

11. PERSONNEL

The following personnel worked on this project, a number of them in a voluntary capacity and the coordinator would like to acknowledge all their contributions.

Design

J. Brodie, R. Volker, B. Mapstone, D. Sutton

Water Sampling and Analysis

J. Faithfull, P. Bachiella, G. Brodie, J. Orr, K. Vernes, P. Brodie,
S. Brodie, J. Coghlan, D. Payne, A. Hesse, J. Brodie.

Microbiological Analysis

R. Stockwell, S. Smith

Nassarius Study

R. Mitchell, M. Morrice

Data Handling and Analysis

K. Vernes, G. Brodie, B. Mapstone, I. Kneipp, R. Pearson

Report Preparation

J. Brodie, B. Mapstone, R. Mitchell

Typing and Diagrams

L. Derbyshire, G. Brodie

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9.17.15.3

PLEASE QUOTE.....

YOUR REFERENCE

Professor H. Choat
Department of Marine Biology
James Cook University
Townsville Qld 4810

Dear Professor Choat,

I refer to our recent discussions concerning the review of:

- 1) The Fringing Reefs of Magnetic Island: Benthic Biota and Sedimentation Study - a Baseline Survey by the Quantitative Ecology Division, Department of Marine Biology, James Cook University, and,
- 2) Magnetic Quay Water Quality and Sediment Baseline Study by the Australian Centre for Tropical Freshwater Research, James Cook University.

As a general comment, both reviewers and Authority staff have commented favourably on the benthic biota and sedimentation study. While the water quality study would appear to have met our requirements, the report appears to be in need of some revision. As you will be aware our main concern is the development of a feasible and quick reactive monitoring protocol for sedimentation.

Please find enclosed reviewers comments on the two reports (Attachment A refers). The reviewer's comments are to be addressed in finalising your baseline study reports and the impact assessment program for the proposed Magnetic Quay development at Nelly Bay, Magnetic Island. In particular the following points should be noted:

The Fringing Reefs of Magnetic Island: Benthic Biota and Sedimentation Study - a Baseline Survey by the Quantitative Ecology Division, Department of Marine Biology, James Cook University

a) Report Structure

An executive summary should be included in the report.

b) Anova Models

Using percent cover data, Model 4 Anova can detect a 20% change in most reef forming taxa (page 53 refers). However, what is not indicated is the percentage change that could be detected, if for various reasons, Model 4 is inapplicable.

c) Attributes

There is still considerable information in the data that could be analysed if time and resources permitted. Your comment is sought on the suggestion to examine size frequency and analysis of 'runs' after the assessment program is completed.

d) Evaluation of Nelly Bay Reef

The reviewer's comments regarding the demonstration of gross biological pattern (cluster analysis) using pooled taxonomic data, biotic uniqueness, rare species and resource evaluation should be noted. It would be useful if the aesthetic value of each of the different surveyed reefs and bays could be rated by the field survey personnel (for eg: using similar ratings to manta tow ratings). Similarly, trends or qualitative observations from the field survey team, which are not statistically verifiable should be noted and reported where possible.

Considering that discussions were held with reviewers prior to both the baseline field work and the report preparation I assume that species which are likely to be less tolerant of the projected increase in sediment loads or changes in water quality parameters were taken into account in your comments regarding comparison between bays etc. However it is suggested that this avenue be further examined as we discussed in our recent meeting.

e) Cluster Analysis

The designated impact stations are shown by cluster analysis to be biotically different from the controls (Figure 6B and Table 6 refers). How does this affect their suitability as controls?

f) Comparative Abundances

The critical issue for the interpretation of all future monitoring data is the assumption by the authors that if no impacts were to occur they would expect "...that changes in abundance would be the same, on average, at all sites, and unrelated to the patterns in absolute abundance among sites, stations etc on any given occasion" (page 31, para 1 refers). The reviewer has suggested that verification of this assumption be obtained by resurveying all or some of the transects prior to the commencement of the construction activities. Your advice regarding this assumption and the suggested verification proposal would be welcomed. What additional information which may influence the design of the monitoring program would be provided?

g) Sedimentation Levels

The indicated figures for the upper limit of average

sedimentation at a reef slope station (page 36 para 4 refers) are for wind speeds greater than 25 knots. What limits are envisaged for calm conditions? Given that sedimentation rates are averaged over a week or so from sediment trap data, if a reactive monitoring strategy required at least say 24 hours to provide sediment level results, could serious effects have already occurred (or do we have a day or two's grace).

