Pier Reviewed

A Study of Port-related Structures
in South Australia

By Amer Khan

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South Australia
2006
DECLARATION

This thesis represents original research undertaken for the Masters in Maritime Archaeology Degree at Flinders University. It was completed in 2006. The interpretations presented in this thesis are my own and do not represent the view of any other individual or group.

Amer Bazl Khan
August 2006
This thesis will address the study of port-related structures in South Australia. Port-related structures have not been widely studied within Australian approaches to maritime archaeology; instead, the examination of ships and shipwrecks has been the usual preoccupation for many maritime archaeologists in the field. Due to recent theoretical developments however, this appears to be changing. Furthermore, recognition of the symbiotic relationship between ships and ports has underscored the need for a critical theory assessment of port-related structures.

This thesis will demonstrate the application of site formation theory in the assessment of port-related structures. An understanding of site formation processes, as a means to link material and spatial phenomena evident in the archaeological record with past human behaviour, serves as the theoretical focus for this study. Subsequent regional applications of this approach can be used to demonstrate the complex relationships between the numerous components of the maritime cultural landscape of the region.

The study of port-related structures and the potential for anthropological study through the maritime infrastructure has not yet been fully explored. Clear opportunities exist for the development of critical theory through the study of these structures. It is hoped this thesis will be one of many steps in this direction.
ACKNOWLEDGEMENTS

I would like to thank the teaching faculty of the Department of Archaeology, particularly Associate Professor Mark Staniforth, Ms. Jennifer McKinnon, and Dr. Susan Briggs. They have all provided me with invaluable guidance and support. The academic staff, Mr. Mark Lethridge, Mr. Eric Compass, and Mr. Robert Keen, at the School of Geography, Population and Environmental Management, has similarly provided me with excellent access to the GIS resources available at Flinders University.

Access to government documentation at Flinders Ports was made possible with the help of Peter Hanson. Neville Collins, an Adelaide resident and author of The Jetties of South Australia: Past and Present, provided me with essential insight and resources concerning the development of South Australia's maritime infrastructure.

I would also like to thank the students of the M.A. in Maritime Archaeology program at Flinders. My endless theoretical discussions with Jun Kimura, general laments on survey equipment with Rick Bullers, and finding the light at the end of the tunnel with Peta Knott, come to mind. I must also thank Brandi Lockhart, Debra Sheffi, Amanda Hale, and Diana Zwart for their assistance with site surveys, editing and general support:

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The biggest thank you goes, of course, to Nazia. To Nazia and to Mahe Noor. For surviving this with me. For their support, their patience, and their understanding.
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<tr>
<td>Barge</td>
<td>A flat bottom vessel normally used to transport cargo short distances. Are often un-powered and pushed by other vessels.</td>
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<td>Bay</td>
<td>The distance between two bents of a jetty or wharf</td>
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<td>Beam</td>
<td>Section of timber, steel or concrete used to reinforce components of a port-related structure</td>
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<td>Bent</td>
<td>A two-dimensional frame in a jetty or wharf, consisting of piles and lateral support beams</td>
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<td>Berth</td>
<td>The point where a vessel docks against the structure</td>
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<td>Bracing</td>
<td>Structural member, usually diagonal, that provides both vertical and lateral load support</td>
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<tr>
<td>Bulk carriers</td>
<td>Vessels used for the sole transport of a single type of cargo. These vessels are usually very large and specialised for the type of cargo</td>
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<td>Clustering Algorithm</td>
<td>Rules which govern how distances are measured between groupings of points in a dataset</td>
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<td>Coefficient of</td>
<td>Also called the R-squared value. Varying from 0 to 1, it is an indicator of how closely the estimated values for a trendline correspond to the actual data. A trendline is most reliable when its R-squared value is at or near 1</td>
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<td>Determination</td>
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<td>Collar</td>
<td>An encasing around the base of a timber pile made of steel or cement and used to prevent water and marine organism damage to the pile</td>
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<tr>
<td>Commercial Jetty</td>
<td>A jetty used for industrial and passenger transport purposes, usually having greater structural reinforcements than promenade/recreational jetties</td>
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<tr>
<td>Composite piles</td>
<td>Timber piles encased in a concrete or steel collar</td>
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<tr>
<td>Containerisation</td>
<td>A standardization practice for the transport of cargo in large containers of fixed size. This practice started in the 1960s</td>
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<tr>
<td>Corbel</td>
<td>Structural member of a jetty or wharf that attaches the girders and deck to the piles</td>
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<td>Crossheads</td>
<td>Horizontal beam connecting two or more piles, and used to provide lateral support at the head of the pile</td>
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<td>Decking</td>
<td>The flat working surface of a jetty or wharf</td>
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<td>Term</td>
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<td>Dendogram</td>
<td>A hierarchical, binary tree used to represent clustering solutions within a dataset</td>
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<td>Dolphin</td>
<td>A type of fendering system. It is an arrangement of piles for the absorption of lateral berthing loads, often connected to the main jetty structure by a walkway</td>
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<td>Fendering system</td>
<td>Arrangement of free standing piles driven just clear of the berthing station on a jetty, and built to absorb the lateral loads of berthing vessels</td>
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<td>Girders</td>
<td>Longitudinal beams that run between two bents of the structure, providing longitudinal support to the structure</td>
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<tr>
<td>Idiographic</td>
<td>Concerning individual or unique events and the specific histories of people, including unique processes, facts, and idiosyncrasies</td>
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<td>IQR (Inter-Quartile Range)</td>
<td>The difference between the third and first quartiles. It is a measure of statistical dispersion in asymmetrical datasets</td>
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<td>Jetty (also Pier)</td>
<td>A port-related structure built perpendicular to the waterline or a causeway</td>
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<td>Lighter Aboard Ships (LASH)</td>
<td>Vessels that use removable standardized barges for cargo holding, loading and unloading. They have no direct interaction with port-related structures</td>
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<td>Lightered</td>
<td>A type of loading and unloading strategy where small vessels are used to ferry cargo to and from a vessel</td>
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<td>Mann-Whitney Wilcoxon U-Test</td>
<td>Non-parametric statistical significance test for assessing whether the difference in medians between two observed distributions is statistically significant</td>
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<tr>
<td>Mean</td>
<td>The sum of all measurements divided by the number of observations in the data set</td>
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<td>Median</td>
<td>The middle value that separates the higher half from the lower half of the data set</td>
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<tr>
<td>Monkey</td>
<td>A hammering load used to drive piles into the ground</td>
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<tr>
<td>Nomothetic</td>
<td>The search for general laws and principles of human behaviour</td>
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<tr>
<td>Non-parametric dataset</td>
<td>An asymmetrical distribution of data, unlike a standard bell curve</td>
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<tr>
<td>Term</td>
<td>Definition/Description</td>
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<td>P-Value</td>
<td>Takes a value between 0 and 1. It represents the amount of overlap between two datasets. A high P-value corresponds to a greater overlap and a small P-value suggests less overlap of the datasets. A P-value less than 0.05 suggests a statistically significant difference in the medians of two datasets</td>
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<tr>
<td>Pier</td>
<td>See (Jetty)</td>
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<tr>
<td>Pile</td>
<td>A timber, steel or reinforced concrete post driven or screwed into the ground to provide vertical load support to a structure</td>
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<tr>
<td>Promenade Jetty</td>
<td>A jetty used for recreational purposes</td>
</tr>
<tr>
<td>Quay</td>
<td>See (Wharf)</td>
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<tr>
<td>Ro-Ro (roll-on, roll-off)</td>
<td>Container vessels with build-in ramps for wheeled cargo e.g. automobiles, trailers, and rail-carriages</td>
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<td>Vessels</td>
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<tr>
<td>Shoe</td>
<td>Metallic point placed at the end of a timber or concrete pile, and used to protect the base of the pile as it is driven into the ground</td>
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<tr>
<td>Spiral blade cap</td>
<td>A screwed shaped tip for piles that are screwed into the ground</td>
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<tr>
<td>Standard Deviation</td>
<td>The root mean square (RMS) deviation of the values from their mean. A common measure of statistical dispersion, measuring the distribution of values in a dataset</td>
</tr>
<tr>
<td>Waling / Crosswaling</td>
<td>Horizontal beam connecting two or more piles, and used to support diagonal bracing. It can also provide lateral load support along the middle or lower portion of the pile</td>
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<tr>
<td>Wharf (also Quay)</td>
<td>A port-related structure with the berthing station built parallel to the waterline</td>
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### ABBREVIATIONS

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<td>Broken Hill Pty.</td>
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<tr>
<td>DEH</td>
<td>Department of Environment and Heritage (South Australia)</td>
</tr>
<tr>
<td>DEP</td>
<td>Department of Environment and Planning</td>
</tr>
<tr>
<td>DMH</td>
<td>Department of Marine and Harbours</td>
</tr>
<tr>
<td>DRG</td>
<td>Departmental Record Group</td>
</tr>
<tr>
<td>ESRI</td>
<td>Environmental Systems Research Institute</td>
</tr>
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<td>GIS</td>
<td>Geographic Information Systems</td>
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<td>GPS</td>
<td>Global Positioning System</td>
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<td>IQR</td>
<td>Inter Quartile Range</td>
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<td>MBSA</td>
<td>Marine Board of South Australia</td>
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<tr>
<td>MHB</td>
<td>Marine and Harbours Board</td>
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<td>RETP</td>
<td>Round Edge Timber Pile</td>
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<td>RNE</td>
<td>Register of the National Estate</td>
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<td>SAHC</td>
<td>South Australian Heritage Committee</td>
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<td>SAPP</td>
<td>South Australian Parliamentary Papers</td>
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<tr>
<td>SDE</td>
<td>Spatial Database Engine (GIS database)</td>
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<td>SEMP</td>
<td>Square Edge Metal Pile</td>
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<tr>
<td>SETP</td>
<td>Square Edge Timber Pile</td>
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<td>SUHR</td>
<td>Society for Underwater Historical Research</td>
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Chapter 1

Introduction

The basic function of a port is to provide a link between land and sea transport and to furnish means by which transfers of freight and passengers between the two systems can be made efficiently (Tull 1997: 1)

Ports and commercial ships have a symbiotic relationship so far as contemporary design is concerned (Bach 1976: 404)
CHAPTER 1

INTRODUCTION

Introduction
The study of port-related structures and maritime infrastructure has largely been overlooked in Australian approaches to maritime archaeology. As is evident from numerous academic, museum, or state heritage publications, the focus of Australian maritime archaeology has traditionally been the study of ships and shipwrecks (Gibbs 2006; Hosty and Stuart 1994; Nutley 2006). Bach (1976: 256, 404) describes a "symbiotic relationship" between port-related structures and ships, where each develops in conjunction with the other. This calls for an anthropological study of port-related structures in addition to the study of ships, and where possible a critical theory approach to the study of the maritime infrastructure.

This thesis will attempt to apply critical theory to the study of port-related structures in South Australia. The theoretical framework will rely on a combination of middle range theory, behavioural archaeology, regional approaches, and maritime cultural landscapes. A combination of archaeological and historical sources will be used to study the development of port-related structures, while employing a number of archaeological and data analysis methodologies. Conclusions regarding the relationships between port-related structures and the maritime cultural landscape may be reached as a result.

Aims and Objectives

- To identify site-specific cultural transforms of port-related structures, through the application of Site Formation Theory.

- To identify regional correlates by (i) examining patterns within regional datasets of jetties and wharves, and (ii) linking them with factors affecting the maritime cultural landscape of the region.
• To further an archaeological understanding of the “symbiotic relationship” between ships and port-related structures, as described by Bach (1976: 256, 404).

• To demonstrate the utility of studying port-related structures for the field of maritime archaeology in Australia.

This chapter will define the term “port-related structure” as it is used in this thesis. The structural considerations of port-related structures will then be examined, to enable the assessment of sites investigated within the field-work component of this thesis. This will be followed by a brief history of the maritime industry in Australia focusing on the development of port-related structures. The chapter will conclude with an outline for the remainder of the thesis.

Definitions

The study of port-related structures requires the clarification of specific terms as they have been used in existing studies on the subject. The term "port-related structures" was defined by Cumming and Garratt (1995: 5) for their archaeological investigations of jetties and wharves in Western Australia as:

'Modifications to the shoreline and its immediate surrounds which were designed specifically to cater for the movement of people, materials and goods to and from the vessels which served the ports and harbours under scrutiny'.

This was in contrast to The International Maritime Dictionary definition of port-related structures as:

'A place for the loading and unloading of vessels recognized and supervised for maritime purposes by the public authorities'. (deKerchove 1948)

McCarthy meanwhile has specified a functional definition for port-related structures suitable to the Australian model of remote and isolated settlements as:

Any facilities built for landing passengers and goods at any place designated for the loading and unloading of vessels”. McCarthy (2002: 7)
While a number of interpretations of port-related structures exist in all of these cases mentioned, the actual material culture from both maritime and archaeological perspectives has been either the jetty or wharf.

Jetties and wharves are alternatively called piers and quays, respectively (Ford 2000: 1). While functionally equivalent, jetties and wharves differ in form, and the decision to employ one over the other is based on a variety of environmental and cultural factors. Agershou and Lundgren (1983) distinguish between jetties and wharves, with the former defined as a structure that lies perpendicular to a waterline or causeway, while the latter runs parallel. Ford (2000: 1) specifically defines jetties as "[structures] built out from land, made of steel, cement, wood or as a combination of these, and used as a working platform, or for recreational needs". However, she does go on to use the same working definition for wharves and piers later in her thesis.

There appears to be an interchangeable use of the terms port-related structures, jetties, piers, wharves and quays, in existing research. Based on this precedence, port-related structures will be understood to mean a structure built for landing passengers and goods at any place designated for the loading and unloading of vessels. This will include jetties, wharves, piers and quays. The thesis will not distinguish between these terms or structures, except in the specific analysis of the relationship between jetty length and depth in Chapter Five. In this case, the analysis and implications will apply specifically to jetties based on the relationship between depth at berth and jetty length.

**Structural considerations**

While all port-related structures, as defined in this thesis, are similar in construction and function, they are employed within different contexts. Where there is insufficient berthing depth at shore, jetties are built out from land to access deeper water. Alternatively, in rivers where vessel obstruction in narrow waterways takes priority, wharves are the preferred port-related structure (Agerschou, Lundgren et al. 1983: 245). These are significant factors along the South Australian coastline, where extensive shallow tidal flats within the Spencer...
and St. Vincent Gulfs limit coastal access and dictate the need for jetties. However, along the Murray River and in the restricted waterways of Port Adelaide, wharves in conjunction with dredging operations are the necessary alternative. The choice between jetty and wharf is thus both environmentally and culturally driven.

Further choices need to be made during the construction of jetties and wharves. Usually built on piles driven into the seabed (see Figure 1-1), they can however also be rock or cement filled structures. Pile jetties and wharves are often preferred in areas with high traffic, as they reduce wave reflection, do not drastically change local tidal flows, and help dissipate wave energy in busy harbours.

Cement, steel, or timber is most commonly used for pile construction. While steel and timber piles are cheap, easily maintained and individually replaceable, cement piles tend to have long working lives (often up to 80 years). Timber piles on average need replacement every 12-15 years, however this varies depending on the type of timber used and its resistance to marine borers (Maiden and
DeCoque 1895: 7). Jarrah and Turpentine piles have been known to last up to 40 years (Greene 1917: 8) in areas where marine borers have been eradicated due to urban pollution. Other types of piles include composite piles, in which the timber is protected by a cement or metallic collar at the base (Haswell and Newman 1981: 194). The collar provides a cost effective way of reducing maintenance costs, while increasing the pile’s lifespan.

Timber jetties in South Australia are mostly 'pile driven'. This is a process where a large weight, called a monkey, is hoisted up and dropped onto the pile to drive it into the ground. The timber pile is fitted with a metal collar around the head, to prevent splitting during the driving process, and a tapered metal shoe at the point. The piles are driven into the seabed at an outwards angle that is eight to ten degrees off vertical, so that the distance between the bases of the piles is greater than the distance between the pile heads. Once braced this provides lateral reinforcement for the structure (Chellis 1945: 139). This method is used in areas without a rock substrate, as the piles cannot be driven into the seabed unless the rock is removed or blasted with explosives. Screw piles, made of wrought or cast iron, can alternatively be inserted if a rocky seabed is encountered. The piles are tipped with a screw-shaped cap and have traditionally been screwed into place using a horse driven spindle and pulley apparatus. In 1859, the Glenelg jetty was the first in the state to be built by this method (Collins 2005: 21).

Timber piles tend to provide the greatest flexibility under strain, while minimizing damage to vessels (Agerschou et al. 1983: 244). However they need extensive cross-bracing and cross-waling reinforcements between the piles to provide lateral support. The degree of lateral stability and reinforcement applied to a jetty is based on environmental conditions, and the expected lateral loading from berthing vessels. Similarly, vertical loading limits are set by the types of ship cargoes and the expected use of the structure. Jetties and wharves often provide direct rail links to ships and accommodating the increased vertical loads becomes an important consideration. Recreational and promenade requirements are often less stringent than industrial and commercial needs, requiring fewer structural reinforcements (Chellis 1945: 144).
Jetties tend to be most flexible in the middle of their span, with the head of the structure being the most vulnerable to both collisions and the environment. Collisions at the head often cause significant damage to the super structure. This is also where storm damage tends to be most significant (Chellis 1945: 144). "Fendering systems" are often employed to protect the head and berthing stations of a jetty. They consist of a series of freestanding piles, also referred to as dolphin piles that take the direct force of a berthing vessel to protect the main jetty structure (Agerschou, Lundgren et al. 1983: 245). However according to Anderson (in Cumming et al. 1995: 4) the fendering system can sometimes act as a 'battering ram' in severe storm conditions, and thus damage parts of the jetty itself.

Another structural consideration is the head of the jetty. The head is not always constructed in-line with the rest of the structure; "L", "F", "T", and "Y" shaped jetty heads are common. These configurations are used to provide multiple berthing stations for ships, where the specific design employed is dictated by the type of expected vessels, draft requirements, loaded displacement, shape, length, beam, types of cargo, and loading facilities on vessel (Cumming, Garratt et al. 1995: 5). Environmental factors, including the direction of prevailing winds, waves and tides, all play a significant role in the choice of jetty configuration.

Lastly, the height of the deck on a jetty is a key consideration. If the deck is too high relative to the water level, the jetty may only be used at high tide, or by sufficiently large vessels. If the deck is too low, it can be damaged during high seas or storms by being completely lifted off the piles (Cumming, Garratt et al. 1995: 4). A large tidal range poses a significant challenge in the determination of a suitable deck height.

Environmental and cultural considerations are central to the safe and suitable construction of port-related structures. An understanding of these considerations is necessary for the assessment of jetty and wharf sites, as choices made in construction, can often provide valuable insight into the expertise of local
tradesmen involved in construction, the expectations of the community and the role of trade in the region.

