THE ROYAL INSTITUTION OF NAVAL ARCHITECTS AUSTRALIAN DIVISION

DEVELOPMENT OF AN OFFSHORE FLOATING HOTEL IN A CORAL LAGOON

BY

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SYDNEY

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1. ABSTRACT

A unique international standard floating Resort was conceived, planned, constructed, transported, installed, and put into operation by Barrier Reef Holdings Ltd. The Resort is located at the John Brewer Reef in Australia's Great Barrier Reef Marine Park. The concept stemmed from the desire to provide overnight accommodation to enable tourists to experience and enjoy the beauty of the Great Barrier Reef throughout the day and night.

A comprehensive Environmental Impact Statement (EIS) was prepared and put both on public display and to the Federal Government for review. Design and operation proposals were extensively covered in the EIS. Design criteria, governing legislation and safety standards were detailed. A conditional permit was issued by the Great Barrier Reef Marine Park Authority (GBRMPA).

The hotel was built in a Singaporean shipyard, transported by heavy lift carrier to near the Reef and manoeuvered into location. The counterweight articulated single point mooring was designed using environmental criteria produced in the EIS. This was installed and tested prior to arrival of the hotel.

Opening the Resort was delayed as a result of a tropical cyclone which passed immediately over the hotel while installation and commissioning was being completed. The Resort has been proven to withstand cyclonic conditions.

2. INTRODUCTION

The floating hotel idea was first conceived by a now director of Barrier Reef Holdings Ltd, Mr Doug Tarca, who operates a successful fast catamaran service taking tourists on day trips out to the John Brewer Reef, a 7.2 km by 3 km coral reef some 42 nautical miles North-East of Townsville. This is one of 2,000 reefs which comprise the Great Barrier Reef Marine Park stretching about 1,500 km along the North-East coast of Australia. (see Diagram 1)

There has been a growing demand by tourists to be able to extend their stay on the main Great Barrier Reef beyond the few hours which the day trips allow. The idea of a hotel at John Brewer Reef was developed to enable visitors to enjoy the beauty of the Great Barrier Reef at all times, day and night, with world class facilities and comfort.

A preliminary feasibility study was begun in April 1984 and resulted in a decision to proceed with preparation of an Environmental Impact Statement (EIS) which would examine all the environmental impacts of locating a floating hotel on John Brewer Reef.

3. ENVIRONMENTAL IMPACT STATEMENT (EIS)

That study presented and examined all relevant issues as required by the Commonwealth Environmental Protection (Impact of Proposals) Act of 1974. Because of the uniqueness of this project, the required contents of the EIS were established in close consultation with the Australian Federal Department of Arts, Heritage and Environment, the Great Barrier Reef Marine Park Authority and the Premier's Department in the State of Queensland.

The contents of the EIS (Diagram 2) show the extent of the study and I will not attempt to examine it all in this paper, but will highlight some of the aspects.

3.1 The EIS covered in detail, the design and operational aspects which would be included in the development so as to provide maximum safety and minimum impact on the environment.

3.2 No waste is discharged into the lagoon.

All sewage is treated onboard (tertiary treatment) and the liquid (treated water) is pumped to storage tanks onboard. All solid sewage is pumped to a sludge tank and thereafter injected into a high temperature incinerator onboard and burnt. The treated water is loaded into a supply barge on a regular weekly basis and released into open water at least 5 km from the Reef in accordance with International and Australian Regulations (Sea Dumping Act).

All wastes from kitchens, machinery spaces etc is either compacted and burnt in the incinerator onboard and the ashes taken ashore for disposal, or taken ashore directly for disposal.

3.3 A Resort Management Plan was stipulated to be prepared prior to commencement of operations and the Resort, according to the issued permit, must operate according to that Plan. The Plan details day to day operating procedures to ensure safety of people and minimal risk to the environment as well as detailing the emergency procedures and operations.

The main components of the Resort's operations governed by the Plan are:

- transport to and from the floating hotel
- water based recreation activities
- docking and storage of vessels and recreational equipment
- maintenance procedures for the floating hotel
- interaction with existing users
- bunkering of fuels and transfer of waste to transport barges
- emergency procedures (eg fire, cyclone).

Incorporated in the Resort Management Plan is the Environmental Monitoring Program developed in close consultation with the Great Barrier Reef Marine Park Authority (GBRMPA), and designed to determine whether any facets of the Resort's existence or operations are altering the reef environment. Studies have already been carried out prior to commencement of any work at the location and prior to installation of the mooring and the hotel. This forms the base line definition. Ongoing studies will be made in accordance with the monitoring program, in order to monitor variations from that base line definition due to the presence and operation of the Resort.

A marine laboratory has been incorporated in the Resort to provide facilities for the performance of the environmental monitoring program. It is also made available for approved scientific study by other scientific organisations, and will provide an excellent base for such work in close proximity to the Reef.

3.4 The EIS reviewed all existing Australian legislation governing the proposed development and also defined the internationally recognised safety standards to be incorporated in the design and operation of the hotel. Some examples are:

- the hotel is designed, built, and certified to the requirements of the Australian Department of Transport (basically SOLAS 1974

plus amendments) and the classification society Det norske Veritas for its highest classification notation.

- the single point and stern moorings are designed, manufactured, installed and certified to the requirements of Det norske Veritas for mooring systems used in the offshore loading of oil.

- both the hotel and mooring systems are to be routinely inspected to both Department of Transport and Det norske Veritas requirements.

3.5 The EIS also investigated and provided environmental engineering data used as design criteria in the development of the project and the design of the Resort and its moorings.

This included a comprehensive study of wind strengths and wave heights expected both outside and inside John Brewer Reef in "normal" conditions throughout the year and also during extreme conditions (tropical cyclones).

This work was done by Professor Kevin Stark and his colleagues at James Cook University in Townsville, Australia and played a significant part in the design phase of the Resort.

