When the Tank's Empty

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Design strategies for the adaptive reuse of urban tank farms

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ABSTRACT

Urban tank farms, technically known as bulk fuel storage facilities, have been a feature of the urban industrial landscape for close to 100 years. Often established in prime waterfront locations near city centres, their future in these locations is uncertain. The toxic and volatile nature of their operations pose a threat to the environment and public safety, while many of the sites they occupy are being vacated as the oil industry consolidates and their activities are moved elsewhere. City waterfronts and industrial areas are also undergoing regeneration as urban centres increase in residential density and change in use from industrial and commercial activities to those based more on leisure and lifestyle.

Tank farms and similar industrial 'non-buildings' have only relatively recently been recognised as having significant industrial heritage and cultural value, often only attained after a period of abandonment. Adaptive reuse of industrial buildings has long been applied to factories and warehouses but industrial non-buildings present greater challenges for a reuse project. Built with a singular purpose unintended for human inhabitation, the uncompromising nature of this type of structure and the difficulties in reusing them means few have been retained for reuse. The poisonous legacy of contamination further reduces the opportunities for retention of this heritage and reuse of the structures.

Such sites and structures often face conflicting notions of site rehabilitation, industrial heritage retention, urban redevelopment and adaptive reuse. The design exercise of this thesis attempts to reconcile these notions by combining strategies of existing models and precedents with the necessities and aims of a continually evolving urban environment. Alongside these strategies, a step further than the typical landscape park and industrial sculpture of earlier examples is taken, proposing a new multi-use solution for an existing tank farm on Sydney Harbour. An architectural intervention for several of the largest tanks is presented, together with other elements of urban infill, environmental regeneration and public access and recreation.

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INTRODUCTION

Urban tank farms and fuel storage facilities are primary examples of urban industrial heritage. Should they be demolished, removed and replaced or can they be adaptively reused and reintegrated into the urban landscape?

Virtually every city the world over has a means of receiving, storing and supplying the oil-based fuel necessary to heat buildings, run vehicles and often generate electricity. A primary point in the distribution chain of this fuel is through storage tanks in the area of its eventual consumption. Sometimes underground but most often not, these almost always cylindrical tanks occupy positions of high accessibility and prominence in our urban and industrial areas and ports. Due to the insatiable appetite for fossil fuels over the last hundred years or more to sustain the industrial age and the immense volume these fuels occupy, the requirements of storing fuel have been visible in our urban environment for generations.

Facing obsolescence for a variety of reasons, these ubiquitous structures have an uncertain future. The toxic nature of their operations, along with other factors such as rising land values, consolidation of industrial distribution networks and urban reclamation of industrial port areas, results in many of these facilities being removed or relocated.

Therefore, this thesis seeks to investigate the ongoing changes to the urban fuel storage facility, investigating the possibilities of its future within the urban fabric. It explores ways of retaining and reintegrating urban tank farms into the evolving urban landscape, whilst retaining aesthetic, cultural and historical links to their heritage of urban industrial energy storage and use.

Figure 1.1-1:
Tate Modern

During the 20th century, the status of similar structures, urban gasometers, was not recognised as a significant part of industrial heritage until they had been largely removed and replaced. Gas holders once were a common sight on the urban landscape but the traces of them have all but disappeared (there is only one left in New Zealand – the Gasworks Museum in Dunedin). Tank farms are now similarly regarded as gasometers were then; an increasingly unnecessary eyesore taking up valuable space in the midst or on fringes of urban centres. They are often on waterfront or central urban sites with extensive industrial infrastructure but often suffer poor integration with the surrounding urban area.

Present and recent proposals have sought to remove structures and redevelop tank farm sites with little regard to the heritage and legacy of the sites. Urban fuel storage facilities may go the same way as late 19th and early 20th century gasometers have in recent decades if nothing is done to preserve and reuse the structures in a way which is sustainable, sympathetic to their place in urban heritage and a valuable asset to the evolving urban environment.

Though a few obsolete energy infrastructure facilities are awaiting redevelopment, most have been removed from urban areas and replaced during the last few decades. However, there are several precedents for such facilities that have become standard bearers for the adaptive reuse of such distinctive and unusual structures:

A site with four disused Victorian era gasometers in urban Vienna was commissioned in the 1990s to four architecture practices for structural retention and redesign into a multipurpose complex of housing, commercial and retail uses. This spurred the subsequent redevelopment of the surrounding low income housing and industrial estates, thereby retaining and improving their landmark status and industrial heritage (O'Kelly & Dean, 2007, p. 180).

Also in the 1990s, Bankside Power Station, a large and highly visible building on the south bank of the Thames in central London was adaptively reused to become the Tate Modern national museum of modern art (Figure 1.1-1). This is the centrepiece of a larger development of social, cultural, commercial and housing regeneration of London's South Bank district.

It also instigated further infrastructural development, most notably the Millennium Footbridge link over the Thames (Powell, 2004, p. 78).

The gasometer in Oberhausen, Germany, the largest of its kind in Europe, was decommissioned in 1988 and was soon reused and reopened as an exhibition centre.

The gasometer remains an important landmark in Oberhausen and a symbol of the industrial history of the Ruhr area, a point of orientation and identification in the city, and an events venue unique in its size and capacity. The former industrial site surrounding it has followed with cultural, commercial, leisure and retail developments, some also incorporating features of the industrial past. (Percy, 2003, p. 159)

The only existing example in New Zealand of a gasometer is now the Dunedin Gasworks museum, the last working example of its kind in Australasia and one of only three worldwide. These examples have multiple aspects which provide evidence that adaptive reuse of such structures is a viable and positive alternative to complete removal once obsolete.

There is little existing research on the adaptation of urban tank farms themselves but their predecessors, the gasometers, and relatives, power stations, have been written about. David Worth's chapter, Gas and Grain, in Industrial Archaeology – Future Directions (Casella & Symonds, 2005, pp. 135–154) argues for the reuse of "networked industrial landscapes" (Worth, 2005, p. 135), focusing on the understanding of the heritage and rehabilitation of gasometers and grain elevators in South Africa. Niall Kirkwood's book on industrial landscapes, Manufactured Sites: Rethinking the Post-industrial Landscape, covers other relevant topics such as site regeneration and current design practices in industrial site renewal and includes several case studies (Kirkwood, 2001).

As changing energy sources and consumer uses saw the demise of the urban gasometer, the urban tank farm is also possibly faced with obsolescence by the initiation of green energy policies, sustainable solutions of energy conservation and changing patterns of source and supply demands. The need for continuing further adaptation of present facilities arises for several reasons: the rising land values in urban centres and importance placed upon the need for urban centres as places of recreational, social, cultural and commercial activity; greater importance now given to issues of sustainability; the positive effects on countering urban sprawl that urban industrial site reclamation can achieve; the greater importance now placed upon large urban open spaces, particularly those with waterfront or elevated features, as a public asset and place for public rather than private access and activity.

Fuel storage facilities and tank farms present a particular challenge with regard to these new criteria of redevelopment. Often occupying locations highly valued by developers, such as river- or harbour-side sites close to city centres, they represent prime opportunities for development into high value commercial and residential properties. Not only do the structures that new developments seek to replace contain an aspect of industrial heritage, they can also possess an aesthetic appeal related to their history, unusual structure and purpose that a subsequent tabula rasa development cannot reproduce anew. As such, they possess a largely unrecognised value and potential for sustainability and design innovation.

However, urban fuel storage facilities also present specific problems associated with their commercial function which may also contribute to the complete removal of structure and also earth from the site. The very nature of fuel storage itself means issues of corrosion, soil contamination and pollution must be addressed before anything can be done to redevelop the site. This can require complete removal of all material from the site or costly decontamination on site, further pushing the case for complete removal.

Former energy infrastructure-based industrial storage facilities on brownfield sites are being considered for demolition, removal and replacement, often with generic developer-driven schemes which add nothing to the interest and quality of urban spaces. Developments such as this may disregard their place in urban industrial heritage while excluding a broader cross-section of the public by over-gentrification and perpetuating privatisation of property in which the public has a vested interest.

Not only can urban tank farms be reintegrated as representations of adaptive reuse and industrial heritage, there are other positive benefits. By attaining a distinctive image and character for an urban area, adaptive reuse in this manner can also demonstrate its value as a stimulant for further high quality development in the surrounding area, adding more value to the surrounding urban fabric than might be otherwise achieved.

The nature of tank farms and their uncompromising structural typology presents difficulties of conversion not faced by most industrial reuse projects. This research project aims to show not just the cultural and heritage value of tank farms but also how the technical and practical impediments to their conservation and reuse can be overcome.

The established precedents for other forms of industrial energy infrastructure facilities

show that similar principles and methods (to those of gasometer and power station reintegration) could be applied to tank farms. Aspects of these and several other examples are investigated in detail to ascertain the strengths and weaknesses of each; their inception, overall concepts, execution and subsequent related development.
Though few examples of fuel tank facility reuse exist, by assessing reuse projects of a similar nature many instructive principles can be brought into the design phase of the research, not only for the tanks themselves but also for their wider urban environment.
It is hoped that the outcomes and principles of the research and design involved in this research may be applied to other sites of the same or similar nature. Though the research covers only a specific type of structure, the location and nature of urban tank farms and their high visibility is such that the effects of their adaptive reuse is likely to be noticed on an extensive scale.

Chapter Two investigates the history and present state of urban tank farms and energy infrastructure facilities as they are today, why their operations should be relocated and the structures and sites reused.
Chapter Three explores literature on three interconnected themes: industrial heritage and the remediation of industrial sites; brownfield regeneration and urban redevelopment; and industrial structures and the challenges of reuse. Also investigated in this chapter are the structural, material and constructional properties of a fuel tank itself and possibilities for reuse.
Chapter Four examines the existing similar examples of adaptively reused industrial energy structures mentioned above. These are assessed as specific case studies in detail, evaluating the positive and negative properties of each example of adaptive reuse and qualities that may be adapted to a tank farm reuse.
Chapter five discusses how an urban tank farm today might be adaptively reused using methods learned from the case study examples of Chapter Four and developed through the associated research. It is necessary here to point out the sometimes subtle differences between each of the case studies, other related projects and a tank farm and how these differences may affect an adaptive reuse project with similar methods of reuse applied. Conditions of urban tank farms may be adaptable in some ways similarly to other precedents and also have characteristics unique to their local context. Therefore, the proposed project here is likely to have properties new to an adaptable reuse project. In light of this, the relevant criteria for a tank farm reuse project are outlined, followed by a brief assessment of possible candidate sites.
Chapter Six explains the selected site for the project design, the original facility as it was in operation under its intended purpose and a detailed analysis of the site and its urban context. The criteria necessary for the reuse of this particular site is discussed, followed by the programme of implementation for adaptive reuse project for the site. Outlined are the separate stages of the project and opportunities for further future development to take place.
Further discussion and a conclusion, with analysis and assessment of the design research project undertaken is in Chapter Seven.

2.0

BACKGROUND

This chapter discusses some of the reasons why tank farms' operations are no longer appropriate for the sites they have occupied over the last century, the general nature of fuel storage and state of the industry at present.

2.1

TANK FARMS AND THE CASE FOR REHABILITATION

Technically known as bulk liquid handling facilities but more commonly known as tank farms, a tank farm can be described as a cluster of fuel, chemical or liquid storage tanks for the handling and distribution of bulk liquid commodities. Usually cylindrical for structural reasons, they are constructed of welded plate steel over a structural steel skeleton (or occasionally of concrete) and are an integral feature of any major city's infrastructural, industrial and economic necessities.

They may be ubiquitous now but have only spread rapidly over the last hundred years alongside the equally rapid growth and trade within the world commodities markets, particularly oil. In the past, the similarly-shaped and -sized gas holders or gasometers of the last century were usually in the centre of towns to be close to consumers on 'town gas' made from coal at the nearby gasworks. These days, tank farms are more often than not located at the primary nodes of the commodities supply infrastructure: the industrial port facilities of cities' harbours and riversides, areas which are now experiencing constant change and (re)development.

Though they may be an important factor in the continuing economic life of a city and its region, there is a growing case for the removal or rehabilitation of the sites they occupy. Whether the existing tank farms are still operating productively or have fallen into disuse there remain good reasons for relocation or operational cessation of active sites and rehabilitation of obsolete and disused sites.

The more immediate argument against having working tank farms present in our urban areas and on our city waterfronts is one of safety and security. Environmental considerations have an caused increasing scrutiny of the effects of industrial chemicals and processes in our urban midst, spurred by greater legislative regulation and activism by environmental groups that brings attention to the potential dangers they represent. Tank farms also draw criticism from nearby inhabitants for the unpleasant (and unhealthy) odours they can generate, much as their gasometer forbears did. Current theory on this theme is examined in Part 1.2.2. In many cases, cities have expanded to encroach on the periphery of tank farm sites that once may have been isolated from regular urban activity and population by a buffer of industrial zoning or semi-rural location on harbour edges (e.g. New Plymouth Moturoa, Melbourne Williamstown).

With populations increasingly within closer proximity to tank farms, the potential danger that they represent has occasionally been realised. As recently as October 2009 a tank farm in Puerto Rico exploded with the equivalent magnitude of a 2.8 earthquake and burned for three days before it was brought under control, causing the evacuation of 1500 nearby residents (BBC News, 2009).

Similar events have also occurred nearer to New Zealand: on August 21, 1991 lightning struck a storage tank at the Coode Island tank farm in Melbourne causing a fire and the subsequent burning of 8.5m litres of toxic chemicals and releasing clouds of noxious fumes over the nearby suburb of Yarraville. 250 residents were evacuated and the estimated final cost overall was AUD$20m (Emergency Management Australia, 1991). Even in a spill that doesn't burn the results can be catastrophic to the local environment. The August 1999 spill by an Italian tanker unloading at Gore Bay tank farm on Sydney harbour resulted in 300 tonnes of crude oil escaping into the harbour, causing significant damage to local birdlife, repercussions for tourism and leisure, and a massive cleanup operation costing AUD$4.5m (NSW State Government, 2001, p. 34).

Aside from the inherent dangers of their contents, the long term outlook is most urban tank farms for the storage of fossil fuels will eventually become an obsolete feature of city infrastructure in the same way that gasometers once did. Predictions vary on whether the oil industry has yet to reach the state of peak oil production, or is still yet to do so, but the fact remains that oil is a finite resource and production will ultimately decline (Cohen, 2007; Koppelaar, 2005, p. 3).

In some cases these facilities have already fallen into disuse and obsolescence with plans for removal and site redevelopment already undertaken or in process. However, this is more likely to be a result of shorter term realities for the oil industry and has come about due to corporate relocation and by local authorities recognising the need for removal and repossessing or rezoning waterfront land (e.g. Wynyard, Auckland and Ballast Point, Sydney).

Consolidation and modernisation of the industry has meant that older sites of tank farms are too small to accommodate the large, multi-purpose and multi-user facilities that are now the industry norm. Single-purpose tank farms owned by oil companies are more often giving way to specialist bulk liquid storage sites and companies that have more varied capacity to store and distribute a wider range of liquids, both volatile and non-volatile. Therefore, sites for newer and upgraded tank farms are generally larger and more isolated from general urban activities and the tanks themselves are often larger.

Existing examples of industrial energy infrastructure reuse are assessed in Chapter Four. Furthermore, in the wake of terrorist attacks perpetrated around the world over the last decade or so, critical infrastructure (of which the energy sector, especially oil and gas, is an integral component) has been identified by security services as a primary target for attack and disruption. Governments and maritime authorities are increasingly looking to corporate owners of this network to identify vulnerabilities and review and strengthen their security arrangements. In light of security assessments, New Zealand and its major trading partners have renewed policy to cope with the threats posed by disruption to critical infrastructure (Australian Department of Foreign Affairs and Trade, 2004; NZ Office of the Auditor-General, 2003). Elsewhere, relocation to less vulnerable sites away from urban populations along with diversification in source and supply are options currently under debate (United States Congress, 2005, p. 10). This presents yet another reason for consolidation and relocation – in both security and safety respects it is certainly easier to secure one large isolated site than many small dispersed and urban ones.

Not only do disused tank farms represent an opportunity to serve as a reminder of past industrial heritage as rehabilitated gasometers do, they also can become indicators of the future that may be possible. The building industry currently produces over 40% of landfill refuse and a growing awareness exists to reduce this waste and to recycle and reduce building material costs and volumes (BRANZ, 2010, p. 20). Reusing and recycling existing elements of built structures and material demonstrates, particularly with industrial or unusual structures, economic and environmental possibilities that may not have otherwise been considered.

These cases for removal and rehabilitation demonstrate that tank farms are an increasingly undesirable and vulnerable part of inner urban infrastructure, the land they occupy can be vacated and the structures reused for more inclusive and sustainable purposes.

3.0

LITERATURE REVIEW

Though little specific literature on the subject of tank farms themselves is apparent, let alone of their rehabilitation, there is a reasonable amount of literature on use, reuse and renewal of the sites they typically occupy and on the reuse of urban industrial structures in general. Much of the theory and method discussed has clear similarities or is somewhat applicable to urban tank farms and the issues facing their use and reuse. This includes examples of their nearest relatives, gasometers, several of which have been adaptively reused in European cities. This can be broadly divided into separate categories, of which some factors and characteristics overlap:
The first addresses abandoned, disused or obsolete industrial sites and structures which, until recently have been largely ignored in terms of heritage value. Also addressed is the legacy of the sites in terms of contamination and the necessary steps to rectify them.
The second looks at the reasons why redevelopment of former industrial sites is desirable and necessary and what steps can be taken to do so, how the so-called brownfields and the industrial buildings on them can be integrated into the redevelopment process, and how industrial sites such as tank farms can also be a part of the process.
The third looks at responses to the 'non-building' structures (i.e. built structures that have some utilitarian purpose, originally unintended for occupation) that remain and their possibilities for change and reuse within their urban context.


Figure 3.1-1: Typical tank access stairs

3.1

DERELICTION, CONTAMINATED WASTELANDS AND INDUSTRIAL HERITAGE

3.1.1 The Value of Retention

In many cases, urban tanks are reaching the end of their life with industrial zones undergoing redevelopment around them. Cities realise the social and economic value of waterfront areas is higher when held in the public realm rather than devoted to private industrial purposes. Regardless of a tank farm's status as an obsolete or operational facility, the fact remains that these sites will undergo change in the near future, whether by the decline of the oil industry or for environmental and security reasons, or both. Also contributing are escalating land values which means sites are no longer economically justifiable – older facilities that are closer to city centres may lie on land worth far more than the present activities can justify, especially if that land is highly valued waterfront.
It is only relatively recently that features of industrial energy infrastructure have become recognised as industrial heritage. More conventional industrial buildings, such as factories and warehouses have proved simpler to overcome their unwanted status to be redeveloped into loft-style apartments, offices and retail parks. Many examples of this type exist in such places as New York's Meat-packing District and London's Docklands and South Bank. These former industrial districts have undergone significant renewal after public

and private investment and rezoning. However, unusual industrial sites or non-buildings that face dereliction are often regarded as blights on the urban landscape, devoid of interest and unworthy of preservation. This is perhaps borne out by the proportionately small number of these sites that feature on lists of protected heritage around the world or have undergone successful reuse.

3.1.2 Recognising the Value of Industrial 'Non-buildings'

It may also be argued that later 20th Century industrial structures, tank farms among them, are neither old enough nor significant enough to have sufficient architectural value for heritage status. It is perhaps a result of the fact that industrial non-buildings were never recognised spaces of inhabitation in their original guise that they are often not given the recognition they deserve as contributors to industrial history. Even if a structure has recognised historical significance it does not guarantee its retention:

Even where value has been accorded to industrial traces, there has been a tendency to focus on certain kinds of residue or to characterise them in certain circumscribed ways—as monumental, sublime, old, rare or technologically significant. Established procedures and criteria for conservation may actively disfavour industrial buildings and landscapes. Industrial buildings may not be registered because they are too recent, too altered, or have no conventional architectural aesthetic.
(Alfrey & Putnam, 1992, p. 9)

The heritage value of a reused textile mill, brewery or shoe factory is probably more likely to capture one's imagination or reverence than that of a gasometer, a steel foundry or, indeed, a tank farm. The assessment of value for conservation has influences that are continually under debate. Andrew Saint (1997, p. 35) and Michael Stratton (2000, p. 22) both claim that, counter to standard practices of selecting only the best examples, the case for conservation based purely on grounds of aesthetic qualities, structural innovation or historic association are no longer valid. Industrial buildings and areas must look forward as well as back in accepting dynamic fundamental changes when undergoing reuse. Stratton (1997, p. 6) also points out that public sentiment and opinion is no indicator of merit, as academics and media have caught up decades later to praise the value of surviving factories or structures.

3.1.3 The Necessity of Site Remediation

Whether the structures upon them remain or not, such sites will normally require remediation measures to realise their potential value.

Virtually every city in the nation's older industrial regions, no matter its size, grapples with the challenge of unused manufacturing facilities and other industrial sites… Public concern about health effects from hazardous chemicals, stricter environmental laws, and changing private-sector development priorities have made it increasingly difficult for communities to restore and reuse former manufacturing sites.
(Bartsch & Collaton, 1997, p. vii)

The nature of the products that tank farms contain is a major reason behind the argument for their removal and difficulties of renewal: contamination. The petrochemical business is inherently toxic and tank farms are a visible and sometimes pungent reminder of that toxicity. Tank farms and other facilities of similar nature have already proved to be difficult to rehabilitate due to soil contamination issues and associated problems with the decay of the infrastructure they leave behind.
Though the owners of tank farms may do their utmost to contain their entire valuable product, leaks, soil and groundwater leaching, noxious fumes and spillages are inevitable. Major incidents such as fires, large spillages and toxic gas cloud escapes are uncommon but when they do occur it is often on a catastrophic scale, affecting the lives and health of those nearby.
Once an industrial facility has been abandoned or removed, the problem of contamination still remains, often for decades. There are various strategies to deal with the problem.

