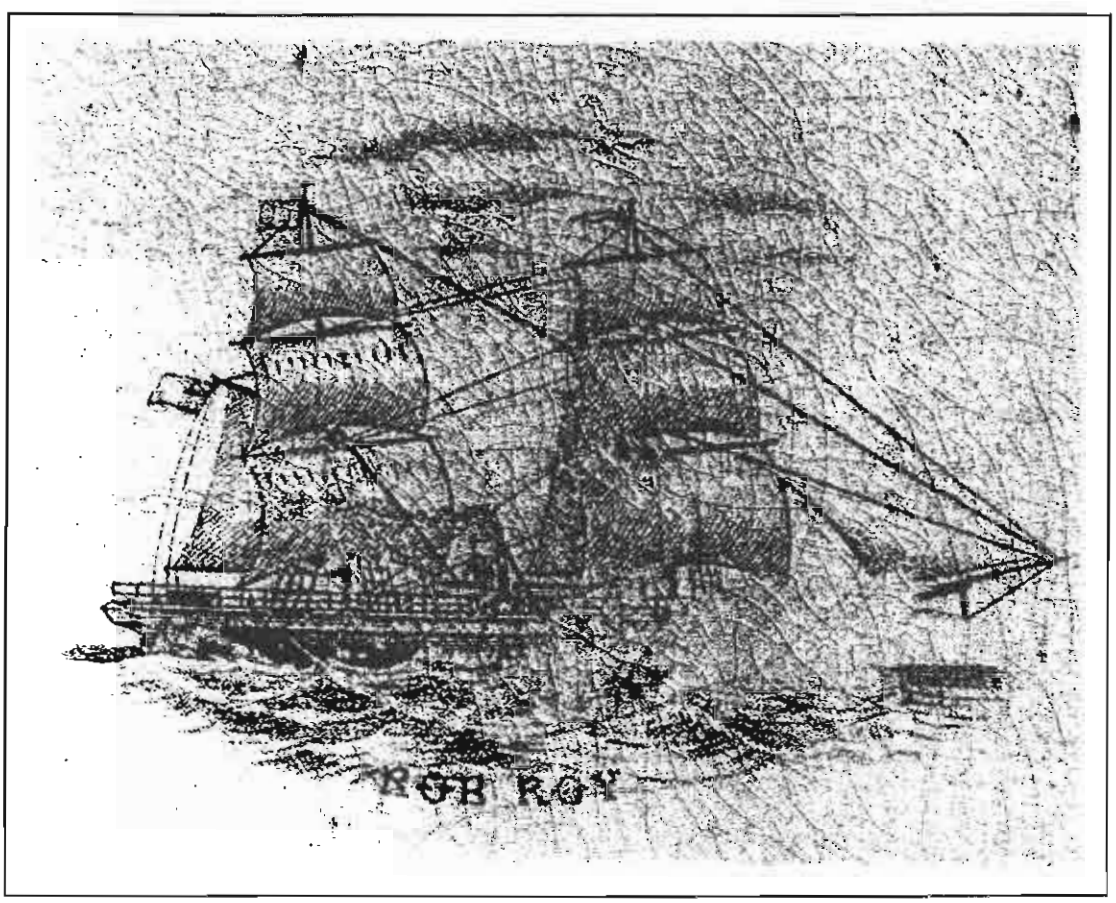
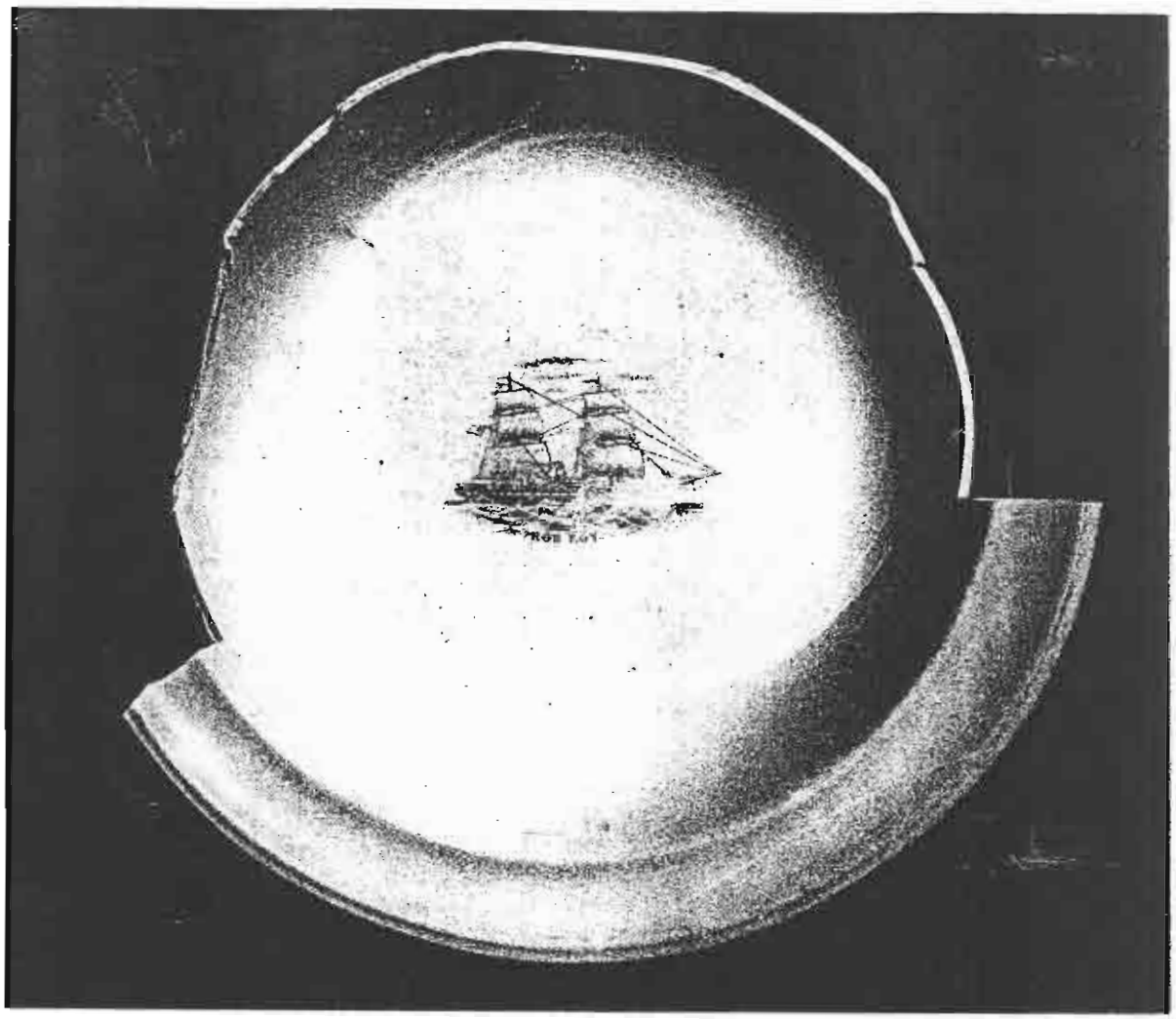
AN ASSESSMENT OF THE SUBMERGED ARCHAEOLOGICAL REMAINS AT THE ALBANY TOWN JETTY



Report - Department of Maritime Archaeology
Western Australian Maritime Museum, No. 96.

AN ASSESSMENT OF THE SUBMERGED ARCHAEOLOGICAL REMAINS AT THE ALBANY TOWN JETTY



Prepared for LandCorp
by

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With contributions from
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August 1995

Front cover: Detail from *Rob Roy* plate (ATJ 21)
This page: *Rob Roy* plate (ATJ21)

ABSTRACT

A conceptual plan mooted for the redevelopment of the Albany Foreshore in 1988 involved the dredging of an area adjacent to the *Town Jetty*. This proved a potential threat to historic material known to lie on and under the seabed in the region of the Jetty. In advising that material deposited before 1900 was protected under the terms of the *Maritime Archaeology Act* of 1973 but that its extent had not been properly assessed, the Western Australian Maritime Museum sought the provision of funds to enable it to examine the seabed and to assess the extent of the cultural resource.

In 1994 plans for the development matured and the Museum received funds from the developing agency LandCorp, in order to conduct the proposed maritime archaeological assessment of the areas identified for dredging and future land reclamation. Funds were also supplied for the monitoring of any spoil produced by the proposed dredging process, for the conservation of any historic artefacts raised and for the production of a final report.

This report deals with excavations conducted earlier, the legislative situation, and the 1994 excavation itself, including methodology. An artefact catalogue, details of a pre-disturbance survey, conclusions and recommendations appear. The history and significance of the Jetty itself is also discussed as are a number of post-excavation strategies. Technical and other appendices then follow.

A jetty

A jetty is a maritime colonnade - the humble equivalent of Bernini's great St Peter's colonnades.
The construction is self-evident, employing a trestle arrangement similar to that used in light railway bridges.
The engineering is so direct and explicit that we fail to see that it has a lot more to tell us.
The jetty is an illustration of economic externalism - one among many such markers in the Australian economic record
...it is a physical reminder of the paramount role of trade in the economy.
Their scale and simplicity was a response to limited means.
They are a more reliable guide to working Australian than the high-style architecture of the day decked out in its borrowed period finery.
Few structrures speak so poignantly or with such forceful directness about the outwardness of Australian life.
Whilst the jetty is a manifestly utilitarian structure, it clearly signals the main orientation of Australia: the extent of Australia's dependence on outside contacts in the economic sphere; our role in supplying raw materials and a history of involvement in other people's wars.
The jetty, railway, and the roads radiating north and south and inland were a diagram of intermeshing extractive activities, a convergence of economic forces and trade directed away from Australia.[1]

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[1]Extracts from; Philip Drew, 1994. *The coast dwellers: Australians living on the edge*. Penguin Books, Ringwood, Victoria.

CONTENTS

PART E. THE EXCAVATION PROCESS

PART F. CULTURAL SIGNIFICANCE

PART G. POST-EXCAVATION MANAGEMENT

ACKNOWLEDGMENTS

The authors and contributors acknowledge the assistance of WA Maritime Museum and Residency Museum staff, especially Museum diving/conservator Nikki King Smith, photographer Pat Baker, Head of conservation, Dr Ian MacLeod, diving consultant and professional diver John Clarke (Smallcraft Pty Ltd), volunteer divers John Buchanan, Rod Dickson, Ray Shaw, Bob Sheppard and Ross McGuffie. Fairlie Sawday assisted with artefact management advice and in the movement of artefacts through conservation. Thanks also to the members of the South Coast Diver's Club who were involved in the previous excavations in 1988 and 1989, particularly Mr Ron Moore and Mr Gary Wellstead. Mr Les Bail of Albany and his crew assisted, as did the owners and operators of the tug *Avon* when staff were called away to salvage Stan Austen's historic yacht *Kestrel*.

Ray Shaw, of Shaw International, produced the site plans and schematic representations of the test pits and test trenches reproduced in what follows. Artefact drawings are by Rod Dickson and Nikki King Smith.

External support was provided by marine biologists Ms Jenny Carey and Dr Ray Masini who assisted with information on seagrass beds. Gillian Taylor of the NWG Macintosh Centre for Quartenary Dating, University of Sydney, advised on Radiocarbon Dating and facilitated the analyses. R.S. Schulz, Principal Chemist of the Environmental chemsitry Laboratory, J.K.W. Ellis, J. Avraamides and staff of the Chemistry Center (WA) provided analytical expertise as did R.J. Hart, Senior Chemist and Research Officer of the Environmental Chemistry Laboratory. Comment was also received from Dr Richard Lugg, Medical consultant, Environmental Health, Health Department of WA and Dr Kevin Buckett, Toxicologist.

Mr Ric Mahoney of Coastal Information and Engineering Services, Department of Transport, provided oceanographic information.

Mr Phil Slater, Urban Design Manager for Regional Centres, LandCorp provided information and advice and liaison between LandCorp and the Maritime Museum.

The excavation of the Albany Town Jetty was funded by LandCorp

FIGURES

LIST OF ABBREVIATIONS

ATJ	Albany Town Jetty
CSR	Colonial Secretary's Office
IRS	Internal Revenue Service
MSJ	Mail Steamer Jetty
PAHs	Polycyclic Aromatic Hydrocarbons
ppm	Parts Per Million
PEG	PolyEthylene Glycol
PWDWA	Public Works Department, Western Australia
RN	Royal Navy

LIST OF APPENDICES

Executive Summary

The impact of the proposed dredging and development of the area around the Albany Town Jetty has been assessed by the Department of Maritime Archaeology at the Western Australian Maritime Museum utilising a grant from the Western Australian Government agency, LandCorp.

A pre-disturbance survey funded by the Western Australian Museum was conducted by the Museum's Department of Materials Conservation in order to ascertain the conditions at the site and their implications for the future preservation and conservation of the remains on the sea-bed. Standard surface survey and test excavation techniques were then utilised in order to test the remains.

It has been ascertained that much of the earlier (pre 1870s) part of the Albany Town Jetty and its associated artefact layers lie under existing land-fill. Unless excavation of the land adjacent the present jetty is envisaged, these will remain well-preserved beneath the soil. Some heavy concentrations of artefacts remain under the sea-bed around the Jetty.

With the exception of scour pitting caused by large propeller-driven vessels, the area is physically stable. Should the proposed sea-bed dredging be limited to the already heavily disturbed area to the east of the existing jetty, then the layers of 19th century artefactual material remaining will be relatively undisturbed.

The sediments at the Jetty, though physically stable are chemically dynamic. The existence of pollutant material in some of these sediments needs be taken into account in the management of the site and any material raised, including artefacts.

Michael McCarthy
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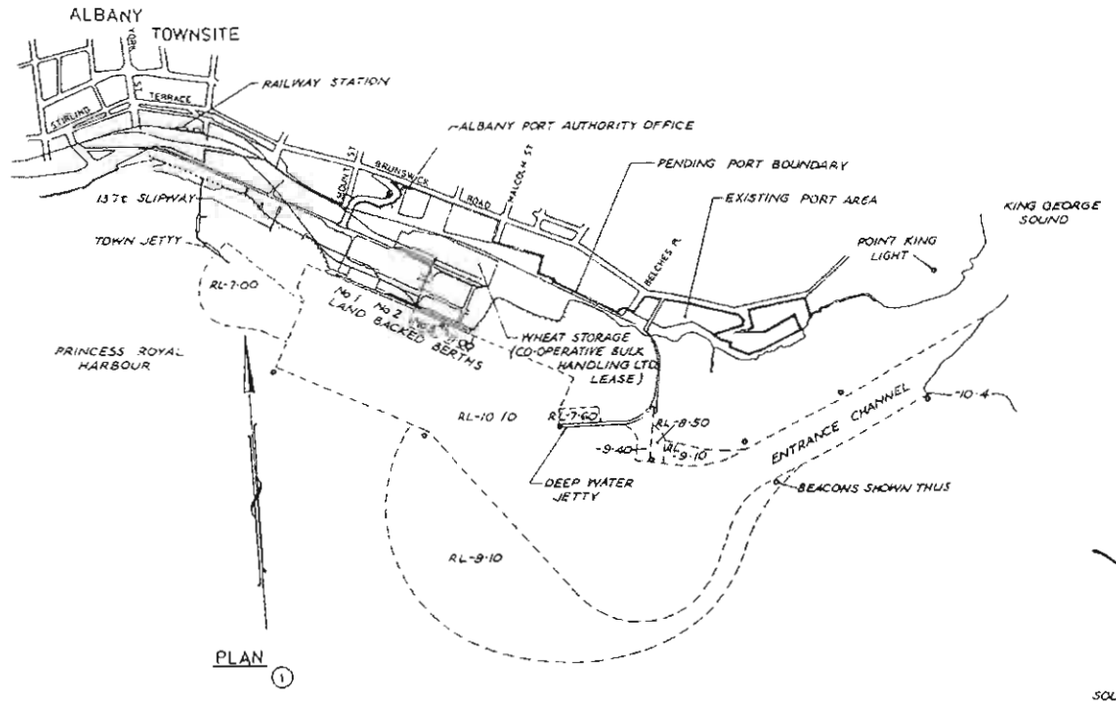
Western Australian Maritime Museum.

Figure 1: The port of Albany: showing the location of the Albany Town Jetty



PORT INFORMATION

POSITION: LAT 35°02'S LONG 117°53'E
DATUM: L.W.M. ALBANY (CHART DATUM), WHICH IS ZERO ON THE TIDE GAUGE AND 0·771m BELOW A.H.D.
ACCOMMODATION: WELL DEFINED APPROACHES THROUGH NARROW ENTRANCE CHANNEL LEAD INTO PRINCESS ROYAL HARBOUR, A LAND LOCKED HARBOUR AT THE HEAD OF KING GEORGE SOUND. HARBOUR WATERS EMBRACE 233.0ha WHICH ARE SAFE IN ALL WEATHER CONDITIONS. LAND BACKED BERTHS PROVIDE 3 BERTHS WITH AN OVERALL LENGTH OF 608m WITH 104m AT No 1 & No 2 BERTH & 110m AT No 3 BERTH. GOODS SHEDS, BONDED STORE & CUSTOMS OFFICERS ARE AVAILABLE.
IMPORTS: GENERAL CARGO, ROCK PHOSPHATE SULPHUR AND PETROLEUM PRODUCTS.
EXPORTS: WOOL, SHEEP, MEAT, WHEAT, OATS BARLEY AND WHALE OIL.

CARGO HANDLING: ON LAND BACKED BERTHS BY SHIPS GEAR ON AND OFF RAILWAY WAGONS AND ROAD TRANSPORT. A 5 TONNE MOBILE CRANE AND A 3 TONNE MOBILE CRANE ARE ALSO AVAILABLE. BULK WHEAT IS LOADED FROM A MODERN CONVEYOR SYSTEM OPERATING FROM No 2 BERTH.
SERVICES: RAILWAY FACILITIES: FULL FACILITIES ARE AVAILABLE ON ALL BERTHS. THE RAIL TRACKS ARE CONNECTED WITH THE RAILWAY SYSTEM OF THE SOUTH-WEST OF WESTERN AUSTRALIA.
FRESH WATER: AVAILABLE FROM ALL BERTHS.
OIL SERVICE POINTS: PROVIDED ON ALL BERTHS. THE BUNKERING OF SHIPS AND THE DISCHARGE OF REFINED PETROLEUM PRODUCTS IS FROM DEEP WATER JETTY.
ELECTRICAL SERVICES: FLOODLIGHTING IS PROVIDED FOR THE 3 LAND BACKED BERTHS AND TOWN JETTY. THE DEEP WATER JETTY HAS GENERAL LIGHTING ONLY. 100 A & 30 A 3 PHASE 440V 50Hz OUTLETS ARE PROVIDED ON THE LAND BACKED BERTHS. 10 A SINGLE PHASE 250V 50Hz OUTLETS ARE PROVIDED ON THE 3 LAND BACKED BERTHS
ROAD SERVICES: CONNECT THE LAND BACKED BERTHS WITH THE STATE ROAD NETWORK.
REPAIR FACILITIES: FAIRLY EXTENSIVE REPAIRS ARE POSSIBLE
PORT OPERATING AUTHORITY: ALBANY PORT AUTHORITY.
TIDE DATA: AN AUTOMATIC TIDE RECORDER IS INSTALLED AND THE MAXIMUM AND MINIMUM TIDE RECORDED SINCE 1951 ARE +1·8m AND -0·1m RESPECTIVELY. PREDICTIONS ARE AVAILABLE. PILOTAGE COMPULSORY.-RESIDENT HARBOUR MASTER.
ANY METEOROLOGICAL DATA RELATING TO THIS AREA MAY BE OBTAINED FROM THE AUSTRALIAN BUREAU OF METEOROLOGY PUBLICATION- "CLIMATIC SURVEY" - ALBANY - REGION 12 - WESTERN AUSTRALIA.

REFERENCE PLANS

	P.W.D.
No 1 AND 2 BERTHS	36784, 47089
No 3 BERTH	44489, 46426
SLIPWAY 137 t	44433
HYDROGRAPHIC SURVEY 1965	41075
HYDROGRAPHIC & SUB BOTTOM SURVEY 1971	46823 Bk 3
TOWN JETTY	47836
DREDGING & RECLAMATION CONTRACT 1967	46348
PORT BOUNDARY	45591
NAVIGATION AIDS	30294
ADMIRALTY CHARTS	BA 1034
	BA 1418
	BA 2619

(1) 100 50 0 100 200 300 400 500 600 700 SCALE OF METRES (1:20 000)

(2) 1000 0 1000 2000 3000 4000 5000 6000 7000 SCALE OF METRES (1:200 000)

GENERAL NOTES
UNLESS OTHERWISE SHOWN ALL DIMENSIONS ARE IN METRES
REVISED TO JUNE 30, 1975
SEE DRG 11-2 FOR CROSS SECTIONS AND DESIGN LOADINGS

REV	DATE	REVISION	DES	APPD
		SURVEY BOOKS	FILE No	
			PW 1248/65	

SCALES AS SHOWN
PHOTONEGATIVE PHOTOPROJECTION 12-12-75
DATUM AS SHOWN

DESIGN CALC BOOK
CHECKED BOOK
DRAWN CHECKED
TRACED J.M. CHECKED C.S.

DATE 1-12-75 ENGINEER FOR DESIGN
DATE 4.12.75 ENGINEER FOR HARBOURS & RIVERS

PUBLIC WORKS DEPARTMENT - WESTERN AUSTRALIA
REGIONAL PORTS OF WESTERN AUSTRALIA
PORT OF ALBANY
LOCALITY PLAN AND SERVICES DATA
P.W.D.W.A. 48583 — 11 — 1
REVN

PART A. SITE DESCRIPTION AND BACKGROUND

1.0 The Site

The Albany Town Jetty Site is one part of a complex of port related structures serving the town of Albany and its environs. Its place within that context is conceptualised in the illustrations above and in the following chart excerpt.

1.1 Site Name(s)

The site incorporates the remains of the *Albany Town Jetty,* the former *Mail Steamer Jetty,* (also known as the Quarantine Jetty), a more modern section colloquially known as the *Whaler's Jetty* and the adjacent sea-bed for a distance of approximately 20 metres either side of each structure. Included within that area are a number of modern berths dating from the 1960s; the most prominent being those of the Pilot Boat, a charter vessel and the harbour tugboat, the MV *Warren.*

File Name: Albany Town Jetty **File No**: MA 80.94
File Name: Jetties and Port-related Structures Project **File No**: MA 2.93

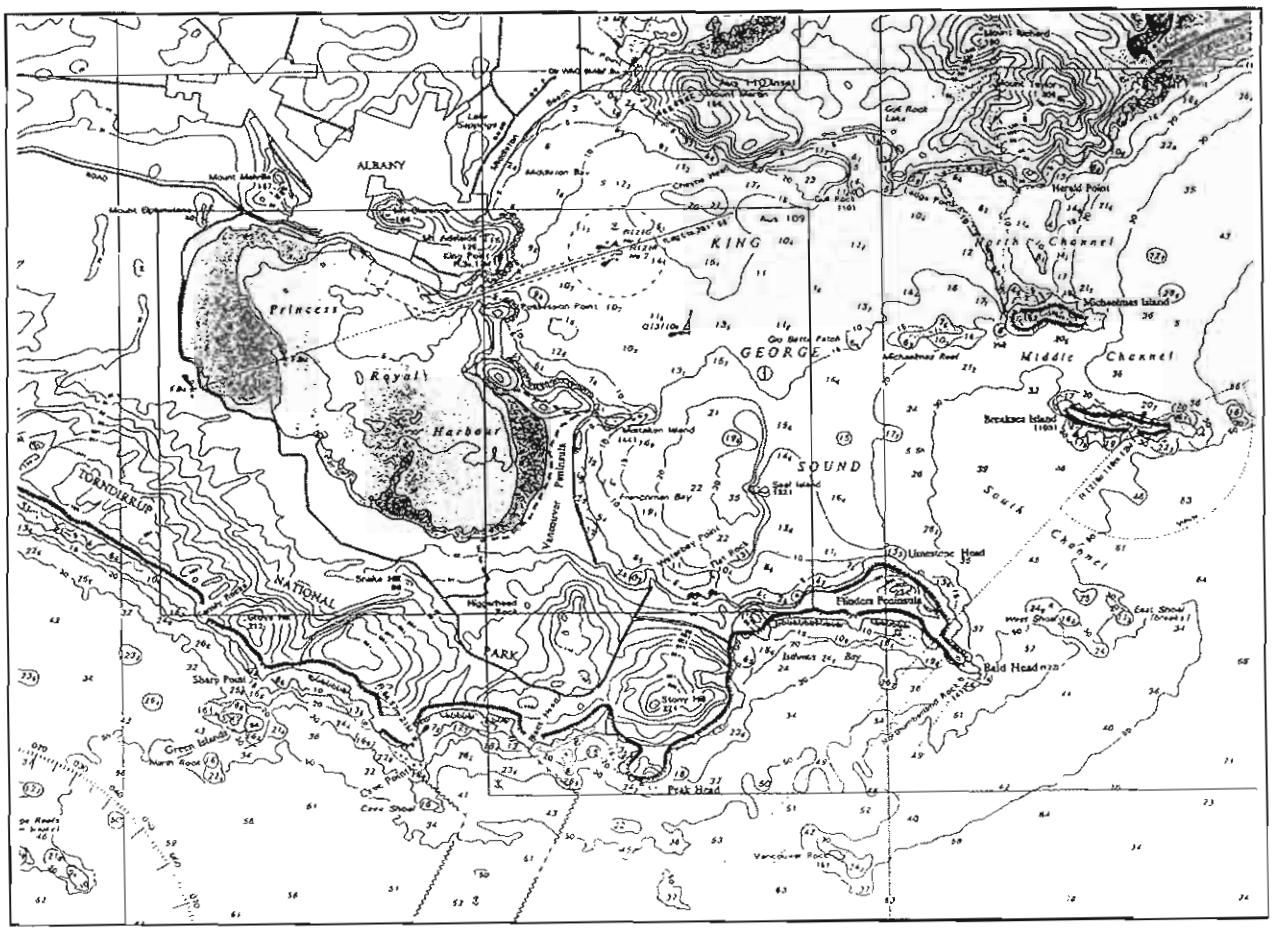


Figure 3. **Chart Excerpt:** AUS 118, *Approaches to King George Sound.* 1983, 1; 75 000.

1.2 Descriptive Data

Date of Assessment: 21/11/94 to 9/12/1994

Personnel: See section 6.0, Participants and Their Roles, page 25.

Location: Albany Town foreshore.

Charts: BA 1034, *Cape Naturaliste to King George Sound.* 1914, 1: 603 000.
AUS 109, *Port of Albany.* 1982, 1: 12 500.
AUS 110, *King George Sound.* 1983, 1: 12 500.
AUS 118, *Approaches to King George Sound.* 1983, 1: 75 000.
AUS 336, *Cape Leeuwin to King George Sound.* 1984, 1: 300 000.
AUS 759, *Hiller Point to Bald Island.* 1984, 1: 150 000.

Maps: Dept. of Lands and Surveys, WA. *Plantagenet,* 4 57 B40, 2" to 1 mile, (Undated).

Plans: *Albany Harbour Works; Jetty extension contract.* Sheet No. 1. Harbours and Rivers Department, plan 568A. June 1899. 50 ft to 1 inch.
PWDWA, 48583-11-1 *Port of Albany.* 1975.
Western Australian Railway Department, *Albany Town Jetty, Proposed Alterations*, October, 1944. CCE plan 35262, 22/1/45. 50 ft to 1 inch.

1.3 General Site Description

Progressing south from the existing shoreline along the rock-lined jetty approaches, visible ahead are the remains of the 1893 jetty. Progressing from the tarmac onto the wooden jetty, on the left hand, (eastern side) is the mail and passenger landing (Mail Steamer Jetty). The original jetty construction of 1862 and the 1873 extension are not visible and are now covered by land-fill. There is also no visible evidence of the swimming baths. Vessels moor either side of the remaining Town Jetty, which appears strong and well maintained. The decking of the Mail Steamer Jetty is in poor condition.

A modern finger jetty to the east of the walkway between the Town Jetty and what is colloquially called the Whaler Jetty caters for the tug MV *Warren,* the largest and most powerful vessel utilising the facility. The *Warren* jetty is modern and in good condition. Ahead lies the Whaler Jetty connected by a narrow neck which is also in good condition and often frequented by anglers. The Whaler Jetty, on the other hand, is in a state of disrepair and is closed to all traffic.

The surface of the sea-bed is littered with modern material, primarily jetsam from fishing boats and discarded material from people using the jetty itself. The sea-bed directly underneath the berth for the Albany Harbour Authority tug, *Warren* has been cleared of all silt, due to the action of the tug's propeller wash. This gully, or 'scour pit', extends the full length of the vessel, penetrating approximately 2 metres below the surface sediment to expose a layer of ancient shell bed. The *Warren* scour pit (Figure 9), also extends under the jetty to the southern end of the *MV Princess Royal* berth which lies on the western side of the Town Jetty, (Figure 19). There, a c. 5 metre diameter scour pit is evident. Further to the north is another smaller scour pit. In the immediate vicinity around these scour pits modern material and once buried artefacts lie scattered over the sea-bed. An area on the east side of the jetty, abaft the port quarter of the Tug *Warren* is covered in a layer of recently dredged scallop shell to a depth of approximately one metre. A fisherman advised that this was the vicinity where an entire catch was processed and the shell abandoned some years ago.

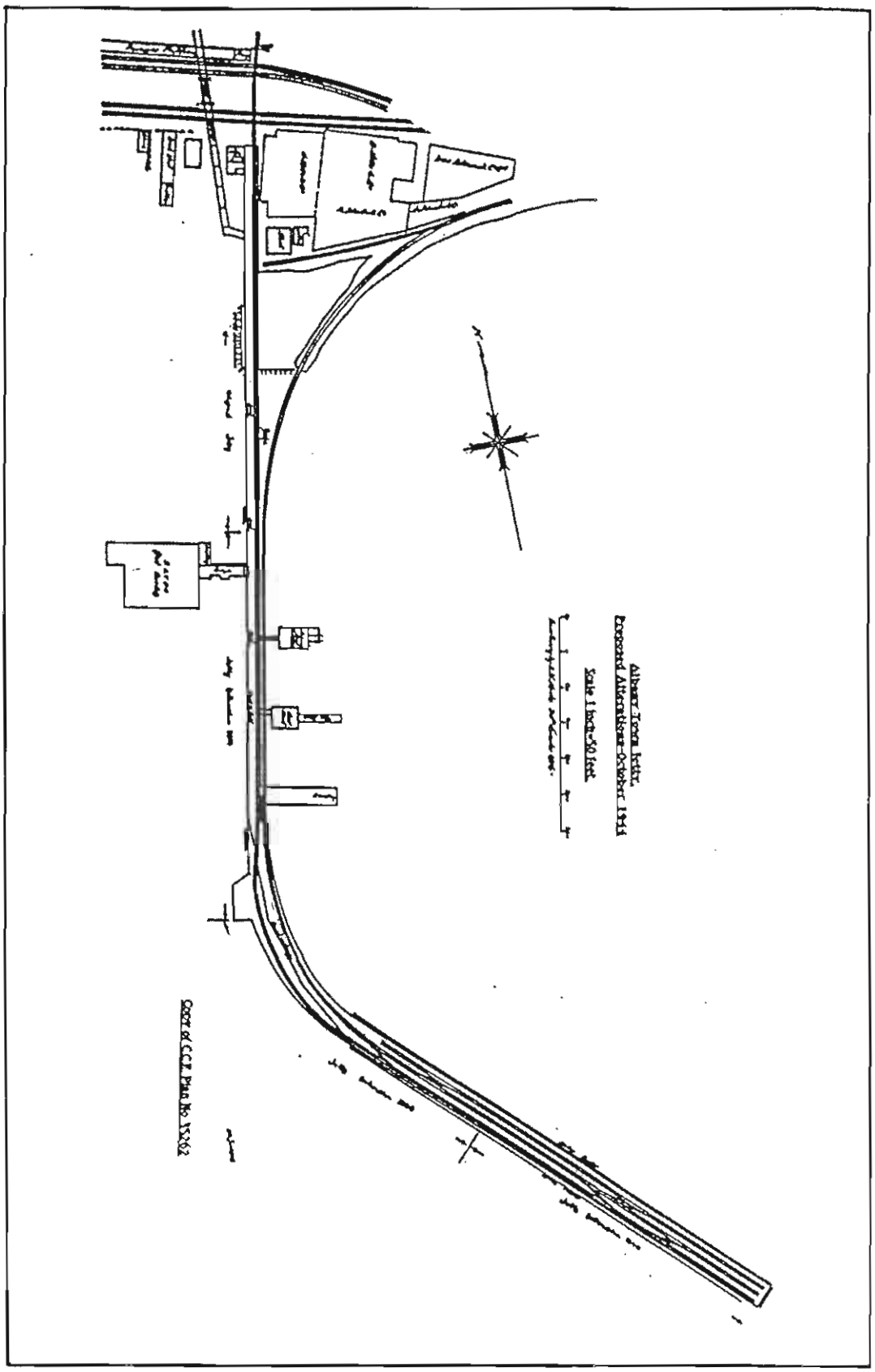


Figure 4. **Plan:** CCE Plan No. 35262. *Albany Town Jetty; proposed alterations. October 1944.* [1]

[1] Supplied by Wolfe and Associates.

2.0 Background to this Study

In the latter half of the 19th century, the Port of Albany was the international maritime gateway to Western Australia. Often dotted with ships *en route* to and from Australia, the adjoining, sheltered waters of King George's Sound and Princess Royal Harbour, were closely tied to the economic well being of the Town of Albany. The port generally is an integral part of the Town's cultural history. The town centre, located on Stirling Terrace, was once connected by lower Stirling Terrace to the Jetty for example, causing the community to view both the jetty and the town as one entity.

By the 1970s, there was a growing awareness that the Town had become physically and emotionally cut off from the waters of the Harbour. The community realised that economic opportunities had been lost as a result and that a re-development of the foreshore could revitalise the Town and allow it to link again with its roots on the foreshore.

The separation of the Town from the Harbour commenced in the 1880s when the Western Australian Land Company purchased a strip of land along the foreshore in order to build a railway. The strip started at the Deepwater Jetty, near the entrance to Princess Royal Harbour and ran west along the foreshore past the Town and Mt Melville before turning north, towards Beverley and Perth. The Company viewed the foreshore as their private domain and attempted to deny all public access by erecting gates across all roads leading from the Town to the Harbour. Only when the Town Council threatened legal action was the matter resolved in favour of the public. Despite this the railway remained as a permanent and visible physical barrier cutting the Town off from the Harbour.

The process continued with the growth of the Port area around the Town Jetty and the development of new railway facilities after the Western Australian Colonial Government acquired the Great Southern Railway in 1896. A feature of this development was the appearance of large stock piles of bagged wheat and mallet bark which were piled near the base of the jetty for export.

Land reclamation in the 1950s lead to the widening of the foreshore and the construction of warehouses and railway facilities. In addition a new port, with land-backed wharves and bulk handling facilities, was built on reclaimed land, east of the Town Jetty. One of the effects of this change was to cut the traditional commercial and geographical link through Lower Stirling and Lower Spencer Streets between the Town, the jetty and the old Port. By the end of the decade the two had been separated and isolated by an inhospitable expanse of railway yards, roads, industrial buildings and waste ground.

In hindsight it is evident that the new Port, the Town and the essential ingredient of transport, namely railways and roads, occupied mutually exclusive areas; yet ignored the fact that for all three to thrive, they required good access to the Harbour. To this extent the Town was dealt the worst hand.

In 1983 the Frederickstown Committee was formed, consisting of private people interested in promoting the idea of removing the barrier, re-establishing the link between the Town and the Harbour and redeveloping the foreshore as an area of economic opportunity. In the following year the committee was incorporated into the Albany Tomorrow Strategy Group.

The formation of the strategy group was announced by the then Western Australian Premier, Mr Brian Burke, who stated that the group's objectives were to implement initiatives which would help secure Albany's economic future. These initiatives were to redevelop the foreshore, re-establish links between the Harbour and Town centre; and promote appropriate urban and landscape design in the foreshore area. This would reflect the Town's maritime traditions.

In 1988 the State Government approved $5.8 million to begin the first stage of the development. In November of that year, the Department of Maritime Archaeology at the Western Australian Maritime Museum advised that the jetty and the sea-bed in the area were of historic significance and that these factors needed consideration before development that

included disturbance of the sea-bed was to commence. In general the Museum advised that its interests under the Western Australian Maritime Archaeology Act (1973) which would be best served if the artefactual material was not disturbed by the proposed dredging (McCarthy to Hocking, Patman, Antill, 7/11/1988). This was noted and incorporated into the developer's planning strategy.

The Maritime Museum then conducted a number of brief test excavations of the sea-bed in the region of the Albany Town Jetty in association with Albany divers. These excavations, while revealing that some areas contained modern material, re-affirmed the belief that around the older parts of the jetty the archaeological deposits were extensive.

In the meantime the Great Southern Development Authority, later Commission, was tasked with the job of preparing an overall plan for the project. This was completed in 1989 and outlined the construction of a 150-boat marina, a fishing boat harbour, boat ramps, and residential and hotel developments.

Further refinement resulted in a basic planning concept being adopted in 1990.

A feature of this plan was the retention and restoration of the Town Jetty for commercial and tourism purposes. To achieve this, a financial partnership was proposed between the proposed developer, LandCorp and the Albany Port Authority in order to upgrade the existing jetty structure, provide new tug and pilot boat berths and install support facilities. Though work had not commenced in the harbour proper, on-going discussion were held with the Museum throughout this period, culminating in a meeting with Museum staff and LandCorp.

The final foreshore concept plan was announced by the Premier of Western Australia, Richard Court in July, 1994.

Shortly after LandCorp assumed responsibility for the implementation of the first stage of the development. This included the upgrading of the Town Jetty, the construction of a pedestrian footbridge linking the Jetty to the Town over the railway and Princess Royal Drive, the installation of public ablution facilities, a boat ramp and the construction of a Town Square at the south end of York Street.

In April 1994, LandCorp requested of the Maritime Museum, that it outline its heritage based requirements re the proposed development and dredging and that it also outline a vision for the exhibition of artefacts raised. The Museum's response was to the effect that it would require that the area for the proposed dredging be assessed and that a salvage archaeological project be funded by LandCorp in the event that material was shown to be at risk. The Museum also indicated that it would undertake the conservation of the material raised for a future exhibition in Albany based on the jetty and the Port itself (McCarthy to Slater, 9/5/1994).

A team of consultants were appointed in the meantime to inquire into issues relating to:

Town planning
Heritage management
Traffic flow and control
Civil and marine engineering
Landscaping
Architecture
Urban design
Property marketing

The Albany Foreshore Heritage Study was commissioned by LandCorp to examine the heritage management issues. The study aimed to:

1) Integrate and interpret the maritime and terrestrial heritage of the foreshore area into the re-development project;

2) Ensure the appropriate compliance with the provisious of the Western Australian Maritime Archaeology Act (1973), the Heritage Act of Western Australia (1990), and any other relevant acts and professional guidelines;

3) Provide a resource for other consultants involved in the planning and design of the project.

4) Provide a resource for the general promotion and interpretation of the project.

A draft report was completed in October 1994. This report noted that the re-development of the Albany Town Jetty site and adjoining waters would involve:

a) The rebuilding of the jetty and the removal of the original mail and passenger landing (bnilt in the 1880s or 1890s) and the ruins of the 1893 jetty extension.

b) The dredging of parts of the adjoining sea-bed on the east side of the jetty.

In cognisance of the Maritime Museum's position, the report concluded by recommending that 'known maritime archaeological artefact deposits are excavated, analysed, conserved and managed by the Western Australian Maritime Museum.' (Wolfe, 1994b).

In November 1994, LandCorp and the Western Australian Maritime Museum entered into a contract to a ceiling of $30,000 in order that it could carry out the proposed maritime archaeological excavation of the sea-bed near the Albany Town Jetty and the associated areas that were subject to the proposed developments.

The 'Scope of the Services' requested by LandCorp in providing the funds to the Museum were:

i) A Sea-bed survey of identified areas and future land reclamation.
ii) Dredge spoil monitoring.
iii) Conservation of historic artefacts.
iv) Reporting of findings - to be incorporated in the Albany Foreshore Heritage Study being prepared by Wolfe and Associates.

A contract was signed between LandCorp and the Maritime Museum on 18 November 1994 allowing work to begin. Work commenced on site on 21 November 1994, concluding on 9 December. Archival research and laboratory analyses were then conducted, culminating in the receipt of the final specialist reports in June 1995. Following are the results of the study.

PART B. HISTORICAL BACKGROUND

3.0 The History of the Albany Town Jetty[2]

On 25 December 1826, at 5.30 pm, the New South Wales Colonial Brig *Amity* arrived in Princess Royal Harbour and anchored half a mile off the north shore, abeam of the present day Residency Point, formerly known as Point Frederick. On board were the commanding officer, Lieutenant Festing (RN); Major Edmund Lockyer and his son; Captain Wakefield; a contingent from the 39th Colonial Regiment; a surgeon and 24 convicts. (Stephens, 1962:24-25).

The next day Lockyer landed and set about establishing the settlement of King George's Sound as part of the colony of New South Wales (Lockyer, 1827:7). The settlement was administered from Sydney until the 7th March 1831 when it was handed over to the control of the Swan River Colony, later Perth. (Stephens, 1962:24-25; Garden, 1978:6).

In January 1832 the Western Australian Governor, Sir James Stirling, came to King George's Sound and renamed the settlement Albany. By this time the Sound and the adjoining Harbours had a reputation as a safe shipping haven providing good careenage, drinking water, and timber for fuel. (Garden, 1977:39; CSR, 17/15).

Five months later, after the change of name, an ordinance was passed in Mauritius authorising the importation of salted provisions, duty free, from New South Wales, Van Diemen's Land and the Swan River Colony (CSR, 23/34-35). Trade increased and as a consequence more vessels called at the Sound *en route* between the Island and Eastern Australia. To avoid becoming wind-bound by easterly winds, which prevail at certain times of the year and expensive harbour dues, these vessels generally anchored off Ellen Cove at the south end of Middleton Beach and did not enter Princess Royal Harbour (CSR, 55/10). This caused a certain amount of inconvenience as goods and passengers had to be transported overland from Ellen Cove into Town and the Government was deprived of much needed revenue.

In order to improve the situation and make Princess Royal Harbour more attractive to shipping, the Albany Government Resident, Sir Richard Spencer (RN), wrote to the Colonial Government in Perth requesting that they fund the construction of a well on the foreshore to provide water for ships and a landing for the loading of passengers and cargoes. Shortly after a well was dug near the bottom of Osnaburg Street, now Bridges Street, and a small landing completed in 1834 (Garden, 1977: 79; Garden, 1978: 8).

The inadequacies of the landing soon became evident and a new round of negotiations were begun between Perth and Albany to have a more substantial structure built. These negotiations continued into 1836 when the Government called for tenders to build a jetty. Several tenders were received but no work was undertaken (CSR, 55/10).

In February 1837 the Albany Government Resident, Sir Richard Spencer (RN), reminded the Governor of the Colonial Governments commitments to the improvement of harbour facilities at Albany. The Governments response was to allocate £50 in the April public works budget for the construction of a jetty.(CSR, 51/207; 53/62; 54/87).

A new round of tenders were called in June 1837. Two were received. One from Gordon Sinclair and James Daniells and the other from James Dunn and John McKail. On inspecting these tenders Spencer found that the costs were too high and to save money he decided to shorten the length of the proposed jetty.(CSR 54/87).

Dunn and McKail's tender for £100 was eventually successful. They agreed to build a jetty, at the reduced length, opposite beach allotment No 2, below Osnaburg Street, where a stake had been driven into the sand. The work was to be finished by March 1838. Work commend but due to delays was not completed until May 1838 (CSR 54/87).

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[2]Prepared for this study by Wolfe and Associates.

The Governor, Sir James Stirling (RN) had chosen the jetty site for the convenience of watering ships, rather than for the benefit of trade. This caused some disquiet amongst the merchants of the Town. They complained that the jetty was too far from York Street; that it did not reach into deep enough water; and was next to useless for the landing or loading of cargoes. At a Town meeting held on 12 July 1842 the matter was discussed and a decision was made to send a petition to the Governor requesting that the jetty remain, but that the local community be allowed to raise funds to extend the jetty into deeper water (CSR, 112/41).

A second petition was sent by a group led by one of Albany's prominent entrepreneurs, Mr Thomas Sherratt. They requested that a new jetty be built at the bottom of York Street. After further discussion the group decided to build a jetty regardless of official sanction and in February 1850 the first piles were driven at the bottom of York Street. Unfortunately winter rains washed away part of York Street, which was unsealed at the time, and the inshore piles were buried under sediment. This and a lack of capital eventually killed the project (CSR, 112/41;112/31; 189/213;202/62; Hassell, nd).

In the meantime the Government had been keeping a mindful eye on the Osnaburg Street Jetty and the problems posed by the adjoining shallows. During the summer of 1849-50 the Governor visited Albany on his annual inspection and made arrangements to extend the jetty into deeper water. The work was undertaken by James Daniells and completed by February 1850 (CSR, 202/73).

The jetty was also used by the Peninsular and Orient Steam Navigation Company (P&O) who established a coaling station in Princess Royal Harbour in 1853 and later in 1859. They used the jetty to store; and load and unload coal. The weight of the coal on the deck damaged the deck planking and eventually caused one side of the jetty to subside. As a consequence the Albany Government Resident decided to limit the use of the jetty to small boats unloading passengers and cargo (CSR, 482/36).

The jetty remained in operation until 1864 when a new Town Jetty was officially completed and opened at the foot of Spencer Street. The old jetty was for all intent and purpose abandoned and soon after June 1877 was demolished (CSR, 875/30).

With the renewal of the steam mail contracts between Australia and Britain, following the end of the Crimean War in 1856, there was an increase in the number of ships calling at the Port. The need for new port facilities became imperative.

In 1860 a site for a new Town Jetty was selected at the bottom of Spencer Street and tenders called for its construction. Two were received. One from Mr Metcalf and the other from Mr James Covert. After delays, caused by discussion about the merits of each option, Covert's tender was accepted on the 6th of September 1861(Letter, IRS/29M/4; CSR 482/44).

Work did not start immediately. Timber had to be cut and transported into Albany, workmen employed and iron fittings procured. It was not until 1862 that the work finally commenced. Progress was slow. A year later, on 2 May 1863, the Albany Government resident, Sir Campbell-Burt, wrote '...Mr Covert has made very considerable progress and I have no doubt will continue to give the Jetty every attention...' (CSR, 526, 2/5/1863).

Some time after this date Covert had to cease work for reasons which are, at present, unknown. The jetty was subsequently abandoned and remained incomplete. The Government, possibly embarrassed by this state of affairs, took the matter in hand and in 1864, Alexander Moir, resident of Albany was appointed to finish the work (Letter, IRS/29/M/7; CSR, 20/9/1864). With the jetty complete regulations were promulgated in the Western Australian Government Gazette regarding its use. They stated that:

> 1. No vessel or boat shall be fastened to any part of the Public Jetty at Albany except to such ring bolts or fastenings as are provided for the purpose, and no vessel or boat shall be alongside of such Jetty unless so fastened. All cargo boats, vessels or flats, so fastened shall also be anchored in such a manner as to relieve the Jetty as possible from the weight of such craft.

2. No vessel or boat shall be so fastened except for the purposes of loading or unloading or for any longer period than shall be reasonably required for such purposes.
3. No Stone, Bricks, Clay, Sand, Lime, Firewood, Timber, Trypots, Cannon or Ships Anchors, to be loaded or unloaded on the Jetty.
4. Passenger boats only shall be allowed alongside the steps of such Jetty and for no longer period than may be necessary to embark or disembark passengers and their personal luggage.
5. All goods to be removed from the Jetty before Sunset.
6. No Gunpowder to be left on the Jetty without a Keeper, not without being well covered with a tarpaulin.
7. No goods shall be landed on the Jetty on Sundays except in case of extreme emergency, the permission of a Magistrate being first obtained.
8. No substance of any kind whatsoever shall be thrown into the water from the Jetty or boats lying alongside of it.
9. No fire shall be made near the Jetty.
10. No goods of any kind shall be handed over the rails of the Jetty.' [sic] (CSR, 545/117).

The Town Jetty, when finished, consisted of a straight arm with two sets of rails laid on the deck and wooden hand railings along both sides. Landings were located towards the head of the jetty and hand operated trucks ran on the rails. In addition a kerosene lamp, was hoisted on the mast on the jetty head at night to guide boats landing from the mail steamers (CSR, 741/104); Harbour Master's Letter Book, 26/4/1878). As well as being a place to load and unload cargoes the jetty was also used for official purposes such as the measurement and licensing of ferry and cargo boats used on the Harbours and Sound (Harbour Master's Letter Book, 26/4/1878).

It is not known if those responsible for planning and building the jetty took into account the future growth and needs of the shipping industry at Albany. Over the next few years changes occurred which were to highlight this possible lack of foresight and the inadequacies of Albany's improved port facilities.

In 1867 the Government agreed to build Government offices and a customs store at the bottom of Spencer Street, beneath Stirling Terrace, behind the Town Jetty. A three storey building was subsequently completed in 1870 and the jetty declared an official landing or custom purposes. The customs store was on the bottom floor and connected to the jetty by a tram line.

The decision provoked a hostile response from Albany merchants who claimed that the jetty was unsuitable as an official landing due to the shallowness of the adjoining waters. They also claimed that it was costly and inefficient to use because of the extra costs involved in landing goods on the jetty, loading them into trucks, pushing the loaded trucks along the jetty to the shore and then unloading the goods into carts for distribution in the Town. It was far cheaper in their opinion to unload goods direct from boats into carts, driven into the sea by horse and then carted into town for distribution (CSR, 2/3/1867). Despite this opposition the Government went ahead and confirmed the jetty as an official landing.

The merchant's concerns reflected the fundamental problem faced by the Town Jetty and all future commercial jetties built in Princess Royal Harbour. The geography of the Harbour meant that a jetty had to traverse a long stretch of shallows before reaching water deep enough for decent sized ships. At the same time the limitations of the cargo handling technology of the period meant that all cargoes had to be handled several times before they arrived on dry land. As a consequence the costs of operating and maintaining these jetties to both Government and merchants were high.

Eventually, plans were made public to extend the jetty into deeper water. Captain Henry Toll, one of the managers from the P&O coal depot, saw the plans and wrote to the Government suggesting that they be modified to show a 'diamond' shaped jetty head instead of a conventional 'T' head. He claimed that a 'diamond' head would enable vessels to lie alongside the jetty head at all times, bow on, or stern to, the prevailing south easterly or south westerly seas and winds. This would ensure a more comfortable berth and place less strain on the jetty structure (CSR, 719/211).

Toll's suggestion was based on his experience of operating the P&O Coal Jetty which had a 'diamond' head with berths aligned with the direction of the prevailing south east and south west seas and winds. Unfortunately no heed was given to Toll's suggestion.

By the beginning of 1873 a contract had been awarded to Mr Josiah Harwood to extend the jetty and work was soon under way. The planned 'T' shaped head was retained and an iron crane was fitted on the south west corner of the new jetty head (CSR, 742/113; 741/116; Albany Harbour Master's Letterbook, 9/10/1873; 13/10/1873).

The continued use of deck rails for trucks were considered an important issue. The Town Council learned from an unknown source that plans had been made for only one line. They protested and a letter was sent to the Government requesting that two lines of rails be laid. After a considerable delay sufficient rails and fastenings arrived by the SS *Georgette* to finish the work. Two lines of rails were layed and the jetty extension was finally completed in mid 1874 (CSR, 741/104; 750/42; 741/90).

Despite the work and the considerable expense which had been incurred there were serious doubts about the suitability of the jetty head as a berth for larger ships. The Albany Harbour Master, Captain George Butcher, advised the Government that without improvements the ring bolts in the jetty would be inadequate to hold ships such as the SS *Georgette* in heavy weather.(Albany Harbour Master's Letterbook, 7/12/1874).

There were also concerns about the lack of berthing room. Only one vessel could berth alongside the jetty at any one time. If more than one ship wanted to come alongside the vessels would have to raft up. One vessel would lie alongside the south end of the jetty head while the others would moor outboard. On more than one occasion up to three vessels were berthed in this fashion making landing and loading cargo difficult and putting undue stress on the jetty structure.