The Resort and its mooring system were designed to withstand the most severe weather conditions expected to occur in the area of John Brewer Reef, including cyclonic conditions, for a return period of once every 100 years. This is comparable to the criteria normally adopted for offshore installations in the oil and gas industry with a life of 20-30 years.

3.6 The EIS was completed in March 1985 and put on public display for 6 months. It was also reviewed by the Federal Department of Arts, Heritage and Environment and the Great Barrier Reef Marine Park Authority during that same period. At the completion of that review the final EIS was prepared and the Department considered that all possible impacts of the Resort on the environment had been adequately addressed and that appropriate safeguards had been proposed.

The Great Barrier Reef is a World Heritage Area and the Australian Government has the responsibility for its administration. The Resort

is located in an area administered by GBRMPA from its principal office in Townsville under powers granted to it in accordance with the Great Barrier Reef Marine Park Act 1975. Under this Act, GBRMPA is empowered by the Federal Government to prepare a zoning plan for an area that includes John Brewer Reef. A zoning plan was prepared and, following public inspection, was formally adopted in October 1987.

John Brewer Reef is zoned "Marine National Park A". The objective of this zone is to provide for the protection of natural resources whilst allowing recreational activities, limited fishing and permitted research.

Barrier Reef Holdings Ltd was issued in December 1985 with a permit that allowed installation and operation of the Resort to proceed. This was subject to implementation of the strict environmental safeguards described in the EIS and operation in accordance with the approved Resort Management Plan. The permit also required Barrier Reef Holdings Ltd to enter into a Deed with GBRMPA, which includes covenants by the Company to indemnify GBRMPA for costs incurred in rehabilitating the Marine Park in the event of an accident.

4. DESIGN AND CONSTRUCTION

4.1 Hotel Structure

Conceptual designs and construction specifications for the hotel part of the Resort were produced prior to and during preparation of the EIS.

The design of the hotel structure and outfitting, and of the mooring systems has been carried out with the highest regard for safety standards and reliability. The hotel itself exceeds, in many places, passenger ship standards of fire safety. For example, the Resort has vertical fire zones protected by structural fire protection, a fully pressured sprinkler system plus an automatic fire detection system using heat and smoke detectors. This is in addition to fire hoses and portable fire extinguishers and an evacuation area - the tennis court which is moored adjacent to the hotel.

The hull of the hotel is based on conventional shipbuilding design and construction and contains most of the services provided within the hotel such as power, water and sewage treatment. (Diagram 3) The first two decks are also

constructed using conventional shipbuilding methods and include the public spaces, conference rooms and some guest rooms.

The guest rooms and staff quarters (levels 2 to 6) were designed in modular form - each module sitting across the vessel and incorporating a guest room at either end and the passageway in the middle. The modules were intended to be outfitted prior to assembly on the vessel and this was to a large extent achieved during construction. In all there were 96 modules which were stacked to form the accommodation part of the hotel.

Form and style was achieved by covering the external surfaces with fibreglass panels and adding wings also constructed in fibreglass.

The Resort particulars are:

Lenth (overall)	89.2 m
Width (overall)	27.6 m
Superstructure length	79.2 m
Superstructure width	18.0 m (max) 14.0 m (min)
Height from water level	24.2 m (max)
Draught	3.0 m
Freeboard	3.0 m
Ballast capacity	3300 tonnes
Liquid fuel storage capacity	770 tonnes
Potable water production	150 tonnes /day
Potable water storage	1239 tonnes
Sewerage treatment capacity	210 tonnes /day
Waste water storage (total)	3500 tonnes
Incinerator capacity (solids)	3200 kg/day
Incinerator capacity (sewage)	1300 kg/day
Generating capacity	2700 kw

The Resort is fully self-contained and self-sufficient for extended periods.

A summary of the plant and systems is as follows:

- 3 heavy fuel diesel generators capable of providing power to all equipment at full capacity with any one of the generators in stand-by as a back up at all times.

- Emergency generator capable of operating all essential loads.

- Two independent reverse osmosis type fresh watermakers generating 150 tonnes of fresh water per day in total.

- Two boilers and two colorifiers with adequate capacity to supply 150% of total hotwater requirement.

- Incinerator to combust solid sewage sludge, oil sludge and other wastes. Air quality standards maintained through emission control.

- Two self-contained sewage treatment plants complying with I.M.O., Det norske Veritas, Department of Transport and Great Barrier Reef Marine Park Authority requirements having a capacity of 210 tonnes/day.

- A large capacity, high velocity heating, ventilating and air conditioning system.

- Three lifts, two 'panoramic' see-through guest lifts and one service elevator.

- Auto-ballast system.

- Fire detection and prevention system

- Comprehensive radio and communications equipment.

Shipbuilding tenders were called in December 1985, and a contract was let with a Singaporean yard in May 1986. The hull was launched in January 1987 and the hotel was delivered in Singapore in December 1987.

4.2 Mooring System

The hotel is moored at its bow by a counterweight articulated mooring system. The main components of this are shown in diagram 4, and basically the system consists of 6 off 18.4 tonne Stevshark anchors laid in a star pattern and each connected to a central riser by a 230 m long chain leg of 89 mm diameter high tensile (K3) chain. The riser consists of a counterweight mass of about 123 tonnes to which the chains are attached. Above this is a universal joint shackled to a 450 tonne SWL mechanical swivel which is in turn shackled to the top universal joint attached to the bow extension of the hotel.

The mooring was designed by IMODCO in the USA who specialise in designing mooring systems for the offshore oil industry. Both scale model testing and computer modelling were carried out as part of that design study. A unique set of circumstances

- shallow water, large environmental loads and restricted access, made this mooring design a special one.

