	61	1836066
1/03/1999	13.4	667	281259
3/03/1999	23.4	1111	294869
4/03/1999	18.2	1117	228111
3/04/1999	38.4	854	629508
4/04/1999	26.8	1918	195620
8/04/1999	83	6346	183107
9/04/2000	50.8	1561	455605
1/04/2000	123.4	10823	159623

As Table 2 shows many of the daily overflows are of the order of 1000kL or less and dilution is greater that 100,000 to 1.

Inflows
The more detailed model described above also gives an estimate of inflows required to provide makeup water for the growing ponds. Requirements were found to be significantly lass than previously estimated. These revised inflows were applied to the catchment/dam/offstream storage model and it was found that offstream storage capacity could be reduced by about 50%.

4. Frequency of Overflow

A frequency analysis of total wet season rainfall for Darwin (defined as December to March inclusive) was carried out. Results are plotted below.



As shown on the plot the nine (9) highest totals all plot at or above the 10% Exceedence Probability. The three (3) highest totals are greater than the 5% (or 1 in 20) probability. This suggests that frequency overflow, even with the assumed 1.2 rainfall factor is of the order on 1 in 10.