On 15 May 1881 HMS *Bacchante* came into Princess Royal Harbour with a damaged rudder. On board were Prince Edward and Prince George of Wales. The rudder was unshipped on Saturday 21 and secured to the side of a lighter which was then towed across to the Town Jetty. The rudder was then hauled out of the water using the jetty crane and transported ashore. Unfortunately the weight of the rudder exceeded the design load weight of the crane and it was damaged. At a later date a new crane was erected on the jetty and the old crane placed near the shore.

Between 1885 and 1889 the Western Australian Land Company built a railway between the towns of Albany and Beverley to connect with the line to Perth. The line started at the Albany Deepwater Jetty, which was completed in 1888, and ran along the north shore of Princess Royal Harbour to the Albany Town foreshore. The line then made its way west, around the south side of Mt Melville, before turning inland and north to Perth.

To build the railway the Land Company resumed all of the Town foreshore, including the land at the foot of the Town Jetty. In the process the Company attempted to cut the Town off from Princess Royal Harbour by erecting gates across roads leading to the Harbour and the Town Jetty. Naturally this raised the ire of the local community but it was not until some years later, when the Town Council challenged the Land Company in the courts, that the gates were removed.

Water for ships was supplied to the jetty from tanks near the Albany Post Office. The tanks were fed by soak wells in Brunswick Road and later Frederick Street. In 1896 this supply was augmented by water from the Albany Fishponds which had belonged to the Great Southern Railway of Western Australia Ltd, formerly the Western Australian Land Company. The Fishponds and the rest of the Company's assets were bought by the Western Australian Government in September 1896 for £1,000,000 (Garden, 1977: 228). New pipes were laid and the ponds connected to a 25,000 gallon iron tank near the Albany Post Office. In turn the tank was connected to a four inch (100 mm) cast iron pipe which ran out along the Town Jetty (Carrington, 1902, PWD File, 221/97).

Sometime after 1888 a passenger and mail landing was built on the east side of the Jetty near the jetty head to help overcome the problems caused by the limited berthing. With its construction the mail steamers could lie out in the harbour, avoid delays in waiting to come alongside and use their boats to land and load passengers and the mails. This saved both time and money.

Demand within the community and the development of Albany as tourist destination, led to the building of sea baths on the west side of the jetty in 1889. The baths consisted of a fenced in enclosure where, for a fee, patrons could swim in comparative safety without fear of possible shark attack (Garden, 1978:50, 1977:219).

The advent of the Western Australian gold-rush in the 1890s caused an increase in the number of ships calling at the Port and a corresponding increase in the number of passengers passing through the Town. By 1898 500 passengers a week were coming ashore generating an annual income of £50,000 pounds for the community (Garden, 1977:246-247).

To meet this increase in traffic the jetty was further extended in 1893 with the construction of a curved arm extending from the 1874 Jetty head towards the south east. The extension was 35 feet (11 m.) wide and about 532 feet (162 m.) long. At the same time the waters around the jetty were dredged. Other improvements were also proposed at this time. These included converting the existing customs shed and tide-waiter's office, which had been built at an earlier date, on the west side of the jetty base, into a Queen's Warehouse for receiving goods left unclaimed after 48 hours on the jetty; and for goods which were to be forwarded on the Great Southern Railway line. The existing Customs Warehouse under the Post Office was to be used for stores. Other proposed improvements included erecting a receiving shed on the east side of the base of the jetty (Law, 21/2/1896, PWD File, 202/99).

At the same time as these proposals were being made concerns were raised about the adequacy of the existing jetty facilities. The Customs Department noted that the mail landing was too small and needed to be extended to cater for the increased demands of the steamer trade while the Albany Government Resident noted that the lack of available room on the landing meant that often considerable delays and confusion were experienced when the mail steamers arrived. Often there was insufficient room for landing both passengers and mail (Law, 21/2/1896, PWD File, 202/99; Troode to Sub-collector of customs, 20/3/1896; 28/3/1896).

As the result of this correspondence it was proposed to extend the landing two bays along the jetty, towards the south and one bay along the jetty, towards the north. (Sub-collector to Bell, 4/4/1896).

Shortly after tenders for the proposed work, including the erection of a receiving shed at the base of the jetty, were called. These were received by 12 May 1896 and included submissions from; Smith, Finlayson and Simms of Fremantle, W.B Sexton of Perth, Wishardt and Son of Busselton and Couston, Holman and Finlayson.

Couston, Holman and Finlayson were the eventual successful tenderer. Unfortunately the planned work ran foul of the Great Southern Railway Company who refused to allow the receiving shed to encroach onto their land at the base of the Jetty (Law to Thompson, PWD, 13/6/1896).
Perhaps anticipating the future take over of the Company the Government decided do nothing and to cancelled the project. This was confirmed on 3.December 1896 and Couston, Holman and Finlayson were paid £600 by way of compensation (PWD, Thompson, 23/6/1896).

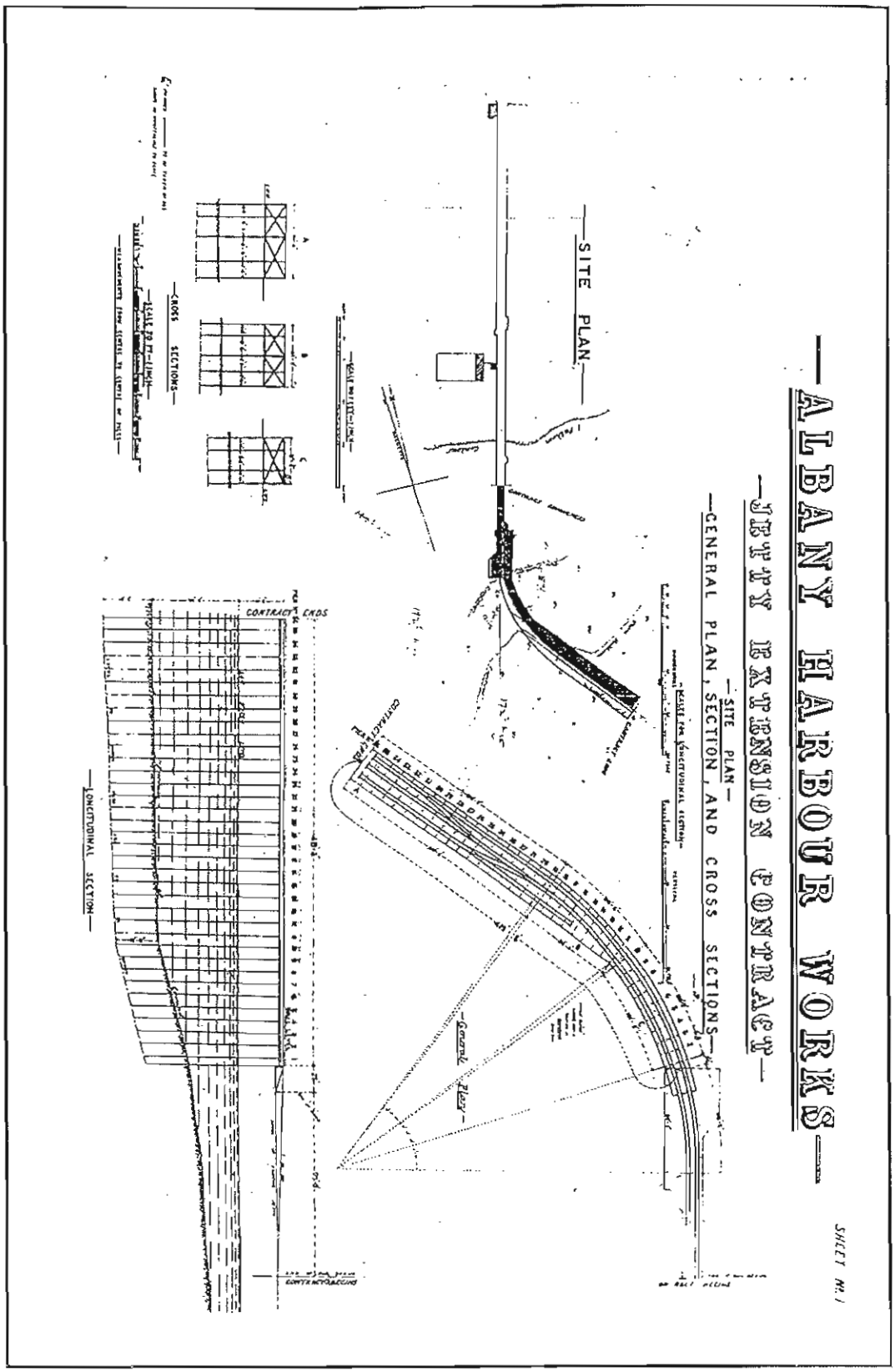


Figure 5. **Plan:** *Albany Harbour Works; Jetty extension contract.* Sheet No. 1.

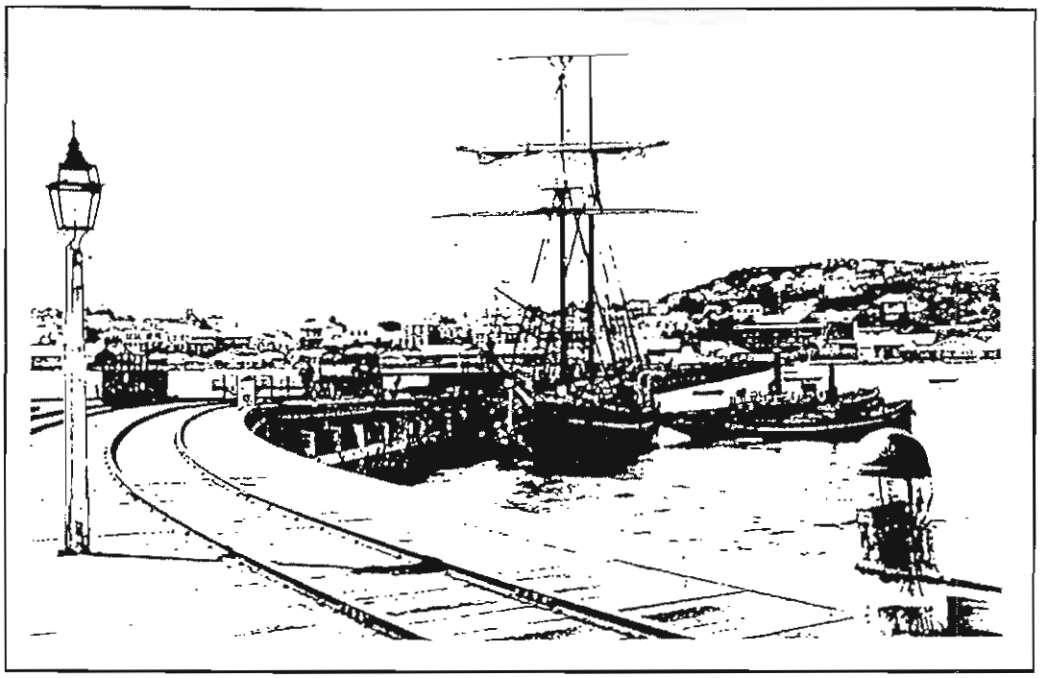


Figure 6. Albany Town Jetty circa 1890s. Tugs *Escort* and *Loch Lomond* with the coastal trader, *Grace Darling*. (Photo: Albany Residency Museum)

With the cancellation of the work there was considerable community agitation to have the jetty improved. The Government was reminded that the jetty was in poor condition and that improvements were essential to the development of the Port. (Landing surveyor's Office to Sub-collector of Customs, 22/2/1897, Law to Hodgson, PWD).

By 1898 the proposed extension to the mail and passenger landing had been approved and work was in hand. Despite this no other work was done. The Government was further reminded by the Albany community that without improvement to facilities the continued viability of the Port would be in doubt and ship owners would be likely to take their ships else where if nothing was done (Greenshields to Piesse, 5/1/1899).

Finally, in 1898 the Government acted and work to improve the Albany Town Jetty began in 1899. The curved arm was extended towards the south east and a railway viaduct was built on the east side of the jetty to carry a railway out onto the jetty head (Greenshields to Piesse, 18/1/1899).
Men and materials were dispatched from Fremantle to do the work. At the time Albany was experiencing a period of high unemployment and the arrival of workers from Fremantle nearly caused a riot amongst the local unemployed carpenters, smiths, and labourers. Fortunately after a series of negotiations the Government undertook to employ local artisans where ever possible (Keyser to Piesse, 27/1/1899); Director PWD to Keyser, 1/3/1899).

The Town Council, mindful of the poor condition of the old end of the jetty also took the opportunity to remind the Government that it was in urgent need of repair. They also inquired about seating for pedestrians. The seating was agreed to and three seats were installed (Director, PWD to Under Secretary, PWD, 27/10/1899).

As work progressed on the jetty consideration was also given to the installation of light fittings and a railed in footway. Negotiations between the Town Council and the Government led to agreement on the lights but no action on the footway .

The improvements to the jetty were finally completed in 1900 and the new extension declared open for shipping.

The Princess Royal Yacht Club was formed in 1909 at a meeting held at the White Hart (later White Star) Hotel in Stirling Terrace. Shortly after debentures were issued to raise funds for a boat shed and possible club rooms to be built on the Town Jetty. Negotiations were entered into with the Public Works Department and agreement reached to erect a timber boat shed and slip resting on 25 piles on the east side of the jetty, south of the baths. The cost was £300 and the work was completed by December 1911. The building remained in use until 1958-59 when the club relocated to Little Grove (Austen, 1986: 25, 37, 38, 49, 128, 131).

At a later date another shed and a slip were built approximately 75 feet (23 m.) south of the Yacht Club boat shed on the east side of the Jetty. The shed was made of timber and iron (Albany Town Jetty Plan, October, 1944). In 1961 the shed was demolished and at the time was described as being used by the Naval cadets (Garden, 1978:64).

In 1924-25 the sea baths on the west side of the jetty were rebuilt. In addition a dance hall, shop and an accommodation area were added to the south side of the baths with a verandah along the west side of the jetty. By this time the jetty had become a focus for the Towns social and community life including promenading, fishing, swimming and recreational boating. Even when the weather was bad and high seas and strong winds swept over the jetty deck it was still a popular with visitors who could enjoy the elements from the shelter of the verandah (S. Austen, pers com, 1994).

By 1944 after five years of world war the jetty was in a decayed state and in little use. In January that year the Town baths were inspected by the General Purposes Committee of the Albany Town Council. They recommended that the structure be repaired and that the dance hall and other buildings be demolished. It is not known if the demolition went ahead at the time however (*Albany Advertiser*, 13/1/1944; 31/3/1944).

In the following year the Railway Department noted that they had no further use for the Town Jetty (which they controlled) and commented that they were more interested in the ongoing upkeep and operation of the Deepwater Jetty at the eastern end of the Harbour (*Albany Advertiser*, 13/1/1944; 31/3/1944).

In July 1944 the Western Australian Government invited the Albany Town Council to take over the running of the jetty. The Council declined the offer and reminded the Government that the jetty was their responsibility (*Albany Advertiser*, 13/1/1944; 31/3/1944).

There had been talk in the Town about the need to reclaim the foreshore to create additional space for port facilities and by 1945 this work had begun. The first 300 feet (91m.) of sea-bed under the jetty was reclaimed and in 1948 the Town Council began reclaiming other areas of the adjoining foreshore. At the same time the Tydeman report was produced which recommended the reclamation of there foreshore east of the Town Jetty to build a land backed wharf and bulk handling cargo facilities. This work commenced in 1951 and was completed by 1953. In the process a further 150 feet (46m.) of the shore end of the Town Jetty was demolished and buried under Land-fill (Western Mail, 21/4/1949; Garden, 1978: 60 -65; Albany Harbour Jetty, PWD Plan, 47836).

The remaining part of the jetty was subsequently repaired and continued in operation. In particular the old jetty head was used as a berth for the whale chasers which arrived with the opening of the Cheynes Beach Whaling Company at Frenchman Bay in 1952. In 1961 further work resulted in the removal of the sea baths and the demolition of part of the south-east arm of the jetty (Garden, 1978:64).

In 1972 a new jetty head was built 486 feet (148 m.) along and to the east of the existing jetty alignment. The new structure culminated on the east side of the site of the 1874 jetty head. In addition the old south east jetty head built at the turn of the century was further shortened by 134 feet (40.84 meters) and the former Princess Royal Yacht Club boat shed and the Naval cadet shed demolished. Improvements were also made for berthing the Pilot boat and other craft (Albany Harbour, Town Jetty, 47836).

In the following year the curved section joining the old Jetty head to the new jetty head was removed leaving an angled walkway joining the two.

At a later date 221 metres of old Jetty neck extending from the shore was demolished and reclaimed under land fill. A concrete boat ramp was then built on the south west side of the seaward end of the reclaimed land and car park facilities installed. Finally in 1978 with the closure of the Cheynes Beach whaling station the whale chasers left the jetty. The old jetty head was then closed off and abandoned.

3.1 Modern Use of the Site

The chief commercial users are local fishermen, boat charter operators, of which there are two in Albany, and the operators of the Albany Port Tug and line boat and the Pilot Service.
Usually there are less than six commercial fishing vessels berthed at the Jetty at any one time.
The berths for the pilot and line boat are on the north side of the old mail and passenger landing and are surrounded by a security fence. The tug is located on a purpose built, finger berth, immediately south east of the old 1874 jetty head.

Recreational users include sport anglers, local and visiting yachtsmen and women and pedestrians. A boat ramp on the west side of the base of the jetty is used by recreational boat users, recreational and commercial fishermen and divers.
The 1893 south east jetty extension was used as a berth for the Cheynes Beach Whale catchers until 1978 when it was closed off to the general public. Since that time the extension has deteriorated and is now in a condemned condition.

PART C PRE-EXCAVATION MANAGEMENT

4.0 Background to the Excavation

As indicated above, LandCorp provided a sum up to a ceiling of $30,000 to the Western Australian Maritime Museum in order that it could carry out a maritime archaeological excavation of the sea-bed under and adjoining the Town Jetty.
It was agreed that the Department of Maritime Archaeology would undertake the following:

i) A sea-bed survey of areas identified for dredging and future land reclamation
ii) Dredge spoil monitoring
iii)Conservation of historic artefacts
iv) Reporting of findings to LandCorp

4.1 Research Design for Excavation

The proposed developments at the site appear in *General Arrangement Option 1, The Albany Town Jetty Upgrade* which is reproduced in *Figure 2* above. These show that two new jetties were to be constructed following the demolition of the existing *Whaler's Jetty* and the *Mail Steamer Jetty.* It is expected that demolition of these two structures, when it occurs, will involve minimal impact with the sea-bed and, though they are of heritage interest, this was not the immediate concern of the archaeological team.
Dredging for the new tug berth and berths alongside the new jetties was the archaeologists major consideration and the Albany Jetty project became, in effect, a program designed to ascertain the potential effect of the proposed development and to recommend strategies in order to minimise its impact.
Test excavation rather than surface sampling was therefore indicated and the following phases and objectives were decided upon:

4.2 Objectives of this Excavation

Phase 1
(i) The collection and recording of evidence from a surface search and a number of sample trenches throughout the area affected in order to ascertain the horizontal and vertical spread of artefactual material associated with the Albany Town Jetty.

(ii) The processing and analysis of that evidence in order to suggest strategies for the minimisation of the impact of the proposed development.

(iii) The conservation of the material raised for the purposes of collection and exhibition in a public environment, preferably in Albany.

(iv) The production of a report for analysis by LandCorp, the development agency.

Phase 2
A sea-bed survey of areas for dredging and future land reclamation.

Phase 3
i) The conservation of historic artefacts and their presentation for storage or exhibition at an appropriate location, preferably in Albany.

ii) The presentation of a report to the developers and the publication of the results in popular and academic journals.

Phase 4
The monitoring of future dredge spoil on the understanding that some materials may be raised by this process and will need collection and recording.

4.3 Constraints

A time span of one month was allowed for the assessment program. This and a budget to a ceiling of $30,000 and a target of $25,000 were the major constraints.
Reporting to LandCorp was to be by 31 March 1995. (This was extended due to unforseen delays in receiving the chemical and biological reports). A brief resume was presented as an interim report.

4.4 Research Hypothesis

Excavations conducted at other jetty sites, notably the Long Jetty at Fremantle (Garratt, McCarthy, Carpenter et. al., 1994), indicated that artefactual material would appear in considerable concentrations for a distance of around 20 metres either side of the structure. Less concentrated scatters of material further from the Jetty reflect abandonment practices by the crews of vessels moored away from it, before or after coming alongside.
In the Fremantle Long Jetty instance, the concentrations of material were known to lie both on the surface of the sea-bed and to a depth of two metres below it, and within a band 15-20 metres wide either side of the Jetty. This reflects a maximum width for a 19th century vessel, of the draught capable of being received alongside, of around 8-10 metres. Material deliberately abandoned was often thrown or heaved from the ship or Jetty structure.
It was expected that artefactual material would be deposited in a similar fashion on the sea-bed at the Albany Town Jetty throughout its entire period of use. Given the abandonment behaviour of most past societies in using the sea, rivers and water generally as useful dumping ground, some of that material would not only reflect the Jetty's construction or repair phases, but also dumping practices generally. Though attractive surface material indicative of these activities would have been recovered by divers after the advent of sports diving in the 1960s, a great deal of artefactual material has remained buried below the sea-floor, especially in areas that have seen little natural or artificial water movement. Where a jetty lies in an exposed situation, wave action may have a considerable effect in revealing or burying material. In the case of Fremantle, a port noted for its unsuitability due to its exposed position, the occasional fierce storm was known to reveal new pockets of material by wave action alone.
Albany Jetty on the other hand did not experience this phenomenon to the same extent. The harbour is renowned as a safe haven having little 'fetch', though the seas , as opposed to the swell that can reach 2 metres or more. Post-depositional 'scrambling' of material (Muckelroy, 1978) at this structure was generally by the action of ship's propellers alone in the pre-sport diving days. The Albany Jetty then, was expected to reveal more evidence of superposition of artefactual material or 'cultural layering' than the Fremantle jetty.
Finally, from a purely cultural perspective, though the material remains at the Albany Town Jetty are expected to be similar, to those at the Fremantle Long Jetty, the assemblage found in the latter instance indicated that a considerable amount of both alcoholic and non-alcoholic beverages were consumed. These were far beyond the quantities expected of normal maritime activities. This gave rise to the belief that, in effect, the structure had become a 'colonial beer-garden' (McCarthy, 1987), reflecting its use as both a promenade and recreational centre. The material also illustrated what was possibly an excessive consumption of drink at Fremantle, a port noted for its unsuitability and labour problems (Garratt, McCarthy and Carpenter, 1994). Of interest was the question whether the remains at the Albany Jetty would mirror this phenomenon, or whether society in maritime Albany was more temperate in its habits.

4.5 Legal Issues

In 1989 the South Coast Divers Club of Albany contacted the Department of Maritime Archaeology at the Western Australian Maritime Museum complaining that visiting divers were recovering artefactual material of significance to the town from the MV *Warren* and *MV Princess Royal* scour pits.
This matter and the problems associated with protecting the historic material known to lie near the Fremantle Long Jetty were taken to the Maritime Archaeology Advisory Committee, which advises the Director of the Western Australian Museum. From there the matter was passed on to Crown Law for comment. In the interim the Albany Port authority were approached and the area was gazetted as a no swimming area under the Port Authority legislation.

Upon deliberating on the extent and the provenance of the remains at the Long Jetty at Fremantle, it had earlier become apparent that artefactual material associated with jetties that were in operation before 1900 could be protected under the 1973 *Maritime Archaeology Act.* Thus the remains lying on and under the sea-bed in the vicinity of jetties in operation pre 1900 throughout the State of Western Australia became a maritime archaeological site under the terms of the 1973 *Maritime Archaeology Act*, though the jetty structures themselves could not be protected at the time.
On 24 October 1988, the sea-bed around the pre 1900 section of the Long Jetty at Fremantle was declared an historic site under the terms of the 1973 *Maritime Archaeology Act.* The artefactual remains at other jetties of a similar vintage, eg., the Albany Town Jetty, then became historic under this precedent. In short, the interpretation and relevant section of the Act reads thus.

Interpretation of the Maritime Archaeology Act No. 66 of 1973.

> 'If there are known to be (or there are likely to be) *objects* as referred to in 5.6 (3) of the Maritime Archaeology Act in the vicinity of the Long Jetty, then that vicinity is a Maritime Archaeological Site under the Act." (Senior Assistant Crown Solicitor to the Director, 28/11/1986).

Definition of 'object' from 5.6 (3) of the Act

> 'Any object which, in the opinion of the Director was abandoned in the State before the year 1900 and derives from or was associated with any ship, whether or not an historic ship..."

Thus with respect to artefactual remains emanating from jetties before the year 1900, their association with any ship is a crucial element in the their legal protection as a maritime archaeological resource. As indicated the maritime archaeological legislation did not cover the jetty structure itself.

5.0 Previous Assessments and/or Excavations

Although jetty construction phases, dredging and shipping activities may have shifted artefacts around on the sea-bed for a hundred years, they at least remained *in situ.* The jetty site had remained an untapped resource for bottle collectors and treasure hunters. It was not until SCUBA equipment became readily available in the 1970s, that artefacts could be selectively removed, sometimes in vast quantities. This site has been subject to twenty years of bottle collectors activities and two previous archaeological assessments of the sea-bed in the vicinity of the Whaler's Jetty in 1988 and 1989.

5.1 Evidence of Previous Disturbance/Salvage

Front page news in the *Albany Advertiser* in 1972 was a story of divers recovering old bottles and historical material from the area around the Albany Town Jetty. This coincided with diver activity at other underwater sites throughout Western Australia, as antique collectors generally came to recognise the value of the underwater remains in the vicinity of jetties, wharves and other submerged features. Crews from large fishing vessels were also known to recover material by scouring the sea-bed near the Albany Town Jetty in this period. It appears that they occasionally ran their propellers at full revolutions whilst moored alongside, thus creating a series of large artificial scour pits alongside the jetty. When the resulting clouds of disturbed sediment cleared, the crew dived for the exposed artefactual material and bought it back on board for cleaning. Bottle hunting is still a favourite pastime for divers today and was in full swing at the Albany Town Jetty up to 1988 when the 1973 Maritime Archaeology Act was applied and swimming and diving was banned at the Jetty site by agreement with the Albany Port Authority. Even then some divers have conducted their collecting operations under cover of darkness.

5.2 Site Inspections Conducted Previously

(see site plan on page 19 entitled *Transects and excavation points at the Albany Town Jetty,*)

In March 1988, discussions were held between Mr Ron Moore, Secretary of the South Coast Diver's Club and Mr McCarthy of the Department of Maritime Archaeology at the WA Maritime museum regarding the artefactual deposit at the Albany Town Jetty and the need for an assessment of its extent. After some discussion a decision was made to facilitate a study by the South Coast Diver's Club, encompassing archival research and a surface survey of the area occupied by the now demolished arm of the Jetty. It also appears that larger than usual quantities of material were being exposed by the action of a large, powerful, tug-boat the *Warren* and by the ferry *Princess Royal.* Anecdotal evidence was to the effect that the scour pit produced by the tug especially was much larger than any other previously produced and that there was a considerable amount of material to be found.

A surface survey was planned for June 1988 to be followed by a test excavation that would be conducted by Museum staff in the following August. These developments coincided with conceptual proposals to redevelop the Albany Town foreshore and to conduct large scale dredging operations as indicated above. (Albany Town Jetty File, WA Maritime Museum). While indicating that it had no objection to land-fill that would preserve the material covered by spoil, the Maritime Museum indicated that any dredging would need to be preceded by thorough archival research, a sea-bed search for visible historic material and the sampling of the sea-bed itself in order to indicate the extent and historic nature of the remains themselves. In the interim, with the looting and the proposed development in mind, the Albany divers were authorised to record and recover any surface material of interest, provided that it was not dispersed and that it was properly conserved and made available for eventual display in Albany. It was also agreed that all the artefacts found in this phase would be conserved by the South Coast Divers under advice from the Department of Materials Conservation at the WA Maritime Museum. It was also agreed that once conservation was complete the material would be made available for exhibition at the Albany Residency Museum, a branch of the WA Museum. This, it was believed, would help develop a sense of 'local ownership' of the materials being found and help prevent them being dispersed and lost to the town and the local museum. The proposed archival research was to help develop a similar regional appreciation of the historic nature of the jetty and the materials on and under the sea-bed.

The 1988 South Coast Divers Excavation

Between the period 25 June to 12 November 1988 the South Coast Divers established a 20 x 40 metre grid which was set up over the south-east extremity of the Jetty. This was initially designated Area A. (See Figure 19). Following this a surface survey commenced under the leadership of Mr Moore.

Considerable problems were experienced with the weather and underwater conditions but the group persevered and completed the survey. The finding of purely modern material including ceramics, bottles, and a discarded whaling harpoon head was a considerable disappointment to the group. Only a yellow china dinner plate and a Brylcreem jar were retained. These were allocated artefact numbers ATJ (Albany Town Jetty) Nos. 1 & 2. Daunted by the difficulties and the obviously modern nature of the surface deposit the divers ceased in the gridded area. The South Coast Divers then turned their attention to the propeller wash (scour pit) that had been produced by the tug-boat moored near the base of what was then the Whaler's Jetty, (see Figure 19). This proved to be a rich source of nineteenth century artefactual material having apparently been the area in which early steamships and other vessels were moored. So too did the *Princess Royal* berth which was immediately opposite the *Warren* scour pit on the western side of the jetty.

A considerable amount of material, both modern and historic, was raised and the process of conservation begun by the South Coast Divers at the Albany Residency Museum as agreed. This did not prove a success and eventually the material was taken for treatment to the Department of Conservation at the WA Maritime Museum. The material consisted of a number of late nineteenth century bottles, a turn of the century penny, pipe fragments and other assorted material notably ceramic sherds, some carrying steamship company insignia.

These were allocated artefact numbers ATJ 3-8 and 36-55. The proposed locally-based archival research also did not eventuate, leaving some doubt as to which parts of the jetty structure where in use at any particular time.
In the interim a test excavation of the South Coast Diver's grid area was planned to ascertain what lay beneath the surface layer. This was to begin with the excavation of a test pit timed to coincide with a visit by Graeme Henderson, Curator of the Department of Maritime Archaeology at the Maritime Museum.

The WA Maritime Museum Excavation, 2 February 1989

En route to Fremantle from an excavation in the Esperance area, Henderson's team were able to spend one day on the Jetty. Taking a bearing of 300° at a distance of 8 metres from the southern-most visible jetty pile, the team established a 4 x 1 metres area on an 080°-260° axis in Area A. This grid shown in the plan of the area was excavated to a maximum of 90 centimetres. In the first 0-30 cm excavated the group found oily rags, a knife, a milk bottle and a medicine bottle. In the next excavated layer 30-60 cm down , an iron bar, rope, coal, plastic, bone and beer bottles were found. In the final layer, which was only part excavated, a beer and wine bottle were found. Of the material recovered, four items were retained and allocated artefact numbers ATJ 9-12.

Result

The surface recording and recovery operation in the region of Jetty conducted by South Coast Divers and the test excavation led by Henderson revealed modern material with some artefacts possibly dating back to the turn of the century. In hindsight, this was to be expected, given that the area was dredged in the early part of the Twentieth Century. (See historical precis pp. 10-18).

The WA Maritime Museum Excavations, 10-12 February 1989

With the aim of attending to the original request of the South Coast Divers Club ie., to provide experience in excavation and recording methods, to help properly ascertain the artefactual resource at the Jetty and to help set up a display on the Jetty, Mr McCarthy travelled to Albany in the period 10-12 February 1989.

Discussions were held with Mr Ron Moore and Mr Gary Wellstead of the Dive Club about the possibility of continuing the work begun by Mr Henderson. Unfortunately conditions precluded work in the area excavated or in the region gridded by the Club and a decision was made to commence work in Area B, an area more sheltered (See figure 19).

Firstly the sea-bed was examined, showing that at a point midway along what was then locally known as the 'Whaler's Jetty,' the sea-bed lay at a depth of 6.4 metres. Progressing away from the jetty, the depth rapidly changed in the first 5 metres to 5.5 m levelling out to 5.6 m at circa 15 metres from the structure.

A 2 x 10 metre grid at right angles to the Jetty was established and excavated. In similar fashion to the earlier excavation, the top 90 cm of material was modern and greatly disturbed. Concreted sunglasses, beer and milk bottles, an engine room name-plate and a concreted harpoon were located. Great difficulty was experienced in penetrating the modern layer due to the presence of ironwork, timbers and assorted detritus. Having ascertained that the remains were relatively modern and that the artefactual deposit there was not at risk from divers due to the difficulties in penetrating the upper layers, a decision was made to relocate to the scour pit produced by the MV *Warren* (See area within the dotted line on Figure 19)

A datum line 7 metres long was stretched from the eastern side of the jetty across the scour pit. The tug had scoured a pit beginning at the mean sea-bed level at 6.4 metres down to a sand layer 1.2 metres further down. Two layers were then excavated. The upper layer 30-40 cm below the sea-bed produced modern material, followed by a weed mat and an artefact-rich layer in which appeared nineteenth century black glass, ceramics, hessian sacking, pipe fragments, a shoe and ballast stones. Also found was a plate depicting the steamship *Rob Roy* which operated into Albany in the period 1878 until it was withdrawn from the Albany run in 1893 (See frontispiece illustrations). The lower level which proceeded a further 0.6 metres below to a depth of 8.2 metres and a clay bottom consisted of a sterile sand deposit.

Divers interested in our activities discussed their earlier finds with us, one producing an 1877 penny, others attesting to an earlier abundance of intact ceramics and black glass which had been raised, leaving only sherds and other less valuable material.

Result

From the extent of the remains found up to 1988, it appears that the area at the town end or base of what is popularly known to be the 'Whaler Jetty' was once a focus for nineteenth century shipping and maritime activity.

The jumbled nature of the historic and modern material found in the *Warren* and later in the *Princess Royal* scour pits indicated that the propellers of the nineteenth century steamships and later more modern vessels, especially those with powerful propellers, had a significant 'scrambling' effect on the cultural layers on the sea-bed. This caused a mixing of both artefactual and biological material as indicated by the position of the weed bed identified by biologists, Dr Ray Massini and Ms Jenny Carey (see 9.3 below).

The assemblage at the 'Whaler Jetty' reflects the fact that the area had been dredged in the early part of the twentieth century and that it has been in regular use until 1978.

PART D. THE 1994 SITE ASSESSMENT

6.0 Participants and Their Roles

A). WA Maritime Museum personnel	Duties
M. McCarthy	Senior Archaeologist/Project leader
P. Baker	Photographer/Diver
B). Department of Materials Conservation	
J. Carpenter	Conservator/Diver
N. King Smith	Conservator/Diver
V. Richards	Conservation research/Diver
C). Consultants	
J. Clarke (SmallCraft)	Contract diver
D. Garratt (Shaw International)	Maritime Archaeologist
A. Wolfe (Wolfe and Associates)	Maritime Archaeologist
D). Voluntary Assistants	
J. Buchanan	Diver/Technical assistant
R. Dickson	Cook/General assistant
R. McGuffie	Diver (MAWWA)
R. Shaw	Diver/Engineer/draughtsman
R. Sheppard	Diver

6.1 Facilities and Equipment

Vessel: WA Maritime Museum workboat, *Seaspray*.

Excavation tools: Two 'water dredges' were used during the course of the field work. The primary unit consisted of a 16 HP Briggs and Stratton Vanguard V-Twin engine powering a Gaan MT 33 water pump. The smaller capacity unit was a Davey pump, model 93206-0.

Diving equipment: Two standard 'Hookah' units were used for most diving activities. SCUBA equipment was restricted to activities which required greater mobility, such as photographic or reconnaissance work.

On-site conservation equipment: Storage tubs, specimen bags, protective wrapping, pre-treatment solutions.

Pre-disturbance environmental assessment equipment
pH electrode: *Activon* AEP433 pH electrode with flat surface pH probe.
pH meter: *Hanna* HI 8314 membrane pH meter.
Multimeter: *Escort* EDM 162 multimeter.
Conductivity meter: *Phillips* PW 9525 meter with water-proof probe.
Dissolved oxygen meter: *Hanna* HI 8543 oxymeter with dissolved O_2 probe.

Survey equipment
Chart: AUS 118, 1:75 000 *Approaches to King George Sound*, (see Figure 3, p. 4)
Plans: *Albany Town Jetty upgrade, 15-09-1994. General arrangement & site plan.* Halpern, Glick, Maunsell. Drawing No. S3448-01, Rev. 3
Albany Town Jetty . Proposed Alterations-October 1994. Copy of C.C.E. Plan No. 35262. (see Figure 2, p. 3)
Tide Tables: *South Coast - Albany*. p. 170. (Appendix N)
Australian Height Datum: Public Works Department, Permanent survey station summary, Albany wharf, October 1965. (Appendix N)
Reference map for AHD; PWD WA 48100-T1. (Appendix N)
Tide records
Tape measures (30 metre and 100 metre)
2 metre stainless steel grid square
Spirit level
Plumbob
Sample bags
Compass
Marker buoys
15 mm underwater cameras
Land cameras
Video camera in waterproof housing

First-aid and safety equipment
Diver's flag
Oxy-viva resuscitation kit
First-aid kit
Stand-by diver

6.2 Diving Regime

Diving operations were conducted over a period of 16 days, commencing on 22 November and continuing until 7 December. Divers worked in teams of two, often diving twice a day, sometimes up to three hours at a stretch. Most dives were conducted using surface supplied air equipment (hookah). A stand by diver and boat operator were in attendance, except when operating from the jetty where only a stand by diver was required. In all, a total of just over 175 hours were spent underwater. Within the survey area the depth ranged from one to eight metres. Visibility ranged from zero to around 5 metres.

7.0 Environmental Assessment–Pre-disturbance (See detailed report appendix H)

At the commencement of diving operations, a predisturbance survey was conducted by Richards and Carpenter, (Materials Conservation Department, WA Museum).

7.1 Sea Conditions

Princess Royal Harbour in which the Jetty is situated is all but land-locked. (See plan). Conditions at the site were generally calm with no swell, though the occasional storm prevailed, producing a short, steep wave. The tidal range was up to 1.2 m, semi-diurnally with a mean variation of 0.4 m. Underwater visibility ranged from 3-4 m. over undisturbed sea-bed.

7.2 Sea-bed

The sea-bed examined lay between 2 metres and 7 metres below the surface at mid-tide and consisted of fine calcareous sediments covered with epiphytes and organic detritus which rose in a cloud into the water column when disturbed. The site generally slopes gently to deeper water from the shore in a southerly direction. In a number of scour pits the slope is steep, at angles varying considerably to that generally found. Below the sand were layers of bivalves.

7.3 Flora and Fauna

Seagrass remnants were found in the scour pit created by the tug MV *Warren* during the WA Maritime Museum excavation in February 1989. Biologists Dr Ray Masini and Ms Jenny Carey operating nearby at the time, were requested to comment on the phenomenon. Their report reads thus.

> ...[we] examined the organic material which formed a layer some 10 to 20 cm thick approximately 1m below the present surface of the sea-bed. We found the layer to comprised[sic] predominantly of seagrass leaves of the genera *Posidonia*. The fibrous material (approx. 5-10 cm long) in that layer seemed to be remnants of the leaf sheaths of that seagrass which are extremely durable and would take considerable time to break down. The seagrass leaves were compressed flat with little evidence of any rhizome material and no evidence of a rhizome mat which in our opinion should still be present if a seagrass meadow had been there in the last 100-200 years.
>
> Given that you found artefacts at considerable depths beneath this layer and rhizome mats of this genera of seagrass are very tight and relatively impenetrable this also tends to support our impression that the layer is not the remains of a seagrass meadow.
>
> A more likely explanation is that seagrass drift (dead or detached seagrass leaves and plant parts) accumulated at some time perhaps in a depression, and subsequent to that, sediment was redeposited over the top to the level it is at present. (Masini and Carey to McCarthy, 21/02/89. Albany Town Jetty Day Book and Department of Maritime Archaeology, WA Maritime Museum, File No. 80.94.)

The jetty piles and other large structures on the sea-bed were encrusted with tunicates, barnacles, mussels, sessile invertebrates, algae and seaweed.

7.4 Pre-disturbance Survey : Rationale

As indicated the full pre-disturbance survey, on which these analyses is based appears in appendix H. Where possible these surveys are conducted by diving biologists, chemists and corrosion specialists in an attempt to obtain data relevant to the management of the site as a whole and to the management and conservation of the materials raised. Excavation strategies and conservation processes can hinge on the results of a properly conducted pre-disturbance survey (McCarthy, 1982). In this instance the pre-disturbance study provides a base on which to predict and monitor chemical and physical changes to the inundated parts of the jetty and the adjacent sea-bed as a result of further sea-bed disturbances or changes in the micro-environment at the jetty.

Of immediate significance is the presence of toxic materials. In hindsight, given the dumping practices of past societies and the large amount of coal loaded at the jetty, the presence of toxic substances should not have been a surprise. It must now be assumed that other port-related structures serving large populations over many decades in similar situations are also contaminated. The developers and relevant Government agencies were advised of these findings and were provided with a copy of the Appendix.

PART E THE EXCAVATION PROCESS

8.0 Logistics

The Albany Residency Museum's research station was selected as the location for a base camp due to its close proximity to the boat launching ramp and the jetty site. This ensured that;
(a) travelling time to and from the site was limited to ten minutes each day and
(b) the daily crew and equipment changeover times were minimised
Personnel were organised in such a way that at all times during diving operations, a core team of two divers, a stand-by diver/boat handler and at least one conservator and photographer were working on-site.

It was considered essential that each day's field-work data and artefacts were recorded and processed on the day of recovery. At the conclusion of each day's diving, recovered artefacts were registered and stored appropriately and all information from the underwater data sheets was plotted on the master plan and logged into a computer data base. Where possible, the excavation processes were recorded on videotape and replayed each evening. This aided in recording and interpreting information accurately, with the events of the day still fresh in the diver's mind. Any over-sights, or inaccuracies in the data were then be checked on the following days diving.

8.1 Excavation Methodology

A pre-disturbance analysis was conducted at pre-determined locations under and alongside the jetty structure.
A number of transect lines West to East (WE Transect No. 1, WE Transect No. 2) and North to South (NS Transect No. 1, NS Transect No. 2), were then established at angles to the Jetty(s) and through the area nominated for dredging in order to properly sample the area designated for development. A surface search along these transects was conducted and excavations were conducted at pre-determined intervals along the transects. (See Figure 19).

The excavation was conducted using standard water-dredging techniques, coupled with a grid frame to provide the necessary vertical and horizontal controls (Green, 1990). Two excavation systems were employed. These were:

i) The test pit (Shown as a circle (O) on the plan entitled; *Transects and excavation points*) (Figure19).

ii) The test trench (Shown as a square (⊠) on the plan).

A test pit sampling strategy was utilised in order to examine the area beneath the existing sea-bed. This involved, where possible, the laying of a two metre square grid frame on the sea-floor and excavating beneath it, then recording detail in the pit and in its walls. The grid was levelled using a builder's level and depth was measured from it using a plum-bob. Excavation was by water-dredge, with two divers, an operator and recorder. The end result in each case was a conical pit circa 1.5 to 2 metres deep, just sufficient to allow diver and excavation equipment access. Visibility in and around the pits was zero and all recovery was by feel alone. Recording was performed either visually by rising above the cloud of silt or within the pit by feel. Photography was possible only pre-excavation or on the following day when the silt had settled.

The test trench was used within the existing scour pits, again utilising the 2 metre square grid system. Being up to 2 metres deep and often quite extensive, with good visibility and stable slopes, the walls of the scour pits lent themselves well to layered excavation. In this instance the grid was supported on four stainless steel legs above the excavation and was levelled using a builder's level. Measurement was in 3D, using a sliding scale on the grid for easting and northings and depth by plum-bob. With visibility being in the order of 0.3 metres plus, measurement was normally a straightforward exercise.

A Nikonos camera fitted with a 15 mm underwater lens system and video-recording using a Hi 8 system in an underwater housing was used to augment manual recording.

The features, artefacts and structures found were recorded, analysed and in some cases sent for further treatment or analysis.

A surface search of other areas designated for development was also made, without significant result.

Three sites were excavated (pits and trenches #1-#3), underneath the Mail Steamer Jetty and one trench, #33) was dredged underneath the 1874 section of the Town Jetty.

West-East (WE) transect No. 1 and North-South (NS) transect No. 2 were selected for testing in order to provide information on the sea-bed and the material beneath it within the area of the proposed dredging. (see Figure 19).

WE Transect No. 2 was selected for test trenching due to previous evidence of artefactual material. This material was found along the length of the *Warren* scour pit and the trenches were excavated in order to examine the extent of the material and to test the hypothesis that a cultural layer would be evident. The scour pit also extended over to the western side of the existing jetty and test trenches were excavated in that region also.

North-South transect No. 2 was selected to sample the region from the Mail Steamer Jetty across to the *Warren* scour pit.

In order to sample the area of the Whaler's Jetty, NS Transect No. 2 was extended. Pits #23 and #24 and pits #25–#27 were excavated at right angles to it in order to gauge the spread of material emanating from the structure and the vessels moored alongside. Pits #28 and #29 on the southern side of the Whaler's Jetty were excavated to gauge the extent of the material there. The region of the old Swimming Baths which is expected to be reclaimed was examined, as was the area to the west. (Pits #35 and #36).
For the purposes of this report, a description of each excavation appears summarised below. Figure 19 locates the excavations over the area affected.

MAIL STEAMER JETTY

Test Trench #1.
This was conducted at the Datum Pile, and included a pre-disturbance analysis by the conservators. Material was visible throughout, though most was concentrated modern material which prevented excavation through to the earlier layer.

Test Trench #2.
Trench #2 was excavated underneath the Mail Steamer Jetty, adjacent to the 1874 jetty. Modern surface material such as rope, wire and engine parts had to be removed before excavations could commence. The trench was excavated through sediment to sterile sand at a depth of 1.8 metres. Little artefactual material was found, apart from some ballast stones.

Test pit #3.
An artefact-rich layer 45 cm thick was located 70 cm below a surface layer of seagrass and silt. Most of the artefacts identified were of organic materials such as bone, timber, coke and rope.

Test pit #4.
The choice of location for this test pit was based on the premise that artefactual material would be concentrated in an area where vessels had regularly moored alongside a jetty.
A range of artefacts consistent with ship-board materials was recorded in this test pit to a depth of 65 cm. At this depth, a layer of seagrass 15 cm thick delineated the lower boundary of the artefact-rich strata. Underneath the seagrass matting lay three distinct shell strata.

NORTH-SOUTH TRANSECT No. 1.
Test Pit #5
This pit was excavated to a depth of 180 cm through six distinct strata comprised of silts, cockle shell, sand and fine shell and finally a layer of large oyster shells. Within the sand and

fine shell layer were small fragments of timber, coal and clinker, interspersed with modern items such as a battery lead and a rubber hose. This material was located between 60 cm and 120 cm below the sea-bed.

Test pit #6.
This test pit was excavated to a depth of 111 cm and revealed three distinct strata comprised of silt overburden 45 cm in depth covering a 10 cm thick layer of seagrass over compacted cockle shells. No artefacts were found.

Test pit #7.
The profile of #7 is similar to test pit #6.

Test pit #8.
The profile of #8 is similar to test pit #6 and #7, although this excavation showed no evidence of a seagrass layer above the shell strata that extends from 60 cm to 170 cm below the sea-bed. Sand and mud extends to an undetermined depth below the shell layer.

EAST-WEST TRANSECT No. 1.

Test pit #9.
Located at western side of the head of the 1874 Jetty. A significant number of artefacts were recovered from this test pit, primarily glassware and ceramic sherds.

Step trench #10.
Located at the eastern side of the head of the 1874 Jetty. A significant number of artefacts were recovered from the test trench area including shipboard items such as ballast stone and wire rigging as well as glassware and ceramic sherds. The trench extended to a depth of 148 cm on a north-south axis.

Test pit #11.(See Figure. 21 and discussion pp. 44-45)
Situated on the north side of the *Warren* tug berth, and also crossed by the NS. Transect No. 2. The surface material consists of a mixture of sand and silt with fragments of degraded *posidonia* and small shells. A layer of compacted cockle shells is evident at 127 cm from the surface of the sea-bed. Shell samples ATJ 125 A, B, and C, were removed for carbon dating analysis from this test pit. The results are as follows;

Sample A: 1730 BP (+/- 80 BP),
Sample B: 2670 BP (+/- 60 BP),
Sample C: 5070 BP (+/- 80 BP).

No artefacts were recorded.

Test pit #12.
The pit was excavated to a depth of 160 cm. A layer of cockle shells 100 cm deep lies over a thin 5 cm stratum of large and small oysters. Below this stratum is a 20 cm layer of sand interspersed with *posidonia* fibres. Shell samples ATJ 125 D, and E were taken at depths of 62 cm and 105 cm. The results are as follows;

Sample D: 1700 BP(+/- 80 BP);
Sample E: 3140 BP (+/- 70 BP).

No artefacts were noted. (See Figure 7, over).

Test pit #13.
The stratification is similar in all respects to #12.

Test pit #14.
Five strata were noted in this test pit, which was excavated to a depth of two metres. A silt layer extends 55 cm below the sea-bed to a 10 cm-thick oyster shell layer, below which is a 65 cm stratum of silt. A 60 cm thick layer of cockle shells extends down to 190 cm below the sea-bed to sand with embedded *posidonia* fibres. No artefacts were noted.

Test pit #15.
The stratification is similar to #14.

Results of test pit analysis. Figures 7 and 8. are indicative of the general results.

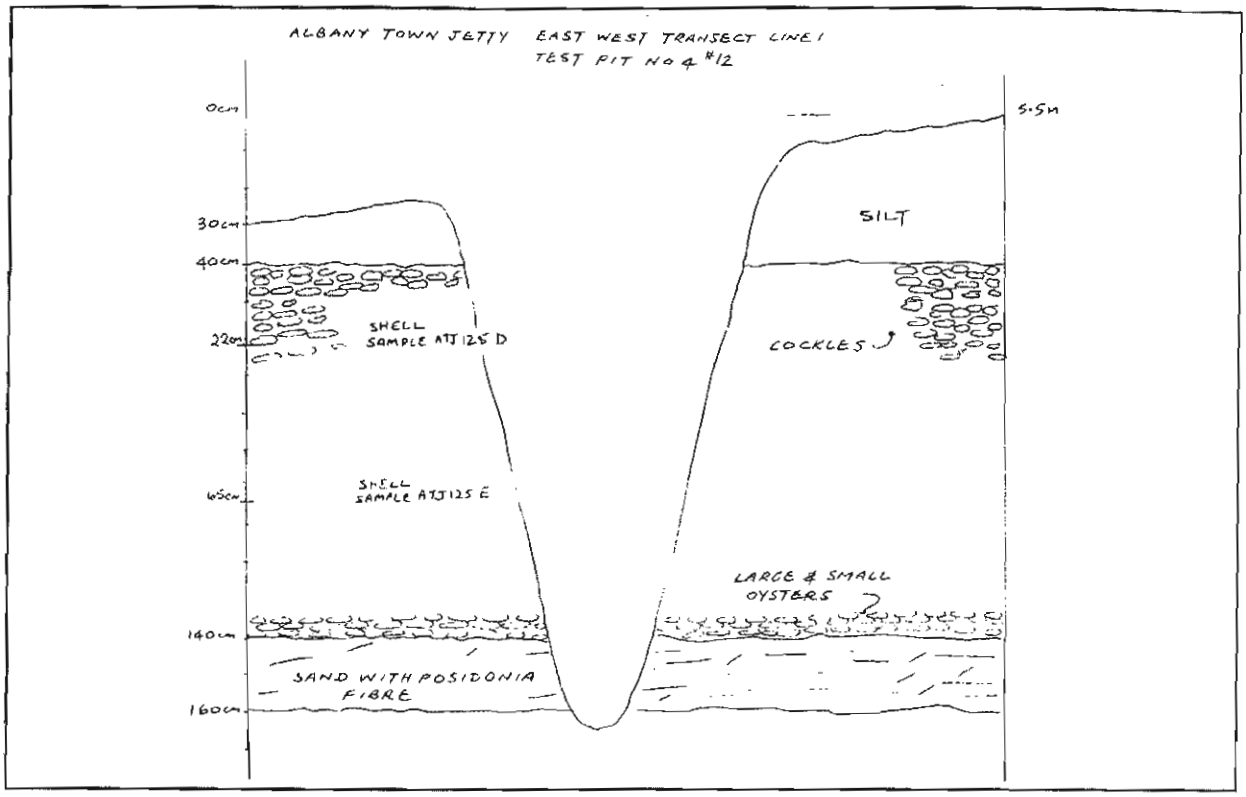


Figure 7. **Test pit #12.** Outside the mooring area, away from the Jetty, a generally sterile soft silt layer, (Sterile: ie. with no artefacts) overlaying sand, seagrass fragments and shell beds.