A number of redesigns were carried out during the development due to relocation of the hotel within the lagoon, in order to increase safety, and to allow for increased redundancy in the mooring legs of the system.

Comprehensive soil testing of the anchor points was carried out by James Cook University and this was used in the design of the anchors on each of the chain legs.

The mooring components were purchased from Europe, the USA, and Australia and assembled and installed in the lagoon prior to arrival of the hotel from Singapore. Installation was carried out in difficult circumstances due to restricted water depths, restrictions on siting the chain legs due to the presence of coral bommies, and the need to maintain even spacing between the legs. Each anchor was 'set' to the maximum design load of 310 tonnes by cross tensioning each pair of chain legs in the star pattern prior to connection to the central riser (Diagram 5).

5. TRANSPORTATION AND INSTALLATION

The hotel was transported by a heavy lift carrier from Singapore to John Brewer Reef. This was a separate contract and included all the walkway and ancillary pontoons such as the tennis court and swimming pool. In all there were 15 separate floating items loaded onto the heavy lift carrier. This required quite a complex loading operation in Singapore and offloading at John Brewer Reef because the sequence of loading/ offloading each item was critical.

The voyage to Australia took 14 days and because of delays in completing some of the outfitting work in Singapore, a workforce of 50 sailed with the hotel to complete the work during the voyage.

The transport contract also included manoeuvering of the hotel through the twisting narrow channel (diagram 5) to the final location. The channel was a difficult one because of the desire to use as much as possible a natural channel having the required depth. An additional complexity was that the offloading and installation was being carried out in the tropical cyclone season for that part of the coast.

The hotel was offloaded on the 19 January 1988, and was at its final location at 11am that day. The main single point mooring hook up was completed by 9pm the same day. Much emphasis was placed on doing this as quickly as possible so as to have the hotel structure securely moored to its main mooring in the event that a cyclone should descend upon us during this period.

Final commissioning and training was carried out with the intention of opening on 29 February 1988. However the opening was delayed as a result of tropical cyclone 'Charlie' which passed directly over the Resort. The emergency procedures in the Resort Management Plan were put into effect with all staff being evacuated with the exception of engineering and technical staff. The windspeed exceeded 70 knots, but due to the protection of the fringing reefs of John Brewer Reef, the waves did not exceed 1.5 m significant wave height at any state of the tide.

No damage was sustained to the hotel or its moorings. Some damage was caused to the external pontoons used for sunbathing and swimming. The initial disappointment of a delayed opening has been easily balanced by the confidence arising from the fact that the hotel sustained no damage and our commitment to high design and safety standards has been verified. The Resort is now proven to be able to withstand cyclonic conditions.

6. CONCLUSION

Opening and operation of the hotel

The hotel subsequently opened on 18 March 1988, only 2-3 weeks after the height of the cyclone and guest numbers have been quite satisfactory since the opening.

We believe we have provided a facility which:

- enables people to experience the Great Barrier Reef Marine Park throughout the day and night while living in world class accommodation.

- has adequate safeguards to prevent undesirable impacts on the environment and this will be continually monitored under the procedures included in the Resort Management Plan.

We believe the Resort will be successful in increasing our guests awareness of the beauty of the Great Barrier Reef and confirm the desire to preserve it for others.