h) Pooling of Taxa

The reviewers note that the pooling of taxa may combine inappropriate features and obscure certain changes resulting from the development. For example, the combination of species and species groups on taxonomic grounds may combine sediment susceptible forms with tolerant growth forms and thus obscure what may be a major effect on the former. Accordingly it is suggested that some scale of sediment trapping feature of morphology be recorded so that an analysis of treatment versus morphology could be examined.

i) Pre-construction Monitoring

"The potential for erroneously concluding that differences in sedimentation between Nelly Bay and control stations are cause for management action is great owing to the limited period over which the range of differences were assessed." In order to address this problem it is recommended that:

- (1) continued regular measurements of sedimentation, and,
 - (2) further baseline work to establish whether there are short term relations between turbidity and sedimentation
- be undertaken in the period prior to the commencement of construction activities. The critical question here is what additional information would be provided by such studies and how would we use it?

j) Reactive Monitoring Strategy

A rapid management response to any unforeseen sediment effects which occur during the construction phase of the proposed Magnetic Quay development is dependent upon the on site supervisor having some quick and expeditious measurement of suspended sediment which is indicative of physical or stressful effects on the corals.

While I appreciate the logic behind the 5 step process on which to basis a decision on when an impact has occurred, I am very concerned about the practicality of the procedures. Particularly, it seems to me that a decision to implement a "reactive sampling" procedure when a significant difference is detected in an environmental variable is likely to result in gross time delays in decisions about whether to halt construction or not. An observed characteristic of large construction projects is that they are very difficult to stop indeed and that such decisions have to be based on simple

criteria if they are to be implemented by supervision personnel. Furthermore, the construction organisation itself prefers simple decision making procedures, preferably based on a single criterion, even if this sometimes leads to a decision being made to cease construction when more complex analyses might show that such cessation is unnecessary.

I believe that it is important to stress that the baseline study must provide guideline figures of certain sediment concentration or equivalent which would lead to certain management actions.

While I appreciate that the figures will be guidelines, it should be emphasised that they may be subject to modification during the course of the construction in the light of experience. I believe that it is better to approach this issue conservatively and relax the levels, if required, rather than go the other way. Accordingly, I would suggest that a flow or decision diagram be developed in conjunction with the Authority to assist both the developer and the on site supervisor in the use of the short-term, quick and expeditious reactive monitoring program.

While potential sedimentation is obviously the prime cause for concern during construction, are there any other parameters that we should be concerned about for the short-term, quick and expeditious reactive monitoring program.

Magnetic Quay Water Quality and Sediment Baseline Study by the Australian Centre for Tropical Freshwater Research, James Cook University

a) Report Structure and Content

The quality of the report is very patchy and somewhat repetitive requires revision in lines with the reviewer's comments prior to submission to this Authority. An executive summary should be included in the report. Further analysis of the data should be considered in an attempt to identify whether relationships exist between the bays.

b) Analytical Methods

The number of replicates collected and analysed or controls run are unknown. No data was presented on the sensitivity or precision of the methods used, nor of variability due to sample handling in the field and laboratory. Similarly, it is not known whether the analytical tests were run blind or whether a percentage (~ 10%) of the samples were retested as is the usual laboratory procedure.

Reviewers have previously expressed doubts about the use of plate-count or MPN methods for bacterial counts preferring instead the use of epifluorescence microscopy after staining with a fluorescent nuclear stain. The comment does not appear to have been accepted and your advice for this decision is sought. There is no estimate given for the reliability of total bacteria

numbers and they should be taken as relatively guides only unless calibrated.

Your advice regarding the suggested modification to the chlorophyll analysis would be welcomed.

I understand no clear relationship could be demonstrated between secchi disc reading, suspended solids and sedimentation rates. Were secchi disc readings taken daily or only weekly to correlate with sedimentation rates etc.

c) Verification

The reviewers note that the concentration of nitrite, in particular, seems very high. It is suggested that these results be confirmed.

Some verification of the accuracy of the coliform counting measurements is required.

Proposed Monitoring Program

a) Sampling of Sediment Traps

How will the sampling of the sediment traps fit in with the short-term, quick and expeditious reactive monitoring program?