3.1.4 Methods of Remediation

A common method of gradual soil remediation, and perhaps the most cost-effective at sites of low land value, is natural attenuation. This is the process in which bacteria naturally present in soil slowly break down contaminants in soil over a period of years. This method requires the abandonment and economic dormancy of a site and often includes active replanting of vegetation to assist the attenuation process (phytoremediation). It can also be coupled with other methods of remediation to enhance the process, such as groundwater remediation wells, oil-catching drainages and hydraulic soil washing measures (Yong & Mulligan, 2004, p. 8.4).
Other methods of soil remediation exist which preclude the abandonment and dereliction of sites where a swifter outcome is required for redevelopment and reuse. For a site that requires immediate redevelopment the challenges facing it can be numerous and costly. The most prevalent method in the past has been what is known as 'dig-and-dump' soil remediation, in which contaminated soil is physically excavated, removed and transported to a landfill or site where remediation can take place at a less pressured pace (or not at all, depending on the prevailing legislation and environmental climate). Other methods include: soil aeration, which may merely transform contaminants to airborne pollutants; bioremediation by injection of microbial bacteria and nutrients to stimulate native microorganisms; thermal or aerobic remediation to volatize chemical contaminants out of the soil for vapour extraction (air sparging); electromechanical extraction and filtering of groundwater and vapours; and containment by capping or paving in place. Often one of these methods will be used to assist another. As may be expected, the cost of these measures in both financial and environmental terms is often relative to the speed and intensity; a gradual process over several years incorporating bioremediation is likely to be more cost effective in this sense than a dig-and-dump or containment solution.
In a few cases, the rehabilitation for a site by natural attenuation and phytoremediation has

incorporated industrial heritage preservation and the creation of public parkland to be used and appreciated as the remediation process takes place. Emscher Industrial Park near Duisburg is such an example.

3.1.5 The value of abandonment

As in Duisburg's Emscher Park, one method is to take a passive approach to the site and allow a site to remediate itself by abandonment, encouraged through landscaping intervention measures on the site's surface to gradually return it to a more natural, biologically neutral state.
Urbanist Kevin Lynch argues that "we should acknowledge most waste and the processes of wasting as valuable and necessary in the lives of people, things and places," asserting that a reclaimed site needs 20 years to mature to a stable state. He continues to critique wastelands in urban areas as a necessity of regeneration, aspects of which are avoided but unavoidable, like cemeteries, dumps, incinerators and treatment plants.

Wasting is a pervasive (if valiantly ignored) process in human society, just as it is elsewhere in the living system. It is a feature of the underlying flux that carries us along, the everlasting impermanence of things. There is a short term wasting of things but a long term wasting of place. Each has its own characteristics... If we look for continuity and not permanence ... then wasting might be turned to account. (Lynch, 1990, p. 22)

Michael Southworth (2001) agrees and questions whether derelict sites are undesirable and to be avoided. He also states that, though a site may be abandoned or disused, there are still purposes for its current state of inactivity that are justifiable until an appropriate use can be identified and implemented:

A dereliction-free world would be sterile and oppressive. Cities actually benefit from a certain amount of land and structures that are underutilized, lying dormant for some future, unknown purpose. Urban wastelands can provide adaptability for future change. Derelict places can provide habitats for new uses, new users, new ecologies to take root and develop. (Southworth, 2001, p. 9)

Consistent with the views of Lynch is David Worth and the notion that industrial sites, though they have heritage value, need not be preserved as an entire entity but can be subject to ongoing remediation and reuse without loss of their industrial heritage.
Worth, in his thesis Gas and Grain – The Conservation of Networked Industrial Landscapes, argues for the preservation and intelligent reuse of what he calls the 'networked industrial landscapes' of gasworks and grain elevators of South Africa which were built to facilitate industrial and agricultural development. The heritage of these is a "material manifestation of human activity" which ought to be acknowledged and understood so they can be conserved, used and reused to "further developmental objectives in the future." He also criticises the fact that the gasworks, a historical source of fuel but also of pollution and stench, were removed because they did not fit into current notions of heritage and were therefore lost (Worth, 2005, p. 135). Tank farms, being of similar nature, may also soon fall into this category of unrecognised industrial heritage.
Industrial archaeologist Michael Stratton and other contributors back this up further in Industrial Buildings: Conservation and Regeneration, stating that "incremental approaches are more likely to result in sustainable success" (Stratton, 2000, p. 28)

Architect Hugh Hardy also advocates the appreciation of gradual regeneration of degraded industrial behemoths in The Romance of Abandonment: Industrial Parks. Pointing out two such reused examples, Bethlehem Steel in Pennsylvania and Thyssen Steelworks in Duisburg, he discusses the prospects of regeneration and resulting measures to counter urban sprawl driven by such projects and comments on how the pace of redevelopment can be gradual, inclusive and "combine old and new, built and bucolic, commercial and cultural to get the best redevelopment results." The Duisburg site is described as "almost the ideal reuse of an industrial site," where the area's history is preserved through slow reclamation and evolving design that can be funded incrementally (Hardy, 2005, p. 35).
Other observers also contend that disused industrial sites are worthy of respect and gradual rehabilitation back into use rather than immediate abandonment, intensive site sanitising and rapid, cost intensive measures that may give scant regard to the site's former use and heritage.
As Worth laments Cape Town's developer-driven commercialisation of industrial heritage, Hardy also criticises stripping-to-bare-bones methods of reuse such as at London's Tate Modern, which results in blandness and a lack of identity with the past, and claims "intelligent use of industrial sites can provide a genuine sense of place" and are "easier to implement when understood by the public" (Hardy, 2005, p. 37).
Irene Curulli (2007, p. 17) remarks that "recent design trends emphasise the superficial facelift, 'painting' them green and cramming them with new commercial functions... Camouflaging an abandoned site with a festive façade merely hides the causes of its abandonment."

3.2

BROWNFIELD REDEVELOPMENT, INDUSTRIAL NON-BUILDINGS AND URBAN REGENERATION

3.2.1 Positive reasons for redeveloping brownfields

Many urban centres with ageing industrial zones and ports have undergone regeneration as a result of decline in the industries located there. Subsequently, the redevelopment of former industrial zones and brownfield sites has featured largely in local and nationwide plans for urban renewal, principally for residential use to repopulate urban centres. The progress of sustainable building has invigorated and reinforced them over the last 20 years.

The 1990s witnessed a further development in the regeneration arsenal – the concept of genuine sustainability. Encapsulating a philosophy of low level intervention, integration of work, leisure and urban living, and due regard for existing built-environment assets, sustainable planning seeks a balance between conservation and lasting worthwhile progress (Falconer, 2007, p. 75).

A notable success in this field in Britain has been the findings (and subsequent government policy implementation of) Lord Richard Rogers' Urban Task Force Report, Towards an Urban Renaissance (Urban Task Force, 1999). Six years later Lord Rogers noted in his follow-up report (2005, p. 2) that there was a 40% increase in redevelopment of brownfield land and increasing populations of these areas, though despite some successes, more work was necessary to recognise the energy and recycling potential embodied in structurally sound and potentially re-usable buildings. The report was not without some dissent – one of the report's co-authors, Professor Sir Peter Hall, disagreed with the necessity of developing brownfields. He claimed that the south of England has a surplus of greenfield and that prioritising development of brownfields would lead to inflexibility by inhibiting new housing and increasing undesirable apartment construction unsuitable for families. The accepted and sometime legislated necessity of reducing urban sprawl and densifying urban centres can rebut these claims. Furthermore, this argument is strengthened by recent widespread concerns over rising food prices and food miles which, flawed as they may be, nevertheless emphasise the importance of retaining existing productive land beyond city edges.

3.2.2 Including existing structures in brownfield redevelopment

In spite of some inevitable dissention, urban planners recognise the necessity of limiting urban sprawl by densification, thereby reducing carbon emissions, fossil fuel dependency and infrastructure spending. As the growing emphasis on environmentally sustainable development has been given considerable weight in implementing government policy in the EU (Lloyd-Jones, 2006, p. 30), it has also taken hold in this part of the world.
This is supported by the fact that many city councils in this part of the world have also implemented similar plans and policies to counter the negative effects of urban sprawl by encouraging renewal and redevelopment of urban brownfield and former industrial sites. An integral component of these principles is the reuse of structures on urban industrial and brownfield sites by making use of existing structures to save on limited energy and resources and reduce waste generated by both the new building and demolition processes. This also makes sense economically because, as "remodelling existing buildings is labour intensive whereas new building tends to be capital expensive" (Brooker & Stone, 2004, p. 11), labour is a local, sustainable resource whereas capital is less so.

3.2.3 Brownfield redevelopment in ports and waterfronts

Urban regeneration of industrial areas is particularly prevalent in waterfront and port zones for several convergent reasons: Much of the industrial activity during the growth of cities that took place here has now moved on. As global trade and industry has grown, corporatized and consolidated, these functions have moved to larger and more specialised port locations where the current scale of industrial activity can be accommodated. Older industrial areas remain close to the CBDs of cities, increasing the attractiveness for development,

making land more valuable and redevelopment plans more viable, particularly if there are local authority incentives driven by densification and urban renewal policies. Local authorities also recognise the cultural value of public access to waterfronts in port area redevelopments, of which a substantial portion was formerly inaccessible to the general public. Also, residential and commercial properties with views, proximity and access to water bodies command and sustain higher values than those without.
Port area redevelopments can now be found throughout the developed world and many, if not most, of them incorporate reused industrial buildings (warehouses, factories, mills, etc.) and occasionally industrial non-buildings. Examples include Dublin (gasometer), Seattle (gasworks) and Amsterdam (silos). Here in New Zealand, both Auckland's Wynyard Quarter and Wellington's CentrePorts proposed developments on former industrial port land retain a few token structures for reuse whilst essentially overhauling the entire site. It must be noted that the Auckland development proposal does include the retention and reuse of a few of the existing cylindrical silos.
Taken altogether, these are compelling reasons for reuse and regeneration of waterfront industrial sites, in which tank farms have a ubiquitous presence.

3.2.4 The difficulties of reusing industrial non-buildings

There are numerous recent examples of urban industrial redevelopment that have adaptively reused factories, warehouses and even power stations. However, in addition to site issues of contamination, industrial non-buildings present greater challenges to adaptive reuse due to the uncompromising nature of their structures and the difficulties associated with reusing them. The reuse of structures within this type of site is most often limited to conventional buildings with some historical value and which have properties which are more open to redevelopment and conversion. Typically warehouses, breweries, mills and factories can be more easily converted to other uses and are able to invoke the memory of past uses by retaining the basic form and façade of the original as a heritage object, whilst effectively sustaining new use. Industrial non-buildings such as tanks, gasometers, steelworks and machinery rarely feature in redevelopment plans for serious utilisation and may only remain due to difficulty of removal or as sculptural memorials to defunct industry.
There are difficulties associated with the unusual and uncompromising non-building typology of tank farms. Other structures may be easier to reuse, due to simple factors of their construction and past inhabitation. Old factories, mills and warehouses, though their principal purpose is industrial production, were still built to be inhabited by the people employed to manage those activities. Tank farms almost universally consist of huge cylindrical steel forms with little more attached than pipelines and an access stairway spiralling up the side. Conforming to accepted physical rules and ratios for their dimensions and construction properties, the only visible variation among them seems to be between large and massive, though some distinct variations do exist.
In most cases, oil storage tanks are essentially little more than immense steel balloons consisting of welded or riveted steel plates, held together by a truss-supported conical roof. Exceptions to these are typically larger examples of flat-roofed tanks that have internal structure to support the roof, and floating roof tanks that, as the name implies, have a structurally unattached roof that moves up and down with the contents of the tank. This is to minimise the amount of potentially hazardous volatile fumes that may build up inside a partially filled tank, causing pressure imbalances, gas leaks and risk of explosion or fire. Floating roof tanks must have stronger walls, usually by having ring beams around the walls to maintain the integrity of the tank walls. These may be stronger but still require the integrity of the circle to remain intact. Floating and conical roofed tanks also have the advantage of being column-free volumes.
Under both fixed roof and floating roof tank circumstances, an entire segment of the tank's wall should not be removed without a considerable and possibly detrimental amount of bracing, as this would break the circle of the walls and ultimately result in collapse. Therefore, any penetrations or cuts to the wall of the tank may result in failure of the structure unless reinforced. Saying that, it is possible to reinforce the tank as necessary around penetrations to or add new structure to support any additions.
To convert a volume originally designed for the uninhabitable singular purpose of liquid storage into one of inhabitation is perhaps a step beyond a typical industrial building conversion. Despite the difficulties, it is still possible to retain substantial elements of them in a reuse project. They can be adapted to new uses which are appropriate for their new purpose without losing their value as a historical and cultural artefact, while still prevailing over the technical, environmental and practical challenges they undoubtedly face by such an adaptation. British research into such industrial building reuse indentified "over 600 examples, involving every imaginable kind of building and use, suggesting that the physical problems are capable of resolution in most contexts" (Falk, 2000, p. 95)
Some examples of reuse projects that have achieved that are examined in the next chapter of case studies. Further examples appear in Appendix 1.

3.3

RESPONSES, EXISTING EXAMPLES AND PRECEDENTS

3.3.1 A variety of responses to reuse

Graeme Brooker and Sally Stone identify the four primary approaches to building conservation in their book rereadings (Brooker & Stone, 2004, p. 11):

Preservation, as the name implies, maintains and makes safe the building in its current state, ruinous or not, for historical understanding.

Restoration returns the building to its original state, often with original materials and construction processes.

Renovation renews and updates a building for present purposes without substantially altering it.

Remodelling, otherwise known as adaptive reuse or reworking, fundamentally alters a building. Change of function, circulation, orientation and spatial relationships are modified. The existing building may be heavily modified, often major additions are inserted and other parts may be removed.

For industrial buildings, it is usually the remodelling or adaptive reuse of a structure that is most appropriate; the function is likely to change, as is the relationship to its context and as a result, major additions and subtractions are necessary to realise its new use.

Though reuse of industrial non-buildings may be a difficult task to achieve, there are some notable examples around the world that show how such a structure may be rehabilitated back in to its urban environment with a new purpose, free of the processes that commissioned it but still recognisably intact and often with additions as evidence of the remodelling. Transformed into a functionally different entity but still essentially possessive of its original form, they represent the possibilities for a future of industrial heritage recognition, while retaining the sustainable qualities that a change of use can express.

3.3.2 Conflicting interests

Reconciling a structure's industrial heritage with the conversion measures necessary for reuse is not without its challenges. Constructed with a singular purpose such as storage, smelting, brewing or generating power, the interests of both heritage preservation and adaptive reuse are likely to be at odds with

one another. Stratton (2000, p. 39) admits that such examples illustrate the problems of adapting such structures into usable buildings and reuse may compromise utilitarian form and archaeological interest.

On the other hand, Richard Williams' chapter on converted industrial gallery spaces in Mark Crinson's book, Urban Memory: History and Amnesia in the Modern City (2005, pp. 121–139), rejects the notion of nostalgic consumption of heritage as overly simplistic and self-serving. The Tate Liverpool's historical approach and references to the past in the conversion's maritime theme (it was a Victorian dock warehouse) sits at odds with Herzog and de Meuron's Tate Modern.

While the Tate Liverpool (Figure 3.3-1) is suffused with historical imagery, the Tate Modern's (Figure 3.3-2) imagery is blurred between new and old, new components often indistinguishable from the original. The heritage of the building is obvious and evocative without being glamorised and the result is a building that "superficially has the character of a historical structure, but conspicuously lacks its effect" (Williams, 2005, p. 129) Though both buildings are very different in their approach to industrial heritage and the technical aspects of conversion, each could be deemed successful in their own right, even if opinions differ.

In many cases of heritage preservation and reuse of industrial non-buildings, the Tate Modern again being an example, it is the overall form of the structure that is the significant indicator of its original purpose and heritage, freeing the spaces within from a need to preserve specific heritage elements. Though some may have deplored its stripped-bare conversion, there is little need at the Tate to retain the industrial elements of its former use when the structure itself evokes ample recognition of its past. The Turbine Hall is that much more effective as an exhibition space without the turbines in it.

3.3.3 Reuse as public open spaces

Though there is an overwhelmingly larger number of formerly inhabited industrial buildings that have been reused compared to non-buildings, the vast majority of conventional building reuse options undertaken are often limited to offices, apartments or museums and gallery space. A similar thing could be said about industrial non-buildings but the successful reuse responses for non-buildings have required a little more imagination due to their unusual typology and have sometimes resulted in a diverse range of solutions.
Usually, a non-building's original purpose was not inhabitation but as part of a series of industrial objects with a utilitarian function, positioned on the site with space between it and neighbouring objects of similar nature.

Not being designed for habitation, non-buildings often do not have a specific series of components that one would expect to see on any conventional building. There might not be present what one would consider an entrance, fenestration, conventional walls or roof. There may even be a lack of clearly defined edge to the structure, as is the case in something like a steel works, where gantries, pipes and vents may extend beyond and around the enclosed shell as peripheral fixtures.
However, what appears to be more common for larger industrial sites is the incorporation of public landscape parks as the primary reuse activity on the site. Due to the scale and typology of these industrial non-buildings, it may be difficult to imagine any of them to be reused as anything but parks and museums or monuments to the industry they once supported, or as a physical backdrop to the architecture of reuse that may supplant it. While the industrial structures may be redundant or disused, this does not necessarily preclude the reoccupation of the site.
Unexpected and unusual intervening secondary activities can be applied in or around the structures. For instance, at Zollverein in Germany (another former steelworks), a public swimming pool and ice rinks were inserted amongst the blast furnace structures (Figure 3.3-3).
Even so, many of the industrial non-buildings subjected to rehabilitation have been 'objects in space' situated on large, sprawling sites and have often undergone reuse as isolated objects on the surface of the land. There are similarities here of objects in space with the mid-20th century modernist theoretical urban schemes and their large monolithic shapes in the landscape.

Figure 3.3-3: Zollverein blast furnace ice rink (above)

Figure 3.3-1,2:
Tate Liverpool (opposite) and Tate Modern (left)

Among Le Corbusier's early theories is the notion that the essentials of architecture are on a basis of pure geometry of spheres, cones and cylinders. This he presented alongside photographs of contemporary (cylindrical) American grain elevators in Towards a New Architecture (Le Corbusier, 1946, p. 29), celebrating the simplicity and functional form generated by engineering necessities. In the case of gasworks, steel foundries and similar structures without clearly defined volumes these industrial objects lose their utilitarian function after rehabilitation and become mere sculptural elements.
A typical example of this type of response is Seattle's Gasworks Park (see 9.1.2), a 77ha landscaped park with a former gasworks remaining on the site after decommissioning, completed in 1975. Standing on the lakeshore opposite downtown Seattle, Gasworks Park retains the distinctive towers of the gasworks and the pump- and boiler-houses but much of the original structures that filled the site were removed and replaced by grassy parkland, including the storage tanks and gasholders. Though the park has become a widely praised industrial archaeological monument to its former use, in terms of reuse it seems little more than an interesting sculpture on the park landscape, the pump- and boiler-houses merely a picnic shelter and children's play barn. A park with such a 'structure-as-sculpture' may still be the only possible use for the gasworks site, as contaminants remain in lake sediment that precludes swimming or boating (City of Seattle, 2010) and the earth on site is leaching contaminants, requiring an ongoing programme of various remediation measures (Welch, 2007). Though this example of industrial site rehabilitation appears to fall into the preservation category of building conservation as much as (if not more than) the reuse category, there are others which have incorporated a wider range of activities into the programme. Some of these are investigated as case studies in the next chapter.

3.3.4 Reuse as cultural facility

Another common method of reuse for industrial sites and structures is as an exhibition, gallery or similar space for cultural purposes. Industrial spaces typically have large interior volumes and often good daylighting, properties which lend themselves well to exhibiting outsized art and installations which might not be accommodated by traditional, purpose-built gallery and museum spaces. Visitors can also appreciate the heritage architecture and conversion of the space at the same time as appreciating the cultural activity contained within (or around, as the case may be).
Typical examples include, again, the Tate Modern with its massive five-storey high Turbine Hall which featured the opening exhibition of artist Louise Bourgeois' Maman (a 10m high spider sculpture). Even larger was The Weather Project by Olafur Eliasson (Figure 3.3-6), which created a 20m wide artificial sun against the 35m high mirrored ceiling, effectively doubling the volume. Sometimes specially commissioned, projects such as these demonstrate the possibility of showcasing installations that might not otherwise have been created without a spatial volume large enough to exhibit them.

3.3.5 Industrial and commercial Reuse

The very nature of an empty tank and its immense volume and minimal internal structure in the case of floating roof and conical roofed tanks suggests that they could easily be adapted for industrial and commercial purposes that differ widely from their intended original purpose. Though the original purpose of oil tanks is storage of liquids, storage of other solid commodities is also possible with minor modifications to the overall structure and form of the tank. As long as the self-supporting structural integrity of the tank can be maintained, it is possible to make reasonably large penetrations for access if they are suitably reinforced. Tanks can then be easily converted and used for safer, cleaner and more locally appropriate storage purposes, given that tank farms are often already located in ports and other areas of related industrial activity.
Retail has also proven to be an occasional reuse option. Old warehouses have ideal spatial qualities for showrooms of larger display items such as furniture. In one of the few former fuel tank reuse examples, the California Garden Centre in Miramar, Wellington (see 9.1.4), occupies an 8.5m litre (≈1000m² x 9m) 1920s era tank. The only remaining one of five originally on the site, the adaptive reuse intervention has been simple but practical, with a few minor additions and modifications over the years. The tank has proved to be a useful and capacious, column-free space for the display and retail of outdoor furniture and also contains the centre's cafe. The lack of daylighting in a tank with few wall penetrations is mitigated by a large, circular skylight of translucent roofing over the original roof trusses. Prior to its role as a garden centre, the California Garden Centre

spent some years as a storage warehouse for The Evening Post's newsprint rolls and printing supplies.