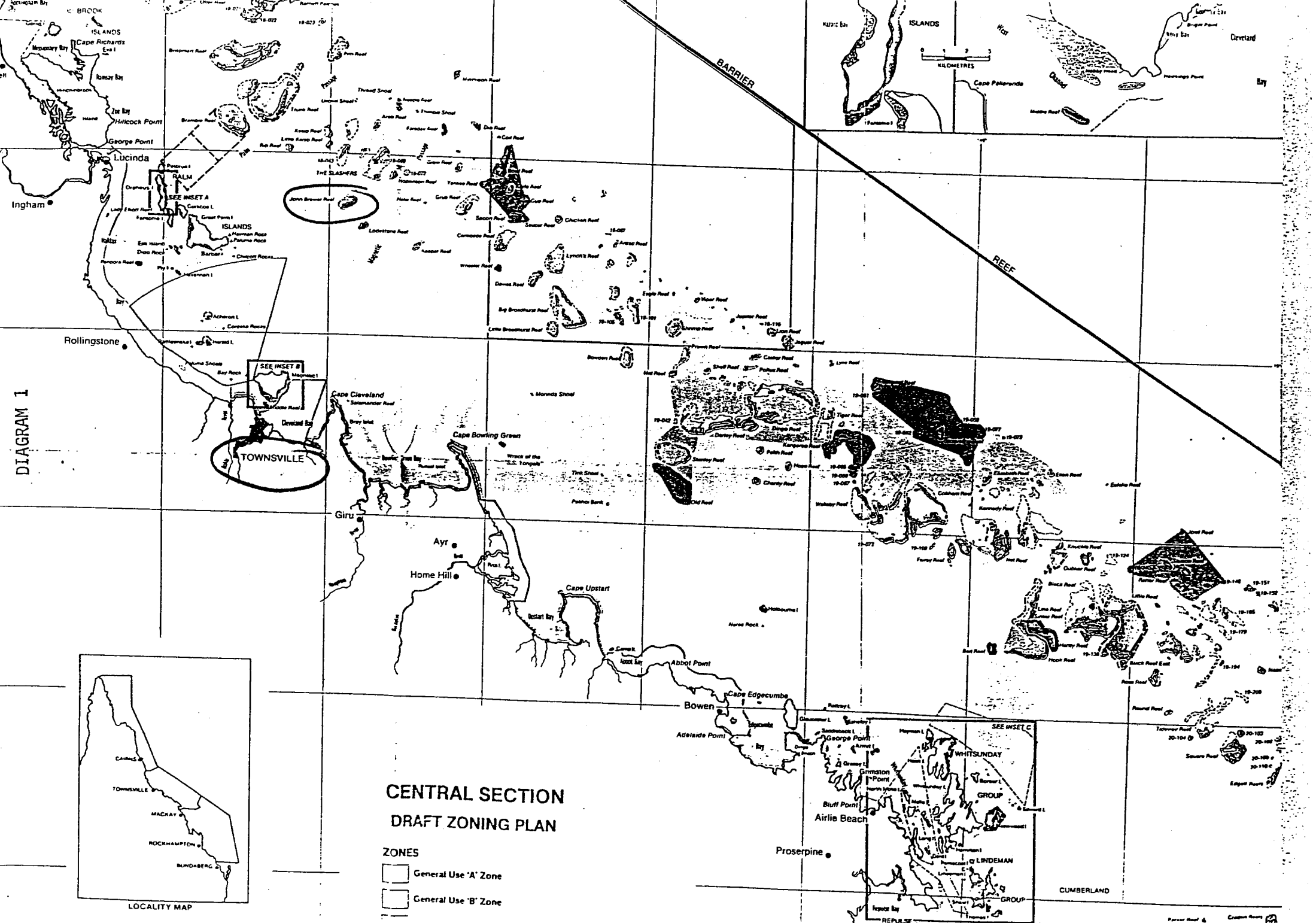


DIAGRAM 1
BARRIER REEF
ISLANDS
Cape Richards
Missionary Bay
Ramsay Bay
Zoe Bay
Hillcock Point
George Point
Lucinda
Ingham
PALM
SEE INSET A
ISLANDS
Rollingstone
SEE INSET B
Cape Cleveland
Cleveland Bay
TOWNSVILLE
Cape Bowling Green
Giru
Ayr
Home Hill
Cape Upstart
Abbot Point
Cape Edgecumbe
Bowen
Adelaide Point
Proserpine
Airlie Beach
Bluff Point
Grimston Point
George Point
SEE INSET C
WHITSUNDAY GROUP
LINDEMAN GROUP
CUMBERLAND
REPULSE
THE SLASHERS
Cleveland
Cape Palmerston
KILOMETRES
CAIRNS
TOWNSVILLE
MACKAY
ROCKHAMPTON
BUNDABERG
LOCALITY MAP
CENTRAL SECTION
DRAFT ZONING PLAN
ZONES
General Use 'A' Zone
General Use 'B' Zone

