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## **Impact assessment case study the floating hotel at John Brewer Reef.**

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IMPACT ASSESSMENT CASE STUDY  
THE FLOATING HOTEL AT JOHN BREWER REEF

(Floating Hotel Impact Assessment)

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Key Words: Barrier Reef; marine park; environmental impact; impact assessment; John Brewer; floating hotel; tourist development.

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## Abstract

The first floating hotel in the world to be sited on a remote coral reef is now operating at John Brewer Reef in the Great Barrier Reef Marine Park. Management of the Marine Park is the responsibility of the Great Barrier Reef Marine Park Authority. Proposed activities in the Park, which may have significant adverse environmental impacts, may only be carried out with the written permission of the Authority. Permission may be granted only after the potential environmental impacts have been assessed. Should a project be allowed to proceed, the permit system provides a regulatory mechanism for setting conditions and standards which the proponent must meet. This paper outlines the process of environmental impact assessment undertaken to establish controls and conditions for the development and operation of the floating hotel. As the first of its kind, the hotel has given a focus to a number of environmental issues which the Authority had not previously encountered.

## Introduction

The Great Barrier Reef is a system of coral reefs extending for some 2000 kilometres along the north-eastern coast of Australia, from Cape York in the north ( $10^{\circ} 41'S$ ) to just north of Fraser Island ( $24^{\circ} 30'S$ ) (Figure 1). The Barrier Reef is not a single entity, but comprises some 2600 individual offshore reefs ranging in size from less than 1 hectare to more than 100 square kilometres. In some areas the reefs are separated by channels only 200 metres wide, while elsewhere they may be 20 kilometres apart. Most reefs remain submerged at all times, although some are exposed at low tide. Few reefs support vegetated cays.

The Great Barrier Reef has been described as the largest and richest system of coral reefs in the world (GBRMPA, 1981). The need to ensure that the Barrier Reef may be used and enjoyed by future generations was recognised by the Commonwealth Parliament through passing of the Great Barrier Reef Marine Park Act 1975 (the GBRMP Act). Further recognition of the Reef as a unique natural feature of global significance came in 1981 with inscription onto the World Heritage List.

John Brewer Reef, located in the Central Section of the Marine Park, was chosen as the site for the development of the Four Seasons Barrier Reef Resort complex. 72 kilometres across open water to the north-east of Townsville, John Brewer is the closest reef to this regional population centre and the focus for many reef related activities. For a long time the destination for line and spearfishing John Brewer Reef provides a safe anchorage for recreational and commercial fishing vessels. The only tourist use of the area prior to 1983 was fishing and diving from charter vessels based in Townsville. Since then, pontoons and an underwater viewing vessel have been installed at the Reef as part of the 'Reeflink' day trip operation, serviced by a high speed catamaran.

The floating hotel is the first in the world to be sited on a remote coral reef. The site chosen for the hotel is a few hundred metres from the northern edge of John Brewer Reef, protected from the ocean swell within the Reef lagoon (Figure 2). Here the water depth is between 6 and 10 metres at low tide, over a sand bottom between scattered coral outcrops.

Because of its proximity to Townsville, John Brewer Reef is also a major site for research conducted by the James Cook University and the Australian Institute of Marine Science. An increase in the research effort was facilitated through improvement in access offered by the catamaran service.

#### Description of the Development

The floating hotel is based on the 'Coastel' design developed by Consafe AB of Sweden, employed at several locations around the world to provide offshore accommodation. Built complete with fit-out in a Singapore shipyard by a subsidiary of Bethlehem Steel, the cost to the owner, Barrier Reef Holdings Pty Ltd, was around A\$35 million.

Similar to a cruise liner in its facilities, the Hotel provides accommodation for up to 366 guests and 100 staff in a structure of seven decks, based on a 89 x 26 metre barge hull. In addition, there is a restaurant, a bistro, a disco, bar areas, a conference room, entertainment area and a gymnasium. There are also administrative offices, a laundry, store rooms, library and a marine research laboratory.

A desalination plant provides fresh water to the Hotel by processing an average of 80 tonnes of sea water per day. About 20 tonnes of fresh water is separated by a reverse osmosis process and the remaining 60 tonnes of hypersaline water is ejected directly into the lagoon.

Burnable waste is fed into a high temperature incinerator for destruction. Incineration at 1400°C creates exhaust fumes with a very low concentration of particulates and stack emissions should be effectively smokeless. Non-burnable waste and ash from the incinerator is packed into drums and carried to the mainland for dumping at the municipal tip.