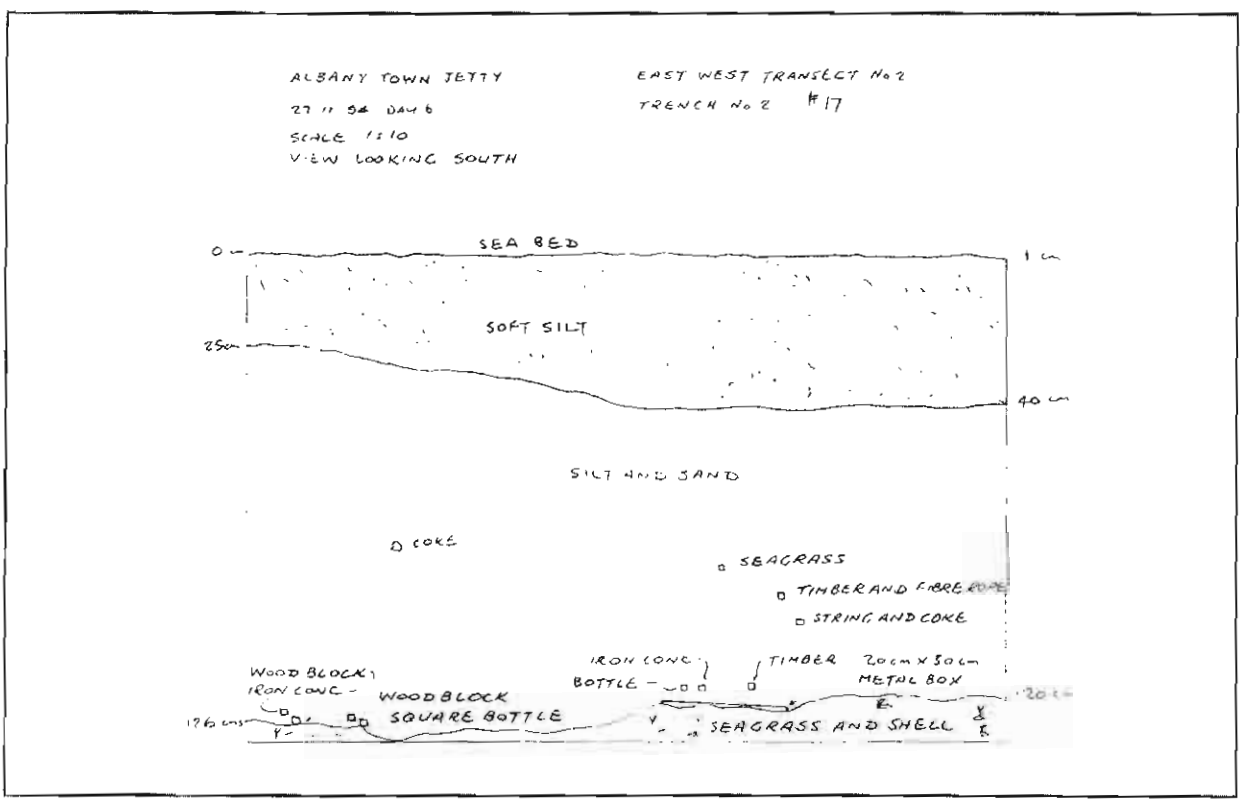


Figure 8. **Test pit #17.** Adjacent to the Jetty, a soft layer of silt overlaying a heavily-disturbed layer of sand and silt containing artefactual material and then a layer of seagreass and underlying shell beds.

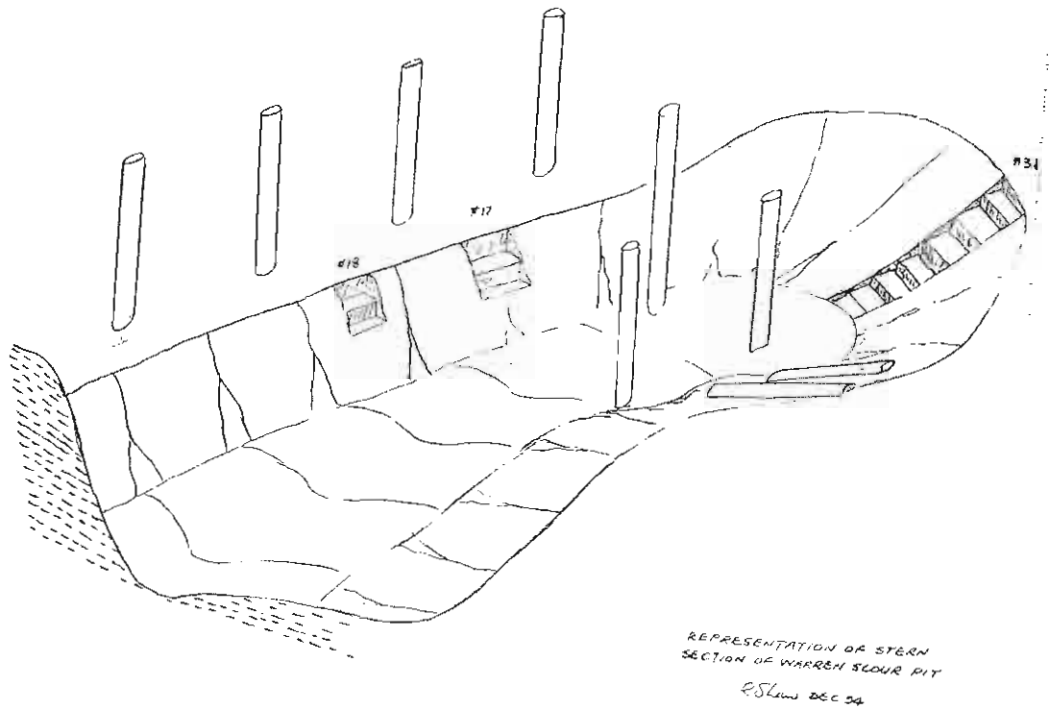


Figure 9. The MV *Warren* scour pit showing the tug berth jetty piles and step trenches #17, #18 and #31 excavated within it. The piles shown in the background form the modern finger jetty for the *Warren* tug berth. The piles to the right are the narrow jetty joining the end of the 1874 Town Jetty to the Whaler's Jetty.

Figure 10. Wolfe and Garratt at work. Here the scour pit itself has been used as an aid to excavation. The measuring system, including the plumbob appears.

Test pit #16.
The stratification is similar to #14.

EAST-WEST TRANSECT No. 2.
The transect is aligned with the piles of the *Warren* tug berth with a view to testing the walls of the scour pit. (See Figure 9). The test trenches were excavated into the sloping side of the scour pit that has been formed by the wash of the tug.

Step trench #17.
Below 40 cm of soft silt is an artefact-rich layer of sand and silt that extends to a depth of 126 cm. Below this is a bed of sterile seagrass and shell containing no artefacts.

Step trench #18.
The stratification of the sedimentary layers and distribution of artefacts is similar to #17.

Step trench #19.
The stratification of the sedimentary layers and distribution of artefacts is similar to #17.

Step trench #20.
The trench was excavated on three levels. From the surface of the sea-bed to 42 cm; from 42 cm to 65 cm and from 65 cm to 98 cm. Artefacts were located below a shell layer at a depth of 93 cm.

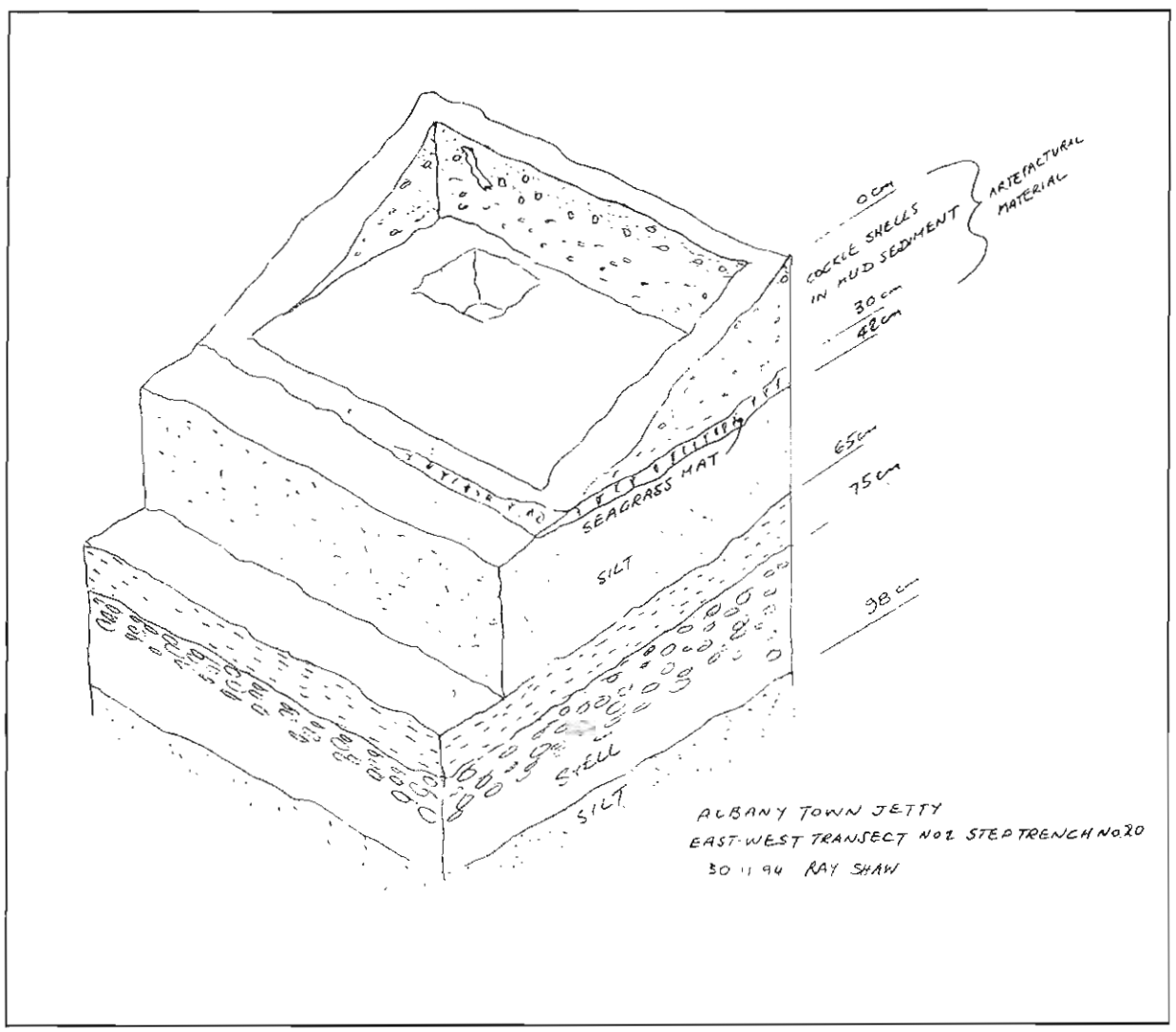


Figure 11. East-west transect No. 2. Step trench 20.

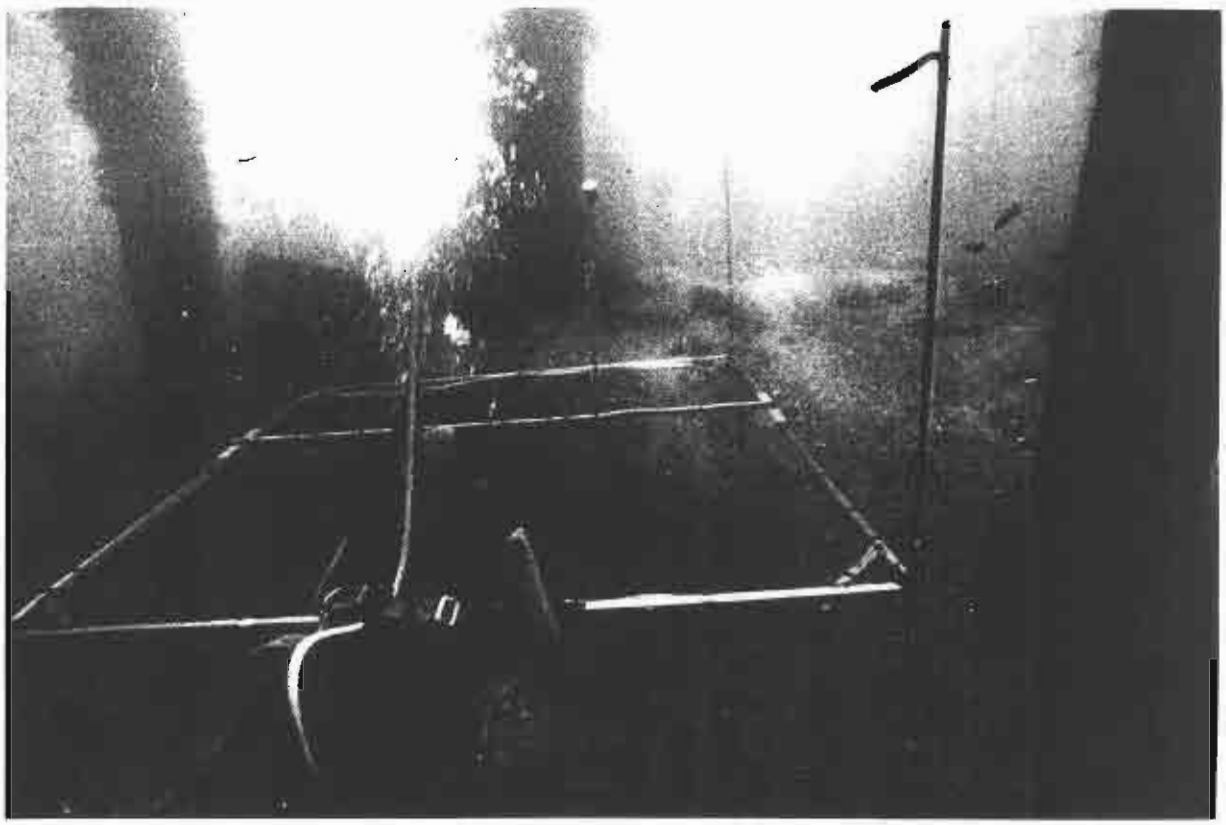


Figure 12. Steptrench #20 showing the grid frame and the good conditions encountered in the test trenches.

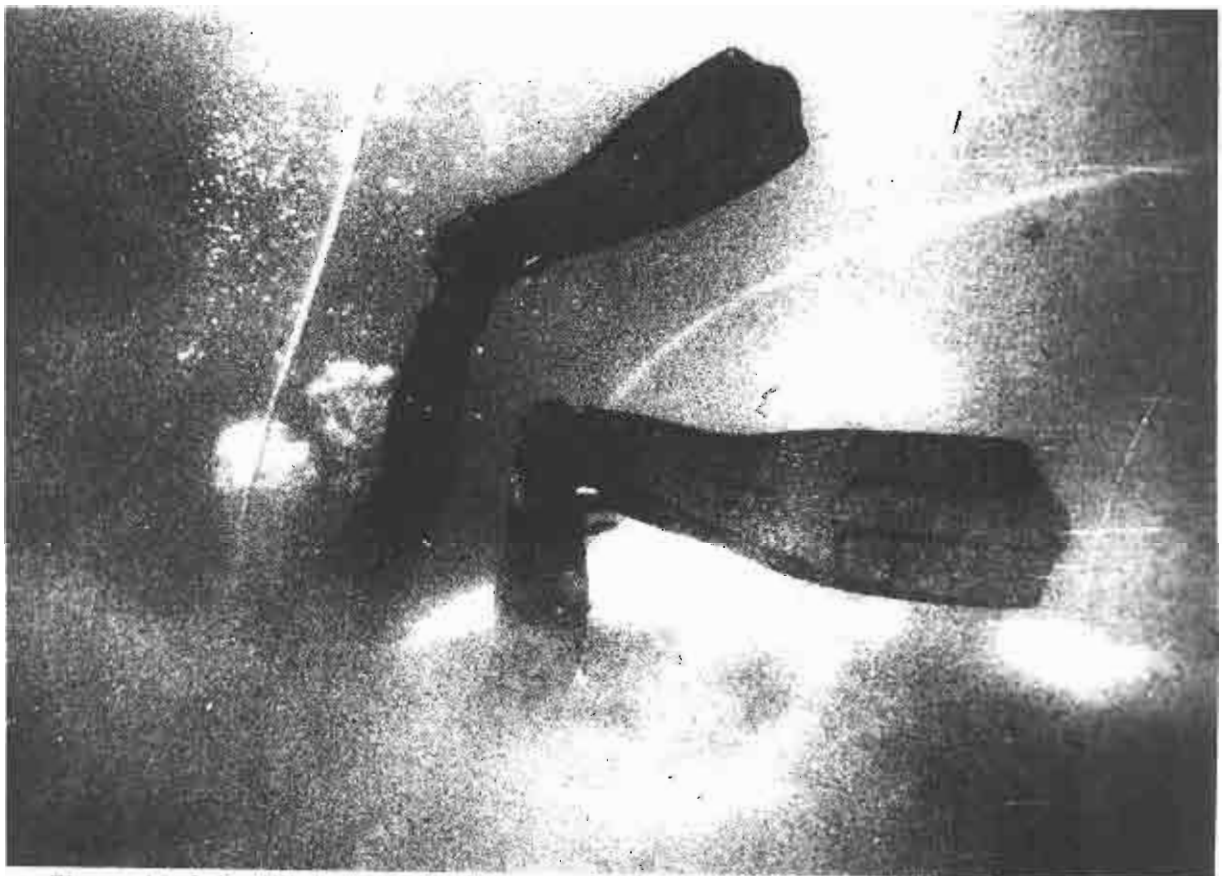


Figure 13. John Clarke working in a test pit, showing the poor visibility often encountered.

NORTH-SOUTH TRANSECT No. 2.

This transect runs parallel to the 1874 Jetty, between the Mail Steamer Jetty and the Whaler's Jetty and incorporates test pits #21 to #24. Test pits #25, #26 and #27 were positioned 5 metres apart, running out at right angles to the eastern side of the Whaler's Jetty.

Test pit #21.
Soft calcareous deposits to a depth of 140 cm.

Test pit #22.
Soft calcareous deposits to a depth of 45 cm, then calcareous deposits with small shells. Excavation depth, 100 cm.

Test pit #23.
Soft calcareous material to a depth of 120 cm, over a 30 cm-thick deposit of oyster shell. A section of timber was found beneath the shell layer at a depth of 150 cm. Excavation depth, 180 cm.

WHALER'S JETTY

Test pit #24.
Soft calcareous deposits to a depth of 110 cm.

Test pit #25.
Calcareous material to a depth of 130 cm, containing an array of late 20th century materials such as coal, bone and glass fragments.

Test pit #26.
Calcareous material to a depth of 140 cm, containing coal, bone and modern glass fragments, then a cockle shell stratum to an undetermined depth.

Test pit #27.
Calcareous material to a depth of 150 cm, containing coal, bone and modern glass fragments, Substrates of cockle shell and oyster shell at 190 cm.

Test pit - east #28.
Six strata were noted in this test pit, which was excavated to a depth of one metre. A calcareous layer to a depth of 10 cm, an artefact layer 25 cm deep, containing an array of late 20th century materials, with substrates of calcareous material containing tube worms, cockle shells, oyster shells, and sand with seagrass.

Test pit - west #29.
Artefact-rich area to a depth of 130 cm over a 10 cm substrate of large oyster shells. Small oyster shells and sand were encountered at a depth 160 cm.

WARREN TUG SCOUR PIT -WEST END

Surface collection #30.
Nineteen artefacts (or groups of artefacts) were recorded in a surface inspection of the west side of the *Warren* scour pit, extending for a distance of 13.5 metres from the north west pile of the end of the 1874 Jetty.

Experimental trench #31.
This step trench extended for a distance of 5.7 metres in six levels to a maximum depth of 2.2 metres. The sea-bed consists of a layer of c. 30 cm of coarse sand and shell grit containing some artefactual material. Beneath that appeared a 10 cm deep, tightly packed, artefact-rich layer of fine grit, (level 1) underlaid with undisturbed shell beds. A large oyster shell exposed in level 2 at a depth of 80 cm was sampled for carbon dating. Results as follows; (1340 BP +/- 70 BP). The oyster (ATJ 143) sent for carbon dating is clearly shown.

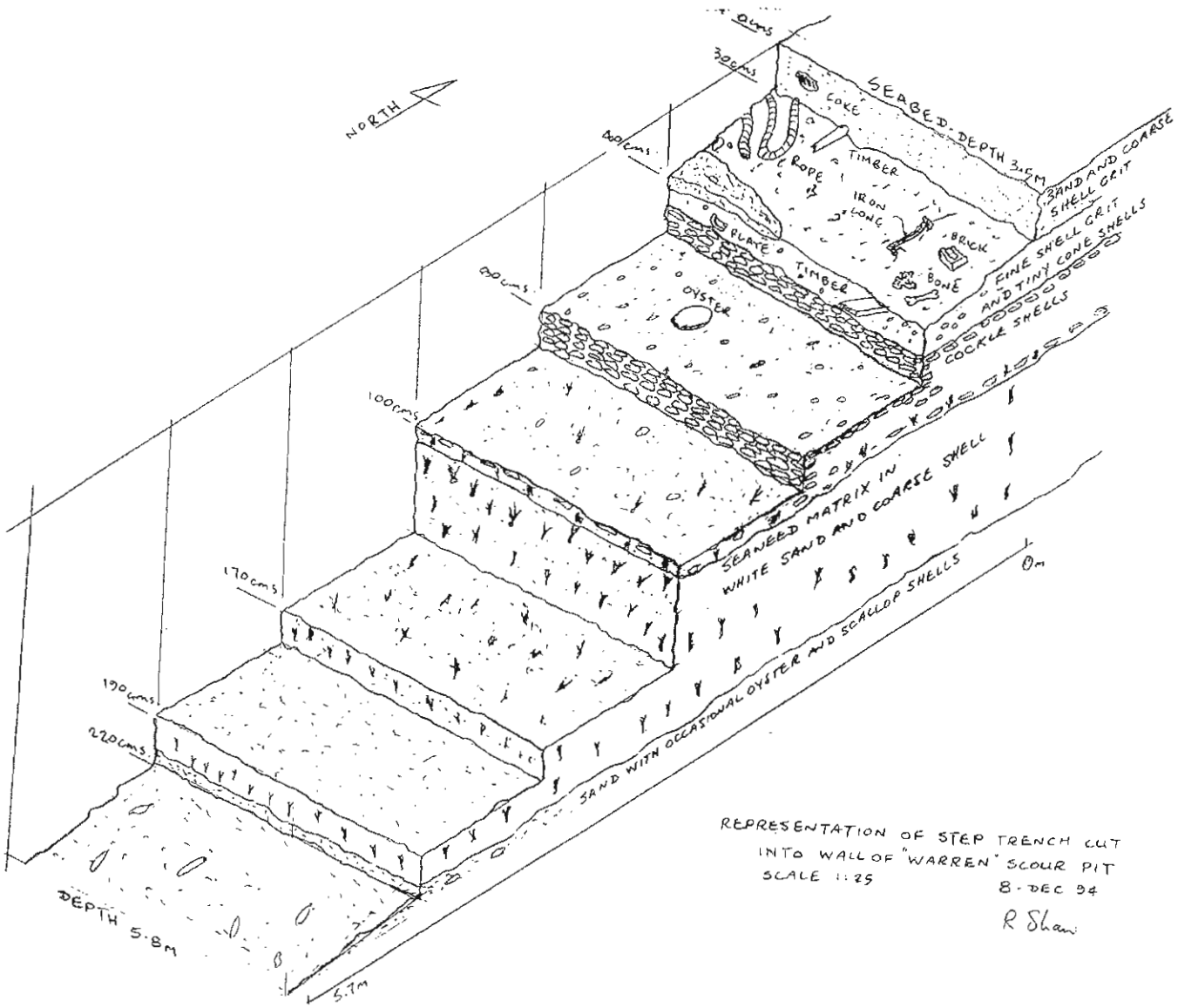


Figure 14. Results of test trench #31 cut into the *Warren* scour pit

Test pit #32.
Calcareous deposits, rich in artefacts to a depth of 120 cm above a 10 cm deep weed layer. Below this is a 10 cm shell layer on a substrate of sand and fine shell.

Experimental trench under Jetty #33.
Four strata, were noted in this pit, which was excavated to a depth of 190 cm. A 10 cm surface layer of sand covers layers of soft silt, compacted calcareous material and calcareous material with cockle shells. Artefactual material appears primarily in the third and forth strata at depths between 30 cm and 140 cm.

Test pit #34.
An artefact-rich layer between 15 cm and 35 cm below the sea-bed lies above layers of seagrass, calcareous deposits and cockle shells.

Baths test pit #35.
The pit was excavated 12.5 metres from the base of the batter wall of the breakwater and a depth of 180 cm was attained. The sea-bed in this location is primarily sand. Timber and bone fragments were the only artefacts found at depths between 107 cm and 135 cm. Large oyster shells were encountered at 160 cm.

Foreshore test pit #36.
Sterile sand to a depth of one metre with no evidence of artefactual material.

The following illustrations serve to fix the excavations referred to in this report and to illustrate the methods used.

Results of test trench #33 and test pit #34. Test trench #33 was excavated under the jetty itself. Test pit #34 was conducted alongside the jetty. The results indicate that the original sea-bed consisting of various shell layers, sand and weed has been overlaid with artefactual material, which itself is covered with a layer of fine silt and sand.

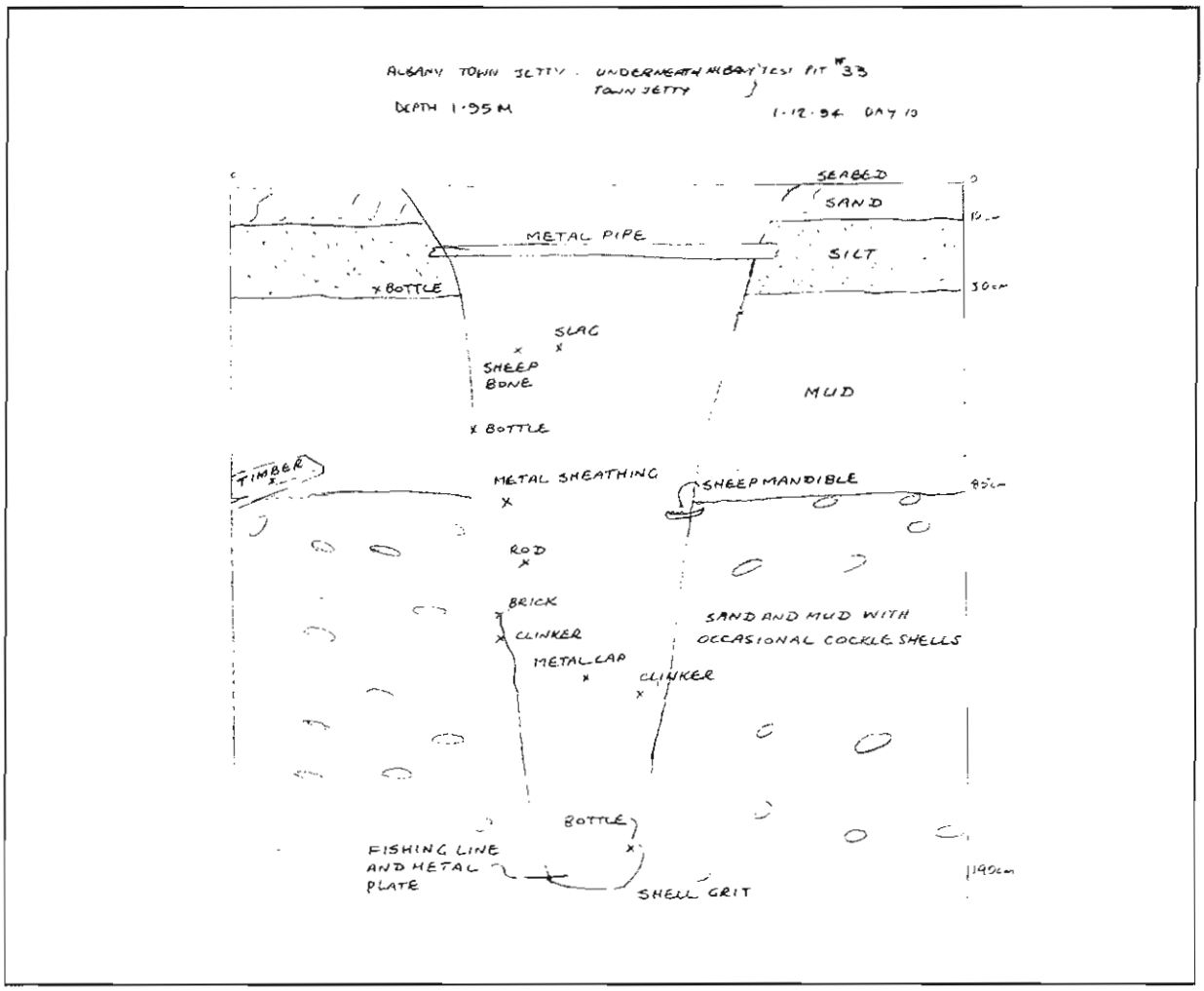


Figure 15. Test trench #33.

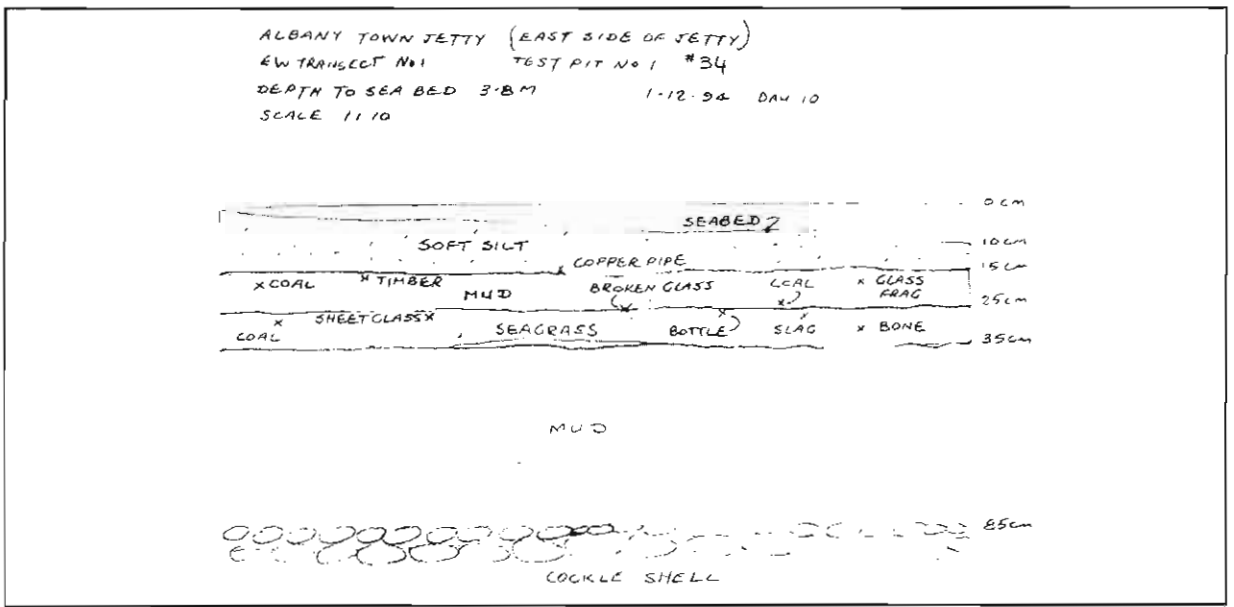


Figure 16. Test pit #34.

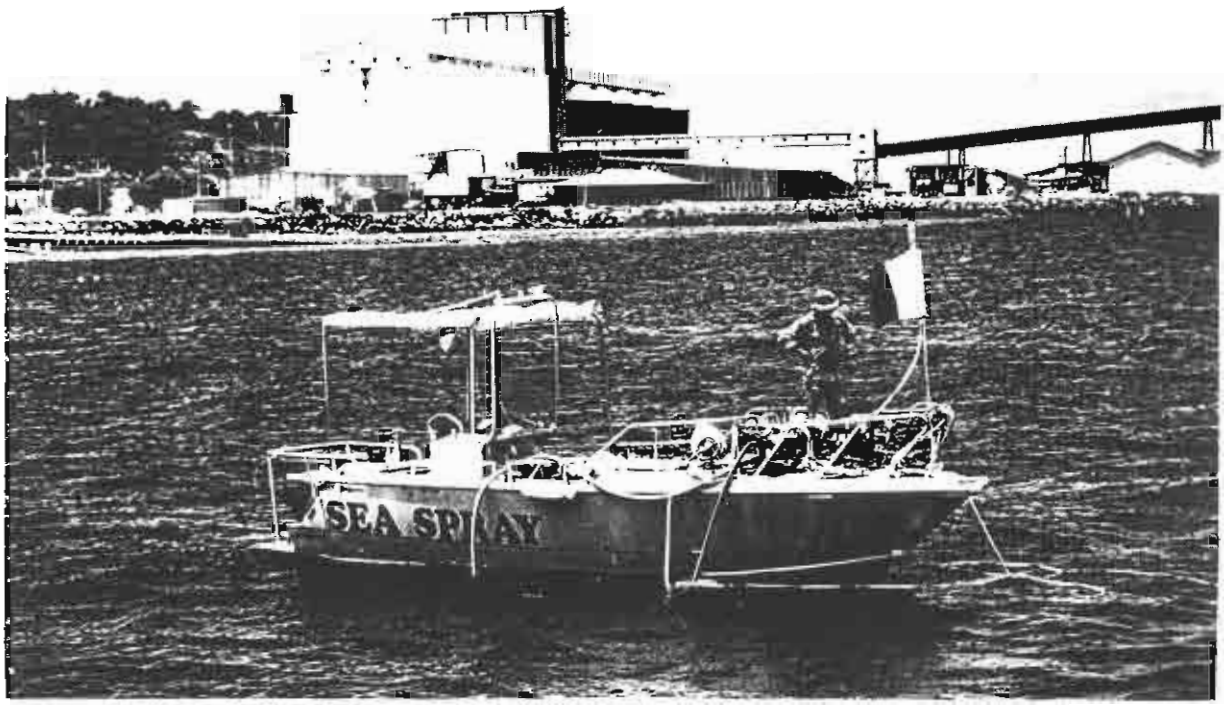


Figure 17. The Museum's work boat above excavation points #14 to #16.

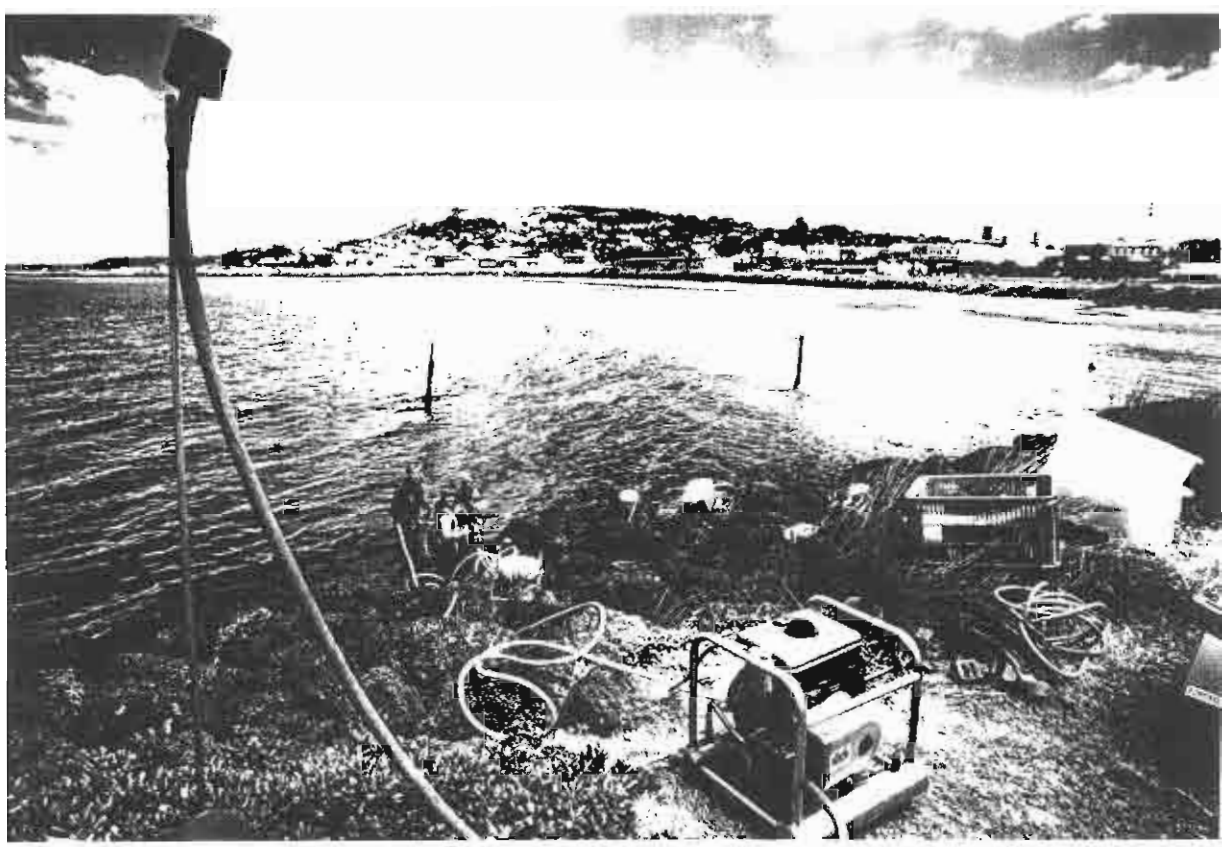
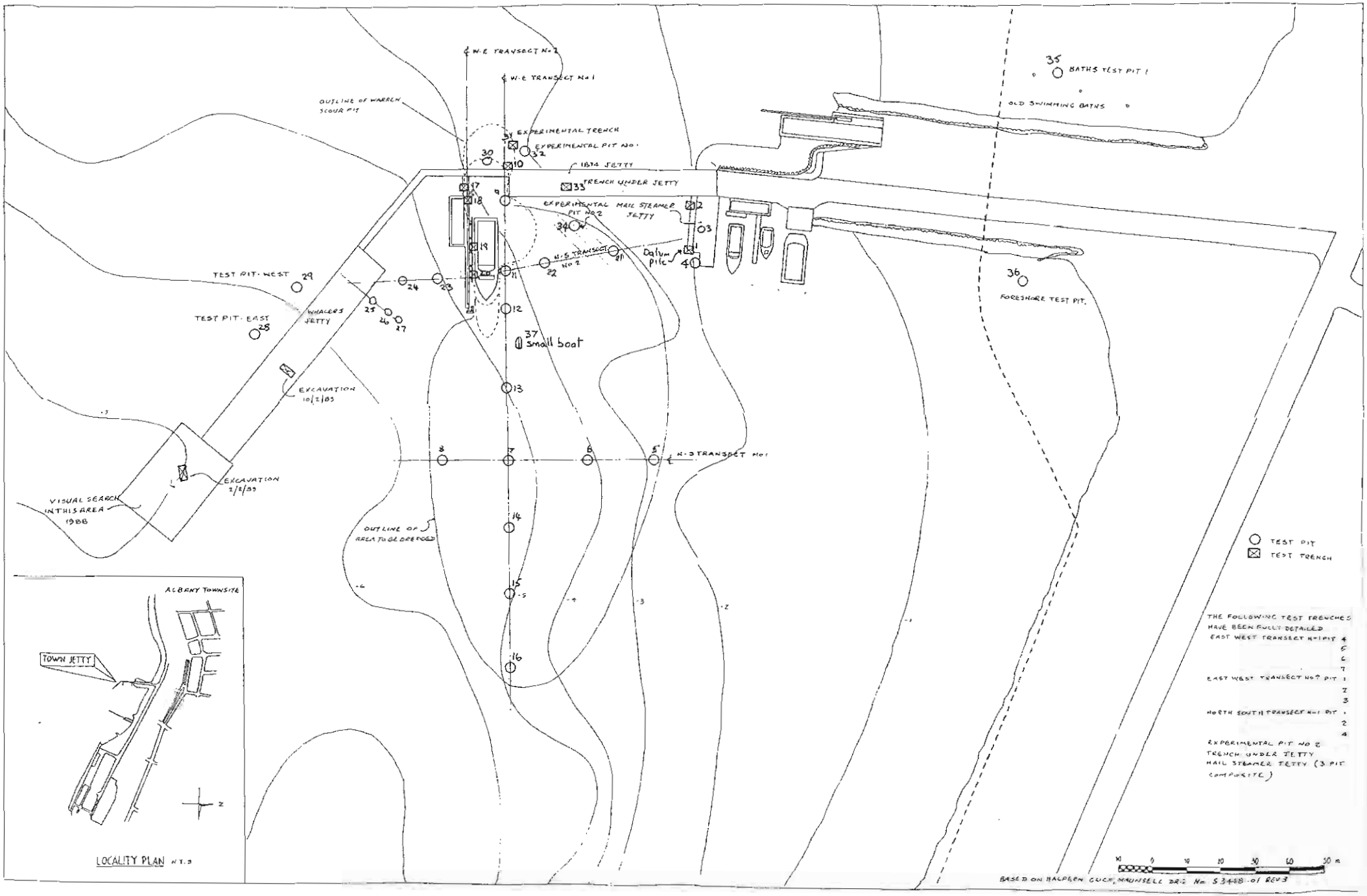


Figure 18. Working from the shore at pit #35 (the Old Baths): showing the equipment used.

Figure 19. Transects and excavation points at the Albany Town Jetty (Highlighted)



9.0 The Finds

The location of material is consistent with the expectation that concentrations of historic material lie under and alongside jetties and to approximately 10 metres either side of them. Where vessels have previously moored at the head of a jetty, as opposed to alongside it, again the artefact spread was expected to reflect this practice. In the Albany Town Jetty case, the head of the 1874 Jetty has proved especially rich. Unfortunately the *Warren* scour pit cuts through this deposit. The range and age of the artefacts recovered from the jetty area is consistent with expectations of finding detritus from a working jetty which was in operation from the mid 19th century to the present day. Most of the material recovered is associated with ships and shipping activities eg., loading and unloading. Some material reflects casual visits for fishing or recreation.

9.1 Artefactual Material

The vast majority of the artefacts recovered are ceramics and glassware of various types. Most are of Australian or British origin, including locally-made bottles. A range of pickle jars, sauce bottles and medicine containers were excavated, some containing their original contents. As expected, most of the ceramic material is associated with the shipping companies that ported at Albany. This is indicated by the various shipping company markings on the ceramics.
Underlying the material noted above are a series of tightly packed layers of shell, dating to c. 5000 years BP to the depth excavated. With the exception of the two main scour pits these layers are relatively undisturbed.

9.2 Shipwrecks

No evidence has been found to indicate the presence of wrecks in the near vicinity of the existing Jetty. The wreck of a small boat was located however. This is described by Mr Wolfe in Appendix K. It is possible that wrecks lie inland under land-fill. Such vessels may date from the time when the Jetty was built in the 1860s and could be of significance.

9.3 Anchors and Other Large Artefacts

Coal hulks and barges were moored in the waters around the jetty. Mooring buoys were anchored to the seabed for the use of shipping generally and for and small boats. The anchors and cables from these moorings may date from the time the jetty was built in the 1860s and may lie partly exposed or buried in the sea-bed. (See Wolfe, 1994 a & b).

10.0 On-site Management of Artefacts

Artefacts were placed in plastic bags along with a waterproof tag bearing a unique identifying code number. (With this number, present and future researchers are able to pinpoint the original location of each artefact). The bags containing the artefacts (and their tags) were carefully placed in a plastic crate on the sea-bed, then hauled to the surface by means of a rope. Once aboard the boat, items were placed in containers filled with sea-water to maintain 100% humidity.

10.1 The Underwater Conditions and their Effects on the Artefacts

The metal artefacts exposed on the sea-bed surface were actively corroding as is to be expected of material located in an aerobic environment. Artefacts that were recovered from the sea-bed excavations were in good condition, though there had been some physical and mechanical damage due to their movement in the scour pits or breakage before they were discarded into the sea. In cases where a reduced pH and 'redox' potential was noted under the surface sediment there was generally a decrease in the rate of corrosion and enhanced protection of organic materials.

10.2 On-site Treatment, Transportation and Packaging of Artefacts

At the conclusion of each diving session, the containers of artefacts were placed in crates and transported to the Residency Museum whilst still in the boat. This strategy avoided some of the risks associated with multiple handing of artefacts. Recovered artefacts were immediately placed in plastic tubs of tap water to start the desalination process. Care was taken not to remove any sediments from inside the bottles as these may be required for chemical analyses at a later date. Fragile items were wrapped in soft nylon mesh to protect them from damage prior to registration. Artefacts were registered on the day of recovery. Bottles were encased in protective tubes of expandable styrofoam before being placed into plastic tubs which were lined with wet hessian. The tubs were then sealed with tight-fitting lids so as to maintain high humidity. Other delicate items were cushioned in bubble wrap before being carefully placed in individual containers that were filled with tap water and securely sealed. The small containers were then placed in large tubs in readiness for transportation. All the artefacts were transported by road to the Department of Materials Conservation laboratory in Fremantle for conservation.

11.0 Radiocarbon dating

Eight samples of shell material retrieved from four test trenches were selected for radiocarbon dating. The samples were sent to the University of Sydney, N.W.G. Macintosh Centre for Quaternary Dating, from where they were submitted to Beta Analytic Inc. in Florida, USA for analysis. (See appendix C for initial results and calibration instructions). The Museum is awaiting the return of the remainder of the sample material from Beta Analytic Inc in order that it may be analysed by pre-historians, biologists and natural scientists. These reports and analyses will be presented as a codicil.

In brief, the radio-carbon dating indicates that the shell beds that were analysed in the areas examined were laid down between 1340 +/- 70 BP to 6520 +/-80BP. Some of the relevant data is presented below.
Experimental Trench 1 (Excavation #31) appearing below, shows the composition of the modern seafloor and earlier cultural layer, underlayed by shells containing a solitary oyster, ATJ 143, amidst a tightly-packed layer of cockles. This was dated to 1340 +/- 70 BP. The oyster shell was found fixed into the matrix, indicating the age of the matrix and that its position was not the result of sea-bed disturbance.

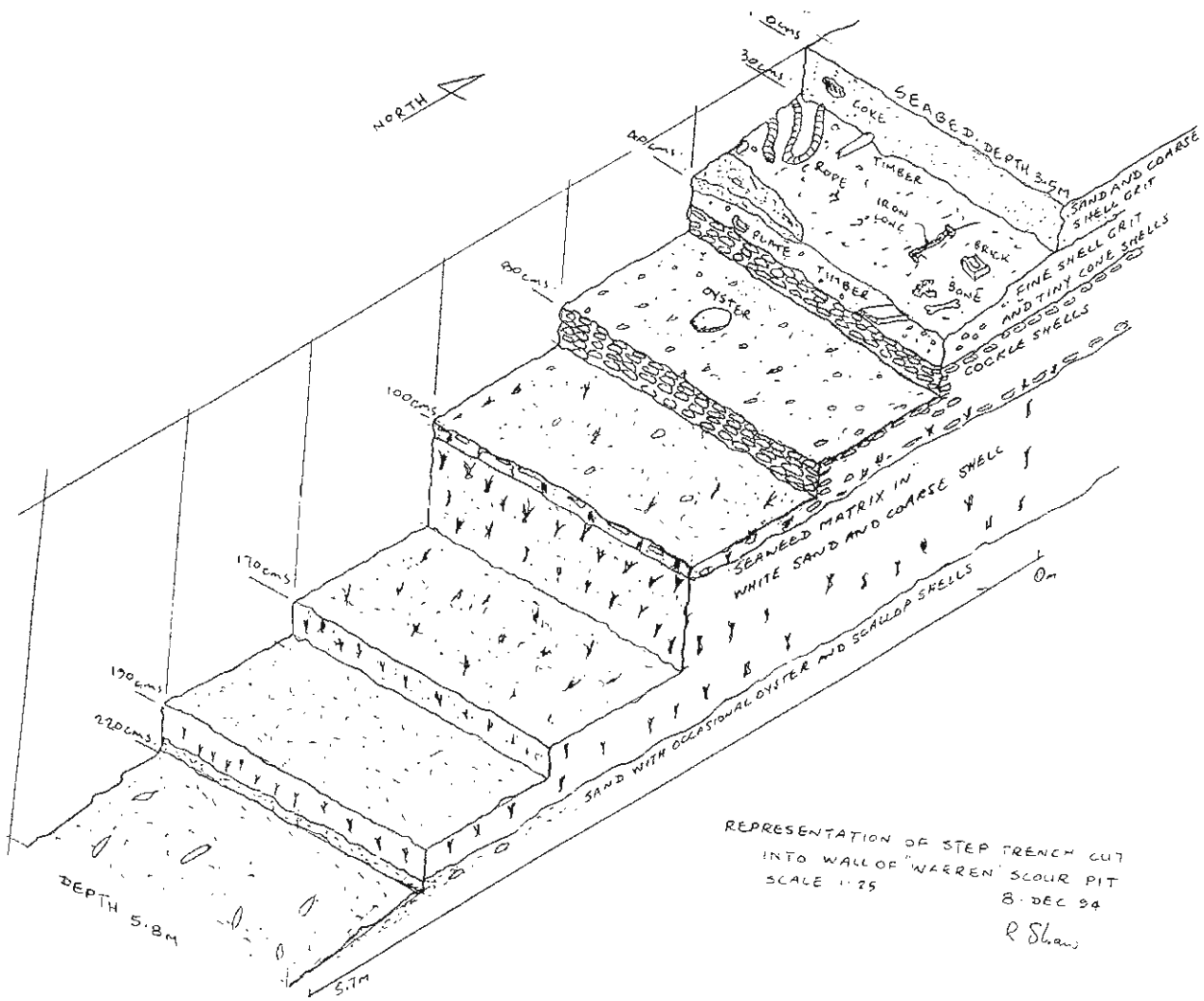


Figure 20. Experimental Trench No. 1 (Excavation #31) showing the layers and the oyster ATJ 143.

In EW Transect, test pit No. 3, (excavation #11), where vertical control within the underlying shell layers was best obtained, three samples of bivalves were submitted for carbon-dating. Labelled A to C in depth, these ranged from;

A) 1730 +/- 80BP
B) 2670 +/- 60BP
C) 5070 +/- 80BP

The return of the samples submitted is still awaited. When received they will be submitted for biological analysis and the results will be made generally available so that further analyses can be made. Of significance is the age of the beds and the fact that the steamships that have operated in these regions do not appear to have disturbed the shell layers themselves.