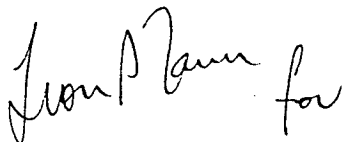
After 18 months of construction (end of 1991) I would have thought annual re-surveys would have been sufficient.

b) Experimental Study Payment by Developer

I am concerned about getting the developer to pay for the lipid investigation and the reproductive condition investigation given the experimental nature of these studies. While I agree that they are valuable studies the developer should be made aware of the likelihood of their producing useful information for impact assessment.

I look forward to our further discussions with you and your associates at the Authority's office at 2pm on 10 April 1989.

Yours sincerely,



Wendy Craik
Assistant Executive Officer
Research and Monitoring

cc Mr J. Neal (Linkon Construction Pty Ltd)

Review of the Magnetic Quay Water Quality and Sediment
Baseline Study by the Australian Centre for Tropical
Freshwater Research, James Cook University

The quality of the report is uneven. Some portions were soundly done, some gaps exist and some data seems to be considerably at odds with historical data from the GBR region and should be verified by independent means.

Sampling

The spatial and temporal extent of the sampling scheme was adequate only to resolve important short-term water quality characteristics in the area of the proposed Magnetic Quay development. With regard to the full range of conditions (floods, cyclones, harbor dredging) which could considerably affect water quality in Nelly Bay, insufficient environmental variability prevailed during the study period to allow a realistic assessment of longer-term fluctuations. The values obtained, in the absence of other considerations discussed below, would likely reflect general patterns under normal weather conditions.

Analytical methods

On the face of it, most of the analytical methods selected were or should be appropriate for a survey of this type. The number of replicates collected and analyzed or controls run are unknown.

I have considerable doubts about plate-count or MPN methods for bacterial counts, though recognized as "standard" methods for counting certain types of bacteria, in that local expertise in culture procedures, media preparation, sample inoculation can all affect results. Culture methods chronically under-estimate total bacterial numbers. There is no estimate given for the reliability of these numbers and they should be taken as relative guides only unless calibrated.

Does the CHN analyzer really use IR detection?

In the future, it is recommended that the chlorophyll analyses be run shortly after proper grinding and extraction rather than overnight extraction to minimize degradation of the chlorophyll. This would be particularly important in shallow water samples where high phaeophytic concentrations from resuspended sediment might interfere. Use of fluorometric detection would also improve sensitivity and reduce the sample size needed.

No data was presented on the sensitivity or precision of the methods used, nor of variability due to sample handling in the field and laboratory. This is a serious omission.

Results and Reporting

The format used for reporting the results is very confusing. Table 2, which summarizes the mean values (pg. 34), is generally lacking in units, as are the Appendix Tables for the spatial and temporal variability studies. Consultation of the Appendix Table 2 (?) suggests concentrations of nitrate-N and nitrite-N are on the order of $1 \mu\text{g-at/l}$ ($\mu\text{g-N/l}$ divided by 14.01) while the conversion of the mean value in Data summary table 2 (pg 34) apparently divides the reported values by the total mass of the ions. The tables should be recalculated, with appropriate labelling and have all values presented either as the mass, but preferably the concentration, of the element, not ion of interest (e.g. $\mu\text{M-N}$ or $\mu\text{M-P}$). This would facilitate comparison with other studies in the GBR region.

The concentrations of nitrite, in particular, seem very high (see Table 1, pg 15) and bear confirmation. The summed concentrations of nitrate and nitrite approach values suggested as being deleterious to corals. If such values represent conditions widely occurring in Cleveland Bay, certain corals on Magnetic Island may be stressed already and susceptible to accelerated degradation by localized inputs of nitrate/nitrite which exceed threshold values for damage.

The disparity between secchi disk depth (or water clarity) and suspended solids concentrations is not surprising. Close correspondence would imply homogeneity in the material attenuating light in the water. This is probably not the case in inshore waters such as Nelly Bay. Light can be attenuated quite effectively by particulate organic and dissolved substances which do not have the mass of suspended clay particles or other mineral materials also recovered on filters.

Report Recommendations

The proposed changes to the sampling strategy for monitoring during the construction phase are sensible. Water movements and water residence times in Nelly Bay are overwhelmingly driven by events in Cleveland Bay. Given the apparent degree of temporal variability in measured values of parameters at one site and lack of strong spatial variability, a reduction in the number of sites with an increase in the number of replicates taken per site will still give an adequate indication of water

quality in Nelly Bay. A capability to undertake contingency sampling in response to perceived events should be maintained.