3.3.6 Other uses

Other possible use for spaces of large volume offered by former industrial spaces are indoor sports facilities, music venues and artists' workshops and studios, and occasionally retail. However, some of these options may prove more challenging for the reuse of a circular structure like a fuel tank, particularly those involving music as the acoustic properties of round interiors are not ideal.
The popularity in New Zealand of indoor cricket and netball has seen many venues created from former warehouses and factories. Other sports such as ten-pin bowling, paintball and go-karting have also effectively used former warehouses and factories.
The dance music culture which began in the late 1980s became an unusual source of industrial space reuse. Founded around clandestine DJ parties which were publicised at the last minute by word of mouth and hastily printed flyers, they were often held in abandoned factories and warehouses which were set up within hours and dismantled just as quickly. As this type of event gained wider acceptance and legality the venues were often the same but converted to clubland in a more permanent manner, often with the industrial atmosphere and feel of the venue intact or enhanced. Though not the ideal shape for such a venue, an example is the former gasometer at the Westergasfabriek (Western Gas Factory) in Amsterdam (see 9.1.5). This 2500m² column-free round space, following rehabilitation and remediation of the entire gasworks site, is now also used for commercial and public events, fairs and festivals. Though some acoustic issues are irresolvable, they are improved with acoustic damping measures, and the space is still regularly used as a backdrop for film and photo shoots and music events.
Studios and workshops have regularly been the first to reoccupy former industrial spaces, as their tenants' materials are often fairly ephemeral and require the least modification of the space for it to be useful. The early 1990s spawned a network of converted factories in declining European urban centres which now house a diverse range of activities including artists workshops, theatre rehearsal studios, film sets and concert venues, in a continually transitional use of space (TransEuropeHalles, 2002).
These latter reuse options have often made the conversion to new use with the barest essentials of intervention but nevertheless show that, given some imagination and opportunity, an appropriate activity for an unusual space can be found. In fact, for many of these activities it is the activity that seeks out and finds the appropriate space to inhabit, rather than the other way around. Though they may be utilitarian conversions with a minimum of initial intervention, sites such as the Westergasfabriek and California Garden Centre demonstrate that reuse can be a gradual process with the activities within changing as the reuse programme and requirements develop.

There are several concepts outlined within this chapter that can be taken forward and inform the design of a tank farm reuse project.
Foremost among these is the retention of the tanks themselves as valid and important industrial heritage objects. These objects may face difficulties for reuse but none that are insurmountable. There are also limitations on what can be done with such an uncompromising structure as a steel tank but none that preclude a reuse solution that goes beyond mere preservation as industrial sculpture.
Secondly is the importance of an incremental approach to site remediation and reuse. Industrial sites can be subject to gradual change in some areas while other remain dormant, not only with the site but also the structures upon it. Also, the structures themselves can be adaptable to change of use and reuse as circumstances change around them.
Thirdly, the reintegration of the sites and their structures into the public realm can be of positive benefit environmentally, socially and economically. Their reuse can reduce building waste and consumption and mitigate urban sprawl. At the same time, reuse can bring more accessibility, density and urban integration to valuable urban and (often) waterfront land to which the public is generally excluded.

Figure 3.3-6: Interior of Tate Modern's Turbine Hall featuring Olafur Eliasson's The Weather Project (2003).

4.0

CASE STUDIES

The following case study chapter examines in detail some of the examples and precedents that bear some relationship with industrial sites and structures, particularly round ones, and relevance to tank farms. Many of the successful principles and precedents involved in the reuse of these structures can also influence the design phase of the reuse project.

4.1

REUSED TANKS AND SIMILAR EXAMPLES

Though there appears to be few examples of former oil storage tanks being retained, rehabilitated and reused for a new purpose, there are other examples of similar industrial non-buildings which have been converted. Principal among these are gasometer conversions, most of which are in European cities where they were most prevalent in the past. They range in size from relatively small to immense, as in the case of the Gasometer redevelopment in Vienna. Other industrial reuse projects in non-buildings include such structures as power stations and steelworks sites. Four such reuse projects were selected for this case study chapter for their variety and the diverse nature of their original purpose and eventual reuse. Brief descriptions of other structures mentioned here and elsewhere can be found in Appendix 1.

LOCATION
Santa Cruz de Tenerife, Canary Islands, Spain
CONSTRUCTED
1929
FORMER USE:
Oil storage tank (column supported flat roof)
REHABILITATED
1997
CURRENT USE
Cultural exhibition and performance venue
ARCHITECTS
AMP Arquitectos, Artengo-Menis-Pastrana

4.1.1 Espacio Cultural El Tanque (The Tank Cultural Space), Santa Cruz de Tenerife, Spain

Since its inception as Spain's first refinery in 1930, the extensive tank farm and oil refinery has been a feature of the downtown and waterfront of Santa Cruz de Tenerife, the island's major port and largest urban centre. As the oil company, CEPSA, consolidated and modernised their operations here, the opportunity arose for rehabilitation of a tank as part of a wider urban regeneration plan for the area.
Envisaged as a large scale development with several other landmark pieces of architecture among retail, commercial and residential blocks, the development would replace a large portion of CEPSA's site between a major thoroughfare into the city and the harbour. An historic proposal montage featured a tank as a circular pivot amongst rectangular blocks at an intersection of this major route. Many of the proposed buildings have since been completed, including the trade exhibition hall, tower blocks (Torres de Santa Cruz, the tallest residential blocks in Spain) and the shopping mall (Centro Comercial Meridiano). Also recently completed is Santiago Calatrava's Auditorio de Tenerife on the waterfront.
However, the vision of the montage has yet to be completely realised. Much of the building in the spaces between these larger projects remains unbuilt. Furthermore, the actual tank that was used for the reuse project is not the one depicted but one in the next block, between the twin towers and the shopping centre. At this stage, the Espacio Cultural El Tanque still remains the most isolated object in a slowly diminishing barren landscape, presumably with further development to follow and eventually surround it. Though the tank is of the fixed roof type with an internal structural steel skeleton and the space inside is not column free, it still proved to be useful for the desired purposes of the city owners. The space has an ongoing programme of diverse exhibitions, installations and events, some of which could not conceivably be held elsewhere and some which were designed specifically for the tank. The current (July 2010) installation (appropriately for an industrial heritage space, on the construction of memory) required 4 tons of water for the show, a task few other cultural exhibition spaces would be able to fulfil. The project may have been well realised in an architectural sense but still appears not to have successfully reintegrated with the surrounding urban fabric. This may yet change as the process of urban renewal continues around it.
Architecturally, a conscious effort was made to preserve the integrity of the exterior form of the tank to emphasize its symbolic character and refinery origins (Via Arquitectura, 1999, p. 94), to which the port of Santa Cruz has had an enduring relationship. In keeping with the preservation of form, the entrance, lobby and restrooms are buried underground to the side of the tank and access from outside and to the interior is via ramps. Perhaps reflecting the source of the tank's original contents, the entrance lobby has a raw, earthy impression, utilising the original tank foundations and boundary walls to enclose it. Adding contrast and a dramatic transition into the immense volume of the interior, burying the entrance also avoids penetrating the structurally weak steel exterior.
Inside, the tank remains largely unmodified, with merely power and lighting to facilitate the exhibitions. The presence of the steel columns also adds an explicit atmosphere of industrialism, enhanced by ambient lighting, that typically sanitised and whitewashed conventional cultural gallery spaces are unable to offer.

LOCATION
Simmering, Vienna, Austria
CONSTRUCTED
1896–1899
FORMER USE:
Coal-gas storage tanks
REHABILITATED
1999–2001
CURRENT USE
Multi-purpose
ARCHITECTS
Jean Nouvel (Gasometer A),
Coop Himmelb(l)au (Gasometer B),
Manfred Wehdorn (Gasometer C),
Wilhelm Holzbauer (Gasometer D)

4.1.2 Gasometer, Vienna

At one time the largest of their kind in Europe (90,000 m³ each), this series of immense gasometers was decommissioned in 1984 and, having already attained heritage status in 1978, a new use was sought for them. Before undergoing the large-scale remodelling that resulted in their present incarnation, they were often used in the intervening period as a backdrop for film production (James Bond's The Living Daylights being the most notable example) and as a venue for hosting dance parties or raves – indicating that once structures such as these have become obsolete there are previously unconsidered uses to be found for them when they become available.
After lying dormant for a decade, a bold decision was made within local government to reuse and redevelop the structures with a view to making them the centrepiece of a wider redevelopment programme in the surrounding district. Four prominent architectural practices (Jean Nouvel, Coop Himmelb(l)au, Manfred Wehdorn and Wilhelm Holzbauer) were selected to apply an architectural redevelopment programme to one each of the four brick Victorian-era gasometer shells, with public retail, leisure and sports programmes to connect them at base level.
The immense size of these structures has allowed the interior spaces to be treated as internal urban space and enabled a variety of uses on a large scale. Each of the four gasometers has retained the original brick façade, enclosed them with glazed domes and incorporated functions within, with a variety of configurations of courtyards or atria. One of the structures (Gasometer B, Coop Himmelb(l)au) has also added a narrow external 'shield' tower on the north side containing more apartments and office space.
The programme of functions is mainly divided into zones vertically, with apartments at the top, office spaces in the centre floors and entertainment and retail in the lower floors connected by sky bridges. Together with the external tower, the whole complex holds 615 apartments, an event arena, cinema, student hostel, school, kindergarten, medical clinic and municipal and commercial offices.
The size and variety of uses in this project has also enabled the complex to develop a micro-city atmosphere within its walls, even to the extent of a local virtual internet community.
Furthermore, the development has provided a stimulus and focal point for the continuing redevelopment of the urban industrial district which surrounds it, assisted by the upgrading of existing local transport connections and close proximity to major road transport routes.

LOCATION
Duisburg North, Germany
CONSTRUCTED
1901
FORMER USE:
Iron blast furnace
REHABILITATED
1991–1999
CURRENT USE
Landscape park
ARCHITECTS
Peter Latz (Latz + Partner)

4.1.3 Landschaftspark Duisburg-Nord (Duisburg-North Landscape Park), Duisburg

The original Thyssen Meiderich blast furnace was decommissioned in 1985 and preserved from demolition as an industrial heritage monument following massive protests (Duisburg Marketing, 2010). Consequently, in 1989 the Emscher Park International Building Exhibition (IBA) was established as a state-sponsored organisation committed to developing the site and extended to housing, urban development and social initiatives within the wider region. The abandoned site was a highly visible indication of the surrounding urban decay and economic decline. The IBA sought to break this image and regenerate the region from a place of heavy industrial production and manufacturing to one of services, consumption and leisure (Percy, 2003, p. 157).
Peter Latz' design for the park associated strongly not only with the industrial heritage of the area but also with the site's agricultural origins. Much of the blast furnace, coal production facilities and associated structures were retained in the construction of a new multipurpose industrial park. Elevated and ground level cycling and walking trails now criss-cross the park and many of the existing structures have taken on new uses with largely unmodified appearances. The former coke bunkers are now climbing walls, a gasometer has become an indoor diving centre and buildings such as the Engine House and Casting Hall have been converted to a concert venue and multipurpose exhibition and event arenas.
In the 'Piazza Metallica', a 7x7 grid of seven tonne steel plates taken from the original foundry pits were installed on the ground in a space surrounded by the immense steel structures of the blast furnace. This is the park's central focal point, being at the heart of the complex and is intended as a gathering space and site for outdoor events and performances. This space and its surroundings are further dramatised at night by a multicoloured lighting display by British light designer Jonathan Park illuminating the blast furnace.
New areas and structures continue to be redeveloped and reused while others are left to nature. Since the park's inauguration more functions have been added such as a cafeteria and bar, youth hostel and theatre in the former factory offices. Though most of the conversions have made primary use of existing structures, ongoing rehabilitation has also included small but significant new elements. For instance, the Casting Hall has been in use since the mid-1990s for open air concert and theatre performances but is soon to have a mobile roof installed to enclose the audience (Duisburg Marketing, 2010).
Also, the gasometer dive centre, which began as an independent venture by a few enthusiasts, soon went bankrupt but re-emerged to become a highly popular novelty destination for divers from all over Europe as well as training centre for police, rescue and special forces divers (Tauchrevier Gasometer, 2010).
These examples demonstrate how such a rehabilitation project can be constantly upgraded and evolve to the changing needs required of it, improving on the successes where necessary to ensure an ongoing programme of reuse and renewal. The project can also be opportunistic according to the reuse possibilities, where some of the more difficult parts (e.g. the coke bunkers) are changed very little for reuse and others can undergo significant intervention.
Also significant to this project was the incorporation of remediation measures to facilitate the ongoing cleansing of the ground and the waterways that course through and around it. While some of the most contaminated earth was completely removed and other sections covered and sealed, phytoremediation through an extensive planting programme alongside natural vegetation growth has allowed gradual decontamination of much of the site's soil. The polluted canal that ran through the site was replaced with a new freshwater canal as part of a sophisticated rainwater collection, storage and distribution system (Diedrich, 1999, p. 73).
Not only a monument to the past, the park has rehabilitated the site structures within with new and unconventional reuse programmes and embraced the notion of decay and regeneration as a part of its continuing evolution. More than just physical renewal and regeneration has also occurred. The immense blast furnace against the skyline no longer signifies the demise of industry here but now represents the cultural, environmental and economic revitalization of a region once blighted by pollution and decay. The park now symbolises the rehabilitation of the social understanding of the region as a whole, from one of depressing urban and industrial decline into one of pleasurable rejuvenation and diverse social and cultural activity.
As a result, the park now attracts over half a million visitors a year (Stilgenbauer, 2005, p. 7).

LOCATION
London, United Kingdom
CONSTRUCTED
1947–1963
FORMER USE
Oil-fired power station
REHABILITATED
1995–2000
CURRENT USE
Modern art gallery
ARCHITECTS
Sir Giles Gilbert Scott (original),
Herzog and de Meuron (reuse)

4.1.4 Tate Modern, London

Bankside Power Station, designed by the architect of some famous landmarks and icons of Britain such as Liverpool Cathedral, Battersea Power Station and the once-ubiquitous red phone booth, soon became a landmark in its own right. Just downstream from another of Scott's masterpieces and what is now one of the world's most famous derelict buildings, Battersea Power Station, Bankside endured barely fifteen years of full operation after its completion in 1963. It was then decommissioned and sat idle for another five years, the electricity company owners running only a substation in the switch house on the south side.

At the height of the London Docklands regeneration programme of the 1990s a design competition was held for the adaptation of the building for a new Tate Museum of Modern Art. Heritage organisations had been arguing for the preservation of Bankside and were pleased that the competition had been won by Herzog and de Meuron's minimalist intervention, consisting largely of a simple 'light beam' extension on the roof, over other more radical ideas for the exterior. They were slightly less pleased with the removal of two, lower, tiered sections of the north side of the building facing the river, though these were inextricably attached to the structure supporting the turbines that were to be removed (Powell, 1997, p. 77).

Apart from stimulating the ongoing redevelopment of the Docklands, the Tate's rehabilitation of Bankside also helped development of the new local transport routes to the area being established. Principal among these was the construction of the Millennium Bridge across the Thames, a high-tech footbridge linking the Bankside and the City near St. Pauls Cathedral and the first new bridge over the Thames since 1894. Despite the fact that the bridge was closed for two years immediately after opening to install dampers to eliminate uncomfortable resonance, it remains the most popular route of access to the gallery.

Since opening in 2000, the Tate's immense Turbine Hall has played host to many modern art exhibitions on a grand scale that many other museums or galleries would struggle to accommodate. However, other parts of the conversion have drawn criticism, such as poor vertical circulation, and particularly the other gallery spaces for being small, cramped and crowded. The crowning 'Swiss Light' on the chimney, not part of the original design but an artist's collaborative installation, also drew some criticism as being an "inelegant and pointless addition" (Powell, 2004, p. 66). This was removed in 2008 due to damage suffered under high winds (The Guardian, 2008).

This cramped state of affairs is set to change within the next two years as Tate Britain has now acquired two thirds of the southern switching room from the power company that still use it and three massive oil tanks buried immediately outside it. The switching room will add more circulation and gallery space, as will the tanks and a new, 11-storey tower () to be built on top of them, adding 21,500m² to the existing 35,000m² (London SE1, 2008). The new extension was again designed by Herzog and de Meuron.

The new tower, originally proposed as a glass covered ziggurat, was redesigned and unveiled in 2008 as a twisted and perforated, brick-clad, three-dimensional trapezoid . While the brick exterior will maintain a closer relationship with the original structure, the lattice-like surface with horizontal slices will make the building glow from within at night – an effect somewhere between the solid brick and transparent light beam of the existing building. The buried tanks will be expressed on the ground in front of the tower as a piazza, linking up with a new walkway through the building and landscaped gardens on the east side. This will extend the link from the City across the river and south to Southwark.

The redesign also incorporates more progressive energy efficiency measures such as the use of thermal mass, natural ventilation and natural daylighting. Waste heat from the relocated transformers in the switching room will also provide heating, while cooling will be from water pumped up from underground river terrace gravel (Tate Modern, 2010).

Although Tate Britain acquired Bankside with the intention of developing it in two phases, the extension was not originally planned until around 2020. The runaway success of the Tate Modern (nearly five million visitors in 2009, against a predicted two million) meant that space rapidly ran short and the project was brought forward. Advances in technology also meant the Switching Room transformers could be smaller, thereby freeing up more space for the Tate (London SE1, 2008).

4.2

CASE STUDIES SUMMARY

The examples of non-building reuse in this chapter and the appendix (see 9.0) show several factors often in common among them – some of which inform and influence the subsequent design exercise in this thesis. The vast majority of case studies here and similar reuse projects concern a single structure or a group of different ones. The Viennese Gasometer project is the only example of an array of similar structures that has survived intact. Even those that were once part of a cluster of objects, such as the Tenerife tank, have only survived as a single example of what once existed. In the case of tank farms and gasometers, this raises the question of whether the significance and heritage status of the array is compromised when the array is reduced to a single object. The character of the site undoubtedly changes when a collection of near-identical objects upon it is reduced to a single item – a single tree does not make a forest (or even a grove). This is an important factor that must be given due consideration in the design of a tank farm reuse project.

For the vast majority of non-building adaptive reuse projects there appears to be a period of abandonment and dereliction before that structure is considered a heritage object worthy of saving. Almost without exception, the reuse projects in the course of this research were dormant for several years or more, sometimes decades. They often lie abandoned and remain disused due to the challenges they present in contamination of site, lack of funding and difficulty of removal or reuse. However, what may once have been considered an eyesore during its operational life is subsequently endowed with industrial heritage status when it is eventually recognised as an important artefact of the area's social and industrial history. Once a sufficient amount of funding, political will and public pressure is brought to bear, the wide variety of non-building type, size and former purpose does not seem to be an impediment to considering such structures for reuse. In some cases the reuse may have been limited by contamination or legal and financial obstacles. Nevertheless, given the opportunity, a structure so singular of purpose that one might not have expected it to have any reuse value outside that purpose (such as a blast furnace) can prove to be a highly successful reuse project, upheld as an ideal example of adaptive reuse.

As the range of typology for non-buildings can be diverse, so can the programme of functions for reuse, within some limitations. In practice, this appears to be limited more by the structure's location than by its former function. Museums and galleries are appropriate for city centre sites such as Bankside but might not be as successful on a brownfield site in an industrial, rural or suburban area. In these cases, rather than specific 'destination' functions like galleries, a more appropriate use may be landscape parks, residential or mixed use adaptations like those of the Vienna Gasometer and Landschaftspark Duisburg-nord.

What also appears to be a common factor across the examples in this chapter (and those in Appendix 1) is the conservative nature of the architectural intervention applied to the original structure. These non-buildings that have gradually lost their former eyesore status through a period of abandonment and dereliction to attain heritage significance are revered to such a degree that any attempt to subvert the existing form of the structure can be met with strident opposition. For instance, both Bankside and Battersea Power Stations, once reviled for being polluting eyesores in the heart of London, now hold a privileged position of industrial heritage. So much so that Tate Britain were lauded for saving Bankside and the derelict and rapidly deteriorating Battersea Power Station cannot be demolished now due to its current Grade II heritage listing.

Limited intervention is more likely to gain public approval and acceptance than large scale and highly visible additions. One of the reasons Herzog and de Meuron won the competition for the Tate Modern was their minimal interference with the original exterior and this approach is borne out in other examples; the entirely intact tank exterior and buried entrance in Tenerife, the barely-touching blade alongside Vienna's Gasometer B, and the bolted-on elevated walkways and renovated offices at Duisburg-nord. Larger additions must pay due homage to the host structure, lest they be seen to be competing with or desecrating the original, hence the change from glass ziggurat to brick tower for the new Tate Modern addition.

However, in most cases this unwillingness to significantly alter the appearance of an existing structure continues to speak about the past use and says little of the present or potential future reuses (Eckardt & Kreisl, 2004, p. 73). In Duisburg-nord, this present and future is articulated more by vegetation, a deliberate expression of dereliction and by social interpretation. Meanwhile, the structures themselves remain largely unchanged, only slowly gaining major additions like the new theatre roof. It is also perhaps unlikely that Tate Modern's new tower would have met wide approval at the outset of the reuse project. Like most heritage objects, former 'eyesore' non-buildings, when subject to reuse, seem to meet with as much or more opposition than typical heritage buildings or new ones do. These examples reinforce the notion that gradual change is often more acceptable than large-scale, high-impact renovation, not only in terms of public perception but perhaps also in terms of funding, site regeneration and the ongoing performance of the project in its new role.