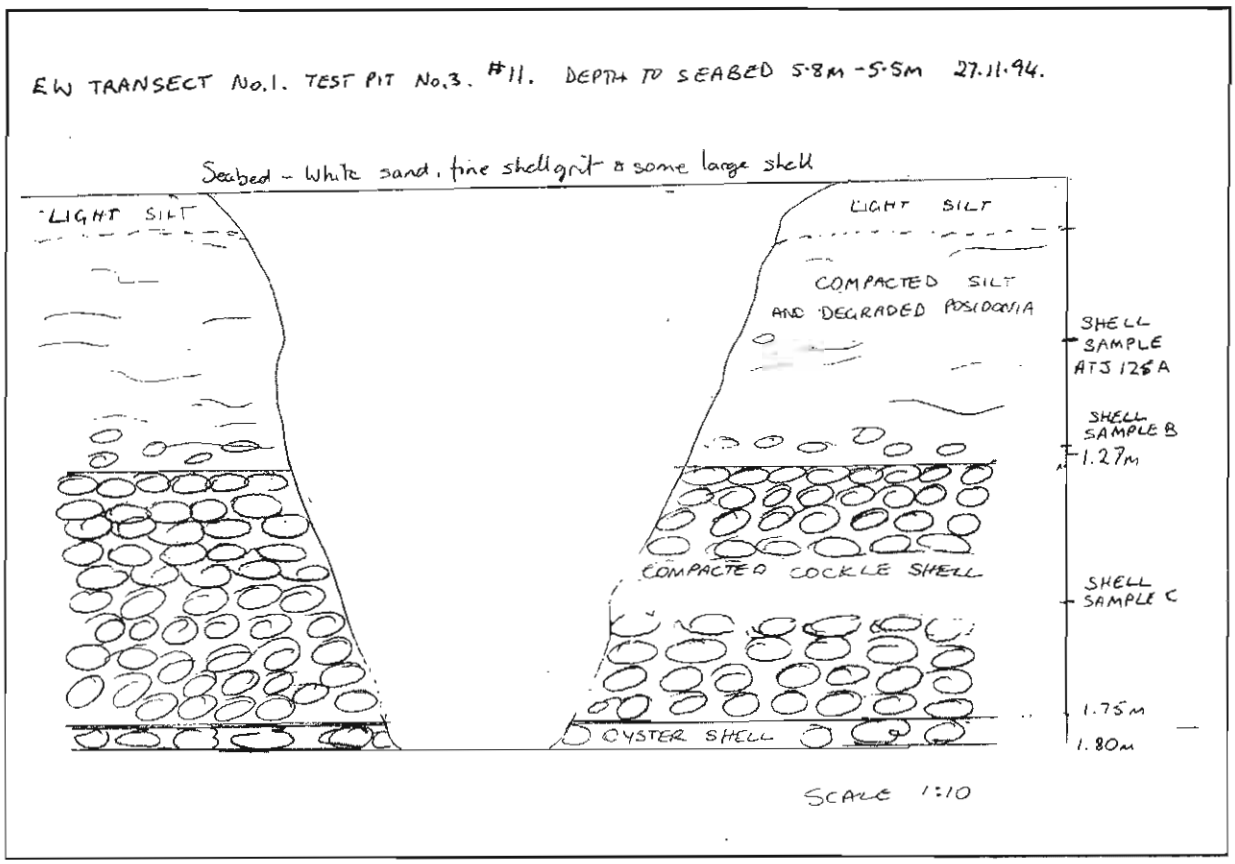


Figure 21. A representation of Test pit #11, showing the layers sampled

12.0 Artefact Management

The artefacts recovered from the 1988 and 1989 excavations have been catalogued, conserved and prepared for display and study purposes. Forty-five artefacts from this collection were selected by the Curator of the Albany Residency Museum and are on exhibition there. (For details see appendix E). Finds from the 1994 excavation have been catalogued and are presently undergoing conservation treatments.

In all, 125 artefacts (or groups of artefacts) were recovered from the site and recorded in an artefact register. Artefacts were allocated a registration number, classified by material composition and briefly described. The date of recovery is included, and a unique grid number to indicate the original position of the find. This information was then entered onto a computer data base, using an Omnis database package on Macintosh hardware. (see appendix D, *Register of artefacts recovered from the Albany Town Jetty, 1988–1994*).

12.1 Treatment of Finds

The Albany Town Jetty artefacts are divided into eight tubs, each containing like materials: the inorganic materials are glass, stone, coal and bricks, and the organic materials bone, leather and hessian. Desalination of the inorganic artefacts commenced on 16 December 1994 and all materials are releasing chloride (Cl^-) salts at steady and increasing rates. To date, the glass has released the least amount of Cl^- salts (104 ppm) and the bricks have released the greatest quantity of Cl^- salts (1150 ppm). Eighteen bone artefacts and three leather shoe fragments are undergoing desalination. The artefacts are still in the first wash solution of tapster and will require subsequent washes in deionised water. The time required for complete desalination may vary between a further six months for the glass to a further $3^1/_2$ years for the bricks. The hessian has been desalinated and is presently in storage awaiting the final treatment process, impregnation with a PEG (polyethylene glycol) solution.

12.2 Collection recording–Artefact Drawing

To date, twelve artefacts have been drawn. These are listed in the Catalogue of Albany Town Jetty artefact drawings, (appendix F).

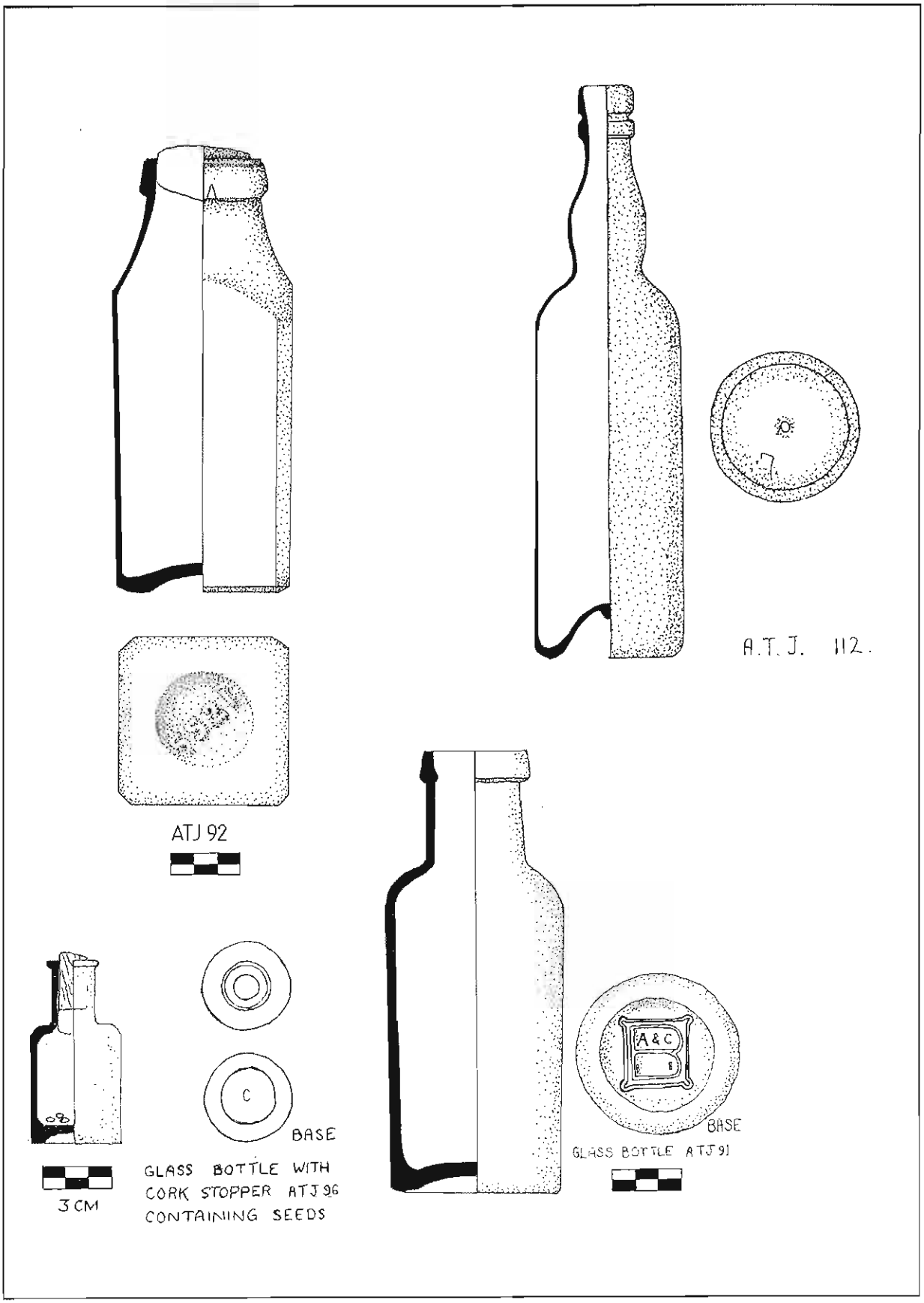


Figure 22. Glassware recovered from the Albany Town Jetty. (Nikki King Smith & Rod Dickson)

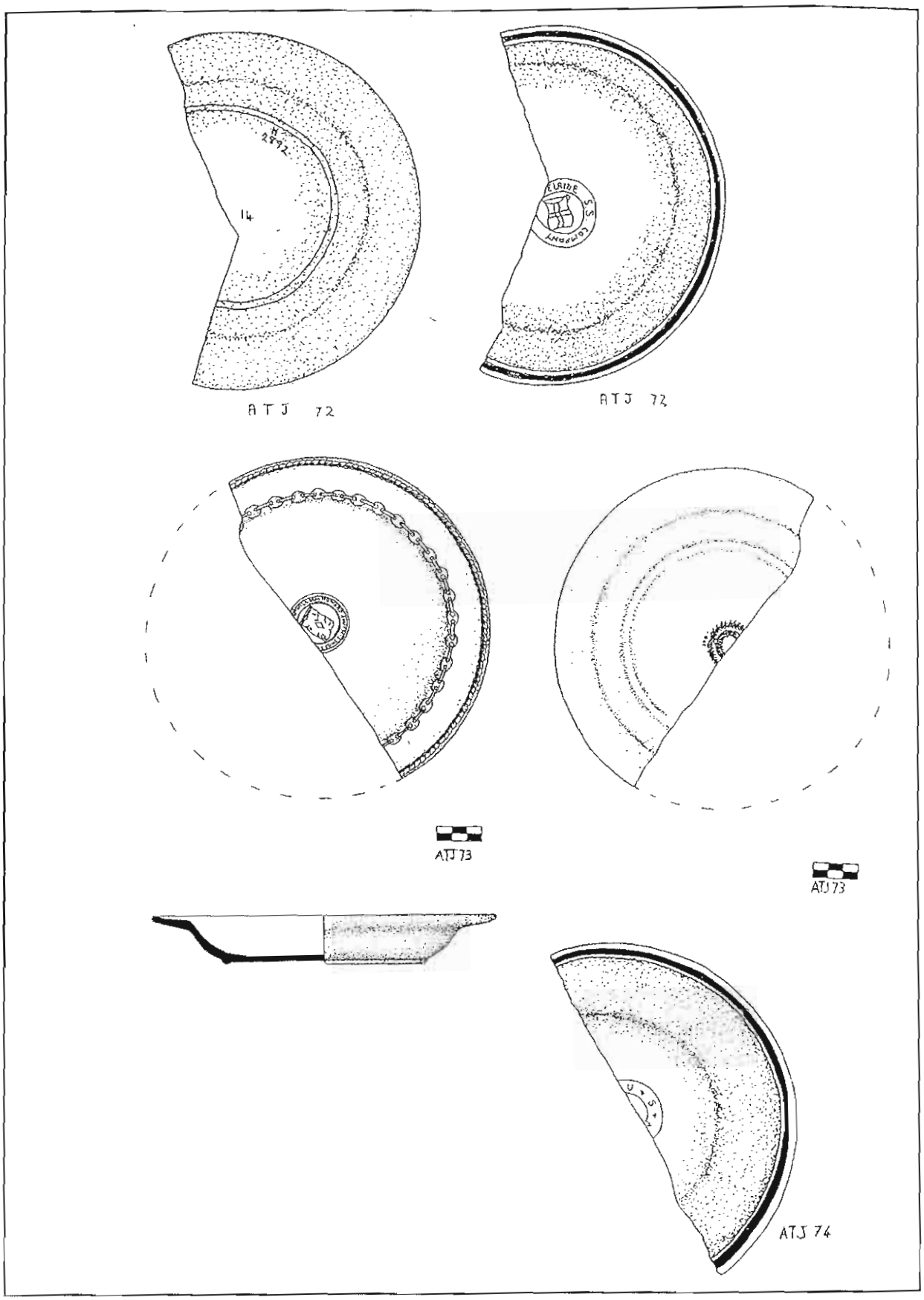


Figure 23. Ship's crockery showing insignia recovered from the Albany Town Jetty.

(Nikki King Smith)

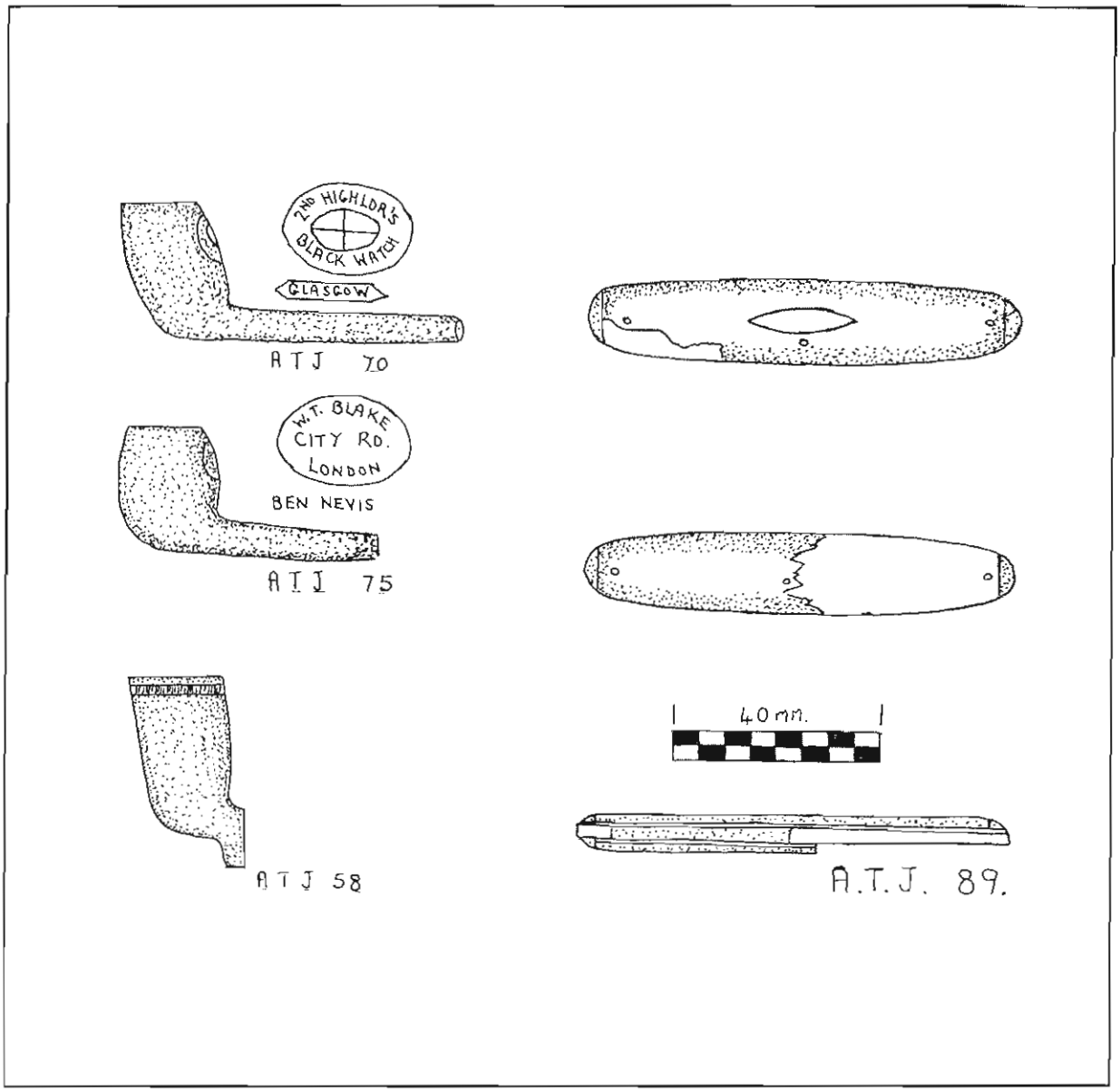


Figure 24. Clay pipes and a pocket knife recovered from the Albany Town Jetty excavations. (Rod Dickson)

13.0 Conclusion

Through the application of a grant from LandCorp, the WA Maritime Museum has ascertained:

#1 That much of the earlier (pre 1870s) part of the Albany Town Jetty and its associated artefact layers lie under existing land-fill. Unless excavation of the land adjacent the present jetty is envisaged, these will remain well-preserved beneath the soil. This is an accepted management strategy, preserving material for decades, even centuries.

#2 With the exception of scour pitting caused by large propeller-driven vessels, the area around the existing Jetty is physically stable and underlaid by a compact shell deposit of considerable age and of possible interest to marine biologists.

#3 An artefact rich area at the head of the original 1874 jetty, has been heavily disturbed by work boats and ferries over the last decade. Should the proposed sea-bed dredging that resulted in the provision of a grant for this study be limited to the already heavily disturbed area to the east of the existing jetty structure, then the rich layers of 19th century artefactual material still remaining on the west side and under the Jetty will remain relatively undisturbed.

#4 Modern, though not necessarily insignificant, material lies on sand under the sea-bed around the Whaler's Jetty.

#5 Toxic materials lie within some of the sediments examined, notably those under the old Mail Steamer Jetty.

#6. The sea-bed around the Albany Town Jetty appears to contain a lower percentage of alcoholic and non-alcoholic containers when compared with the Fremantle Long Jetty. This indicates that the Albany Town Jetty was not used as a promenade or for recreation to the same extent as the Fremantle Long Jetty. This observation is confirmed by the historical record and it appears to have been the result of the Port and Town being physically separated by the railway in the 1880s. (See page 7 and pages 10-18 for details).

14.0 Recommendations

#1 It is recommended as a result of this study, that the entire west side of the existing jetty structures be left undisturbed by any future development. This area is highlighted below. Some means of preventing the MV*Warren* propeller wash penetrating through to this western side should be examined.

#2 That the proposed refurbishment of the Albany Town Jetty structures be designed to produce a limited impact on the sea-bed.

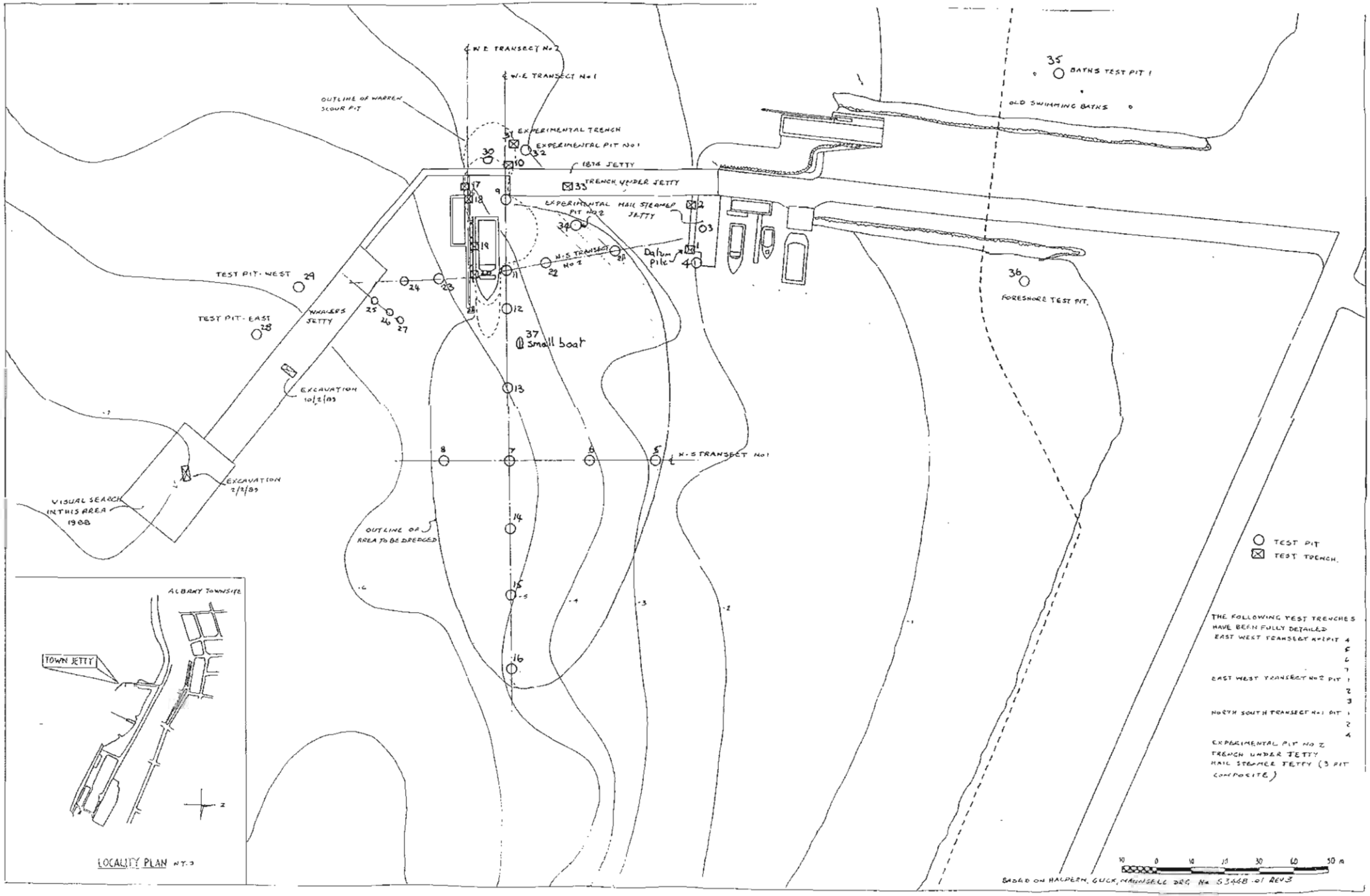
#3 If possible, the area around the Whaler's Jetty be also left undisturbed by dredging as it contains material that will in time be considered of significance.

4 Should the area under and around the existing jetties need to be dredged, the possibility of disturbing toxic material must be considered in the management of the spoil and the materials contained within it.

#5. The results of the Albany Town Jetty excavation should be compared in greater detail with remains found at other jetties such as The Fremantle Long Jetty and Glenelg Jetty at Holdfast Bay, South Australia.

#6 Technical and popular reports should follow this study.

Figure 25. Site Plan: The relatively undisturbed, artefact rich areas. O The area for proposed dredging. O



PART F. SIGNIFICANCE OF THE JETTY

15.0 Assessment of Cultural Significance

This assessment of the cultural significance of the Town Jetty is based on the criteria adopted in *The Australia ICOMOS Charter of the conservation for places of cultural significance (Burra Charter)* .

15.1 Historical Significance

The Town Jetty site is of national and regional significance. This has been treated in depth in a number of previous heritage studies, notably Wolfe (1994). It is also included in an analysis of port-related structures on the Coast of Western Australia generally (Cumming, Garratt, McCarthy and Wolfe, in prep). The Jetty was the gateway to Australia for international passenger steamships arriving from Europe via Cape Leeuwin between 1862 and 1900. During this period it was also the principal landing place in Western Australia for the international mails and also immigrants and visitors arriving in the State. It was also an embarkation and disembarkation point of passengers on the Western Australian coastal shipping service and a significant landing and loading point for Western Australian imports and exports between 1862 and 1900.

The Town Jetty also has high local significance. It was an integral part of the Town and the focus of commercial traffic from 1862 until the 1920s. It was also a focal point for the local community and in the early part of the 20th century was fitted with tea rooms, bathing baths, the Princess Royal Yacht Club boat shed and a building for the Naval Cadets. The Jetty was and still is, a popular fishing location, a historic landmark on the Albany foreshore with high aesthetic and social value in the local community. It is also a tourist asset.

15.2 Technological Significance

The Jetty site has the potential to illustrate the symbiosis between harbour and railway technology in the late 19th century, the development of 19th and 20th century jetty construction in Western Australia, changes in cargo handling technology in the latter part of the 19th century; and the problems of locating harbour facilities in shallow water at a time of rapid change in cargo and ship handling technology.

15.3 Scientific Significance

The Jetty is of maritime archaeological importance. The sea-bed under and adjoining the Jetty is known to contain deposits of artefact material which may date from the early 1860s which may be able to contribute to our knowledge of cargoes, trade patterns and other marine related activities on the Western Australian coast since this time.

The extensive shell deposits could contain indications of a pre-historic aboriginal presence along the shore-line.

The site also has the potential to provide information about the hydrography and benthic environment of Princess Royal Harbour and the degradation and preservation of materials in a marine environment.

15.4 Educational Significance

The Jetty has the potential to help illustrate and provide a focus for studies into the development of mail and steamship services to and from Western Australia in the 19th century, the development of port facilities in Western Australia, the development of Western Australia's coastal steam ship service in the 19th and 20th centuries, migration to Albany and Western Australia in the 19th century, the development of the Port of Albany and the operation of Albany's tug boat and launch services in the 19th and 20th centuries.
Being a multi-purpose site the site generally can assist in providing a focus for studies into the history of Albany's swimming baths, the early history of the Princess Royal Yacht Club and the development of tourism at Albany.

These facets also suggest that the Albany Town Jetty also has relevance within the context of the following themes:

1. Transport and communication;
2. Maritime services;
3. Trade;
4. Tourism and recreation;
5 The study of port related structures generally.

15.5 Rarity

Though most of the original structure now lies under the land-fill, in the 1960s and the 1970s parts of the remaining Jetty were rebuilt leaving some of the 1890s structure intact and in use today. The Albany Town Jetty then may be the oldest jetty site still in use in Western Australia. Within this context the site could be considered rare.

15.6 Representativeness

The Albany Town Jetty site, in part, is an example of a wooden jetty built in the late 19th century.

15.7 Grouping

Similar jetty structures, or their remains survive elsewhere and some of these structures are of a similar age, design and purpose. As a group they have the potential to reveal a broad range of comparative historical, social, technological, scientific and educational data. As a result, the management strategies below should be implemented as soon as possible.

PART G. POST EXCAVATION MANAGEMENT

16.0 Management Strategies

16.1 Legal Protection

The site will be nominated to the Heritage Council of Western Australia for protection as an historic structure under the *Heritage Act* (1990). The sea-bed around the jetty is protected under the *Maritime Archaeology Act* 1973.

16.2 Site Inspections

The Maritime Museum will conduct further site inspections. These will be undertaken on an *ad hoc* basis, preferably at intervals no greater than two years.

16.3 Collection Display Issues

Selected materials recovered from the jetty are exhibited at the Residency Museum and can be prepared for other suitable venues in the Albany area as part of the Western Australian Maritime Museum's public education brief and as a means of allowing visitors and residents an insight and appreciation of the history of the region.

16.4 Records Management

The documents and pictorial records associated with Maritime Museum activity with the site are documented, catalogued and stored in such a manner as to be accessible to *bona fide* researchers. The results of this and further archaeological research and associated analyses will be published in a variety of sources. Duplicates of photographs and transparencies from the photographic collection can be made available to other researchers.

16.4.1 Working Files

The Department of Maritime Archaeology at the WA Maritime Museum maintains a file on the Albany Town Jetty (File No. MA 80.94, 'Albany Town Jetty'. Other records relating to the jetty are located in file No. MA 2.93, 'Jetties and Port-related Structures Project' and File No. MA 195.72 (5 volumes), 'Area-Albany Wrecks'. The fieldwork Day Book and the Artefact Register are incorporated in one book. Excavation plans, underwater data sheets, artefact drawings, maps and plans have been photocopied in case of loss or damage to the originals. The copies and the original documents are located in a Department map filing cabinet marked 'Albany Town Jetty'. Computer records are archived on optical disks and stored in the department. Access to these should be provided to scholars, as is currently the case.
The Department for Materials Conservation maintains records for artefacts that are undergoing or have completed conservation treatments.

16.4.2 External Publications

Two recently published reports by Wolfe, (1994 a & b) provide information on the history and cultural significance of the jetty and its environs. These should be made generally available in Albany libraries and heritage repositories.

16.4.3 In-house Publications and Unpublished Articles

The reports by Richards (1995), which gives detailed information on the dynamics between the physical environment and the artefactual material on the Albany Town Jetty site, (see appendix H), should be available at the relevant repositories.

16.4.4 Audio/Visual Collection

The photographic collection consists of monochrome and colour photographs and slide transparencies. The audio/visual collection includes video tapes in Hi 8 and V8 formats. These collections have been catalogued and indexed and the records can be accessed on-line or via several printed indexes in the Department of Maritime Archaeology. (See appendix G).

17.0 Future Research Suggestions

The Principle Australian Themes project conducted by the Centre for Western Australian History (1994) has identified a number of themes relevant to the study of Australian history. These themes have also been used in the Historic Shipwrecks National Research Plan (1994) to make recommendations regarding research priorities for the future study of maritime archaeology in Australia. These themes and priorities are also relevant to the Albany Town Jetty site, a rich cultural resource presenting many diverse opportunities for further research.

The themes identified in the Principle Australian themes project are:

1. Tracing the evolution of Australia's special environments
2. Populating the continent.
3. Developing an Australian economy linked to world markets.
4. Building Australian towns and cities.
5. Working in Australia.
6. Educating Australia.
7. Governing Australia.
8. Developing Australian cultural institutions and ways of life.

Based on this framework, the Historic Shipwreck National Research Plan has recommended...*that the historic themes of 'Populating the continent' 'Developing an Australian economy linked to world markets' and 'Developing Australian cultural institutions and ways of life' be adopted as setting the framework for research into Australia's historic shipwrecks.* (Edmonds, et. al (1994).

17.1 Historical

A data-base of publications for Jetty and Port Related Structures on the Western Australian coast generally has been prepared by a number of scholars, notably the late Denis Cumming, assisted by Wolfe and Garratt, supervised by Mr McCarthy. Garratt is currently under contract to the Maritime Museum in order to complete and compile the work. This and Wolfe's historical account in these pages can be used in conjunction with his recent *The Albany Maritime Heritage Survey : 1627—1994* (Wolfe, 1994b), De La Marshall's *Memories of maritime Albany* (de la Marshall, 1994) and other recent works as a basis for further thematic or site and topic-specific studies on this particular site and on port-related structures generally. These will be made available in the relevant repositories, including those at Albany.

Within the context of the general themes outlined above, further study of the history of the Albany Town Jetty could contribute to an understanding of:

1. Migration to Australia from 1862 to the early 1900s. **(Populating the continent).**

2. The development of port facilities at Albany and in Western Australia generally;
   The development of coastal trade;
   and the development of communication and shipping routes to Australia.
   (Developing an Australian economy linked to world markets).

3. The development of tourism and recreation in Albany and Western Australia since thelate 1880s. **(Developing Australian cultural institutions and ways of life).**

4. The development of Albany's first town centre; and the development of Western Australia's port towns and cities. **(Building Australian towns and cities.)**

5. The evolution of the working environment on the Albany and Western Australian water front. **(Working in Australia).**

6. Albany's and Western Australia's custom Services; Albany's Port administration; and Albany's role in the Boer War and World War I and II. **(Governing Australia).**

17.2 Archaeological

There is scope for comparative studies of the archaeological record from the Albany Town Jetty excavation with other jetty excavations throughout Australia and overseas. An analysis of results from the excavations of the Ocean Jetty (Long Jetty) at Fremantle, Morgan Wharf and Holdfast Bay Jetty in South Australia and overseas at Derby Wharf in Salem, Massachusetts in the United States for example, may assist in recognising and describing the processes of deposition and distribution of cultural material at jetty sites.

The possibility that the extensive shell deposits in the region could contain indications of a pre-historic Aboriginal presence on the shore of the harbour was not tested due to the small sample of shell material analysed. The layers may also be of biological interest. The inter-disciplinary analysis of shell layers is an interesting possibility, one that is worthy of future study given that this excavation has shown that the beds can be excavated and accurately assessed. This is especially so in the test trench mode, (utilising existing slopes exposed in scour pits),. as opposed to the test pit mode, which generally results in an unsatisfactory excavation wall and nil visibility.

17.3 Materials Conservation

A report by Richards (1995) gives detailed information on the dynamics between the physical environment and the artefactual material on the Albany Town Jetty site. (See appendix H). This study represents the beginnings of this type of analysis in the study of port-related structures generally. The archaeological and materials conservation/management value of these studies has been previously demonstrated at the excavation of the SS *Xantho* (McCarthy, in prep), and more recently at other places where excavation is conducted. It is expected that all other excavations at port-related structures will be preceded by similar pre-disturbance work.

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APPENDICES

A. Catalogue of excavation sites–Albany Town Jetty

B. Catalogue of Albany Town Jetty excavation drawings

C. Radiocarbon dating analyses of shell samples recovered from the Albany Town Jetty

D. Register of artefacts recovered from the Albany Town Jetty 1988–1994

E. Catalogue of Albany Town Jetty artefacts on exhibition, Residency Museum, Albany

F. Catalogue of Albany Town Jetty artefact drawings

G. Catalogue of Albany Town Jetty audio/visual materials

H. Conservation management–Albany Town Jetty

I. Chemistry Centre (WA) report–Albany Town Jetty

J. Health Department of Western Australia report–Albany Town Jetty

K. Small Boat Wreck Inspection report
Data-Scour pit west of the *Warren* tug boat berth at the Albany Town Jetty

L. Dive Log–Albany Town Jetty

M. Maritime Heritage Inspection Report–Albany Town Jetty

N. Height Datum References

O. Wages and Salaries c1870 (annual income)

APPENDIX A

CATALOGUE OF EXCAVATION SITES–ALBANY TOWN JETTY

APPENDIX A

CATALOGUE OF EXCAVATION SITES–ALBANY TOWN JETTY

Key: # indicates excavation site number.

AREA	Excavation date
Mail Steamer Jetty	
#01. Test pit near Datum pile	22.11.94
#02. [a,b,c] Test pit, No. 1. [Inner]	03.12.94
#03. Test pit No. 2.[(Middle]	03.12.94
#04. Test pit No. 3.[(Outer]	03.12.94
North-South Transect No. 1.	
#05. Test Pit No. 1.	24.11.94
#06. Test Pit No. 2.	28.11.94
#07. Test Pit No. 3. [Also titled EW No.1 Test pit No. 6]	28.11.94
#08. Test Pit No. 4.	28.11.94
East-West Transect No. 1	
#09. Test pit No. 1.	23.11.94
#10. Step trench No. 2.	26.11.94
#11. Test pit No. 3.	27.11.94
#12. Test Pit No. 4.	30.11.94
#13. Test Pit No. 5.	30.11.94
#14. Test Pit No. 7.	30.11.94
#15. Test Pit No. 8.	30.11.94
#16. Test Pit No. 9.	30.11.94
East-West Transect No. 2	
#17. Trench No. 2.	27.11.94
#18. Step Trench No. 1.	27.11.94
#19. Step trench No. 3.	29.11.94
#20. [a,b,c,d] Step trench No. 4. [extended]	30.11.94
North-South Transect No. 2.	
#21.	03.12.94
#22.	03.12.94
#23.	03.12.94
#24.	03.12.94
Whaler Wharf - east side	
#25.	02.12.94
#26.	02.12.94
#27.	02.12.94
Whaler Wharf - west side	
#28. Test pit - east No. 1.	07.12.94
#29. Test pit - west No. 2.	07.12.94
#30. Tug wash scour pit- surface inspection.	07.12.94
West side of ATJ in tug *Warren* scour pit.	
#31. Experimental trench No. 1.	08.12.94
#31. Experimental trench No. 1.	08.12.94
#32. Final experimental trench	08.12.94

Appendix A (cont)

#33. Underneath ATJ	01.12.94
#34. East side of ATJ	01.12.94
#35. Old Baths site [west side of batter]	03.12.94
#36. East side of batter	07.12.94
#37. Small boat	02.12.94

APPENDIX B

CATALOGUE OF EXCAVATION SITE DRAWINGS–ALBANY TOWN JETTY

APPENDIX B

CATALOGUE OF EXCAVATION SITE DRAWINGS–ALBANY TOWN JETTY

Key: # indicates excavation site number. Refer to master plan.

Mail Steamer Jetty.	
#01. Test pit near Datum pile	22.11.94
#02. [a,b,c] Test pit, [Inner]	03.12.94
#03. Test pit No. 2. [Middle]	03.12.94
#04. Test pit No. 3. [Outer]	03.12.94
North-South Transect No. 1.	
#05. Test Pit No. 1.	24.11.94
#06. Test Pit No. 2.	28.11.94
#07. Test Pit No. 3. [Also titled EW No.1 Test pit No. 6]	28.11.94
#08. Test Pit No. 4.	28.11.94
East-West Transect No. 1.	
#11. Test pit No. 3.	27.11.94
#12. Test Pit No. 4.	30.11.94
#13. Test Pit No. 5.	30.11.94
#14. Test Pit No. 7.	30.11.94
East-West Transect No. 2.	
#17. Trench No. 2.	27.11.94
#18. Step Trench No. 1.	27.11.94
#19. Step trench No. 3.	29.11.94
#20. [a,b,c,d] Step trench No. 4. [extended]	30.11.94
Whaler Wharf - west side.	
#28. Test pit - east No. 1.	07.12.94
#29. Test pit - west No. 2.	07.12.94
Tug *Warren* - Wash scour pit	
#30. Surface inspection. (A Wolfe)	07.12.94
#31. Experimental trench No. 1. View 1. (R. Shaw)	08.12.94
#31. Experimental trench No. 1. Views 2 & 3. (A. Wolfe)	08.12.94
#32. Final experimental trench	08.12.94
ATJ	
#33. Test pit underneath ATJ	01.12.94
#34. East side of ATJ	01.12.94
#37. Small boat - Isometric (A. Wolfe)	12.12.94

APPENDIX C

RADIOCARBON DATING ANALYSES–ALBANY TOWN JETTY

Prepared by Beta Analytic Inc. for the NWG Macintosh Centre for Quarternary Dating, University of Sydney, NSW.

BETA ANALYTIC INC.

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REPORT OF RADIOCARBON DATING ANALYSES

OR: Ms. G. Taylor and Dr. M. Barbetti
The University of Sydney

DATE RECEIVED: January 25, 1995
DATE REPORTED: March 2, 1995

Sample Data	Measured C14 Age	C13/C12 Ratio	Conventional C14 Age (*)
eta-79754	5340 +/- 130 BP	+ 2.4 o/oo	5800 +/- 140 BP
AMPLE #: ATJ 124 NALYSIS: radiometric-standard ATERIAL/PRETREATMENT:(shell): acid etch OMMENT: small sample resulting in low precision (< 1 gm C)			
eta-79755	1290 +/- 70 BP	+ 1.9 o/oo	1730 +/- 80 BP
AMPLE #: ATJ 125A Sample 1 NALYSIS: radiometric-standard ATERIAL/PRETREATMENT:(shell): acid etch			
eta-79756	2250 +/- 60 BP	+ 0.7 o/oo	2670 +/- 60 BP
AMPLE #: ATJ 125B Sample 2 NALYSIS: radiometric-standard ATERIAL/PRETREATMENT:(shell): acid etch			
eta-79757	4640 +/- 80 BP	+ 1.3 o/oo	5070 +/- 80 BP
AMPLE #: ATJ 125C Sample 3 NALYSIS: radiometric-standard ATERIAL/PRETREATMENT:(shell): acid etch			

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

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REPORT OF RADIOCARBON DATING ANALYSES

OR: Ms. G. Taylor and Dr. M. Barbetti

Sample Data	Measured C14 Age	C13/C12 Ratio	Conventional C14 Age (*)
ta-79758	1270 +/- 70 BP	+ 1.2 o/oo	1700 +/- 80 BP

MPLE #: ATJ 125D Sample 4
ALYSIS: radiometric-standard
TERIAL/PRETREATMENT:(shell): acid etch

Sample Data	Measured C14 Age	C13/C12 Ratio	Conventional C14 Age (*)
ta-79759	2690 +/- 70 BP	+ 2.1 o/oo	3140 +/- 70 BP

MPLE #: ATJ 125E Sample 5
ALYSIS: radiometric-standard
TERIAL/PRETREATMENT:(shell): acid etch

TE: Two additional samples, ATJ 123 and ATJ 143, are "on hold" pending instructions.

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

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REPORT OF RADIOCARBON DATING ANALYSES

FOR: Ms. G. Taylor and Dr. M. Barbetti
The University of Sydney

DATE RECEIVED: Auth. March 13, 1995
DATE REPORTED: March 21, 1995

Sample Data	Measured C14 Age	C13/C12 Ratio	Conventional C14 Age (*)
Beta-79753	6070 +/- 70 BP	+ 2.3 o/oo	6520 +/- 80 BP
SAMPLE #: ATJ 123 ANALYSIS: radiometric-standard MATERIAL/PRETREATMENT:(shell): acid etch			
Beta-79760	900 +/- 60 BP	+ 1.3 o/oo	1340 +/- 70 BP
SAMPLE #: ATJ 143 ANALYSIS: radiometric-standard MATERIAL/PRETREATMENT:(shell): acid etch			

NOTE: It is important to read the calendar calibration information and to use the calendar calibrated results (reported separately) when interpreting these results in AD/BC terms.

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By international convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

THE NWG MACINTOSH CENTRE FOR QUATERNARY DATING

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Director : Mike Barbetti

Radiocarbon Manager : Gillian Taylor

Dr Mike McCarthy
Department of Maritime Archaeology
WA Maritime Museum
Cliff St
Fremantle WA 6160

3rd April 1995

Dear Mike,

Please find enclosed the result report for your remaining two shell samples submitted to Beta Analytic USA for radiocarbon dating.

Results are obtained on the portion of suitable carbon remaining after necessary chemical and mechanical pretreatments of the submitted material. These pretreatments were applied to isolate C14 which may best represent the time event of interest. Along with each sample result, the individual analysis method and delivery basis, material, and chemical pretreatment is reported. The pretreatment method used for your samples is described in the accompanying note.

Materials measured by the radiometric technique are analysed by synthesising benzene (92% C) from the sample carbon, measuring for C14 content in one of Beta's 68 liquid scintillation spectrometers, and then calculating for radiocarbon age. AMS results are derived from the synthesis of graphite (100 %C) from the sample carbon, along with standards and backgrounds, followed by C14 measurement and calculation in the accelerator-mass-spectrometer located at one of three collaborating laboratories ; Lawrence Livermore National Laboratory (CAMS) in California, Eidgenossische Technische Hochschule University (ETH) in Zurich, or Oxford University (Ox) in Oxford, England.

The "Conventional C14 Age (*)" is the result after applying C13/C12 corrections to the measured age and is the most appropriate radiocarbon age (the "*" is discussed at the bottom of the report sheet). Applicable calendar calibration (results 0 to 7200 BP, suitable materials) are enclosed, along with a calibration explanation note. This should be read before interpreting the results.

If you have any further queries regarding your samples, please do not hesitate to contact us.

Best Wishes,

Gillian Taylor

PRETREATMENT

Pretreatment of submitted materials is required to eliminate secondary carbon components. These components, if not eliminated, could result in a radiocarbon date which is too young or too old. Pretreatment does not ensure that the radiocarbon date will represent the time event of interest. This is determined by the sample integrity. The old wood effect, burned intrusive roots, bioturbation, secondary deposition, secondary biogenic activity incorporating recent carbon (bacteria) and the analysis of multiple components of varying age are just some examples of potential problems. The pretreatment philosophy is to reduce the sample to a single component, where possible, to minimise the added subjectivity associated with these types of problems.

"acid etch"

The calcareous material was first washed in deionised water, removing associated organic sediments and debris (where present). The material was then crushed/dispersed and repeatedly subjected to HCl etches to eliminate secondary carbonate components. In the case of thick shells, the surfaces were physically abraded prior to etching down to a hard, primary core. In the case of porous carbonate nodules and caliche, very long exposure times were applied to allow infiltration of the acid. Acid exposure tomes, concentrations, and number of repetitions were applied accordingly with the uniqueness of the sample.

Typically applied to: shells, caliche, calcareous nodules

BETA ANALYTIC INC.
RADIOCARBON DATING LABORATORY
CALIBRATED C-14 DATING RESULTS

Calibrations of radiocarbon age determinations are applied to convert BP results to calendar years. The short term difference between the two is caused by fluctuations in the heliomagnetic modulation of the galactic cosmic radiation and, recently, large scale burning of fossil fuels and nuclear devices testing. Geomagnetic variations are the probable cause of longer term differences.

The parameters used for the corrections have been obtained through precise analyses of hundreds of samples taken from known-age tree rings of oak, sequoia, and fir up to 7,200 BP. The parameters for older samples, up to 22,000 BP, as well as for all marine samples, have been inferred from other evidence. Calibrations are presently provided for terrestrial samples to about 10,000 BP and marine samples to about 8,300 BP.

The Pretoria Calibration Procedure program has been chosen for these dendrocalibrations. It uses splines through the tree-ring data as calibration curves, which eliminates a large part of the statistical scatter of the actual data points. The spline calibration allows adjustment of the average curve by a quantified closeness-of-fit parameter to the measured data points. On the following calibration curves, the solid bars represent one sigma statistics (68% probability) and the hollow bars represent two sigma statistics (95% probability). Marine carbonate samples that have been corrected for $\delta^{13/12}C$, have also been corrected for both global and local geographic reservoir effects (as published in Radiocarbon, Volume 35, Number 1, 1993) prior to the calibration. Marine carbonates that have not been corrected for $\delta^{13/12}C$, have been adjusted by an assumed value of 0 ‰ in addition to the reservoir corrections. Reservoir corrections for fresh water carbonates are usually unknown and are generally not accounted for in those calibrations. In the absence of measured $\delta^{13/12}C$ ratios, a typical value of -5 ‰ was assumed for freshwater carbonates. There are separate calibration data for the Northern and Southern Hemisphere. Variables used in each calibration are listed below the title of each calibration page.

(Caveat: the calibrations assume that the material dated was living for exactly ten or twenty years (e.g. a collection of 10 or 20 individual tree rings taken from the outer portion of a tree that was cut down to produce the sample in the feature dated). For other materials, the maximum and minimum calibrated age ranges given by the computer program are uncertain. The possibility of an "old wood effect" must also be considered, as well as the potential inclusion of some younger material in the total sample. Since the vast majority of samples dated probably will not fulfill the ten/twenty-year-criterium and, in addition, an old wood effect or young carbon inclusion might not be excludable, these dendrocalibration results should be used only for illustrative purposes. In the case of carbonates, reservoir correction is theoretical and the local variations are real, highly variable and dependant on provenience. The age ranges and, especially, the intercept ages generated by the program must be considered as approximations.)

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=2.3:Delta-R=-5±35:Global res=-200-500:lab mult.=1)

Laboratory Number: Beta-79753

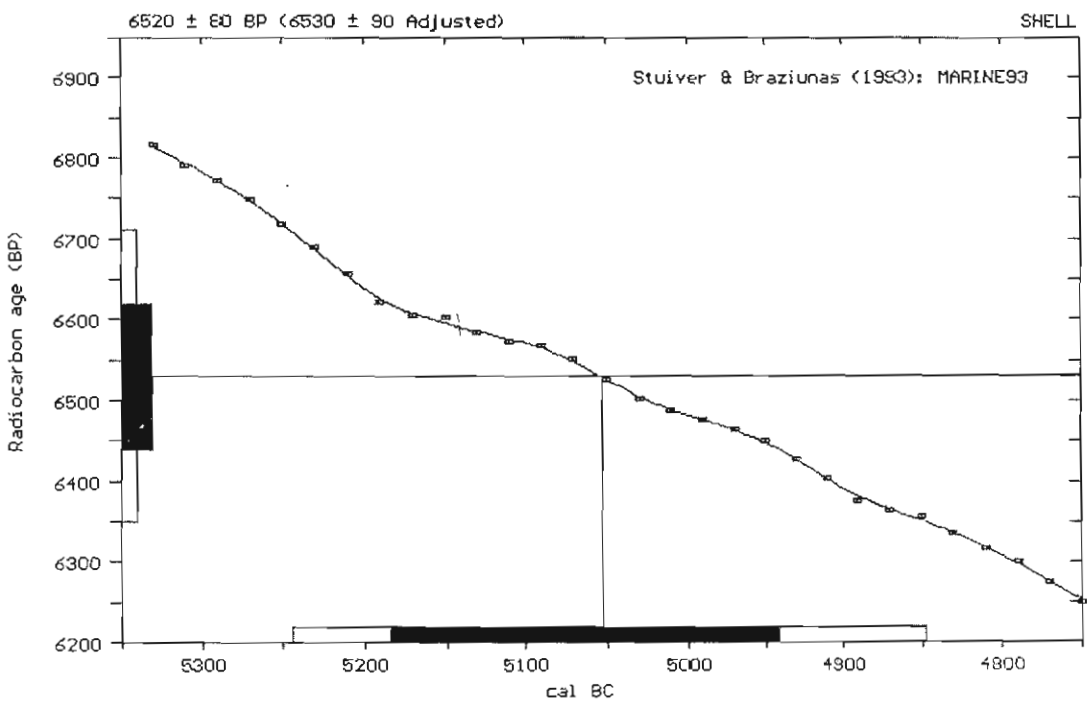
Conventional radiocarbon age: 6520 +/- 80 BP
(6530 +/- 90 adjusted for local reservoir correction)

Calibrated results: cal BC 5245 to 4845
(2 sigma, 95% probability)

Intercept data:

Intercept of radiocarbon age with calibration curve: cal BC 5055

1 sigma calibrated results: cal BC 5185 to 4940
(68% probability)



References:

Vogel, J. C.,Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., Radiocarbon 35(1)

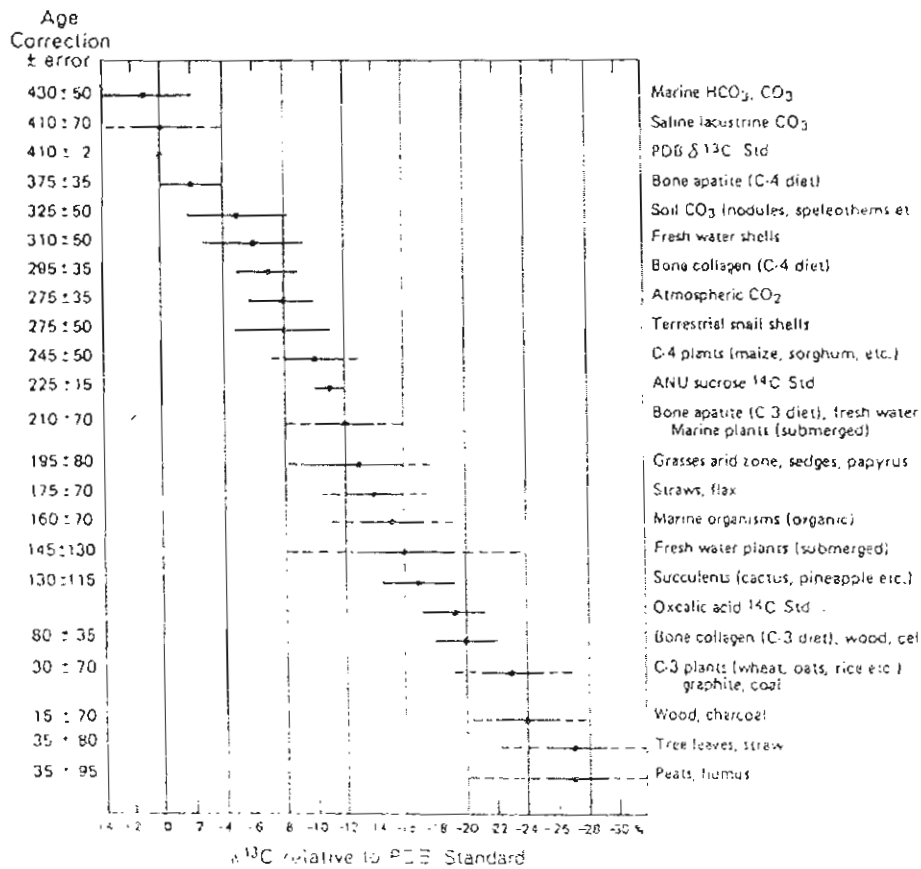
Results prepared by:

Beta Analytic, Inc. 4985 S.W. 74th Court, Miami, Florida 33155

Derivation of a radiometric or accelerator dendro-calibrated (CALENDAR) date requires use of a CONVENTIONAL radiocarbon date (Stuiver and Polach)[1]. The conventional date is a basic radiocarbon date that has been normalized to the modern standard through the use of C13/C12 ratios* (analyzed or estimated). The statistical error (+/-) on an analyzed C13/C12 value is quite small and does not contribute significantly to the combined error on the date. However, use of an estimated C13/C12 ratio for an unknown sample may incur a very large combined error term. This is clearly illustrated in the figure below (Gupta & Polach; modified by J. Head)[2] where the possible range of C13/C12 values for a particular material type may be so large as to preclude any practical application or correction.