Review Recommendations

1. The reporting format should be modified to include consistent units throughout and to clarify the results. The data tables from the baseline report should be redone in this new format to be consistent with all following reports and to provide a less ambiguous data set for comparison with future values.

1a. It may be desirable for GBRMPA to consider specifying one, or perhaps two, standard formats for reporting water quality, chemical and hydrographic variables measured in baseline, impact and monitoring studies that could be readily incorporated into any computer data base maintained by GBRMPA. This would make it easier for reviewers and managers to compare data sets in printed form or by computer techniques. While rigid formats can cause inconvenience in specific studies, computers can usually deal with these problems. Many of the same variables will be measured in most impact and monitoring studies and a range of contractors may eventually become involved in monitoring activities, making some formalized basis for review and comparison essential.

2. The consistently high nitrite values measured in Nelly Bay were surprising and should be independently confirmed. These values are significantly higher (10-fold) than usually measured in shelf waters of the GBR and rival values observed after cyclone events. As stated above, the summed concentrations of nitrate and nitrite approach (on average) and not infrequently exceed concentrations reported (but not experimentally verified) to cause deleterious effects to some corals. In view of the values measured, some rigorous experiments to confirm direct nitrate 'toxicity' or indirect negative effects on corals should be conducted. In the long term, if such high concentrations and the nitrate 'toxicity' problem are real, inputs of nitrate+nitrite attributable to the Magnetic Quay project could cause localized problems. The greater danger may still come from chronic, non-point inputs of nutrients from development around Cleveland Bay and natural nitrification processes in Cleveland Bay which are influenced by these inputs.

3. Given the obvious importance of estimating direct inputs of human sewage from developments, boats and surrounding areas, generally monitored as coliform bacteria, some evidence of the accuracy of coliform counting measurements is important. How are the methods calibrated within laboratories and is there an

independent method for quality control of reported results? Some interaction between contractor laboratories and state health laboratories normally conducting these measurements would be useful.

4. As stated above, the report lacks data on the sensitivity and precision of individual analyses or reported values. It was therefore impossible to objectively examine the quality of individual numbers, though some look suspiciously high or low. Some indication of precision and sensitivity should be included in contractor reports to allow this.

5. I do not feel that measuring pH is worth the effort. Seawater is generally well buffered and making quality pH measurements requires considerable care and proper instrumentation. Interpretation of the results would also require careful consideration of spatial and temporal variations. All of this may be beyond the scope of a monitoring program unless specific problems are identified which justify the considerable effort required.

6. The attempt to monitor Tri-butyl-tin (TBT) by its effect on the sexuality of resident snails is an interesting and potentially cost-effective method. It should be pursued. Clearly, some lab work is needed to verify that local snails are reliable TBT indicators and the results are not confounded by unforeseen factors. If this technique can work, it offers the potential to monitor TBT effects cheaply throughout the marine park. Field work is also needed to assure that the sampling method obtains an unbiased selection of snails appropriate for analysis.

Attachment

A

GREAT BARRIER REEF MARINE PARK AUTHORITY
REPORT OF ASSESSOR

PROJECT TITLE

Review of Kelly Bay Baseline Study

PROJECT NO.

INVESTIGATOR

INSTITUTION

(Please see notes before writing report)

1. Sampling design ok to resolve temporal + spatial variability
2. No estimate of sensitivity + precision of methods used in survey, precluding detailed examination of data. Basic methods, possibly excluding bacterial counts, should be reliable if properly performed.
3. Nitrite values very high. Need to be verified by independent means
4. Formatting, and reporting of results clumsy, lacking units in some cases, making comparisons difficult. Should be re-done. GBRMPA should consider a standardized report format for database archiving and reviews.
5. Snail monitoring for TBT a potentially useful and cost-effective method for monitoring TBT pollution. Worthy of support for calibration and verification.

PUBLICATION: Recommended - ~~in present form~~
with modification - see attached notes
~~not recommended~~

(Please add further comments on extra sheets if necessary)

NAME OF ASSESSOR

SIGNATURE

TI

INSTITUTION

ASSESSMENT

PROPOSAL INVESTIGATOR REPORT 24/3/1989

Please enter grade

B-

C

REFERENCING FEE

Secured / ~~not secured~~

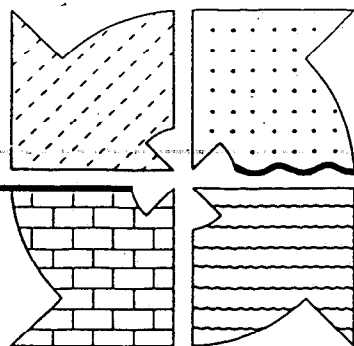
Comment on Magnetic Quay water quality and sediment baseline study of March 1989.