What is also significant, on a level of public involvement, is that the successful adaptively reused structures have restored public access to their sites, almost without exception. The structures that were for many years highly visible to the general public around them, were equally inaccessible to all but those who worked in them. In some cases (e.g. the steelworks at Duisburg-nord) this may have been a significant number of local residents but in most cases was a relative minority. In fact, it seems the very success of non-building reuse projects has depended largely on the restoration of public access and the subsequent response by the public to take advantage of it. None of the case studies here could be considered a good example of adaptive reuse were it not for the huge numbers of people that visit or inhabit them. Also, these 'reusers' do not come because of what the structures were but because of what they have become – a good place to climb or cycle, a pleasant community to live in, or a great venue for a show or exhibition.

5.0

TANK FARM SITE REHABILITATION

This chapter assesses tank farm sites and selects a suitable candidate for a reuse design case study. By outlining the criteria that make a site a valid opportunity for a reuse project the chapter also introduces new material about the physical and urban properties of tank farm sites.

As Chapter Four has shown, the location and configuration of a site is often more important to its reuse viability than the structures themselves. For this reason, and the fact that the tanks are fairly generic in structure and form, the emphasis for selection shifts to site characteristics and location.

Following the site selection is an analysis of the site itself, its history and its urban context. The most important criteria for reuse of this particular tank farm are identified with regard to its location and urban context.

5.1

SUITABILITY OF SITES FOR TANK FARM REHABILITATION

While it may be desirable that all tank farm sites can eventually be rehabilitated, reuse projects for the tanks themselves may have limited possibilities. Reuse of a site is almost always possible but retention of the tanks on it might not always be appropriate. There may be other considerations that make the reuse of the tanks unfeasible.

A series of site selection issues ought to be addressed before a tank farm site may be considered for rehabilitation and reuse. These include:

Location _Facilities with some degree of separation from the wider urban fabric are unlikely to attract either funding or patronage where the reuse project programme is changed from storage to human use or habitation.

Heritage value _Though there is no minimum age at which industrial facilities might be considered heritage, many of the older facilities have played a significant role in the industrial development of their local area. Retention and reuse is easier to justify if the facility has become a landmark and distinctive feature of its surroundings with connections to the memories and history of the local community.

Value of finished reuse project _There may be an extreme and unjustifiable difference between the social, monetary and heritage value of a tank reuse development proposal and a proposal for that of a site with tanks removed. This situation may exist in a downtown port or CBD situation where the continuing existence of the tanks may actually preclude a much more intensive redevelopment of the site that a reuse project cannot offer.

Integration with existing redevelopment programmes _a single reuse project may have limited appeal on its own but could find greater support if part of a wider regeneration strategy.

Obsolescence or impending removal _As the bulk liquid storage industry consolidates and upgrades facilities.
Impedance of site to public use and valuable redevelopment of the site and surroundings.
Nearby residential or environmental protection areas to which accidents, leaks and spills pose a risk.
Tank farm sites which may be considered most appropriate for rehabilitation are likely to be those which have become obsolete by industry standards and operated by single oil companies. These older storage facilities are usually smaller and more centrally sited in relation to the ports and cities they served. They are also more likely to be surrounded by changing land use patterns and ever-encroaching land redevelopment, while originally they were relatively isolated or in specific port and industrial zones. The tank farm on Wellington's Miramar Peninsula once had five large tanks and this consequently diminished to the single tank that is now the California Garden Centre, as residential and light industrial development crowded what was originally a fairly sparsely developed neighbourhood. This can also be said of Auckland's Wynyard Quarter tank farm, a formerly busy port now undergoing redevelopment proposals as retail, commercial and leisure-based development spreads along the CBD waterfront while port operations have gradually shrunk.

5.2

PROJECT SITE SELECTION – THE RUNNERS-UP

Several possible sites in New Zealand and Australia were considered for the design project component of this thesis. These were generally facilities located in port zones currently undergoing some degree of redevelopment or changing use, some having lain dormant for a period of inactivity since their last commissioned use and some still operating. The intention of the site selection process is to identify and select a tank farm site that is most likely to be a viable and reasonable proposition for a reuse project in the immediate future. Among those considered and subsequently rejected were the following sites:

5.2.2 Williamstown, Melbourne

Tanks here were constructed in the 1950s to accommodate tanker ships associated with the adjacent port operations. On the outskirts of greater Melbourne, this heritage listed site occupies the south end of the port at Williamstown with a view of Melbourne's skyline to the north and overlooking Port Phillip Bay to the south. There is changing land use zoning and heritage redevelopment proposals for the former Port Phillip Woollen Mills site opposite and others nearby, though further research revealed that this site is considered a 'strategic asset' associated with the adjacent BAE Systems defence shipyard. Though the site is a picturesque, if somewhat isolated location, the tank farm zoning is unlikely to change and may even be growing in future to service a greater number of warship visits (Victoria State Government Department of Planning and Community Development, 2010, p. 55).

5.2.2 Coode Island, Melbourne

Now actually a peninsula, Coode Island is a large hazardous chemical storage facility at the confluence of the Maribyrnong and Yarra Rivers in Melbourne's western Docklands. Though not strictly containing petroleum oil (storing mostly hazardous chemicals, vegetable oils and tallow), the facility still has all the attributes of a tank farm, not just in appearance and operations but also including accidents, spills, noxious vapour emissions and public misgivings and requests for removal. In the early 1990s the State Government recommended the facility for removal which it soon retracted, deciding that the risks were acceptable (Coode Island Community Consultative Committee, 2002).
Large scale port redevelopments have been underway at Victoria Docks to the east of Coode Island since the construction of Etihad Stadium in 1996 and have spread westward as far as the intervening CityLink Tollway since. However, a large area of Ports of Melbourne operations remains between the Docklands development and the tank farm. This immediate area is unlikely to be redeveloped in the foreseeable future (Ports Of Melbourne Corporation, 2010). This is especially true when considering the tank farm operations have consolidated to the western side of the peninsula to make way for the P&O container port on the eastern side. Ports of Melbourne Corporation recently spent a reported AUD$800 million to dredge the shipping channels to allow larger tanker and container ships up the Yarra River (Murphy, 2007).
Therefore, any reuse and rehabilitation project undertaken at this facility would be likely to remain isolated in an industrial landscape for the foreseeable future.

5.2.3 Moturoa, New Plymouth

In operation from the 1960s, these fuel oil storage tanks are adjacent to the mothballed New Plymouth Power Station and have been unused since the fuel oil capability of the power station was decommissioned in 1991. The power station's use had been declining since 1999 and, apart from short periods of operation in the intervening years to make up for shortages caused by low hydro-lake levels, was fully decommissioned in 2008 (Dominion Post, 2008). A beautiful location on the outskirts of New Plymouth with a backdrop of mountains and sweeping views over the Tasman Sea, the site's tanks and power station would make an interesting reuse project. However, without close proximity to other urban development this site is perhaps too rural to make anything but an Emscher-style industrial park as a reuse project a feasible option.

5.2.4 Wynyard Point, Auckland

The tank farm at the tip of Auckland's Wynyard Point represents a prime opportunity for a reuse project. The site is already slated for redevelopment under the principle of Auckland's Waterfront Vision 2040 (Auckland Regional Council, 2005, p. 17) and has a draft development programme proposed under the Draft Wynyard Point Concept Vision (Auckland City Council, 2006). Though this site is a good example of a tank farm that meets the criteria for redevelopment that this thesis seeks to identify, it is not the intention of this thesis to critique or compete with existing development proposals with a design and development of its own. Also, even though the tank farm site in the draft proposal is mostly park, the Wynyard Point site is in such a prominent position on Auckland's downtown harbour edge, that the tank farm site may be more suitable for a more intensive building programme than an industrial tank reuse project can sustain across the entire site. Nevertheless, parts of the draft proposal for Wynyard Point contain useful guidelines to be noted for the design component of this thesis.

5.3

THE GORE BAY TERMINAL

5.3.1 Site selection and justification

Of the sites considered, the Shell Terminal at Gore Bay in Greenwich on the north shore of Sydney Harbour presented the most viable and attractive option for a reuse project. The Gore Bay Terminal is the last remaining of a series of small tank farms established on Sydney Harbour in the first decades of the 20th Century, representing a long heritage of oil company involvement in the development of the harbour as a working port. Two other former tank farms, the former BP facility to the east at Waverton and the former Caltex facility across the harbour at Ballast Point in Balmain, have recently been returned to public ownership and converted into municipal parks.

These two parks have retained aspects of their past through retention of particular features of their past use, without actually retaining any of the tanks themselves. For instance, Waverton Peninsula Reserve has small artificial wetlands in the footprints of the now-removed tanks and heritage protection of the cuttings made into the sandstone cliffs to accommodate them (North Sydney Council, 1999). In Ballast Point Park a steel frame representing the 'skeleton' of the tank that formerly occupied the site was erected and embellished with poetry as an 'interpretative structure'. Fittings and fixtures of the tank infrastructure have been incorporated into the gabion walls throughout the park with round lawns in the former tank's footprints (Sydney Harbour Foreshore Authority, 2009, pp. 21–31).

The Gore Bay Terminal site represents an opportunity for reuse that can incorporate other functions in the retained tanks alongside a programme of parkland as part of the site remediation measures and connection with its surroundings. It is the intention of this thesis to demonstrate that the Gore Bay site can be transferred from its present network of industrial activity into the new network of industrial parks, whilst taking the principles of them a step further; retaining the majority of the tanks for reuse and re-reuse as an integral part of the heritage and future of the site and its place in the ongoing growth and development of its environs.

5.3.2 Site location and present status

Surrounded by suburban residential homes and established municipal parks, the tank farm lies, in a small cove three kilometres from Sydney CBD within the jurisdiction of Lane Cove City Council, taking up one kilometre of the eastern side of Greenwich Peninsula. At ten hectares it is relatively small in modern terms of working oil storage facilities but larger than Waverton Peninsula Reserve (2.4ha) and Ballast Point Park (2.7ha) combined.

The Shell Gore Bay facility was opened in 1901, long before the Harbour Bridge was constructed and North Sydney was still relatively rural, with the visit of the S.S. Turbo. This ship was the first steamer to unload bulk oil in Australia (North Shore Historical Society, 1976, p. 5), perhaps in itself a significant moment in Australia's industrial heritage.

Also on the site originally and established around the same time was Fell's Refinery, making lubricants from oil extracted from shale mined nearby in the Blue Mountains. Fell's employed a large workforce of over 1000, adding further archaeological and social heritage value to the site. John Fell was eventually forced to sell in the face of cheaper imports to the British Imperial Co. (later Shell Australia) and the entire site came under their control. The terminal is still in operation today, storing crude oil and feedstock for the Clyde Refinery at Parramatta in 20 cylindrical tanks ranging from 15m to 45m in diameter. This is resupplied by regular visits of small and medium-sized tanker ships to the docking pier at the southern end of the site and pumped to the refinery via an 18km, 300mmø pipeline (Shell Australia, 2010).

The site and its continuing operations at Gore Bay have been the subject of some debate in recent years, with the state government and industry supporting the present operations as an enduring element of Sydney Harbour's status as a working port (BBC News, 1999), while environmentalists and local residents express their desire for its operations to relocate (ABC News, 1999). This debate was particularly vocal after several spills in the 1990s, culminating when the Laura D'Amato, an Italian tanker, spilled 250 tonnes of crude oil into the harbour on August 3, 1997. The spill caused widespread environmental damage with oil sheen and slicks spreading throughout the harbour (Australian Maritime Safety Authority, 2000) and cost an estimated AUD$4.5 million to clean up (Skelsey, 2001).

Aside from these spillages, Sydney Harbour has also been found to be among the world's most polluted (AAP, 2010; Roberts, 2008), caused largely by runoff from industrial facilities and further advancing the argument for relocation of industrial activities on the harbour. Though Shell have taken some initiative to improve their operations and relations with the local authorities and community including the removal of some tanks and the repainting of others (Shell Australia, 2010), it is perhaps appropriate now for a gradual decrease and ultimate cessation of operations and return of the site to public ownership, as the sites at Ballast Point and Waverton have done. The Clyde refinery is already also served by an additional pipeline from larger storage tank facilities now established at Botany Bay which may further justify the eventual relocation of operations.

5.3.3 Site and environs analysis

5.3.3.1 Topography

Sydney has a vast harbour with numeous coves and steep, rocky peninsulas and Greenwich Peninsula, shaped rather like a high-heeled boot, is a typical example. Unusually for most tank farm sites, the tank farms of Sydney Harbour have been situated on these rocky and steep sided peninsulas. The terrain rises steeply from the water's edge over most of the Greenwich peninsula and rounds out to nearly 40m above sea level at its highest points, with the highest points on the tank farm site at 20–30m.

On the site, this topography required the necessarily flat footprint of the tanks to be deeply carved out of the terrain and often enclosing the tanks to a wide (geometric) degree. Among the tank farms, this effect is most evident on the Gore Bay site and has resulted in some of the tanks being tucked into the landscape, the hillside behind carved out almost to the same level as of the roof of the tank in front, consequently making the topography a significant part of the tank farm itself.

This has also resulted in the site's terrain taking on a terraced appearance. All of the immediate waterfront is relatively flat at 2–4m above sea level and varies in width from just a few metres at the south end to 50m at the largest tanks at the north end. Behind this lies a second tier of tanks at 10–15m above sea level. Between the upper sections of the site adjacent to the roads (10–20m asl) and the lowest level at the foreshore (up to 6m asl), much of the site has a middle level of relatively flat terrace (at around 10–20m asl).

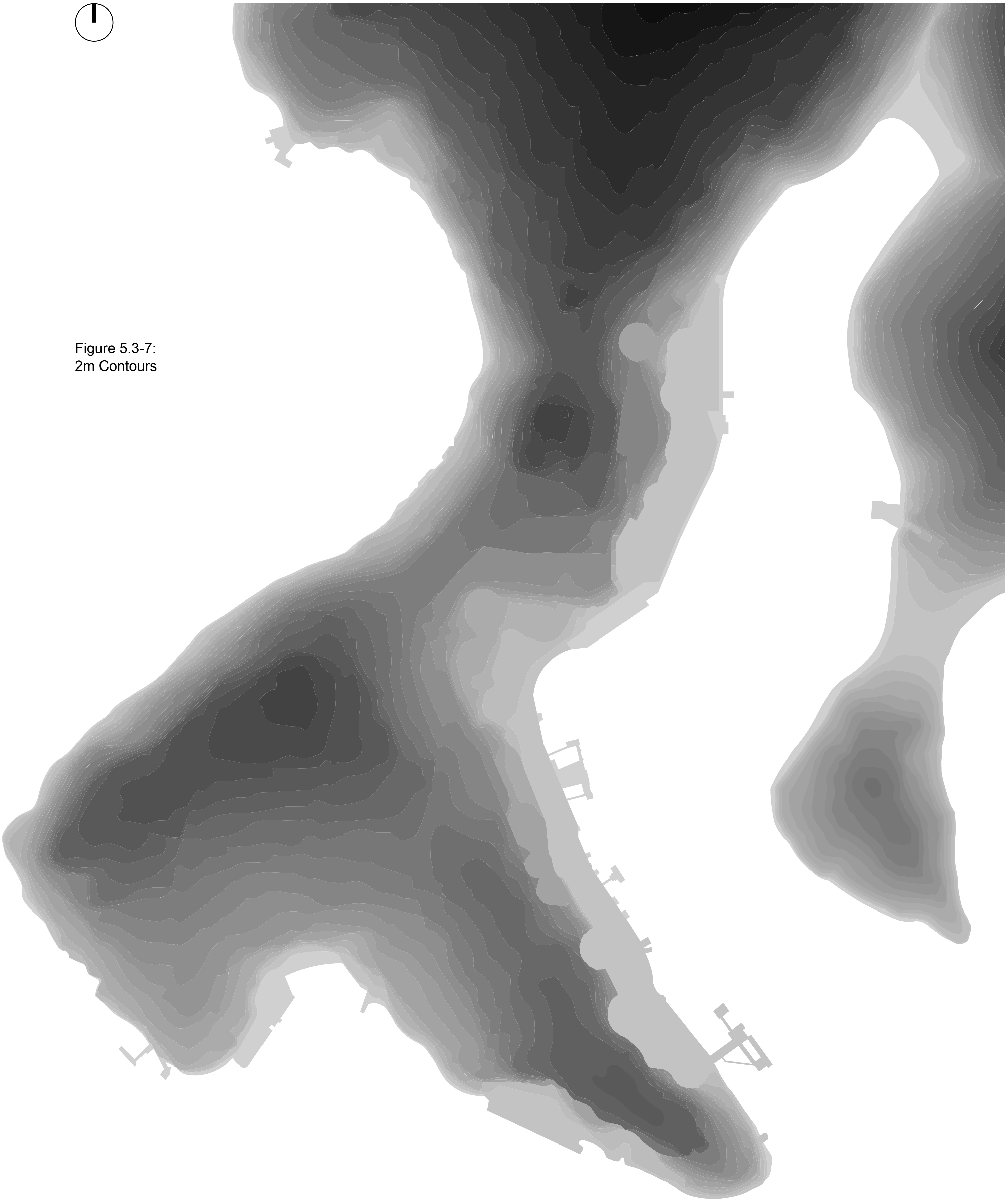


Figure 5.3-7:
2m Contours

This extends along most of the site apart from the narrowest southern end. Much of these terraces, and practically all of the waterfront, are paved in flat expanses of concrete.
The site can be roughly divided up into three topographical areas (Figure 5.3-9):
The north end of the site has a broad, 50m wide lower level with six of the largest tanks on site, a 30m wide second tier with one tank set deep into the north hillside and two more at the south end and a third on the third tier behind them. Between these tiers are near-vertical or steeply inclined rocky hillsides.
The middle and broadest part of the site, on the lowest and narrowest part of the peninsula, has a several tiers rising in smaller increments up the hill to the crest of the peninsula's isthmus.
The south end of the site is the narrowest and has a 20–30m wide waterfront along its length and a small second tier behind at the north-west end. The site boundary roughly follows the cliffs that have been cut out of the terrain and rise to over 20m above sea level behind.

5.3.3.2 Harbour

The terminal has a harbour frontage of around 900m facing eastward into Gore Bay and across to Berry's Island Reserve peninsula. Most of the site's waterfront is typical Sydney sandstone seawall with two major tanker docking wharves and a several smaller jetties. The calm and sheltered cove itself is deep enough to accommodate medium sized oil tankers at the south end (10m+) and gradually shallows to the Berry Creek outlet at the north end. The rest of the cove is rocky shoreline with bush reserve immediately behind.

Figure 5.3-8: Site topography

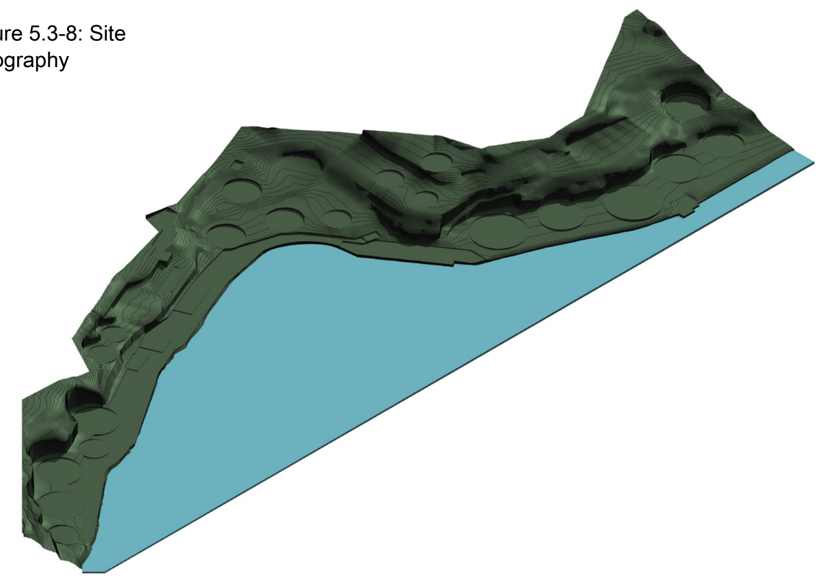
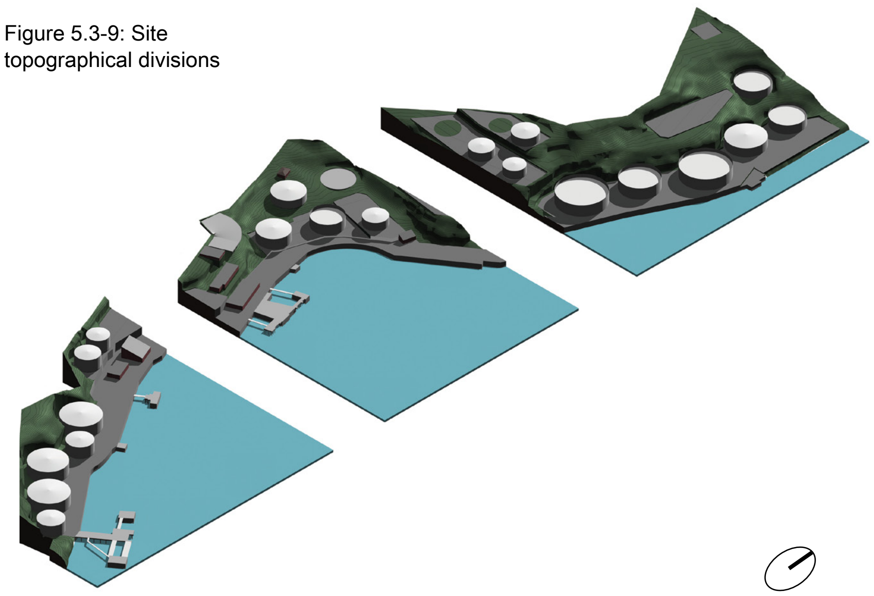


Figure 5.3-9: Site topographical divisions



5.3.3.3 Built form

The dimensions of the tanks on the site easily dwarf any of the buildings on the peninsula, both in footprint size (and, with the exception of a block of flats or two across the road, in height), as can be seen in the figure/ground image (Figure 5.3-10). The nearest built form which comes anywhere near the dimensions of the tanks on site are the large blocks at the HMAS Waterhen naval base to the east in Ball's Head Bay. In terms of footprint and height, the only exception being a small cluster of apartment blocks on Greenwich Road, the majority of buildings on and around Greenwich Peninsula are one- and two-storied houses typical of an established Australian suburb, predominantly larger on the peninsula itself than those further into Greenwich proper. Average prices for property in the area are around AUD$1.7m for houses and AUD$0.6m for units (Domain.com, 2010), indicating a reasonably upscale neighbourhood and suggesting that any further development on the peninsula would command similarly high prices.