The Maritime Infrastructure: A Historical Background

The role of Australia's maritime industry has been broadly demonstrated by numerous historians to have been pivotal for European settlement (Bach 1976; Parsons 1986). According to Drew (1994), remote coastal communities were established to support isolated penal stations, to ensure wide scale resource exploitation, and to prevent settlement by competing European colonial powers. These requirements led to the establishment of widely distributed and isolated coastal populations solely serviceable through the maritime industry. Staniforth (2003) in defining the material dependence of these colonies within the context of a consumer culture, stresses the role of maritime trade in sustaining these early settlements. While the maritime industry was central to the import of material culture and enabling European colonization, it was also responsible for the reverse export of natural resources. This "extractive activity", as described by Drew (1994: 46), proved to be the engine for colonial settlement, driven by a dependence on international and maritime trade.

Reliance on the maritime industry, while necessary for international trade and European imperialism of the time, was also a key feature of early inter-state commerce and transport within Australia. The isolation of settlements and the lack of substantial road or rail networks made water transport the only viable option (Coroneos and McKinnon 1997: 1). No significant investment was undertaken in rail and road infrastructure until the latter half of the nineteenth century, rendering terrestrial transport inferior to maritime transport up to that point. Indeed even after the introduction of the railway system, tracks were rarely laid to link coastal settlements to each other, but were instead built to enable access to the interior regions from the coast (Drew 1994: 42). As such, for a considerable period coastal trade remained a uniquely maritime affair.

The early development of a distinctly Australian-built vessel type has been extensively studied by a number of archaeologists and historians (Bach 1976;
Bullers 2006; Coroneos 1991; Jeffery 1989, 1992; Kerr 1987; Nash 2004, O'Reilly 2005; Pemberton 1979). These coastal traders have been characterized as shallow drafted and flat-hulled, for easier coastal access; rigged with additional topsail for speed and manoeuvrability; and built from indigenous Australian timbers by a local ship-building industry (see Figure 1-2). The use of these vessels, mostly small ketches and schooners, in shallow coastal regions and rivers, dictated many of these design adaptations. Further adaptations include retractable centreboards for shallow water navigation and beach landings (Bullers 2006: 24-27; Jeffery 1992: 216; Kerr 1987: 8; O'Reilly 2005: 21; Salter 1991: 16). The design adaptations of locally built vessels are thus also based on a combination of environmental and cultural considerations.

Across Australia and specifically in South Australia, port-related structures have similarly developed in response to the cultural and environmental constraints of coastal access, inter-state trade, settlement and resource exploitation. According to Bach’s postulated "symbiotic relationship" between ports and ships, port-related structures should reflect similar adaptations to local conditions, as locally built vessels.
Local Developments:

In South Australia, Adelaide was selected as the capital, and Port Adelaide as the base for the state's maritime infrastructure due to the merits of its safe harbour (Bach 1976: 271; Parsons 1986: 18-20). Port Adelaide, however, proved difficult to navigate due to shallow water access, shifting sand bars, and a large tidal range, all of which impacted the choice of vessels and port-related structures.

Development of ports outside of Port Adelaide broadly followed settlement patterns within the state. Kangaroo Island and the coast south of Adelaide down to the mouth of the Murray were the earliest areas developed. These were followed by Gulf St.Vincent, Spencer Gulf, and East from the Murray to the Victorian border. The Yorke Peninsula and the Western Coast were developed last (Parsons 1986: 88).

Following Port Adelaide, smaller "outports" were established at Port Onkaparinga (Noarlunga), Port Willunga, Myponga Beach, Yankalilla (Normanville), Second Valley, Rapid Bay, Cape Jervis, Rosetta Bay, Victor Harbor [sic], and Port Elliot (Collins 2005: 4). These ports were used to service the earliest pastoral and agricultural initiatives along the Fleurieu Peninsula. Local produce, destined for international markets, was transported to Adelaide by small coastal traders. Vessels were beached on falling tides to enable loading, a process which was often complicated by an unpredictable and treacherous coastline. In the 1850s, the South Australian government began to construct jetties at these locations in response to local industry demands.

The Waste Land Amendment Act of 1869 encouraged agricultural and mining development in the outer regions of the previously pastoral Yorke Peninsula (Collins 2005: 4). Almost 20 new port-related structures were built to service the new wheat, grain, lime, gypsum, and copper industries. According to Collins (2005) this maritime infrastructure was developed solely with land access in mind, with jetties often placed in unsuitable locations in terms of shelter and depth of water.
These outports were serviced by the small coastal traders of the "mosquito fleet" (Parsons 1986: 88), comprised mostly of small ketches, schooners and steamers. Larger vessels occasionally visited these ports for direct export. In such cases however, cargo was still lightered by smaller craft as insufficient depth often prevented direct berthing. According to Collins (2005), jetties need to be either extended beyond shallow water for greater depth, or rebuilt altogether in more suitable locations.

The economies of scale in 20th century saw cargo and transport vessels grow significantly larger, creating the need for modern port-related structures capable of managing these vessels and their cargoes. The required deepening operations, specialized cargo handling capabilities and successive jetty extension programs added to the cost and complexities of these ports. According to Bach (1976: 259) these new developments created a competitive and politicized rivalry between major ports. Such competition ensured maritime infrastructural spending was dedicated for the major ports, to the detriment of the smaller outports. The resulting attrition of smaller ports, in the absence of government funding, has led to the extensive decommissioning and abandonment of port-related structures across the state (Ford 2000: 26).

Investment in maritime infrastructure was proportional to the size and prosperity of the local industries. In South Australia, investment in maritime infrastructure was severely impacted with the demise of local industries due to market collapse and resource depletion (Parsons 1986: 280). For example, the closing down of copper mining operations, near Wallaroo on the Yorke Peninsula, led to the abandonment and decommissioning of commercial jetties along the Spencer Gulf.

Similarly, competitive pressures of road, rail, and air, as transport alternatives, took their toll on the maritime industry. As competitive technologies, road and rail provided complete point-to-point transport solutions where shipping companies could only deliver to the closest port. The rail-link between Port Adelaide and Victor Harbour, and the Kapunda to Morgan line, converted local transport from maritime to terrestrial. The decline of shipping as a transport
solution led to a cascading deterioration in the maritime infrastructure. By the 1920s, jetties at Largs, Semaphore, Grange, Glenelg and Brighton had been converted to promenade jetties. Such structures, however, do not bring in taxable levies, further reducing income for the government run Department of Marine and Harbours (Parsons 1986: 281).

The depressions in the 1890s and 1920s, the First World War, and the introduction of trade unionism all affected the local maritime industry to varying degrees. Furthermore, after WWII and in the 1960s the introduction of large bulk carriers requiring heavy loading and unloading installations at berth led to the replacement of many existing timber jetties for tubular steel and reinforced concrete structures (Bach 1976: 361,404).

The history of port-related structures in South Australia is marked by a period of initial expansion, driven by settlement and resource exploitation, followed by formalized industrial restructuring and consolidation, prior to a period of eventual decline in the role of maritime transport in the state's economy. These periods of construction, use, modification, and abandonment of maritime infrastructure since the mid 1800s has left an appreciable archaeological record. Today, remains of these jetties and wharves can be found all along the South Australian coastline. These structures exist in varying degrees of preservation, many in precariously poor condition due to environmental and human development pressures. While a significant number of major ports essential to the state's economy are still active, many of the jetties and wharves of smaller ports have been returned to local council control. Provided as long-term leases to local councils, this divestment scheme was set up by the Department of Transport, Energy, and Infrastructure in 1996. These council administered jetties are limited to recreational use.

Thesis outline

This chapter has defined “port-related structures” and associated terminology for use in the remainder of this thesis. The structural considerations of port-related structures have been examined to enable the assessment of sites investigated within the field-work component of this study. Lastly, a brief history of the
maritime industry in South Australia, focusing on the development of port-related structures was provided.

Chapter Two reviews the existing research on port-related structures, and provides a theoretical framework for this study. Critical theory requirements for the anthropological study of port-related structures are selected and their application explained. The study is framed within broad theoretical developments in archaeological thought, specifically the transition from a particularist to processual perspective. This is followed by an explanation of site specific and regional applications of middle range theory and behavioural archaeology. Finally, regional applications of this approach are related to maritime cultural landscape theory.

Chapter Three provides a detailed explanation of the methodologies used for an archaeological and historical investigation of port-related structures. The sampling strategy and survey methods used for the field-work component of the study are examined. The use of various survey techniques, Geographic Information Systems (GIS), and statistical methodologies in the analysis of site specific and regional data are also explained.

Chapter Four will present the results of field surveys and site formation assessments. The identification of cultural site formation processes, to account for material and spatial phenomena evident in the archaeological record, will be demonstrated. This will assist with the development of cultural correlates regarding human behavioural phenomena and the archaeological remains of port-related structures.

Chapter Five will present results for the regional application of site formation theory. It will attempt to demonstrate patterns within regional datasets of South Australian port-related structures and correlate them to a range of economic, social, and technological factors affecting the maritime cultural landscape of the state. As a part of this analysis, the symbiotic relationship between vessel type and jetty construction will be investigated.
Chapter Six will conclude by discussing the implication of these research findings and posing questions for further research.
Chapter 2

Theoretical Frameworks for Port-related Structures

The jetty is an illustration of economic externalism... it is a physical reminder of the paramount role of trade in the economy (Drew 1994: 42)
CHAPTER 2: 
THEORETICAL FRAMEWORKS FOR PORT-RELATED STRUCTURES

Introduction

Port-related structures exist within a broad context of political, economic, technological, and social influences. This provides a rich theoretical framework for anthropological study. Chapter Two will review existing research on port-related structures, and layout a theoretical framework for this thesis. It will introduce relevant theory in maritime archaeology, beginning with particularist to processual developments in archaeological thought. An explanation of middle range theory and behavioural archaeology will then provide the theoretical focus for this study. The use of site specific formation theory will be explained, followed by an assessment of this methodology towards a regional approach. The combination of site formation theory and regional approaches will help develop perspectives for a regional maritime cultural landscape.

Studies on Port-related Structures

There have been a number of studies conducted on jetties and port-related structures in Australia, largely by state heritage institutions. From 1993 to 1995 the Western Australian Maritime Museum (funded by the National Estate Program, a Commonwealth financed grants scheme administered by the Australian Heritage Commission) and the Heritage Council of Western Australia, conducted numerous surveys of port-related structures in Western Australia. The studies focused on developing an historic framework of analysis for these structures, and to establish a relative significance assessment procedure for the Heritage Council. The studies involved mostly non-disturbance surveys of historic jetties with limited excavation of associated artefact fields around the structures. The results from these studies have been published in a series of site inspection reports (Cumming, Garratt et al. 1995; Garratt 1993a, 1993b, 1993c, 1994a, 1994b, 1994c, 1994d, 1994e, 1995; Wolfe 1996). These studies were site specific and emphasized heritage management requirements. Site formation processes were briefly considered for assessing distribution patterns of the
artefacts found around the jetty. The jetty structures themselves were not studied from a theoretical perspective (McCarthy 2002).

Numerous other attempts at rescue archaeology and significance assessments have followed in Western Australia (Carpenter 1984; McCarthy 1997; Taylor 1996; Worsley 1995). Gainsford (2004) in a thesis study of the Hamelin Bay jetty in WA effectively considers a number of cultural and environmental site formation processes, using an historical and non-disturbance survey approach. This study however remains non-comparative in nature and does not explicitly identify transformation processes active at the site.

Heritage studies have also been conducted in a number of other states. In New South Wales for instance studies have been conducted on jetty and wharf structures along the Paramatta River (Wolfe 1991), Myall Lakes, the Manning River, and the Macleay River (Nutley 2003a, 2003b). These studies were conducted in response to urban development, requiring the need for limited site-focused heritage assessments. Similarly in Tasmania, surveys conducted at the Port Arthur Historic Site have focused on heritage and historical perspectives, with limited critical theory or site formation analysis (Coroneos 2004; Jackman 2004). This was the location for the annual Flinders University maritime archaeology field school in 2005, where site surveys on the structural remains of industrial jetty structures included basic historical and site formation assessments.

In South Australia, heritage studies have been conducted on the Murray River and Morgan wharf (Ellis 1979; Marfleet 1980, 1983). A number of studies on the Holdfast Bay jetty at Glenelg, conducted in conjunction with the Society for Underwater Historical Research (SUHR), have focused on site formation analysis of the artefact field associated with the jetty (Drew 1983; Richards and Lewczak 2002; Rodrigues 2002). Similarly, a descriptive assessment of the maritime cultural landscape of Port Willunga by Ash (2004) included surveys of the jetty sites in the District of Onkaparinga, but was not extended towards a regional or comparative perspective.
Ford's (2000) thesis, *The Use and Abuse of Jetties*, considers issues of government control of jetties in South Australia. Although not explicitly referring to site formation processes, this thesis descriptively provides an explanation for the level of repair and maintenance conducted on the structures, from a regional and historical perspective. Site survey reports for the Semaphore, Victor Harbor, Rapid Bay, and Brighton jetties are combined with an extensive list of historical sources. The study does not explicitly establish a research design structured around site formation theory, but inadvertently succeeds in identifying a number of cultural and non-cultural transforms acting on the structures.

Heritage management concerns appear to dominate a large proportion of the few studies on port-related structures in Australia. The few attempts at studying jetty structures, instead of associated artefacts, have not explicitly incorporated site formation theory or attempted to model formation processes using multi-site comparisons. Correlations have been limited to descriptive and implicit explanations for linking the archaeological patterning with behavioural phenomena.

While critical theory applications in the archaeological studies of port-related structures have been limited, the history books have not. A number of excellent sources on Australian maritime history can provide useful background on the development of the regional maritime infrastructure. *The Maritime History of Australia* by John Bach (1976), *Southern Passages* by Ronald Parsons (1986), and *The Jetties of South Australia* by Neville Collins (2005), all serve as valuable resources.

Internationally, studies on port-related structures from a critical theory perspective have also been hard to find. Investigations at the 17th century Port Royal site in Jamaica have been ongoing through the University of Texas A&M for many years (Bass 1972; Clifford 1993; Darrington 1994). The theses coming out of these investigations have employed a broad use of historical particularism with a focus on shipwreck and artefact catalogue development. Other significant port-related studies have been published on the archaeological site of Dwarka in
India, by the Marine Archaeology Centre of the National Institute of Oceanography, Goa. The proto-historic to historic span of finds at Dwarka have directed research towards site descriptions and the identification of "cultural authorship" (Gaur and Vora 2005; Rao 1999, 2001). Meanwhile, the Thames Archaeological Survey, by the University College London and the Museum of London, has similarly involved a historical archaeology and descriptive approach towards investigating the Thames inter-tidal zone and Port of London area (Milne 2003; Milne, Bates et al. 1997).

The application of critical theory towards the study of port-related structures appears possible through a range of approaches. Indeed a combination of approaches is often needed when placing a particular form of material culture into a larger historical and regional context. The remainder of this chapter will describe some of the theoretical options available, assess their limitations, and select a focus for the study.

From the Particularist to the Processual

Within the context of maritime archaeological studies in Australia, the question of theory has been broadly framed by the published works of Keith Muckelroy, *Maritime Archaeology* (1978), and Richard Gould's (1983), *Shipwreck Anthropology*. It is in response to these early theoretical contributions, and an entrenched marginalization by terrestrial archaeologists, that Australian maritime approaches have strived to find direction. Muckelroy’s definition of maritime archaeology as "the scientific study of the material remains of man [sic] and his activities on the sea" (1978: 4) has been an important focus for theoretical approaches in Australia.

According to McCarthy (2000) early shipwreck studies in Australian maritime archaeology led to a highly specific 'Shipwreck Archaeology'. This approach was characterized by a site specific, ideographic, and historically particularist emphasis. The precise temporal, spatial, and ethnic nature of shipwrecks, with an often rich accompanying documentary and historical record, especially in the context of Australia, has led to what Martin (2001: 383) would describe as an
"over-particularizing" of shipwreck archaeology. Subsequent developments in processual thought introduced the need for an anthropological understanding of cultural processes and human behaviour (Gould 1983; Watson 1983). Processual attempts were characterized by hypothesis driven research designs, multidisciplinary collaboration, predictive modelling, and comparative analysis approaches.

According to Babits and Tilburg, historical particularism remained, however, a necessary step in the logical progression of archaeological thought:

First, sites must be exploited to the fullest informational extent possible; second, sites of a given locality or type must be interrelated with each other to provide both interpretations and predictive modelling; finally sites must be presented within interdisciplinary and regional, if not global, perspectives to allow determinations of importance and provide better understanding of each individual site. (Babits and Tilburg 1998: 2)

This placed historical particularism as an early and essential step in the development of theoretical sophistication through processual approaches (Staniforth 2000: 90). As particular events appear embedded in process, so too particularism becomes a precursor to processualism.

Signatures of cultural process should be evident across a variety of material remains of past human activity. Once the questions being asked are processual in nature, the object of study loses particularist value, and becomes a means to a processual understanding of past maritime activity. This 'de-particularized' view of material culture has broadened the scope of maritime archaeological theory, by shifting the focus away from the particularized study of shipwrecks, towards other material remains of cultural process. Within this context of theoretical developments in maritime archaeology, the anthropological study of port-related structures becomes an important avenue of investigation.

**Middle Range Theory and Behavioural Archaeology**

According to Binford (1977: 6), processual theories strive for an understanding of human behaviour through the interpretation of material and spatial phenomena within the archaeological record. He identifies the essential difficulty in linking static observations of the archaeological record with statements of social
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dynamics concerning past societies. This link between what Binford describes as the static and dynamic has been called middle range theory.

According to Schiffer (1988: 462), middle range theory enables the archaeologist to link artefacts to human behaviour and transform 'evidence into inference'. Schiffer and others recommend the use of behavioural archaeology i.e. the study of interactions between people and material objects, for the determination of these links (Kosso 1991, 2001; LaMotta and Schiffer 2001: 14; O'Reilly 2005; Rathje and Schiffer 1982; Reid 1995; Schiffer 1988; Walker, Skibo et al. 1995: 5). Schiffer utilizes a parallel terminology of systemic and archaeological contexts to identify the static and dynamic domains as they are understood in middle range theory (Schiffer 1995: 252).

Schiffer highlights the three essential aspects of archaeological data as:

- consisting of material in static spatial arrangements
- acted on by a series of systemic cultural formation processes (C-tranforms)
- and a series of non-cultural (environmental) formation processes (N-transforms)

These C-transforms and N-transforms are the cultural and non-cultural processes responsible for the resulting archaeological data, as found by the archaeologist. These processes characterize transformations that affect the artefact as it transitions from both within and across the systemic and archaeological contexts.