In cases where analyzed C13/C12 values are not available, we have provided (for illustration) dendro-calibrations assuming a mean "chart" value, but without an estimated error term.

Where a sample carbon reservoir different from the modern oxalic acid/wood modern standard (e.g. shell) is involved, a further correction must be employed; the necessary variables are displayed on the calibration sheet.



[1]Stuiver, M. and Polach, H.A., 1977 Discussion, Reporting of 14-C data, Radiocarbon 19 355-363

[2]Gupta S.K. and Polach H.A. 1985 Radiocarbon dating practices at ANU Handbook,p.114. Radiocarbon Laboratory, Research School of Pacific Studies, ANU, Canberra.

*Radiocarbon is incorporated into various materials by different pathways and this introduces differing degrees of isotopic fractionation. The C13/C12 ratio of any material is the millesimal difference of the sample to the carbonate PDB standard and is directly related to the C14/C12 ratio. The degree of sample C-14 enrichment or depletion then is normalized to that of the modern standard.

APPENDIX D

REGISTER OF ARTEFACTS RECOVERED FROM THE ALBANY TOWN JETTY
1988—1994

APPENDIX D

REGISTER OF ARTEFACTS RECOVERED FROM THE ALBANY TOWN JETTY 1988—1994

Reg. No.	Code	Description	Date	Area	Notes
ATJ 1	29	Yellow china dinner plate 25cm Diam.	12.11.88	A1 p.6	Johnson Australia Removed by South Coast Divers in surface search of grid area.
ATJ 2	44	Brylcream jar	12.11.88	A2	As above
ATJ 3	44	Boiler Glass (Now broken)	12.11.88	C2 p.10	Removed by SCD in Tugwash, area C
ATJ 4	44	Small 'Champagne' bottle	12.11.88	A2	Removed by SCD in Tugwash, area C
ATJ 5	44	3 x small black beers	12.11.88	C	Removed by SCD in Tugwash, area C
ATJ 6	44	Small green bottle	12.11.88	C	Removed by SCD in Tugwash, area C
ATJ 7	44	clear jar	12.11.88	C	Removed by SCD in Tugwash, area C
ATJ 8	29	Coal fragment White plate section. 2 x Adelaide Steamship Co. plate sections	12.11.88	C	Removed by SCD in Tugwash, area C
ATJ 9	44	Small perfume/medicine bottle	02.02.89	A2 p.8	10cm deep
ATJ 10	44	'Pick Axe' beer bottle	02.02.89	A2	20cm deep
ATJ 11	44	Black beer bottle	02.02.89	A2	80m deep
ATJ 12	44	Green 'Champagne' bottle	02.02.89	A2	
ATJ 13	82	Harpoon head	11.02.89	B 3/4 p.10	20cm deep
ATJ 14	12	Lump coal	11.02.89	B5	
ATJ 15	82	Engine room sign	11.02.89	B3	
ATJ 16	86	Sunglasses in conc	11.02.89	B4	
ATJ 17	41	Shoe	12.02.89	C	Tug prop wash (6-8m from Datum)
ATJ 18	41	Shoe	12.02.89	C	
ATJ 19	41	12 x assorted cut bones	12.02.89	C	Jawbone down 8m
ATJ 20	29	14 x Ad.Steam. Co. sherds	12.02.89	C	

ATJ 21	29	*Rob Roy* sherd	12.02.89	C	Others found many years ago complete from Whaler prop wash. or south side of jetty 7.4m down with pewter capsule.
ATJ 22	29	Plate and assorted sherds	12.02.89	C	
ATJ 23	28	3 xiIntact bottle necks	12.02.89	C	
ATJ 24	44	4 x 'Champagne'	12.02.89	C	
ATJ 25	44	Black bottles(2 small. 2 large)	12.02.89	C	
ATJ 26	44	7 x green bottles	12.02.89	C	
ATJ 27	44	Bottle light green (Pickle)	12.02.89	C	
ATJ 28	44	Pale green bottle	12.02.89	C	
ATJ 29	44	Amber bottle	12.02.89	C	8.0m depth
ATJ 30	46	Rope / hessian	12.02.89	C	
ATJ 31	12	Coal	12.02.89	C	8.2m depth
ATJ 32	27	Pipe stem	12.02.89	C	
ATJ 33	32	Brooch	12.02.89	C	
ATJ 34	44	Hamilton Bottle 'Ross's Belfast'	12.02.89	C7	
ATJ 35	13	Ballast rock	12.02.89	D	On surface of tugwash extremities By SCD under *Princess Royal* Berth
ATJ 36	44	3 x small black bottles	10.01.90	D	" "
ATJ 37	44	8 x champagne	10.01.90	D	" "
ATJ 38	29	5 x sherds	10.01.90	D	" "
ATJ 39	44	2 x green bottles	10.01.90	D	" "
ATJ 40	44	'Lamont' bottle	10.01.90	D	" "
ATJ 41	44	Pickle bottle /jar. pale green	10.01.90	D	" "
ATJ 42	44	Pickle bottle /jar. pale green with cork	10.01.90	D	" "
ATJ 43	44	Whisky bottle	10.01.90	D	" "
ATJ 44	44	Bottle (small black with conc)	10.01.90	D	" "
ATJ 45	44	Blue glass stopper	10.01.90	D	" "
ATJ 46	44	Glass tumbler base	10.01.90	D	" "

ATJ 47	44	Blue Line serving plate frag	10.01.90	D	" "
ATJ 48	44	3 x Adelaide S. Co. plate sherds	10.01.90	D	" "
ATJ 49	44	Plate frag (green/white)	10.01.90	D	" "
ATJ 50	44	Mug sherd (blue floral)	10.01.90	D	" "
ATJ 51	21	Stoneware jar lid	10.01.90	D	" "
ATJ 52	21	Stoneware jar base sections x 2	10.01.90	D	" "
ATJ 53	32	Brass ferrule(poss knife handle)	10.01.90	D	" "
ATJ 54	28	Plate Adelaide.Steamship. Co.	31.01.91		SCD (22.1.91)
ATJ 55	52	Penny (English, 1910) Edward VII 1902-	31.01.91		SCD (22.1.91)
ATJ 56	44	Clear glass pickle bottle 2 pc mould, applied top	2.11.94	C ext	'...GW 388' "Warren " tug wash
ATJ 57	44	Black 'champagne' mid size	22.11.94	C ext	Warren tug wash
ATJ 58	27	Pipe bowl with prominent spur	22.11.94	C ext	Warren tug wash Mail Steamer Jetty
ATJ 59	21	Stoneware bottle, two-tone glaze 22cm buff (base) caramel (top)	23.11.94	D.MSJ	Found at depth of 1m.
ATJ 60	44	Clear glass (toilet water) bottle Height 15cm	22.11.94	D.MSJ	Silt-1m.
ATJ 61	44	Clear glass screw top bottle 2-piece mould. 'GSR Property of GRS (sic) Mineral Water Co.Katanning'	23.11.94	D.MSJ	Silt/shell-1.10m.
ATJ 62	48	Oyster, helmet, triton shells x4	23.11.94	D.MSJ	Depth 1.10–1.45.m
ATJ 63	12	2 x coal	23.11.94	D.MSJ	Depth 40cm-70cm.
ATJ 64	46	Mens leather shoe (heel separate)	23.11.94	D.MSJ	Depth 1m. Heel 1.6m.
ATJ 65	41	Bone	23.11.94	D.MSJ	Depth 1.60m.
ATJ 66	44	'Champagne' bottle	23.11.94	D.MSJ	Depth 40cm.
ATJ 67	44	'Codd' bottle (broken neck) 'PJ Lambert Albany'	23.11.94	D.MSJ	Found beside wheel near the datum pile.
ATJ 68	13	3 x ballast stones	25.11.94	D.MSJ	
ATJ 69	63	Cut branch approx. 1.2m long	25.11.94	D.MSJ	Poss. sandalwood.
ATJ 70	27	Clay pipe	25.11.94	C	2m outside grid, SW direction.

ATJ 71	44	Blue poison bottle.	25.11.94	C	35cm from SW corner of grid.
ATJ 72	21	Half plate 'Adelaide Steamship Co'	25.11.94	C	Surface material from tug wash.
ATJ 73	21	Half soup bowl 'Howard Smith & Co'	25.11.94	C	Surface material from tug wash.
ATJ 74	21	Half plate, 'AUSN'	25.11.94	C	Surface material from tug wash.
ATJ 75	27	Clay pipe 'William Blake City Road London'	25.11.94	C	Surface material from tug prop wash.
ATJ 76	32	Umbrella handle, copper/wood	25.11.94	C	" "
ATJ 77	44	Clear glass tumbler base	25.11.94	C	" "
ATJ 78	22	Part plate 'AF&Co. Brook St. Works Harley England'	26.11.94		" "
ATJ 79	22	Pot base. Impressed 'A'.	26.11.94		
ATJ 80	22	Part saucer 'Adelaide S.S. Co.'	26.11.94		Impressed mark on base.
ATJ 81	22	Part saucer	26.11.94		Surface material from tug prop wash.
ATJ 82	22	Part of fruit compote (bowl)	26.11.94		Surface material from tug prop wash.
ATJ 83	22	Part of saucer	26.11.94		Surface material from tug prop wash.
ATJ 84	22	Part plate Willow pattern	26.11.94		Surface material from tug prop wash.
ATJ 85	22	Egg cup (broken)	26.11.94		Surface materialfrom tug prop wash.
ATJ 86	44	Medical bottle, clear glass	26.11.94		Surface material from tug prop wash.
ATJ 87	67	Wood/brass umbrella handle	26.11.94		Surface material from tug prop wash.
ATJ 88	15	2 x flint stones	26.11.94	C	EW transect Grid No. 2.
ATJ 89	80	Pen knife	26.11.94	C	EW transect Grid No. 2.
ATJ 90	29	Portion of water jug (Art Deco)	27.11.94	C	Surface material from tug prop wash.
ATJ 91	44	Pickle jar with stylised 'B'Vita Reg No.	27.11.94	C	EW Transect Grid No.1, Line 2

ATJ 92	44	Square pickle Jar	27.11.94	C	EW Transect. Grid No. 1, Line 2
ATJ 93	44	Champagne type bottle	27.11.94	C	Grid No 11
ATJ 94	48	4 x cockle shells	27.11.94	C	Grid No 11
ATJ 95	44	3 x piece mould bottle clear glass	27.11.94	C	EW Transit Grid No. 2, Line 2
ATJ 96	44	2 x scent bottles	27.11.94	C	
ATJ 97	32	Compressed sheathing	27.11.94	C ext	Surface collection
ATJ 98	44	'Fanta' bottle	7.11.94	C	Surface immediately North of Grid 1
ATJ 99	21	Plate frag Green vine pattern	28.11.94	C	NS Transect .Hole 3 surface
ATJ 100	44	Green three piece mould bottle	28.11.94	C	NS Transect. Hole 3
ATJ 101	44	Black glass bottle with cork	28.11.94	C	NS Transect. Hole 3
ATJ 102	46	Right shoe (leather)	28.11.94	C	NS Transect. Hole 3
ATJ 103	44	Glass stopper with cork seal	29.11.94	C	EW Transect. Hole No. 3. N=1.10m, E=20cm, Z=45cm.
ATJ 104	32	Brass fastening 36mm long	29.11.94	C	EW Transect, Hole No. 3. N=70cm, E=35cm, Z=32cm.
ATJ 105	32	Brass rod with brass split pin	29.11.94	C	EW Transect. Hole No. 3. N=75cm, E=90cm, Z=90cm.
ATJ 106	32	Brass sheathing with fastening head embedded	29.11.94	C	EWT ransect. Hole No. 3. N=70cm, E=35cm, Z=32cm.
ATJ 107	48	4 x scallop shells, 3 x oyster shells (together), 1 piece coal.		29.11.94	WJ Hole No. 5. 1.9m below sea bed, sea bed depth 5.37m.
ATJ 108	44	Brown glass bottle	28.11.94		
ATJ 109	32	Sheathing metal (now 2 piece broken while packing)	30.11.94	C	EW Transect No 2. Step trenchNo4. N=38cm E=10cm, Z=30cm.
ATJ 110	41	Bone (beef?)	30.11.94	C	Transect No 2, Step trench No 4 Extended.N=120cm, E=90cm. Z=94cm.
ATJ 111	12	3 x coal, 2 x coke	30.11.94	C	Transect No 2, Step trench No 4

					Extended.N=120cm, E=90cm, Z=1.08m.
ATJ 112	44	Green glass bottle	30.11.94	C	Transect No 2, Step trench No 4 Extended. Distance from grid 1.16m N, Z=1.13m.
ATJ 113	48	2 Cockle shells	30.11.94	C	Transect No 2, Step trench No 4 Extended. Distance from grid 1.16m, Z=1.13m.
ATJ 114	44	'Champagne' bottle (green)	01.12.94	C. ATJ	Test pit No .1 under jetty. N=70cm, E=1.35m,Z=43cm
ATJ 115	44	'Champagne' bottle (green)	01.12.94	C. ATJ	Test pit No 1 under jetty. 65cm depth
ATJ 116	44	'Champagne' bottle (green)	01.12.94	C. ATJ	Test pit No 1 under jetty. 30cm depth
ATJ 117	44	'Champagne' bottle (green)	01.12.94	C. ATJ	Test pit No 1 under jetty. surface collection. No relation to trench.
ATJ 118	44	'Champagne' bottle (green)	01.12.94	C. ATJ	Test pit No 1 under jetty. 1.82m depth
ATJ 119	44	'Champagne' bottle top with cork inserted	01.12.94	C. ATJ	Test pit No 1 under jetty. Collected from spoil
ATJ 120	86	Conc with glass fragments	01.12.94	C. ATJ	Test pit No 1 under jetty. Retained for display
ATJ 121	12	Coal block	01.12.94	C. ATJ	Test pit No. 1 under jetty. Surface collection, outside hole, NE corner.
ATJ 122	21	Mug, (incomplete)	02.12.9		Surface collection, EW No. 1.
ATJ 123	48	Oyster shell (for analysis)	03.12.94	MSJ	Hole No. 1. Depth 1.7m
ATJ 124	48	Small oyster shells (for analysis)	04.12.94	MSJ	Hole No. 2. Depth 1.8m.
ATJ 125	48	5 bags of cockle shells (a,b,c,d,e)	05.12.94		EW 1. No. 1, 3 &4. For analysis.
ATJ 126	44	Glass jar (height 110mm)	07.12.94	MSJ	Whalers west trench No. 2

ATJ 127	44	Glass jar (height 179mm)	07.12.94	MSJ	Whalers west trench No. 2
ATJ 128	48	Tube worm casings	07.12.94	MSJ	Whalers east trench No. 1
ATJ 129	67	Wood with iron conc.	08.12.94		W. end tug wash. Surface collection
ATJ 130	25	House brick. A.B. Co.	08.12.94		W. end tug wash. Surface collection
ATJ 131	12	Coal	08.12.94		W. end tug wash. Surface collection
ATJ 132	12	Coal	08.12.94		W. end tug wash. Surface collection
ATJ 133	12	Coal	08.12.94		W. end tug wash. Surface collection
ATJ 134	25	House brick. 'A.B. Co'	08.12.94		W. end tug wash. Surface collection
ATJ 135	41	Bone -beef	08.12.94		W. end tug wash. Surface collection
ATJ 136	41	Bone -beef, scapula	08.12.94		W. end tug wash. Surface collection
ATJ 137	41	Bone	08.12.94		W. end tug wash. Surface collection
ATJ 138	41	Bones - miscellaneous	08.12.94		Final exp. trench. West 1874 jetty
ATJ 139	46	Leather - man's shoe/boot sole	08.12.94		Final exp. trench. West 1874 jetty
ATJ 140	48	4 x barnacle shells	08.12.94		Final exp. trench. West 1874 jetty
ATJ 141	30	Drive-in theatre speaker	08.12.94	WJ	S side. West trench
ATJ 142	30	bolt with washer	08.12.94		West end. tug wash. Surface colln.
ATJ 143	48	Shell - complete oyster	08.12.94		Final exp. trench. West 1874 jetty

Albany Town Jetty Artefact Register (cont)

ATJ 144	21	Large oval platter - incomplete	08.12.94		West end. tug wash. Surface colln.
ATJ 145	21	Bowl base. B&W transfer	08.12.94		Final step. trench. West tug wash.

ATJ 146	21	Large soup plate- incomplete	08.12.94	West end. tug wash. Surface colln.
ATJ 147	21	Plate frag. (blue decoration)	08.12.94	West end. tug wash. Surface colln.
ATJ 148	21	Side plate frag. (A.S.S. Co.) (H2829 on obverse)	08.12.94	West end. tug wash. Surface colln.
ATJ 149	44	Bottle - 'Coca Cola'	08.12.94	West end. tug wash. Surface colln.
ATJ 150	21	Plate frag. (blue ribbon decor.)	08.12.94	West end. tug wash. Surface colln.
ATJ 151	21	Plate frag. green glaze.	08.12.94	West end. tug wash. Surface colln.
ATJ 152	44	Bottle. 2-piece mould	08.12.94	West end. tug wash. Surface colln.
ATJ 153	44	Bottle. green. tall 'champagne'	08.12.94	West end. tug wash. Surface colln.
ATJ 154	44	Bottle. sml 'champagne'	08.12.94	West end. tug wash. Surface colln.
ATJ 155	44	Bottle. sml 'champagne'	08.12.94	West end. tug wash. Surface colln.
ATJ 156	44	Bottle. sml 'champagne'	08.12.94	West end. tug wash. Surface colln.
ATJ 157	44	Bottle. sml 'champagne'	08.12.94	West end. tug wash. Surface colln.
ATJ 158	44	Bottle. small 'champagne' top of neck missing	08.12.94	West end. tug wash. Surface colln.
ATJ 159	44	lge green 'champagne'	08.12.94	West end. tug wash. Surface colln.
ATJ 160	44	Clear glass stopper	08.12.94	West end. tug wash. Surface colln.
ATJ 161	30	Tubing with hex nut	08.12.94	Whalers jetty Near trench No. 1.
ATJ 162	25	2 x fire bricks	08.12.94	Whalers jetty. Nth side. Surface
ATJ 163	25	2 x fire bricks	08.12.94	Whalers jetty. Sth side. Surface near trench No. 1.

APPENDIX E

CATALOGUE OF ALBANY TOWN JETTY ARTEFACTS ON EXHIBITION AT THE RESIDENCY MUSEUM, ALBANY

APPENDIX E

CATALOGUE OF ALBANY TOWN JETTY ARTEFACTS ON EXHIBITION AT THE RESIDENCY MUSEUM, ALBANY

APPENDIX E

CATALOGUE OF ALBANY TOWN JETTY EXHIBITION ARTEFACTS

Albany Town Jetty materials on exhibition, Albany Residency Museum, December 1994

	Reg No.	Qty	Description
1	ATJ 1	1	Plate, yellow earthenware; 'Johnson, Australia'
2	ATJ 2	1	Brylcream jar
3	ATJ 3	1	Boiler glass
4	ATJ 4	1	'Champagne' type bottle, small
5	ATJ 5	3	Beer bottles, black
6	ATJ 7	1	Jar, colourless glass
7	ATJ 9	1	Small perfume bottle
8	ATJ 10	1	Beer bottle, brown - 'Pick axe beer'
9	ATJ 11	1	Beer bottle, black
10	ATJ 15	1	Sign from engine room, iron
11	ATJ 20	1	Mug, earthenware, Adelaide Steamship Co(H 2892)
12	ATJ 20	1	Cup, section only, red rim, Adelaide Steamship Co.
13	ATJ 20	2	Saucers, Adelaide Steamship Company (1 lg; 1 sml): 'Brown-Westhead, Moore & Co'.
14	ATJ 20	1	Side plate, Adelaide Steamship Co.
15	ATJ 20	1	Oval serving plate, Adelaide Steamship Co.
16	ATJ 22	1	Dinner plate, white, complete
17	ATJ 22	1	Dinner plate, grey & white printed earthenware, Fern design.
18	ATJ 22	1	Plate or bowl sherd, blue & white printed earthenware.
19	ATJ 24	1	'Champagne' style bottle
20	ATJ 25	1	Beer bottle, black
21	ATJ 26	3	Dark green glass bottles, small w/ sloping shoulders
22	ATJ 26	2	Dark green glass bottles, small w/ rounded shoulders.
23	ATJ 27	1	Pale green preserve bottle
24	ATJ 28	1	Pale green bottle
25	ATJ 29	1	Amber bottles
26	ATJ 32	1	Clay pipe stem - 'Davidson, Glasgow'
27	ATJ 32	1	Clay pipe bowl - cogwheel pattern
28	ATJ 32	1	Clay pipe bown and stem - 'Ben Nevis'
30	ATJ 33	1	Brooch—on reverse 'RBO 2553'
31	ATJ 34	1	Hamilton bottle, 'Ross's, Belfast'
31	ATJ 37	5	Bottles, 2 x round shoulders; 3 x sloping shoulders
32	ATJ 38	1	Plate section, green glaze, moulded vine leaves and grapes
33	ATJ 39	1	Small green glass bottle w/ rounded shoulders
34	ATJ 40	1	Lamont-Letchford bottle w/ cork and stopper inside
35	ATJ 41	1	Pale green pickle bottle
36	ATJ 43	1	'Ainslie's Whisky' bottle: 'This bottle is the property of J & W Bateman Ltd.'
37	ATJ 45	1	Blue glass stopper
38	ATJ 46	1	Glass tumbler base
39	ATJ 48	1	Plate section with brown lines and flag with no surrounds, Adelaide Steamship Co.

40	ATJ 49	1	Plate or bowl sherd, green and white printed earthenware, rope and chain. Printed mark on front: '...ward Smith'; stamped mark on reverse (? romance) and printed maker's mark 'T.B.& S' [Possibly T. Boote & Sons]
41	ATJ 50	1	Mug sherd, earthenware, blue floral and cable transfer.
42	ATJ 51	1	Circular stoneware jar lid.
43	ATJ 52	1	Stoneware jar base section. Marked: '6 Qt, George Skey, Wilnecote Works, Tamworth (Staffordshire).
44	ATJ 54	1	Plate, nearly complete, section of rim missing, Adelaide Steamship Co.
45	ATJ 21	1	Plate, with design "Rob Roy" on front.

APPENDIX F

CATALOGUE OF ALBANY TOWN JETTY ARTEFACT DRAWINGS

APPENDIX F

ALBANY TOWN JETTY ARTEFACT DRAWINGS

Reg. No.	Material	Description
ATJ 72	ceramic - earthenware	Plate (half) "ADELAIDE S.S. COMPANY"
ATJ 73		plate/bowl (half) "WILLIAM HOWARD SMITH SYDNEY"
ATJ 73 (reverse)		plate/bowl (half) "TB&S"
ATJ 74		plate (half) "AUSN"
ATJ 58	clay	pipe bowl with prominent spur
ATJ 70	clay	pipe "2nd HIGHLDR'S BLACK WATCH" on bowl, "GLASGOW" on stem
ATJ 75		pipe "W.T. BLAKE CITY RD LONDON" on bowl, "BEN NEVIS" on stem
ATJ 91	glass	bottle, "A&C" inside large "B" on base
ATJ 92		bottle, "5521" on base
ATJ 96		bottle with cork stopper, contents possibly seeds
ATJ 112		bottle, green
ATJ 89	miscellaneous	penknife

APPENDIX G

CATALOGUE OF ALBANY TOWN JETTY AUDIO/VISUAL MATERIALS

APPENDIX G

CATALOGUE OF ALBANY TOWN JETTY AUDIO/VISUAL MATERIALS

Photographs
(Listed in Department of Maritime Archaeology PINDEX)
B&W (Historic) MA 4569–MA 4571
B&W (1994 excavation)
ATJ 4289 Slide copies
ATJ 4290 - 1 Artefacts
ATJ 4292 Shell samples

(Filed in the Department of Materials Conservation)
File No. 811 Artefact Registration No. 21 Description –Plate, Decoration--Rob Roy

Transparencies
(Listed in Department of Maritime Archaeology SLIDE PHOTO INDEX)
ALBW 1–27 Underwater, 1989
ALBW 101–115, 127–160, 211–219 Misc., 1994
ALBW 221–336 Underwater 1994

Video
No. 122 (Hi8) Jon Carpenter, November 1994
No. 123 (V8) John Clarke, November 1994
No. 173 (VHS) Channel 9 News item, December 1994

APPENDIX H

CONSERVATION MANAGEMENT REPORT–ALBANY TOWN JETTY

22–24 November 1994

CONSERVATION MANAGEMENT REPORT

ALBANY TOWN JETTY

Vicki Lewana Richards
Research Chemist

Jon Carpenter
Conservator

Materials Conservation Department
Western Australian Museum
1995

CONTENTS

FIGURES

TABLES

CONSERVATION MANAGEMENT REPORT

ALBANY TOWN JETTY

DATE OF INSPECTION: 21 November - 9 December 1994

WEATHER AND SEA CONDITIONS

Generally fine with the occasionally light fall of rain, becoming overcast by late afternoon. The wind direction was variable, however the predominant direction was from the south-east by late afternoon. The average wind strength is about 5-15 ms^{-1} [Atkins et al., 1980]. Sea conditions were generally calm, with no swell. The tides are semi-diurnal and the maximum tidal range is +0.2m to 1.2m, the mean variation being 0.4m [Bastyan, 1986]. Waterborne particulate matter was in suspension and the visibility was measured to be 3.3m from the surface of the water and the in-water horizontal visibility recorded as 3-4m. The water temperature varied daily between 19-24°C, the pH ranged between 8.17 and 8.53 and the redox potential was -38mV relative to the normal hydrogen electrode. The dissolved oxygen content on the surface was 102% saturation of 9.5mg/L and at a depth of 2.4m was 77% saturation of 7.1mg/L. The decrease in the dissolved oxygen content at depth would be due to the plant material, situated near the sediment surface, utilising the oxygen for bacteriological degradative processes. The salinity was 34.6ppt at 19°C. Atkins et al. (1980) showed that Princess Royal Harbour (PRH) has a salinity and temperature range of 31 to 37ppt and 13 to 21°C.

ALBANY TOWN JETTY SITE

a) Location

The areas under investigation were situated in the immediate vicinity of the Albany Town Jetty (ATJ) in Princess Royal Harbour (PRH) (Site plan). PRH is an almost land-locked bay and is connected to King George Sound by a narrow channel. The harbour is characterised by a deep basin with a sandy marginal shelf around the western and southern shores. There is a deeper, dredged area around the wharf in the shipping area.

Wind plays a major role in water circulation in the harbour. The predominant south-easterly winds favour large scale clockwise water circulation in the harbour. The level of exchange with the ocean in King George Sound is satisfactory to allow dispersal of discharge from the harbourside industries. The average water exchange with the Sound is 24%. The rate of flushing of waters on the shallow western margin of the harbour, where the ATJ is situated, is strongly dependent on wind direction and speed. South-easterlies, which blow along the length of the harbour and the shallows, are much more efficient at water replacement than winds blowing from the south-west, across the harbour. Nevertheless, there is reduced water movement on this extensive shallow shelf [Atkins et al., 1980; Mills and Brady, 1985].

b) Description

i) General

The site is relatively level, comprising of a fine sand sea bed covered with organic detritus. This material affected visibility significantly when disturbed. The average approximate depth to sediment ranged between 2-7m.

ii) Flora and Fauna Assemblages

There was very little higher vertebrate life present on this site. The surface of the sea bed was covered with detritus and infrequently, live tunicates and small seagrass beds. The jetty piles were encrusted with tunicates, barnacles, mussels, sessile invertebrates, algae and seaweed.

iii) Freshwater Influence

There was no apparent fresh water influence. No major rivers discharge into PRH and the only source of fresh water are drainage channels, local run-off and direct precipitation.

iv) Human Disturbance

Albany supports industries including a superphosphate plant, woollen mills, abattoirs and food processing works. Some of these industries discharge effluents directly into PRH [Atkins et al., 1980]. The harbour acts as a main port and as a base for professional fishing operations. The harbour also provides recreational opportunities and attracts tourists to the area.

MAIL STEAMER JETTY SAMPLE SITE

a) General Observations

These areas under investigation were situated adjacent to the remains of the mail steamer jetty (Site plan). The average depth of the site was 3m. The site gently slopes down to the south and the seabed comprises of glutinous and fine siliceous sediments. The sediment is heavily covered by epiphytes and organic detritus. The jetty is constructed of wooden piles. The piles were colonised by macroalgae. A single pile, severed at water level, was chosen as the datum reference point for the maritime archaeological excavation and selected for conservation sampling purposes. The sea bed in close proximity to the piles was predominantly littered with artefact material of more recent origin, e.g. aluminium cans, tyres, etc. There was some evidence of artefacts of more historical interest, e.g. spoked wheel.

b) Degree of Site Exposure

The height of the datum jetty pile from the seabed was 2.8m. The wheels and other miscellaneous material were exposed about half a metre above the sediment.

c) Evidence of Seasonal Exposure

The site appears to be reasonably stable.

d) Evidence of Human Disturbance

Directly, the historical association of the jetty with the Albany township has resulted in an accumulation of cultural and modern material on the site. The mooring of watercraft has resulted in disturbance of the seabed by propeller wash.

e) Exposed Artefacts

i) Iron

There were two flanged, five spoked iron wheels with minimal concretion and light encrustation by secondary marine organisms. Corrosion potentials and pH of the wheel hubs were measured and the results are presented in Table 1.

ii) Copper Alloys

A small copper alloy wood screw with copper enrichment of the outer surface was found adjacent to wheel hub (2). The screw had been previously buried in the sediment. The corrosion potential was measured, however, the pH of the fastening was not measured. The average pH of the open sea water, 8.53, was used. Again, the results are presented in Table 1.

Table 1. Chemical measurements of exposed artefacts on the Albany Town Jetty site.

Description of Material	pH	E_{redox}(mV)[1]
Ferrous Materials		
wheel hub (1) (few mm concretion)	6.78	-254
(3cm graphitised)	6.40	-240
wheel hub (2) (3cm graphitised)	6.19	-122
(3cm graphitised)	6.17	-178
Copper Alloy Materials		
copper alloy wood screw	8.53	61

[1] Relative to the normal hydrogen electrode.

f) Biological Survey

Samples of marine biota were collected from the datum pile at a number of depth intervals. The sample area was approximately 100mm square. The biota was carefully scraped from the pile and placed in numbered, polyethylene bags. The samples were returned to the shore and stored in a solution of 5% formaldehyde. Immediately after removal of the marine organisms, the redox potentials of the underlying surface was measured. The measurements are shown in Table 2. The pH and redox potential of the sediment directly below the datum pile was 7.79 and -146mV, respectively.

Table 2. Electrochemical measurements of the datum pile.

Position on Datum Pile	Depth (m)	E_{redox}(mV)
Surface (below surface)	0.0	-45
Midway	1.0	-43
Base	3.1	-3
Sediment	3.5	-146

g) Organic Survey

i) Wood

Subsequent to the biological sampling, core samples of the wood were taken in the same areas. Immediately after coring, the redox potentials, surface pH and the depth of core penetration were measured. The results are tabulated in Table 3. On visual inspection, the pile appeared to be jarrah. A pH profile was carried out on the datum pile at a depth of 3.1m. The results are shown in Table 4. Two pH profiles were acquired from a piece of wood which was exposed in test pit B. The results are shown in Table 5. There was evidence of past marine borer attack. A sample of this wood was collected for identification.

Table 3. Chemical measurements of the datum pile.

Position on Datum Pile	Depth (m)	Depth Core(mm)	pH	E_{redox}(mV)
Surface (below water)	0.0	5	8.49	-55
Midway	1.0	<2	8.45	-56
Base	3.1	<5	8.42	-60
Sediment	3.5	-	7.79	-146

Table 4. pH profile of the datum pile.

Depth of Penetration (mm)	pH
0	8.42
2	8.34
4	8.35
15	7.86

Table 5. pH profiles of wood sample.

Core A Depth (mm)	pH	Core B Depth (mm)	pH
surface	8.39	surface	8.37
24	7.30	15	7.20
total penetration	-	30	7.26
		35	7.96
		35	7.98
		sound wood	-

ii) Sediment

A test pit was excavated under the mail steamer jetty (#2) (approximately 1.5m diameter and 1.8m depth). A series of pH and redox potential measurements of the sediments were taken at the following depth intervals, usually where changes in seabed composition occurred (Table 6).

Physical parameters of sea water column:

Temperature of sea water	=	20°C
Maximum depth of site	=	2.2m
pH sea water	=	8.35
E_{redox} sea water	=	-33mV
E_h Ag/AgCl/sea water	=	280mV

Table 6. Chemical measurements in the test pit under the mail steamer jetty (#2).

Depth from water surface (m)	Depth of pit from sediment surface (m)	pH	E_{redox} (mV)	Sediment Composition
2.2	0.0	7.60	-156	sediment
2.5	0.2	7.23	-160	sea grass
2.8	0.5	6.88	-137	sea grass
3.0	1.0	6.87	-127	sea grass
3.3	1.1	7.68	-147	shell
3.4	1.2	7.74	-147	shell
3.9	1.5	7.92	-141	sand (grey)

h) Interpretation of Results

i) Iron

The two wheels had only minimal surface concretion and very little secondary encrustation by fouling assemblages which would seem to indicate that these artefacts are usually covered with sediment and sand. In addition, the concretion was dense and relatively non-porous supporting concretion formation in low oxygenated environments. The pH measurements and corrosion potentials were plotted on the Pourbaix diagram for iron (10^{-6}M) in aerobic sea water at 25°C (Figure 1). The intercepts for these wheel hubs indicate that these iron objects are actively corroding in this environment.

ii) Copper Alloys

The surface pH and corrosion potential of the copper alloy wood screw was plotted on the Pourbaix diagram for copper (10^{-6}M) in aerobic sea water at 25°C (Figure 2). The intercept on the Pourbaix diagram indicates that the copper alloy is in the passive cuprite region. When subjected to an aerobic marine environment copper readily forms adherent films of cuprite (Cu_2O). Cuprite corrosion products are biologically toxic in nature and inhibit the growth of marine organisms. This would explain the absence of encapsulating concretion and secondary colonisation on this object.

Figure 1. Pourbaix diagram for iron (10^{-6}M) in aerobic sea water at 25°C indicating the state of iron objects on the Albany Town Jetty site.

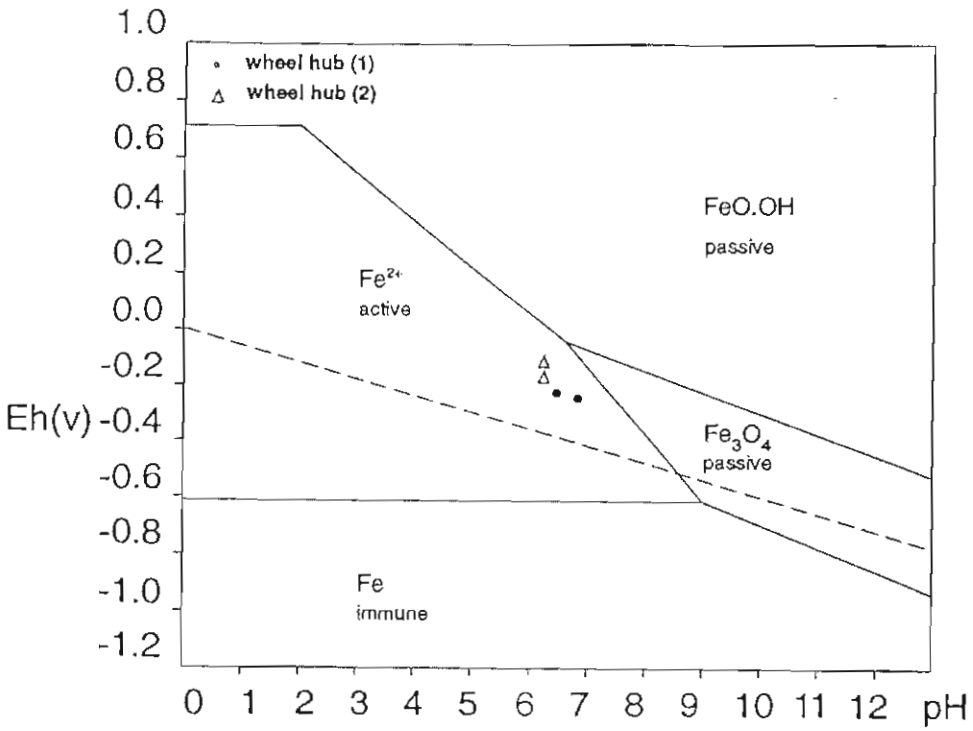
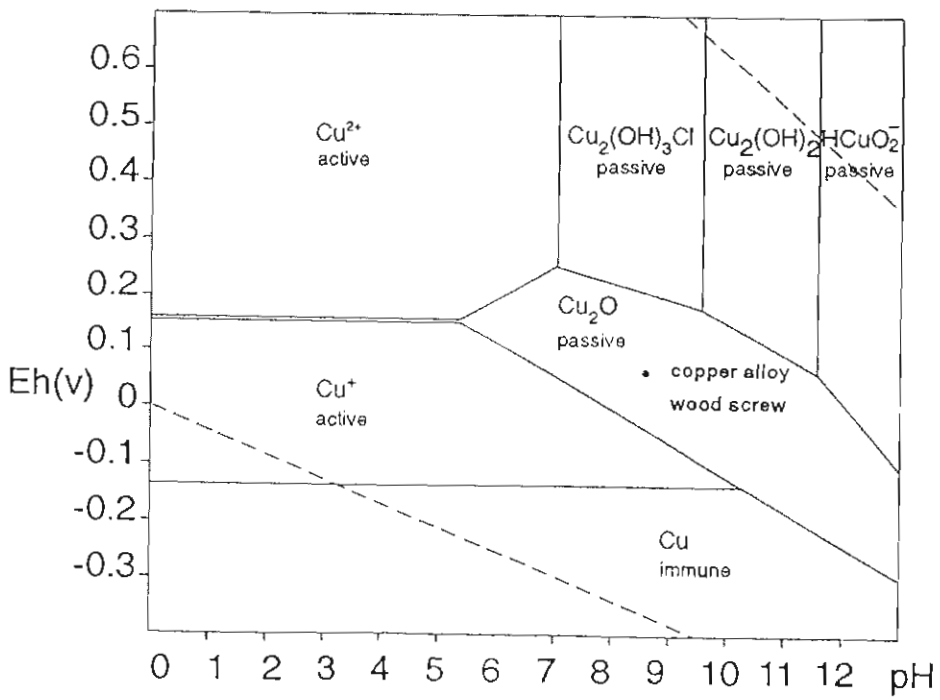


Figure 2. Pourbaix diagram for copper (10^{-6}M) in aerobic sea water at 25°C indicating the state of the copper alloy object on the Albany Town Jetty site.



iii) Biological Survey

Marine biota collected from the datum pile from four different sample depths (Table 2) were identified and generally classified by Alan Kendrick (WAM). The results are outlined in Table 7.

Table 7. General classification of sessile organisms on the datum pile.

Position	Depth (m)	Marine biota
Surface	0.0	tunicates (8); barnacles (3); seaweed
Midway	1.0	tunicates (4); barnacles (5); unknown (3)
Base	3.1	tunicates (4); barnacle fragments; unknown (1)
Sediment	3.5	tunicate/large ascidian (1)

The barnacles were identified by Dianne Jones (WAM) as *Balanus variegatus* Darwin, 1854. This barnacle is a littoral species which is known to foul boats, jetties, etc. It is a temperate species found in the waters of Southern Australia and New Zealand. In Australia it occurs from NSW to WA. On the west coast of WA it extends as far north as Carnarvon but the species is not very prevelant north of Perth. All fouling assemblages require an aerobic environment to develop and multiply and therefore do not survive in anoxic environments or in sediments. Many fouling assemblages also require sunlight for photosynthetic processes and specific salinities with available nutrients.

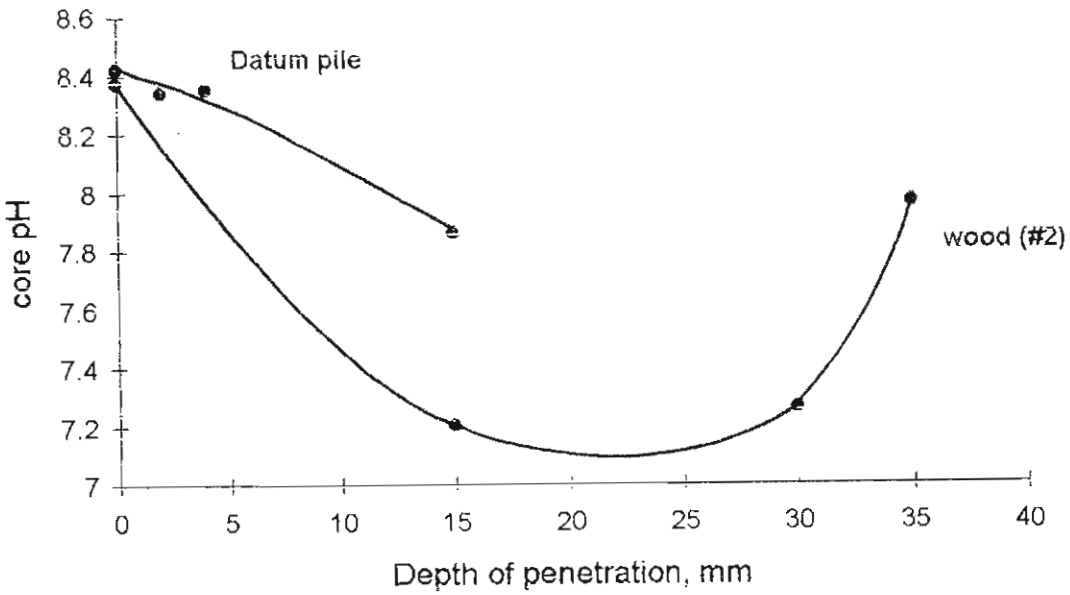
These fouling organisms identified on the datum pile are typical on wooden structures present in shallow, temperate, open aerobic marine environments. There does not appear to be any significant differences between the concentration of marine organisms fouling the wood at different sampling depth intervals. However, there appears to be a slight increase in biological activity on the datum pile just under the water surface where the dissolved oxygen content, light penetration and water movement is slightly greater.

The redox potentials of the underlying wooden areas measured immediately after the removal of the marine organisms, were slightly reducing in nature. This would be expected as the colonisation of the pile would decrease the dissolved oxygen flux to the wood surface. Therefore, producing a more reducing environment directly beneath the marine organisms. The sediment was significantly more reducing in nature at -146mV and the pH had decreased (7.79) from that of the open aerobic sea water (8.53) (Table 2). Basically, the reducing environment and increase in acidity of the sediment can be directly attributed to the production of hydrogen sulphide from sulphate reducing bacteria present in the sediment. The reducing environment in the sediment would reduce iron (III) to iron (II) species, greatly increasing their solubilities. The hydrogen sulphide would react with the iron ions to form black iron sulphides which were observed in the sediment as excavation commenced.

iv) Wood Survey

After the biological samples were collected, core samples were taken and the pH and redox potentials of these core sites were measured (Table 3). The average depth of penetration was <5mm. There was no significant changes in

Figure 3. The pH profiles of wood samples from the Albany Town Jetty.

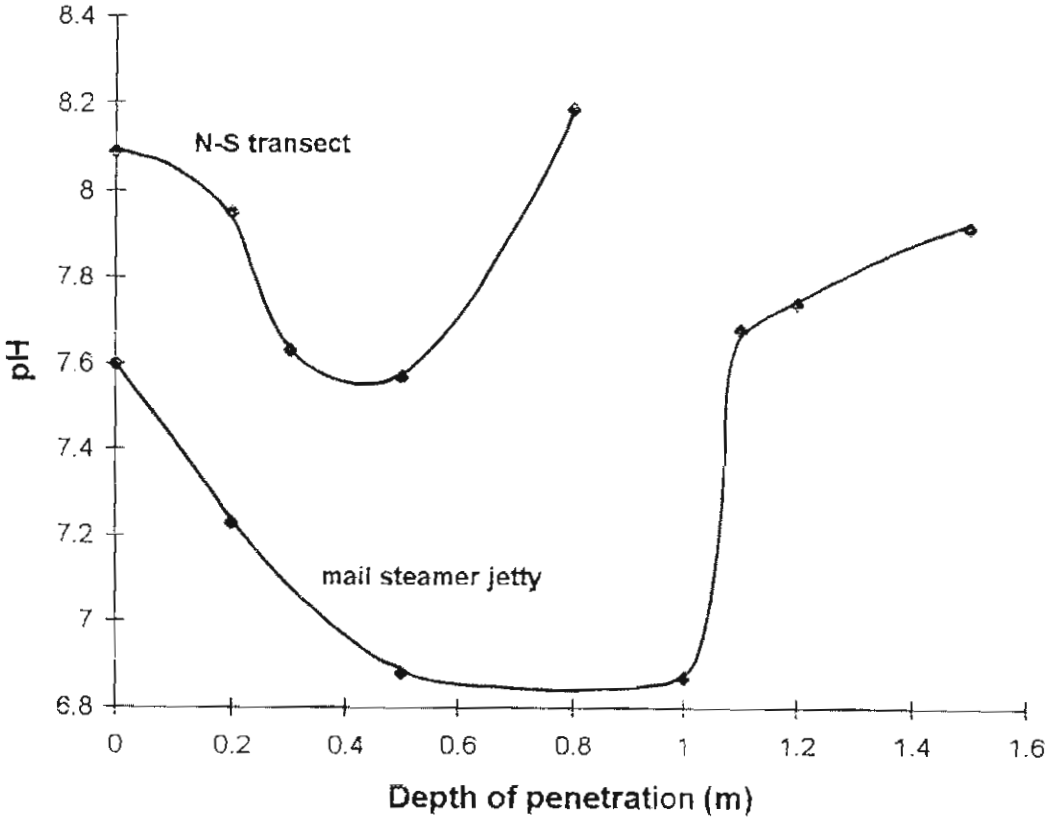


pH and redox potential with respect to different depth intervals. Therefore, the average pH and redox potential of the wooden datum pile at a core depth of approximately 5mm was calculated at 8.45±0.03 and −57±3mV, respectively. The wood was only slightly more acidic than that of the surrounding sea water (8.53 and −35mV). These results indicate waterlogging of the pile to this depth and a slightly more reducing environment due to a decrease in the dissolved oxygen concentration into the wood. The results of the pH profile of the datum pile at a depth of 3.1m (Table 4) is shown diagrammatically in Figure 3.

The higher pH of the wood closer to the sea water surface is indicative of the area of greatest deterioration. Degradation occurs from the outer, more exposed areas in the initial instance. Hence, the normally acidic nature of the wood becomes more alkaline with increasing degradation due to the inward diffusion of sea water. The pH then decreases as the depth increases into the wood core to the area of least degradation where the wood is less waterlogged. This profile is typical of wood with a thin (<5mm) outer layer of degraded wood with a relatively undegraded inner core.

The results of the pH profiles measured on the anaerobic timber found in test pit B (Table 5) are shown graphically in Figure 3. The explanation used to explain the datum pile pH profile can be applied to the profile obtained for this timber, with the exception that there was probably some sea water contamination at the 35mm core depth and this would increase in pH at this depth interval. However, it may be possible, that there is a discrete area of greater deterioration towards the centre of the wood and the pH will increase accordingly, but it is unlikely. The irregularities between the profiles could be due to differences in wood species, extents of degradation and microenvironment. Generally, the pH profiles are typical of slightly degraded wood with a relatively thin, (<5mm) degraded, outer layer.

Figure 4. The pH of different sedimentary layers as a function of increasing depth.



v) Sediment

There was no significant trend in the redox potentials at different depth intervals in the test pit under the mail steamer jetty (#2), however, the sedimentary layers in the excavated pit were essentially reducing in nature (Table 6).

The pH at increasing depth intervals were plotted on a graph which is shown in Figure 4. The pH of the surface sediment (<0.2m) compared to the aerobic water column (8.53) is to be expected due to the oxidation of organic detritus by bacteria producing acidic metabolites and by-products. The next 0.8m was characterised by mats of dead sea grass and a decrease in pH. Anaerobic sulphate-reducing bacteria would continue to decompose this organic matter producing weak acids and polysulphides. In the shell layers, ranging from a depth of 1.0 to 1.5m, there was a significant increase in the pH. This effect may be due to the dissolution of calcium carbonate in the shell.

The bicarbonate/carbonate equilibrium is quite an important and complex equilibrium system in the ocean and sediments. The Henderson equation

$$pH = pK_a + \log \frac{[base]}{[acid]}$$

can be applied to this situation and the ratio of bicarbonate to carbonate calculated. If the average pH of this sediment layer is 7.7 and the pK_a of the HCO_3^-/CO_3^{2-} equilibrium is 10.2 then it follows that

$$\log \frac{[CO_3^{2-}]}{[HCO_3^-]} = pH - pK_2$$

$$= -2.5$$

$$\frac{[CO_3^{2-}]}{[HCO_3^-]} = 3.16 \times 10^{-3}$$

Therefore the ratio of $[HCO_3^-]:[CO_3^{2-}]$ is 316:1 i.e. 99.7% bicarbonate and 0.3% carbonate. This equilibrium could explain the increase in alkalinity, however, a simpler explanation may be that due to the more open packing of the shell, sea water may have penetrated the layer, thus increasing the pH of the pore water. The increase in the pH of the sand at the bottom of the excavation pit would be due to sea water contamination.

NORTH-SOUTH TRANSECT AREA

a) General Observations

This area of open seabed was located approximately 20m, east of the mail steamer jetty structure. The seabed was level and comprised of fine sand, interspersed with patches of living seagrass.

b) Degree of Artefact Exposure

None evident.

c) Evidence of Seasonal Exposure

The sediment would be stable due to the presence of the seagrass.

d) Evidence of Human Disturbance

Not evident.

e) Exposed Artefacts

None evident.

f) Biological Survey

Not applicable.

g) Organic Survey

i) Sediment

The first test pit of the north-south transect was excavated and a pH and redox potential profile was aquired the following day. The results are presented in Table 8. A sample of the compacted organic matter was collected for analysis.

Physical parameters of sea water column:

Temperature of sea water	=	20°C
Maximum depth of site	=	2.4m
pH sea water	=	8.52
E_{redox} sea water	=	-80mV
E_h Ag/AgCl/sea water	=	280mV

Table 8. Chemical measurements of the sediment from the north-south transect excavation pit.

Depth from Water Surface (m)	Depth of Pit from Sediment Surface (m)	pH	E_{redox} (mV)	Sediment Composition
2.4	0.0	8.09	-161	surface sediment
2.5	0.2	7.95	-132	compacted organic matter
2.9	0.3	7.63	-170	grey sand/large shell fragments
3.0	0.5	7.57	-164	grey sand/large shell fragments
3.1	0.8	8.19	-180	grey sand/small shell fragments

b) Interpretation of Results

i) Sediment

The north-south transect excavation pit (1) was sterile with respect to artefact material. The sediment layers of this pit was essentially reducing in nature, indicated by negative redox potentials. The pH versus depth intervals are plotted on the graph in Figure 4. The pH gradually decreased to a minimum at 7.57. This test pit was excavated in a relatively stable sediment area covered with live sea grass. There appeared to be less organic detritus on the surface sediment. This could explain the higher pH of the surface sediment compared to the other excavation pit due to less aerobic oxidation of organic material.

The pH of the sand containing large shell fragments was similar to the sedimentary shell layer of the mail steamer jetty pit. The explanation for the latter would also apply to this excavation pit. The pH of the sediment at the bottom of the test pit, at a depth of 0.8m, then increased to 8.19 which would be indicative of sea water contamination of the pore water.