All waste water produced on the hotel receives chemical treatment onboard to the secondary level and the treated effluent accumulates in a holding tank. In the treatment process sludge is first separated from the liquid fraction to be burned in the incinerator. The liquid fraction is further treated by chemical oxidation to break down organic material, chlorination and irradiation with ultraviolet light then destroys virtually all bacteria. Testing of the treatment plant produced effluent with specifications given in Table 1. Contents of the holding tank are periodically transferred to a barge for transport and dumping, at a predetermined site, in deep water remote from the Reef.

Ancillary structures included as part of the development are two smaller barges, one converted to a helicopter landing pad and the other doubling as a tennis court and emergency evacuation barge. There is also a complex of pontoons that are designed to provide a swimming pool, boat marina and underwater viewing chamber.

Table 1. Treated water specifications

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BOD <sub>5</sub> *	less than 10 mg/l
Bacteria	4/100ml
Solids	zero
Chlorine	zero

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\* Five day biochemical oxygen demand

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Attached at a single point to the main mooring, the Hotel is able to swing into the wind during a storm to reduce wind resistance. The Hotel is also designed to withstand twice the force of the most severe cyclonic storm with a return period of one hundred years i.e. a cyclone with winds of 162 km/hr. In relatively calm weather the Hotel is held in place by two additional stern moorings.

The main mooring is a similar design to those used to moor super tankers in deep water and consists of six 230m long chain legs laid out in a radial pattern, each attached to an 18 tonne anchor at one end and the central counterweight at the other. The counterweight in turn is attached to the Hotel mooring boom through a series of joints and swivels. In total, the whole mooring system weighs 480 tonnes (Figure 3).

### Management Framework

The GBRMP Act established the Great Barrier Reef Marine Park Authority (the Authority), a resource planning and management agency with the goal of providing for the protection, wise use, appreciation and enjoyment of the Great Barrier Reef in perpetuity, through the development and care of the Great Barrier Reef Marine Park. The Act also determined that management of the Park is based on zoning plans. Zoning plans accommodate multiple use of the Park's resources and provide for separation of conflicting uses.

Under the Regulations pursuant to the Act, the Authority has developed a permit system that operates within the broad guidelines of the zoning plans and applies to a range of activities, including the installation and operation of structures such as a floating hotel. The Regulations require all potential environmental impacts to be considered in carrying out a permit assessment. Where the Authority considers that a proposal might have impacts on the use and amenity of an area, the Regulations also require the proponent to advertise the proposal for public comment. However, where there is potential for significant environmental impact, the Authority invokes the assessment procedures of the Commonwealth Environment Protection (Impact of Proposals) Act 1974 (EPIP Act).

Because the floating hotel is within the Great Barrier Reef Marine Park but outside Australian territorial waters, a number of relevant legislative controls could only be applied through the GBRMP Act. Therefore, for several aspects of the development the Authority found it necessary to draw on the expertise of other Commonwealth, State and Local Government agencies. For example, the Department of Transport and Communications acted as agent of the Authority to verify that the design and construction of the facility met relevant standards.

### Assessment of Environmental Impacts

During 1984, the Authority received an application to develop a facility with overnight guest accommodation at John Brewer Reef. An initial assessment indicated that the development

could have the potential for significant environmental impact. The matter was therefore referred for consideration under the EPIP Act.

An environmental impact statement was commissioned by the proponent and completed in 1985 (Det Norske Veritas, 1985). Assessment of the EIS was carried out by the then Department of Arts, Heritage and Environment. The Department consulted with other Government Departments, particularly the Great Barrier Reef Marine Park Authority and also took into account public submissions on the proposal. The assessment concluded that likely environmental effects of the proposal were appropriately identified and examined in the EIS.

In summary, the major impacts of the proposal were expected to be:

- . visual intrusion as a result of placing the structure into a natural environment;
- . possible water and air pollution;
- . effects on marine life due to moorings, divers' fin damage, anchor damage, shading, lights, pollution and the presence of boating traffic; and
- . the possibility of accidents, particularly the grounding of the hotel itself. (Dept. of AH&E, 1985)

The Department also recommended conditions for the protection of the environment. These included the development of a resort management plan and an environmental monitoring program, as were offered in the EIS.

Considering the degree of public interest in the Hotel, the EIS attracted little criticism. Only six public submissions were received in response to the call for comments on the proposal.