Though the site is currently zoned as Working Waterfront (Figure 5.3-11), the surrounding area is mostly zoned as Low-Density residential with a small area of High-Density Residential across Greenwich Road (Lane Cove Council, 2009).

There are many sites and features amongst the local buildings that have specific individual importance as heritage objects (Figure 5.3-16). Many of these are houses but also included are streetscape elements, retaining walls and wharves to name a few. In the case of the Shell Terminal, the entire site is listed as an archaeological item and the whole peninsula south of the isthmus has General Heritage Conservation Area status in the council Local Environmental Plan (Lane Cove Council, 2009).

On the site itself, there are few conventional buildings among the 20 tanks. Most visible among these are three low brick buildings, each about the size of a large house, standing near the water and a small administration building near the centre of the site by the main entrance.

Despite unsuccessful attempts to contact Shell Australia for some details of their site and the tanks on it, the tanks are by no means unique and some assumptions can be made regarding their construction. Of the 20 tanks, six of the

largest have floating roofs and the remainder have conical fixed roofs, suggesting triangular truss roofs and little internal structure.
Many of the tanks on site, particularly the larger ones at the water's edge, also have 2-3m high concrete walls, known as bund walls, around them to contain any spillages, should the tanks rupture or leak. These bund walls have the effect of partitioning the larger tanks off from one another.

5.3.3.4 Transport network
Despite the challenging terrain, local roads follow a typical grid layout of 80x100m blocks on the lower section of the peninsula and long 50x300m blocks on the upper section with roads on the periphery tending to follow the terrain. At the isthmus this network is squeezed down to a single thoroughfare to the lower peninsula. This thoroughfare, Greenwich Road, follows the ridge down the 1.5km from the Pacific Highway and is the only major road to the peninsula. Many of the secondary streets are narrow and often steep.
The peninsula is served by a number of public transportation modes (Figure 5.3-13).
The 265 bus service between Lane Cove and Milson's Point uses Greenwich Road every half hour, linking up with ferry services between Circular Quay, Lane Cove, Balmain and Parramatta. The ferry wharf at the southern tip of the peninsula is also served by a private ferry between Lane Cove and Circular Quay, with another stop at a small wharf on the northwest side of the peninsula. Wollstonecraft Train Station, on the North Sydney line, is a fifteen minute walk northeast through suburban streets and over Ball's Creek.

Figure 5.3-10:
Figure/ground

Greenwich road is also the only road which has integrated cycle lanes to link up with Sydney's somewhat patchy cycleway. A more extensive network for non-vehicular traffic are the many public walking tracks that traverse the area's waterfront parks and intertidal zones. If it were not for the existence of the Gore Bay Terminal (and a few small pockets of private waterfront), one could walk from Sydney Harbour Bridge to Lane Cove (~ 10km) almost entirely on public tracks through waterfront areas.

5.3.3.5 Open Space, Vegetation and Eco-zones.

Contrary to much of the privately owned waterfront of Sydney further east and south of the Harbour Bridge, the area around Greenwich has a series of coastal parks and public open spaces. Immediately abutting the Gore Bay Terminal are three parks, each with significant heritage, conservation or recreational qualities (Figure 5.3-12).

Hollaway Park and the adjacent Greendale Park immediately to the north lie on the west side of Berry Creek, parts of which are designated Environmental Protection zones. On the opposite bank and falling within North Sydney Council's jurisdiction are Berry's Island Reserve and Smoothey Park, zoned as Public Recreation Open Spaces.

Three more Environmental Protection zones exist on the peninsula: one at Manns Point Park on the peninsula's 'toe' and two in the 'heel' at Greenwich Point Reserve and Foreshore reserve. The remainder of the public foreshore is zoned as Public Recreation and covers much of the rest of the peninsula's foreshore.

The terminal site has pockets of established vegetation in a few places, particularly on the perimeter, but much of the greenery on site is shrubs and small trees that appear to have been unchecked spontaneous growth rather than deliberately planned planting. Even so, the vegetation is limited and much of the unbuilt site is covered by barren stretches of bare rocky ground and concrete pads.

5.3.3.6 Harbour Views

The harbour views of Sydney residences are an increasingly important factor in terms of desirability and value , often giving the lie to location as the most important factor in real estate value (Bremner, 2005). Though the tank farm site is surrounded by suburbia, those houses' and units' views are generally away from the tank farm where possible, either westward up the harbour or south to the main harbour and city CBD instead of into Gore Bay itself. This leaves only houses on the terminal's immediate boundary and a few across the cove actually overlooking the site. Practically the entire terminal site overlooks Gore Bay and views from the higher elevations of the site are possible over the treetops of Berry's Island to North Sydney and as far as Sydney Harbour Bridge and CBD, with sweeping views of the harbour.

5.3.3.7 Access and Amenities

Not only is the site cut off visually from the neighbourhood, it also remains privately owned and contains hazards preventing public access. One kilometre of picturesque waterfront remains unavailable for public use and inter-

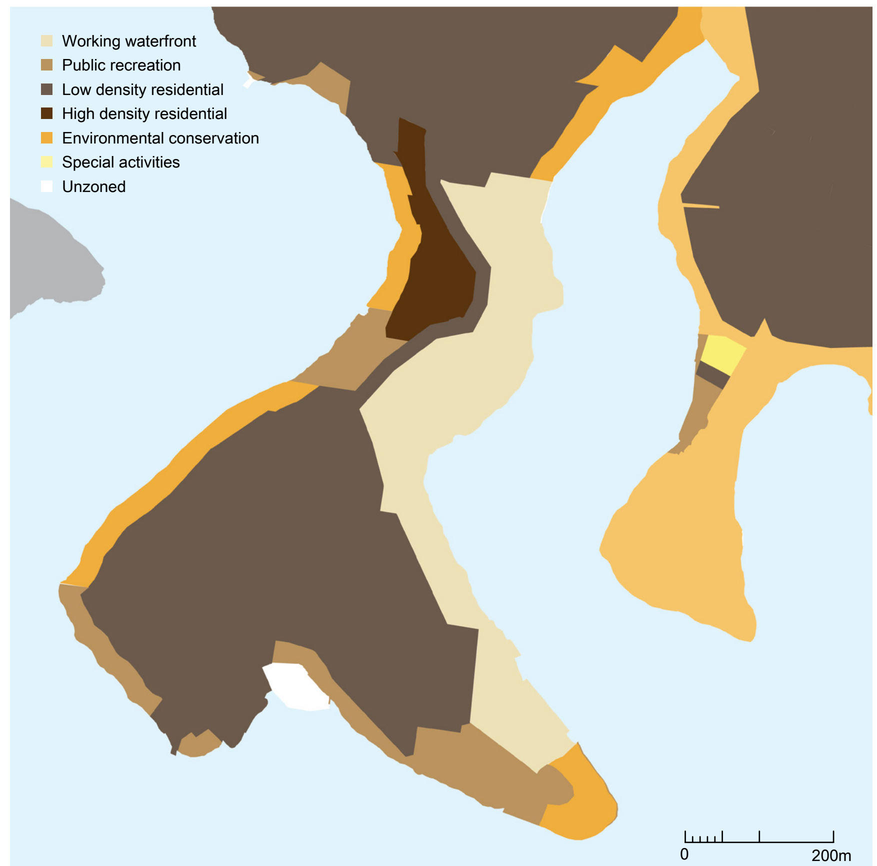


Figure 5.3-11:
Land zoning

Figure 5.3-12:
Locator

Figure 5.3-13:
Existing 265 bus and ferry transport routes
Figure 5.3-14:
Existing marked cyling and walking routes

rupts an almost continuous five kilometres of public, accessible waterfront from HMAS Waterhen in the east to Gore Creek Reserve in the west.

The peninsula is also somewhat limited in public amenities immediately adjacent to the site. However, the closest group of shops, 500m up Greenwich Road, features a range of shops including a small post office, supermarket, pharmacy and wine merchant. A swimming club and baths in the 'arc' of the peninsula offers the only real beach with a small café alongside. Further east is a small sailing club and council-maintained boat ramp, described by boaters as lacking facilities, steep and with limited parking (NSW Marine Directory, 2010). From this it could be surmised that the local residents must leave the peninsula to do most activities and, by the same token, there are few visits to the peninsula by non-residents.

5.4
REUSE PROGRAMME CRITERIA

Several important criteria need to be fulfilled to accomplish a successful reintegration of this tank farm back into its urban environment. These criteria, and other principles derived from research for the previous chapters, will be carried through to the design stage in the next chapter. While some of them are constructional issues that apply to the reuse of the tanks themselves, others are urban issues with effects beyond the boundaries of the site.

Figure 5.3-15:
No entry – the southern boundary at Manns Point Park

5.4.1 Improving harbour accessibility

As the Gore Bay Terminal currently maintains a large section of waterfront as inaccessible private property, the site rehabilitation must include new access to and along the waterfront for the use and enjoyment of the general public. This necessarily precludes the subdivision and sale of waterfront land to private interests, principally developers of residential apartments. This is also supported by recent local government guidelines, particularly Sharing Sydney Harbour Access Plan (NSW Dept. of Infrastructure Planning and Natural Resources, 2003, p. 5), which outlines a future vision of improved access to the harbour for a broad range of users including pedestrians, cyclists and recreational boaters. Increasing the permeability of the site to such users and a linking up of the three parks adjoining it would be a key advantage to these users. The relatively high price of property in the vicinity means only private interests, particularly developers of residential apartments would be likely to be able to afford such property, effectively extending the private nature of the land as it is at present.

Figure 5.3-16:
Heritage listed areas and objects (LCC, NSCC)

5.4.2 Recognising industrial heritage

Considerations should be made with regard to the heritage of the tank farm and its place in the history of Sydney Harbour as a working port and as a longstanding feature of the oil industry in Australia.

Any additions to the tank farm should not overpower or diminish the geometry and volume of the tanks to a point where their original purpose or form may be unrecognisable.

Not only do the tanks themselves have heritage value but so too does the landscape modified to accommodate them, as is the case at Waverton Peninsula Reserve and Ballast Point Park. The nature of the Gore Bay Terminal site's terrain is unusual for a tank farm in general but consistent with other former tank farm sites on Sydney Harbour. Consequently, the rehabilitation project should reintegrate not only the tanks on site but also the terrain as a part of the entire programme. For this reason, large scale earthworks, excavation or further modification of the landscape might not gain approval. This was proven in the case of a marina proposal for Waverton's Berrys Bay, in which the development was rejected by local

councillors in part because a proposed building blocked the view of the historic tank cuttings (Boyd, 2009, p. 6).
Despite the peninsula's status as a General Heritage Conservation Area (Figure 5.3-16), no tanks or their associated infrastructure have specifically been subject to heritage protection yet – the assessment of their heritage status would likely be appraised as a part of reuse proposal considerations. Heritage status may have to be applied to specific tanks or infrastructure to prevent their complete removal, should Shell wish to do so to carry out their site remediation obligations.
On the contrary, though the tanks have heritage value and importance, they are by no means unique, are not considered sacred and need not be preserved as monuments. A reuse project should have the flexibility to modify or reconfigure existing tanks central to the programme or completely remove tanks that prove to be conflicting with the rehabilitation and reuse plans. Should any of the tanks and their associated infrastructure stay unchanged as part of the reuse strategy, it would be necessary to ensure that they are made safe and adequately maintained to remain so.

5.4.3 Improving environmental quality

At odds with the surrounding area is the lack of vegetation and environmental habitat for flora and fauna. This is in contrast to the numerous parks and areas of ecological conservation in the area immediately around the site. Not only are these areas important for the ecology of the Sydney harbour foreshore and surrounds, they also provide valuable leisure activity space for Sydney's residents and visitors. Therefore, linking up of the existing parks and ecological zones which are adjacent to the site and nearby should be a crucial consideration in the reuse programme.
Also, this strategy is likely to work together with ongoing environmental remediation, such as through an associated programme of passive phytoremediation. Detailed proposals for eco-remediation are beyond the scope of this thesis, yet master planning and architectural interventions are consistent with this objective. While Shell Australia (the current owners) may be inclined to completely remove the tanks for remediation purposes, heritage protection status would dissuade them and may even help. If contaminated soils can remain sealed under their concrete foundations and the pads that surround them, as per one method of toxin containment, then the scope of remediation work could be lessened or supplanted with another (e.g. groundwater well filtering). Remediation of the site is likely to be forced upon Shell Australia before it is vacated, though measures taken to do so are likely to be incomplete in practical terms. Therefore, future uses should take into account the likelihood of remediation as a continuing process that can be aided and enhanced by the nature of the reuse project.

5.4.4 Density without congestion

As the site is on a peninsula with access off a single road, this access route is unlikely to be able to support a reuse programme that may cause undue congestion. As most of the traffic presently involved in the site's operation is not by road but via sea and pipeline, any new uses for the site are likely to increase vehicular traffic along this single route. Extra capacity may be achievable with road upgrades but is limited by factors such as space available for widening measures. Strong opposition from those residents it would affect is also likely.

However, due to the relatively sparse spread of built form on the site compared to the surrounding area, an opportunity remains to densify the site with a variety of uses and additions to the existing built form presently on the site. Infill and intensification of such sites has proven elsewhere in Australian cities to be profitable and supported by planning guidelines (Randolph, 2004). Strategic densification coupled with improved accessibility to urban open spaces and the natural environment are also key parts of New South Wales' State Planning Department's plans for the future management of Sydney's growth in the decades to come (NSW Dept. of Planning, 2005, pp. 119, 140, 150).

Any reuse and development programme should be consistent with these and other guidelines in local government planning documents. It would also have an advantage to be sympathetic to the wishes of local residents, especially where issues of noise and traffic congestion apply.

5.4.5 Additional considerations

Much of the research of previous chapters and analysis of this particular site suggests a low intensity intervention is the most appropriate for the Gore Bay Terminal. Keeping the redevelopment of the tank farm site to a low-impact approach would satisfy many of the criteria above and reinforce the heritage importance of the tank farm site and its modified landscape. It may also go some way to alleviating the concerns of residents and easing pressure on potentially constrained local infrastructure.

While the criteria listed above are the major factors to consider and specific to this site, there are other factors necessary to consider that will influence the outcome of the reuse project. While some of these may not be directly associated with the tanks or industrial heritage of the site, they still may be considered good urban design practices and hence be influences on the redevelopment.

The scale of any buildings added to the site as a means of increasing density should be somewhere between that of the tanks remaining on site and the other built form on the peninsula. This would provide a visually balanced transition between the large volumes of the tanks and the houses and apartments beyond the perimeter of the site, particularly if they are to be placed in the spaces between the two.

Materials used in further additions to the site should also be sensitive to the status and history of the site as an industrial working waterfront. Steps can also be made here to provide a visual link between the remaining tanks and the industry they represented and the future of the tanks, reused and reconfigured.

Where possible, most of the peninsula's buildings are orientated away from the Gore Bay Terminal. In reusing the site, the opportunity arises to orient new and reused structures back into the cove and to take advantage of the spectacular views of the cove, harbour and city beyond. Also, as proven by the rejection of the proposed development at Waverton, sight lines from vantage points across the cove and on the peninsula itself should be maintained where possible.

These criteria, and other principles outlined in the previous chapters, will be carried through to the design stage of this thesis to establish a viable project for reintegration of this tank farm back into its urban environment. While some of them are issues that apply to the site and tanks themselves, others are urban issues with effects beyond the boundaries of the site.

6.0

AN ADAPTIVE REUSE PROPOSAL FOR GORE BAY TERMINAL

This chapter takes the criteria and principles outlined in the previous chapters and applies them to a reuse project for the Gore Bay Terminal.

Figure 6.1-1:
Gore Cove from Manns Point Park

6.1

DESIGN STRATEGY AND JUSTIFICATION

6.1.1 The scope and limits of the design component

A site of this size and nature is likely to be a sum of parts planned and designed by a number of parties across a number of disciplines – architects, landscape designers, city planners, structural engineers, etc. and carried out over an extended period of time. It is beyond the scope of this thesis to delve into all of these disciplines and design a rehabilitation project for the entire site. Therefore, the design component here concerns the first part of the redevelopment strategy, focusing in particular on the first steps of rehabilitation of the whole site – an architectural intervention for the area of the largest tanks at the north end. This not only fits in with the redevelopment strategy of gradual and incremental change for the site but, by having a number of design contributors over time, would avoid any homogeneity that may result from a specific design formula spanning the entire site.
Nevertheless, an indicative masterplan for the entire site outlining a vision of its possible future in terms of land use, pathways, connections and built forms has been drawn up (see fold-out masterplan insert p. 55).

6.1.2 A mixture of uses

The site's location on a peninsula among low density housing with limited road access precludes a high density and highly active end destination development. Possible develop-

Figure 6.1-2:
Boat ramp and swing mooring distribution on Sydney Harbour

ments such as high-density housing, commercial business park or events centres over the entire site may stretch local infrastructure, especially road access, beyond present or feasibly upgradable capacity. For this reason, a low impact scheme of development overall is considered most appropriate. This would still include factors of housing, leisure, commercial and cultural activity but on a scale within the limits of resources.

A mixed use development is suitable for this site due to its large area and the opportunity to apply uses to the site that may have an attraction for a wider cross-section of both local and visiting users rather than a single type of user. Commercial interests can be accommodated on the site with sufficient additional space for park, leisure and residential purposes.

Unlike the other former tank farm sites on Sydney Harbour, the one at Gore Bay is significantly large enough to support a variety of uses, whilst still having the potential for large areas of public open space and activity. Furthermore, a variety of uses presents an opportunity to create a vibrant and active addition to the urban harbour setting and to also generate income in the form of property leases and rates. Single use parkland, as at Waverton and Ballast Point, may only present another drain on resources for local taxpayers, despite the obvious benefits of the local environment and population.

As the site has a reasonably low existing density of (non-)buildings, a degree of infill under the guidelines of local and state planning authorities would be appropriate densification of currently underdeveloped urban land, though this would necessarily be medium density with regard to those guidelines and the site's location and surrounding environment.

The location and topographical nature here presents some opportunities consistent with a mixed use development across the site. For instance, changes in elevation support the strategy of providing views and accessibility to residential areas set back from the water, while lower elevations by the water suit more active public use.

6.1.3 A new maritime precinct

Taking advantage of the topography and location of the Gore Bay Terminal, the key strategy for the reuse of this tank farm is to create a maritime-based precinct in a gradually phased redevelopment programme. This would support a mixture of public open space, residential accommodations and commercial interests. Maintained throughout the site is the overriding principle of encouraging and enhancing access to, and enjoyment of, the site's primary assets – its unique industrial heritage, landscape and extensive foreshore.

The first and perhaps largest element of this proposed maritime precinct is a dry stack boat storage facility in the three largest tanks on the site. This would be followed by marine workshop facilities and maintenance facilities in other tanks, along with public open spaces and new residential buildings. These elements of redevelopment would satisfy several criteria outlined in local and state government planning guidelines and policies covering boat storage and launching, harbour access, maritime activity, and urban redevelopment.

Of particular interest is the increasing number of boat registrations, current moratorium on commercial marinas, congestion of bays by swing moorings and insufficient number of adequate launching facilities noted in Boat Storage Policy for Sydney Harbour (NSW Dept. of Infrastructure Planning and Natural Resources, 2004, p. 8). All of these factors could be somewhat alleviated by the establishment of dry stack facilities, of which there is surprisingly only one (due to open in Rozelle Bay) and, as the report notes (p. 11), there ought to be more.

The advantages of dry stack boat storage to the city and boaters are numerous, including:
Less congestion of existing overcrowded boat ramps
Less road congestion of towed boats
Easing pressure on a congested harbour of swing moorings
Increasing boat protection and reducing boat maintenance
Though this type of facility targets a specific demographic (i.e. boat owners), this key feature will anchor the project and be incorporated into a gradual redevelopment of the tank farm that will eventually spread across the site with facilities and activities beyond its initial users to the general public.