The difference in the width of the compacted organic matter layers between the two test pits indicated that there was a greater concentration of sea grass coverage in close proximity to the mail steamer jetty than the north-south transect area. In addition, these results indicate that there is greater water and sediment movement in the north-south transect area than under the mail steamer jetty and this former area contains a more sterile microenvironment. Therefore, microbiological and chemical activity and hence, the rate of degradation of organic and inorganic materials, would be greater in the sediment present under the mail steamer jetty than in the sediment in the north-south transect area.

WEST-EAST TRANSECT AREA

a) General Observations

This area was located behind the stern of the motor vessel, *Warren*. The seabed had been blasted by the propellor wash of the vessel, creating a large depression in the sediment. This scouring effect had exposed a large concentration of scallop shells, interspersed with sand.
The average depth was approximately 6-8m.

b) Degree of Artefact Exposure

None evident.

c) Evidence of Seasonal Exposure

The fine sediment had been removed by frequent scouring, exposing scallop shells, shell fragments and coarse sand.

d) Evidence of Human Disturbance

Other than the scour from the motor vessel, there does not appear to be any strong evidence of human disturbance.

e) Exposed Artefacts

None evident.

f) Biological Survey

Not applicable.

g) Organic Survey

i) Sediment

The first of a series of excavation pits of the west-east transect (1) was dredged and this pit (1) lay just west of the *Warren*'s stern. Five samples of surface sediment were collected from this pit, one from each of the corners of the 2m grid square and one from the centre. These samples were labelled sediment sample 1 (Appendix I). The pH and redox potentials of the five sample sites were measured. The results and sampling information are presented in Table 9.

Physical parameters of sea water column:

Temperature of sea water	=	20°C
Maximum depth of site	=	6.5m
pH sea water	=	8.25
E_{redox} sea water	=	-56mV
E_h Ag/AgCl/sea water	=	280mV

Table 9. Sampling information and chemical measurements of the sediment sample (1) from the west-east transect (1) excavation pit.

Grid Position	Sample	Depth from water surface (m)	pH	E_{redox} (mV)	Sediment Composition
A	14	6.2	7.86	-156	) scallop shell
B	20	5.6	8.05	-146	) interspersed
C	17	6.1	8.09	-151	) with grey sand
D	13	6.4	8.18	-160	) all surface
Centre	7	6.1	8.06	-134	) sediment samples

The sediment from the second of the excavation pits (2) dredged on the west-east transect (1) was sampled at increasing depth intervals. The sampling information is presented in Table 10. The sediment samples collected at the surface and depths of 0.3m and 0.6m were labelled sediment samples 2,3 and 4, respectively (Appendix I).

Table 10. Sampling information of the sediment samples 2,3 and 4 collected from the excavation pit on the west-east transect (1).

Grid Position	Sample	Water Depth Sediment Depth (m)	Sediment Composition
A	35	7.2 (0.0)	sand and
B	41	7.2 (0.0)	small shell
C	39	7.2 (0.0)	
D	19	7.2 (0.0)	
Centre	37	7.2 (0.0)	
A-D	38	7.5 (0.3)	sand
A-B	1	7.5 (0.3)	sand
B-C	30	7.5 (0.3)	sand
A-B	4	7.8 (0.6)	sand
B-C	2	7.8 (0.6)	sand
A-D	5	7.8 (0.6)	sand

Sediment samples were collected from the south face (1) of the west-east transect (2) as excavation proceeded. Again the samples were collected at increasing depth intervals. The sampling information is presented in Table 11. The sediment samples collected at the surface and at depths of 0.4m and 0.9m were labelled sediment samples 5,6 and 7, respectively (Appendix I).

All sediment samples collected from the same depth intervals were homogenised. The pore water was extracted from sediment samples, 2 and 4, collected from the same grid at the surface of the west-east transect grid (2) and at a depth of 0.6m, respectively. The sediment samples were analysed for size fractionation, organic screen and inorganic analysis. The extracted pore water samples (9) and (10) and the water sample (8), collected from the general area, were analysed for inorganic elemental analysis only.

Table 11. Sampling information of the sediment samples 5, 6 and 7 collected from the excavated south face of the west-east transect (2).

Face Position	Sample	Water Depth Sediment Depth (m)	Sediment Composition
start of face	36	6.1 (0.0)	sludge
mid face	32	6.5 (0.4)	sand
lower face	16	7.0 (0.9)	sand
hole bottom		7.3	

All methods employed are detailed in Appendix I. The analyses were performed by the Chemistry Centre (WA) and paid for by the Materials Conservation Department of the Western Australian Museum. The raw data and some recommendations are presented in the Chemistry Centre (WA) report written by R.S. Schulz and this document is reproduced in full in Appendix I.

h) Interpretation of Results

i) Sediment Sample 1 {W-E transect (1) excavation pit (1)}

The moisture content and loss on ignition at 550°C and 1050°C of this homogenised surface sediment sample (14, 20, 17, 13, 7) indicated that there was very little organic matter and most of the minerals present in the sediment were in the final oxidised state. This indicates that the surface sediment was relatively oxidising in nature, however, the redox potentials (Table 9) indicate a slightly reducing nature. The contradictions in the analyses and direct measurements can be easily explained by the position of this excavation pit with respect to the *Warren*. When the *Warren* is started, the propellor wash dislodges the surface sediment, which can then be suspended in the water column. The heavier shell fragments and coarse grain sediment will redeposit quickly, while the smaller particulate matter will remain in suspension for longer periods of time and can thus, be dispersed and redeposited at different positions, south west of the original excavation site. The sediment will be exposed to an increased dissolved oxygen flux, which will subsequently oxidise organic material and inorganic minerals prior to redeposition.

The pH of the surface sediment was similar to that of the immediate water column, indicating a mobile sediment and irregular packing of the coarse grain sand, allowing the passage of sea water through the sediment.

The size fractionation analysis of this sediment presented in Table 12, reproduced directly from the Chemistry Centre report (Appendix I), supports the deposition regime outlined above. There was higher concentrations of coarse grain sand, larger particles and shell fragments (50.0%) in this surface sediment than in the other sediment samples. The quantity of medium and fine grain sand (47.0%) and coarse silt to clay (3.0%) had decreased which seems to indicate that these particles have been selectively removed from the sediment. The removal of the finer sands and coarse silt would be due to the increased water movement created by the *Warren* propellor wash. The larger particles would be more difficult to disperse and their deposition rate is faster than smaller particulate matter. Therefore, there would be increased concentrations of larger particles deposited in the surface sediment compared

to the finer grained sands and silts, which would be more widely dispersed. Under these turbid conditions, flocs of silt and clay particles, with much larger aggregate diameters, would also be destroyed.

There was no recognisable artefacts recovered from this test pit. This indicates that either, the artefacts were not deposited in that area or they have been degraded or physically removed by the tug propellor wash.

This sediment sample contained elevated levels of lead (150mg/kg) and iron (3000mg/kg) (Appendix I). The sediments were not analysed for mercury. The marine life in PRH has been contaminated with lead and mercury, which emanated from the surperphosphate plant present on the harbour shoreline. Lead and mercury are strongly associated with fine organic fractions of the surface sediments and with the algae and seagrass. This is the reason for the lead concentrations being greater in the surface sediments compared to the sediment samples collected at increased depth intervals. Since 1984, there has been no significant input of lead and mercury to PRH, however, it is obvious that these heavy metals introduced to the harbour prior to this time still contaminate marine plants, biota, organic materials and sediments.

Gas-chromatographic-mass spectrometric analysis of an organic solvent extract of this surface sediment and characterisation of the major compounds (Appendix I) revealed that the sediment contained butylated hydroxy toluene (BHT), cholesterol and cholestanol and a large quantity of elemental sulphur.

Table 12. Screen analysis of core sediment samples.

Sample	Coarse Sand (%) (+1mm)	Coarse Sand (%) (+600 m)	Fine Sand (%) (+150 m)	Coarse Silt (%) (+38 m)	Coarse Silt (%) (-38 m)[1]
1	42.9	7.1	47.0	2.0	1.0
2	30.5	9.5	50.8	6.3	2.9
3	0.4	1.3	86.5	9.9	1.9
4	1.2	1.9	86.2	9.7	1.0
5	4.7	2.4	36.2	16.0	40.7
6	9.9	4.1	62.9	18.5	4.6
7	9.9	4.1	62.9	18.5	4.6

[1] Less than 38 m in diameter indicates a region which encompasses coarse silt through to very fine silt and clay.

The sulphur may have originated from industrial sources, thermally labile naturally occurring organic compounds like some mercaptans and sulphides or from the anaerobic corrosion of iron artefacts beneath the sediment. BHT is a very common antioxidant added to consumer products during processing and a UV-absorber used in the plastics industry. BHT is used in petrol, lubricating oils and rubber, but not generally in food. It is also used in polyethylene film and a legal standard allowing an amount <2mg/kg to be absorbed by the food. Interestingly, it is banned for use as an antioxidant in WA. Cholesterol and cholestanol are steroids chemically related to the bile acids. They are produced in the liver but are mainly from biological materials like meat, animal fats, etc. The abattoir would be the major source of these compounds [Selinger, 1986].

From the size fractionation and inorganic elemental analysis of this surface sediment it appears that this area is very mobile. Therefore, any artefacts that were present in this surface sediment in the past would be subjected to rather destructive physical and mechanical forces which would increase the rate of degradation dramatically. The increased dissolved oxygen flux to the artefacts would also increase the rate of deterioration. Lighter artefacts may even be shifted further west or south depending on the direction of the propellor wash.
This surface sediment is polluted with lead, iron, large quantities of elemental sulphur, BHT and biological steroids. The organic compounds will have minimal effect on artefacts, however, the iron and sulphur may solubilise under the reducing environment and impregnate organic materials with iron sulphides, which can cause post-conservation problems.

ii) Sediment Samples 2,3 and 4 {W-E transect (1) excavation pit (2) collected at 0.0m, 0.3m and 0.6m, respectively}

The surface sediment sample 2 (35, 41, 39, 19, 37) was very similar in sediment composition and inorganic concentration as sediment sample (1). The same arguments used to explain sediment deposition and oxidation states of minerals in sample (1) also apply to surface sample (2). The size fractionation analysis of sediment sample (2) was slightly different to sample (1) (Table 12). There was less coarse grain sand and larger particles (40.0%) and greater quantities of medium and fine sand (50.8%) and coarse silt to clay (9.2%). This trend can be easily explained due to the more westerly position of this excavation pit and thus, the greater distance from the *Warren* propellors. The increase in distance from the propellor wash would have a decreased effect on sediment agitation. Overall, there would be less movement of the surface sediment and a decrease in the amount of dispersion of the finer particulate matter. In addition, the suspended finer grained sands and silts selectively removed from the area near sediment sample (1) could be dispersed and deposited in the more westerly sediment sample (2) excavation site. This would also attribute to the increase in the concentration of finer particulate matter in this surface sediment sample (2).

Again, there were very few artefacts recovered from this site and the objects collected were found in the top 30cm of the sediment. The artefacts may have been moved there by the propellor wash or more likely, the sediment that had previously been covering the objects was removed and dispersed by this excessive water movement.

The size fractionation analyses of sediment samples 3 (38, 1, 30) and 4 (4, 2, 5) indicated that the sediment at depths of 0.3m and 0.6m were essentially the same (Table 12). In comparison with the surface samole (1), there was very little coarse sand and larger particles, a significant increase in medium to fine grain sands and a decrease in the quantity of coarse silt to clay particles. These results indicate that the sediment at these depth intervals is very stable and is not affected by increased water movement from the propellor wash, nor has any large quantities of sediment been deposited in the past.

There are slightly higher concentrations of lead and iron in sample (2) compared to sample (1). The lead level in sample (2) (750mg/kg) is above the investigation level quoted for contaminated soils. The release of heavy metals upon dispersion of surface sediments is well-known. Hence, a decrease in surface sediment movement will subsequently, decrease heavy metal release

and the concentration of these metal ions in the sediment will remain high. There was no elevated levels of metal elements in the sediment samples at depth (3 and 4). Heavy metals are most commonly associated with fine organic-rich sediment fractions, which occur on the sediment surface. Contaminated living plant matter, seagrasses and algae, which occur on the sediment surfaces, usually contain significant concentrations of heavy metals. There is clearly a relationship between the fine sediments and the concentration of metals and this would explain the decrease in heavy metal concentration as the depth into the integrated sediment column increased.

The surface sediment is highly contaminated with large numbers and concentrations of polyaromatic hydrocarbons (PAH) (Appendix I). The PAHs were found at levels between 0.1-1.8mg/kg wet sediment sample. In comparison, the upper limit for benzo(a)pyrene in drinking water is 0.00001mg/kg. Most PAHs are known to be co-carcinogens and benzo(a)pyrene and especially methylated PAHs are known to be powerful mutagens and carcinogens. Sample 3, collected at a depth of 0.3m into the sediment column, contained some long chain hydrocarbons (>C-15) at relatively low levels. Sample 4, recovered from a depth of 0.6m, included various alkylated aromats, low levels of unsaturated hydrocarbons and an alkyl substituted aromatic carboxylic acid.

From the size fractionation and inorganic elemental analysis of these sediments it is obvious that this sampling area is more stable and more reducing than the sample (1) excavation site. However, the sediment in this area is severely polluted with respect to lead and PAHs. These inorganic elements and organic compounds will not have any marked detrimental effect on the degradation rates of artefacts. On the other hand, under the essentially anaerobic conditions of these sediments, the rate of deterioration of organic and inorganic materials wil be effected. Copper alloys will initially corrode then form a range of stable copper sulphide corrosion products on the residual metal surface. Alternatively, iron will actively corrode when continuously buried beneath the sediment and the mechanism is basically the same as for aerobically corroded iron. Iron ions will react with the sulphide ions produced from the sulphate reducing bacteria in the sediment and result in the formation of ferrous sulphide and elemental sulphur in the corrosion product matrix. The other main corrosion products formed would be Fe_3O_4, $FeCO_3$ and iron and chloride containing compounds. The rate of degradation of organic materials will be considerably reduced under low oxygenated environments.

iii) Sediment Samples 5,6 and 7 {W-E transect (2) excavation face 0.0m, 0.4m and 0.9m, respectively}

Only surface sample 5 (36) has any significant organic content and this corresponds to the highest concentration of coarse silt to clay particles (40.7%) (Table 12) incorporated in the surface bedload. The screen fractionation analyses of samples 6 (32) and 7 (16), collected at depths of 0.4m and 0.9m, respectively, produced exactly the same grain size distribution. These sediments consisted mostly medium to fine grain sands (62.9%) and fine grain sands to coarse silts (18.5%). There was a large collection of artefacts recovered from the south face of the W-E transect (2) (#17) between 80 and 120cm below the sediment surface. This was unexpected as other excavation pits had liberated artefact material at depths into the sediment of less than 50cm from the surface. Evidently, when docking, the *Warren* tug intially noses towards the jetty on a west-easterly line and then completes a 180° turn so that the stern is facing west, again, lined up along the W-E transect. The size fractionation analysis for sediment sample (1) was

previously described above. The medium and fine grain sand and coarse silt to clay of the sediment sample (1) excavation area were selectively dislodged by the *Warren* propellor wash and suspended in the water column. The 180° turn of the vessel allows the water movement from the propellors to disperse the suspended particulates in a predominantly southerly direction where the material is eventually redeposited. The heavier, coarser sand grains will deposit faster than the smaller silt and clay particles. Hence, there will be a larger concentration of the smaller particulate matter on the surface of sediment sample (5). This deposition of the finer particulates from the other sediment site (1) would bury any exposed artefacts. Therefore, this would explain the extended depth range of the artefact finds.

This size fractionation analysis suggests that the sediment column is particularly stable, including the surface sediment and the anomaly in size distribution of the surface sediment is due to deposition of the finer sands, silts and clays from the sediment sample (1) excavation site.

In the surface sediment (5) there is elevated levels of iron, aluminium, sulphate and potassium. In addition to these elements, sample (6) also contained increased concentrations of lead. Fine silt and clay particulate matter are known to absorb nutrients and organic detritus. Possibly, the source of aluminium may have come from alum used as a flocculating agent and a mordant used in the wool dying process in the Albany Woollen Mills (AWM). Higher concentrations of potassium indicate accumulation of organic matter, which is supported by the significant organic content of this sediment sample (5). The high sulphate values indicate contamination of the upper sediment column. The increased organic content and the high concentration of sulphate in the surface sediment will provide conditions for vigorous bacterial reduction, so that these sediment layers will be commonly anaerobic and charged with hydrogen sulphide. Sediment (7) did not have any large increases in the measured inorganic levels.

The organic extract analysis of these samples, showed that the sediment was also contaminated with PAHs (Appendix I). Sample (5) and (6) showed virtually identical chomatographic profiles and the materials detected in these samples were similar and of the same order of magnitude. The PAHs were present at concentrations between 0.05-0.2mg/kg wet weight. The presence of high concentrations of elemental sulphur in sample (5) and (6) support the sulphate contamination and hydrogen sulphide production. PAHs in sample (7) were found at levels between 0.05-0.4mg/kg wet weight. Sample (7) also contained BHT.

From the size fractionation and inorganic elemental analysis of these sediments, it is obvious that this sampling site is considerably more stable than than the previous excavation grid areas. Due to the increased stability, the sediment is extremely polluted with respect to heavy metals and PAHs.

iv) Water Sample 8 (Bulk Water Sample)

The results of the inorganic analysis of the sea water were as expected, however, there were slightly elevated nitrogen (N) and phosphorus (P) values (Table 13). The majority of the inorganic nitrogen directly available to marine biota such as algae, is in the fully oxidised form, NO_3, indicating an aerobic water column. Despite the fact that there is no real guidelines for the trophic status of marine embayments in Australia, Atkins et al., (1980) said that nuisance algal growth could be expected when the concentration of inorganic P and N equalled or exceeded 0.01mg/L and 0.3mg/L, respectively.

Table 13. Nutrient values of the bulk sea water and pore waters.

Sample	P_SR[1]	P_{org}	P_{total}	N_NH_3	N_NO_3	N_{org}	N_{total}
water (8)	0.01	0.05	0.06	<0.02	0.13	0.54	0.69
pore (9) (0.0m)	0.09	11.90	12.00	11.00	1.30	32.70	45.00
pore (10) (0.6m)	0.02	3.08	3.10	0.61	1.40	10.99	13.00

[1] The description of the analytical method is outlined briefly in Appendix I.

The total N and P levels in the water column exceed these approximate concentrations. The total N and P concentrations in the water appear at similar levels as the organic N and P. Therefore, the N and P are predominantly organic in nature. Some of the organic N and P in the water will be tied up in the phytoplankton, the remainder probably originates from wind stirring of sediments and industrial waste, which is unavailable for phytoplankton uptake. Inorganic nitrogen levels may, at least, partly control or limit phytoplankton growth [Atkins et al., 1980; Bastyan, 1986].

The abattoir and the main drain near the fertiliser plant are the major nutrient sources. Although, the area between the Southern Ocean Fish Processors and the Albany Woollen Mills discharge high levels of organic P. The area under investigation is characterised by reduced water movement, higher nutrient levels and higher productivity of macroalgae and epiphytes amongst sea grasses. High nutrient levels over sea grass beds can result in their degradation and ultimate loss. Such a loss can lead to erosion of the sediment on this shallow shelf and a reduction in secondary marine growth, such as mussels and worms which live on the sediments and other materials present in the aerobic water column. Nutrient enrichment can also cause microscopic algal blooms which can upset the base of the normal food chains and result in degrading masses of plant material and decreases in the dissolved oxygen content, pH and redox potential of the water column.

$$O_2 + CH_2O \rightarrow CO_2 + H_2O$$

This equation represents the biochemical oxygen demand resulting from the bacteriological breakdown of carbohydrates. On the other hand, nutrient accumulation may cause increased colour and turbidity, which reduces light transparency of the water and can suppress algal growth. The reduction in light penetration due to the increase in turbidity will have detrimental effects on the growth of seagrass because of the reduction in photosynthetic reactions [Atkins et al., 1980; Bastyan, 1986].

v) Pore Water Samples 9 and 10 {extracted from sediment samples (2) and (4), respectively}

Both pore water samples were much the same in inorganic composition (Appendix I) with elevated levels of N and P (Table 13). The concentration of these nutrients was much higher than in the water column sample (8) and indicates a significant store of nutrients in the sediments and interstitial water. Again, the majority of N and P was present as organic N and P. This implies that the P and N are associated with and bound to particulate matter and/or are in organic forms. Pore water sample (9) extracted from the surface

sediment sample (2) contained higher concentrations of N and P than sample (10) extracted from sediment sample (4) at a depth of 0.6m. This is to be expected as nutrients are closely associated with organic particulate matter present on the sediment/water column interface. The conductivity of the pore water samples was significantly higher than the sea water sample indicating increased levels of total dissolved salts. The pH of the pore water was 8.0 compared to 7.4 for the sea water sample. The increase in pH of the pore water would be due to an increase in the quantity of dissolved salts, such as carbonates and bicarbonates in the interstitial water.

The problems associated with high nutrient levels and highly productive epiphytic phytoplankton briefly outlined above will indirectly apply to these pore water and sediment samples. One of the most important parameters in predicting what changes a proposed dredging operation will have on water quality is the amount of soluble ammonia in the sediment. The release of this nutrient appears to be almost instantaneous on dispersion of the sediment. This increases microscopic plant production which, in turn, can smother sea grass and significantly decrease the water and sediment quality.

CONCLUSIONS

In summary, the harbour is well mixed vertically in the deeper areas and there is supposedly sufficient exchange with the Sound to allow dispersal of industrial discharge from the industries. However, there is a long resident time of water on the shallow western shelf which has markedly decreased the water and sediment quality in this area. The western shallow shelf includes the Albany Town Jetty site at the north-western edge and the water is circulated mainly by wind. This area bore very patchy sea grass areas, intermingled with areas of algae. There were large quantities of unattached algae on the periphery of the shallow flats. The sea grass was heavily covered in epiphytes and other substrates, such as shells and wooden pylons, were colonised by macroalgae.

Temperature, salinity and dissolved oxygen can vary greatly in harbours compared to the open ocean, which undergoes only minor fluctuations. Changes in these physical parameters can effect the corrosion and degradation rates of inorganic and organic materials in the marine environment, however, the ATJ site was relatively stable with respect to these measurements. The changes in the measurements observed on the ATJ site would not have any significant effect on the deterioration rate of historical materials on-site. In fact, the decrease in dissolved oxygen with increasing depth would decrease the rate of aerobic deterioration of exposed artefact materials.

Interestingly, there were very few historical artefacts actually recovered from the excavated areas of the ATJ site. The metal artefacts which were exposed on the sediment surface were actively corroding. This is to be expected as the water column is an open circulation, aerobic, marine environment. The majority of the objects were glass bottles, ceramic plates and coal, recovered from within the excavation pits. Those artefacts that were recovered from the sediment were in good condition , however, there had been some physical and mechanical damage to selected objects. It was only under the surface sediment and at depth that the redox potentials and pH decreased, indicating a reducing environment, which would, under certain circumstances, decrease the rate of metal corrosion and definately protect organic materials.

The highest concentration of artefacts in most areas were recovered in the first 50cm of the sediment. One noted exception was the artefacts in the south face of the W-E transect (2) which were found at the extended depth range of 80-130cm. This has been explained by deposition of the smaller particulate matter removed from the sediment in the W-E transect (1) by the propellor wash of the *Warren* as the vessel docks. In addition, any artefacts that were buried to a depth less than 0.3m, in close proximity to the W-E transect (1), which was situated directly behind the *Warren* propellor wash, would be subjected to severe sand and water impingement causing extensive mechanical and physical degradation. This destructive effect on artefacts would decrease with an increase in the distance from the propellors. There were very few artefacts recovered in the first test pit excavated in this area as they would have been removed by the constant, excessive water movement provided by the prop-wash and destroyed or deposited in a more westerly position. This inference is supported by the greater artefact distribution found in the second grid excavated on the W-E transect (1).

The excavated sediment areas that were investigated in this ATJ study were found to be relatively stable, with the exception of the first 30cm of the surface sediment on the W-E transect (1). If these areas were to be dredged the immediate detrimental effect to large concentrations of artefacts would be minimal. However, one of the primary concerns regarding dredging and the open-water disposal of dredged sediments is the possibility of water pollution.

In general, the sediments were severely polluted with high nutrient levels, animal by-products, heavy metals and PAHs, which are basically anthropogenic in nature. Some of the PAHs reported are carcinogenic, however, the others are either co-carcinogens or suspected carcinogens. These organic compounds that were identified in these sediments are not of petrogenic origin but rather are products of the effluents discharged from the harbourside industries. Obviously, the PAHs detected in the sediment samples pose an unacceptable health risk to human and aquatic life, however, the effect on organic and inorganic materials would be minimal.

Many samples contained elevated levels of lead, iron, aluminium, potassium and sulphate. One problem that arises because of the high concentration of iron in the sediments and the reducing nature of the sediment, is impregnation of buried organic artefacts with iron sulphides. Iron sulphides may cause post-conservation problems after stabilisation. The major corrosion products need to be characterised prior to commencement of the treatment regime, so that these problems may be minimised.

More importantly, the concentrations of these elements, especially lead, are greater in the surface sediment than in sediments at increasing depth. These elements can be easily released into the water column on disturbance of the contaminated sediment, such as dredging. Therefore, the heavy metal levels will detrimentally effect the quality of bottom dwelling marine organisms and fouling organisms. This will directly effect secondary colonisation of concreted marine artefacts postioned on the surface sediment, which may decrease the density of the concretions and in the long term, increase the degradation rate of artefact materials.

During dredging the high concentrations of soluble phosphorus and nitrogen in the sediment will be released, increasing the nutrient level in the surrounding water column, which is already polluted with respect to these

elements. Increases in these nutrient levels released from the discharged sediment during dredging will be followed by increases in the abundance of algae and epiphytes.

Accumulations of algae are the major threat to seagrass beds, as they smother the plants. As seagrass beds disappear, sand movement will increase and dredged channels may be filled and the harbour banks eroded. The increase in water and sand movement will promote physical destruction of artefact material. Degrading plant material will also decrease dissolved oxygen contents, pH and redox potentials of the immediate water column and sediment surface, which will, in turn, effect the deterioration of artefact material and alter degradation mechanisms.

In conclusion, it is very obvious from this investigation that the ATJ area is a chemically dynamic but physically stable site. There are many synergistic and opposing chemical and microbiological reactions occurring on the site which makes predicting the overall effect of this site on the rate of degradation of artefact material very difficult. Similarly, the *Warren* propellor wash also has a dramatic effect on the stability of the sediment and thus, affects the chemical and physical state of the objects on-site. Overall, the few historical artefacts that were found in the excavation pits were in relatively good condition due to the primarily anaerobic burial conditions. Generally, dredging of this area east of the ATJ would have little effect on the artefacts because of the insignificant distribution of objects in this area. However, gross disturbance of the sediment would increase the oxidising potential of the sediment and expose artefacts and subsequently, the rate of deterioration of material would increase dramatically.

In addition, dredging of the site would release large concentrations of absorbed heavy metal toxins, PAHs, soluble nutrients and organic detritus which will have a detrimental effect on the water quality and marine biota. The PAHs are lipophilic and will therefore, not easily solubilise in the water column, however, the carcinogenic nature of these organic compounds pose an unacceptable health risk to human and aquatic life.

Hence, in evaluating the potential pollutant release from these sediments during dredging, there is a need to establish the amount of pollutants that will be released both when the sediment is first dispersed and after it has been redeposited, before any dredging in this area commences.

FUTURE RESEARCH SUGGESTIONS

Significant artefact distributions were located on the west side of the ATJ, hence, an in depth conservation pre-disturbance survey of this area needs to be carried out. This would include on-site chemical measurements of inorganic and organic materials recovered from both, the surface and in the sediment. A thorough investigation of this area should include size fractionation, inorganic elemental analysis and organic screening of the local sediment at varying depth intervals to ascertain the effect of the different microenvironments on artefact survival. These types of investigations of sediments are very important as the sediment strongly influences the nature of both organic and chemical activity in the bed, which, in turn, effects the rate of artefact deterioration. Thus, some form of investigation of the sediments should be involved in virtually every maritime archaeological inspection.

However, prior to any conservation assessment being undertaken, the severe pollution indicated in the sediment, particularly with respect to PAH compounds, should be further investigated. It is essential that a more extensive investigation into this problem be undertaken to assess the extent and severity of the contamination prior to any continued inspection of the ATJ site.

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APPENDIX I

CHEMISTRY CENTRE (WA) REPORT–ALBANY TOWN JETTY

Your Ref :
Our Ref : 94E1630
Enquiries to :
Telephone :

CHEMISTRY CENTRE

W A Maritime Museum
Cliff Street
FREMANTLE WA 6160
Attention: V. Richards

REPORT ON THE ALBANY TOWN JETTY EXCAVATION STUDY 7 SEDIMENT SAMPLES, 1 WATER AND 2 POREWATER SAMPLES WERE RECEIVED ON 20 FEBRUARY 1995

Sample Details

All sediment samples were homogenised from up to 5 individual core samples taken in special acrylate corers supplied by ECL. Details are given below. The water sample was taken from close vicinity of the sediments and the pore water was extracted from samples 2 and 4 after homogenisation. Three additional cores were not analysed as requested and are held in storage.

Set 1	Sediment sample 1: area north of the stern of the Warren; surface cores numbers 14, 20, 17, 13, 7.
Set 2	Sediment sample 2: grid 2 East West transect (7.2m) surface; cores numbers 35, 41, 39, 19, 37 Sediment sample 3: grid 2 East West transect (7.5m); cores taken at 0.3m depth, core numbers 38, 1, 30 Sediment sample 4: grid 2 East West transect (7.8m); cores taken at 0.6m depth, core numbers 4,2,5.
Set 3	Sediment sample 5: experimental face (Warren hold south face); (6.1m) surface core taken number 36. Sediment sample 6: experimental face (6.5m) ; core sample number 32 Sediment sample 7: experimental face (7.0m) ; core sample number 16
Note	Cores 18, 31, 33 stored frozen for potential future requirement .
Set 4	Water sample

Methodology

All methods employed are detailed in the respective appendices, further details can be supplied if required.

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

Results of examination:

The analytical results cover three distinct areas and hence are attached as appendices as given below.

1) Inorganic elemental analysis:

These results are presented in appendix 1. The variation between the sediments is considerable. Only sample 5 has any significant organic content as determined by the LOI at 550°C.

Elevated levels of lead (sediments 1, 2 and 6), iron (sediments 1, 2, 5 and 61), and aluminium (sediments 5 and 6) are noted.
The lead levels in sample 2 is above the "investigation" level quoted for contaminated soils.
Sediments 5 and 6 show sulphate values indicating contamination. The results are given as SO4 but are calculated from sulphur as determined by ICP AES.
While the sea water results are as expected with slightly elevated nutrient values, the elevated nitrogen and phosphorus in the pore waters could indicate a significant store of nutrients.

2) Size fractionation:

These results are presented in Appendix 2 with the summary presented in Table 1 and Tables 2 to 8 gives full details for each sample.

3) Organic screen analysis:

These results are presented in Appendix 3. As detailed in this report some severe pollution is indicated in the sediment, particularly with respect to PAH compounds. This should be further investigated.

All samples will be held in storage for 6 months (until 1/11/95) unless otherwise advised.

Recommendation:

Based on the above results, it is recommended that you make the data available to officers of the Department of Environmental Protection (DEP) to allow the extent and severity of the contamination to be assessed.

You should advise the Director, Dr. Chris Simpson of the Marine Impact branch of the Department of Environmental Protection of these results for potential further investigation.

R.S. SCHULZ
PRINCIPAL CHEMIST
ENVIRONMENTAL CHEMISTRY LABORATORY

28 April 1995 dc

Cost: 4758.00

Your Ref: Albany Town Jetty Study/
Our Ref: 94E1630; 3.1.1
Enquiries to: Roger Schulz
Telephone:

CHEMISTRY CENTRE

WA Maritime Museum
Cliff Street
FREMANTLE
6160
Attention : V Richards

Report on:

1 sample of sediment received on 13 February 1995
2 samples of Pore Water received on 20 February 1995
6 samples of sediment received on 20 February 1995
1 sample of water received on 20 February 1995

94E1630/001 Cores 14,20,17,13,7 homogenised
94E1630/002 Cores 35,41,39,19,37 homogenised
94E1630/003 Cores 38,1,30 homogenised
94E1630/004 Cores 4,2,5 homogenised
94E1630/005 Core 36
94E1630/006 Core 32
94E1630/007 Core 16
94E1630/009 Pore water from cores 35,41,39,19,37
94E1630/010 Pore water from cores 4,2,5

CCWA ID		94E1630/001	94E1630/002	94E1630/003	94E1630/004
Client ID		1	2	3	4
Analyte	**Unit**				
H2O_105C	%	<1	<1	<1	<1
LOI_1050C	%	11	5.9	0.5	0.5
LOI_550C	%	1	1	<1	<1
Al_total	mg/kg	350	280	300	330
As_total	mg/kg	<10	<10	<10	6
B_total	mg/kg	9.0	10	2.0	2.0
Ba_total	mg/kg	11	18	<2.0	<2.0
Ca	mg/kg	100000	60000	500	230
Cd_total	mg/kg	<2.0	<2.0	<2.0	<2.0
Co_total	mg/kg	<5.0	<5.0	<5.0	<5.0
Cr_total	mg/kg	4.0	4.0	2.0	2.0
Cu_total	mg/kg	20	30	2.0	<2.0
ECond	mS/m	142	144	152	138
Fe_total	mg/kg	3000	6500	270	290
K	mg/kg	130	110	100	80
Mg	mg/kg	970	750	320	270
Mn_total	mg/kg	15	36	<2.0	<2.0
Mo_total	mg/kg	<5.0	<5.0	<5.0	2.0

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

REPORT OF EXAMINATION

CCWA ID		94E1630/001	94E1630/002	94E1630/003	94E1630/004
Client ID		1	2	3	4
Analyte	**Unit**				
Na	mg/kg	3400	2500	2000	1700
Ni_total	mg/kg	5.0	5.0	<5.0	5.0
Pb_total	mg/kg	150	750	10	75
SO4_S	mg/kg	4200	4000	1300	1200
SiO2_Si	mg/kg	100	100	100	120
V_total	mg/kg	6.0	5.0	<5.0	5.0
Zn_total	mg/kg	75	50	2.0	2.0

CCWA ID		94E1630/005	94E1630/006	94E1630/007	94E1630/008
Client ID		5	6	7	Water
Analyte	**Unit**				
H2O_105C	%	3	1	<1	-
LOI_1050C	%	24	12	2.6	-
LOI_550C	%	19	9	1	-
Al_total	mg/kg	6100	1000	330	-
As_total	mg/kg	62	18	10	-
B_total	mg/kg	46	25	10	-
Ba_total	mg/kg	15	8.0	11	-
Ca	mg/kg	23000	30000	15000	-
Cd_total	mg/kg	2.0	2.0	2.0	-
Co_total	mg/kg	<5.0	5.0	<5.0	-
Cr_total	mg/kg	19	5.0	4.0	-
Cu_total	mg/kg	12	25	5.0	-
ECond	mS/m	2030	95	253	3150
Fe_total	mg/kg	9000	4000	2200	-
K	mg/kg	600	210	120	-
Mg	mg/kg	3000	1900	600	-
Mn_total	mg/kg	12	12	2.0	-
Mo_total	mg/kg	9.0	5.0	10	-
Na	mg/kg	7000	3700	2500	-
Ni_total	mg/kg	10	10	6.0	-
Pb_total	mg/kg	65	120	22	-
SO4_S	mg/kg	30000	10000	2400	-
SiO2_Si	mg/kg	380	150	<100	-
V_total	mg/kg	21	10	6.0	-
Zn_total	mg/kg	56	65	12	-
CO3	mg/L	-	-	-	<2
Ca	mg/L	-	-	-	220
Cl	mg/L	-	-	-	11000
Fe	mg/L	-	-	-	<0.50
HCO3	mg/L	-	-	-	180
K	mg/L	-	-	-	230
Mg	mg/L	-	-	-	710
Mn	mg/L	-	-	-	0.20
Na	mg/L	-	-	-	6800
P_SR	mg/L	-	-	-	0.01
SO4_S	mg/L	-	-	-	1700
TSS_calc	mg/L	-	-	-	17000
pH		-	-	-	7.4

CHEMISTRY CENTRE (WESTERN AUSTRALIA)
ENVIRONMENTAL CHEMISTRY LABORATORY

REPORT OF EXAMINATION

CCWA ID		94E1630/005	94E1630/006	94E1630/007	94E1630/008
Client ID		5	6	7	Water
Analyte	**Unit**				
N_NH3	mg/L	-	-	-	<0.02
N_NO3	mg/L	-	-	-	0.13
N_total	mg/L	-	-	-	0.69
P_total	mg/L	-	-	-	0.06

CCWA ID		94E1630/009	94E1630/010
Client ID		2 Pore	4 Pore
Analyte	**Unit**		
CO3	mg/L	<2	-
Ca	mg/L	400	400
Cl	mg/L	19000	19000
ECond	mS/m	6160	-
Fe	mg/L	<0.50	0.50
HCO3	mg/L	240	-
K	mg/L	410	400
Mg	mg/L	1200	1200
Mn	mg/L	<0.20	<0.20
Na	mg/L	11000	11000
P_SR	mg/L	0.09	0.02
SO4_S	mg/L	2900	3100
TSS_calc	mg/L	34000	-
pH		8.0	-
N_NH3	mg/L	11	0.61
N_NO3	mg/L	1.3	1.4
N_total	mg/L	45	13
P_total	mg/L	12	3.1

Analyte	Method	Description
H2O_105C	iMOIS1SAGR	Water, loss at 105C.
LOI_1050C	iLOI1SAGR	Loss on ignition at 1050C, volatile solids.
LOI_550C	1LOI2SAGR	Loss on ignition at 550C, volatile solids.
Al_total	iMET1STIP	Aluminium total
As_total	iMET1STIP	Arsenic total
B_total	iMET1STIP	Boron total
Ba_total	iMET1STIP	Barium total
Ca	iMET1STIP	Calcium
Cd_total	iMET1STIP	Cadmium total
Co_total	iMET1STIP	Cobalt total
Cr_total	iMET1STIP	Chromium total
Cu_total	iMET1STIP	Copper total
ECond	iEC1WZSE	Electrical Conductivity, 25 degrees celcius.
Fe_total	iMET1STIP	Iron total
K	iMET1STIP	Potassium
Mg	iMET1STIP	Magnesium
Mn_total	iMET1STIP	Manganese total
Mo_total	iMET1STIP	Molybdenum total
Na	iMET1STIP	Sodium
Ni_total	iMET1STIP	Nickel total
Pb_total	iMET1STIP	Lead total

REPORT OF EXAMINATION

Analyte	Method	Description
SO4_S	iMET1STIP	Sulphate, sulphur expressed as sulphate.
SiO2_Si	iMET1STIP	Silica, silicon expressed as silica.
V_total	iMET1STIP	Vanadium total
Zn_total	iMET1STIP	Zinc total
CO3	iALK1WAAA	Carbonate
Ca	iMET1WCIP	Calcium
Cl	iCL1WAAA	Chloride
Fe	iMET1WCIP	Iron
HCO3	iALK1WAAA	Hydrogen Carbonate
K	iMET1WCIP	Potassium
Mg	iMET1WCIP	Magnesium
Mn	iMET1WCIP	Manganese
Na	iMET1WCIP	Sodium
P_SR	iP1WTCO	Phosphorus, soluble reactive.
SO4_S	iMET1WCIP	Sulpate, sulphur expressed as sulphate.
TSS_calc	iSOL1WDCA	Total Soluble Salts Estimated (ECond * 5.5). Applicable to <100 mg/L HCO3 samples.
pH	iPH1WASE	pH
N_NH3	iAMMN1WAAA	Nitrogen, ammonia fraction.
N_NO3	iNTAN1WAAA	Nitrogen, nitrate fraction.
N_total	iNP1WTAA	Nitrogen, persulphate total.
P_total	iPP1WTCO	Phosphorus, persulphate total.

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

Note: Conductivity is quoted as mS/m in a 1:5 distilled water extract for all sediment samples iesamples 1 to 7.

Roger Schulz
Principal Chemist
ENVIRONMENTAL CHEMISTRY LABORATORY

1 May 1995

1. SAMPLE

Seven marine core sediment samples were received in wet condition on 22 February 1995, with a request for screen analysis. Sample numbers were 94E1630/1 to /7 inclusive, and sample weights varied from 38g to 618g (dry). The results reported apply only to the samples tested.

2. PROCEDURES AND RESULTS

The test procedure was as follows:

2.1 The whole of each sample was screened wet at 1.0mm and the -1.0mm fraction then wet screened at 38µm.

2.2 The fractions were dried at 90°C. The -1.0mm + 38µm fraction was then dry screened using 600µm, 150µm and 38µm sieves. All fraction weights were recorded.

3.3 The -38µm fraction was bottle rolled and recombined with the other fractions, rolled gently to mix and bagged for return to ECL.

Screen analysis results are shown in Tables 2 - 8 and summarised in Table 1.

Please note that Sample 4 contained a spherical lead particle, possible a fishing weight, which was removed from the +1.0mm fraction before weighing, and was returned to the client separately from the other screen fractions.

J.K.W. Ellis
Principal Metallurgist

J Avraamides
Chief
Mineral Processing Laboratory

Table 1

Screen Analysis of Core Sediment Samples

Weight Percent Retained

Sample	+1.0mm	+600µm	+150µm	+38µm	-38µm	Total
94E1630/1	42.9	7.1	47.0	2.0	1.0	100.0
94E1630/2	30.5	9.5	50.8	6.3	2.9	100.0
94E1630/3	0.4	1.3	86.5	9.9	1.9	100.0
94E1630/4	1.2	1.9	86.2	9.7	1.0	100.0
94E1630/5	4.7	2.4	36.2	16.0	40.7	100.0
94E1630/6	9.9	4.1	62.9	18.5	4.6	100.0
94E1630/7	9.9	4.1	62.9	18.5	4.6	100.0

Table 2

Mineral Processing Laboratory

Particle Size Distribution

Sample No. 94J88
Client Sample ID 94E1630/1 Head weight: (g) 566.6
Description ECL Core Sediment

Aperture µm.	weight retained g	weight retained %	cumulative weight retained %	weight passing %
1000.0	243.2	42.9	42.9	57.1
600.0	40.3	7.1	50.0	50.0
150	266.1	47.0	97.0	3.0
38.0	11.2	2.0	99.0	1.0
Passing 38	5.8	1.0	100.0	

Calculated Head (g) 566.6

Table 3

Mineral Processing Laboratory

Particle Size Distribution

Sample No. 94J88
Client Sample ID 94E1630/2 Head weight: (g) 618.7
Description ECL Core Sediment

Aperture µm.	weight retained g	weight retained %	cumulative weight retained %	weight passing %
1000.0	189.0	30.5	30.5	69.5
600	58.5	9.5	40.0	60.0
150	314.0	50.8	90.8	9.2
38	39.1	6.3	97.1	2.9
Passing 38	18.1	2.9	100.0	

Calculated Head (g) 618.7

Table 4

Mineral Processing Laboratory

Particle Size Distribution

Sample No. 94J88
Client Sample ID 94E1630/3 Head weight: (g) 478.5
Description ECL Core Sediment

Aperture µm.	weight retained g	weight retained %	cumulative weight retained %	weight passing %
1000	2.0	0.4	0.4	99.6
600	6.4	1.3	1.7	98.3
150	413.5	86.4	88.1	11.9
38	47.5	9.9	98.0	2.0
Passing 38	9.1	1.9	99.9	

Calculated Head (g) 478.5

Table 5

Mineral Processing Laboratory

Particle Size Distribution

Sample No. 94J88
Client Sample ID 94E1630/4 Head weight: (g) 454.1
Description ECL Core Sediment

Aperture µm.	weight retained g	weight retained %	cumulative weight retained %	weight passing %
1000	5.3	1.2	1.2	98.8
600	8.8	1.9	3.1	96.9
150	391.4	86.2	89.3	10.7
38.0	43.9	9.7	99.0	1.0
Passing 38	4.7	1.0	100.0	

Calculated Head (g) 454.1

Table 6

Mineral Processing Laboratory

Particle Size Distribution

Sample No. 94J88
Client Sample ID 94J1630/5 Head weight: (g) 38.1
Description ECL Core Sediments

Aperture µm.	weight retained g	weight %	cumulative weight retained %	cumulative weight passing %
1000	1.8	4.7	4.7	95.3
600	0.9	2.4	7.1	92.9
150	13.8	36.2	43.3	56.7
38	6.1	16.0	59.3	40.7
Passing 38	15.5	40.7	100.0	
Calculated Head (g)	38.1			

Table 7

Mineral Processing Laboratory

Particle Size Distribution

Sample No. 94J88
Client Sample ID 94E1630/6 Head weight: (g) 71.4
Description ECL Core Sediments

Aperture µm.	weight retained g	weight %	cumulative weight retained %	cumulative weight passing %
1000.0	7.1	9.9	9.9	90.1
600	2.9	4.1	14.0	86.0
150	44.9	62.9	76.9	23.1
38	13.2	18.5	95.4	4.6
Passing 38	3.3	4.6	100.0	
Calculated Head (g)	71.4			

Table 8

Mineral Processing Laboratory

Particle Size Distribution

Sample No. 94J88
Client Sample ID 94E1630/7 Head weight: (g) 77.6
Description ECL Core Sediment

Aperture µm.	weight retained g	weight retained %	cumulative weight retained %	weight passing %
1000	3.0	3.9	3.9	96.1
600	1.5	1.9	5.8	94.2
150.0	58.4	75.3	81.1	18.9
38	12.9	16.6	97.7	2.3
Passing 38	1.8	2.3	100.0	
Calculated Head (g)	77.6			

94E1630 / 001-007
94E1630 1-7 (Sub samples)
Reinhold J. Hart
22-23089

The Officer in Charge
Chemistry Centre of W.A.
Environmental Monitoring Section
125 Hay Street
East Perth 6004 W.A.

Attention: Mr Roger Schulz

REPORT ON THE ANALYSIS OF 7 CORE SEDIMENT SAMPLES SUBMITTED ON FEBRUARY 20 FOR ORGANICS SCREEN.

METHOD OF ANALYSIS:

Gas-Chromatography/Mass-Spectrometry (GC/MS) of an organic solvent extract
A blank sample was also run using glass distilled water and the solvent mixture used for sample extractions.

RESULTS OF ANALYSIS:

94 E 1630-1 (cores 7,13,14,17,20 homogenised)

butylated hydroxy toluene (BHT)
a large quantity of elemental sulphur,
cholesterol, cholestanol

94 E 1630-2 (cores 7,13,14,17,20 homogenised)

fluoranthene,
pyrene, methyl pyrenes (3 isomers), cyclopenta(c,d)pyrenes,
11H-benzo(b)fluorene,
tetramethyl phenanthrene, 4-hydroxy-3,4-dimethyl-1(4H)phenanthrenone
benzo(b)naphtha(2,3-c,d) furans (2 isomers)
benzo(b)naphtha(2,1-d)thiophen (at least 2 isomers)
benzo(a)anthracene (and 1 isomer)
chrysene (and 1 isomer), at least 2 methylchrysenes
benzo(e)pyrene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene
perylene, benzo(g,h,i)perylene

94 E 1630-3 (cores 7,13,14,17,20 homogenised)

some long chain hydrocarbons (>C-15) at low levels

94 E 1630-4 (cores 2,4,5 homogenised)

a pentamethyl cyclohexane and 2 isomers,
various other alkyl substituted aromats,
low level unsaturated hydrocarbons (few only)
alkyl substituted phenanthrene carboxylic acid

94 E 1630-5 (core 36)

elemental sulphur in high concentration
phenanthrene, tetramethyl phenanthrene
anthracene, benzo(a)anthracene,
fluoranthene, chrysene
pyrene, benzo(e)pyrene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene
perylene (and 1 isomer)
benzo(g,h,i)perylene

94 E 1630-6 (core 32)

the chromatogram showed virtually an identical profile as the previous run 94 E 1630-5, also the materials detected in this sample were similar and of same order of magnitude.

94 E 1630-7 (core 16)

a BHT, other alkylated (methylated) phenolic polyaromatic hydrocarbons (partially saturated)
dimethyl phenanthrene, dimethoxy anthracene (probably)
a butyl-tetrahydro anthracene, a methyl-isopropyl phenanthrene,
a polymethylated phenanthrenecarboxylicacid ester (partially saturated)

COMMENT, CONCLUSION AND RECOMMENDATIONS

High elemental sulphur levels, as found in samples 94 E 1630-1, 5, and 6 could originate from industrial sources or thermally labile naturally occuring organic sulphur compounds like some mercaptans and sulphides.

BHT is commonly used as an UV-absorber in the plastics industries and as an anti-oxidant in certain foods like margarine (but banned in W.A.!)

Cholesterol and cholestanol are from biological materials like meat, animal fats etc.

Sample 94 E 1630-2 represents one of the worst cases of PAHs contamination.. Not only were a very large number of these materials detected, but also the alkylated derivatives were found at extremely high concentrations. Assuming a wet sediment sample weight of about 100 g, PAHs were found at levels of between 0.1-1.8 mg (!) per kg wet sediment sample. For example, the National Health and Medical Research Council sets an upper limit value for benzo(a)pyrene in drinking water of 0.00001 mg/L.
Some of these materials are co-carcinogens, but benzo(a)pyrene and the alkylated (e.g. methylated) PAHs are known to be powerful mutagens and carcinogens.

Samples 1630-5 and 6 showed a very similar profile, only one alkylated PAH was detected, namely tetramethyl anthracene at an estimated level of 50 ug per kg wet sediment sample. All the other PAHs were present at concentrations between 0.05-0.2 mg per kg wet weight.

PAHs in sample 1630-7 were found at levels between 0.05- 0.4 mg per kg wet weight, the 2 alkylated ones being of highest concentrations.

The PAHs reported above are not of petrogenic (crude oil, petroleum products), but rather anthropogenic nature, i.e. they are products of industrial activities around the locations they were found.

Obviously, the PAHs detected in the samples pose an unacceptable health risk to human and aquatic life. It is strongly recommended to undertake a more in depth investigation into this problem in order to identify the sites of greatest concern and devise a strategy for proper remediation.

Analysis performed only on samples as received

References :

Encylopaedia of Occupational Health and Safety
3rd Edition, Part 2, 1983
International Labour Office, Geneva, Switzerland

Environmental and Occupational Medicine
1st. Edition, 1983
Little, Brown and Company, Boston, USA

National Health and Medical Research Council
Australian Drinking Water Guidelines
Draft, June 1994

R J HART
SENIOR CHEMIST & RESEARCH OFFICER
ENVIRONMENTAL CHEMISTRY LABORATORY

CHARGEABLE COST: $2400.00
DATE: 28 April 1995

FAX TRANSMISSION COVER SHEET

Department of Maritime Archaeology
WESTERN AUSTRALIAN MARITIME MUSEUM
Cliff Street, Fremantle, Western Australia 6160
FAX NO: (61-09) 335 7224 & (61-09) 430 5120; TEL NO: (61-09) 431 8488
E-Mail Address: wrecks@mm.wa.gov.au

FROM:	Mike McCarthy	TO: Address:	Dr Richard Lugg Health Department
Date:	2 May 1995		
No of Pages: 17 + cover sheet		Fax No:	388 4975

Comments/Message:

Dear Richard,

re: As discussed

Please find attached the report of the Chemistry Centre on sediments raised - to Ms V. Richards, the conservator in chief on my excavation of the Albany Town Jetty, November/December 1994.

The matter is referred to you direct on advice from Mr R.S. Scholz, Principal Chemist at the Environmental Chemistry Laboratory on the basis of what is noted as 'an unacceptable health risk to human and aquatic life'. (Hart to Schulz report on the analysis of 7 core sediment samples submitted on 20 February for organics screen (p.3/4).)

The report strongly recommends more in-depth investigation, something I understand is the premise of the Department of Health and the Environmental Protection Authority.

I also seek the advice of the Health Department on the implications of these findings on the divers involved so that I can keep them properly informed. Obviously I am also concerned at the ramifications of this for the natural environment and the community at large.