There are clear parallels between Binford's static and dynamic domains in middle range theory, and Schiffer's use of systemic and archaeological contexts in site formation theory. Although they are similar in approach and structure, there are differences in focus between the two approaches. Schiffer focuses on individual and event level transformations on the material record, and subsequently derives systemic properties. Binford on the other hand argues for long term institutional and social transforms, and the derivation of generalized theory (Tschauner 1996: 9-10).
Variations on these approaches include Muckelroy's (1978: 158) 'extractive filters' and 'scrambling devices' for shipwreck site formation. Gibbs (2003; 2006a) extends Muckelroy's site formation schema by defining cultural site formation processes of discard, abandonment, scavenging and salvage, to resolve issues of ambiguity within Muckelroy's model. Gibbs suggests this framework for cultural transformations can be used to extract and synthesize information from multiple data-sets, compare and contrast site relatedness, and provide a plausible process model for insufficiently documented sites (Gibbs 2006a: 4). Similarly, others (Stewart 1999; Ward et al. 1999; Wheeler 2002) have described physical, biological, and chemical processes to characterize the N-transforms active in shipwreck site formation.

This thesis will adopt both a site specific and regional perspective towards port-related structures. It will use Schiffer's site formation analysis methodology in assessing site specific C-transforms. While patterning associated with non-cultural processes will be identified where possible, the main focus will be the identification of cultural transforms. A regional approach consistent with Binford's concept of generalized theory will then be used to describe long-term institutional and social transforms.

**Cultural Formation Processes**

Schiffer defines cultural formation processes as “the processes of human behaviour that affect or transform artefacts after their initial period of use in a given activity” (Schiffer 1987: 7). Schiffer characterizes cultural formation processes based on the types of transformations applied to the material culture, within the systemic and archaeological contexts. He defines four types of cultural formation processes as: cultural deposition, reclamation, re-use and disturbance (see Figure 2-1).
Cultural Deposition:

Cultural Deposition (S→A) transforms the material culture as it is deposited from the systemic into the archaeological context. This process, as defined by Schiffer, includes discard from primary or secondary use, loss, maintenance, disposal and abandonment processes. In each of these cases material moves out of its dynamic social context into the static archaeological context (see Table 2-1).

According to Schiffer, these deposition processes can be accompanied by additional sub-processes. 'De-facto refuse', a sub-process of abandonment, involves cultural materials still usable, but left behind when an activity area is abandoned (Schiffer 1972: 160; Schiffer 1976: 33; Schiffer 1987: 89; Wheeler 2000: 11). Similarly, 'curate behaviour', where items which are still usable or repairable are removed from the abandoned area for continued use in another location (Schiffer 1972: 160; Schiffer 1987: 90). Lastly, maintenance processes exhibit unique renewal and replacement patterning in archaeological record. In the context of port-related structures, a combination of these processes will be identified at the sites assessed in this study.
Reclamation Process:

Reclamation (A→S) processes transform material from the archaeological context, back into the systemic context (Schiffer 1987). This involves deposited artefact reclamation, and in the context of structures or buildings, the re-occupation of sites (Schiffer 1987: 100). The essential aspect of this process is that the material culture has already left the systemic context through a cultural deposition process, and is then reclaimed. Sub-processes associated with reclamation, include salvage and scavenging, where materials from abandoned structures are reappropriated. Both salvage and scavenging behaviour are applicable to port-related structures, where materials from one abandoned structure are re-used for the construction or maintenance of another. Archaeological excavation is itself a reclamation process, transforming the material from an archaeological context back into a systemic context.

Re-use Process:

Re-use (S→S) processes include the transformation of material within the systemic context prior to any deposition events (Schiffer 1987: 29). 'Lateral cycling', a sub-process of re-use, involves the transference of material ownership between users without any change in the material itself. In the context of jetties and wharves this can be difficult to detect archaeologically, but is easily identified through historical documentation. Alternatively, the 'recycling' sub-process, applies to material culture that is returned to a manufacturing state whereby its initial identity is lost. Recycling is similar to the salvage process, but applies specifically to material that has not moved out of the systemic context. 'Secondary-use', a third sub-process of re-use, is where the material is employed for a secondary function without the need for extensive modification. Finally, the 'conservatory' sub-process includes material alteration, or the intentional use of specific modern materials for conservation and preservation purposes (Schiffer 1976: 40; Schiffer 1987: 32).
Disturbance Process:

Disturbance ($A \rightarrow A$) processes are associated with state changes to the material culture entirely within the archaeological context (Schiffer 1987: 121). While subject to ongoing systemic activity, the material culture does not explicitly re-enter the systemic context for this process. Post-abandonment demolition, earth moving and land reclamation activities associated with coastal development and construction are the most common disturbance processes impacting port-related structures. This is usually brought about by harbour and coastal development, or navigational hazards removal, both of which can have destructive effects on the archaeological record of port-related structures.

<table>
<thead>
<tr>
<th>Process Types</th>
<th>Processes</th>
</tr>
</thead>
</table>
| $S \rightarrow A$ processes  
(Cultural Deposition) | Abandonment                                   |
|                     | Maintenance                                    |
|                     | Discard                                        |
|                     | Loss                                           |
|                     | De facto Refuse                                |
|                     | Curate Behaviour                               |
| $A \rightarrow S$ processes  
(Reclamation Processes) | Reoccupation                                   |
|                     | Salvage                                        |
|                     | Scavenging                                     |
|                     | Archaeological Excavation                      |
| $S \rightarrow S$ processes  
(Re-use Processes) | Recycling                                      |
|                     | Lateral Cycling                                |
|                     | Secondary-use                                  |
|                     | Conservatory processes                         |
| $A \rightarrow A$ processes  
(Disturbance Processes) | Demolition                                     |
|                     | Earth moving processes                         |
|                     | Land reclamation processes                     |

Table 2-1: Cultural formation processes. (Adapted from Murphy 2003; Schiffer 1976, 1987)

Schiffer (1987: 267) explains how the investigator may not always be able to infer cultural transformations based solely on the material culture. This may be the case where insufficient experimental or ethno-archaeological data limits pattern identification. Alternatively different processes may leave very similar patterning on the archaeological record, making them difficult to differentiate. Furthermore, later processes may overlay and mask patterning from earlier processes. Given the vast number of overlapping combinations, formation processes for port-related structures can not always escape ambiguities in their application towards
correlating human behaviour with patterning evident in the archaeological record. Finally, clear principles and techniques for formation process analysis need to be sufficiently developed with each specific class of material culture. For the purposes of this study, this class of material culture would be jetties and wharves. The identification of patterning associated with cultural transformations, thus become a necessary first step in the analysis of port-related structures in South Australia.

**Process Transformations**

According to Schiffer, the link to past human behaviour is reached through a set of principles known as *correlates*. These are used to relate material and spatial phenomena to behavioural phenomena (Schiffer 1987: 5). Such correlates, when linked to established and understood *patterns* in the archaeological record, can be used to make inferences about past behaviour. This 'inferential procedure' assumes that past systemic contexts are solely responsible for the archaeological record as it is found today. Schiffer explains that this approach alone is insufficient, and mandates the inclusion of what he calls the *transformation position* (Rathje and Schiffer 1982; Schiffer 1972, 1975, 1976, 1987). He suggests that the archaeological record is a transformed and distorted view of artefacts that once participated in the systemic context. This distortion is not just a function of degradation and entropy, as described by Ascher (1968), but also the result of active cultural and non-cultural formation processes. These formation processes can introduce patterning of their own, in *addition* to the patterning from behavioural phenomena within the systemic context. Inferential procedures in site formation analysis need to first isolate the source of patterning before making inferences about behaviour. The development of patterning-behaviour correlates first requires an understanding of transformation patterning before inferences about the remaining material and spatial phenomena can be made.

The deductive nature of transformation identification, suggests that processes determined by this study would be valid at site specific, or at best, local and regional levels. Caution should be exercised in attempting to ascertain universal transformations of any kind, indeed expanding the scope of site specific
transformations to a regional perspective is also fraught with what Gibbs (2006a) calls "ambiguities". Inductive applications of inferential procedures based on these transformations would need to take these limitations into account.

Limitations to these approaches

A number of authors have taken issue with middle range theory and behavioural archaeology. Johnson (1999) questions the uniformitarian assumptions implicit in middle range theory and behavioural archaeology, where conditions in the past are assumed to be similar, or analogous, to those in the present. The validity of constructing cross-contextual (temporal and cultural) correlations is brought into question.

Hodder (1986) faults middle range theory for not sufficiently incorporating individual agency in defining the relationship between human behaviour and material culture. He argues that middle range theory fails to explain human behaviour as a product of individual intentionality, internal state and human consciousness. Hodder (1986: 12) argues that there is no "universal, cross cultural relationship between behaviour and material culture". Similarly, McGuire (1995: 166) states that although behavioural archaeology has been successful in reconstructing behaviour through material culture, it has failed to explain the human behaviour itself. Earle and Preucel (1987: 511) go on to question the site formation focus of behavioural archaeology, and its limitations of inference as detracting from the development of generalized and high level behavioural theory.

While these are convincing critiques of site formation analysis and its usual application in the pre-historic context, with port-related structures in South Australia, these limitations can be addressed by the concurrent use of historical and ethnographic sources. In the well documented and relatively recent maritime history of Australian colonization, archival sources are readily available. Also, given the cultural continuity of jetty construction and use since the mid 1800s, ethnographic explanations can assist interpretations of the material culture. Thus
the use of site formation theory, in conjunction with historical and ethnographic data may help fill in the "explanatory gaps" with this approach.

**Historical Approaches**

The archaeological study of jetties, like much of the archaeology of European colonization and settlement in Australia, exists in concurrency with a rich historical record. Muckelroy and Lyon, as cited by McCarthy (1998: 99), raise the question of redundancy in the archaeological approach within a historically documented time frame. McCarthy challenges this assertion through the application of a processual approach using archaeological and historical sources in the study of the SS *Xantho* engine. In doing so, he demonstrates the presence of parts recycling, standardization, mass production, technological innovation, and "frontier strategies" of early colonization. This is importantly achieved not simply by using archaeology to corroborate the historical record, but where possible, to challenge existing historical paradigms.

The historical approach can provide valuable background and explanations for a range of economic, social, or technological constraints within the systemic context. Site formation studies can thus link static archaeological data to the systemic context, while incorporating explanatory perspectives from the historical record. Human intentionality and explanations of human behaviour through a careful study of the historical record can prove particularly useful for the determination of ambiguous C-transforms within the archaeological record. This would mitigate the explanatory limitations of behavioural archaeology as described by Hodder and McGuire.

The careful choice of historical data is essential. Since history is usually written by only select groups in society, individual agency can be difficult to detect, even in historical form. Diaries, ledgers, and local newspaper articles generally provide better perspectives on individual agency than official government documents and construction drawings. In this sense Bullers (2006: 18) cautions against the trappings of the "spectacular or the unusual" through an over-zealous
use of historical sources. Indeed an over-reliance on the historical record may very easily bias the archaeologist's perspective.

Jeffery (1989) suggests that a combination of approaches can be useful in reframing known historical paradigms, corroborating or challenging the historical record, and shedding new light on a selectively documented past. For instance, in the face of limited archaeological data, Nash (2004) employs a synthesis of archaeological and historical sources (the National Shipwreck Database) in the identification of typical Australian-built vessels.

This study on port-related structures will similarly assess archaeological data in conjunction with ethno-historic sources. Site based observation will be used to identify patterning in the archaeological record. This will be accompanied by historical and archival research for the identification of likely cultural processes responsible for the patterning.

**Regional Approaches**

According to Richards (2006: 41-53), regional and thematic approaches in Australian maritime archaeology, have relied on database analysis using a large collection of sites. Unlike site specific formation analysis, the underlying philosophy for regional and thematic studies is not site focused - it is comparative in nature. The correlation with broad historic, economic, social and technological trends can be used to demonstrate generalized links between the archaeological and systemic contexts.

The hallmarks of [regional studies] can be seen predominantly in their generalizing potential, facilitated through their ability to synthesize large amounts of data from a sizeable number of sites, and resulting in the capability to communicate issues of national and international significance. Richards (2006: 41)

The generalized theory development possible through a regional approach draws clear parallels to middle range theory in the identification of broad institutional and social transformation processes. This approach has been demonstrated by Richards (1997; 2002) and (Foster 1987-1990), by correlating patterns within regional datasets to broad historical and regional trends.
The identification of statistical correlation does not suggest a simple or direct causal relationship. Regional formation processes are often a complex combination of many different economic, social and technological constraints. The use of large sample sizes for regional data analysis, attempts to reduce stochastic variation, and assists with the deductive approach towards pattern and behaviour correlation. In fact as sample size is reduced, the complexities of cultural variability and human intentionality undermine any attempts at testable, predictive modelling. Alternatively, the synthesis of information from regional datasets, while useful for limited site comparisons and constructing plausible process models for insufficiently documented sites, does not indicate any kind of universally applicable relationship. Indeed deductive correlations at a regional level are only valid within very specific temporal and spatial contexts (Schiffer 1987: 267). Statistical correlation should not imply a positivist expectation of cause and effect.

**Regional Correlates**

Regional approaches, as an extension of site formation analysis, require a comparative analysis of a large number of sites. This form of data synthesis focuses on generalized formation processes active on regional, national, and international scales. Specific correlations are identified between patterns in the dataset and historically defined behavioural phenomena, active across the temporal and spatial scope of the dataset. Parallels are apparent in the definition of generalized regional correlates, and site specific correlates. Where previously patterns in the archaeological context were correlated to behavioural phenomena in the systemic context, now patterns in the *datasets* can be correlated to generalized, historically identified behavioural phenomena.

A number of regional possibilities are available for this kind of study of the maritime infrastructure. Richards (2002) demonstrates such an approach in the analysis of ship abandonment behaviour in Australia, by using a combination of historical sources and database analysis techniques. The construction and use of port-related structures can similarly be correlated to historical events, periods of
economic growth, economic depression, legislative changes, and the introduction of competitive technologies.

The Maritime Cultural Landscape

The blurring of the land-sea divide, as stated by Gibbs (2006b: 69), provides for a greater range of conceptual resources within maritime archaeology. Ports, as exchange points for trade and transport mechanisms, also serve as coastal communities where inland people meet people from the coast (Westerdahl 1992). These are points of contact and transference of cultural norms. A critical theory approach towards understanding the unique cultural relationships evident between ports and the greater maritime infrastructure can be demonstrated within Westerdahl's (1992) post-processual conception of the 'Maritime Cultural Landscape'. This theoretical approach has challenged existing notions of cultural significance while providing ways to understand relationships between components of a regional maritime infrastructure. Independent parts of the cultural landscape no longer exist in isolation, but stand together as an accumulated representation of human behaviour (Vrana and Stoep 2003: 20). Furthermore, archaeological analysis while still potentially nomothetic in nature becomes more interested in the relationships between cultural components rather than the components themselves.

The early colonial demands of inter-settlement trade and shallow coastal conditions have helped develop perspectives on typical vessel types in Australia (Jeffery 1989, 1992; O'Reilly 2005; Parsons 1986). Within the context of the maritime cultural landscape, this perspective has been extended to describe the growth of Australian ship-building, in response to the lack of suitable foreign built vessels (O'Reilly 2005: 8). The symbiotic relationship between port-related structures and typical vessel types could therefore suggest a relationship between port-related structures and Australian ship-building. This would imply that port-related structures are built to suit the ships intended to service them. Similarly, ships are built and used at ports they are capable of safely and economically visiting. Within the conception of maritime cultural landscapes, these relationships between coastal conditions, typical vessel types, port-related
structures and Australian ship-building may be investigated using a regional approach. An investigation of these relationships will be attempted in Chapter Five.

Conclusions
This chapter has established a theoretical framework for the study of port-related structures in South Australia. Theoretical constructs of archaeological and systemic contexts, site formation theory, transforms, correlates, inferential procedures, and maritime cultural landscapes have been introduced. The application of site formation theory for the correlation of material and spatial phenomena in the archaeological context, with behavioural phenomena in the systemic context, has been explained. Furthermore the value of identifying formation processes, and their associative patterning, has been highlighted as a first step towards any such analysis. The use of this methodology within a regional approach has been identified as a means to further understand the maritime cultural landscape. The following chapter will explain the methodologies required for such site focused and regional studies.
Chapter 3

Researching Port-related Structures:
Methods and Sources

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. (Drew 1994: 46)
CHAPTER 3:

RESEARCHING PORT-RELATED STRUCTURES: METHODS AND SOURCES

Introduction

This chapter outlines methodologies employed in site formation and regional analysis of port-related structures in South Australia. It will explain the selection criteria used to identify jetties and wharves investigated for this research and will outline the archaeological and historical data gathering procedures used. This will be followed by an explanation of cultural transform identification for the surveyed sites. Finally, regional applications of formation theory and the identification of regional correlates using a combination of historical sources and data analysis will be described.

Selection Criteria

A site sampling strategy was determined by a number of selection criteria. The determination of cultural transforms required the study of structures with readily available archaeological remains and historical records. Given the localized nature of formation processes, sites were selected where similar or common formation processes were reasonably expected to exist. This would allow for meaningful comparisons and the application of inference procedures in cases where limited data is available.

Port-related structures built within South Australia place a regional constraint on the selection criteria. It is unclear whether formation processes identified from the selected sites will be equally applicable across this whole range, or alternatively, if they will be inapplicable beyond it. Future research may do well to identify formation processes that extend beyond these regional constraints.

Site selection was fundamentally dictated by the limitations of accessibility, cost, and time associated with a masters thesis of this scale. As such most sites were selected based on their proximity to Flinders University in Adelaide, South
Australia. This has resulted in an over representation of sites on or near the Fleurieu Peninsula.

Different formation processes are likely to be prevalent at sites that are in some form of active use, as opposed to sites that have been formally abandoned. A combination of such sites was used to identify the different transformation processes involved. Sites abandoned after a short usage period are of particular interest, as the likelihood of patterns for construction and initial use may be more apparent. Similarly, sites in current use or with a long use-life may be more likely to demonstrate patterns associated with maintenance and secondary-use processes.

The determination of transformations can ideally be used to apply inference procedures on sites where limited historical data concerning the systemic context is available. Within the region of South Australia, this would be most applicable to the earliest constructed jetty and wharf structures, where limited historical records are available. The sampling strategy thus included a selection of early sites.