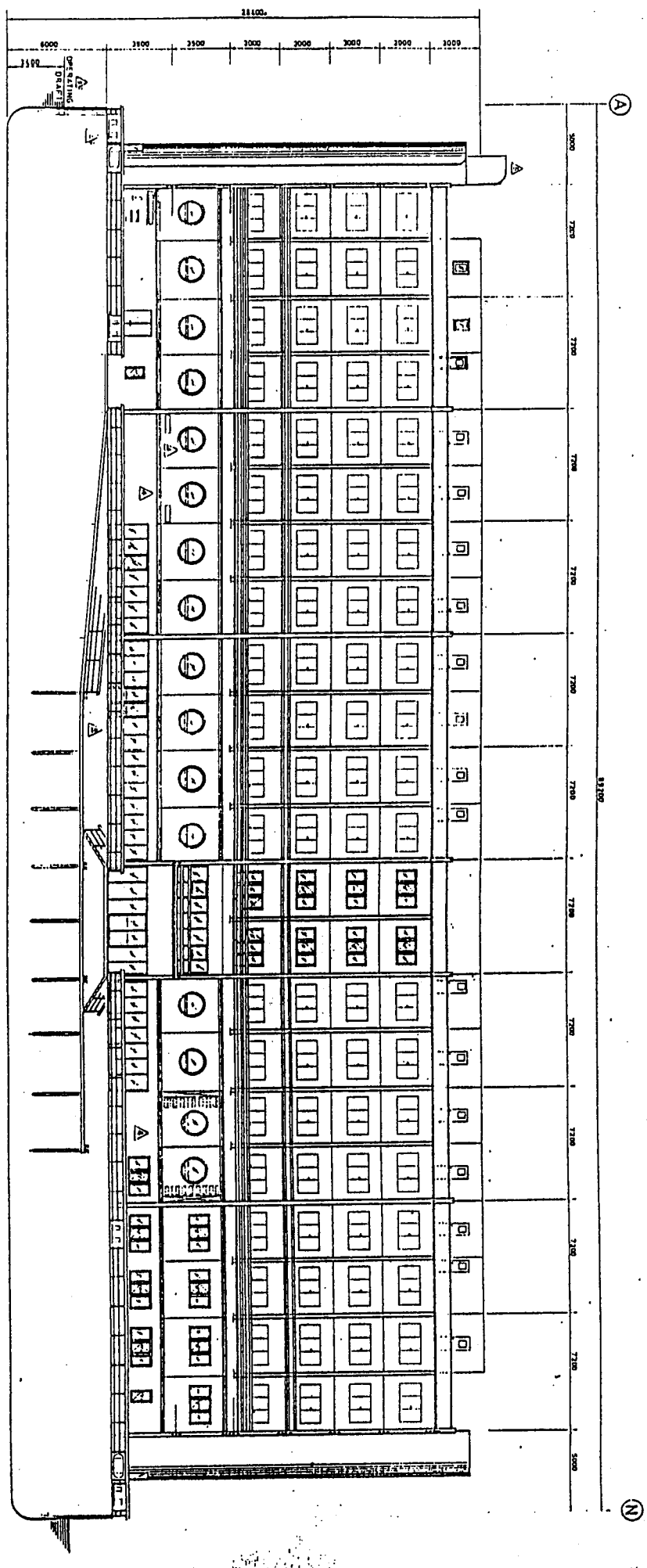
DIAGRAM 2

Environmental Impact Statement

CONTENTS

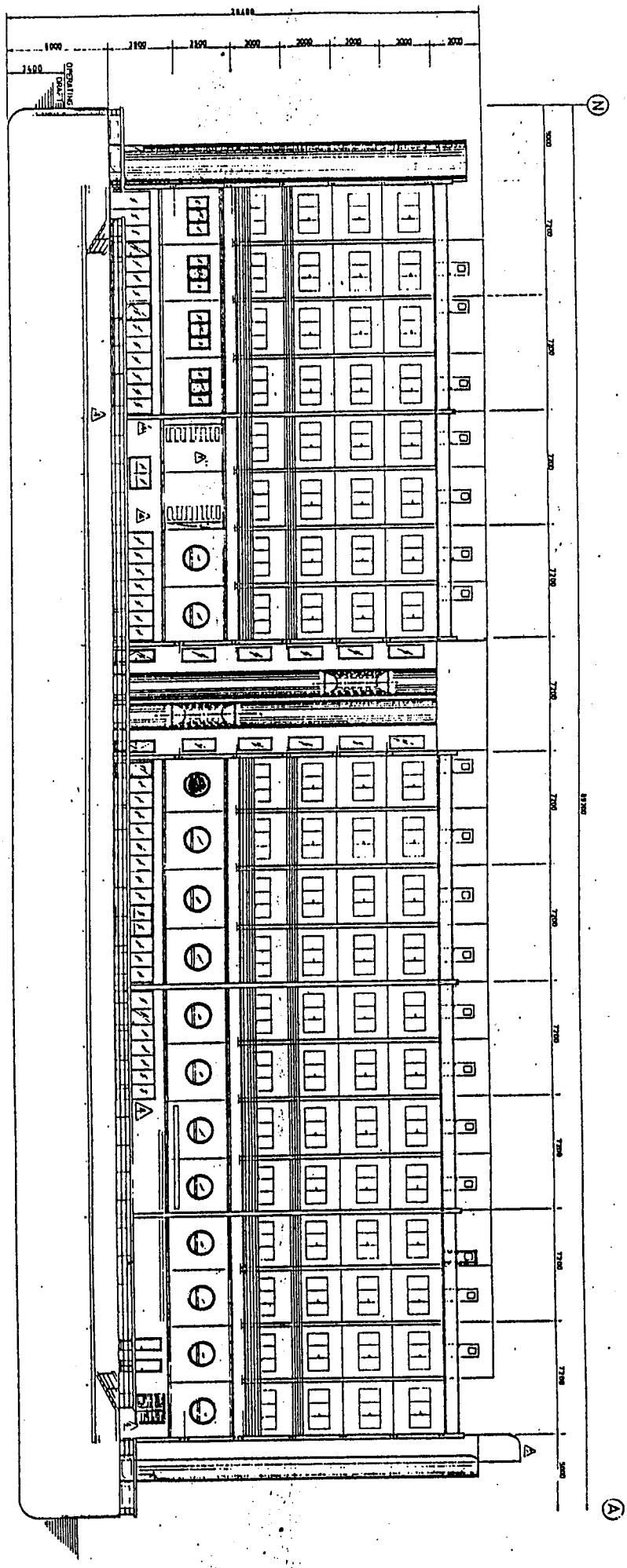
DIAGRAM 2

DIAGRAM 3 a)