Four of the submissions came from environmental lobby groups, three of which expressed the opinion that similar structures should not be permitted anywhere on the Great Barrier Reef. This stance, widely reported in the media, has centred on the philosophical and aesthetic argument that the 'wilderness value' of the Park will be compromised by the profile of the Hotel protruding above the horizon, considered to be a form of visual pollution. It is apparent that resolution of these arguments requires the preparation of broad strategic guidelines, to set limits on the extent to which developments will be permitted in the Marine Park. The setting of such strategic direction is clearly beyond the scope of an environmental assessment relating to an individual project.

Another criticism of the EIS was that a detailed inventory of the biological characteristics of John Brewer Reef was not included. However, inclusion of such an inventory with the EIS would not have assisted assessment or management of the environmental impacts of the proposed operation and it was therefore not a requirement. Furthermore, changes to the biological make-up of the Reef will be identified by the Monitoring Program, rendering a biological inventory a superficial appendage to the EIS.

## Outline of Permission Granted

In December 1985, the Authority issued a permit to develop the floating hotel at John Brewer Reef. Conditions of the permit were based on the assessment of the environmental impact study and the Department's recommendations. Important requirements were that:

- . the proponent develop and implement a resort management plan, to the Authority's satisfaction, taking into consideration all legislation applying to the proposal.
- . the proponent develop and implement a satisfactory environmental monitoring program so that results of the program would assist management of the development, including amendment of the management plan if appropriate; and
- . among insurance requirements, a A\$1 million bond be posted to provide for removal of the structure at the cessation of operations, if necessary, or to counter any unacceptable environmental impacts.

The developer was told that the Resort Management Plan should build on information provided in the EIS and be consistent with management objectives for the John Brewer Reef area. The Plan was also to contain details of review mechanisms, including interaction with the monitoring program.

Objectives set for the monitoring program were:

- . test whether the environmental effects of the development are as predicted in the EIS;
- . test effects of activities which could not be assessed in the EIS; and
- . provide a measure of the state of health of the Reef biota adjacent to the Hotel site.

The proponent was also required to undertake modelling studies to determine the rate of dilution of the brine plume arising from the desalination plant discharge and the dispersion characteristics of the incinerator and generator stack emissions. Further information was also required on erosion and sedimentation processes in the vicinity of the hotel.

Separate specific permits were issued for each stage of development, covering such activities as approved site works (cropping of coral outcrops), installation of moorings and ancillary pontoons and commencement of operations at the floating hotel. This staging of permissions enabled the Authority to set specific conditions based on the results of the further detailed studies.

The general permit for installation and operation of the hotel was re-issued in January 1988 for a period of five years, incorporating changes made in the light of knowledge and events that had arisen in the two years since first issue. The Resort Management Plan and the Monitoring Program



were included as attachments. A summary of the assessment stages appears in Table 2.

### Assessment of Post EIS Issues

Some changes were made to the plan for the development in response to issues that arose after the EIS was completed. Among the changes, the Hotel site is not in exactly the same location as identified in the EIS. This is because further studies cast doubt on an initial assumption that wind and waves would come from the same direction during a cyclone. A more sheltered site further towards the centre of the lagoon was chosen to allow for the more severe condition of wind and waves coming from different directions. The minor change of site did not invalidate the EIS.

Preparation of the new site required 'cropping' of more coral outcrops than envisaged in the EIS. However, as major modification was only required in the case of three bommies, the environmental impact of the cropping was judged to be within the broad scope of the original assessment and therefore did not warrant further investigation under the EPIP Act. Conducted with a pontoon-mounted back hoe, the cropping operations were controlled under a specific permit and were closely monitored, particularly for the impact of disturbed sediments. All live corals encountered were transplanted to a nearby area.

The EIS envisaged that treated waste water would accumulate in the Hotel holding tank at an average of about 800 cu.m per week. This amount was to be transferred to a barge with a similar capacity once a week and discharged in a stream on the return trip to Townsville. In the event, the developer has chosen a contractor with a barge housing a much smaller tank capacity (80 cu.m.) and the barge must make repeated trips to a dump site in order to drain the holding tank.

Although treated, the nutrient content of the effluent is undiminished and staff of the Authority were concerned that currents should not carry effluent back onto the Reef as nutrient rich water is deleterious to coral health. The change of plans presented the Authority with the problem of nominating suitable disposal sites at the minimum safe distance from John Brewer and neighbouring reefs. Oceanographic researchers at the Australian Institute of Marine Science were consulted. The researchers were able to offer advice on suitable dump sites based on computer modelling of water current circulation. Waste dumping at sea also falls within the ambit of the Commonwealth Environment Protection (Sea Dumping) Act 1981 and staff of the Authority were consulted in drawing up conditions for the permit issued under this Act.