The duration of measurements is not sufficient to draw many conclusions on year-round conditions in Nelly Bay but the work carried out is adequate within this constraint. A few suggestions follow with regard to methodology.

Although this is environmental impact work rather than scientific work more detail would be appreciated on methodology. For example were automated or manual methods used for nutrients? What path length cuvette was used for the chlorophyll measurements? It is difficult to work out when replicate measurements were made. If temperature and salinity are to be measured using field probes the accuracy should be given and measurements using sensitive mercury thermometer and laboratory inductive salinometer should be reported simultaneously from time to time to confirm calibration. Perhaps some indication of accuracy of other data or methods could be given where possible. Evaluation of the data is made difficult by choice of units of measurement reported (or not reported in several places such as tables 2 and 3). The convention for nutrients in marine waters is to use $\mu\text{g-atom/litre}$ or μM and this should be adhered to throughout the report.

(Chlorophyll measurements will require more than one litre of sample water to obtain accurate values on many days if a spectrophotometric method is used.)

(In table 1 the final value of 0.20 in Cleveland Bay should be under phosphate not ammonia.)



Australian Centre for Tropical Freshwater Research

James Cook University, Townsville, Qld 4811 Australia

JEB:LD/(077)81 4191

10 April, 1989

Dr. Wendy Craik,
Assistant Executive Officer,
Research & Monitoring,
Great Barrier Reef Marine Park Authority,
TOWNSVILLE. QLD. 4810

Dear Dr. Craik,

I refer to your comments on the Magnetic Quay Water Quality and Sediment Baseline Study expressed in your letter to Professor Choat of about 31 March.

We have modified the report in line with your own and the reviewers' comments and our own review, and are resubmitting it with this letter. I will also comment directly in this letter on the points you raise.

- (a) Covered in revised report as far as time allows.
- (b) Quality control of analytical data is now summarized in the revised report.

The methods used (heterotrophic plate count and MPN) were chosen specifically to allow correlations with currently used methods for microbiological examination of water and wastewater. This study was not an ecological study of the reef environment, but a specific examination for particular organisms. The heterotrophic plate count is used to detect bacteria capable of growth in high nutrient environments such as those occurring where sewage or wastewater outfall is occurring or will occur. The occurrence of low nutrient and non-viable bacteria detected using epifluorescence, would not provide data of relevance to assessment of heterotrophic bacteria. To quote the standard text of "Methods for the Examination of Water and Wastewater" (16th Edition, 1985: Part 900 Microbiological Examination of Water) "the heterotrophic plate count is the best available measure of water treatment plant efficiency, after growth in transmission lines, and general bacterial composition of source water".

For the faecal and total coliform bacteria, and the hydrocarbon utilizing bacteria, the methods used were the only available to meet guidelines for water quality assessment (see Microbiological Methods Manual, Rural Water

Commission of Victoria, Water, Materials and Environmental Science Branch, Report No. MB2, January 1988) and could not be performed by epifluorescence microscopy.

I have no comments at present regarding the modification to the Chlorophyll method suggested but we will look further into this and if it seem appropriate will adopt the modified method for further monitoring.

Secchi disc readings were taken weekly. There has been no attempt to correlate daily readings with suspended sediment values or sedimentation rates.

(c) We will attempt to verify high nitrite values by using manual analysis methods for some of the construction phase monitoring.

Reference to "Microbiological Water Quality Criteria: A review for Australia" (Department of Resources and Energy, Australian Water Resources Council, Technical Paper No. 85, Aust. Govt. Publishing Service, Canberra, 1985) has shown that in Australia different coliform methods are used in different laboratories for different sample types. Assessment of methods relating to seawater samples led to the selection of two standard methods which were compared during initial sampling. One of these using Membrane Enriched Teepol medium had consistently higher counts and was therefore selected for use in this study. No calibration with other laboratories was attempted as no set standard method exists, and sample differences (e.g. temperate vs tropical) would not facilitate comparisons between laboratories using similar methods. (Dr. A. McNeil, Victorian Water Resources Commission, pers. comm.). The sample variability detected for most water quality parameters including bacteria supports the reviewers' observation that numbers obtained are relative guides only to these parameters.

Yours faithfully,


J. Brodie,
Coordinator

Encl.