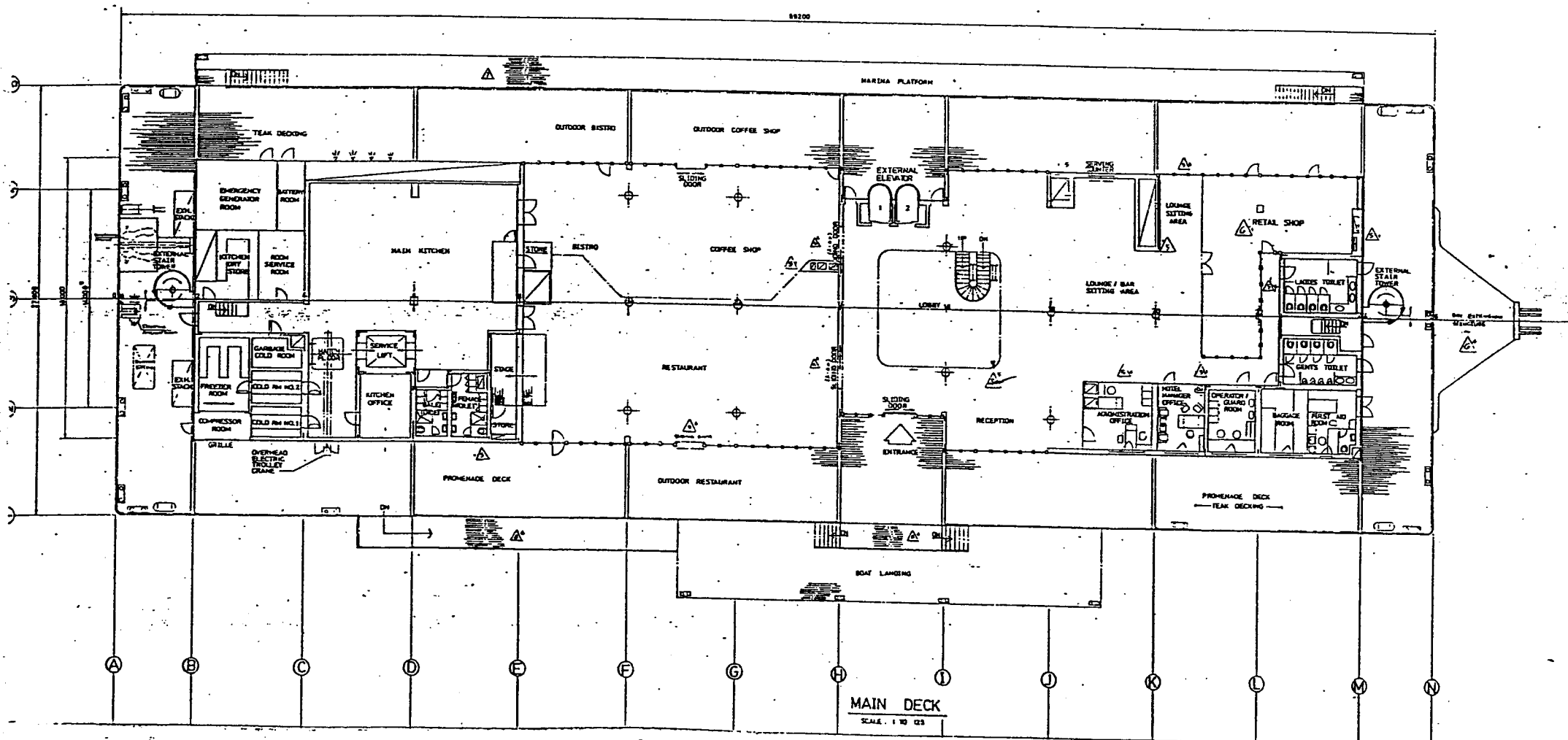
BOAT LANDING ELEVATION

DIAGRAM 3 b)



MARINA ELEVATION

e)



MAIN DECK