In summary, the selection criteria for port-related site analysis were:

- Built in South Australia.
- Archaeological remains, for identification of material and special phenomena.
- Historical records, for identification of behavioural phenomena.
- Inactive: structures no longer in use.
- Active: structures in current use.
- Accessible sites based on cost and time constraints.
Based on these selection criteria the following ten sites were investigated (see Table 3-1 and Map 3-1)

<table>
<thead>
<tr>
<th>Port-related Structure</th>
<th>Built in SA</th>
<th>Archaeological Remains</th>
<th>Historical Records</th>
<th>Current Use</th>
<th>Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reeves Point, First Jetty (1838)</td>
<td>Yes</td>
<td>Pile stumps</td>
<td>Limited</td>
<td>Inactive</td>
<td>Limited</td>
</tr>
<tr>
<td>Reeves Point, Gully Jetty (1841)</td>
<td>Yes</td>
<td>Pile stumps</td>
<td>Limited</td>
<td>Inactive</td>
<td>Limited</td>
</tr>
<tr>
<td>Reeves Point, Quarry Jetty (1851)</td>
<td>Yes</td>
<td>Piles</td>
<td>Limited</td>
<td>Inactive</td>
<td>Limited</td>
</tr>
<tr>
<td>Port Elliot Jetty (1852)</td>
<td>Yes</td>
<td>Pile stumps and new structure</td>
<td>Heritage survey</td>
<td>Active</td>
<td>Average</td>
</tr>
<tr>
<td>Port Willunga, First Jetty (1853)</td>
<td>Yes</td>
<td>Pile stumps</td>
<td>Construction plans</td>
<td>Inactive</td>
<td>Good</td>
</tr>
<tr>
<td>Victor Harbor, Lilliputian Jetty (1854)</td>
<td>Yes</td>
<td>Complete refurbished structure</td>
<td>Secondary sources only</td>
<td>Active</td>
<td>Average</td>
</tr>
<tr>
<td>Port Lincoln Town Jetty (1857)</td>
<td>Yes</td>
<td>Complete refurbished structure</td>
<td>Construction plans</td>
<td>Active</td>
<td>Limited</td>
</tr>
<tr>
<td>Port Willunga, Second Jetty (1868)</td>
<td>Yes</td>
<td>Piles</td>
<td>Construction plans</td>
<td>Inactive</td>
<td>Good</td>
</tr>
<tr>
<td>Mount Dutton Bay Jetty (1881)</td>
<td>Yes</td>
<td>Complete refurbished structure</td>
<td>Construction plans</td>
<td>Active</td>
<td>Limited</td>
</tr>
<tr>
<td>Myponga Jetty (1896)</td>
<td>Yes</td>
<td>Piles</td>
<td>Secondary sources only</td>
<td>Inactive</td>
<td>Good</td>
</tr>
</tbody>
</table>

Table 3-1: Port-related structures surveyed and the selection criteria used
Excluded Sites

A number of other sites satisfy these selection criteria but have not been included in the survey component of this study. These are:

- Semaphore Jetty (constructed 1859)
- Brighton Jetty (1886)
- Goolwa Wharf (1852)
- Port Noarlunga: First Jetty (1855)
- Second Valley: First Jetty (1855)
- Rapid Bay: First Jetty (1865)
- Victor Harbor: Screwpile Jetty (1881)
- Normanville: Third Jetty (1866)
- Normanville: Haycock Point Jetty (1923)

The Semaphore, Brighton, Rapid Bay, and Victor Harbor (Screwpile) jetties have been surveyed recently, and were thus not included in the survey sample. In the case of the Second Valley and Brighton jetties, more recent structures have been built directly over the original structures resulting in the near complete destruction
of the archaeological context of the original jetties. In other cases, development and reconstruction have led to the inaccessibility of the original structures, as is apparent in the Goolwa wharf. Meanwhile the loss of structure from the first Port Noarlunga jetty and early Normanville jetties due to environmental processes has limited the non-disturbance survey of these structures. The obscuring of structure due to sand cover has made these jetties difficult to locate. While suitable for this study, the finding and survey of these structures, in addition to the ten already sampled, lie beyond the cost and time constraints of this thesis. Alternatively, in the case of the Haycock Point jetty near Normanville, site conditions due to surge and wave action on the day of survey proved too dangerous for participants to complete survey work. The archaeological assessments of these excluded sites may well enable future research.

Survey techniques

Observation and survey techniques involved the use of non-disturbance site surveys, as described by Green (1990) and the NAS Guidelines (NAS 1992: 118-119). The surveys included position fixing of identifiable structure, area survey measurements, and structural component measurements. Photographic records, survey measurements, and environmental observations were recorded for each site and collated into individual site plans (see Chapter 4 and Appendix 1). Survey data was combined with coastline and aerial photography data, within a GIS management system, to provide accurate geospatial representations of the remaining structures. Observations on material and spatial patterning associated with likely cultural formation processes were recorded at the time of survey.

Based on preliminary observations of the sites, archaeological remains are limited to the most structurally robust components (i.e. piling). The number and precise locations of the piles was measured, and whenever possible height and diameters recorded. For abandoned structures this approach appeared sufficient given the limited nature of the remains. For jetties and wharves in current use, however, the structures were considerably more complete. Measurements of structural components like decking, corbels, girders, and lateral bracings were also possible
in such cases. Wood samples were taken where possible for the identification of materials used in construction.

**Historical Research**

Historical research was conducted for each site using a range of archival and secondary sources. Primary archival records were sought from the Marine and Harbours Board documents and South Australian Parliamentary Papers, at the State Records. Jetty and wharves listings from Flinders Ports, formerly Ports Corp, and the Department of Transport, Energy, and Infrastructure (Transport SA), provided detailed plans and schematics for the original structures. Further photographic and documentary sources were obtained from State and local libraries. Lastly, secondary sources were employed for background information on broader social and economic factors relevant to a regional understanding of the maritime infrastructure.

**GIS**

A geographic information system (GIS) was used to incorporate a number of spatial datasets and construct spatially accurate geo-referenced maps of the jetty survey sites. The quality of these maps was substantially dependent on the quality of the feature datasets used. Feature Datasets were used from the geoserv.ssn.flinders.edu:geodata corporate SDE database provided by the DEH, and Flinders University. These feature datasets are dated from 1986.

The following feature datasets from the geoserv.ssn.flinders.edu:geodata database were rendered within ArcGIS (an ESRI product) along with the survey data:

- GEOGRAPHY.Hydrology:Surfacewater_Basins_50k
- GEOGRAPHY.Hydrology:Coastline_50k
- GEOGRAPHY.Hydrology:Watercourse_line_50k
- GEOGRAPHY.Hydrology:Waterbodies_50k
- GEOGRAPHY.Cultural:Builup_areas_50k
- GEOGRAPHY.Cultural:Cities_15m
- GEOGRAPHY.Relief:Contours_50k
- GEOGRAPHY.Transportation:Road_50k
- GEOGRAPHY.Transportation:Road_1m
Site Transformations

Site specific transformations, as defined by Schiffer (1975, 1976), can be inferred from material and spatial phenomena within the archaeological context. Cultural transformations determine how cultural systems output material into the archaeological context. Patterns associated with C-transforms thus need to be differentiated from patterns associated with behavioural phenomena within the systemic context. Schiffer's classifications of cultural deposition, re-use, reclamation and disturbance will be used to describe the C-transforms apparent at the sites surveyed.

There exists a rich historical record concerning port-related structure use and construction in South Australia. Historical sources can identify precise locations, periods of use, administrative and maintenance regimes, construction technologies, and materials used in assembly. They can also provide explanations for specific behavioural phenomena, which are useful in identifying likely cultural transforms for ambiguous patterning in the archaeological context. Alternatively, discrepancies between the archaeological context and the historical sources may also suggest the existence of undocumented processes active at a site. The cultural continuity in jetty construction and use allows for ethnographic sources to further differentiate patterning in the archaeological record. Site specific transformations can thus be inferred using a combination of direct observation, historical records, and ethnographic sources.

Regional Correlates

The application of regional site formation analysis, towards the construction and use of maritime infrastructure required the use of a regional database of jetties and wharves. A number of historical and archival sources were used to construct and cross reference the data. Three different sources were used in the construction of this database:

- 1883, The Marine Board of South Australia: List of Government Wharves and Jetties. (MBSA 1883)
• 1972, The Department of Marine and Harbours: Register of State Jetties and Wharves. (DMH 1972)

• 2000, Julie Ford: Appendix A - "The Use and Abuse of Jetties: State Government control in the construction and maintenance of jetties in South Australia" (Ford 2000)

The database includes the following data fields (see Table 3-2).

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>The name of the port-related structure</td>
</tr>
<tr>
<td>Date</td>
<td>Year first constructed</td>
</tr>
<tr>
<td>Type</td>
<td>Jetty or wharf</td>
</tr>
<tr>
<td>Length</td>
<td>Initial length of construction – metres</td>
</tr>
<tr>
<td>Depth</td>
<td>Depth at berth – metres</td>
</tr>
<tr>
<td>Modifications</td>
<td>Lengthening, shortening, reconstruction, or demolition of the structure</td>
</tr>
</tbody>
</table>

Table 3-2: Data fields for the port-related structure regional dataset.

Regional correlates were identified by linking patterns within the dataset to behavioural phenomena within the systemic context. Historical sources were used to identify broad social and behavioural phenomena where possible. Trends in jetty and wharf construction from the database above were then compared to changes in economic, social, and technological phenomena. These phenomena included economic expansion, economic depression, government control, the introduction of competitive technologies, and the regional use of vessel types.

During the course of this research, analysis of the 1883 and 1972 datasets, displayed specific patterning within jetty construction data. These patterns indicate a possible correlation with shallow drafted vessel types that were typically used in the state from the mid 1800s. As discussed earlier, the draft requirements of typical vessels play a deterministic role in the construction and viability of jetties. This was further investigated by identifying the proportion of jetties with suitable lengths and depths at berth. The regional use of shallow drafted vessels in South Australia, mostly ketches and schooners, will be correlated to these structural patterns in jetty construction data.
The analysis of jetty dimensions and the regional dataset was conducted using regression analysis on a best-fit trend line in the data. The regression analysis value range from zero to one; a higher value indicates a higher degree of correlation between the two variables (Pallant 2001). The inverse relationship identified in this analysis will be further explained in the data analysis section of Chapter Five. The SPSS (Version 12) statistical analysis package was used for clustering analysis on the dataset, to identify patterns in the data suggestive of a relationship between jetties and typical vessel type.

Further statistical data analysis showed changes in the regional datasets between 1883 and 1972. Initial statistical evaluations involved mean and median calculations for jetty length and depth. These provided a quantitative assessment of the average range of the datasets. Changes in the averages from each dataset were then assessed relative to the historical correlates.

Standard Deviation calculations would typically be used for quantifying the degree of variability in a dataset. The asymmetric nature of the jetty length and depth datasets, however, required the use of inter-quartile-range, or IQR, calculations. This value is similar to Standard Deviation, and provides an estimate of the distribution of values within the dataset from the mean jetty length and depth values. A large value implies the length and depth values are highly dispersed, while a small value implies the jetty length and depth values are tightly bunched around the mean.

Differences in medians between the 1883 and 1972 jetty construction data may suggest a change in construction and use processes for the structures. The Mann-Whitney U-Test was used to compare the statistical significance of these changes in the medians between the two datasets. The test returns a value between zero and one, where a smaller value (usually less than 0.05) indicates a more statistically significant change in the medians.
Limitations in the Methodology

Wood Samples:

Material remains for the jetty structures surveyed were primarily constructed from timber and iron fastenings. Wood samples were obtained for identification. Timber identification, however, proved inconclusive for several samples analysed, and due to the lack of suitable facilities and expertise, a detailed analysis of the materials was not possible. All remaining samples have been stored and catalogued with the Flinders University Archaeology Department, for future investigation.

GIS:

In a number of cases, discrepancies were identified between Surfacewater_Basins_50k and the Coastline_50k feature layers within the SDE database. The boundaries defined in these datasets did not always match, and the GPS position fixing established during the site surveys occasionally placed the structures significantly displaced from their expected locations.

The feature datasets from the DEH were completed in 1986, and locations of roads or coastlines no longer match in some cases. GPS accuracy averaged 5 meters for most of the surveys. However the 1:50,000 scale feature datasets, while suitable for a broad regional analysis, were not sufficient to accurately map the specific jetty sites and structures relative to the surrounding terrain. This is evident in a number of site maps where the coastline or surface-water basin boundaries appear further away from the jetty structures than would normally be expected for a structure in the inter-tidal zone (see the Victor Harbor Lilliputian Site Map in Chapter Four – Map 4-6). Vector datasets for representing roads proved inadequate for accurately representing site maps at these higher resolution maps. Future improvement in the SDE datasets from the DEH would improve site plan generation.

Data Sources:

Discrepancies exist between a number of archival sources on construction dates, dimensions, locations, and usage of certain jetty structures. Changes, variations,
and partial usage of location names in the historical documents occasionally required the correlation of construction date and length dimensions to cross-reference the data. Minor differences in structural dimensions due to conversion from units of measurements (e.g. feet to meters), were not deemed significant.

The best available sources on jetty and wharf construction data were used for the regional analysis component of the study. However inconsistencies and discrepancies between the (MBSA 1883), (DMH 1972), and (Ford 2000) datasets proved problematic. The listings of jetties and wharves differed in the kind of information available. Missing length, depth, or construction dates were the most common limitation. The resulting database is thus a minimal set of entries where a complete set of data was available. The limitations imposed by this data pruning provide clear potential for future work. A further development of archival data through the Marine Harbours Board records could increase the size and improve the quality of the regional dataset.

Conclusions

This chapter has described the archaeological approaches involved in the site formation analysis of port-related structures for the study. The sampling strategy employed for the field-work component of this study has been explained, followed by an explanation of the survey methodologies and interpretive GIS tools employed. Furthermore, the necessary steps for the development of a regional perspective towards port-related structures have been defined through the application of statistical analysis on regional datasets.

The following two chapters will present the results obtained from the application of these methodologies. Chapter Four will present the results of field-work and the assessment of site formation processes. This will allow for the identification of cultural formation process and associated patterning at the sites. The following Chapter Five will present a data analysis approach towards the development of regional correlates, and attempt to inform existing perspectives on the maritime cultural landscape of South Australia.
Chapter 4

The Archaeology of Port-related Structures: Site Formation Analysis

Wharves and jetties are the point at which cargo and people transfer from the land to the sea and from the sea to the land. It is also where people reach out to the sea to fish or to sit and contemplate. The wharves and jetties and any associated archaeological deposits are therefore strongly symbolic and embodied with considerable cultural significance. (Nutley 2006: 95)
CHAPTER 4:
THE ARCHAEOLOGY OF PORT-RELATED STRUCTURES: SITE FORMATION ANALYSIS

Introduction
The ten sites surveyed in this study were used to identify patterning associated with cultural site formation processes as defined by Schiffer (1972; 1987). Formation processes were inferred from patterning in the archaeological record; however, site specific histories have also been compiled to understand activities and events that may have helped shape the archaeological record of each site. The identification of site formation processes was thus completed in conjunction with the archaeological and historical record.

Due to the direct linkage between archaeological patterning and the identification of formation processes, it was deemed necessary to combine the results section from surveys conducted in the field with the analysis section of the site formation processes at each site. Each site was individually assessed in this fashion (see Appendix 1). This chapter will conclude by identifying the set of cultural transforms identified for the port-related structures surveyed.
Mount Dutton Bay Jetty

Mount Dutton Bay is part of the Lake Wangary Hundred proclaimed in 1871. The early period of settlement after the 1860s saw this part of the Eyre Peninsula developed primarily for pastoral use. Wool exports from the district were lightered out from a landing site at nearby Farm Beach, until plans for a jetty at Mount Dutton Bay were prepared by the Engineer in Chief’s Department in 1880 (Collins 2005: 53; SAHC 1984). Construction began the same year and by 1881 a jetty 82 metres in length provided 1.3 meter depth at low tide (SAPP 1880:29a, 1882:40). The jetty was extended in 1911-1912 to 207 metres, but only provided an additional 0.2 metres depth. Minor repairs were later carried out in 1914 to the abutments and approach to the jetty. In 1960, the jetty was completely refurbished, using timbers salvaged from the shortening work at the Louth Bay Jetty. In 1979, the jetty sustained fire damage and incurred a ‘falling incident’ which caused the Department of Marine and Harbours to block access to the structure by removing the decking from the first few bays. Despite the official abandonment, by 1983 the locals were using a makeshift walkway to access the outer sections of the jetty. Petitioning by local residents brought the issue of jetty access under review, and it was restored in 1986 (Advertiser, 20 January 1983, p. 7). Piles of jetty timbers scavenged from this refurbishment still stand on adjacent property. The jetty and the nearby Mount Dutton Bay Woolshed are today State Heritage listed.

Site description and formation processes:

The Mount Dutton Bay jetty currently stands as a functioning recreational and heritage site. The jetty extends into Mount Dutton Bay in a south-westerly direction to a depth of 2.6 metres at low tide. The broadened head of the jetty runs the last 50 metres of its 209 metre span. The structure has a two-pile per bent design for most of the span, and has three piles per bent at the head of the jetty where the width is 5.3 metres (see Figure 4-1 and Map 4-1). Each bent has diagonal bracing, double cross-heads, and cross-waling for lateral support. In comparison to the other jetties investigated along more exposed coastlines, this degree of lateral support appears significantly higher for a jetty in a protected bay and is possibly the result of primary use requirements (Figure 4-2). The use of
dolphin piles at the end of the jetty structure indicates an attempt to protect the structure from lateral forces of berthing vessels (see Figure 4-3). Although not included in the jetty extension of 1911 (DRG drawings 2237/52, 2239/52), they are present in the structure today (see Figure 4-7). The jetty was partially rebuilt and restored in 1960 when safety standards may have been more stringent than for the other mid to late 1800s constructed jetties. Unique structural patterning could be associated with cultural deposition processes.

As a functioning jetty, it has complete decking with corbel and girder components in place. Three different types of pilings are evident in its construction, namely round edged timber piles (RETP), square edged timber piles (SETP), and square edged metallic piles (SEMP). The SETPs run the initial span of the structure but do not extend up to or into the head. The RETPs, however, are the only pile type used in the head of the jetty, and also appear as sister piles in a number of earlier sections next to the SETPs (see Figure 4-4). This may suggest that the RETPs are associated with lengthening and refurbishment of the structure, whereas the SETPs are part of an earlier construction. Identifiable modification patterning could also be associated with maintenance and cultural deposition site formation processes.

The SEMPs appear along the earlier bays of the structure, and only exist as sister piles. These would most likely be part of a more recent maintenance on the structure, and could be associated with the 1986 heritage restoration. The location of the RETPs appears to always be on the outside of the SETPs whereas the SEMPs always appear on the inside. This could suggest an effort to keep the metal piles under the structure, and out of direct view, so as to preserve the heritage look of the jetty since its induction in the state heritage list. Craig Brown (Brown 2006), involved with the restoration of the nearby Mount Dutton Bay Woolshed, confirmed this intentional use of metal piles in the restoration of the jetty (see Figure 4-5). Such patterning may be associated with secondary-use and conservatory processes. Material scavenged from the 1986 restoration of the structure has been scavenged for resale, and still remains on the adjacent property (Figure 4-6).
The environmental impact from marine borers and water damage on the SETP piles appears to be greater than the RETP pile types. A longer period of exposure to the prevailing N-transform effects of microorganisms and water damage may further support an earlier construction hypothesis. Alternatively, the SETP could be a different timber type more prone to attack by marine organisms and water damage, and thus showing increased patterning from these processes. Timber analysis, pile identification, and specific pile renewal dating from the historical record may help distinguish earlier pile types from more recent modifications. This would be useful for further characterizing formation process active at the site.