An anti-scalant and a flocculant chemical are added to the desalination plant feed water to prevent fouling of osmotic membranes essential to the desalination process. These chemicals are discharged back into the Reef lagoon with the hypersaline water, in concentrations of a few parts per million. Toxicity of these reactive organic polymers was not discussed in the EIS and the developer was asked to investigate the matter. Further investigations concluded

Table 2. Diary of Events

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1984	Initial application to develop a floating hotel at John Brewer Reef
March 1985	Draft EIS prepared by Det Norske Veritas and Coastal Ecosystems
April to May 1985	Public comment invited on EIS (6 submissions received)
May 1985	Proponent prepares addendum to draft EIS in response to public comment
June 1985	Minister advises that EPIP Act requirements are satisfied and recommends further action to be taken by the Authority
December 1985	Authority issues permit to develop a floating hotel at John Brewer Reef. Permit requires that prior to installation there is a need for: <ul style="list-style-type: none"><li>. assessment of the structure by a classification society</li><li>. standards of health and safety to be met</li><li>. bank guarantee of \$1m to be provided to the Authority</li><li>. resort management plan and monitoring program to be finalised before installation</li></ul> Each stage of installing hotel is subject to a separate permit.
July 1987	Approved site works (cropping of coral outcrops) begins
October 1987	Installation of mooring system and helipad begin
December 1987	Approval for installation and operation of the hotel for the next five years, subject to conditions including resort management plan and environment monitoring program
March 1988	Resort opens

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that any toxic effects on biota in the lagoon were likely to be negligible. Conditions were imposed through the Resort Management Plan to minimise the use and discharge of the chemicals and appropriate studies were included in the Monitoring Program to identify any resulting impact.

### Events Since Installation

Cyclone Charlie passed over the Hotel on 27 February 1988, delaying the planned opening date. As hotel staff were on board, this event provided a timely opportunity to test the cyclone evacuation procedure, which ran smoothly. Although Charlie was not a severe cyclone (winds peaked at around 100 km/hr), it was found that the stern moorings did not need to be released, suggesting the Hotel and mooring could easily cope with much more violent storms.

Mooring the ancillary pontoons in the preferred arrangement has proved to be a problem. Wave action during severe weather conditions overstresses the connections between pontoons and makes passage from one to another hazardous. The pontoons have now been moored individually until engineers devise a solution. While previously held at temporary moorings, three pontoons broke free and drifted off the Reef, two of these during Cyclone Charlie. Two were later recovered undamaged. The third was washed up on an island and is to be salvaged when suitable conditions are available.

Appropriate fuel handling procedures are incorporated into the Resort Management Plan, reducing both the risk of a spill and environmental damage if a spill occurs. Despite the precautions, a spill of approximately 30 litres of diesel oil occurred on the 9th of April 1988, caused by a faulty valve in one of the Hotel's fuel tanks. The procedure for oil spills was immediately enacted even though the quantity of fuel spilt was very small. The spill occurred while transferring fuel between holding tanks on board the hotel. The valve has been replaced with one of a more reliable design and the fuel transfer procedure has been upgraded to include manual checking of fuel levels.

### Conclusions

Planning to minimise environmental impact of the project was able to be included at an early stage of the project development because, from the beginning, the Authority has received a high degree of co-operation from the developer.

Changes such as the minor shift of the mooring site to an alternative location on John Brewer Reef and the need to crop or remove part of six additional coral outcrops were able to be addressed within the parameters set by the EIS. Where environmental issues arose that had not been adequately considered in the EIS, the Authority required the proponent to demonstrate that no significant environmental impacts were likely to occur, before permission was granted for the project to proceed to the next stage.

Environmental assessment of the operation of the Hotel, which began with preparation of the EIS and enhanced with reports on subsequent issues, now continues with the hotel in operation through the provisions of the Resort Management Plan and the Monitoring Program. This example of the adaptive environmental management approach has ensured that environmental impacts of the project on the Reef have so far been minor and provides a mechanism to quickly address and minimise unforeseen impacts.