SCALE : 1 TO 125

DIAGRAM 3 d)

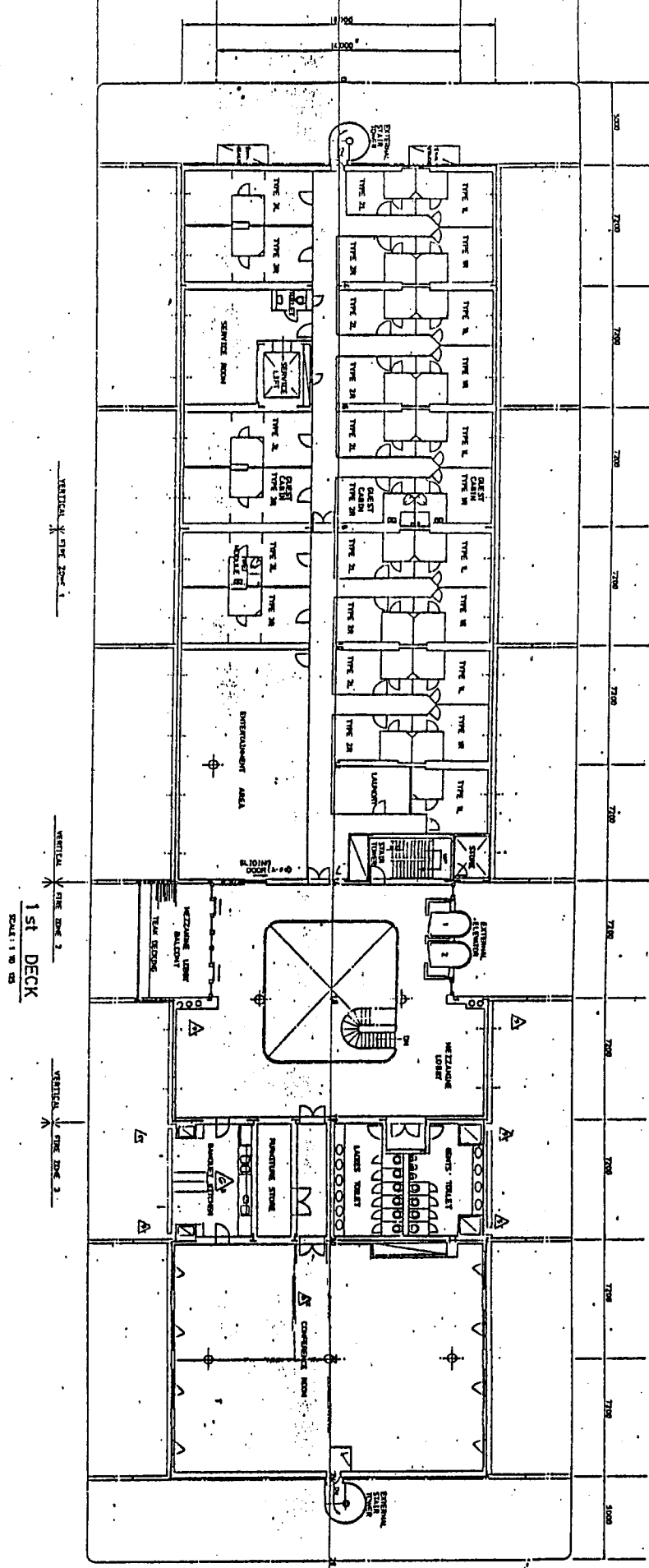
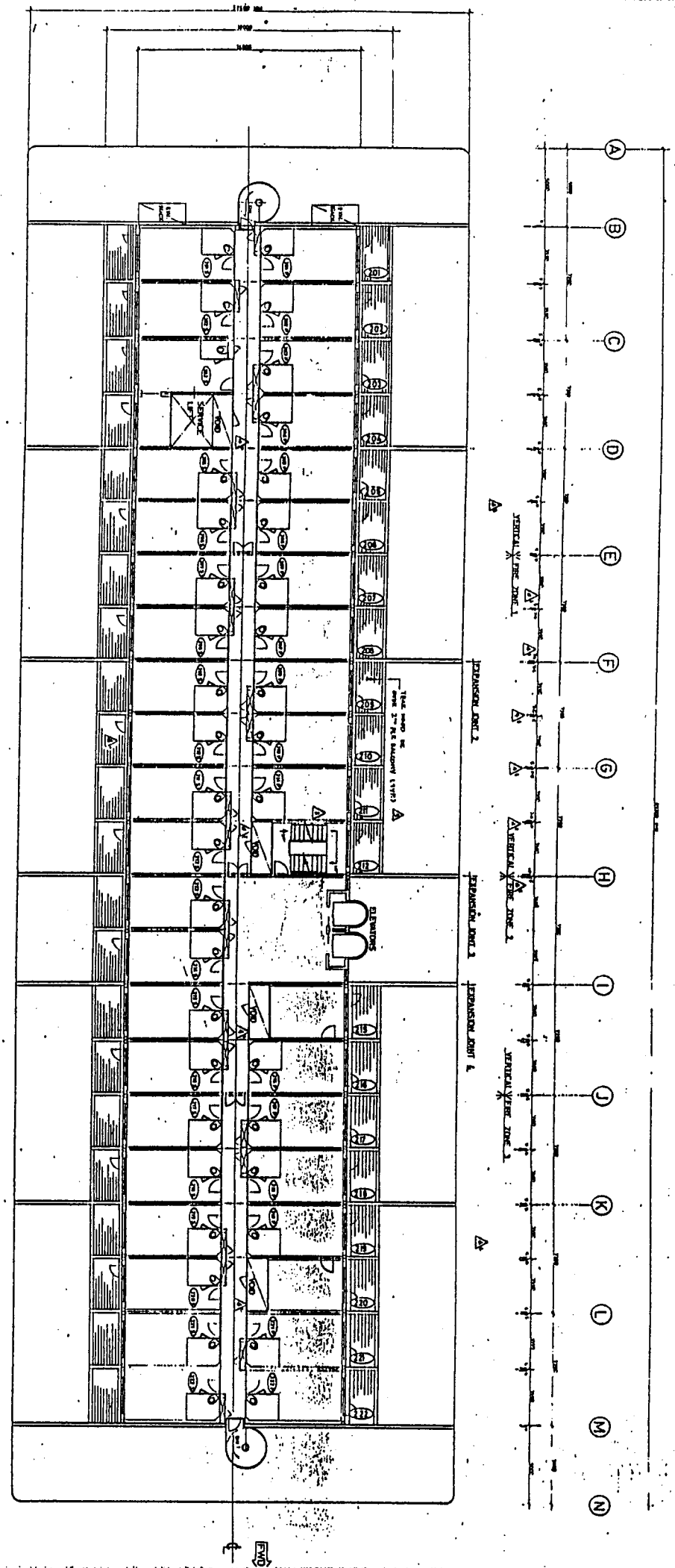