**Cultural Site Formation Processes Identified:**

- Cultural Deposition: maintenance
- Reclamation Processes: salvage
- Re-use Processes: secondary-use, conservatory
Map 4-1: The Mount Dutton Bay Jetty Site - map generated in ArcGIS
Site Photographs: Mount Dutton Bay Jetty

Figure 4-1: The Mount Dutton Bay Jetty showing cross-bracing between the piles. Photo by Amer Khan 2006

Figure 4-2: Primary use of the structure, wool export. Undated photo provided by Craig Brown (2006)

Figure 4-3: Recreational secondary-use of the jetty. Dolphin piles in the distance form part of the fendering system at the head of the structure. Photo by Amer Khan 2006

Figure 4-4: Maintenance process visible in the use of sister piles. The middle pile has completely separated at the waterline. Photo by Amer Khan 2006
Figure 4-5: Conservatory processes visible in the use and placement of iron piles. Photo by Amer Khan 2006

Figure 4-6: Scavenging process visible in the resale of discarded jetty timbers. Photo by Amer Khan 2006

Figure 4-7: Construction plan drawings from the Department of Marine and Harbours drawing no: DRG 2237/52
Myponga Jetty

Myponga was settled in the early period of the state’s development and by the mid 1850s, the need for a local jetty had become apparent. The local produce of grain, wattle bark, and whiskey needed transport up to Port Adelaide for a growing inter-state and international trade. The jetty was built in 1859, by a Mr. Schroeder and took eight months to complete (SAPP 1859: 33a). Due to the rocky seabed along the Myponga coast, several construction plans were reviewed by the Engineer in Chiefs Department (Collins 2005: 177). A number of alternatives, including a log-stacked or stone-filled structure were considered. The final structure, piles and decking were built from local red gum and stood at 110 metres long by 1.8 metres wide. In 1900, the jetty was struck by a fishing boat blown into the structure during a storm destroying the last three bays of the jetty. The high cost of structural maintenance combined with the development of road and rail transportation alternatives along the Fleurieu Peninsula lead to the eventual abandonment of the jetty by the 1920s.

Site description and formation processes:

The Myponga Jetty extends out from the Fleurieu Peninsula in a north to north-easterly direction. A combination of thirty timber piles and stumps are all that appear to remain of the structure (see Map 4-2). The standing piles are about two metres in height, although in a few cases stumps are all that remain. The absence of decking suggests patterning associated with abandonment behaviour (see Figure 4-8 and Figure 4-9). Historic sources on the site confirm an abandonment phase of the structure (Collins 2005: 177).

The jetty has a three pile per bent design, instead of the simpler two piles per bent, possibly indicating a need for a broad working platform. This may also suggest that vessels were expected to be berthed anywhere along the length of the structure. Specified berthing stations at the end of the structure are otherwise typically evident as widened working platforms at the head of the jetty (see the Mount Dutton Bay and Port Lincoln Town Jetties). The width of a two bent design is often limited by the length of the lateral bracing timbers, whereas a three
Pile per bent can be built wider. No cross-heads are evident at the site, however cut marks and fastening holes in the pile timbers indicate such lateral support options were most likely used (see Figure 4-11). The outermost pile in the survey area has what appears to be a cross bracing timber attached, but this is only a 20cm portion of the component. This is positioned 0.5 metres from the seabed, low enough on the pile to be a cross-wale, but the slight upward angle to the plank would suggest it is most likely a brace. The absence of further cut marks or fastening holes lower down on the pile, indicates that no cross-waling was used. This is consistent with the original construction plans for the structure (DRG 2793/65, 2794/65).

There are a number of unusual design aspects to the structure, given the exposed nature of the coastline. The piles have been inserted vertically, instead of at the usual eight to ten degree inward camber used to provide support against lateral berthing loads and wave action. It is unclear why the piles would intentionally be oriented in this fashion, however this may be due to the rocky seabed and a limitation of the pile driving technology of the time.

Jetty piles typically have longitudinal fastenings to attach lateral bracings, cross-heads, and cross-walings to the pile. The presence of lateral fastenings on a number of piles in the structure, is thus unexpected. The existence of lateral fastenings would indicate the presence of some kind of longitudinal bracing between adjacent bents. While this is expected at the top of the pile where the corbels and girders are attached (see Figure 4-8), the presence of such fastenings lower down on the piles is not typical. This may be part of a side fendering system where vessels would tie up against the structure, or a jetty mounted breakwater. The absence of such components in the original construction plans suggests this is part of a subsequent modification or maintenance to the structure (see Figure 4-10).

The reported construction length of the structure is 110 metres, however only 60 metres of piling could be found. Further investigation using SCUBA and an air-probe may be useful in locating any remaining pile stumps.
Cultural Site Formation Processes Identified:

- Cultural Deposition: maintenance, abandonment.

Map 4-2: The Myponga Jetty Site - map generated in ArcGIS.
Site Photographs: Myponga Jetty

Figure 4-8: Fastening bolts used for attaching lateral bracing and corbels. Photo by Amer Khan 2006

Figure 4-9: Abandonment process evident in the absence of decking. Photo by Amer Khan 2006

Figure 4-10: Maintenance process evident in post construction modification using fastening bolt for longitudinal bracing between bents. Photo by Amer Khan 2006

Figure 4-11: Cut marks and fastening holes for attaching cross-heads. Photo by Amer Khan 2006
Port Elliot Jetty

Port Elliot, in Horseshoe Bay, was developed in 1852 as a possible sea port for the export of wool and wheat transported down to Goolwa, via the Murray River. The jetty was constructed in conjunction with the Pullen Island breakwater, a tramway connection from Goolwa, and the Port Elliot Government Store House (DEH 1985a). Together these would provide the necessary infrastructure for linking the river trade to sea transport along the southern coast. This location was thought to be advantageous for transport eastwards to Victoria, as the additional distance from Port Adelaide required passing through the treacherous Back Straits. Port Elliot, however, proved a difficult port to navigate due to the limited manoeuvring space between Pullen Island and vessel anchorages. The eventual rail link between Kapunda and Morgan in 1878, led to much of the river based wool and wheat exports being railed directly to Port Adelaide (Parsons 1986: 95) despite the additional distance by sea.

The jetty was constructed from local red gum, and timber taken from the old canal bridge at Port Adelaide. Construction was completed in 1852 (SAPP 1858: 23). At 30 metres in length, it provided 1.8 metres of water depth at berth. By 1861, Port Elliot had been decommissioned as a commercial port. The jetty was refurbished for recreational use in 1956.

Site description and site formation processes:

The Port Elliot jetty extends out 28 metres into Horseshoe Bay in an easterly direction. It projects out from a stone and rock embankment and is constructed from timber piles and decking. The structure appears significantly changed from photographs and descriptions of the original construction in the mid 1800s. The original structure was a straight jetty, while today it is an L-shaped cross head design suggesting a subsequent phase of significant reconstruction (see Map 4-3 and Figure 4-12). This reconstruction was most likely a part of the refurbishment work implemented in 1956. The use of timber piles during this period when concrete and steel piles were easily available, may suggest an attempt to preserve
the original appearance of the structure for heritage purposes. This type of re-use patterning could be classified as a conservatory process.

The original jetty had five piles per bent, providing a short and wide working platform; the short length of the structure being sufficient for the easily accessible depth of water available in Horseshoe Bay (see Figure 4-13). During its commercial use, the original structure had lateral bracing and cross-waling between all the piles. The existing structure has two piles per bent, and no cross-waling. Changes in the shape of the jetty, the use of fewer piles per bent, and the reduction of lateral support components, suggests a possible shift from commercial to non-commercial function (see Figure 4-14). The under capitalization of structural support i.e. lack of cross-waling and single instead of double bracing of the bents, may have proved sufficient for load requirements associated with recreational uses of the structure. The change in shape of the structures provides an increased perimeter length along the edge of the jetty, and would appear better suited for fishing and recreational re-use, instead of the straight broad platform used for commercial purposes.

While most of the piles appear to have been renewed by this secondary construction phase, two submerged pile stubs are visible under the jetty that appear to be of a different and possibly older period. Directly above these stumps, and within the structure of the jetty itself, are two corresponding pile heads that have been sawn away at the base of the decking (see Figure 4-15). This may suggest that the extant structure was built around the original piles, which have subsequently been removed or replaced. It is not certain if these pile stubs were a part of the original jetty however, as piles may have been renewed several times since original construction. Further investigations under the current jetty, using SCUBA and an air probe may be useful to identify further pile stubs associated with older construction.

**Cultural Site Formation Processes Identified:**

- Cultural Deposition: maintenance
- Re-use processes: secondary-use, conservatory
Map 4-3: The Port Elliot Jetty Site - map generated in ArcGIS
Site Photographs: Port Elliot Town Jetty

Figure 4-12: Aerial view of the Port Elliot jetty. Photo provided by Flinders University GIS SDE

Figure 4-13: The 5 pile per bent design for primary commercial use of the jetty. Mortlock Library (c. 1890)

Figure 4-14: Secondary-use (recreational) of the jetty. Note the two-pile per bent design with limited lateral bracing. Photo by Amer Khan 2006

Figure 4-15: Pile stump visible below the jetty. Note the sawn off pile head directly above it, and embedded within the structure. Photo by Amer Khan 2006
Port Lincoln Town Jetty

Port Lincoln became the primary port for access to pastoral lands on the Eyre Peninsula during the late 19th century. In 1857, the Town Jetty was the first jetty constructed on the peninsula, following a government grant of £2,000 (SAPP 1858: 23). It was built to 159 metres in length, with three metres of depth at low tide (see Map 4-4 and Figure 4-16). Prior to this, goods were lightered from ships in small dinghies to horse drawn drays and wagons waiting close inshore (Axel-Stenross Maritime Museum Display, Port Lincoln, 2006). As the port and surrounding districts developed, shipping congestions often occurred at the jetty (see Figure 4-17 and Figure 4-18). In 1859, it was lengthened to 201 metres, for a greater depth of 3.6 metres. It was again lengthened by 21 metres in 1867, and another 22 metres in 1921. With the construction of the Kirton Point Jetty in 1906, and diversion of industrial goods traffic, the Town Jetty was used mostly for passenger transport. It was closed to all commercial use in 1926 with the construction of the Brennens Jetty, and eventually shortened in 1937 to 218 metres (Collins 2005: 90).

Site description and formation processes:

The Port Lincoln Town jetty extends in a north-easterly direction from the beach front area of the Tasman Terrace. The jetty is 218 metres in length, and used primarily as a recreational structure for community swimming and fishing. The major span of the jetty is a two-pile per bent design, whereas the head of the structure is a three or more piles per bent. The decking is made from timber whereas the jetty piling is a combination of timber, steel, and concrete piles (DRG 2244/53, 2245/53, 2247/53, 2249/53). The increased use of composite concrete and steel piles demonstrates a changing construction technology with the introduction of hydraulic concrete components (see Figure 4-18). Variability in pile materials could be interpreted as modification patterning that may be associated with maintenance and cultural deposition site formation processes.
Construction and repair plans from 1963 indicate specific reinforcements to the head of the structure with longitudinal bracing and a side fendering system, in addition to regular decking and pile renewal (DRG 2250/53, 2251/53). This reinforcement of the structure, evident today as additional cross bracing and side planking, would suggest a continued investment in the valued use of the jetty. Primary commercial use typically imposes greater structural demands on a jetty, thus secondary recreational use should typically be evident as a reduction in structural investment, such as jetty shortening or reduced lateral support components (see the Port Elliot Jetty). This increased structural investment in the jetty is thus unexpected during a period of secondary recreational use, as described by the historical record (Axel Stenross Maritime Museum Display, Port Lincoln, 2006). It is unclear what cultural transformations would lead to a further material capitalization for the secondary recreational re-use of the structure.

Continued undocumented primary use, light commercial use, the introduction of stricter construction and loading standards for jetty construction, or changing environmental and coastal conditions, could be possible causes. Alternatively, since fendering systems provide protection to the jetty structure, as well as to the berthing vessels, such reinforcement may have been provided for the protection of recreational craft using the jetty, rather than the jetty itself.

**Cultural Site Formation Processes Identified:**

- Cultural Deposition: maintenance
- Re-use processes: secondary-use
Map 4-4: The Port Lincoln Town Jetty Site - map generated in ArcGIS
Site Photographs: Port Lincoln Town Jetty

Figure 4-16: Port Lincoln Town jetty. Photo by Amer Khan 2006

Figure 4-17: Use of lightering vessels due to insufficient depth at berth for larger vessels. Undated photo provided by SA State Library

Figure 4-18: The SS. *Rupara* at the Town Jetty, docking was only possible at the end of the jetty due to limited depth at berth along the side. Undated photo provided by SA State Library

Figure 4-19: Composite construction of timber and cement materials. Photo by Amer Khan 2006
Port Willunga Jetties

Port Willunga was developed in response to agricultural demands of early settlement along the Fleurieu Peninsula. During the 1850s, local farming interests and the export of wheat dictated the need for a jetty at Port Willunga. It was required for the loading of grain and wheat onto small coastal trading vessels for transport up to Port Adelaide and eventual export. The first jetty was built in 1853, but at 53 metres long it fell well short of the berthing depth requirements for suitable access by ship. At the low water mark the jetty stood 12 metres from the water's edge. A further petition for a 52 meter extension provided only 0.6 metres depth at low tide. The construction and location of the jetty were considered inadequate as even in the best of conditions, it was frequently unavailable for loading or discharging boats. A final extension to 145 metres in 1857 also proved too shallow (Manning 1988).

By 1860, Port Willunga had became the second busiest port in the colony. A new jetty was deemed necessary and a second structure called the Aldinga Jetty was built in 1868. At a length of 186 metres, the jetty provided a depth at berth of 3.6 metres at low tide. It became the primary transportation platform for wheat exports and locally mined slate for use as roofing material. With the introduction of railway links along the Fleurieu Peninsula, maritime transport of wheat proved a less economical solution (Linn 1991: 72,133). By 1915, a decline in the slate industry, due to the availability of corrugated iron as a roofing substitute, led to a further decline in the use of the local jetties. Extensive damage from storms in 1915 led to the partial and progressive abandonment of the structure (DEH 1985b; Manning 1988).

Site description and formation processes:

The two jetties at Port Willunga extend in an easterly direction from the beach of the old Port Willunga district (see Map 4-5). The first jetty, the northern most of the two, begins near the northern access ramp to the beach (see Figure 4-20). Two embedded pile stumps are visible at the base of the ramp and appear to be associated with the original jetty structure given their location relative to the
orientation of the remaining pile stumps. The easterly orientation is known from historical photographs of the structure, and is confirmed by the arrangement of the few remaining pile stumps. Abandonment of the structure is evident from the lack of any decking and standing jetty piles. Nine of these are visible just beyond the low water mark, with the possibility of further stumps covered by sand. Due to variability in coastal conditions and periodic sand movement, these jetty piles are occasionally exposed (see Figure 4-21). The jetty appears to have been a three pile per bent structure based on the arrangement of the nine piles. The length of jetty surveyed was only 13 of the extended 147 meter structure from 1857. The bay lengths between the three bents do not appear to be consistent, as the first bay is approximately 6.3 metres and the second is 6.7 metres in length. While the historical record suggests a poor quality of construction, this is difficult to determine based on a limited survey of two bays. Pile diameter variation was within 10% of a 26cm average. While only the nine piles were visible during the tri-lateration survey of the piles, an air probe search for further piles would be a useful next step in identifying the remaining pile locations. According to Marine Harbours Board documents, post demolition remains of the structure were sold to the Aldinga District Council in 1919 (DRG 2784/65). While pile stumps are visible just below the waters surface, the absence of pile remains along the major section of beach may indicate an organized attempt at pile removal. Demolition can also include pile reduction where the piles are cut down to below the seabed but not actually removed. The presence of flat pile stumps of relatively similar height may indicate organized pile reduction during the demolition process (see Figure 4-21). In the absence of further archaeological evidence or historical documentation describing the process of demolition, precise inferences of cultural transforms from archaeological patterning remains speculative.

Piles from the second jetty, known as the Aldinga Jetty, stand to the south of the first structure. A walkway cut out of the cliff face descends down to the beach directly inline with the front of the remaining jetty piles. To the south of these piles are a number of fishermen caves cut out of the cliff face. Previous survey results of the jetty structure have been published in Ash (2004). Survey attempts within the context of this study were to identify specific site formation processes
where possible. The Aldinga jetty also appears to have been a three pile per bent design, and while only a few piles from the jetty itself remain standing in this section, a significant number of piles still stand from the wedge shaped causeway constructed at the base of the structure. This extends from the jetty to the walkway at the base of the cliff and the fishermen caves. The lack of a functioning deck and the presence of standing piles provide sufficient patterning to infer abandonment processes (see Figure 4-24). Photographic evidence shows that the whole structure was not abandoned at once, but partial abandonment of the outer sections pre-empted complete abandonment.

The bay size at the base of the jetty appears to be approximately 6.6m which is consistent with the construction and maintenance plans held by the Marine Harbours Board (DRG 2780/65, 2782/65, 2788/65, 2790/65, 2791/65). The expected pattern for structural degradation of the piles due to wave action within the inter-tidal zone, and the impact of marine borers would suggest a greater degradation of piles closer to the water. This, however, is not the visible pattern, as the piles closest to the water stand taller than the piles closer to shore and on the beach itself. This could suggest a salvage or demolition clearing of the piles within the beach area, where piles were reduced or removed completely. Given the historical mention of the demolition of the structure by the army during the Second World War (Collins 2005: 176), it may be possible to correlate this kind of patterning with post abandonment demolition processes (see Figure 4-25).

First Jetty Cultural Site Formation Processes Identified:

- Cultural Deposition: abandonment
- Disturbance Process: demolition

Aldinga Jetty Cultural Site Formation Processes Identified:

- Cultural Deposition: abandonment
- Disturbance Process: demolition
Chapter 4 – The Archaeology of Port-related Structures: Site Formation Analysis

Map 4-5: The Port Willunga Jetty Sites - maps generated in ArcGIS
Site Photographs: Port Willunga First Jetty

Figure 4-20: The First jetty at Port Willunga. Undated photo from the Onkaparinga Library

Figure 4-21: Pile stumps from the First Jetty, at low tide. Pile reduction may be due to demolition of the structure. Photo by Amer Khan 2006
Site Photographs: Port Willunga Aldinga Jetty

**Figure 4-22:** Primary use would suggest concurrent commercial and recreational use of the structure. Photo from the Onkaparinga Library (c 1900)

**Figure 4-23:** Partial abandonment of the structure. Undated Photo provided by the Onkaparinga Library

**Figure 4-24:** Abandonment patterning evident in the absence of majority of structure and decking. Undated Photo provided by www.digitalprintsAustralia.com

**Figure 4-25:** Aldinga jetty piles showing pile reduction on the beach portion of the structure. Photo by Amer Khan 2006
Victor Harbor, Lilliputian Jetty (The Bluff)

The earliest port-related structure at Victor Harbor was constructed at the Bluff, near the base of Rosetta Head. This jetty was originally associated with the nearby whaling station and could only be approached by sea. In 1854, the government constructed a new structure and developed access through a connecting road. It was called the Lilliputian Jetty. The jetty and associated sea wall were repaired in 1956 (Collins 2005: 192). It is listed in the State Heritage Bluff and Whaling Station site, and is still in secondary-use by local fishermen.