Yours sincerely,

Mike McCarthy
Curator
Dept Maritime Archaeology

Copies to: Dr Simpson, EPA
Phil Slater, LandCorp

APPENDIX J

HEALTH DEPARTMENT OF WESTERN AUSTRALIA

ENVIRONMENTAL AND OCCUPATIONAL HEALTH REPORT

POLYCYCLIC AROMATIC HYDROCARBONS (PAHs) IN MARINE SEDIMENTS

APPENDIX F

Western Australia

Health Department of Western Australia — Environmental Health Service

ENVIRONMENTAL AND OCCUPATIONAL HEALTH

Fax Transmission

To:	Mr Mike McCarthy	**Fax No:**	335 7224
Title:	Curator, Department of Maritime Archaeology Western Australian Maritime Museum		
From:	Dr Richard Lugg		
Title:	Medical Consultant, Environmental Health		
Date:	22 May 1995		

You should receive 3 pages including this one.
If you do not receive all pages, please call (09) 388 4974.

Message:

PAHs IN MARINE SEDIMENTS

I refer to our phone conversation and your fax earlier this month regarding the above matter in relation to excavations at the Albany Town Jetty.

I said to you at the time that I thought the risk would be negligible to marginal. I have now had the documentation from the Chemistry Centre that was sent with your fax examined by a Health Department toxicologist, Dr Kevin Buckett, and a copy of his report is attached.

The conclusion to be drawn is that there is no basis for regarding the activities of your divers at the Albany Town Jetty as constituting exposure to a health risk.

More generally, the precautions that could be considered in future excavations of this kind are to remind divers to avoid unnecessary skin exposure where similar sediments are likely to be stirred up in future activities, and of course to avoid swallowing turbid water under such circumstances. Skin which is visibly covered with sediment from such sites should be washed clean upon resurfacing, and wetsuits should be free of sediment before being stored away.

I hope this is some use to you.

Regards

Dr Richard Lugg
MEDICAL CONSULTANT

POLYCYCLIC AROMATIC HYDROCARBONS (PAHs) IN MARINE SEDIMENTS

The note from Mr McCarthy Curator, Department Maritime Archaeology, raises concern about PAH contamination of sediments and risks to divers undertaking archaeological activity.

The attached Chemistry Centre report included data showing a range of PAHs in a number of sediment samples. Levels of PAHs where estimated to be 0.05 to 1.8 mg/kg wet weight of sediment. In the report this was compared with the NH & MRC (draft) Drinking Water Guideline of 10 ng/L for benzo(a)pyrene.

The NHMRC drinking water value is based on consumption of 2 L/day for a lifetime. The value itself is for benzo(a)pyrene, rather than PAHs in general. Many PAHs lack the strong bioactivity of benzo(a)pyrene,and the risks to health associated with PAHs in marine sediment cannot be compared to those associated with benzo(a)pyrene in drinking water.

PAHs are lipophilic and can be absorbed by inhalation, ingestion and via the skin. The first two of these routes are not applicable to divers. Skin contact with the sediment could conceivably pose a risk, however.

PAHs are readily soluble in water, and levels dissolved in water around the sample sites are likely to be relatively low. This may be worth checking by sampling and testing of the water.

Coal tar and coal tar pitches, which contain PAHs, are known to cause skin cancer in humans following dermal exposure. This has been shown for people occupationally exposed to coal tars (cancer of the scrotum in chimney sweeps was the first type of cancer to be associated with the work place). Exposure to PAHs in these cases was at high levels in powders, dusts and tars.

A proposed investigational guideline level for PAHs in contaminated soil is 1ppm (1 mg/kg) (Health Risk Assessment and Management of Contaminated Sites, South Australian Health Commission, 1991). This is based on exposure to children and assumes that ingestion is the major route of exposure rather than dermal contact.

Divers working on sediments containing PAHs at up to 1.8 ppm will not be exposed orally, and dermal exposure is likely to be low.

Conclusions

Assuming the divers are wearing wet suits and gloves, the levels of PAHs in the sediment as measured by the Chemistry Centre WA are unlikely to pose a health risk.

Dr Kevin Buckett
TOXICOLOGIST

22 May 1995
(5522bk1b.doc)/cr

APPENDIX K

WRECK INSPECTION REPORT
SMALL BOAT (Unidentified)–ALBANY TOWN JETTY

APPENDIX K

WRECK INSPECTION REPORT
SMALL BOAT (Unidentified)–ALBANY TOWN JETTY

General Description

The wreck of a small boat consisting of the keel, floor timbers, outer planking, or skin and the remains of the stern and transom, was found east of the Warren tug boat berth.

The boat appears to have been clinker built and copper fastened. The timbers were very soft and appeared to be severely effected by toredo worm. Concreted pieces of iron were visible in the midships and on the port quarter and two concreted lumps were found buried under sediment in the bow area. A black bituminous coating on the inside of the planking suggests that the boat may have been tarred at one time. The visible parts of the wreck, protruding above the sediment were the stern and transom and the tops of the frames and planking on the starboard and port sides. Forward of midships the hull was buried under sediment.

Location

The wreck is located approximately ten metres east of the Warren tug boat berth and lies in 5-6 m of water.

Details

1. Overall length 3.75 m. The stern lies towards the east and the bow towards the west.

2. The remains of the stern and transom stand 25 cm above the seabed and are 60 cm wide. The transom extends 50 cm on the starboard side, from the keel; and 10 cm on the port side, from the keel. On the starboard side the transom is 8 cm high. The remains of a heel knee were visible immediately forward of the transom. The remains of a copper fastening was visible in the lower midship section of the transom.

3. The remains of the garboard and lower skin planking, and the possible floor timbers, or frames, were visible forward of the transom for a distance of approximately 20-40 cm. Forward of this point the skin planking and frames were buried under sediment. The moulding and siding of these timbers were not recorded.

4. The hull had a beam of 1.55 m, 1.95 m forward of the transom. At 70 cm forward of the transom the beam was 1.28 m.

5. The port side of the hull was visible for 1.95 m forward of the transom. Forward of this point the hull was buried under sediment.

6. The starboard side of the hull was visible for 2.4m forward of the transom. Forward of this point the hull was buried.

7. Two lengths of round concreted iron were found on the port quarter. The forward piece of iron was 50 cm long.

8. A twisted length of flat iron, 40 cm long, was located 1.90 m forward of the transom, on the port side. An iron upright, 12 cm high, was found on the starboard side at the same distance from the transom.

9. An iron upright was found 2. 85 m forward of the transom on the starboard side. The upright was 10 cm high.

10. The remains of the bow were hand excavated 3 m forward of the transom. The exposed remains consisted of a small part of a possible frame, two concreted round iron objects and the remains of a possible bulkhead, or floor timber. The latter timber was located 2.9 m forward of the transom, stood 12 cm high above the skin and was 25 cm long.

11. A hole was hand excavated amidships, 1.95 m forward of the transom and hull remains were found at a depth of 25 cm under the sediment.

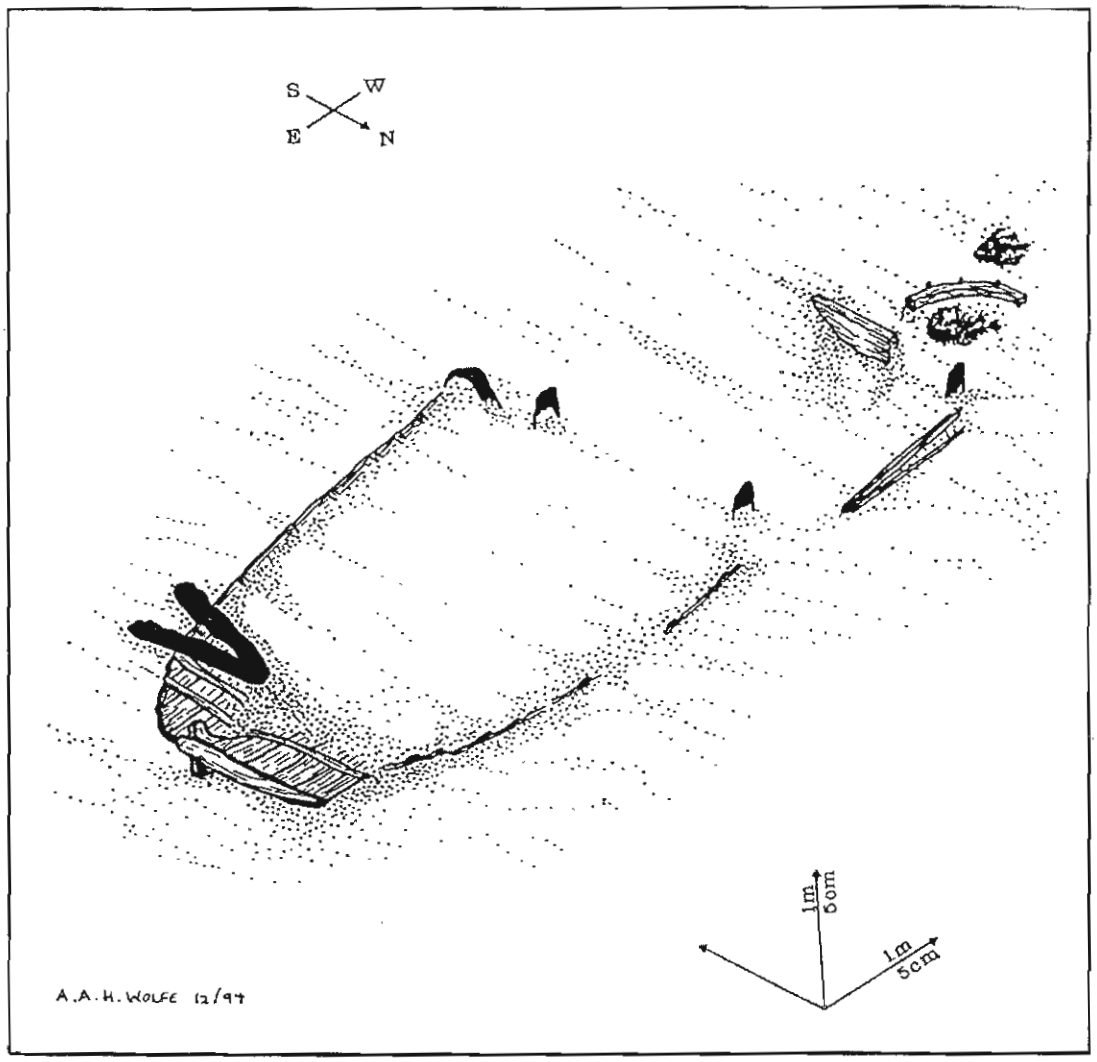


Figure 3: Isometric view of the lower hull remains of a small, timber, clinker built and copper fastened dinghy found east of the *Warren* tug boat berth at the Albany Town Jetty. The stern is at the east end of the site. The bow area is indicated by the piece of frame, the remains of a possible bulkhead and two iron concretions at the west end of the site. The tops of unidentified iron remains, possibly ballast, are visible on the starboard side, aft of the bow area and on both port and starboard sides, amidships. Two concreted iron remains lie on the port quarter forward of the stern.

APPENDIX L

ALBANY TOWN JETTY–DIVE LOG

APPENDIX L

ALBANY TOWN JETTY–DIVE LOG

Key: LS&S = Low Seas & Swell
MSJ = Mail Steamer Jetty

Date: 22.11.94 Location: Albany Town Jetty Site: Mail Steamer Jetty
Depth: 3.1 Conditions: LS&S Wind: variable ENE Water Temp:19°
Personnel: Mike McCarthy, Vicki Richards, Jon Carpenter, John Clarke, Dena Garratt, Adam Wolfe.

Diver	Time In	Out	Total	Task
John	1400	1539	99	Checkout dive with Adam &set up dredge.
Adam	1400	1525	85	Set up & test water dredge.
Vicki	1410	1515	65	Predisturbance survey at Datum pile.
Jon	1410	1620	130	Predisturbance survey at Datum pile.
Dena	1415	1600	105	Measure datum pile. Dredge between outer MSJ jetty piles. (First test trench).
Mike	1532	1605	33	Transect between jetty piles.
Mike	1608	1620	12	Surface search around tug berth.

Dena Standby Diver
Total dive time: 8 hours 49 mins (529 mins)

Date: 23.11.94 Location: Albany Town Jetty Site: Mail Steamer Jetty
Depth: 2.60 Conditions: LS & S Wind: Moderate SW 15-20kts
Personnel: Mike McCarthy, Vicki Richards, Jon Carpenter, John Clarke, Dena Garratt, Adam Wolfe.

Diver	Time In	Out	Total	Task
John	1030	1243	133	Set up dredge under jetty piles, excavate trench
Dena	1030	1243	133	Set up dredge under jetty piles, excavate trench.

Adam Standby diver

Adam	1045	1100	15	Excavated trench.
Adam	1130	1140	10	Excavatied trench.
Vicki	1230	1400	90	Predisturbance survey at Datum pile.
Jon	1230	1430	120	Predisturbance survey at Datum pile.
Mike	1317	1600	163	Excavation of trench, pack up gear.
Adam	1317	1600	163	Excavation of trench, pack up gear.

Dena Standby diver
Total dive time: 11 hours 20 mins (680 mins)
Cumulative dive time: 20 hrs 9 mins

Date: 24.11.94 Location: Albany Town Jetty Site: Mail Steamer Jetty
Depth: 2.70 Conditions: No swell Wind: variable ENE
Personnel: Mike McCarthy, Vicki Richards, Jon Carpenter, John Clarke, Dena Garratt, Adam Wolfe.

Diver	Time In	Out	Total	Task
Jon	0940	1030	50	Still photos & video of datum pile, large wheel,
John	0940	1030	50	test trench at datum pile and excavaton under the Mail steamer Jetty.
Vicki	1045	1205	80	Sediment analysis in excavation trench under the MSJ. Set up grid square at first position of EW transect in area to be dredged.
Jon	1045	1205	80	Recovered ballast stones, sampled wood from transect trench.

Adam Standby diver

Adam	1220	1245	25	

Mike Standby diver

Dena	1305	1550	165	Excavated first trench, EW transect.
John	1305	1550	165	Excavated first trench,EW transect.
Adam	1307	1405	58	Secured water dredge.

Mike	1440	1540	60	Secured water dredge. Observed excavation.

John Standby diver
Total dive time: 12 hours 13 mins (733mins)
Cumulative dive time: 32hrs 22 mins

Date: 25.11.94 Location: Albany Town Jetty Site: Tug wash area
Depth: 6.0m Conditions: LS&S Wind: variable ENE
Personnel: Mike McCarthy, Vicki Richards, Jon Carpenter, John Clarke, Dena Garratt, Adam Wolfe.

Diver	Time In	Out	Total	Task
John	1025	1250	145	Set up grid square & dredge 1st grid EW transect.
Dena	1025	1305	160	Set up grid square & dredge. Measure datum.
Vicki	1150	1335	105	Sediment sampling.
Jon	1150	1430	160	Sediment sampling.
Mike Standby diver				
Mike	1230	1450	140	Dredge first trench in tug wash.
Adam	1230	1450	140	Dredge first trench in tug wash.
John Standby diver				
Jon	1430	1450	20	Video of site.
Mike	1528	1604	36	Site 2 Water jet.
Adam	1538	1558	20	Seabed survey.

Total dive time: 15 hours 26 mins (926 mins)
Cumulative dive time: 47 hrs 48 mins

Date: 26.11.94 Location: Albany Town Jetty Site: Tug berth
Depth: 7.3 Conditions: LS Wind: ENE backing to SSW
Personnel: Mike McCarthy, Jon Carpenter, John Clarke, Dena Garratt, Adam Wolfe.

Diver	Time In	Out	Total	Task
Jon	0950	1150	120	Set up grid EW transect No.2.
Dena	0950	1155	125	Set up grid EW transect No.2.
Adam	1020	1140	80	Set up grid EW transect No.2.
Mike Standby diver				
Mike	1232	1605	213	Warren tug wash.
John	1238	1410	92	Warren tug wash.
Jon	1440	1608	88	Warren tug wash.

Total dive time: 16 hours Mins 13 (1093 mins)
Cumulative dive time: 64 hours 1min

Date: 27.11.94 Location: Albany Town Jetty Site: Tug prop wash area
Depth: 7.0m Conditions: Calm Wind: S 3-5 kts
Personnel: Mike McCarthy, John Clarke, Dena Garratt, Adam Wolfe.

Diver	Time In	Out	Total	Task
Mike	1000	1220	140	Check layers in EW transect No. 2 Step trench No. 1. Excavate step trench No. 2.
Dena	1025	1220	115	Set up grid & record EW Transect No.2, step trenches No.1 & 2.
Adam	1025	1125	60	Set up grid & record EW transect No.2, step
Adam	1130	1218	48	trenches No.1 & 2.
John Standby diver				
John	1245	1615	210	Dredge EW transect No.1. test trench No.3.
Adam	1258	1605	187	Dredge EW transect No.1 test trench No. 3.
Dena	1258	1610	192	Dredge EW transect No.1 test trench No. 3.
Mike Standby diver				
Mike	1445	1615	90	Excavate EW transect No.2 step trench No.3.

Total dive time: 17 hrs. 22 mins.(1042 mins)
Cumulative dive time: 81 hrs 23 mins

Date: 28.11.94 Location: Albany Town jetty Site: NS Transect
Depth: Conditions: Wind:
Personnel: Mike McCarthy, John Clarke, Dena Garratt, Adam Wolfe, Ross McGuffie.

Diver	Time In	Out	Total	Task
Ross	1037	1227	110	Dredging NS transect Test trench No.2&3.
John	1037	1222	115	Dredging NS transect Test trench No.2&3.
Adam	1110	1227	77	Record bio strats of NS No. 2&3.
John	1256	1310	14	Gear retrieval due to tug movement.
Adam	1256	1310	14	Gear retrieval due to tug movement.
John	1332	1507	95	
Adam	1342	1420	38	Move grid from trench No3 to No 4.
Mike	1442	1507	25	Set up dredge under tug excavated trench No4.
Mike	1523	1633	70	EW transect No2. step trenches 3 & 4.

Total dive time: 9 hrs 23 mins (588 mins)
Cumulative dive time: 90 hrs 41 mins

Date: 29.11.94 Location: Albany Town Jetty Site: EW Transect No. 2.
Depth: Conditions: Wind:
Personnel: Mike McCarthy, John Clarke, Dena Garratt, Adam Wolf, Pat Baker.

Diver	Time In	Out	Total	Task
Pat	0955	1117	82	Reconnoiter
Dena	1000	1225	145	Record step trench No3 on EW Transect No2.
Adam	1015	1130	75	Record step trench No3 on EW Transect No2.
John	1015	1225	70	Dredge Whaler Jetty 2 Holes.
Mike	1145	1220	35	Set up grid - step trench No4, EW Transet No2.
Mike	1315	1430	76	Whaling Jetty 3,4,5 Test holes.
John	1315	1430	75	Whaling Jetty 3,4,5 Test holes.
Pat	1320	1420	60	Photograph Whalers Jetty.

Total dive time: 10 hrs 18 mins (618 mins)
Cumulative dive time: 100 hrs 59 mins

Date: 30.11.94 Location: Albany Town Jetty Site:
Max. Depth: Conditions: Wind:
Personnel: MikeMcCarthy, John Clarke, Dena Garratt, Adam Wolfe Patrick Baker.

Diver	Time In	Out	Total	Task
Mike	1005	1145	142	Clean up with water dredge.
Dena	1018	1145	87	Record strata , EW No. 2, steptrench No. 4.
Adam	1017	1135	78	Record strata , EW No. 2, steptrench No. 4.
Adam	1140	1228	48	Record strata , EW No. 2, steptrench No. 4.
Dena	1150	1228	38	Record strata , EW No. 2, steptrench No. 4.
Patrick	1048	1235	107	Photograph work in progress-EW No. 2, steptrench No. 4.
John	1320	1420	60	
Mike	1330	1420	50	Extend step trench EW 2, No.4.
John	1435	1530	55	
Mike	1435	1530	55	

Total dive time: 12 hrs (720 mins)
Cumulative dive time: 112 hrs 59 mins

Date: 01.12.94 Location: Albany Town Jetty Site:
Depth: Conditions: Wind:
Personnel: Mike McCarthy, John Clarke, Dena Garratt, Adam Wolfe.

Diver	Time In	Out	Total	Task
Dena	1040	1210	90	Test grid East side. 1874 Jetty, 16m North from 'T' 15m East.
Adam	1040	1210	90	Test grid East side. 1874 Jetty, 16m North from 'T' 15m East.
Mike Standby diver				
John	1218	1558	220	Test Trench. 1874 Jetty.
Adam	1300	1540	160	Test Trench. 1874 Jetty.
Dena	1248	1558	190	Test Trench, 1874 Jetty.

Total dive time: 12 hrs 30 mins (750 mins)
Cumulative dive time: 125 hrs 29 mins

Date: 02.12.94 Location: Albany Town Jetty Site:
Depth: Conditions: Wind:
Personnel: Mike McCarthy, Dena Garratt, Ray Shaw, Adam Wolfe.

Diver	Time In	Out	Total	Task
Mike	0918	1055	97	Fix position of all trenches & obtain depths to a common datum.
Adam	1024	1100	36	Looked at small boat.
Dena	1039	1105	26	Orientation dive for Ray, tug wash.
Ray	1039	1105	26	Orientation dive for Ray, tug wash.

Total dive time: 3 hrs 5 mins (185 mins)
Cumulative dive time: 128 hrs 34 mins

Date: 03.12.94 Location: Albany Town Jetty Site:
Depth: Conditions: Wind:
Personnel: Mike McCarthy, John Clarke, Dena Garratt, Adam Wolfe, Bob Shephard, John Buchanan, Nikki King Smith.

Diver	Time In	Out	Total	Task
Mike	0940	1000	20	Take depths Holes 8-9 140=6.2m 120=5.5m. Datum -3cm.
Adam	1000	1100	60	Test holes 8-9 140/120 WE line 1.
John	1000	1120	80	Test.holes 8-9 140/120 WE line 1.
Adam	1120	1200	40	Harbor trench 10m-20m.
John	1132	1230	58	Harbor trench 10m-20m.
John	1315	1640	175	Mail Steamer Jetty trenches 1, 2, 3.
Dena	1315	1610	175	Mail Steamer Jetty trenches 1, 2, 3.
Bob	1410	1550	80	Water dredge trials.
John B	1405	1515	70	Water dredge trials.
Nikki	1405	1515	70	Water dredge trials.
Mike	1535	1605	30	Assisted Dena and John.
Bob	1535	1605	30	Assisted Dena and John.

Total dive time: 14 hrs 48 mins (888 mins)
Cumulative dive time: 143 hrs 22 mins

Date: 04.12.94 Location: Albany Town Jetty Site:Albany Jetty Baths site.
Depth: 1.70 Conditions: LS&S Wind: S 5- 15 kts
Personnel: Dena Garratt, Pat Baker, Ray Shaw, Bob Shephard.
Standby Diver: Pat

Diver	Time In	Out	Total	Task
Dena	1020	1215	115	Dredge test trench near Baths, 3m north of southern pile.
Ray	1020	1215	115	Dredge test trench near Baths, 3m north of southern pile.
Bob	1020	1215	115	Dredge test trench near Baths, 3m north of southern pile.
Dena	1310	1215	115	Dredge test trench near Baths. Towed search along shoreline.
Ray	1310	1410	60	Dredge test trench near Baths. Towed search along shoreline.
Bob	1310	1410	60	Dredge test trench near Baths. Towed search along shoreline.

Total dive time: 9 hrs 40 mins (580 mins)
Cumulative dive time: 153 hrs 2 mins

Date: 05.12.94 Location: Albany Town Jetty Site:
Depth: Conditions: LS&MS Wind: W 15-20 kts
Personnel: Mike McCarthy, Dena Garratt, Adam Wolfe, Ray Shaw, Bob Shephard.

Diver	Time In	Out	Total	Task
Mike	1010	1020	10	Reset Datum points & locate small boat.
Adam	1020	1130	70	Prelim. survey of small boat.
Dena	1020	1050	30	Take cockle shell samples from EW transect No.1, holes No. 3&4.
Ray	1020	1050	30	Take cockle shell samples from EW transect No.1, holes No. 3&4.
Bob	1050	1130	40	General U/W duties.
Dena	1050	1130	40	Assist survey of small boat.

Total dive time: 3 hrs 40 mins (220 mins)
Cumulative dive time: 156 hrs 42 mins

Date: 07.12.94 Location: Albany Town Jetty Site:
Depth: 7.2m Conditions: MS &LS Wind: S backing E 10–20 kts
Personnel: Mike McCarthy, Pat Baker, John Clarke, Dena Garratt, Adam Wolfe.

Diver	Time In	Out	Total	Task
Mike	1015	1125	70	Test trench, east side of jetty, inshore.
Dena	1015	1125	70	Test trench, east side of jetty, inshore.
Adam	1300	1515	135	Excavate whaler jetty, west side.
John	1300	1515	135	Excavate whaler jetty, west side.
Pat	1345	1525	100	Photography.
Mike	1535	1700	85	Excavate tug wash trench No. 5.
Adam	1500	1630	90	Surface search for artefacts.

Total dive time: 11 hrs 25 mins (685 mins)
Cumulative dive time: 168 hrs 7 mins

Date: 08.12.94 Location: Albany Town Jetty Site:West side of ATJ.
Depth: 6.4m Conditions:S&S Wind: SE 5–15 kts
Personnel: Mike McCarthy, Pat Baker, John Clarke, Dena Garratt, Adam Wolfe, Ray Shaw.

Diver	Time In	Out	Total	Task
Mike	0950	0955	5	Surface collection of artefacts.
Mike	1010	1135	85	Surface collection of artefacts.
Adam	1005	1135	90	Site plan of surface material.
Dena	1025	1100	35	Record step trench.
Dena	1120	1200	40	Record step trench.
Dena	1208	1300	52	Record step trench.

Ray	1120	1200	40	Record step trench.
Mike	1145	1300	75	Excavate final trench, west of ATJ.

Total dive time: 7 hrs 2 mins (422 mins)
Cumulative dive time: 175 hrs 9 mins

APPENDIX M

MARITIME HERITAGE SITE INSPECTION REPORT
ALBANY TOWN JETTY
November 1994

HERITAGE COUNCIL OF WESTERN AUSTRALIA
SITE PARTICULARS FORM

The Albany Town Jetty

Maritime Heritage Site Inspection Report

Compiler: D. Garratt
Contributors: A Wolfe, J. Carpenter, V. Richards

November 1994

Report - Dept. of Maritime Archaeology
WA Maritime Museum, No 89.

This project was funded by Landcorp as part of the Albany Redevelopment.

Contents

Figures

Acknowledgments

This project was funded by LandCorp as part of the Albany Town Foreshore Redevelopment

Introduction

The purpose of this site inspection was to make a preliminary assessment of the extent of the submerged remains of the Albany Town Jetty and to produce a photographic record of the site and any associated material on land.

Background

Site Name(s): Albany Town Jetty (Incorporates the Mail Steamer Jetty, also known as the Quarantine Jetty, and the Whaler Jetty.

File Name: Albany Town Jetty
File Name: Jetties and Port-related Structures Project
File Name: Area-Albany Wrecks

File No: MA 80.94
File No: MA 2.93
File No: MA 195.72 (5 Vols.)

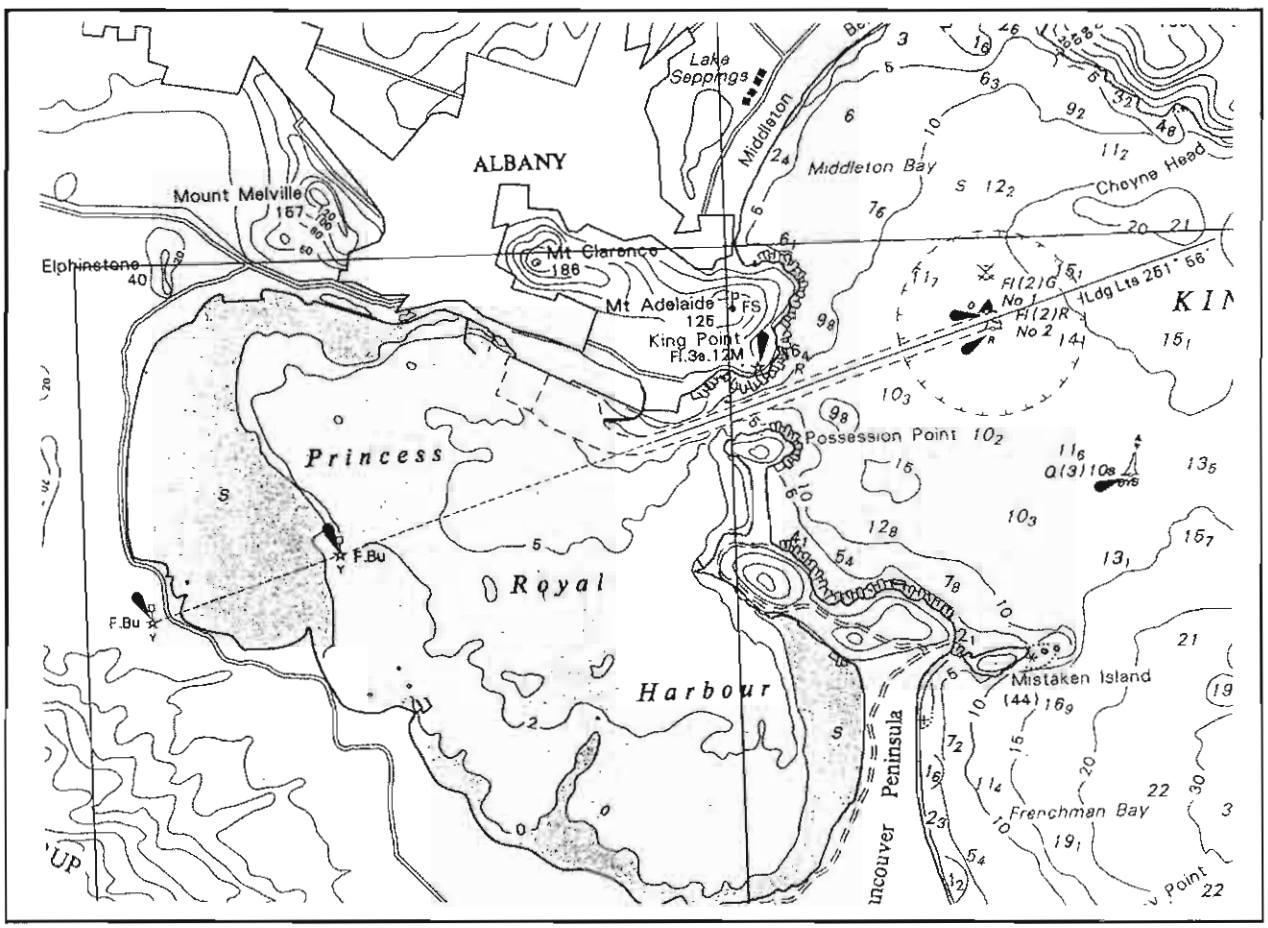


Figure 1. **Chart Excerpt:** AUS 118 *Approaches to King George Sound.* 1983, 1; 75 000.

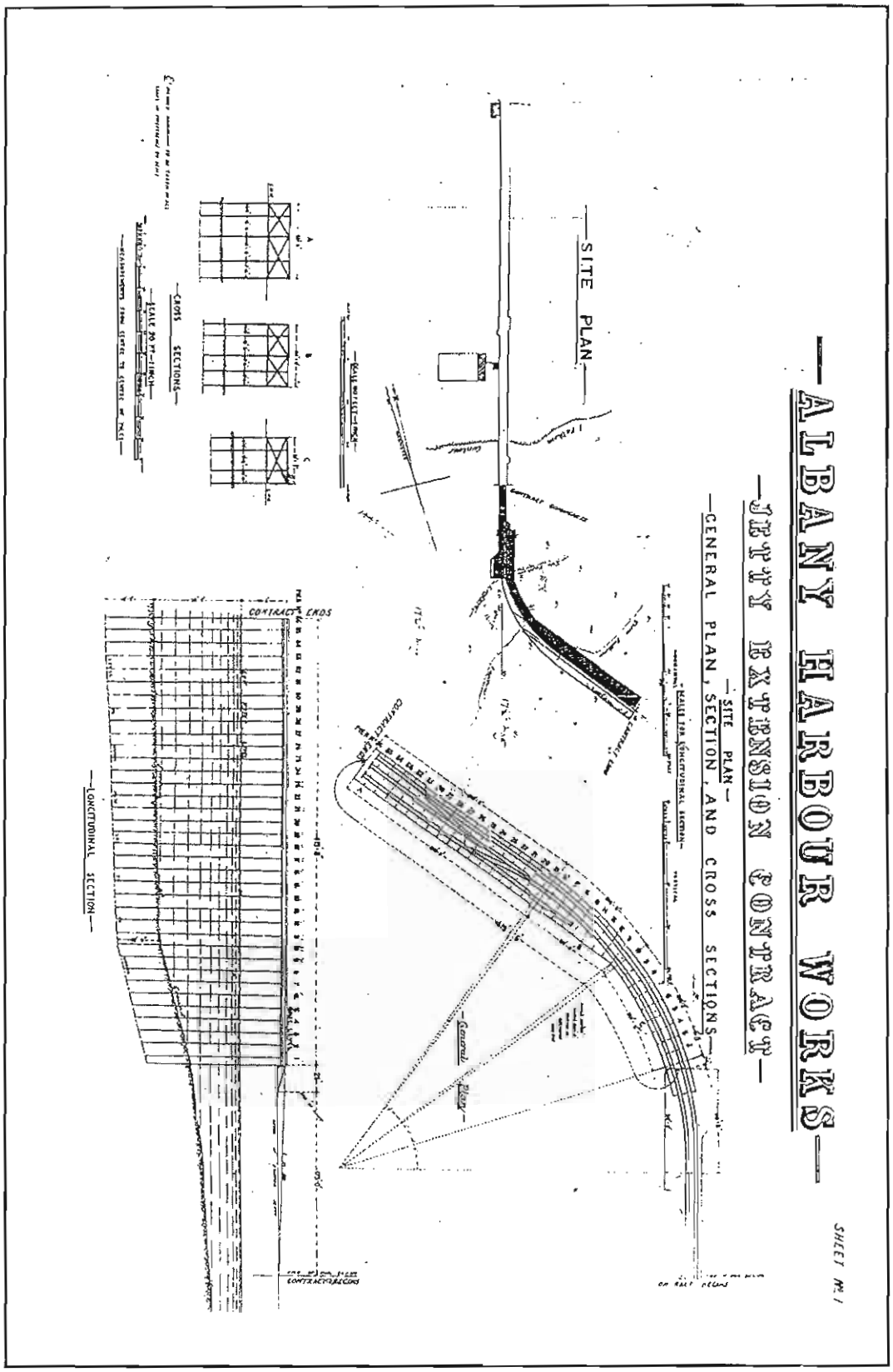


Figure 2. **Plan:** *Albany Harbour Works; Jetty extension contract.* Sheet No. 1.

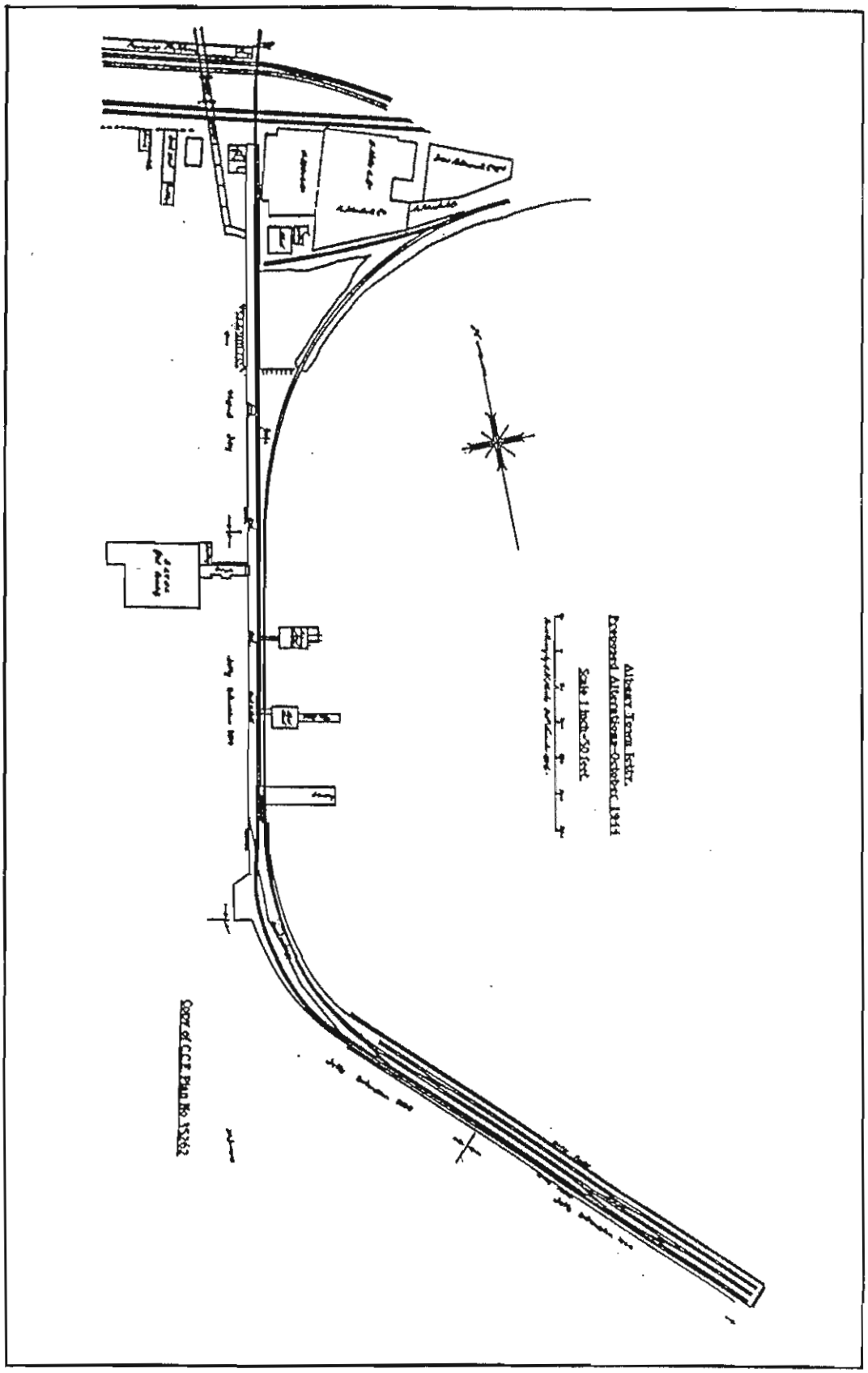


Figure 3. **Plan:** CCE Plan No. 35262. *Albany Town Jetty; proposed alterations. October 1944.*

Technical Data

Date of Inspection: 21/11/94-

Personnel: M. McCarthy, P. Baker, D. Garratt, A. Wolfe, J. Carpenter, V. Richards J. Clarke Ray Shaw, N. King-Smith, J. Buchanan, R. Shephard R. McGuffie and R. Dixson.

Approximate Location: Albany Town foreshore.

Charts: BA 1034, *Cape Naturaliste to King George Sound.* 1914, 1: 603 000.
AUS 109 *Port of Albany.* 1982, 1: 12 500.
AUS 110 *King George Sound.* 1983, 1: 12 500.
AUS 118 *Approaches to King George Sound.* 1983, 1: 75 000.
AUS 336 *Cape Leeuwin to King George Sound.* 1984, 1: 300 000.
AUS 759 *Hiller Point to Bald Island.* 1984, 1: 150 000.

Maps: Plantagenet 457 B40, 2" to 1 mile, Dept. of Lands and Surveys, WA. (Undated)

Plans: *Albany Harbour Works; Jetty extension contract.* Sheet No. 1.Harbours and Rivers Department, plan 568A. June 1899. 50 ft to 1 inch.
PWDWA 48583-11-1 *Port of Albany.* 1975.
Western Australian Railway Department, *Albany Town Jetty, Proposed Alterations*, October, 1944. CCE plan 35262, 22/1/45. 50 ft to 1 inch.

Latitude: C. 35° 02'S **Longitude**: C. 117° 53'.E

Site Photographs:
B/W: U/W ATJ 4290-4292 Cons. 118 (ATJ 21)
Colour: ATJ 4289 slide copies
Slides: ALBW 1-60
Video: No. 122 (Hi8) J. Carpenter, Nov. 1994; No. 123 (V8) J. Clarke, Nov. 1994.
Historic: MA 4569A, MA 4571.
Albany Residency Museum photographic collection, Film Nos. 13,23, 125, 135, 139, 195.

Site Conditions on Inspection:
Swell: low seas and swell
Visibility: 2-3m
Current: Nil
Sea-bed coverage: sand and glutinous sedimentary matter

Chemical Measurements:
Temperature: 19°
Salinity:
pH: 8.17
Dissolved O_2: 9.5 ppt at surface and 7.1 ppt. at 2.4 metres.
Corrosion Potential: -316mV relative to Ag/AgCl/sea water reference electrode.

Biological Data:
Colonising fauna: No vertebrate life present. The seabed was covered with detritus with few live tunicates. The jetty piles were encrusted with sessile invertebrates and forms of algae.

Site Condition and Integrity:
The jetty is constructed of wooden piles which appear structurally sound. The historical association with the Albany township has resulted in an accumulation of cultural material on the site. The activities of watercraft has resulted in the disturbance of the seabed by wash from propellers.

Management Considerations

(i) Natural forces: The jetty is not prone to the damaging forces of heavy seas, strong tides or a large degree of seasonal seabed scouring.

(ii) Present and future human forces: The waters around the jetty have been extensively scoured by local bottle collectors using water dredges and jets. In addition the crews of the whale catchers and commercial fishing boats were in the habit of running their engines and propellers while lying alongside and then diving to recover exposed material. Today these waters are infrequently dived by bottle collectors and other souvenir hunters.

(iii) Projected general site stability: The old 1893 south east jetty extension was used as a berth for the Cheynes Beach Whale catchers until 1978 when it was closed off to the general public. Since that time the extension has deteriorated and is now in a condemned condition.
The Mail Steamer Jetty is similarly in an usafe condition and is closed to the public.

Description of Site

All that remains of the old structure are the remains of the 1893 jetty head at the south east end of the jetty and the mail and passenger landing (Mail Steamer Jetty) on the east side of the jetty immediately south of the reclaimed jetty neck. The original jetty construction of 1862 and the 1873 extension are now covered by landfill. The Whaler Jetty is in a dangerous state of disrepair and is closed to all traffic. No evidence of the baths exists.
The surface of the seabed is littered with modern material, primarily jetsam from fishing boats.
The seabed directly underneath the berth for the Albany Harbour Authority tug, *Warren* has been cleared of all silt, due to the action of the tug's propeller wash. The scour pit extends down approximately 2 metres below the surface sediment and has exposed a layer of ancient shell bed. In the immediate vicinity around the scour pit, artefacts that have been disturbed lie scattered over the seabed. An area on the east side of the jetty is covered in a layer of scallop shell to a depth of approximately one metre.

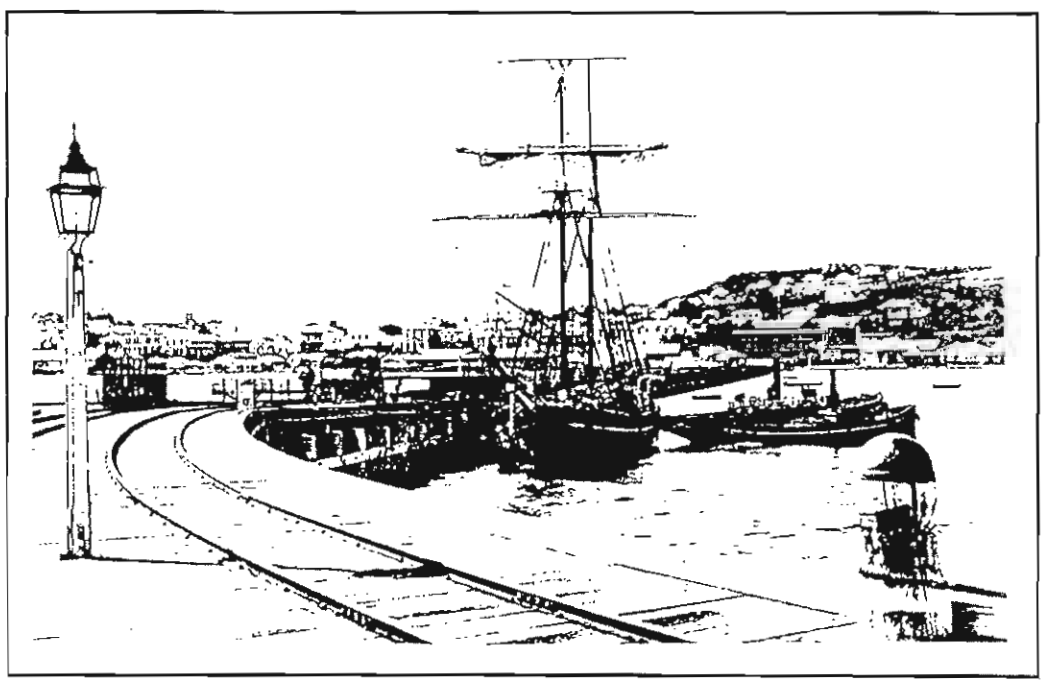


Figure 4 . Albany Town Jetty circa 1890s. Tugs *Escort* and *Loch Lamond* with the coastal trader, *Grace Darling*. (Photo: Albany Residency Museum)

Site Identification Comments (From research notes compiled by A. Wolfe).

With the renewal of the steam mail contracts between Australia and Britain, following the end of the Crimean War in 1856, there was an increase in the number of ships calling at Albany. The need for new port facilities became imperative.

In 1860 a site for a new Town Jetty was selected at the bottom of Spencer Street and tenders called for its construction. Work did not start immediately. Timber had to be cut and transported into Albany, workmen employed and iron fittings procured. It was not until 1862 that the work finally commenced.(1)

Some time after this date the work ceased for reasons which are, at present, unknown. The jetty was subsequently abandoned and remained incomplete. The Government, possibly embarrassed by this state of affairs, took the matter in hand. Alexander Moir, resident of Albany was appointed to finish the work. In 1864 the Town Jetty was officially completed and opened at the foot of Spencer Street.(2)

The Town jetty, when finished, consisted of a straight arm with two sets of rails laid on the deck and wooden hand railings along both sides. Landings were located towards the head of the jetty and hand operated trucks ran on the rails. In addition a kerosene lamp, was hoisted on the mast on the jetty head at night to guide boats landing from the mail steamers.(3) As well as being a place to load and unload cargoes the jetty was also used for official purposes such as the measurement and licensing of ferry and cargo boats used on the Harbours and Sound.(4)

In 1867 the Government agreed to build Government offices and a customs store at the bottom of Spencer Street, beneath Stirling Terrace, behind the Town Jetty. A three storeyed building was subsequently completed in 1870 and the jetty declared an official landing or custom purposes. The customs store was on the bottom floor and connected to the jetty by a tram line.

By the beginning of 1873 a contract had been awarded to Mr Josiah Harwood to extend the jetty and work was soon under way. The planned 'T' shaped head was retained and an iron crane was fitted on the south west corner of the new jetty head.(5)

The continued use of deck rails for trucks were considered an important issue. Plans had been made for only one line, but after protests from the Council, two lines of rails were laid and the jetty extension was finally completed in mid 1874.(6)

There were also concerns about the lack of berthing room. Only one vessel could berth alongside the jetty at any one time. If more than one ship wanted to come alongside the vessels would have to raft up. On more than one occasion up to three vessels were berthed in this fashion making landing and loading cargo difficult and putting undue stress on the jetty structure.(7)

Water for ships was supplied to the jetty from tanks near the Albany Post Office. In September 1896 new pipes were laid and ran out along the Town Jetty.(8)

Sometime after 1888 a passenger and mail landing was built on the east side of the Jetty near the jetty head to help overcome the problems caused by the limited berthing.

The development of Albany as tourist destination and demand within the community led to the building of sea baths on the west side of the jetty in 1889. The baths consisted of a fenced in enclosure where, for a fee, patrons could swim in comparative safety without fear of possible shark attack.(9)

The advent of the Western Australian goldrush in the 1890s caused an increase in the number of ships calling at the Port and a corresponding increase in the number of passengers passing through the Town. By 1898 five hundred passengers a week were coming ashore generating an annual income of 50,000 pounds for the community.(10)

To meet this increase in traffic the jetty was further extended in 1893 with the construction of a curved arm extending from the 1874 Jetty head towards the south east. The extension was 35 feet (10.66 meters) wide and about 532 feet (162.15 meters) long. At the same time the waters around the jetty were dredged.(11) Even after the extensions, there was often insufficient room for landing both passengers and mail.(12)

Finally, in 1899, work to improve the Albany Town Jetty began. The curved arm was extended towards the south east and a railway viaduct was built on the east side of the jetty to carry a railway out onto the jetty head.(13) The improvements to the jetty were finally completed in 1900 and the new extension declared open for shipping.

The Princess Royal Yacht Club was formed in 1909 and debentures were issued to raise funds for a boat shed and possible club rooms to be built on the Town Jetty. By December 1911 a timber boat shed and slip resting on 25 piles was erected on the east side of the jetty, south of the baths. The building remained in use until 1958-59 when the club relocated to Little Grove.(14)

At a later date another shed and a slip were built approximately 75 feet (22.86 meters) south of the Yacht Club boat shed on the east side of the Jetty. The shed was made of timber and iron. (46) In 1961 the shed was demolished and at the time was described as being used by the Naval cadets.(15)

In 1924-25 the sea baths on the west side of the jetty were rebuilt. In addition a dance hall, shop and an accommodation area were added to the south side of the baths with a verandah along the west side of the jetty. By this time the jetty had become a focus for the Towns social and community life including promenading, fishing, swimming and recreational boating. Even when the weather was bad and high seas and strong winds swept over the jetty deck it was still a popular with visitors who could enjoy the elements from the shelter of the verandah.(16)

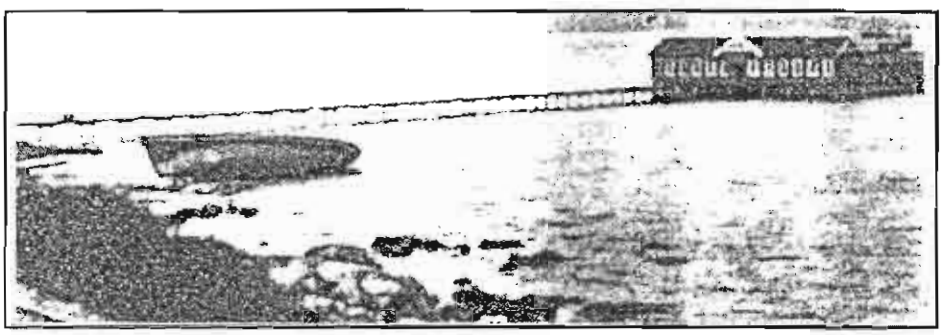


Figure 5. Albany Municipal Baths, 1912, with the abandonded hull of *Loch Lamond* in the foreground. (Photo: Reprinted from Alluring Albany, 1991.)

By 1944 after five years of world war the jetty was in a decayed state and in little use. The Albany Town Council recommended that the structure be repaired and that the dance hall and other buildings be demolished. It is not known if the demolition went ahead.(17)

In 1945 work had begun to reclaim the foreshore. The first 300 feet (91.44 meters) of seabed under the jetty was reclaimed and in 1948 the Town Council began reclaiming other areas of the adjoining foreshore. At the same time the Tydeman report was produced which recommended the reclamation of there foreshore east of the Town Jetty to build a land backed wharf and bulk handling cargo facilities. This work commenced in 1951 and was completed by 1953. In the process a further 150 feet (45.72 meters) of the shore end of the Town Jetty was demolished and buried under landfill.(18)

The remaining part of the jetty was subsequently repaired and continued in operation. In particular the old jetty head was used as a berth for the whale chasers which arrived with the opening of the Cheynes Beach Whaling Company at Frenchman Bay in 1952. In 1961 further work resulted in the removal of the sea baths and the demolition of part of the south east arm of the jetty.(19)

In 1972 a new jetty head was built 486 feet 10 inches (148.38 meters) along and to the east of the existing jetty alignment. The new structure culminated on the east side of the site of the 1874 jetty head. In addition the old south east jetty head built at the turn of the century was further shortened by 134 feet (40.84 meters) and the former Princess Royal Yacht Club boat shed and the Naval cadet shed demolished. Improvements were also made for berthing the Pilot boat and other craft.(20)

In the following year the curved section joining the old Jetty head to the new jetty head was removed leaving an angled walkway joining the two.(21)

At a later date 221 meters of old Jetty neck extending from the shore was demolished and reclaimed under land fill. A concrete boat ramp was then built on the south west side of the seaward end of the reclaimed land and car park facilities installed. Finally in 1978 with the closure of the Cheynes Beach whaling station the whale chasers left the jetty. The old jetty head was then closed off and abandoned.