1st DECK
SCALE: 1 TO 100
VERTICAL FIRE ZONE 1
VERTICAL FIRE ZONE 2
VERTICAL FIRE ZONE 3
EXTERNAL STAIR
SERVICE ROOM
SERVICE LIFT
GUEST CABIN TYPE 2A
GUEST CABIN TYPE 2B
GUEST CABIN TYPE 2C
GUEST CABIN TYPE 2D
GUEST CABIN TYPE 2E
ENTERTAINMENT AREA
LAUNDRY
STORE
STAIR
MEZZANINE LOBBY
MEZZANINE LOBBY BALCONY
TEAK DECKING
EXTERNAL STAIR
FURNITURE STORE
BANQUET KITCHEN
LADIES' TOILET
GENTS' TOILET
CONFERENCE ROOM
EXTERNAL STAIR UNDER

DIAGRAM 3 e)



2 nd FLOOR

DIAGRAM 4

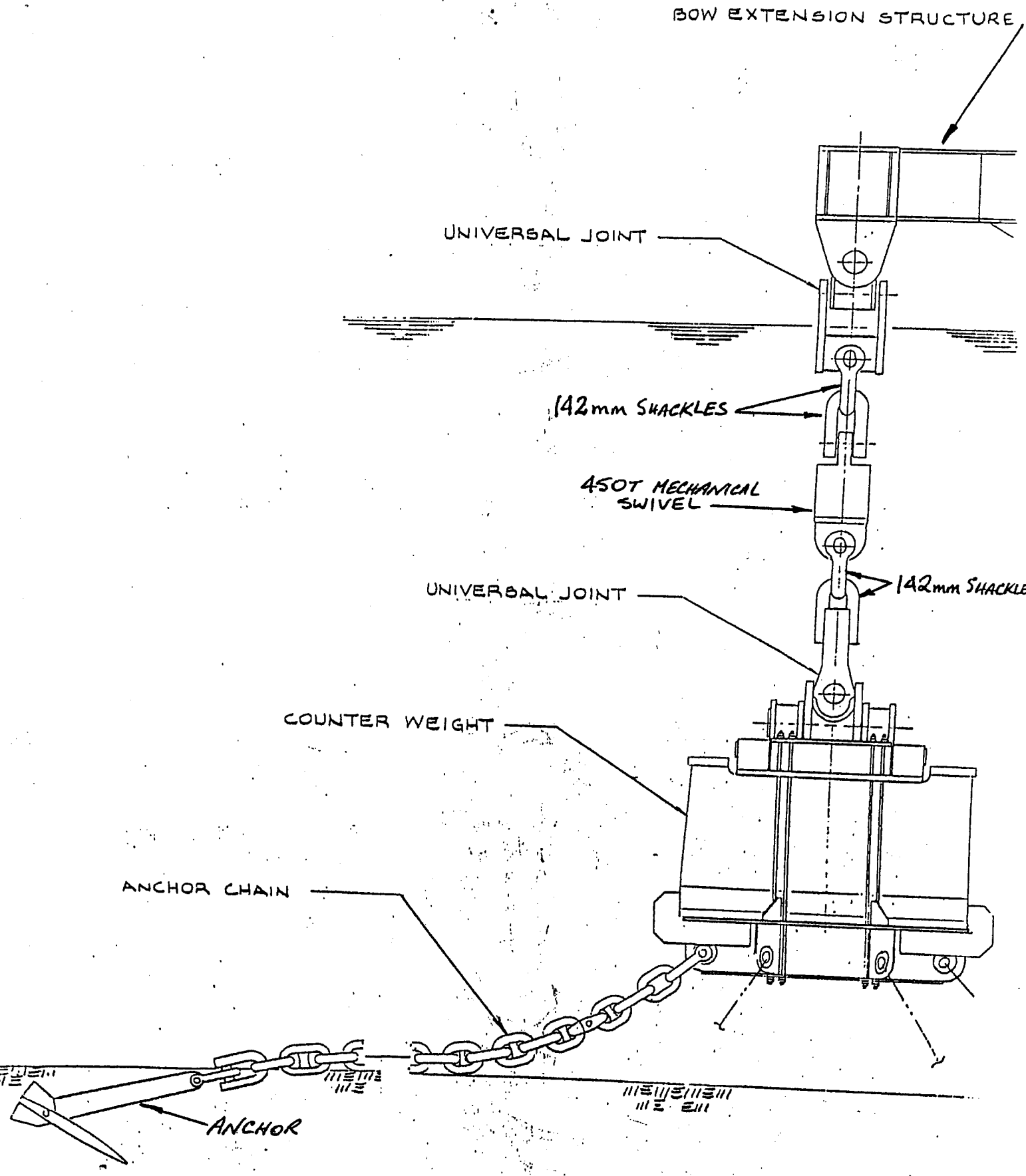
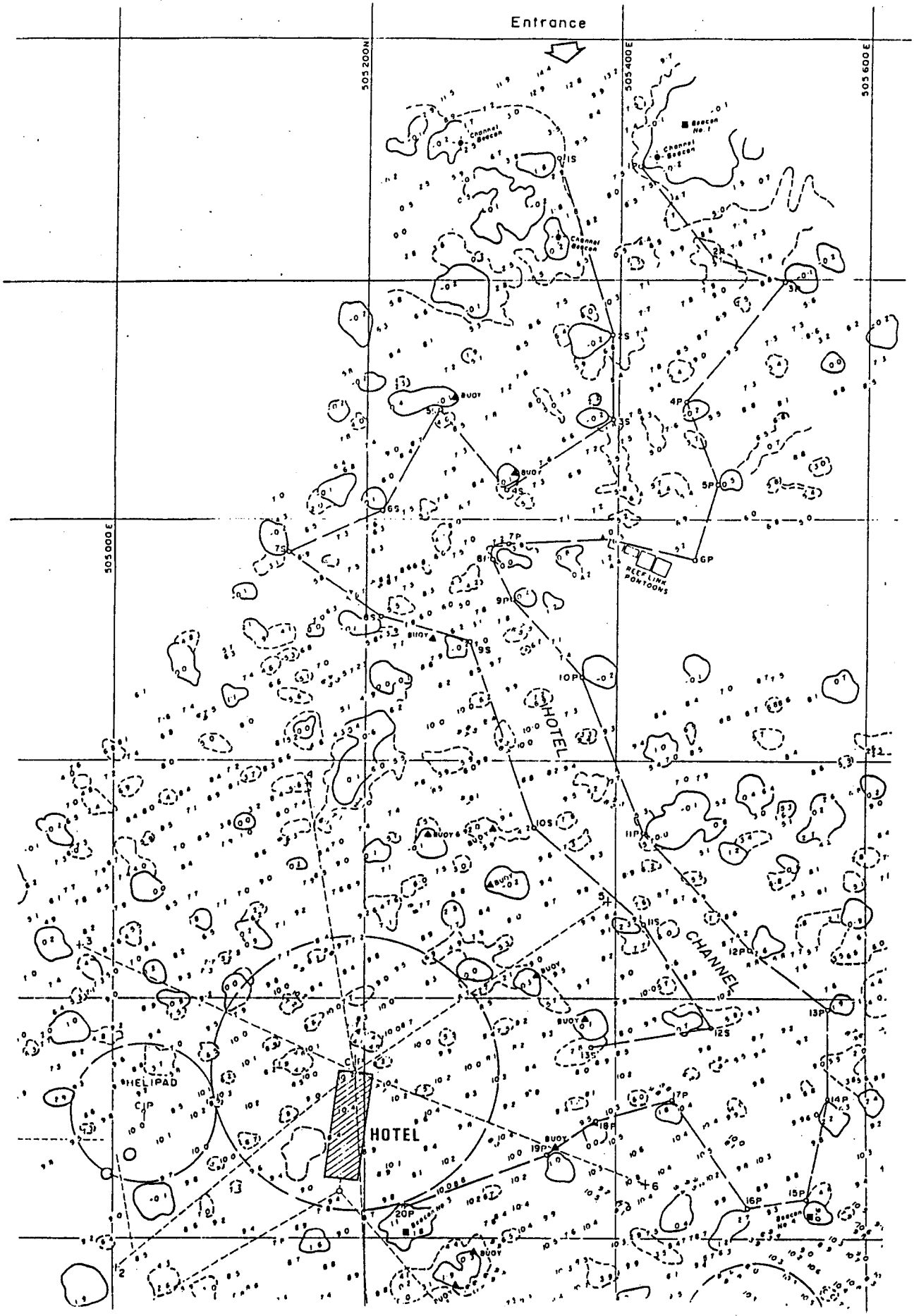

BOW EXTENSION STRUCTURE
UNIVERSAL JOINT
142mm SHACKLES
450T MECHANICAL SWIVEL
UNIVERSAL JOINT
142mm SHACKLE
COUNTER WEIGHT
ANCHOR CHAIN
ANCHOR

DIAGRAM 5


Entrance
305200N
305400E
305600E
305000E
HOTEL
CHANNEL
HELIPAD
CAP
HOTEL
BUOY
REEF LINK PONTOONS