Site description and formation processes:

The jetty extends from the rock embankment and sea wall at the end of the Rosetta Head road (see Map 4-6 and Figure 4-26). While called a jetty, the structure is technically a wharf, spanning a single bay at 4.6 metres long by 12.7 metres wide (see Figure 4-27). It stands on seven outer piles and is supported against the rock and timber embankment by a further four piles. While the outer piles stand vertically, the inner piles lean into the embankment at an angle of 16 degrees. The outer piles have only partial bracing and the structure has girders between the inner and outer bents. The inner bent is made of round edge timber piles (RETP) whereas the outer piles are of square edged timbers. The combination of RETPs and SETPs in the structure may be patterning associated with pile renewal and structural maintenance processes.

A number of fastenings and cut marks on the piles do not appear to be associated with any obvious bracing components, suggesting that the piles may have been salvaged from another structure (see Figure 4-28). This patterning could be an indication of salvage and recycling processes for the ongoing maintenance of the structure. The existence of horizontal support piles projecting from the rock-filled road directly below the jetty and further along the access road, may suggest a longer jetty structure previously existed which has now been shortened. This may in turn have been associated with a shift from primary to secondary use, a collapse of the structure due to cultural or environmental processes, or the
structural repairs conducted in 1956. No plans could be found for the original structure or subsequent reconstructions.

**Cultural Site Formation Processes Identified:**

- Cultural Deposition: maintenance
- Reclamation Process: salvage
- Re-use Process: secondary-use
Map 4-6: The Lilliputian Jetty Site at the Bluff, Victor Harbor - map generated in ArcGIS.
Site Photographs: Victor Harbor Lilliputian Jetty

Figure 4-26: Aerial view of the Lilliputian jetty. Photo provided by Flinders University GIS SDE

Figure 4-27: View of the Lilliputian Jetty at the Bluff, Victor Harbour. Technically the structure is a wharf. Photo by Amer Khan 2006

Figure 4-28: Fastenings not associated with existing lateral bracing, an indication previous pile use. Possible presence of salvage process. Photo by Amer Khan 2006
Reeves Point Jetties (Kingscote)

Kingscote was the earliest settlement site in South Australia and was established by the South Australian Company under the mandate of the British Government. On July 27th 1836, Duke of York anchored in Nepean Bay to help establish the first settlement site at Reeves Point, Kingscote, on Kangaroo Island. The new colony was initially controlled by the Colonial Office and a Board of Commissioners to administer land sales and emigration, under what was known as the Wakefield system (RNE 1998). At its peak, the Kingscote settlement included up to 300 people and 42 dwellings (Truscott 1983). However, the lack of fresh water, poor agricultural soil, difficulty in clearing vegetation, and the Company's eventual failure to obtain title to the land, led to the Company's withdrawal from the area. The site remained in the Company's care until it was re-zoned for pastoral use (DEP u.d.).

Three jetties are known to have been constructed at Reeves Point, from this period. The first jetty was constructed near the point in 1838. The second was built in 1840-41 at a point where a gully meets the Nepean Bay, and was called the Gully Jetty. A third, built after the departure of the South Australia Company, called the Quarry Jetty, was constructed directly east of the nearby stone quarry (Figure 4-29). A survey of the Reeves Point Settlement was conducted in 1983 by M.C. Truscott, for the Heritage Conservation Branch of the Department of Environment and Planning (Truscott 1983). The results of this work were published in the "Archaeological survey of the Reeves Point Site – Place of the South Australian Company's settlement of Kingscote, Kangaroo Island".
Site description and formation processes:

The first, and northern most of the three jetties, has only six pile stumps remaining at the edge of the waterline (see Map 4-7). These six piles are each about 25 cm in height and 10-15 cm in diameter. The precise orientation of the jetty is difficult to determine based on the piles themselves. There appear to be a number of possible arrangements that would fit the pile patterning. A two pile per bent design with the pile arrangement found at the site would suggest a bent width of 0.8 metres (see Figure 4-30). This would imply a very narrow jetty compared to the other jetties surveyed in this study. A three pile per bent design would provide a 2.0 metre bent width, but does not easily fit the pile patterning, as a complete three pile bent is not visible (see Figure 4-31 and Figure 4-32). The orientation and jetty design remain speculative, as the two piles per bent design seems to best fit the pattern, but the three pile per bent design best matches structural requirements of similar structures elsewhere. The use of an air probe to locate further piles, or historical documentation describing the jetty piling, would...
help identify the design employed. Abandonment of the structure is evident. Timbers approximately one metre in length are seen embedded in the mud a few metres out from the pile stumps. For a two pile per bent structure and 0.8 metre bent width these timbers would appear suitable as decking planks. However the timbers are round edged, and do not appear to have been cut flat, as would be expected for decking timbers. Further investigation is needed to determine if these are indeed associated with the original structure.

Only a single pile could be found associated with the Gully Jetty (see Figure 4-33). It was identified, based on its location relative to the gully located 250 metres south of the first jetty. The 1983 survey for the Department of Environment and Planning indicates the presence of two piles at this location. In 2006, only one remaining pile could be found. Dimensions of the Gully Jetty could not be determined from the single extant pile. Beyond structural abandonment, limited diagnostic patterning for the determination of cultural site formation processes could be ascertained from the remains.

From the third jetty, 32 piles were identified (see Map 4-8 and Figure 4-34). No lateral bracing or cross-heads were found, although the 1983 Department of Environment and Planning Survey (Truscott 1983) suggests such lateral support structure was still present at the time of the survey. Similar to the Myponga Jetty, the piles have been driven in vertically instead of at an angle. The piles are arranged in a 2 pile per bent design (see Figures 4-35 and 4-36), and appear less worked than timber piles typical of the other jetties studied, with the natural shape of the tree apparent in the piles. The absence of decking timbers and major structural components indicates structural abandonment (see Figure 4-35: Bent width of the Quarry Jetty. A two-pile per bent design. Photo by Amer Khan 2006). Patterning associated with jetty demolition, typically pile removal or pile reduction, however is not apparent.
First Jetty Cultural Site Formation Processes Identified:

- Cultural Deposition: abandonment

Gully Jetty Cultural Site Formation Processes Identified:

- Cultural Deposition: abandonment

Quarry Jetty Cultural Site Formation Processes Identified:

- Cultural Deposition: abandonment
Map 4-7: Reeves Point– First Jetty and Gully Jetty Sites- maps generated in ArcGIS
### Site Photographs: Reeves Point - First Jetty and Gully Jetty

| Figure 4-30: Width of a single bent based on a two-pile per bent design for the structure. Photo by Amer Khan 2006 |
| Figure 4-31: Size of the jetty bay, as the distance between piles of two adjacent bents. Photo by Amer Khan 2006 |
| Figure 4-32: Six pile stumps visible at low tide most likely associated with the First Jetty at Reeves Point. Photo by Amer Khan 2006 |
| Figure 4-33: The single pile stump found in front of the Reeves point gully, most likely associated with the Gully Jetty. Photo by Amer Khan 2006 |
Map 4-8: The Reeves Point Quarry Jetty - map generated in ArcGIS
Site Photographs: Reeves Point Quarry Jetty

Figure 4-34: The Reeves Point Quarry Jetty as seen from the nearby cliffs. Photo by Amer Khan 2006

Figure 4-35: Bent width of the Quarry Jetty. A two-pile per bent design. Photo by Amer Khan 2006

Figure 4-36: Bay size of the Quarry Jetty. Photo by Amer Khan 2006

Figure 4-37: Abandonment evident in the absence of decking timbers. Photo by Amer Khan 2006
Conclusions

This chapter has presented the results of field surveys and site formation assessments at ten jetty sites in South Australia. According to Schiffer (1988), the identification of cultural transforms is a necessary step in the site formation analysis of an archaeological resource. Since the development of correlates between behavioural phenomena and material phenomena is derived from patterning within the archaeological context, the identification of specific patterning from cultural transforms is a necessary component of site formation studies. This chapter has focused on site specific patterning for this purpose. The following chapter will employ a regional approach to identify regional correlates for port-related structures in South Australia.
Chapter 5

Regional Perspectives and the Maritime Cultural Landscape

*The future of commercial jetties seems assured, although the increasingly large tonnages of cargo ships will mean either they be extended to achieve greater depths, or existing berths be extensively dredged... the future of the state's recreational jetties, on the other hand, appears less promising.* (Collins 2005: 26)
CHAPTER 5: REGIONAL PERSPECTIVES AND THE MARITIME CULTURAL LANDSCAPE

Introduction
A combination of archaeological and historical data was used for the deduction of cultural transforms active at the sites in the previous chapter. This chapter will provide a site formation schema for explaining the arrangement of these port-related structures as found in the archaeological record. This will be followed by a regional assessment of port-related structures in South Australia. A regional dataset of jetties and wharves in the state has been used to identify periods of construction and correlate them with a range of economic, social, and technological trends. These trends, or active and passive forms of cultural constraint, as described by Richards (2002) have a generalized effect on the entire maritime infrastructure.

Site Formation Processes
Site formation analysis involves the identification of cultural transformations through the material and spatial phenomena evident within the archaeological context. Specific site formation processes are responsible for actively transforming the material culture from the systemic context to the archaeological context (i.e. cultural deposition, re-use, reclamation, and disturbance). The processes evident from the port-related sites surveys in Chapter Four are shown in Table 5-1.
### Table 5-1: Port-related sites and formation processes.

<table>
<thead>
<tr>
<th>Port-Related Structures</th>
<th>Cultural Deposition</th>
<th>Reclamation</th>
<th>Re-use</th>
<th>Disturbance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reeves Point, First Jetty (1838)</td>
<td>Abandonment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reeves Point, Gully Jetty (1841)</td>
<td>Abandonment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reeves Point, Quarry Jetty (1851)</td>
<td>Abandonment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port Elliot Jetty (1852)</td>
<td>Maintenance</td>
<td>Secondary-use, Conservatory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port Willunga, First Jetty (1853)</td>
<td>Abandonment</td>
<td></td>
<td>Demolition</td>
<td></td>
</tr>
<tr>
<td>Victor Harbor, Lilliputian Jetty (1854)</td>
<td>Maintenance, Salvage</td>
<td>Secondary-use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port Lincoln Town Jetty (1857)</td>
<td>Maintenance</td>
<td>Secondary-Use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port Willunga, Second Jetty (1868)</td>
<td>Abandonment</td>
<td></td>
<td>Demolition</td>
<td></td>
</tr>
<tr>
<td>Mount Dutton Bay Jetty (1881)</td>
<td>Maintenance</td>
<td>Salvage</td>
<td>Secondary-Use, Conservatory</td>
<td></td>
</tr>
<tr>
<td>Myponga Jetty (1896)</td>
<td>Abandonment, Maintenance</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abandonment Process:**

Patterning associated with abandonment processes is apparent in the archaeological record as a lack of specific portions of the structure. (see Port Willunga, Myponga, and Reeves Point Jetties). Jetties lacking decking, piles, or lateral bracing timbers suggest abandonment and disuse through a non-functional state of the structure. Such patterning can be due to a number of accumulated formation processes however, and as such this patterning does not rule out other forms of cultural deposition. Since precise dates of abandonment are not always available in the historical record, this correlate is largely defined by the archaeological record. Partial jetty abandonment is also apparent as outer sections of the structure are damaged and no longer used. Remaining sections may continue to remain in active use. This intermediate phase of abandonment...
appears difficult to identify archaeologically (see the Port Willunga Aldinga Jetty).

**Maintenance Process:**

Patterning associated with maintenance processes is apparent in the archaeological record as modifications to the original structure. The specifications of the original versus modified structure can be greatly assisted by historical documents, construction plans, and drawings. High variability in pile shape and dimension or changes in materials used for piles may suggest modifications subsequent to original construction. Alterations or additions of components not identified in the original construction plans can suggest transformation of the material culture by maintenance processes (see Mount Dutton Bay, Myponga, Port Elliot, Lilliputian and Port Lincoln Town Jetties).

**Demolition Process:**

Demolition processes in jetties display specific pile removal and pile reduction patterning (see Port Willunga Jetties). The absence of jetty piles in specific sections of the structure, or a uniform height of pile stumps, may indicate pile reduction. Over long periods of time, non-cultural transforms may also reduce pile remains to shortened stumps, in which case historical references to specific demolition events can assist in identifying the transformation process responsible for the patterning.

**Salvage Process:**

Patterning associated with salvage processes is evident in the reclamation of jetty piles from an abandoned structure, for the construction, maintenance, or refurbishment of another. The use of piles in the original abandoned structure usually leaves visible patterning (i.e. cut marks and fastening holes from original use). When seen in the new structure, this patterning provides indications of the pile having been reclaimed from a previous structure (see the Lilliputian Jetty). Records of pile salvage and replacement from the historical record can be useful confirmation of this correlate (see Mount Dutton Bay Jetty).
Secondary-use Process:

Secondary-use processes can display specific patterning evident as a change in material capitalization and support in the structure. Typically, commercial uses of jetties dictate higher structural requirements due to berthing and cargo loads (Agershou et al. 1983: 245). Secondary recreational or light commercial re-use would typically not require the same level of structural reinforcement and may be evident as reduced structural reinforcement (see the Port Elliot and Port Lincoln Town Jetties). Historical records, and maintenance plans can be useful in identifying the level of intended structural reinforcement for the structure. Similarly, when current recreational use of a structure, differs from its original commercial use, the historical record can be helpful in determining the secondary-use (see Mount Dutton Bay and Lilliputian Jetties).

Conservatory Process:

Patterning associated with conservatory processes is evident in attempts to preserve the heritage look of a structure for heritage or conservatory use. In jetty structures this can be identified as the discreet placement of modern construction materials during refurbishment (see Mount Dutton Bay Jetty), or the use of traditional materials in reconstruction attempts, when modern materials would be readily available (see Port Elliot Jetty). The identification of this correlate can greatly benefit from the combination of archaeological and historical data.

Site formation Schema

A number of studies have incorporated archaeological and historical data in developing cultural site formation models (Gibbs 2006a; Muckelroy 1976, 1978; O'Shea 2002; Souza 1998: 43-8). These assessments have kept the shipwreck event as the central moment of deposition with all remaining processes defined as either pre- or post-wrecking. This is most likely a result of the event focused perception prevalent in shipwreck archaeology. For port-related structures, the process schema is better suited to a use-life model (Connah 1986; Murphy 2003) that incorporates regional perspectives and ongoing interactions within the broader cultural landscape (see Figure 5-1).
Construction of Jetty or Wharf

Primary Use

Secondary-use

Maintenance

Abandonment

Demolition

Lateral Cycling

Recycling

Reoccupation

Salvage

SYSTEMIC CONTEXT

ARCHAEOLOGICAL CONTEXT

Figure 5-1: Cultural site formation model for port-related structures in South Australia.
Regional Correlates
The use of site formation theory can be extended towards a regional analysis of port-related structures in South Australia. Site formation theory relies on the correlation of archaeological patterning with behavioural phenomena. A regional approach would similarly attempt to correlate patterning between regional datasets and broad socio-economic phenomena. A range of cultural constraints can have wide-scale effects on the development of port-related structures, and indeed the entire maritime cultural landscape. The identification of such cultural constraints and their effects on the maritime infrastructure can facilitate an understanding of dependent relationships between the various components of the cultural landscape. The impact of cultural constraints such as typical vessel usage, colonial settlement, economic expansion and contraction, government control, and competitive technologies now be assessed.

Vessel Type
Anderson (in Cumming et al. 1995: 5) asserts that “The design of all the [jetties] was dictated by the type of vessel which would be using the facility with respect to draft”. The draft of the typical vessel employed would have a deterministic effect on the design of the jetty structures built. This suggests that to accommodate the draft associated with a typical vessel a longer jetty would be required in shallow water. Alternatively, in deeper water shorter jetties would suffice.

The rate of change of water depth along the coast, or slope, would determine the necessary jetty length required to achieve adequate depth. In other words, the angle formed by the hypotenuse linking the base of the jetty with the perpendicular representing its depth above the ocean floor, should vary as the tangent of depth vs. length. See Figure 5-2.
The length of a jetty is inversely proportional to the slope $\alpha$ (alpha). This relationship when plotted using the 1883 regional dataset for jetties constructed in South Australia, produces the following graph see Figure 5-3.

As expected, there is a strong correlation between slope and length of jetty as previously discussed (i.e. as slope values decrease the corresponding jetty lengths increase and vice versa). This is demonstrated by the high coefficient of determination (R-Squared value) of $R^2=0.6364$. An unexpected aspect of the data is the grouping of data points in the lower left corner of the graph. As the slope values get smaller, most of the jetty length values do not continue to increase, as would have been expected. Short jetties with smaller slope values would indicate a shallow depth at berth. Before determining what cultural constraint is responsible for the development of jetties with shallow depth at berth, it was deemed necessary to establish if this clustering was statistically significant.
Figure 5-3: 1883 Dataset: Jetty Length against Slope. [n=45 jetties]
In order to further examine the grouping of data points in the data set, four different clustering algorithms were employed: Between Group, Within Group, Nearest Neighbour, and the Ward Method (Pallant 2001). Each algorithm produced a unique set of clusters from the data. The consistency of clusters across different algorithms would confirm the existence of underlying patterns in the data itself, rather than being a product of a particular algorithm. The results of this cluster analysis are represented in the graphs in Figure 5-4.

The dendograms in the figure illustrate clustering evident within the data. The longest set of horizontal lines within each dendogram indicates the most stable cluster pattern. Amongst the four different methods used, a range of 3 to 5 major clusters are evident in the graphs. This is further represented in the accompanying cluster plots (see Figure 5-5). The major cluster of "small slope and short jetties" in the lower left quadrant of the graphs, account for between 45% and 90% of the data points, depending on the clustering solution. This suggests a strong likelihood of there being a valid cluster within the dataset.

These low slope and short length values suggest the prevalence of jetties with shallow depth at berth, based on the structural relationship explained above. The presence of limited depth at berth, when considered in conjunction with previous studies on the typical shallow drafted vessel type employed in South Australia (Bullers 2006; Coroneos 1991; Jeffery 1989, 1992; O'Reilly 2005), could suggest a correlation between jetty construction and vessel type. This relationship between vessel draft and jetty depth at berth, demonstrates Anderson's afore mentioned design statement concerning jetties and vessel draft. It may also confirm Bach's depiction of the symbiotic relationship between ports and ships (Bach 1976: 259,404).
Figure 5-4: Clustering solutions for the 1883 dataset of Jettries in South Australia.
Figure 5-5: Graphs of cluster solutions in the 1883 data for Jetties in South Australia.
Alternative explanations:

The clustering of jetty length and slope data through this analysis may be correlated to a typical Australian-built vessel type as described by O'Reilly (2005). A number of alternative explanations are also possible, and as illustrated by Schiffer (1987: 267), the compounded interactions of multiple formation processes can complicate the derivation of simple correlates. The clustering of typical jetties based on their lengths and depths is very likely a function of a range of factors that define the maritime cultural landscape of the region.