6.1.4 Phased development

The development proposed for the Gore Bay tank farm site would be structured into several stages (Figure 6.1-3). The first stage can commence as soon as the site is available and is of a nature that would require the least site remediation. The later stages can also commence at this time but the nature of the rehabilitation there requires a longer process of remediation, replanting and regeneration before the programme for these areas is realised.
The site would be divided into three phases, largely using the three general topographical divisions of the site outlined in the previous chapter as a starting point (the north, centre and south sections as defined in Figure 5.3-9). Other projects outlined in the previous chapters have shown that favourable outcomes have been achieved by incremental or staged development of the site or structure to be rehabilitated. Furthermore, a phased development for the Gore Bay Terminal is likely to reduce the potential impact of a larger scale project on local infrastructure, environment, resident disruption and funding strategies.
Phase One covers the waterfront at the north end of the site which includes five of the largest tanks, plus an area of open space on the terrace behind these large waterside tanks. Much of Phase One would be commercial development of these five tanks and development of their surroundings, including public access routes, the beginning of a waterfront promenade and the ‘greenification’ of the otherwise fairly barren terrain. Due to the topographical constraints of the site, there would be some overlap here and there, such as an access road through Phase Two and the section alongside Greenwich Road delayed until Phase Two.
Phase Two covers the rest of the remainder of the north end of the site and the broader central area of the site. This phase would enable the continued ‘greenification’ of the site started in Phase One and extend it to the broad centre of the site and up to Greenwich Road. The densification programme can continue with the construction of housing units alongside Greenwich Road and the middle terraces.
Phase Three would complete the reuse of the site and cover the remaining southern portion. As happened at London’s Bankside Power Station, in which the electricity company retained use of a portion of the building after Tate Britain had moved in, it may even be possible for the oil company to continue limited operations at the southern end of the site (where the majority of tanker docking facilities, terminal buildings and a denser network of piping and infrastructure remain) for some time whilst the northern end is undergoing reuse project implementation and site remediation.
Should the whole site become available for rehabilitation at once, the site remediation measures and green corridor programme of vegetation renewal can be carried out throughout the entire site, ahead of the phased schedule of the building and reuse programme. This would not mean that this aspect of the rehabili-

Figure 6.1-3: Phases of site rehabilitation


Residential cluster
Semi-circular private gardens behind residential clusters
Residential cluster with car stack parking tanks
Removed tank footprints as remediative wetlands
Existing parking platform retained
Residential cluster
Car stack parking tanks
New entry point connecting the site to Balls Head Park and surrounds
New entry points connecting the site to Waverton and surrounds
Tank 1 reconfigured with added building for a scuba training facility
Maritime workshops in Tanks 2 & 3, with adjacent yards and dedicated boat ramp
Green roofs and skylights on Tanks 2–6
A dry stack boat storage facility in Tanks 4-6 with associated facilities connecting the green corridor, rooftop terrace and waterfront
Access canals to dry stack tanks
An active public promenade at the water's edge runs the entire length of the site
Boat launching ramp for dry stack users
Jetties and ramps for launching small craft
The central park and green corridor ties the adjacent public open spaces to together, advances site remediation and provides a buffer between the activities on the site
Existing wharf and building reused for ferry stop and further commercial activity
The dormant industrial heritage zone featuring abandoned tanks, oil docking wharf and associated infrastructure re-tained as industrial artefacts
INDICATIVE MASTER PLAN 1:2000

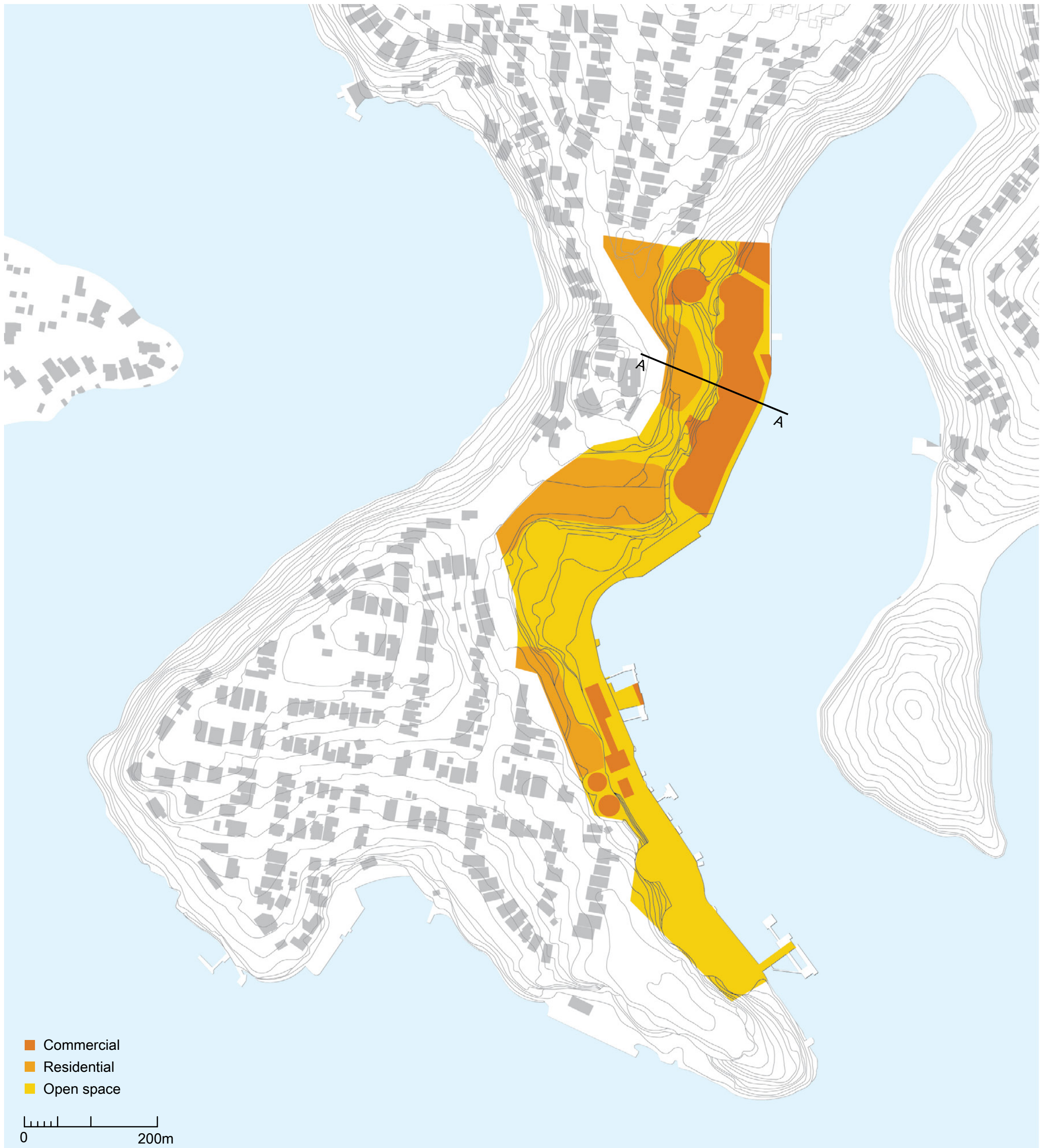


Figure 6.1-4:
Land use plan with
2m contours

tion programme (the green corridor) is complete but begun ahead of schedule. As noted earlier, site remediation, particularly phytoremediation, is often a time dependant process and is likely to continue beyond the completion of all phases of the project.

6.1.5 Topographical division of land use

Under the proposed mixed use for the site a division of land between commercial, public and private can be loosely applied (Figure 6.1-4). Naturally, there are areas where the boundaries are less than clearly defined and activities and uses will blend together and overlap as shared spaces. The interface between the public promenade on the waterfront and the commercial activities is a case in point.
The lowest parts of the site next to the water would be shared by a greater variety of users and provide the most access and activity for the general public. The water's edge is the zone that is most valuable as public leisure space and to which greatest importance is attached by local government guidelines. Therefore, the entire length of the lowest level of the site at the foreshore will be publicly accessible promenade space, interspersed with vegetation, points of access to the water and commercial activity. This would restore public foreshore access to a large section of the harbour between North Sydney and Lane Cove.
The upper terraces at the wider parts in the north and centre represent opportunities for residential apartment development at the inland perimeter of the site. Though there would have to be some permeability of this zone for the use of residents and the public, these parts of the site are sufficiently removed by elevation from the foreshore to allow a greater degree of privacy and proximity to the road that small apartment blocks are likely to need, whilst still having a view of the bay and the city beyond.
The middle tier will provide the space for a landscaped green corridor to bisect the park along its length at the north end, spread wider over the gentler sloped centre section and diverge with the public promenade at the narrow south end of the site. This green corridor will serve several functions. Firstly, it will act as a buffer between the highly active and public foreshore and the less active and semi-private upper tiers by the road. Secondly, it will serve as a secondary path through the site, aside from the waterfront promenade, for pedestrians and cyclists. Thirdly, it will act as a green connection, linking up the parks and conservation areas at either end of the park and across the isthmus. This will also help to add to the biodiversity of the site and its surrounds.
Though some earthworks may be necessary, in many places on this site, divisions between public, semi-private and private areas can be assisted by the existing topography, rather than with structured barriers, planting or other

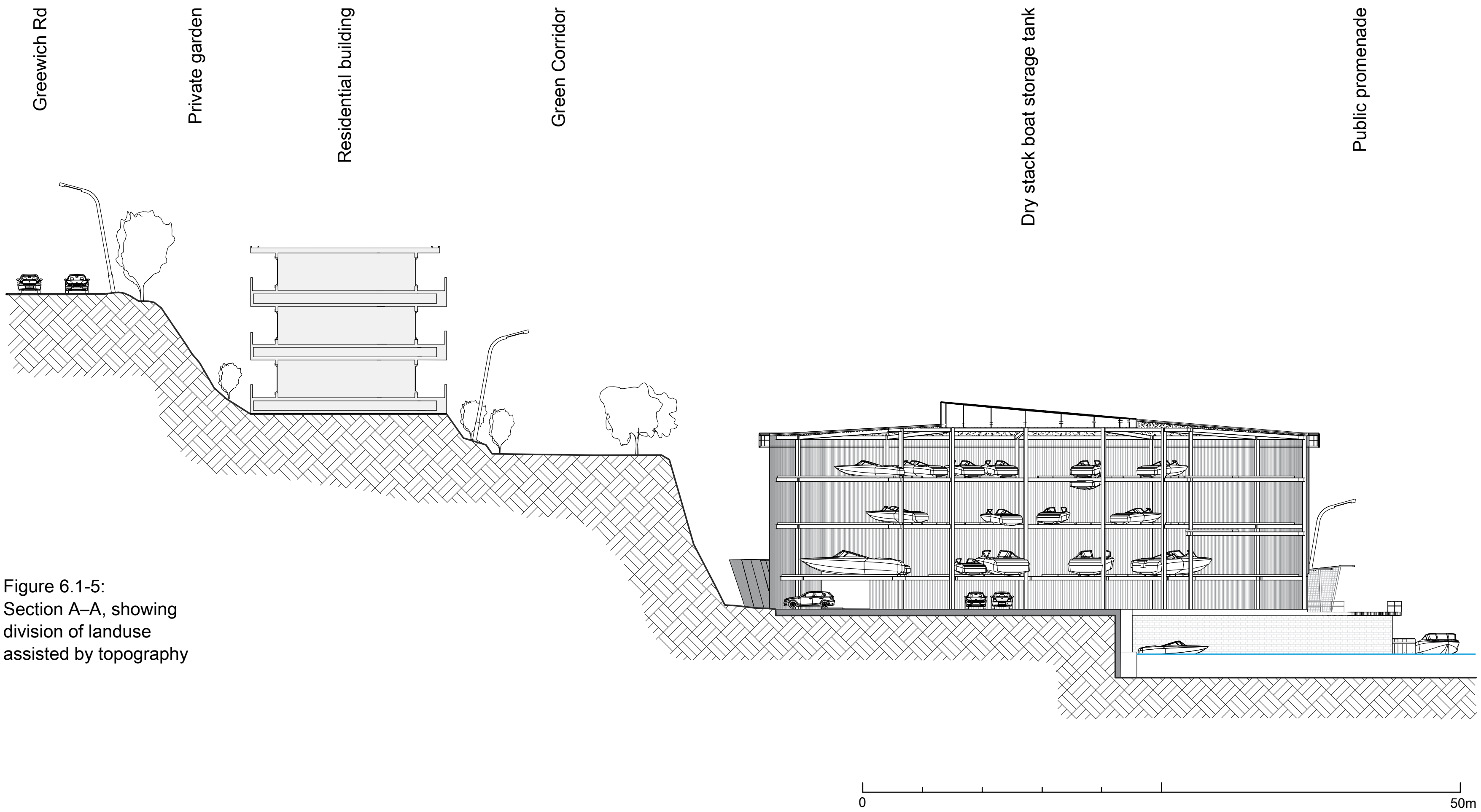


Figure 6.1-5:
Section A–A, showing division of landuse assisted by topography

means of separation (Figure 6.1-5).
For instance, apartment buildings on the perimeter of the site can be part of the public zones that they overlook, while the element of separation and privacy they require is afforded by the slightly higher elevation of the upper terraces.

6.1.6 Topographical division of architectural programme

As the division of land use follows roughly topographical division, so too would the programme of architectural intervention for the tanks and associated structures' reuse proposal in this study.
Those tanks nearest the water and in the zone scheduled for the highest level of intervention and public activity would need to have a function of reuse appropriate to this position.
A commercial or public leisure function would be most able to take advantage of the prominent waterside position and be most beneficial to the success of the project.
Those tanks on the higher, inland side of the site would obviously not have this waterfront advantage and would therefore need an alternative function. It could also be argued that these upper tanks are less important to the site and its heritage, being smaller and less integrated into the landscape than the larger, carved-into-the-hillside waterside tanks, despite their higher ground placing. For this reason, they are probably the most likely candidates for removal. Indeed, several tanks on the hillside have been removed recently after consultation with local residents (Shell Australia, 2011).
Buildings erected as infill amongst the upper tanks would be residential apartment buildings and townhouses, in keeping with the rest of the neighbourhood, particularly along the road at the isthmus.
Though the design component concentrates on one part of phase one, the principles of the strategy outlined here with regard to division of land use, architectural programme and phased, incremental rehabilitation can be continued throughout the site, resulting in a successful, ongoing project of reuse and renewal.

6.2

PROGRAMME FOR PHASE ONE

In light of the design criteria noted above, an appropriate programme of reuse was developed for Phase One of the Gore Bay Terminal's redevelopment. While many of the steps taken to rehabilitate the Gore Bay Terminal adapt successful precedents from existing reuse projects, many of them are unique to, and appropriate for, this site alone. The reuse of the largest three tanks is the principal element and forms the basis of Phase One of the reuse project.

Listed here are the three primary objectives:

A dry stack boat storage facility for the three largest tanks (4,5 and 6), including:

– Installation into the tree tanks of radial boat racks

– An extension on the south side and roof of Tank 5 for the associated functions of a commercial dry stack business and further extensions joining the three tanks together.

– Excavation of three launching canals through the seawall and into these three tanks, with footbridges over the canals and preservation of the remaining seawall.

– Glazed skylights and green roofs for tanks 4 and 6.

– A boatyard and maintenance workshop at the two northernmost waterside tanks (2 and 3) with a dedicated boat ramp.

– New dockside mooring jetties along the seawall in front of the dry stack.

A network of new routes and connections throughout the site, including:

– A waterfront promenade alongside the bay as the principal public open space and primary access to the water.

– A network of pedestrian and cycle paths throughout the site to connect up with existing routes through the adjoining parks and streets, complementing the waterside promenade.

– The vehicular access route to be extended from the main entrance down to the waterfront, including a single boat ramp for the dry stack facility.

– A second vehicular route entering the site to the upper dry stack facility entrance.

The initiation of the Green corridor of planting to extend through the length of the site, including:

– A programme of planting and ground cover as part of the ongoing remediation of the site and to ecologically reconnect the peninsula's green spaces.

– A tree-line, gardens and planters along the waterfront promenade.

– A tree line and ground cover along the middle terrace behind the dry stack tanks, continuing around Tank 6 to the promenade.

6.2.1 The dry store boat stack

6.2.1.1 Demolitions and removals

First, to open up the compartmentalised nature of the tanks, the existing bund walls are removed. Though they may have some heritage value themselves as part of the tank network, they stand in direct conflict to the project objectives of opening the site up with paths and public open spaces throughout. For this reason, they are too difficult to retain as they are. It is conceivable that some of the removed bund walls could be cut down and reused elsewhere as landscaping components (e.g. path sections, steps, solid fill, etc). The

rehabilitation of Ballast Point Park used a similar strategy of recycling, packing gabion walls with rubble and other artefacts from the site. A much larger bund wall was also retained but in this instance it did not interfere with the openness and permeability of the park.
Some of the large expanses of concrete pads amongst the tanks are removed also, to allow for replanting and resurfacing with more appropriate materials. This is primarily on the areas behind the waterside tanks. The area between the dry stack tanks and the water's edge, which includes the promenade and the plaza in front of Tank 5 entrance, will remain as hard surfaces. This is the area of highest activity – where the activities of boat users, residents and other site users are likely to cross over most.
Opening up the centre of the site, for development of the access roads for Phase One and the open spaces and buildings of Phase Two, will also require the complete removal of tanks 9, 10 and 12.
As the three tanks for the dry stack (tanks 4, 5 and 6) are all of the floating roof type they are unlikely to have any internal structure that cannot be removed. Because of this, the roof can be removed from each and the external walls can undergo the required cleaning, sealing and repair where necessary. There is also a network of pipes, valves, gantries and spiral staircases which will need to be removed, recycled or restored as necessary. Some of these elements can be reused as urban furniture and sculptural features in the redevelopment.

6.2.1.2 Site remediation
It is almost certain that some site remediation would have to be undertaken before Phase One can begin. The extent to which that is necessary is likely to remain unknown until the site is investigated and fully assessed. However, it is hoped that the measures necessary for Phase One are more limited than they might be for other parts of the site. Also, the standards of remediation required for a dry stack boat store or similar commercial operation are less stringent than those required for residential and recreational developments (NSW Govt., 2005).
The steel tanks will also require some degree of remediation. After cleaning and repair, the steel itself will most likely need a sealant to lock in any contaminants (e.g. lead) which may have infiltrated it during its working life.
As the public promenade and operations area around the dry stack tanks are largely covered with hard surfaces, remediation of this part of the site may be able to be achieved faster than the rest of the site while remediation of the remainder can commence and continue at a slower and more natural rate.
Furthermore, under NSW State Government law, Shell Australia would remain responsible for addressing remediation of the site before it can be vacated (NSW Govt., 1997). Shell are likely to meet their legal obligations for remediation under the site's current Working Waterfront zoning (into which a commercial boat storage facility falls) but for a change of zoning to residential and recreational use, a further programme of remediation may be imposed upon them or the developer by planning authorities (NSW Govt., 2005).
Shell Australia are obviously aware of this and have taken some steps to deal with the site, commissioning UBM Ecological Consultants to draw up a remediation strategy for the land on the terminal site (UBM, undated). Crucial to the success of the remediation programme is continuing cooperation of Shell Australia, the developer, local planning authorities and consultants such as UBM.