In summary, protection of the environment of John Brewer Reef has been ensured through the following:

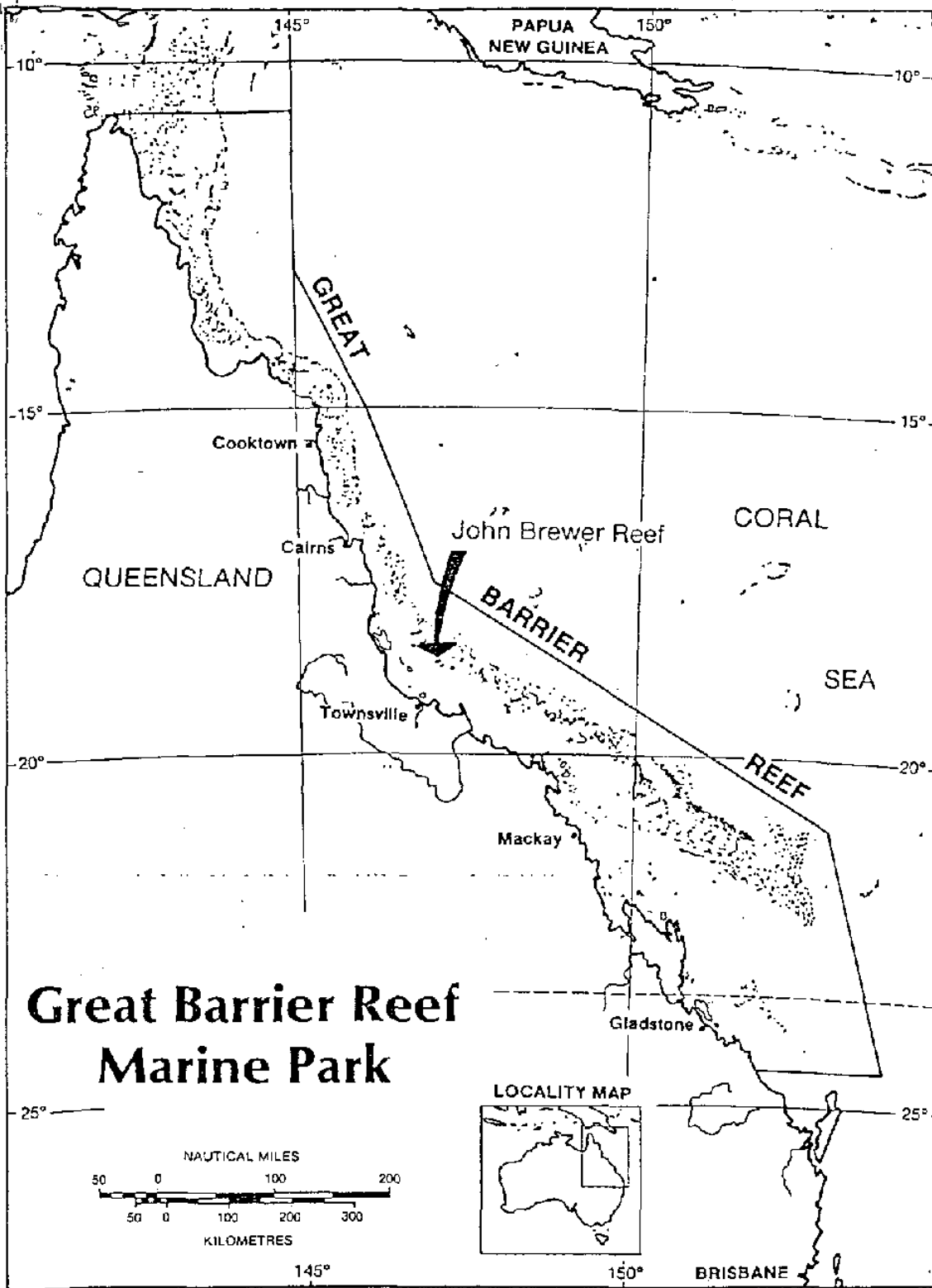
- . measures to minimise environmental impact were considered from an early stage of project planning and design;
- . a high level of co-operation from the developer including a willingness to incorporate preventative controls;
- . tight control of day-to-day operations;
- . monitoring for unforeseen impacts; and
- . provision of an appropriate mechanism to adjust operations to minimise unforeseen impacts.