The construction of jetties would be directly impacted by the costs of building and maintaining longer structures, or the extent of the coastal environment and the presence of coastal tidal flats. Similarly, strategies for extending the use-life of "short" jetties would affect the patterning in the data. In a given context, lightering alternatives, dredging and deepening operations, limited or partial loading of vessels, may all continue to make existing jetty structures viable access points when they would otherwise require lengthening or modification. Broader effects of localized and global economics, alternate transport options, and regional political and legislative changes all impact the maritime cultural landscape. Such factors come together to define a unique economic opportunity cost for developing jetties to specific lengths and depths. Indeed it is the shared effects of this opportunity cost, on the development of port-related structures, typical vessels and Australian ship-building practices that are of interest here. The study of these relationships is what uniquely defines the maritime cultural landscape of the region.

Statistical Analysis:

Further comparisons were explored between this jetty construction data from 1883, with similar data from 1972 (see Figure 5-6). The data from 1883 shows 46 jetties in the state, whereas by 1972 there were over 80 recorded. In 1883 the maximum jetty depth was less than 8 meters, but by 1972, there were 12 jetties deeper than this, with up to a maximum depth of 12.2 meters. This introduction of deeper jetties is statistically evident as a 61% increase in the standard deviation and a 43% increase in the inter-quartile range (IQR) of berthing depth data by
1972. This introduction of deep jetties was accompanied by a reduction in shallow jetties of less than 2 meters at berth. In 1883, 39% of functioning jetties had less than 2 meters of berthing depth, whereas by 1972 this figure had dropped to 21%, suggesting that between 1883 and 1972, deeper jetties were being built and shallower jetties were being abandoned.

![Graph showing the change in berthing depth for port-related structures between 1883 and 1972.](image)

Figure 5-6: Graph showing the change in berthing depth for port-related structures between 1883 and 1972.

Furthermore, by 1972 the average depth at berth had increased 42% to 3.8 meters, while the median depth had increased by 25% to over 3 meters. The Mann-Whitney U-Test, a measure of the statistical significance of the changes in median between the two 1883 and 1972 datasets, returned a P-value of 0.029. This confirms that a statistically significant change in median depth at berth had taken place during this period.

The symbiotic relationship between ports and ships would suggest that this increase in berthing depth between 1883 and 1972 is accompanied by an increase in typical vessel draft. The technological interactions between ports and ships however are complex. Combinations of technological changes including dredging
operations, containerisation, bulk carriers, lighter aboard ships (LASH), and roll on/roll off (RoRo) vessels during this period have all affected the way in which ships and port-related structures interact. An increase in vessel draft based on an observed increase in berthing depth may be deductively reasoned from this data; however, this statistical correlation alone does not serve as conclusive evidence. Empirical research into vessel types and draft during this period of the 20th century may help shed further light on this correlate.

**Colonial Settlement**

The construction of jetties and wharves followed the expansion patterns of settlement activity (Parsons 1986: 88). Initial settlement of the state led to the need for access to coastal transportation in the absence of road and rail networks. Pastoral land use was converted to agricultural use and as new farms were established, jetties and wharves were built to service those areas. Jetty construction during the 1850s and then later in the 1880s, can be correlated to new areas in the state being opened up for settlement (see figure 5-7 up to 1890). The maritime cultural landscape thus grew in parallel to this expansion of state settlement. The jetty sites at Reeves Point mark the earliest period of settlement during the 1830s. Subsequent settlement on the Fleurieu Peninsula led to the establishment of further port-related structures at, amongst others, Port Willunga, Myponga, Victor Harbor and Port Elliot. The last area opened for settlement was the Eyre Peninsula, and while Port Lincoln had been established during the 1850s, further development only came after the 1870s (see the Mount Dutton Bay jetty).

**Economic Conditions**

Tull (1997: 1) states that shipping and trade is a direct measure of a state's prosperity. If this is the case then it would be a significant factor in the construction of port-related structures, by influencing the level of investment in the maritime infrastructure. Charting every direct and trickle-down effect of economic development or decline is beyond the scope of this thesis, however broad patterns within historical jetty and wharf construction data, periods of greater or lesser development and economic boom or bust can be evaluated. What Richards (2002: 195) calls "lag-times", the time before patterns in the construction
of port-related structures respond to changes in the economy, can be an important factor in identifying a correlation between economic transitions and jetty construction.

Early periods of economic expansion in South Australia existed from 1860 to 1873 and 1898 to 1913 and were strongly correlated with national economic trends (see Figure 5-7). These were closely tied with the boost to British trade after the opening of the Suez Canal (Thomson 1978: 142). The 1960s similarly saw an agricultural boom from 1962 to 1971. Economic decline during the 1890s and the Great Depression of the 1920s and 30s left a global impact on international and maritime trade. The construction of jetties can be seen to closely follow these trends in economic expansion and contraction in South Australia. Construction of the Aldinga Jetty in 1868, and refurbishment operations at the Mount Dutton Bay Jetty in 1911 and 1960 occurred during periods of economic growth. Similarly, jetty abandonment at Port Willunga and Myponga occurred during periods of economic depression. Commercial decommissioning of the Port Lincoln Town Jetty, for a secondary recreational use in 1926 corresponds with a global economic downturn during the 1920s. Richards (2002: 194) identifies catalytic factors like wars and gold rushes, that have precipitated broad economic changes and thus also impacted local jetty construction. While most jetties were originally located during settlement, a number of reconstructions can be associated with periods of economic growth. What is also apparent is the clear lack of new jetties during periods of economic decline. Further study may illuminate patterns in jetty extension, modification, or repair as a function of economic expansion and decline.
Government Control

According to Ford (2000: 24) state control of jetties and wharves led to a marked decline in the construction and maintenance of port-related structures. By 1914, when the state government assumed control of the state's maritime infrastructure, 80% of all jetties built in South Australia had already been constructed. A decline in new jetty and wharf construction can be seen after 1914 as state investment in the maritime infrastructure decreased. While the Marine Board of South Australia received income from the levies charged for jetty use, the Engineer in Chief's office, responsible for the actual maintenance of the structures, operated under a separate budget. Thus money needed for upkeep did not go directly to the department responsible for the work. This resulted in long delays and eventually more expensive maintenance projects on port-related structures. Ford discusses this lack of funding for ongoing maintenance, which eventually lead to the decommissioning of many commercial port-related structures. The decommissioning of these structures further reduced funding since recreational jetties did not provide any income for the state. Furthermore, the consolidation of the state's maritime infrastructure led to a budgetary focus on the largest and most competitive ports in the state, leaving insufficient resources for smaller ports. The
lack of funding in local councils further ensured that major repairs on these structures were left to the already inadequate state apparatus (Ford 2000: 46). The divestment of the government's ownership in the maritime infrastructure of the state coupled with a changing legislative environment has greatly impacted the continued use of ports in South Australia and the broader maritime cultural landscape of the region.

**Competitive Technologies**

The introduction of alternative forms of transport, notably roads, railways networks, and later air traffic, has greatly impacted the use of the maritime industry. Innovations in telegraph, radio, and pipeline technologies have also taken their toll (Clark 1981: 29). The increase in total railway mileage from 800 miles in 1870 to 13,500 miles by the turn of the century reduced the need for maritime transport. This can most notably be seen in the impact on the construction of new ports and related structures at the end of the 19th century, when the Adelaide to Brisbane line was established in 1888 and the Trans Pacific Railway in 1917 (see Figure 5-8). The competitive use of railways precipitated a decline in maritime transport, thus reducing the construction of port-related structures (Clark 1981: 46; Parsons 1986: 227). By the 1920s, paved road access was also beginning to have an impact. The introduction and use of competitive transportation technologies can be seen as having a major impact on the maritime cultural landscape of South Australia.

![Figure 5-8: The Trans-Australian Railway (c. 1953). National Archives](image)
Conclusions

The regional analysis of port-related structure datasets, as described in this chapter, has attempted to identify and explain correlations with economic, social, and technological trends. While such factors do appear to impact the development of port-related structures, they are expected to demonstrate visible effects on a wide range of material culture. This has already been demonstrated in ship abandonment, where Richards (2002) identifies similar cultural constraints and their effects on vessel use. Relationships between the various components of the maritime cultural landscape can in turn be compared through the application of this approach with other components of the maritime infrastructure.
Chapter 6

Conclusions

A jetty was not just made of timber, steel and cement, but of all the hopes and dreams of the community it serviced (Ford 2000: 167).
CHAPTER 6: CONCLUSIONS

Introduction
This chapter will discuss the implications of this thesis in light of the aims and objectives introduced in Chapter one. It will comment on the identification of site formation processes as an empirical first step towards understanding the archaeological resource of port-related structures. It will also assess the implications of a regional analysis of these structures by identifying regional correlates. Additionally, the symbiotic relationship between port-related structures and vessel type will be summed up within the context of the maritime cultural landscape. Finally, the value of researching port-related structures within the field of maritime archaeology will be considered. Research potential and future directions for the archaeological study of port-related structures will also be considered.

Future Research Potential
The identification of regional correlates and patterning associated with site formation processes in port-related structures enables the application of inferential procedures at sites for which insufficient ethnographic or historical data is available. Future studies in this capacity should however take note of the temporal and spatial limitations of the inductive application of such inferential procedures. Correlations between behavioural phenomena and material and spatial phenomena are not universally applicable, but exist within the scope of the datasets used. Future studies on regional or national levels may be useful in identifying the precise range and applicability of the regional correlates identified in this thesis.

Further ambiguities in the inference of correlates and transformations may be addressed by future research. For example, the identification of wood sampling of timber components in port-related structures may help identify the provenance of various components of the structures, and provide indications of original construction, subsequent modification, or material salvage. Regional correlations
with construction could be further developed through archival sources for maintenance, decommissioning, and abandonment.

Future applications of "criteria modelling" through GIS could further qualify relationships between the components of the maritime cultural landscape. The location, size, design, and accessibility of port-related structures are expected to correlate with many aspects of the maritime cultural landscape. While material culture can alter the cultural environment, as in trade, transport or settlement activity, it is conversely, just as much affected by it. The multitude of relationships within the maritime cultural landscape may thus be well suited to criteria modelling analysis.

**Discussion and Conclusion**

The study of port-related structures can serve as an integral part of maritime archaeology within contemporary theoretical approaches. The value of port-related structures as an archaeological resource has been explored internationally, but has yet to be fully realized within the context of Australian approaches. This thesis is an attempt to demonstrate the utility of port-related structures as an avenue for anthropological inquiry.

The survey of the ten jetty structures within the context of the field-work component of this study provides a documentary record of the current state of these structures. It is hoped these will become part of a growing documentary and archival record of the existing remains of these structures. The focus on the structural aspects of the jetties and wharves, and the precise mapping of fixed pile components of the structures, is in contrast to the majority of "jetty" studies that have focused on the artefact dispersions instead of the structures themselves.

In most cases, a primarily heritage management and significance assessment approach has been used in the investigation of these structures in Australia. Critical theory approaches would appear to have significant potential, and the identification of formation processes will be a necessary first step in the nomothetic analysis of these structures. Furthermore, the reliability of inferences concerning behavioural phenomena from the archaeological record will benefit
from a combination of archaeological and historical research. Additionally, the application of inferential procedures may prove useful in new sites where sufficient historical or archival information is not available.

Regional assessments of port-related structures, when combined with similar studies of other components of the maritime infrastructure can help develop an understanding of the relationships between components of the maritime cultural landscape. Regional correlates can be used to compare and contrast these relationships. This fundamentally suggests that while the type of material culture studied may vary, the effect of historical and behavioural phenomena is broadly evident across many forms of material culture. A combination of such analysis may, in the future, be synthesized to formulate a relationship model for the maritime cultural landscape.

The identification of regional correlates as they apply to port-related structures stands as a useful point of reference within Australian approaches. Existing studies on ship abandonment have demonstrated similar correlations (Richards 2002). The shared impact of social, economic, and technological factors on different aspects of the maritime infrastructure can facilitate the identification of relationships within the maritime cultural landscape. Parallel patterning within two such datasets supports intuitive assumptions of such relationships. Further analysis conducted on the results for port-related structures have validated them as statistically significant. Such analysis of regional datasets has implications for further site specific and comparative approaches towards the study of port-related structures and the broader maritime infrastructure.

The development of a theoretical structure model for jetties, by correlating slope with jetty length has revealed how typical jetty dimensions can be affected by the techno-economic and environmental context of a region. The discovery of a predominant form of short length jetties with shallow water at berth suggests shallow drafted vessels were the predominant vessel type in use. This appears consistent with a number of independent sources on the development of the coastal trade in South Australia and provides further archaeological confirmation
of the symbiotic relationship between ports and ships, as defined by Bach (1976: 256, 404).

Given the established research on Australian-built craft and the development of coastal trading fleets in South Australia, this research may further provide confirmation for historical trends in Australian ship-building. The adaptation of Australian ship-building in response to local environmental and cultural conditions led to the development of shallow drafted vessels for use within extensive tidal flats and river systems. The co-adaptation of port-related structures as jetties with shallow yet sufficient depth at berth for such vessels would suggest that jetties were built just long enough to be deep enough to adequately serve their maritime transport roles. Coastal access would appear to have been a shared dilemma for both shipwrights and port engineers, with solutions eventually derived from both groups. As vessel hulls grew shallower, jetties grew longer up to the point where they both met and a coastal access solution was reached. Given this relationship, the archaeological record of port-related structures would appear to be an important resource for the study of the maritime cultural landscape.

The time and money already invested in the archaeological assessment of the shipwreck resource has so far resulted in the examination of only 14 Australian-built vessels since Jeffery’s (1989) attempt at identifying a regional vessel type in South Australia (Bullers 2006: 85). There are however almost 2786 Australian-built vessels wrecked according to the National Shipwreck Database, of which only 257 have been found and most of these still await survey (Nash 2004: 95). This would suggest that shipwreck investigations, while central to maritime archaeological traditions in Australia, remain a difficult and expensive way to study past maritime activity.

Port-related structures provide an alternative archaeological resource that may be well suited to answer the same anthropological questions being asked of shipwrecks. Port-related structures benefit from convenient access and lower costs of investigation. As standing structures within the inter-tidal zone they may
not always require the extensive use of complicated underwater diving equipment. Simple terrestrial survey methods can suffice. Additionally, as fixed structures, in known locations, they are easier to find and study than submerged shipwrecks. Finally, as part of the government administered maritime infrastructure their construction, repair, and modification is usually well documented.

Given their proximity to coastal communities and coastal navigation routes however, port-related structures come under continued threat of urban development. Abandoned jetties and wharves are routinely treated as navigation hazards and removed. Port-related structures from the earliest periods of settlement are a limited and threatened archaeological resource, adding urgency and incentive for their study. However, while important from a heritage and conservation perspective, their value in the development of critical theory should not be overlooked.

In light of these considerations, this thesis will once again assert, that the study of port-related structures should be considered as a valid alternative and addition to Australian approaches in maritime archaeology.
Appendix 1

Survey Data
APPENDIX 1

SURVEY DATA

Mount Dutton Bay Jetty Survey

Date of Inspection: 14-02-2006
Personnel: Amer Khan, Ian Moffat, Peta Knott, James Hunter

Approximate Location: North Coast of Mount Dutton Bay and approximately 45 kilometres West of Port Lincoln on the Eyre Peninsula.

Northing: 6178776
Easting: 0539703
Projected Coordinate System: GDA 1994 MGA Zone 53
Latitude: 34° 31' 54.98" S
Longitude: 135° 25' 57.51" E

Sailing Directions: Sail 7 miles in a south easterly direction from Coffin Bay, at the entrance to Mount Dutton Bay head north for 4 miles.

Site Conditions: minimal swell and current, visibility 4 metres.
Flora and Fauna: Colonizing flora and fauna. The piles are home to several species of sponges, crabs, and seaweed will require further investigation for precise identification.
Site Photographs: Digital. Archived with the Flinders University Maritime Archaeology Lab.
Wood Samples: None

No. of Piles surveyed: 97
Jetty Length: 202 metres.
Jetty Type: Straight
Bent Type: 2 piles per bent on approach. 3 piles per bent on head. A few sister piles.
Bent Width: 3.0 metres at base. 5.3 metres at head.
Bay Length: 6 metres between bents on approach. 4.5 metres on head.

GIS Data:
Mt_Dutton_Bay_Jetty_Survey shapefile.
Feature Datasets provided by the SDE database at Flinders University.
Position Fixing:

GPS Model: Garmin 72  
Datum: WGS 84 - (UTM Zone 53H)

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Model: Sokkia SET5F  
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**Myponga Jetty Survey**

**Date of Inspection:** 12-05-2006  
**Personnel:** Amer Khan, Nazia Khan, Russel Wallace

**Approximate Location:** On the Fleurieu Peninsula coast, approximately 55 kilometres south of Adelaide.

**Northing:** 6082506  
**Easting:** 0262344  
**Projected Coordinate System:** GDA 1994 MGA Zone 54  
**Latitude:** 35° 22’ 20.30” S  
**Longitude:** 138° 23’ 1.59” E

**Sailing Directions:** Sail south from old Port Willunga on the East Coast of the Gulf of St. Vincent for 8 nautical miles.

**Site Conditions:** low tide and dry conditions.  
**Flora and Fauna:** Rocky tidal area with very little floral and faunal colonization. Piles show signs of splitting from water and sun damage, and minor Toredo worm activity.  
**Site Photographs:** Digital. Archived with the Flinders University Maritime Archaeology Lab.  
**Wood Samples:** 3 samples taken from piles and bracing. Wood identification results proved inconclusive and are awaiting further analysis.

**No. of Piles surveyed:** 30 piles and stumps.  
**Jetty Length:** 61 metres based on the existing pile remains.  
**Jetty Type:** Straight  
**Bent Type:** 3 piles per bent.  
**Bent Width:** 4.6 metres  
**Bay Length:** 6.2 metres between bents.

**GIS Data:**  
Myponga_Jetty_Survey shapefile.  
Feature Datasets provided by the SDE database at Flinders University.
**Position Fixing:**

GPS Model: Garmin 72  
Datum: WGS 84 – (UTM Zone 54H)

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**Wood Samples:**

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**Site Survey:**

Survey Type: Total Station Survey  
Model: Sokkia SET5F  
Hi = 1.615 m  
Hp = 2.140 m

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Port Elliot Survey

Date of Inspection: 19-02-2006
Personnel: Peta Knott, Brandi Lockhart, Amer Khan

Approximate Location: On the south coast of Fleurieu Peninsula, approximately 70 kilometres south of Adelaide.

Northing: 6065130
Easting: 0290042
Projected Coordinate System: GDA 1994 MGA Zone 54
Latitude: 35° 32’ 6.91” S
Longitude: 138° 41’ 2.96” E

Sailing Directions: Sail East from Cape Jervis following the southern coast of the Fleurieu Peninsula for 35 nautical miles.