6.2.1.3 Added structure and infrastructure
To construct a dry stack boat storage facility within the tanks, plus the additional building required to operate it, it is necessary to add a substantial amount of structure to support them. This was confirmed by a structural engineer to be a viable and practical solution.
A structural steel framework of boat racks is inserted into the three tanks, each of which is high enough to accommodate a three- or four-high stack of 24 boats in a radial rack (Figure 6.2-1). The lower racks in each tank have several segments missing to allow for the entrances and launching canals. The centre tank is slightly smaller and allows a maximum boat length of 8m, while the slightly larger outer tanks can accommodate boats up to 10m. This still allows for an adequate loading and turning circle for the launch forklift (the standard machinery for a dry stack). As is often the case in dry stacks, space is available for car parking under the racks where possible.
The primary structure that supports the boat racks also supports the green roof and skylight on each dry stack tank. On Tank 5, the green roof is reduced to a raised garden to make room for the roof terrace and restaurant. The centrally placed skylights, raised above the line of the edge of the tanks, are surrounded by spirally inclined green roofs. These serve

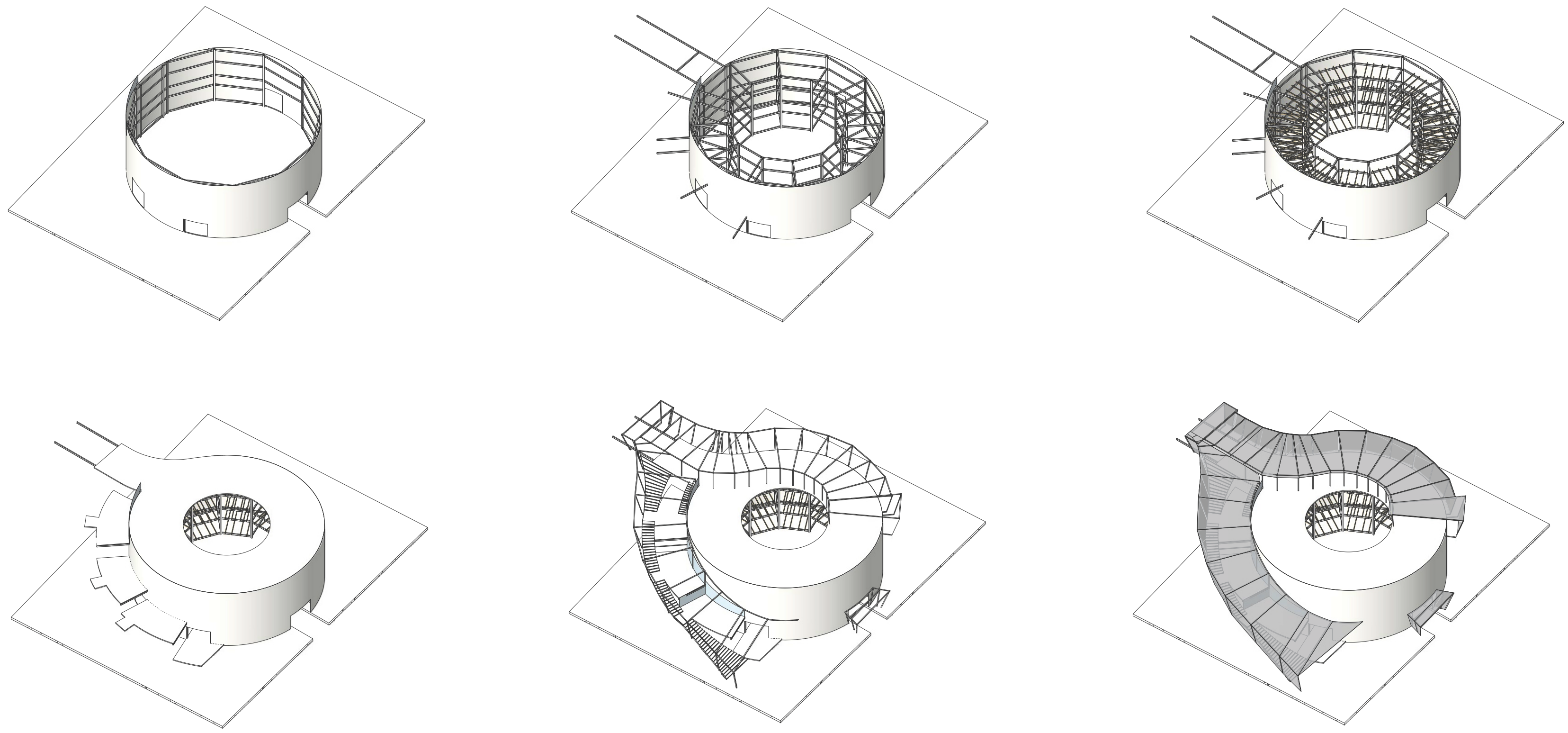
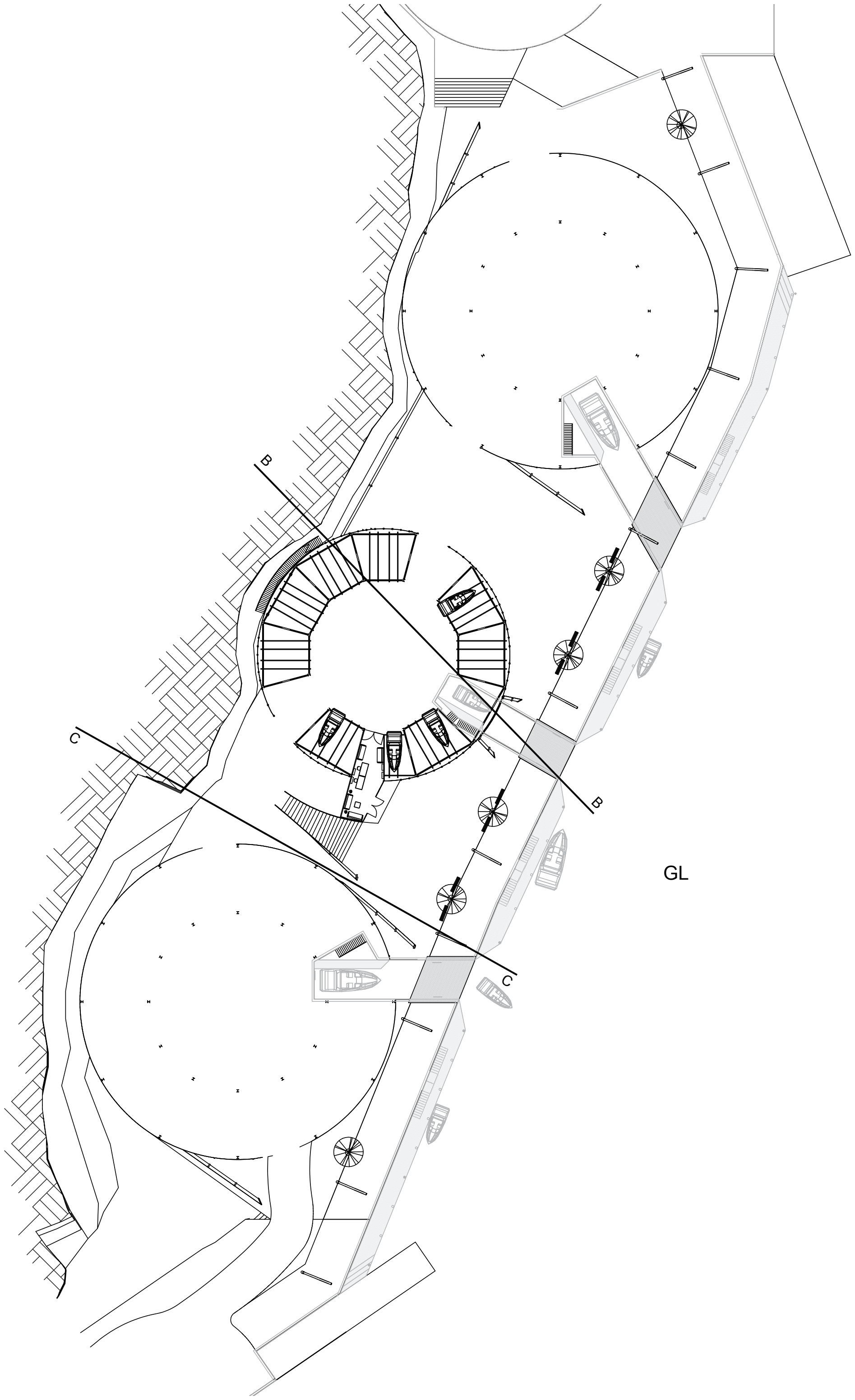


Figure 6.2-1:
Added structure

to catch and direct rain water for reuse and to absorb some of the heat which a large metal tank may otherwise accumulate in the hot summer months. The rainfall tanks can be either buried under or alongside the structure, or placed between the tanks and cutting behind, along with fuel tanks necessary for the dry stack's day-to-day operations. There is a certain irony of installing tanks within tanks but the volumes required in the reuse project fall far short of those offered by the existing tanks on site.
The addition of air vents around the rim also serves to dissipate internal heat gain and ventilate the tanks naturally.
The structural beams that support the boat racks also cantilever through the steel skin of the tank to support the external additions. The beams supporting the entry bridge extend all the way into the terrain behind, connecting the structure to the topography at the upper level. This negates the need for support columns on the exterior of the tank which could interfere with the operations outside.
To this primary structure of beams and columns is added a secondary structure of steel framing supporting the walls and roofs of the additions on the side and roof of Tank 5.

6.2.1.4 Function and form
The intervention for the tanks themselves largely avoids wholesale changes or removals to the existing tanks for several reasons:
As noted earlier, large segments of the tank should not be removed without compromising structural integrity. Also, removing large portions of the tank would reduce the potential capacity of the boat stack and be detrimental to the understanding and appreciation of the actual function of its past and future uses.
Conversely, the potential to make additions to the existing tanks is not so limited, and some are necessary for the dry stack boat storage facility.
Most importantly, the form of the additions to the tanks seeks to complement the existing objects without trying to obtrusively overpower or compete with them. At the same time, these complementary additions are large and distinct enough from the original to avoid being overwhelmed by the sheer volume and singular geometry of the tanks. The geometry of the additions is a step forward in complexity compared with the tanks but can still be regarded as single volumes of visible difference and obvious inhabitation attached to the existing structures.



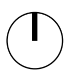
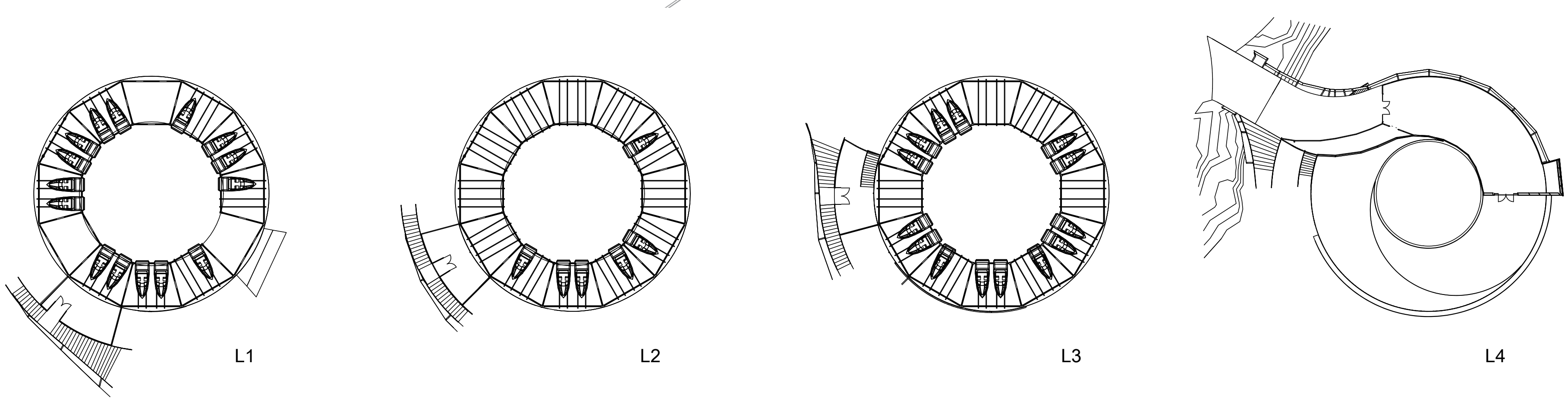


Figure 6.2-2:
Plans 1:1000



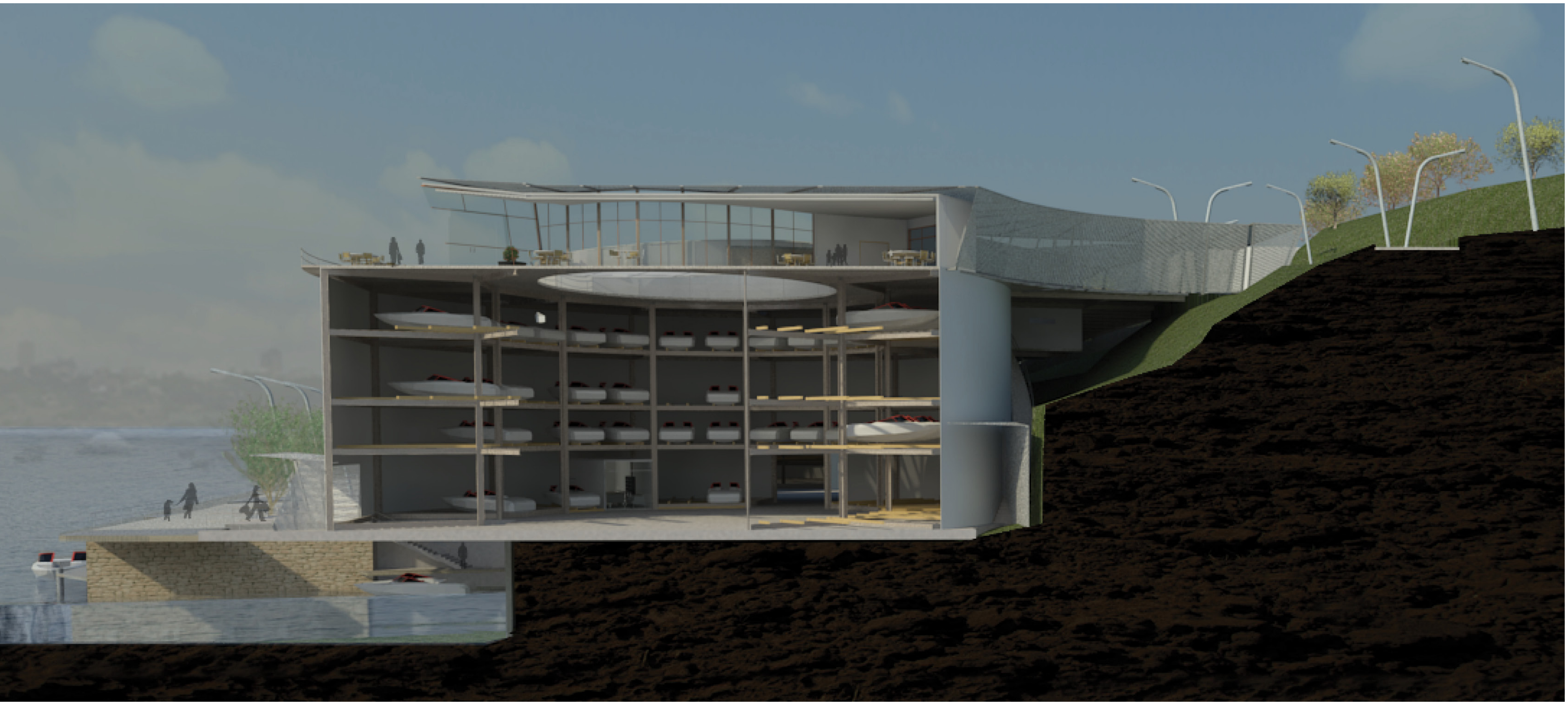


Figure 6.2-3:
Section B–B

The architectural additions to the three tanks fulfil several functions beyond mere boat storage. As is typical for a boat storage facility, additional services for its clients are provided, much as a marina or yacht club might. These include a bar and cafe, reception area, showers and toilets and administration offices.
The bar and restaurant on the top of Tank 5 acts as the focal centre of the boat stack, being connected to the waterside level by the external stairway and to the topography behind via the entry bridge. Outside on the roof, there is a terrace and roof garden. This space allows visitors a visual connection to the comings and goings of the harbour and into the workings of the interior through the central skylight.
The other functions are attached in a descending half-spiral around the side of the tank, from the entry bridge to the waterside, in three split levels – the kitchen, the ablution level, then storage and administration and finishing with the reception and operations office at ground level (Figure 6.2-2). This spiral arrangement of spaces is used as a response to the terrain of the site, linking the upper entrance on the terrace behind with the lower entrance at the waterside. Its form also references its host by evoking the steel catwalks that ring every tank and the spiral stairways that curl up the side of them.
The three tanks are connected by a driveway for the launch forklift and emergency vehicles, which are covered between the tanks by further perforated, aluminium mesh canopies. The launch canals and each of the other entrances also have a similar canopy denoting their openings.
The addition of canopies over the openings, raised skylights and canopied connections between tanks, other tanks and terrain also expresses clearly the change of function from uniform cylinders into a networked array of inhabited spaces.

6.2.1.5 Textures and materiality
These separate levels are covered in insulated translucent polycarbonate panels on aluminium framing. They are all then enclosed with the connecting staircase by an angular, tapering perforated-aluminium screen. This perforated screen is duplicated over the top floor café-bar where it covers the exterior glazing and juts out over the edge of the tank, curving around it to meet the staircase section at the entry bridge.
An identical skin of mesh screen over translucent cladding overlaps the top edges of tanks 4 and 6, enveloping the existing catwalks that encircle them.
This skin over the extension will have the dual effect of being a solid, shiny entity by day and a glowing, porous form at night, extending out of the terrain and wrapping itself around and over the tank, with two circular ‘halos’ on the tanks on either side (Figure 6.2-6).
The materiality of the new additions is intended to reference and pay respect to the industrial nature and origins of the original structures, whilst being distinct enough from them to be an unmistakeable progression

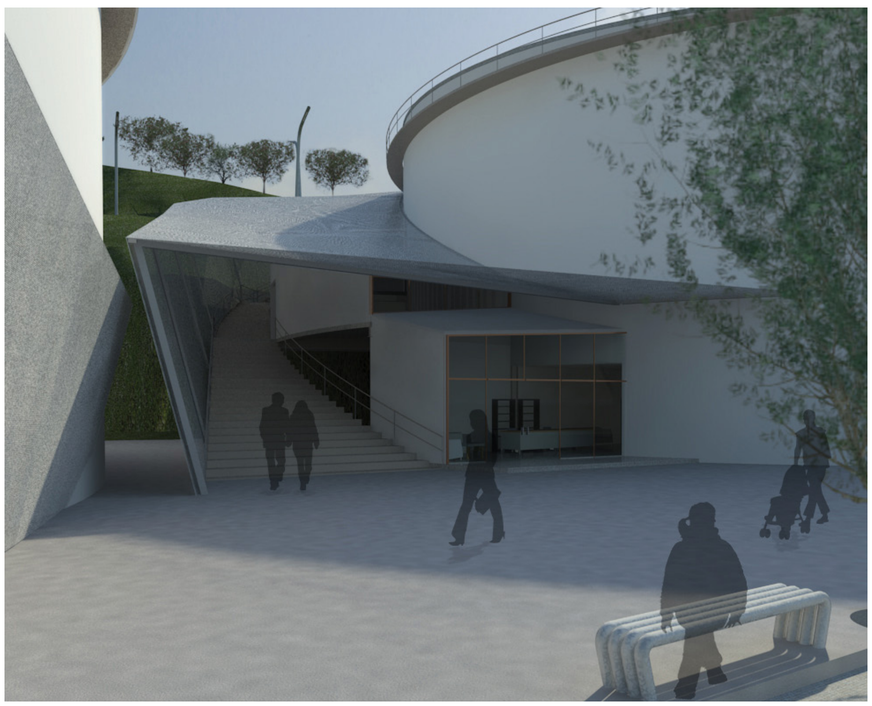


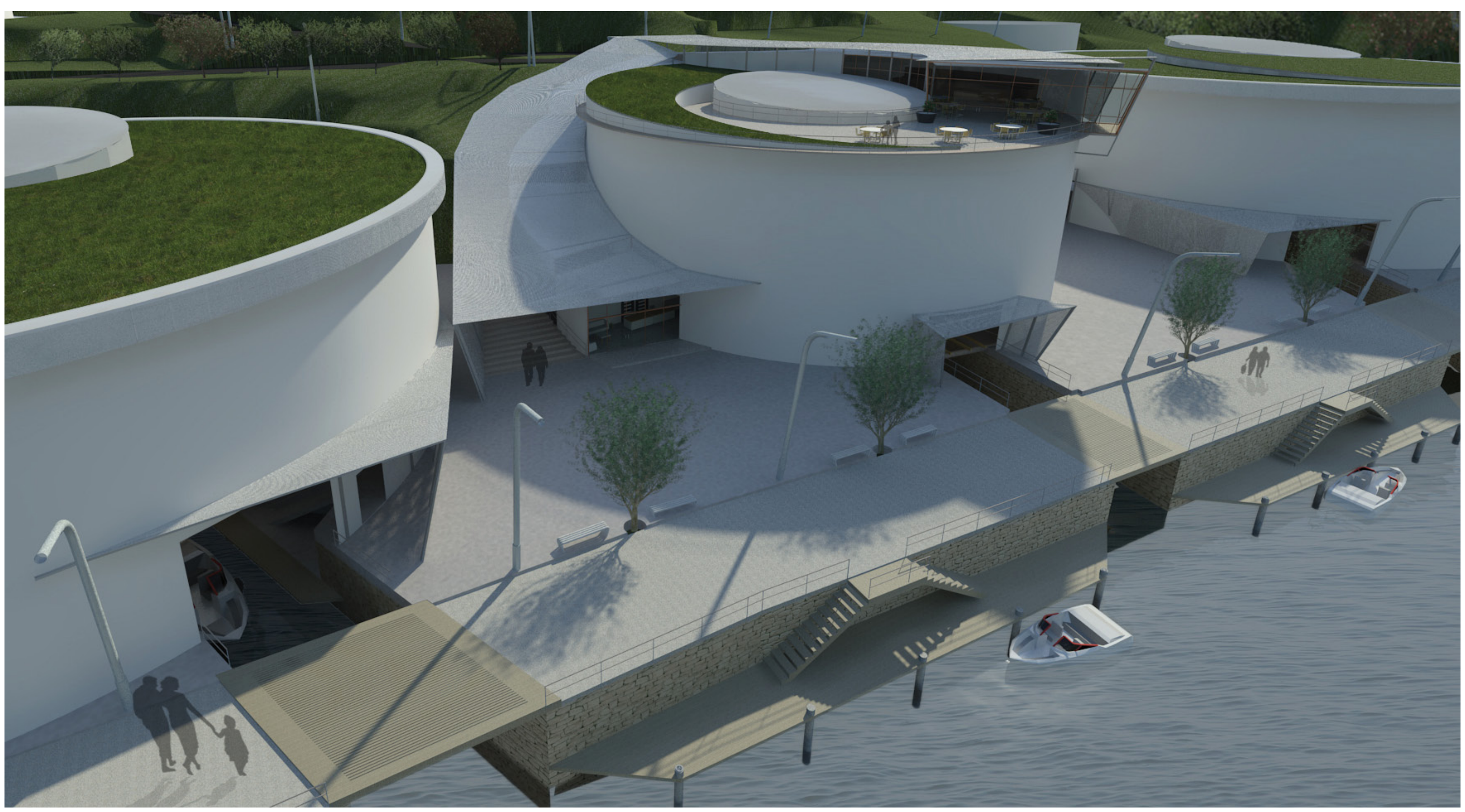
Figure 6.2-4:
Section C–C
Figure 6.2-5:
Plaza
Figure 6.2-6,7:
Night views
Figure 6.2-8:
Waterfront
promenade

in the tanks' form and function. This choice of materiality also provides a link between the industrial and the domestic and the past and present. Where steel and concrete may represent dense, heavy materials of the past and of traditional industry, perforated aluminium and translucent polycarbonate represent lightweight and permeable new industry and contemporary dwellings. The comparison can be drawn further still, from the crude iron, earth and oil of the original functions, to the crafted and refined porosity and translucence of the new.

Despite the differences, each of the major steps in the intervention seeks to establish a relationship with the others through commonalities of material and texture. For instance, the dry stack tanks green roofs link up visually and materially with the green corridor and the recycling of some of the site's past-use artefacts into street furniture acts as a reminder of and reference to its former function.