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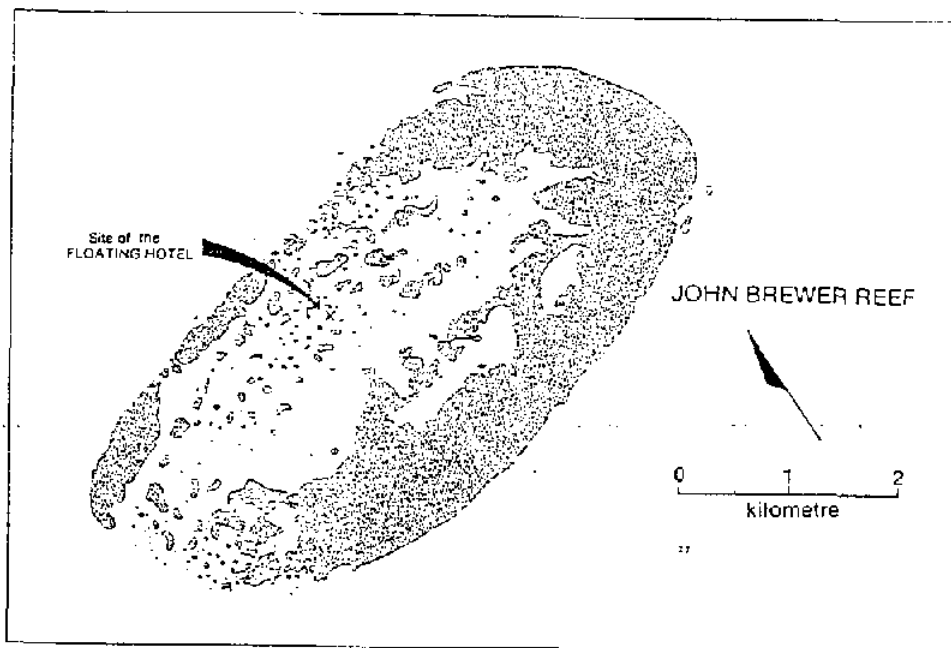


 Great Barrier Reef Marine Park Authority

Title: Impact Assessment Case Study: Floating Hotel,  
John Brewer Reef

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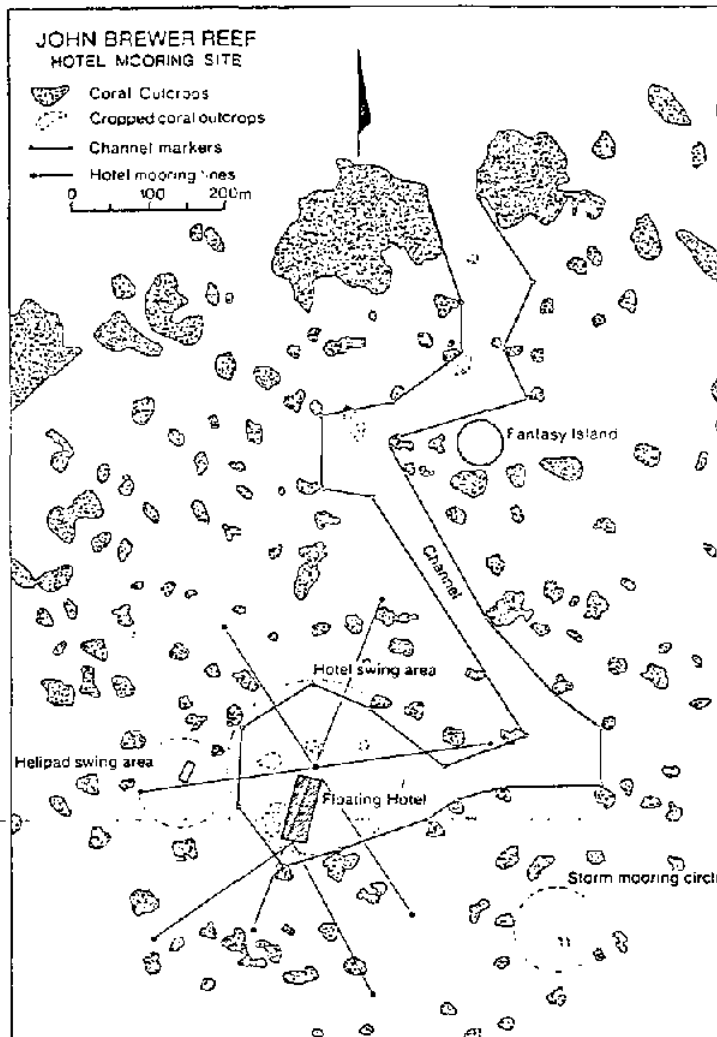
Figure 1. Location Map - Great Barrier Reef



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Figure 2. John Brewer Reef



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Figure 3. Hotel Mooring Configuration