Site Conditions: minor swell, 5 meter visibility.
Flora and Fauna: Rocky tidal area with sandy bottom under the jetty. Minor seaweed colonization under the jetty.
Site Photographs: Digital. Archived with the Flinders University Maritime Archaeology Lab.
Wood Samples: none.

No. of Piles surveyed: 24 piles and stumps.
Jetty Length: 28 metres from base, and 10 metres of causeway.
Jetty Type: L-shaped cross head.
Bent Type: 2 piles per bent.
Bent Width: 3.5 metres and 9.5 metres at the cross.
Bay Length: 4.5 to 5.5 metres.

GIS Data:
Port_Elliot_Jetty_Survey shapefile.
Feature Datasets provided by the SDE database at Flinders University.
Position Fixing:

GPS Model: Garmin 72  
Datum: WGS 84 – (UTM Zone 54H)

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Site Survey:

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Model: Sokkia SET5F  
Hi = 1.550 m  
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<td>169:40:25</td>
<td>1:52:24</td>
<td>R1 point rock</td>
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<td>290060</td>
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<td>32</td>
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<td>9:51:07</td>
<td>R2 cracked rock</td>
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<td>R3 near fence rock</td>
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<td>Backsite check</td>
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Port Lincoln Town Jetty Survey

Date of Inspection: 14-02-2006  
Personnel: Amer Khan, Jun Kimura

Approximate Location: Port Lincoln is near the South East corner of the Eyre Peninsula. The jetty is off the main beach front of the city, near the intersection of Tasman Terrace and Adelaide Place.

Northing: 6157734  
Easting: 0578557  
Projected Coordinate System: GDA 1994 MGA Zone 53  
Latitude: 34° 43' 9.99" S  
Longitude: 135° 51' 19.247" E

Sailing Directions: From Port Adelaide sail South West crossing the Gulf of St. Vincent. At the tip of the Yorke Peninsula head North-West, crossing the Spencer Gulf to reach Port Lincoln. The total distance is approximately 150 nautical miles.

Site Conditions: minor swell, windy conditions.  
Flora and Fauna: sandy bottom under the jetty, with little to no seaweed present. Some limited sponge growth on the piles.  
Site Photographs: Digital. Archived with the Flinders University Maritime Archaeology Lab.  
Wood Samples: none.

No. of Piles surveyed: only 18 perimeter piles surveyed due to limited time on site.  
Jetty Length: 218 metres, 84 metres of which is the head of the structure.  
Jetty Type: Straight  
Bent Type: 2 piles per bent for the approach, and 3 piles per bent for the head.  
Bent Width: 3 metres on the approach and 5.5 metres at the head.  
Bay Length: 6.5 metres on the approach. This was not measured for the head of the jetty due to limited time on site.

GIS Data:  
Port_Lincoln_Town_Jetty_Survey shapefile.  
Feature Datasets provided by the SDE database at Flinders University.
Position Fixing:

GPS Model: Garmin 72  
Datum: WGS 84 - (UTM Zone 53H)

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Site Survey:

Survey Type: Total Station Survey  
Model: Sokkia SET5F  
Hi = 1.590 m  
Hp = 2.190 m

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<th>VA angles</th>
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Port Willunga First Jetty Survey

Date of Inspection: 05-03-2006  
Personnel: David Kalinowski, Brandi Lockhart, Karson Winslow, Diana Zwart, Brian Williams, Mark Opdyke

Approximate Location: On the coast of the Fleurieu Peninsula 40 kilometres south of Adelaide.

Northing: 6095295  
Easting: 0269000  
Projected Coordinate System: GDA 1994 MGA Zone 54  
Latitude: 35° 15' 31.85" S  
Longitude: 138° 27' 38.86" E

Sailing Directions: From the Glenelg Jetty sail south along the Gulf of St. Vincent for 17 nautical miles.

Site Conditions: minor swell, calm conditions.  
Flora and Fauna: sandy beach front, with little to no seaweed colonization.  
Site Photographs: Digital. Archived with the Flinders University Maritime Archaeology Lab.  
Wood Samples: 1 sample taken.

No. of Piles surveyed: 9 piles surveyed.  
Jetty Length: 13 metre section of jetty surveyed.  
Jetty Type: Straight  
Bent Type: 3 piles per bent.  
Bent Width: 4.5 metres  
Bay Length: 6.3 and 6.7 metres

GIS Data:  
Port_Willunga_First_Jetty_Survey shapefile.  
Feature Datasets provided by the SDE database at Flinders University.
Position Fixing:

Model: Garmin 72  
Datum: WGS 84 - (UTM Zone 54H)

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<th>Satellites</th>
<th>Time</th>
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Structural Measurements:

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Site Survey:

Survey Type: Trilateration Survey

Tri-lateration Survey Results:

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Pile Locations:

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Port Willunga Second (Aldinga) Jetty Survey

Date of Inspection: 13-03-2006
Personnel: Amer Khan, Nazia Khan, Russel Wallace, Kathy Wallace

Approximate Location: On the coast of the Fleurieu Peninsula 40 kilometres south of Adelaide.

Northing: 6094952
Easting: 0268885
Projected Coordinate System: GDA 1994 MGA Zone 54
Latitude: 35° 15' 42.88" S
Longitude: 138° 27' 33.97" E

Sailing Directions: From the Glenelg Jetty sail south along the Gulf of St. Vincent for 17 nautical miles.

Site Conditions: minor swell, south westerly winds.
Flora and Fauna: sandy beach front, with little to no seaweed colonization.
Site Photographs: Digital. Archived with the Flinders University Maritime Archaeology Lab.
Wood Samples: 2 samples taken.

No. of Piles surveyed: 34 piles surveyed including piles from the causeway
Jetty Length: A single bay length of 4.6 metres from the end of the causeway was measured. The remaining 17.5 metres of structure measured appear to be associated with the causeway. Further remains may exist below the sand cover.
Jetty Type: Straight
Bent Type: 3 piles per bent.
Bent Width: 5.0 metres.
Bay Length: 4.6 meters

GIS Data:

Port_Willunga_Aldinga_Jetty_Survey shapefile.
Feature Datasets provided by the SDE database at Flinders University.
Position Fixing:

**Model:** Garmin 72  
**Datum:** WGS 84 - (UTM Zone 54H)

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<th>Time</th>
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Site Survey:

**Survey Type:** Total Station Survey  
**Model:** Sokkia SET5F  
**Hi** = 1,618 m  
**Hp** = 2,100 m

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<th>VA angles</th>
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Lilliputian Jetty Survey

Date of Inspection: 19-02-2006
Personnel: Brandi Lockhart, Amer Khan

Approximate Location: Near Rosetta Head, at the south western tip of Victor Harbor. At the end of the access road for the Bluff.

Northing: 6059035
Easting: 0282972
Projected Coordinate System: GDA 1994 MGA Zone 54
Latitude: 35° 35' 19.10" S
Longitude: 138° 36' 16.56" E

Sailing Directions: Sail East from Cape Jervis following the southern coast of the Fleurieu Peninsula for 30 nautical miles.

Site Conditions: minor swell, southerly winds.
Flora and Fauna: rocky seabed with sponge and seaweed colonization under the structure.
Site Photographs: Digital. Archived with the Flinders University Maritime Archaeology Lab.
Wood Samples: none.

No. of Piles surveyed: 10 piles were surveyed including timbers embedded in the access road.
Jetty Length: A single bay length of 4.6 metres from the end of the causeway was measured. Most of the remaining structure appears to be associated with the causeway.
Jetty Type: Straight
Bent Type: 3 piles per bent.
Bent Width: 5.0 metres.
Bay Length: 4.6 meters

GIS Data:
Victor_Harbor_Lillyputian_Jetty_Survey shapefile.
Feature Datasets provided by the SDE database at Flinders University.
Position Fixing:

**GPS Model:** Garmin 72  
**Datum:** WGS 84 - (UTM Zone 54H)

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Site Survey:

**Survey Type:** Total Station Survey  
**Model:** Sokkia SET5F  
**Hi** = 1.502m  
**Hp** = 2.170m

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Reeves Point First Jetty Survey

Date of Inspection: 06-05-2006
Personnel: Amer Khan and Nazia Khan

Approximate Location: Approximately 0.25 kilometre south of the point at Reeves Point, near Kingscote, Kangaroo Island.

Northing: 6052614
Easting: 739160
Projected Coordinate System: GDA 1994 MGA Zone 53
Latitude: 35° 38' 28.93" S
Longitude: 137° 38' 23.55" E

Sailing Directions: Sail West from Cape Jervis for 22 nautical miles to the western coast of Nepean Bay. The jetty site is 0.25 kilometre south of Reeves Point.

Site Conditions: cloudy, easterly winds, low tide.
Flora and Fauna: Rock and pebble beach largely covered in seaweed, with some coastal shrub.
Site Photographs: Digital. Archived with the Flinders University Maritime Archaeology Lab.
Wood Samples: 1 sample taken.

No. of Piles surveyed: 6 piles were surveyed, including nearby embedded timbers that may be associated with the structure.
Jetty Length: For the 2 pile per bent design the length of remaining structure would be 5 metres. For the 3 pile per bent design the length of remaining structure would be 7 metres.
Jetty Type: Unknown
Bent Type: Unknown, possibly 2 or 3 piles per bent.
Bent Width: Unknown. Based on survey measurements and pile orientation a 0.8 metre bent width for 2 piles per bent or 2.0 metres for a 3 pile per bent configuration.
Bay Length: Unknown. Approximately 2.5 to 2.6 metres for either configuration.

GIS Data:
Reeves_Point_First_Jetty_Survey shapefile.
Feature Datasets provided by the SDE database at Flinders University.
### Position Fixing:

**GPS Model:** Garmin 72  
**Datum:** WGS 84 - (UTM Zone 53H)

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### Site Survey:

**Survey Type:** Total Station Survey  
**Model:** Sokkia SET5F  
**Hi** = 1.620 m  
**Hp** = 2.135 m

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<th>VA angles</th>
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Reeves Point Second (Gully) Jetty Survey

Date of Inspection: 06-05-2006
Personnel: Amer Khan and Nazia Khan

Approximate Location: 0.5 kilometres south of the point at Reeves Point, near Kingscote, Kangaroo Island.

Northing: 6052360
Easting: 0739162
Projected Coordinate System: GDA 1994 MGA Zone 53
Latitude: 35° 38' 37.17" S
Longitude: 137° 38' 29.24" E

Sailing Directions: Sail West from Cape Jervis for 22 nautical miles to the western coast of Nepean Bay. The jetty site is 0.5 kilometres south of Reeves Point.

Site Conditions: cloudy, easterly winds, low tide.
Flora and Fauna: Rock and pebble beach largely covered in seaweed, with some coastal shrub.
Site Photographs: Digital. Archived with the Flinders University Maritime Archaeology Lab.
Wood Samples: 1 sample taken.

No. of Piles surveyed: 1 pile found at low tide.
Jetty Length: Unknown.
Jetty Type: Unknown.
Bent Type: Unknown. Could not determine from a single pile.

GIS Data:
Reeves_Point_Gully_Jetty_Survey shapefile.
Feature Datasets provided by the SDE database at Flinders University.
Position Fixing:

**GPS Model:** Garmin 72  
**Datum:** WGS 84 - (UTM Zone 53H)

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<th>Accuracy</th>
<th>Satellites</th>
<th>Time</th>
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<td>8</td>
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<tr>
<td>3. BS2 (Sign)</td>
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Structural Measurements:

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Site Survey:

**Survey Type:** Total Station Survey  
**Model:** Sokkia SET5F  
**Hi** = 1.620 m  
**Hp** = 2.135 m

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Reeves Point Third (Quarry) Jetty Survey

Date of Inspection: 07-05-2006
Personnel: Amer Khan and Nazia Khan

Approximate Location: 0.8 kilometres south of the point at Reeves Point, near Kingscote, Kangaroo Island.

Northing: 6052089
Easting: 0739242
Projected Coordinate System: GDA 1994 MGA Zone 53
Latitude: 35° 38' 45.88" S
Longitude: 137° 38' 32.71" E

Sailing Directions: Sail West from Cape Jervis for 22 nautical miles to the western coast of Nepean Bay. The jetty site is 0.4 nautical miles south of Reeves Point.

Site Conditions: cloudy, easterly winds, low tide.
Flora and Fauna: Rock and pebble beach largely covered in seaweed, with some coastal shrub.
Site Photographs: Digital. Archived with the Flinders University Maritime Archaeology Lab.
Wood Samples: 3 samples taken.

No. of Piles surveyed: 32 piles and stumps found.
Jetty Length: 51 metres of the original structure were surveyed.
Jetty Type: Straight.
Bent Type: 2 piles per bent.
Bent Width: 1.25 metres.
Bay Length: 3.0 metres.

GIS Data: Reeves_Point_Quarry_Jetty_Survey shapefile.
Feature Datasets provided by the SDE database at Flinders University.
Position Fixing:

GPS Model: Garmin 72  
Datum: WGS 84 - (UTM Zone 53H)

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<th>Accuracy</th>
<th>Satellites</th>
<th>Time</th>
</tr>
</thead>
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<td>2. Pile 7</td>
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<tr>
<td>3. Control Point</td>
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<td>0739154</td>
<td>4.5</td>
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<td>4.4</td>
<td>8</td>
<td>Day before</td>
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*Backsite was the CP used for the Jetty 1+2 survey the day before.

Structural Measurements:

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Site Survey:

Survey Type: Total Station Survey
Model: Sokkia SET5F
Hi = 1.533 m
Hp = 2.125 m

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Appendix 2

Regional Datasets for Port-related Structures in South Australia.
APPENDIX 2

REGIONAL DATASETS FOR PORT-RELATED STRUCTURES IN SOUTH AUSTRALIA.

1883 Jetty and Wharf Data

Sourced from
- 1883, The Marine Board of South Australia: List of Government Wharves and Jetties. (MBSA 1883)

<table>
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<th>Depth (m)</th>
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## 1972 Jetty and Wharf Data

Sourced from: 1972, The Department of Marine and Harbours: Register of State Jetties and Wharves. (DMH 1972)

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<td>jetty</td>
<td>123.44</td>
<td>2.74</td>
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<tr>
<td>Port Pirie berth 9 (B.H.A.S.)</td>
<td>1965</td>
<td>jetty</td>
<td>141.73</td>
<td>3.05</td>
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<tr>
<td>Port Pirie berth 10 (B.H.A.S.)</td>
<td>1965</td>
<td>jetty</td>
<td>45.72</td>
<td>4.27</td>
<td></td>
</tr>
<tr>
<td>Port Pirie berth 11 (acid berth)</td>
<td>1958</td>
<td>jetty</td>
<td>584.61</td>
<td>2.74</td>
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<tr>
<td>Price Port</td>
<td>1882</td>
<td>wharf</td>
<td>307.85</td>
<td>2.13</td>
<td>extended 1886, 1905, 1926</td>
</tr>
<tr>
<td>Rapid Bay (BHP)</td>
<td>1941</td>
<td>jetty</td>
<td>381.00</td>
<td>2.44</td>
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<tr>
<td>Robe (new)</td>
<td>1950</td>
<td>jetty</td>
<td>206.04</td>
<td>6.86</td>
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<tr>
<td>Second Valley</td>
<td>1871</td>
<td>jetty</td>
<td>333.76</td>
<td>3.20</td>
<td>extension 1873. shortened 1953</td>
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<tr>
<td>Semaphore</td>
<td>1859</td>
<td>jetty</td>
<td>374.60</td>
<td>8.23</td>
<td>extension 1873. shortened 1966</td>
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<td>Stansbury (new)</td>
<td>1905</td>
<td>jetty</td>
<td>114.30</td>
<td>1.52</td>
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<tr>
<td>Smoky Bay (Promenade Only)</td>
<td>1912</td>
<td>jetty</td>
<td>352.04</td>
<td>5.18</td>
<td></td>
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<tr>
<td>Stanvac (PRA)</td>
<td>na</td>
<td>jetty</td>
<td>128.02</td>
<td>2.74</td>
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## Appendix 2: Regional Datasets for Port-related Structures in South Australia

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Type</th>
<th>Length (m)</th>
<th>Depth (m)</th>
<th>Modifications</th>
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<tbody>
<tr>
<td>South End (Rivoli Bay)</td>
<td>1958</td>
<td>jetty</td>
<td>274.32</td>
<td>3.96</td>
<td>extended 1968</td>
</tr>
<tr>
<td>Stenhouse Bay</td>
<td>1916</td>
<td>jetty</td>
<td>92.05</td>
<td>4.57</td>
<td>extension 1932</td>
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<td>Streaky Bay</td>
<td>1892</td>
<td>jetty</td>
<td>347.47</td>
<td>3.96</td>
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<td>Thevenard</td>
<td>1920</td>
<td>jetty</td>
<td>79.25</td>
<td>0.91</td>
<td>approach widened 1929. lengthened 1965. rebuilt 1972</td>
</tr>
<tr>
<td>Tumby Bay (old)</td>
<td>1874</td>
<td>jetty</td>
<td>406.91</td>
<td>na</td>
<td>extension 1876, 1898, 1905. shortened 1956</td>
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<tr>
<td>Tumby Bay (new)</td>
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<td>jetty</td>
<td>866.85</td>
<td>7.32</td>
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<td>Turton Port (Promenade Only)</td>
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<td>jetty</td>
<td>694.94</td>
<td>3.96</td>
<td>extension 1882, 1904</td>
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<td>Venus Bay (Promenade Only)</td>
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<td>jetty</td>
<td>173.74</td>
<td>2.13</td>
<td>extension 1930. embankment 1967</td>
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<tr>
<td>Victor Harbor (timber causeway)</td>
<td>1862</td>
<td>jetty</td>
<td>207.26</td>
<td>na</td>
<td>extensions 1872, 1878, 1883. rebuilt 1954</td>
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<tr>
<td>Victor Harbor (screwpile jetty)</td>
<td>1881</td>
<td>jetty</td>
<td>1645.62</td>
<td>12.19</td>
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<tr>
<td>Victoria Port</td>
<td>1878</td>
<td>jetty</td>
<td>na</td>
<td>na</td>
<td>extension 1883, 1949</td>
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<td>Vincent Port</td>
<td>1897</td>
<td>wharf</td>
<td>198.12</td>
<td>3.05</td>
<td>extension 1926. altered 1957</td>
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<td>Wakefield Port</td>
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<td>wharf</td>
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<td>2.63</td>
<td>extension 1877, 1904. part rebuilt 1973</td>
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<td>Wallaroo (old)</td>
<td>1880</td>
<td>jetty</td>
<td>253.90</td>
<td>3.20</td>
<td>extension 1901, 1905, 1912. shortened 1964</td>
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<td>Wallaroo (new)</td>
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<td>Whyalla jetty no.2</td>
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<td>wharf</td>
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<td>na</td>
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<td>Wool Bay</td>
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<td>jetty</td>
<td>na</td>
<td>na</td>
<td>extension 1912</td>
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</table>
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