Today the jetty is used by commercial fishermen, the Pilot boat crew and occasional visiting yachts.

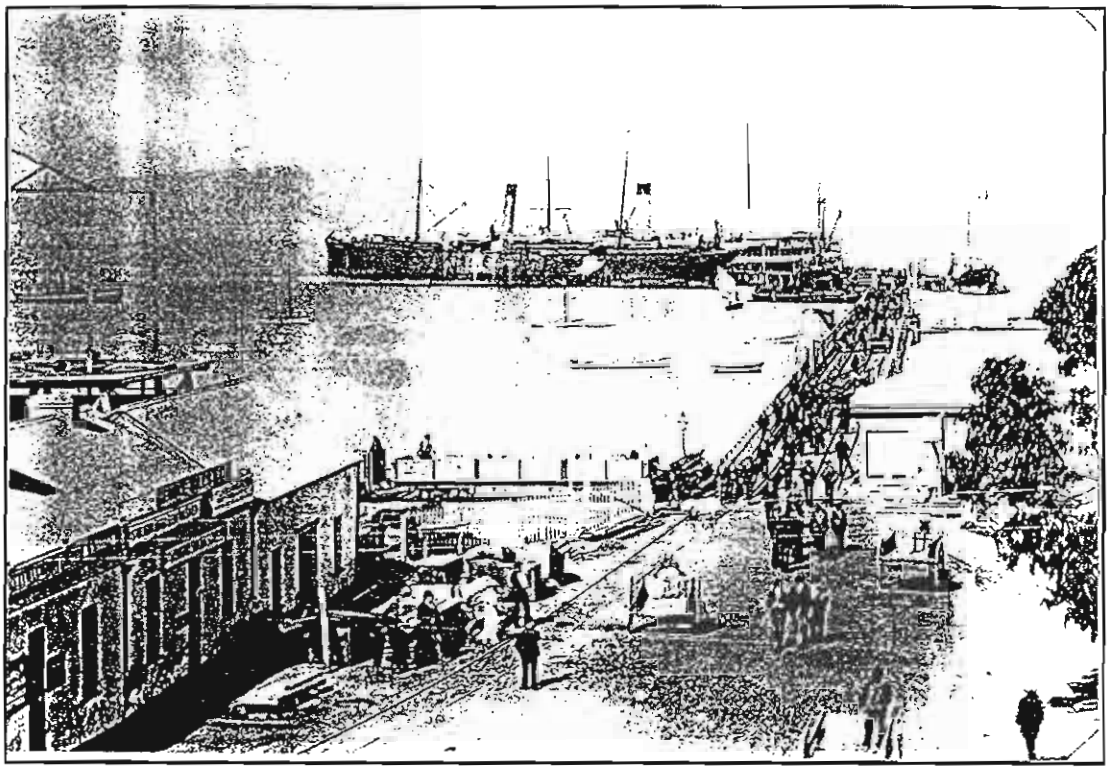


Figure 6. The Town Jetty at the turn of the century. (Photo: R. McKenna)

Associated Shipwrecks and Land Sites

File Name: Escort	**File No:** 12.92
File Name: Fairy	**File No:** 9.92
File Name: Georgette	**File No:** 428.71
File Name: Grace Darling	**File No:** 19.86
File Name: Hulks - Albany	**File No:** 193.79
File Name: Kingfisher	**File No:** 10.92

Assessment of Site Significance

(i) Historical: The Town Jetty has high regional and national historical significance.
It was a gateway to Western Australia for international passenger ships arriving from Europe, South Africa and India between 1862 and 1900. During this period it was also the principal landing place in Western Australia for the international mails and immigrants and visitors. In addition it was a significant landing and loading point for Western Australian imports and exports. In addition the Jetty was associated with the arrival of HMS *Bacchante* in 1881 with the Prince Albert Victor and Prince George of Wales on board.
The Town Jetty also has high local significance and was closely associated with the economic development of the Town and Port of Albany. Most importantly it was the focus of the Towns commercial traffic from 1862 until the 1920s and was also popular as a promenade and venue for swimming, recreational fishing, rowing and yachting.

(ii) Technological: The jetty assemblage is representative of various styles of jetty construction, dating from the mid nineteenth century to the 1970s. Amongst other attributes the Jetty site has the potential to illustrate the following:
1. The symbiosis between harbour and railway technology in the late 19th century.
2. The development of 19th and 20th century jetty construction in Western Australia.
3. The changes in cargo handling technology in the latter part of the 19th century.
4. The problems of locating harbour facilities in shallow water at a time of rapid change in cargo and ship handling technology.
5. The Jetty may also contribute to the understanding of the design and operation of 19th century steam ships.

(iii) Scientific: Information on corrosion rates can be gained from the iron artefacts on the site. The site also has the potential to provide information about the hydrography and benthic environment of Princess Royal Harbour and the degradation and preservation of timber in a marine environment.

Assessment of site significance (cont)

(iv) Educational: Amongst other attributes the Jetty has the potential to illustrate the following:

1. The development of mail and steamship services to and from Western Australia in the 19th century.
2. The development of port facilities in Western Australia.
3. The development of Western Australia's coastal steam ship service in the 19th and 20th centuries.
4. Migration to Albany and Western Australia in the 19th century.
5. The development of the Port of Albany.
6. The operation of Albany's tug boat and launch services in the 19th and 20th centuries.
7. The provision of water supplies for shipping at Albany from 1862 to the present.
8. The history of Albany's bathing baths.
9. The early history of the Princess Royal Yacht Club.
10. The development of tourism at Albany.
11. The symbiosis between harbour and railway technology in the late 19th century.
12. The development of 19th and 20th century jetty construction in Western Australia.
13. The changes in cargo handling technology in the latter part of the 19th century.
14. The problems of locating harbour facilities in shallow water at a time of rapid change in cargo and ship handling technology.

(v) Recreational: Recreational users include sport fishermen, local and visiting yachtsmen and women and pedestrians.

(vi) Cultural: Amongst other attributes the Jetty was associated with the arrival of migrants from Europe and the Eastern States and the embarkation and disembarkation of passengers on the Western Australian Coastal shipping service. The Jetty is a memorial to those who decided to make Western Australia their home and to those who served and travelled on ships on the Western Australian coast.
The Jetty was also a focal point for the local community and in the early part of the 20th century was fitted with tea rooms, bathing baths, the Princess Royal Yacht Club boat shed and a building for the Naval Cadets. The Jetty was and still is, a popular fishing location.
The Jetty is a historic landmark on the Albany foreshore and has high aesthetic and social value in the local community. The Jetty is also a tourist asset.

(vii) Archaeological: The Jetty is of maritime archaeological importance. The sea bed under and adjoining the Jetty is known to contain deposits of artefact material which may date from the early 1860s and may be able to contribute to our knowledge of cargoes, trade patterns and other marine related activities on the Western Australian coast since this time.

(viii) Rarity: The site was an example of a jetty built in the early 1860s and subsequently extended and rebuilt. In 1961 and the 1970s the Jetty was rebuilt leaving part of the 1890s structure intact. This may be the oldest jetty site in Western Australia that has been in continuous use since the early 1860s. Within this context the site could be considered rare.

(ix) Representativeness: The Albany Town Jetty site is an example of a wooden jetty built in the 1860s. Similar jetty sites and remains survive at, amongst other places: Busselton; Esperance; Fremantle; Geraldton;. Port Hedland. Some of these structures are of a similar age, design and purpose. As a group they have the potential to reveal a broad range of comparative historical, social, technological, scientific and educational data.

Discussion

As the sea bed under and adjoining the Jetty is known to contain deposits of artefact material which may date from the early 1860s and may be able to contribute to our knowledge of cargoes, trade patterns and other marine related activities on the Western Australian coast since this time, the site has been determined to fall within the jurisdiction delegated to the Museum by the *Western Australian Maritime Archaeology Act* (1973).

Recommendations

The options are:

(i) Recommend that the site remain undisturbed.

(ii) Erect a marker on the site that will include interpretive material.

(ii) Recommend that the jetty remains be nominated for entry into the Register of Heritage Places of the Heritage Council of Western Australia.

References

1. CSR 502/?, 1 July 1862.
2. Letter IRS/29M/7, (Albany Public Library, local history section), Colonial Secretary's Correspondence received, 20 September 1864.
3. CSR 741/104, 9 June 1873; Albany Harbour Master's letter book 1868-78. Memo from Captain Butcher, 26 April 1878.
4. Ibid. Notice from Captain Butcher, December 1872.
5. CSR 742/113, 21 August 1873; 741/116, 20 June 1873; Albany Harbour Master's letter book 1868-78. Letters from Captain Butcher, 9 October 1873, 13 October 1873.
6. CSR 741/104, 9 June 1873; 750/42, 7 October 1873; 741/90, 23 February 1874.
7. *Albany Mail*, 16 October 1883.
8. Garden, D., 1977, *Albany: panorama of the Sound from 1827.* Nelson, Melbourne, p. 228; Public Works Department file 2212/97. Albany Water Supply. Report prepared by Mr C. Carrington, 9 April 1902.
9. Garden. D., 1977, Op Cit. p. 219; Garden, D., 1978, *Southern haven: a history of the Port of Albany, Western Australia.* Albany Port Authority, p.50.
10. Ibid., p. 246-247.
11. Public Works Department (PWD) File No. 202/99. Albany Town Jetty. Report by G. E. Law, 21 February 1896.
12. Ibid. Letter to the sub-collector of Customs from Mr Troode, Landing Surveyor at Albany, 20 March 1896.
13. Ibid. Application for money authority, 18 January 1899.
14. Austin, S., 1986, *Princess Royal Sailing Club, Albany-75 years of sailing 1909-1984 and a little beyond.* Princess Royal Yacht Club Inc. pp. 25, 37, 38, 40, 128, 131.
15. Garden, D., 1978, Op Cit. p. 64.
16. Ibid; Pers Comms, Stan Austin, mariner and historian, Big Grove Albany, 7 November 1994.
17. *Albany Advertiser* 13 January, 31 March 1944.
18. *Western Mail*, 21 April 1949; Garden, F., 1978, Op Cit, pp. 60, 62, 65; Albany Harbour Town Jetty. General arrangement. Public Works Department plan number 47836. Scale 40 feet to 1 inch, 1 foot to 1/2 inch, 7 February 1973.
19. Garden, D., 1978, Op Cit, P 64.
20. Albany Harbour Town Jetty. General arrangement. Public Works Department plan number 47836. Scale 40 feet to 1 inch, 1 foot to 1/2 inch, 7 February 1973.
21. Ibid.

HERITAGE
COUNCIL
of Western Australia

SITE PARTICULARS FORM

For places considered to possess cultural heritage significance

The purpose of this form is to provide information about places considered to have heritage value.

The information may be used for the assessment of a place for entry into the Register of Heritage Places, the Council's Data Base, or the Municipal Inventory of a local municipal council; or it may be used to provide information in support of a grants application.

You are encouraged to complete the form in as much detail as possible, but to note that it is quite acceptable for parts to be left blank where the information cannot be provided.

If you require assistance with the form, please contact a Conservation Officer at the office of the Heritage Council (details below).

292 Hay St East Perth WA 6004 Tel (09) 221 4177 Facs (09) 221 4151

IDENTIFICATION

(Screens 1,4)

HCWA Reference Number: _____

PLACE DETAILS

Name of Place: *Albany Town Jetty*

Any Former or Other Names: *Mail Steamer Jetty, Quarantine Jetty, Whaler Jetty*

Address/Location: *Albany Town foreshore*

(include a description of site and how to find it. Attach a plan or sketch of the boundaries if the place does not have a defined location. Indicate north and the distance between two points)

Local Government Authority: *Albany Town Council, Albany Port Authority Waterways Commission.*

Map Reference: *Albany ST 50-E, 1:500,000: AUS 118 Approaches to King George Sound. 1983, 1:75,000.*

Area of Site : *From the bottom of Spencer Street to the end of the Whaler Jetty*

OWNERSHIP AND OTHER SITE DETAILS

Owner Name: *Town of Albany*	Owner Name:
Address/phone/facs:	Address/phone/facs:
C/T:Vol /Folio:	C/T:Vol /Folio:
Lot/Location:	Lot/Location:
Diagram/Plan:	Diagram/Plan:
Reserve Details: No.	Reserve Details: No.
Vesting :	Vesting :
Purpose:	Purpose:
Occupied (yes/no) Occupier Name:	*Albany Port Authority*
Public Accessibility: Open	Restricted Nil
Lease details (e.g. mining):	

PARTICULARS OF THE PLACE

(Screen 2)

DATES

Construction Date(s) 1864, 1874, 1893 1900 Estimated /Known Design Date: 1860

Indicate sources e.g. foundation stone, dated plans: (See references)

TYPE OF PLACE (circle appropriate code)

9631	Historic Town or district	(9635)	Other Structures (e.g. war memorial, bridge, mine headframe)
9632	Precinct or streetscape		
9633	Historic Site (non built)	9636	Garden
9634	Individual Building or Group (e.g. House, Farm or Commercial building, Industrial site)	9637	Urban Park
		9638	Urban Open Space
		9639	Other Built Type

USE(S) OF PLACE

Original use: Port facility for the town of Albany

Later and current use(s): Mooring pen for Albany Port Authority tug and local fishing boats.

ARCHITECT/DESIGNER/BUILDER (indicate sources of information)

/ / Alexander Moir (Albany Pub

/ / Library, IRS/29M/7)

DESCRIPTION

Construction materials: Wooden piles and decks with two railway lines

Modifications: Three additions from 1864 to 1900. (See site identification p.6)

Extent of original fabric remaining intact (how much is original): Mail Steamer Jetty (c1888), 1893 extension and Whaler Jetty (1900).

Describe the place and its setting as completely as possible, referring to any notable features If possible, attach a sketch showing the significant parts of the place.

Please refer to Maritime Heritage inspection report. Department of Maritime Archaeology, WA Maritime Museum, Report No. 89.

SIGNIFICANCE

(Screen 3)

This section looks at why the place is important, and what elements or attributes of the place are notable.

YOUR OPINION

What do you consider is the most important aspect of the place?

The Town Jetty has high regional and national historical significance. It was a gateway to Western Australia for international passengers arriving from Europe, South Africa and India between 1862 and 1900.

It was the principal landing place for international mails and immigrants.

HISTORIC THEME

If a survey of your area has been completed, how does this place fit into any of the survey themes.

Incorporated into the Albany Maritime Heritage Survey 1627- 1994.

SIGNIFICANCE CRITERIA

Please endeavour to express what is significant about the place in terms of the six principal criteria. The questions are for your guidance – they do not all have to be answered. Space is provided on the next page to record your responses.

1. AESTHETIC VALUE

Does it exhibit particular aesthetic characteristics valued by the community ?

Does it have townscape or landscape value?

Is it characterised by unity of materials, design, scale or enhancement of its setting?

2. HISTORIC VALUE

Is it important in the evolution or pattern of the history of Western Australia?

Does it have any strong associations with any well known figures, developments, events or cultural phases?

3. SCIENTIFIC VALUE

Does it demonstrate a high degree of technical innovation or achievement.?

Does it have archaeological importance, research value or educational value?

4. SOCIAL VALUE

Is it significant through association with a community or cultural group in Western Australia for social, cultural, educational or spiritual reasons.

5. RARITY

Does it demonstrates rare, uncommon or endangered aspects of the cultural heritage of Western Australia.?

Is it a particularly fine or unique example of its type?

Does it demonstrate a way of life, custom, process or function no longer practised, in danger of being lost, or of exceptional interest?

6. REPRESENTATIVENESS

Is it significant in demonstrating the characteristics of a class of cultural places or environments in the State.

Historical significance:

The jetty was a significant landing and loading point for Western Australian imports and exports. In addition the jetty was associated with the arrival of HMS Bacchante in 1881 with the Prince Albert Victor and Prince George of Wales on board. The Town Jetty has significant regional importance as it was associated with the economic development of the town of Albany and the pastoral hinterland. It was the focus for commercial traffic from 1862 to the 1900s. It was also a focal point for recreational activities until the 1920s.

Technological: The jetty structure is representative of various styles of jetty construction, dating from the min eighteenth century to the 1970s. The site has the potential to illustrate the symbiosis between railway and harbour technology, the development of 19th and 20th century jetty construction and the development of cargo handling technology.

Aesthetic value: The Town Jetty and its environs is an intrinsic part of the Albany townscape and has great potential as a focus of an historic maritime precinct.

Social value: The jetty was a focal point for the local community and in the early part of the 20th century, incorportated tea rooms, bathing baths, a yacht club and a building for Naval Cadets. The jetty was, and still is, a popular fishing venue.

Rarity: The site was an example of a jetty built in the early 1860s and subsequently extended and rebuilt. In 1961 and 1970s the jetty was rebuilt leaving part of the 1890s structure intact. This may be the oldest jetty site in Western Australia that has been in continous use since the early 1860s. Within this context the site should be considered rare.

Representativeness: The Albany Town Jetty site is an example of a wooden jetty built in the 1860s. Similar jetty sites and remains survive at; Busselton, Esperance, Fremantle, Geraldton and Port Hedland. Some of these structures are of similar age, design and purpose. As a group they have the potential to reveal a broard ranger of comparative historical, social, technological, scientific and educational data.

SUPPORTING INFORMATION

(Screen 6)

PHOTOGRAPHS

- If possible please supply photographs (colour slides and black and white prints preferred) or good quality reproductions The photographs should be unattached -- - either loose or in plastic pockets. Please number and list the photographs.

BIBLIOGRAPHY

- Please supply details of sources used. Provide full particulars of author, publisher, title and date wherever possible.

Albany Harbour Master's letter book, 1868-78. Albany Public Library

Colonial Secretary's Correspondence. Battye Library. 17/15; 23/34;23/35; 51/207; 53/62;54/87; 54/148;55/10; 112/31; 112/41; 189/213; 202/62; 202/72; 202/73; 482/36; 482/44; 502/?; 545/117; 719/211;741/104; 742/113

IRS/29M/4,7.letter.Albany Public Library

Lockyer, E., Major, 1827, Journal of Major Lockyer. Copy of the original presented to the Public Library of New South Wales by Nichols Lockyer.

Public Works Department file 2212/97, Albany Water Supply. Battye Library.

Public Works Department file 202/99, Albany Town Jetty. Battye Library.

Wolfe, A. TheAlbanymaritime heritage survey 1627-1994. WA Heritage Council, 1994.

ENCLOSURES CHECK LIST: Please indicate by circling whether you have attached:

Photographs / Site Plan / Location Plan / Sketches / Building Plans / Other *Report*

ASSESSED BY

Name(s)	Contact details (address, phone, facs)
D. Garratt	*WA Maritime Museum,*
	Cliff Street, Fremantle 6160
	Ph: 4318488 FAX: 3355351

Date: *14* / *June* /19*95*

Has owner/occupier been consulted? (yes/~~no~~)

Person contacted and date. *Mr Phil Slater, Urban Design Manager, LandCorp. March '95.*

PREVIOUS LISTINGS/ASSESSMENTS

(Screen 5)

(To be completed by the Heritage Council)

Classified by The National Trust (yes/no) Date _____

Register of the National Estate (yes/no) Date _____

Local authority (yes/no) Date _____

APPENDIX N

HEIGHT DATUM REFERENCES

(i) TIDE TABLES–SOUTH COAST–ALBANY

(ii) PWD PERMANENT SURVEY STATION SUMMARY–ALBANY WHARF

(iii) TIDE RECORDS–ALBANY HARBOUR
2 November–11 December 1994

AUSTRALIA, SOUTH COAST - ALBANY

LAT 35°02′ S LONG 117°53′ E

TIME ZONE -0800 TIMES AND HEIGHTS OF HIGH AND LOW WATERS YEAR 1994

SEPTEMBER

	Time	m		Time	m
1 TH	0821	1.1	16 FR	0300	0.7
	1633	0.5		0927	1.1
				1647	0.5
				2300	0.8
2 FR	0000	0.8	17 SA	0326	0.7
	0211	0.8		0959	1.0
	0858	1.1		1655	0.5
	1638	0.4		2248	0.8
	2302	0.8			
3 SA	0255	0.7	18 SU	0356	0.6
	0932	1.2		1025	1.0
	1650	0.4		1652	0.5
	2256	0.8		2256	0.8
4 SU	0332	0.7	19 MO	0426	0.6
	1008	1.2		1042	1.0
	1708	0.4		1658	0.6
	2307	0.9		2255	0.9
5 MO	0410	0.6	20 TU ○	0456	0.6
	1043	1.2		1051	0.9
	1726	0.5		1703	0.6
	2323	0.9		2300	1.0
6 TU ●	0450	0.6	21 WE	0525	0.5
	1119	1.1		1107	0.9
	1744	0.5		1646	0.6
	2342	1.0		2317	1.0
7 WE	0535	0.5	22 TH	0554	0.5
	1156	1.0		1120	0.8
	1758	0.6		1646	0.6
				2332	1.0
8 TH	0002	1.0	23 FR	0624	0.6
	0625	0.6		1115	0.8
	1230	0.9		1640	0.6
	1800	0.6		2346	1.0
9 FR	0025	1.0	24 SA	0700	0.6
	0722	0.6		1120	0.7
	1256	0.7		1632	0.5
	1728	0.6			
10 SA	0046	1.0	25 SU	0005	1.0
	0839	0.6		0745	0.6
	0927	0.6		1114	0.7
	1603	0.6		1636	0.5
11 SU	0101	1.0	26 MO	0029	1.0
	1511	0.5		0900	0.7
				1027	0.7
				1628	0.5
12 MO ◑	0100	1.0	27 TU	0053	1.0
	1536	0.4		1617	0.5
13 TU	0113	1.0	28 WE ◐	0116	0.9
	0415	0.9		1548	0.5
	0702	1.0			
	1602	0.4			
14 WE	0128	0.9	29 TH	0140	0.9
	0251	0.9		0334	0.9
	0804	1.0		0644	0.9
	1622	0.4		1538	0.5
15 TH	0017	0.8	30 FR	0002	0.8
	0256	0.8		0204	0.8
	0849	1.0		0754	0.9
	1634	0.4		1538	0.5
	2321	0.8		2245	0.8

OCTOBER

	Time	m		Time	m
1 SA	0235	0.7	16 SU	0357	0.6
	0838	1.0		0950	0.9
	1545	0.5		1541	0.6
	2207	0.8		2200	0.9
2 SU	0310	0.7	17 MO	0408	0.6
	0918	1.0		1015	0.8
	1600	0.5		1545	0.6
	2211	0.9		2203	1.0
3 MO	0346	0.6	18 TU	0431	0.5
	0959	1.0		1032	0.8
	1616	0.5		1549	0.6
	2225	1.0		2209	1.0
4 TU	0426	0.5	19 WE ○	0500	0.5
	1040	1.0		1045	0.8
	1633	0.5		1541	0.6
	2244	1.0		2225	1.1
5 WE ●	0508	0.4	20 TH	0531	0.5
	1122	0.9		1109	0.7
	1647	0.6		1547	0.6
	2305	1.1		2245	1.1
6 TH	0554	0.4	21 FR	0603	0.5
	1207	0.8		1125	0.7
	1652	0.6		1550	0.6
	2329	1.1		2303	1.1
7 FR	0645	0.4	22 SA	0636	0.5
	1259	0.7		1142	0.7
	1634	0.6		1543	0.6
	2354	1.1		2322	1.1
8 SA	0747	0.5	23 SU	0711	0.5
				1137	0.6
				1548	0.5
				2345	1.1
9 SU	0015	1.1	24 MO	0750	0.5
	1244	0.5		1141	0.6
				1548	0.5
10 MO	0017	1.1	25 TU	0008	1.1
	1413	0.4		0844	0.6
				1044	0.6
				1537	0.5
11 TU	0013	1.0	26 WE	0030	1.0
	1455	0.4		1505	0.5
12 WE ◑	0016	1.0	27 TH	0048	1.0
	0544	0.9		1436	0.5
	0637	0.9			
	1524	0.4			
	2341	0.9			
13 TH	0418	0.8	28 FR ◐	0050	0.9
	0756	0.9		1430	0.5
	1540	0.4		2304	0.8
	2257	0.8			
14 FR	0342	0.8	29 SA	0256	0.8
	0845	0.9		0656	0.8
	1549	0.5		1432	0.5
	2229	0.8		2133	0.9
15 SA	0349	0.7	30 SU	0251	0.7
	0921	0.9		0815	0.9
	1553	0.5		1445	0.5
	2158	0.9		2118	0.9
			31 MO	0322	0.6
				0909	0.9
				1502	0.5
				2129	1.0

NOVEMBER

	Time	m		Time	m
1 TU	0400	0.5	16 WE	0451	0.5
	0959	0.8		1045	0.7
	1522	0.5		1433	0.6
	2147	1.1		2139	1.1
2 WE	0443	0.4	17 TH	0511	0.4
	1047	0.8		1103	0.7
	1539	0.6		1449	0.6
	2211	1.2		2201	1.1
3 TH ●	0529	0.4	18 FR ○	0538	0.4
	1139	0.8		1121	0.7
	1549	0.6		1504	0.6
	2237	1.2		2225	1.2
4 FR	0618	0.3	19 SA	0609	0.4
	1235	0.7		1143	0.6
	1546	0.6		1503	0.6
	2307	1.2		2248	1.2
5 SA	0717	0.3	20 SU	0640	0.4
	2336	1.2		1207	0.6
				1510	0.6
				2312	1.2
6 SU	0901	0.4	21 MO	0713	0.4
				1232	0.6
				1521	0.6
				2336	1.1
7 MO	0001	1.2	22 TU	0746	0.5
	1142	0.4		1300	0.6
				1523	0.6
8 TU	0002	1.1	23 WE	0001	1.1
	1313	0.4		0826	0.5
	2349	1.0		1351	0.6
				1508	0.6
9 WE	1412	0.4	24 TH	0024	1.0
	2341	0.9		0914	0.5
10 TH ◑	1443	0.5	25 FR	0043	1.0
	2307	0.9		1034	0.5
11 FR	0551	0.7	26 SA ◐	0048	0.9
	0741	0.8		1229	0.6
	1456	0.5		2157	0.8
	2203	0.9			
12 SA	0509	0.7	27 SU	1305	0.6
	0913	0.7		2036	0.9
	1500	0.6			
	2135	0.9			
13 SU	0506	0.6	28 MO	0040	0.7
	0936	0.7		0802	0.7
	1427	0.6		1336	0.6
	2115	0.9		2037	1.0
14 MO	0442	0.6	29 TU	0358	0.6
	0957	0.7		0919	0.7
	1430	0.6		1404	0.6
	2118	1.0		2055	1.1
15 TU	0446	0.5	30 WE	0432	0.4
	1021	0.7		1019	0.7
	1430	0.6		1428	0.6
	2123	1.1		2121	1.2

DECEMBER

	Time	m		Time	m
1 TH	0514	0.3	16 FR	0537	0.4
	1115	0.7		1137	0.6
	1446	0.6		1415	0.6
	2151	1.2		2150	1.2
2 FR	0559	0.3	17 SA	0551	0.4
	1214	0.7		1152	0.6
	1500	0.6		1439	0.6
	2225	1.3		2218	1.2
3 SA ●	0648	0.3	18 SU ○	0614	0.4
	2300	1.3		1208	0.6
				1452	0.6
				2245	1.2
4 SU	0742	0.3	19 MO	0639	0.4
	2331	1.2		1226	0.6
				1508	0.6
				2313	1.2
5 MO	0842	0.3	20 TU	0705	0.4
	2359	1.2		1246	0.6
				1529	0.6
				2339	1.2
6 TU	0954	0.4	21 WE	0732	0.4
				1315	0.6
				1546	0.6
7 WE	0010	1.1	22 TH	0005	1.1
	1206	0.5		0800	0.4
	2340	1.0		1351	0.6
				1559	0.6
8 TH	1319	0.5	23 FR	0027	1.0
	2335	0.9		0828	0.5
				1456	0.6
				1600	0.6
9 FR	0946	0.6	24 SA	0038	1.0
	1010	0.6		0856	0.5
	1400	0.6			
	2257	0.9			
10 SA ◑	0714	0.6	25 SU	0033	0.9
	1121	0.7		0921	0.6
	1415	0.6		2045	0.8
	2135	0.9			
11 SU	0634	0.6	26 MO ◐	0925	0.6
	2052	0.9		1950	0.9
12 MO	0619	0.5	27 TU	0512	0.6
	2043	1.0		2007	1.0
13 TU	0603	0.5	28 WE	0447	0.5
	2040	1.0		2035	1.1
14 WE	0532	0.5	29 TH	0504	0.4
	2100	1.1		1158	0.7
				1315	0.7
				2111	1.2
15 TH	0529	0.4	30 FR	0535	0.3
	1140	0.6		1230	0.7
	1340	0.6		1403	0.7
	2123	1.1		2148	1.3
			31 SA	0612	0.2
				1307	0.7
				1438	0.7
				2227	1.3

TO :
MARITIME MUSEUM

Attention : Dena Garratt
Phone

Fax No : 335 7224

No. of Pages : 3
(inc this page)

FROM : Ric Mahoney
Phone 239 2127

Date: 30 & 31/05/95

MARINE HOUSE
1 Essex Street
Fremantle

TRANSPORT
CIES
COASTAL INFORMATION AND ENGINEERING SERVICES

PO Box 402
FREMANTLE WA 6160

Tel (09) 239 2399

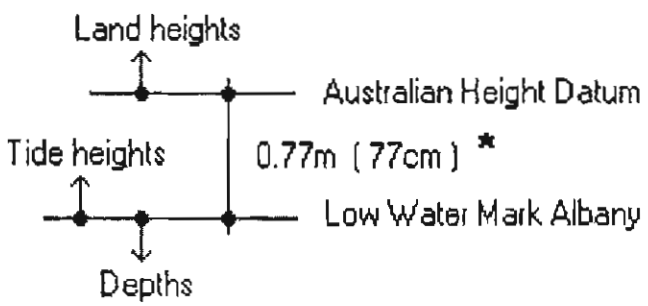
Fax (09) 239 2281

Dena,

Albany observations, 3/12/94 to end of 11/12/94, follow.
~~to for 3 & 4/11/94 and 1/12/94 and the summary sheets for HR1 and 2 follow.~~

I have included a format sheet so you can decipher the output.

The vertical datum relationship for predicted and observed tides is per the diagram below.



* Not the same all around WA

Regards

PUBLIC WORKS DEPARTMENT

PERMANENT SURVEY STATION SUMMARY

STATION	R.L.
HR 1	3.226m

DATUM Australian Height Datum
Australian Geodetic Datum

LWM Albany is 0.771m below AHD.

REF. MAP PWD WA 48100-T1 LOCALITY Albany Wharf

LEVELLING STANDARD ESTABLISHED FROM BM 3

FIELD/LEVEL BOOKS 23761 CALC. BOOK

ESTABLISHED BY D.F. Wallace DATE Oct 1965

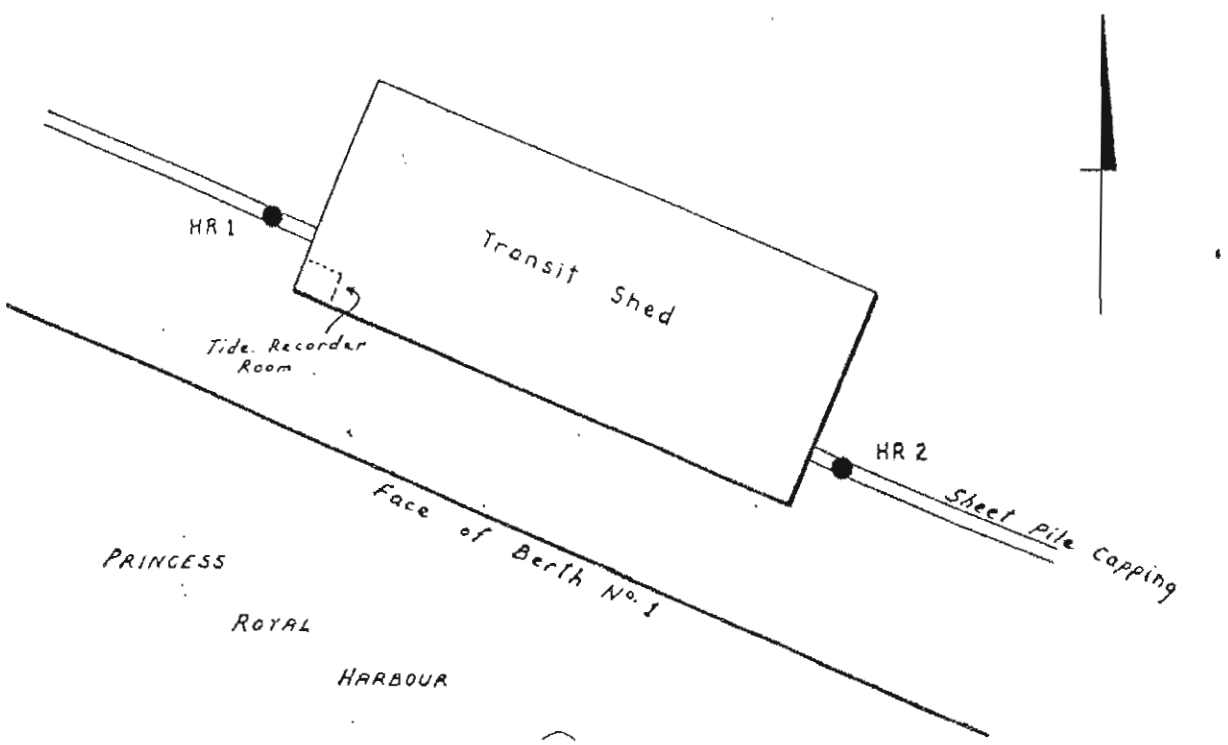
Rectangular Coordinates in Metres Australian Map Grid

Latitude S	Longitude E	Zone	Order
Easting	Northing	Convergence	

Grid Bearing = Adj. Azimuth + Convergence

To	Adj. Azimuth	Adj. Length	Order

DESCRIPTION AND LOCATION OF STATION PWD Bronze Plaque in concrete of steel pile capping approx 0.5m from western end of Transit Shed. Plaque is marked "HR 1 13.11 LWMA".



PUBLIC WORKS DEPARTMENT

PERMANENT SURVEY STATION SUMMARY

STATION	R.L.
HR 2	3.239m

DATUM Australian Height Datum
Australian Geodetic Datum

LWM Albany is 0.771m below AHD.

REF. MAP PWD WA 48100-T1 LOCALITY Albany Wharf

LEVELLING STANDARD ESTABLISHED FROM BM 3

FIELD/LEVEL BOOKS 23761 CALC. BOOK

ESTABLISHED BY D.F. Wallace DATE Oct 1965

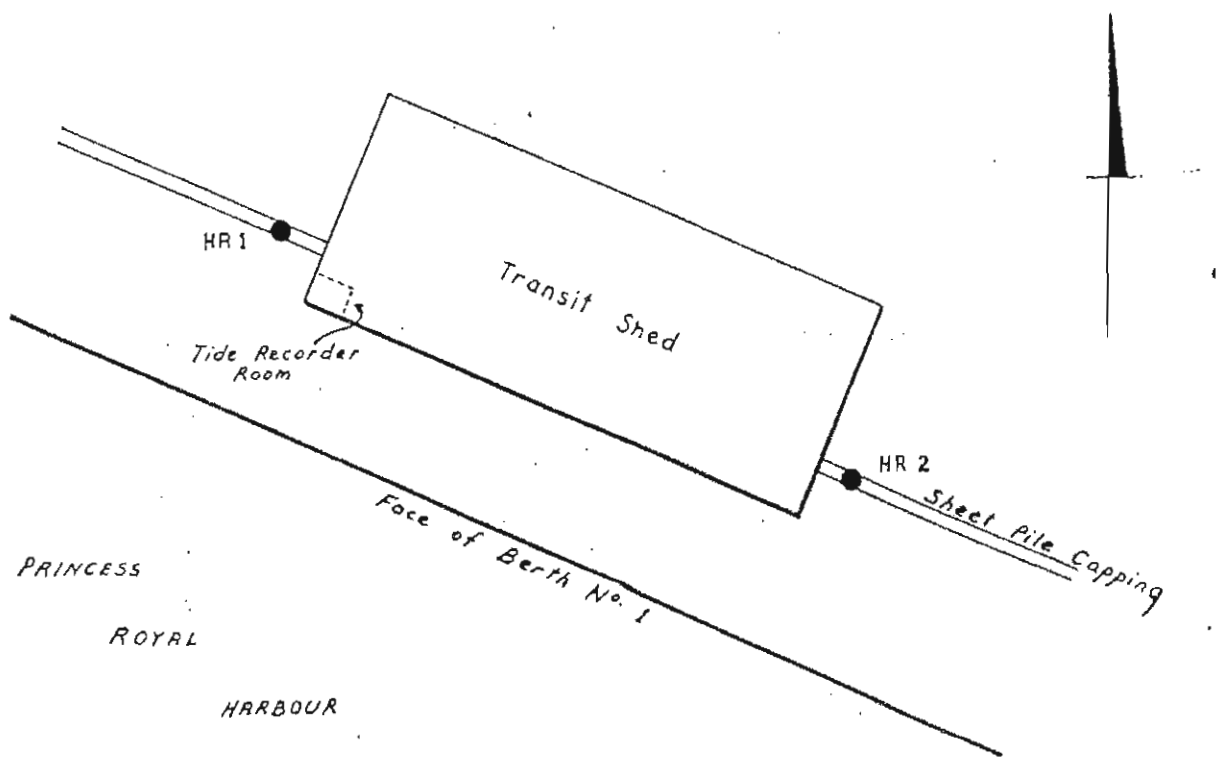
Rectangular Coordinates in Metres Australian Map Grid

Latitude S	Longitude E	Zone	Order
Easting	**Northing**	**Convergence**	

Grid Bearing = Adj. Azimuth + Convergence

To	Adj. Azimuth	Adj. Length	Order

DESCRIPTION AND LOCATION OF STATION PWD Bronze Plaque in concrete of steel pile capping approx 0.5m from eastern end of Transit Shed. Plaque is marked "HR 2 13.15 LWMA".



One day of 15 minute data

BUNBURY	901206	0	78	74	73	75	77	73	74	74	69	71	69	66
BUNBURY	901206	12	60	58	51	51	49	43	41	40	37	35	34	36
BUNBURY	901206	24	35	31	29	29	25	25	22	20	18	15	15	13
BUNBURY	901206	36	16	15	16	19	19	20	23	25	26	23	21	22
BUNBURY	901206	48	23	23	25	21	26	30	30	35	37	41	45	47
BUNBURY	901206	60	47	49	48	45	46	45	44	47	47	48	48	52
BUNBURY	901206	72	57	65	64	68	69	68	68	70	65	65	65	65
BUNBURY	901206	84	66	67	66	69	74	73	75	77	73	76	72	71

PLACE

DATE
YYMMDD

DATA RECORD NUMBER - first one of line

0 = 0000 Hours (not to be written as 2400 hours)
12 = 0300 "
24 = 0600

DATA
Actual recorded tide height above Datum.

UNITS
Centimetres.

DATUM
Tidal Datum for the location.
The relationship of this Datum to AHD
(Australian Height Datum) varies according
to location about the coast.

TIME STEP
15 minute interval.
Each line of data begins on an even hour,
Line 1 0000 0015 0030 0045 0100 ..
Line 2 0300 0315 0330 0345 ..
Line 3 0600 0615 0630 ..

ALBANY H	941102	0	86	81	77	73	71	70	68	64	58	54	52	49
ALBANY H	941102	12	45	42	43	43	42	39	35	33	33	35	37	40
ALBANY H	941102	24	44	45	45	46	48	49	52	56	61	66	68	68
ALBANY H	941102	36	70	72	75	78	81	82	82	80	79	78	78	78
ALBANY H	941102	48	78	76	74	72	70	67	64	63	64	63	61	57
ALBANY H	941102	60	53	53	54	55	55	56	57	58	60	62	64	66
ALBANY H	941102	72	69	72	77	81	84	86	88	90	93	96	99	102
ALBANY H	941102	84	106	107	108	109	109	108	107	106	106	105	103	101
ALBANY H	941103	0	98	94	90	85	81	77	74	73	68	62	55	50
ALBANY H	941103	12	46	44	41	38	34	31	31	30	28	25	24	25
ALBANY H	941103	24	27	28	30	31	30	31	33	36	40	44	46	48
ALBANY H	941103	36	50	54	57	61	62	62	63	65	68	69	69	69
ALBANY H	941103	48	67	66	64	63	61	60	60	61	61	60	55	51
ALBANY H	941103	60	48	50	52	52	52	50	49	50	52	55	58	60
ALBANY H	941103	72	63	66	70	74	78	79	81	83	86	90	95	99
ALBANY H	941103	84	101	102	104	107	109	110	109	109	109	108	107	105
ALBANY H	941104	0	102	100	98	94	90	86	82	78	74	69	65	59
ALBANY H	941104	12	55	50	46	42	39	36	33	30	27	24	22	20
ALBANY H	941104	24	19	18	18	20	21	21	22	24	27	30	30	32
ALBANY H	941104	36	34	37	38	40	43	46	48	50	52	52	53	54
ALBANY H	941104	48	56	57	58	58	57	55	54	54	54	55	54	53
ALBANY H	941104	60	53	52	51	50	49	48	50	52	54	58	58	59
ALBANY H	941104	72	61	64	69	73	75	76	78	80	84	88	92	96
ALBANY H	941104	84	98	100	103	107	108	109	109	110	111	111	110	109
ALBANY H	941105	0	107	106	104	103	101	96	91	87	83	81	79	74
ALBANY H	941105	12	68	62	57	53	50	46	43	39	36	31	27	23
ALBANY H	941105	24	21	21	21	20	18	17	16	16	16	17	19	20
ALBANY H	941105	36	22	23	23	24	25	27	30	32	33	34	36	38
ALBANY H	941105	48	39	40	40	41	42	42	44	45	45	45	44	44
ALBANY H	941105	60	46	47	48	47	47	48	49	50	50	51	52	54
ALBANY H	941105	72	56	58	60	63	67	71	73	75	77	79	81	84
ALBANY H	941105	84	87	91	95	96	97	99	101	103	104	104	102	101

ALBANY H	941130	0	73	69	65	63	61	59	58	55	49	44	40	40
ALBANY H	941130	12	40	40	38	36	33	32	33	35	37	40	40	39
ALBANY H	941130	24	40	42	44	48	49	50	52	55	59	60	62	63
ALBANY H	941130	36	64	66	68	70	70	69	68	68	69	70	69	67
ALBANY H	941130	48	64	64	64	63	62	61	60	60	59	59	57	57
ALBANY H	941130	60	58	61	65	66	66	66	68	71	76	80	82	84
ALBANY H	941130	72	87	91	95	99	101	102	104	106	108	111	115	116
ALBANY H	941130	84	115	115	117	118	119	118	115	112	109	105	102	99
ALBANY H	941201	0	95	92	90	87	83	77	71	67	63	61	59	56
ALBANY H	941201	12	51	47	43	40	40	40	40	40	38	38	37	38
ALBANY H	941201	24	38	39	40	44	48	50	50	51	53	55	60	63
ALBANY H	941201	36	65	66	66	68	70	70	71	73	74	74	73	72
ALBANY H	941201	48	71	70	70	70	70	69	68	66	63	64	66	69
ALBANY H	941201	60	69	68	68	68	70	72	73	75	79	83	87	90
ALBANY H	941201	72	92	94	96	99	103	107	110	114	117	118	120	122
ALBANY H	941201	84	126	126	125	123	123	124	123	121	118	115	112	111
ALBANY H	941202	0	109	106	99	94	89	85	81	77	73	67	61	57
ALBANY H	941202	12	54	50	43	38	35	35	35	33	29	25	21	22
ALBANY H	941202	24	24	27	28	28	28	29	31	32	33	37	41	45
ALBANY H	941202	36	48	50	52	54	56	58	61	65	66	66	65	65
ALBANY H	941202	48	66	68	70	70	70	68	67	66	65	64	65	66
ALBANY H	941202	60	68	67	66	66	67	69	72	74	76	78	81	84
ALBANY H	941202	72	86	89	93	96	100	101	103	106	110	115	118	122
ALBANY H	941202	84	123	124	126	128	130	129	130	129	128	126	124	122

ALBANY H	941203	0	120	118	115	111	107	102	98	94	90	86	81	76
ALBANY H	941203	12	71	66	60	55	51	47	43	41	39	34	30	29
ALBANY H	941203	24	30	30	29	29	29	29	29	29	31	33	37	41
ALBANY H	941203	36	44	45	46	48	50	53	55	58	60	64	65	65
ALBANY H	941203	48	63	64	66	68	72	73	72	70	68	67	67	68
ALBANY H	941203	60	70	71	71	71	71	70	71	73	75	78	82	86
ALBANY H	941203	72	86	87	89	91	95	100	104	105	108	111	114	116
ALBANY H	941203	84	119	121	123	125	127	128	128	127	127	127	128	127
ALBANY H	941204	0	127	125	122	118	115	111	107	103	100	97	93	87
ALBANY H	941204	12	81	75	70	67	64	61	55	49	43	39	37	34
ALBANY H	941204	24	33	31	27	26	25	24	23	22	24	24	25	26
ALBANY H	941204	36	26	28	30	32	35	38	40	41	42	43	44	46
ALBANY H	941204	48	48	51	54	56	56	56	56	56	58	60	62	62
ALBANY H	941204	60	61	61	61	62	63	64	65	67	70	72	74	74
ALBANY H	941204	72	75	79	82	85	88	89	91	94	98	103	107	108
ALBANY H	941204	84	109	109	111	114	118	122	125	124	124	124	124	124
ALBANY H	941205	0	123	123	123	123	121	120	115	111	107	105	103	100
ALBANY H	941205	12	97	92	87	83	79	76	73	68	63	59	55	51
ALBANY H	941205	24	48	46	44	42	40	38	36	33	34	35	36	36
ALBANY H	941205	36	36	35	34	34	36	38	40	41	42	42	42	44
ALBANY H	941205	48	46	48	50	50	51	53	55	56	58	58	59	59
ALBANY H	941205	60	61	62	63	66	66	68	68	68	70	72	74	75
ALBANY H	941205	72	76	77	81	84	86	88	90	91	93	97	101	104
ALBANY H	941205	84	106	108	109	110	112	113	115	116	116	116	117	118
ALBANY H	941206	0	119	118	116	116	116	116	114	112	109	108	106	104
ALBANY H	941206	12	100	95	91	89	87	84	82	78	73	69	67	65
ALBANY H	941206	24	62	59	55	51	48	45	42	40	39	40	40	40
ALBANY H	941206	36	39	37	33	32	33	36	39	38	36	34	33	35
ALBANY H	941206	48	36	38	39	39	38	38	39	41	42	44	45	46
ALBANY H	941206	60	46	46	46	46	49	53	57	58	58	58	58	58
ALBANY H	941206	72	60	64	68	71	71	71	71	72	75	78	81	84
ALBANY H	941206	84	86	90	90	88	88	89	91	93	94	95	96	96
ALBANY H	941207	0	94	92	92	92	92	92	90	89	87	86	86	84
ALBANY H	941207	12	81	79	76	74	72	68	67	66	64	62	58	54
ALBANY H	941207	24	50	50	49	47	44	42	40	38	36	33	33	34
ALBANY H	941207	36	34	33	31	30	30	30	28	26	26	26	26	28
ALBANY H	941207	48	29	29	29	27	25	24	25	28	32	32	32	32
ALBANY H	941207	60	31	31	32	33	38	42	44	44	42	42	44	46
ALBANY H	941207	72	46	48	52	56	57	57	56	57	58	60	63	66
ALBANY H	941207	84	68	69	70	70	70	71	73	73	73	74	74	74
ALBANY H	941208	0	74	72	72	72	73	73	72	70	69	67	65	61
ALBANY H	941208	12	60	61	60	60	59	55	51	48	49	50	50	48
ALBANY H	941208	24	46	43	40	40	40	41	40	40	40	38	34	32
ALBANY H	941208	36	32	32	33	35	37	36	33	30	31	33	33	32
ALBANY H	941208	48	33	34	35	34	31	27	26	26	32	33	34	34
ALBANY H	941208	60	34	33	33	35	36	37	39	42	45	46	45	46
ALBANY H	941208	72	48	50	52	56	57	58	58	59	61	63	65	66
ALBANY H	941208	84	66	66	68	68	69	70	71	72	74	74	75	73
ALBANY H	941209	0	72	70	70	70	71	72	71	69	68	66	65	65
ALBANY H	941209	12	64	64	64	63	61	59	56	56	56	56	57	56
ALBANY H	941209	24	55	53	51	50	52	53	54	54	54	53	52	51
ALBANY H	941209	36	51	53	53	54	54	54	54	54	54	54	54	54
ALBANY H	941209	48	55	55	54	54	54	54	52	53	55	55	55	54
ALBANY H	941209	60	53	53	54	55	57	59	61	61	62	62	62	62
ALBANY H	941209	72	63	65	68	72	74	73	72	73	74	76	78	79
ALBANY H	941209	84	81	82	81	79	79	79	80	81	82	83	82	81
ALBANY H	941210	0	80	79	78	78	78	78	77	75	72	70	69	69
ALBANY H	941210	12	69	70	68	66	64	62	60	61	64	62	62	60
ALBANY H	941210	24	58	58	59	57	58	60	61	58	56	56	59	64
ALBANY H	941210	36	64	57	57	62	62	63	63	60	63	67	65	61
ALBANY H	941210	48	62	63	64	62	60	60	63	62	60	58	57	59
ALBANY H	941210	60	61	62	62	63	64	66	66	65	65	66	67	69

ALBANY H	941210	72	73	72	73	75	76	77	78	78	79	82	82	81
ALBANY H	941210	84	80	81	82	83	83	82	82	81	79	77	76	76
ALBANY H	941211	0	78	78	76	74	73	72	72	71	67	66	67	67
ALBANY H	941211	12	66	62	60	61	61	60	58	58	58	57	56	56
ALBANY H	941211	24	55	55	56	56	58	60	59	57	55	54	57	63
ALBANY H	941211	36	66	65	62	61	62	63	64	65	65	66	67	67
ALBANY H	941211	48	66	64	62	63	65	69	70	68	66	66	68	70
ALBANY H	941211	60	70	71	73	74	75	76	76	77	79	81	83	85
ALBANY H	941211	72	88	89	89	90	92	93	94	95	95	96	97	97
ALBANY H	941211	84	96	94	93	94	95	94	92	90	90	90	90	88

APPENDIX O

WAGES AND SALARIES C. 1870 (ANNUAL INCOME)

WAGES AND SALARIES C. 1870 (ANNUAL INCOME)

As an indication of the magnitude of the expenditure in the construction and maintenance of the Jetty (McCarthy, 1990)

Colonial Secretary	£800
Surveyor General	£600
Treasurer	£550
Colonial Surgeon	£400
Post Master General	£350
Chief Clerk	£300
Harbour Master (Fremantle)	£250
Crown Solicitor	£250
Headmaster (Perth Boys)	£200
Draughtsman	£200
Surveyor (Roebourne)	£200
Inspector of Sheep	£150
Harbour Master (Albany)	£150
Doctor (Roebourne)	£150
Cooper and Warehouse Keeper	£130
Clerk to the Crown Solicitor	£110
3rd. Master (Perth Boys)	£100
Teacher, Girls School	£100
Post Master (Albany)	£100
Shepherd	£91
Schoolmistress (Guildford)	£70
Caretaker of the Public Gardens	£70
Hospital Matron	£50
Chaplain (Fremantle)	£46-10-0
Schoolmaster (Rockingham)	£40
Shepherd (Roebourne)	£36
Assistant Teacher (Busselton)	£20
General House Servant	£16