6.2.1.6 New pathways – a permeable site
The various modes of transport to be using the site – vehicle, pedestrian, cycle, boat and small craft – will be kept largely separate but still cross over one another and share space in places. For this, several new pathways will emerge as part of the rehabilitation plan, some primary and some secondary (Figure 6.2-11). Principal among the primary routes are the waterfront promenade and the green corridor for cycles and pedestrians, and a vehicle route from the main entrance to the dry stack tanks.

6.2.1.7 Foot traffic
The promenade is a wide pedestrian and cycle route following the seawall around the cove.



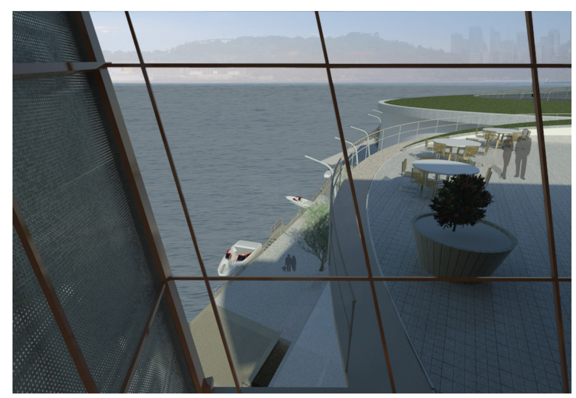


Figure 6.2-9:
Aerial view
Figure 6.2-10:
View from rooftop
lookout

This begins at the north end boundary of the site and links up with paths entering the site from Chisholm St and Hollaway Park. Along this route it passes the three dry stack tanks and crosses the launching canal bridges.
This is the most active part of the site and will become the focal point of Phase One. Lined with trees, seating and street furniture, some of which is crafted from reused piping and site components, it allows the opportunity for users to observe the comings and goings of boats and enjoy the activity at the waterfront.
The green corridor begins from a similar point on the northern boundary as the promenade. This route follows the middle terrace behind the boat stack and meets the promenade near the apex of the cove south of Tank 6. From there it will continue around the cove alongside the promenade in Phases 2 and 3.
Complete viability of the promenade and green corridor may also depend on the upgrade or establishment of connections beyond the boundaries of the site. In particular, it would be ideal for a pedestrian and cycle route to be established through Hollaway Park to Gore Cove Reserve and onward to Wollstonecraft Railway Station. However, this may prove to be costly and difficult due to the steep terrain and Environmental Conservation status of Hollaway Park.
Currently closed entrances to the site from Greenwich Road and Chisholm Street will be re-established, with further entrances for Gother Avenue and Manns Point Park to follow in due course of the project.

6.2.1.8 Vehicular traffic

The primary vehicle access is via the driveway that leads from the existing main entrance down to the boat ramp next to Tank 6. This driveway then continues all the way through the tanks to the workshops at Tanks 2 and 3. Secondary routes through the site include a driveway entering the site at the existing entrance opposite Landenburg Place to the upper entry of Tank 5, eventually leading to the nearby apartments and parking stacks of Tanks 7 and 8 in Phase 2 (Figure 6.2-13). Naturally, boats in the stack need to be launched when required. Standard practice

Figure 6.2-11: New walking and cycle routes

Figure 6.2-12:
The green corridor

for a dry stack is for the forklift to drive them to a launching bay, however, as this would be problematic on a public promenade, the solution is the insertion of the three launching canals. Each of the canals has a hydraulically operated bridge on the promenade to rise slightly for taller craft at high tides. As the heights of the boats are limited by the stack height, this would not be too often or need to go too high.

Alongside the promenade at sea level there are new docking jetties for the mooring of boats and small craft using the bay. This is necessary for the loading and unloading of boat users and adds another dimension of activity to the promenade.

Boats can be initially launched for storage at the boat ramp by Tank 6 but the dry stack facility may have to retain exclusive use or charge for this to discourage the kind of congestion common at Sydney's public boat ramps. Provision is also be made for some trailer storage, which can also be stacked, in the sections between tanks. This would also need to be for the exclusive use of the stack users, as provision of trailer storage and boat ramps for the general public would possible lead to slower uptake of the dry stack facilities and cause exactly the kind of congestion this project seeks to avoid.

Parking for boat owners is initially offered in the dry stack tanks, under the boat racks. This is standard practice for many dry stack operations but, as business improves and the project advances, there may be more boat users wishing to park than this arrangement allows for. It is then that the radial car stacks in other tanks will become necessary (see 6.3.5 below).

6.2.1.9 The green corridor

For Phase One of the redevelopment the corridor begins at Hollaway Park meets the promenade on the south side of Tank 6.

Upon completion of Phases Two and Three it will eventually form the backbone of the site, with sections stretching out either side. This will also serve as an ecological connection between the surrounding municipal parks and Environmental Conservation zones. In one sense, the network of greenery to be established throughout the site can be seen as a replacement of the existing oil pipe and tank network with new green park and path network.

When complete, the green corridor will act as buffer between the public and more private sections of the site, giving a greener and more appealing environmental backdrop to the tanks than what presently exists there.

The green corridor can also play a significant role in the ongoing remediation of the site.

A passive method of remediation such as phytoremediation can be commenced early and continue throughout, while other more active methods may have to be complete before Phases Two and Three can be implemented.

The green corridor in Phase One also becomes a secondary route through the site and enables access to the upper entrance of the dry stack facility and another route down to the waterfront.

Figure 6.2-13: New vehicle access and parking

6.3

PHASES TWO AND THREE

Though the programme of site remediation can be implemented as soon as possible, there remain several features of the site redevelopment that would not be implemented until later stages of the redevelopment. For some of them (e.g. further commercial activity) it may depend on the success of the initial stage for them to be implemented. For others (e.g. residential development), it may require the remediation programme to be complete.

6.3.1 Dive Centre

Once the dry stack and its facilities have been established in Phase One, opportunities arise for further maritime activities associated with it. One of these is a dive training centre to be installed in Tank 1, another large, floating roof example. This would obviously require the removal of the roof and adaptation of the tank to sea water containment, but would not require a replacement roof.

A proven reuse for a former fuel storage tank, this tank perhaps represents the best possibility for such a dive facility on the site. As Tank 1 is the most integrated into the terrain, with the landscape practically meeting the top edge around and behind it, it provides easy accessibility to both the top edge and base. This provides an opportunity to add a structure similar to that on Tank 5 beside it that can overhang the interior of the tank and also extend around and into it.

Comparable to that proposed for Tank 5, the addition would require similar spaces for administration, a small classroom and a dive shop. With the addition of an artificial marine environment, viewing gallery and marine species native to Sydney Harbour, the tank could even double as a marine education centre.

6.3.2 Parkland and more public open space

It is in Phase Two that the centre of the site can be opened up with continuation of the green corridor and establishment of a municipal park and wetland area, stretching from the water's edge up to Greenwich Road. This would include more dockside jetties in the apex of the cove and a launch area for smaller craft such as kayaks.

The gentler sloped centre of the site is an ideal section for a widening of the green corridor into an open green space that connects the two narrower arms of the site either side. This would also ecologically connect the Environmental Conservation zones and parks to the north and south with those across the isthmus. This wide green space can also incorporate a terraced garden of wetlands to work as groundwater filters and rain water collectors as part of the ongoing remediation programme. The configuration of this area will utilise the existing flat terraces created for the tanks and the footprint of those tanks that have been removed. This makes use of the terrain that already exists there and establishes a visual relationship with the other two former tank farm parks on Sydney Harbour – Waverton and Ballast Point.

The green corridor would continue in Phase Three alongside the promenade to the narrow end of the site at Manns Point Park. This continuation of the green corridor into Phases

Two and Three assumes that the site could become available for reuse in sections, beginning at the northern end. However, should the site be surrendered all at once, then the opportunity exists to bring the establishment of the green corridor forward, especially for the strip that follows the waterfront. As stated earlier (see 6.1.4), this would not necessarily mean that part of the site is complete but that the remediation process within the green corridor is begun earlier. It could also mean the southern entrance from Manns Point Park is open sooner.

6.3.3 Ferry service and other public transport links

What would certainly contribute to the activity and generate more recreational, residential and commercial users of the site is the addition of new public transport links to and from it. While the existing bus service could be extended down to the waterfront here and a new path to Wollstonecraft Station will be available, a new ferry connection to Sydney CBD would be the most beneficial (Figure 6.3-1).
The obvious position for the new stop is the existing tanker wharf in the centre of the cove. A new ferry service from here is likely to be an attractive consideration for potential residents and will also bring users from the wider peninsula. An extra stop on the existing services between Parramatta, Lane Cove and the city would add five to ten minutes to these but go a long way to the success of Phases Two and Three. As the peninsula already has two ferry stops, it could be argued that three is too many and the existing ferry stop at the tip of the peninsula (Greenwich Point) be moved. Most of Sydney's peninsulas have only a single stop but Greenwich is served by both the Sydney Ferries network to Parramatta (at Greenwich Point) and the privately owned service to Lane Cove (at both wharves). Moving the Parramatta service would, in fact, bring the ferry closer to the vast majority of residents, for the loss of a few minutes' walk to those nearest to it now.
In theory, the new public transport links could begin at any point but Phase Two is probably the earliest time for it to happen with any degree of economic viability.

6.3.4 The conventional buildings

As development on the site continues, the remaining few conventional buildings on the site can also be reused. Commercial operations in the cluster of buildings next to the existing centre wharf are in a good position to take advantage of the increasing amount of site users, particularly when a new ferry route stop is brought to this wharf. In light of the maritime nature of the reuse project and proximity to the wharf, dry stack and boat workshops, a business such as a marine chandlery would be appropriate.

6.3.5 Radial parking stacks

Automated car stacks are now becoming a more familiar and acceptable method of saving expensive space on parking facilities in urban

Figure 6.3-1: New public transport links

centres. This frees up additional space that car parking may have occupied. For this site, it would allow more space for the site's other proposed uses and avoid having large expanses of asphalt for the parking of site users' cars on a narrow site restricted by terrain and available space.
In an ideal world, the boaters would arrive by public transport or cycle, but in reality they are more likely to come by car(s) and boat trips are rarely undertaken empty handed. As there are obviously more boats than there are parking spaces under the boat racks, car stacks in Tanks 7 and 8 are proposed for the overflow. These two tanks are of sufficient height and diameter to allow five or six radial stacks of 12 cars (>60 per tank). The driveway from the entrance opposite Landenburg Place would continue, past the upper dry stack entrance, to these two tanks.
Assuming that these tanks have little internal structure other than roof trusses, very little modification would be required other than reinforced openings and the installation of the internal mechanisms. Car stack manufacturers already offer radial solutions for existing

or unclad structures, above ground, below ground or a combination of both (Wöhr, 2010). As the site is gradually densified with more activity, residents and users, Tanks 14 and 15 can also be converted to parking stacks. All four of these tanks are beneficial to the aims of this reuse, being in close proximity to the external roads. However, as Tanks 14 and 15 are positioned somewhat lower than Gother Road next to them and would require a centrally located entry ramp, also a possibility offered by car stack manufacturers.

Once the car stacks are working together smoothly with the dry stack, it will be a simple operation for a boat owner to call ahead and arrange launching, drive in and drop off passengers and gear to the boat waiting dockside, drop the car at the car stack and stroll down to board the boat.

Though further possibilities for car stacks exist in Tanks 11 and 13, this may not be necessary if a sufficient number of boat owners using the dry stack also become residents of the rehabilitated tank farm. In that eventuality, the resident need only decide which mode of transport to use before leaving the house.

6.3.6 Residential infill

Though it may be many months between the implementation of Phase One and the completion of the project, a major step of Phase Two will be the construction of residential properties on the site.

New, small scale apartment blocks and townhouses are to be erected in three clusters around the inland perimeter of the site. Though the footprint of these is indicated on the masterplan, this is by no means prescriptive. The ongoing development of the site is likely to involve several designers and design options and so a variety of outcomes and configurations is likely.

However, the footprints do indicate that the residential additions to the site would be of a size and density that fits in with the site and the wider neighbourhood.

High rise and high density developments on this site would be unsuitable for several reasons: they would be ill-fitting and incongruous with the low density nature of the rest of the peninsula, detrimental to the heritage of the tank farm and site, overstretch resources and infrastructure on the peninsula, and probably not meet local authority or residents' approval.

Medium size and density is far more appropriate, not only for the above reasons, but also because of their distribution along the boundary. Medium sized buildings would be a sensible and proportionate visual transition between the size and geometry of the larger tanks predominantly lower down at the water's edge and the much smaller houses and apartments outside the perimeter of the site. The largest cluster at the centre of the site would also be of a complementary size and visual proportion to the few apartment buildings near the site on Landenburg place, the densest area of existing buildings on the peninsula.

Though they may appear to be close at some points to the public areas of the site, they are separated by vegetation and a difference in height due to the terraced nature of the site. As they would all face into Gore Bay, the front of these buildings could be considered semi-private, with the rear of each block having a private garden where on a more conventional site there would be garages.

6.3.7 The remainder of the site

After the completion of Phase Two and the parts of Phase Three that include the final sections of the promenade and green corridor to the end of the peninsula, there remain several pieces that are deliberately ambiguous and as yet unresolved. Foremost of these are the five tanks at the narrow tip of the site and the tanker docking wharf beside them.

These tanks also represent the most difficult examples on the site to reuse, being tucked away under the cliffs at the periphery of the site, barely accessible by vehicles and some distance from the more active zones of the project. This area is also likely to require the longest period of passive remediation, being that nearest the docks and having the densest array of piping and other related infrastructure.

The intention of the reuse project is to retain and reuse the array of tanks under a framework of overlapping time phases, gradually replacing the industrial network with a network representing leisure and living. By continuing an ongoing process of abandonment, remediation and renewal across the site, a visible representation of the process is apparent.

In keeping with the low impact and incremental nature of the rehabilitation of the Gore Bay Terminal it is considered acceptable that these tanks and infrastructure can remain as they are at present, or even removing them. As shown in other examples of non-building reuse, particularly Landschaftspark Duisburg-nord, the structures remaining on a site of incremental rehabilitation can remain dormant until a use for them can be determined. Until then they can remain unchanged as the 'industrial museum' section of the site, appreciated as artefacts of a changing and evolving industry. As proven at Duisburg-nord by the climbing walls and dive tank, such industrial objects can be of previously unacknowledged interest and use for many, on sites to which they were formerly excluded. To this end, 'industrial experience' paths can be established around and onto the tanks.

However, what remains in place here must undergo some extent of modification. While it may be an interesting and novel way to experience industrial heritage up close, public safety must still be upheld. This part of the site would have to be made safe to the extent that these articles are no longer a hazard to the general public. This means some of the dense network of pipes and other related items from this part of the site would need to be removed, leaving those that can remain maintained to an acceptable standard of public safety without being entirely stripped. Where possible, many of those items removed can be recycled and reinserted into the continuing renewal of other parts of the site as heritage artefacts and urban furniture components.

While it is beyond the scope of this study to predetermine uses for the final stages of site rehabilitation which may be years away, this approach still allows for interventions and insertions to be applied in future. Discrete and unexpected insertions, of a similar nature to the swimming pool and ice rink at Zollverein, can be introduced to this part of the site on an ongoing basis. As the research in Chapters Three and Four shows, it is often only after a period of abandonment that new uses for an industrial site may arise.

Figure 6.3-2:
Infrastructure network

7.0

DISCUSSION AND CONCLUSION

Various issues arise when attempting to apply a reuse programme to a tank farm site. Accordingly, not all tank sites are appropriate and reuse projects must often be site specific. The reuse proposal for the Gore Bay Terminal is a solution to a site with unique characteristics and history rather than a generic and prescriptive formula for tank farm reuse. The criteria for reuse of a tank farm site outlined earlier (Ch. 5.1) are specific and under these criteria many tank farm sites would be not be considered for reuse.

Also, this particular tank farm and its uniquely modified terrain, with its place in Sydney's working waterfront history, has a higher heritage status than might be expected of similar facilities elsewhere. This interesting topography and the picturesque setting is a distinct advantage and made it the obvious choice for a reuse project design study.

The reuse of the site can also present as many challenges as advantages. When combined with the requirements of the reuse project and the site remediation difficulties associated with retaining and reusing former fuel tanks, these issues can come into conflict. The bund walls and vast expanses of concrete slabs are another example of a conflict between reuse programme and retention of heritage elements. Therefore, compromises may have to be made with regard to which elements to retain (or remove), the pace and extent of redevelopment or the intensity of modification acceptable.

The tanks themselves present further difficulties to a reuse project due to their size, geometry and structural nature and should be specifically important to their site and surrounds to warrant reuse. Other industrial structures of lesser heritage importance may be easier to reuse due to their geometry, structure and location but might not hold such key significance to 20th century industrial heritage.

The difficult and uncompromising nature of the tanks requires a selective and appropriate reuse response to avoid redundancy. The adaptive reuse of a conventional building allows much greater freedom than could be offered by something of such singular purpose as a fuel tank. Therefore, the choice of programme for a former fuel tank requires a specialised new purpose appropriate to the tank. Furthermore, as in the boat stack proposal, a significant amount of structure may still need to be added.

The poisonous legacy of a tank farm site needs to be addressed sensibly if the industrial heritage, environment and safety of future users are to be maintained. The project proposal here depends very much on the possibilities and methods employed for site remediation. The approach of phased, site-sensitive remediation also has significant impact on design decisions, resulting in a low intensity, incremental development across the site over a long period. This incorporates areas where more rapid redevelopment and reuse may be achievable alongside areas of abandonment, dormancy and long-term regeneration. However, until this site is actually vacated by Shell Australia and returned to public ownership the full extent to which remediation measures need to be applied is likely to remain unknown.

The irony of putting fossil fuel burning cars and boats in former fuel tanks is obvious. However, the intention of the project is not to create an

eco-park of alternative energy and conservation, but to replace one system of storage with another when the former becomes obsolete or unwanted, whilst minimising the environmental and social impact and without disregarding the structure's industrial heritage.
Furthermore, this project seeks to represent an age of changing energy sources and use where, as our patterns of energy generation and consumption gradually change, so the structures and infrastructure that supports them can change and adapt also. The first commercially significant electric cars are now becoming available – it might not be long before electric boats become a familiar sight too. Though the electricity that powers such vehicles is in many places still generated with fossil fuels, alternative sources are growing while the fossil fuel industry continues to consolidate and adapt to the changes.
The project's incremental transition and implementation from industrial fuel storage, to commercial leisure craft storage, through to public leisure space and residential construction also reflects the changing nature of ports and harbours. Where the origins and primary functions of these were founded on commerce and industry, they are increasingly seen and used as places of leisure and living.
The project is sufficiently low-impact to not overstretch local infrastructure and resources on a narrow peninsula, but enough to generate some income whilst freeing up formerly private land for public use and urban infill in an increasingly sprawling city.
Though several of the tanks can be removed for the reuse project, it is important to retain a significant portion of them. Recognition and understanding of the tank farm's industrial heritage, as a networked array of interconnected and related objects, would be compromised when reduced to a few token examples.
Without trying to be all things to everyone, the project attempts to be something for most, similar to the Emscher Park experience, where a variety of activities and uses were applied piecemeal across the entire site over an extended period of time. At the same time, this approach attempts to satisfy some stated local government objectives and local community needs – those of increased harbour access, urban housing infill, environmental conservation and public amenity.

8.1

GASOMETER OBERHAUSEN

LOCATION
Oberhausen, Germany
CONSTRUCTED
1927–1929
FORMER USE
Gas holder
DECOMMISSIONED
1988
REHABILITATED
1993–1994
CURRENT USE
Exhibition centre
ARCHITECTS
Deutsche Babcock AG with IBA

8.2

GASWORKS PARK, SEATTLE

LOCATION
Seattle, USA
CONSTRUCTED
1900–1906
FORMER USE
Coal gasification plant
DECOMMISSIONED
1956
REHABILITATED
1975
CURRENT USE
Municipal park
ARCHITECTS
Richard Haag

8.3

KING'S CROSS GASHOLDER NO. 8 AND GASHOLDER TRIPLET, LONDON

LOCATION
London, UK
CONSTRUCTED
1883
FORMER USE
Gasometers
DECOMMISSIONED
1980s
REHABILITATED
Pending development – competition conducted and winners selected
CURRENT USE
Derelict (Gasholder No.8) or dismantled and in storage (triplet)
ARCHITECTS
Bell Phillips Kimble Architects (Gasholder No.8), Wilkinson Eyre Architects (Triplet)

8.4

CALIFORNIA GARDEN CENTRE,
WELLINGTON

LOCATION
Wellington, NZ
CONSTRUCTED
1926
FORMER USE
Bulk fuel storage (conical truss fixed roof)
DECOMMISSIONED:
1965
REHABILITATED
1965 (newsprint storage),
1971–1992 (garden centre)
CURRENT USE
Retail garden centre
ARCHITECTS
Shell Oil (tank),
Shahrim Jazbani (garden centre)

8.5

WESTERGASFABRIEK, AMSTERDAM

LOCATION
Amsterdam, The Netherlands
CONSTRUCTED
1885
FORMER USE
Coal gasification plant
DECOMMISSIONED
1981
REHABILITATED
2004
CURRENT USE
Multi-use – park, theatre, events, etc
ARCHITECTS
Isaac Gosschalk (gasworks),
Gustafson Porter (landscape)

8.6

WYNYARD POINT, AUCKLAND

LOCATION
Auckland, NZ
CONSTRUCTED
1935
FORMER USE
Oil storage
DECOMMISSIONED
Still in use
REHABILITATED
Pending, in planning
CURRENT USE
Bulk liquid/cement storage
ARCHITECTS
Auckland Regional Council

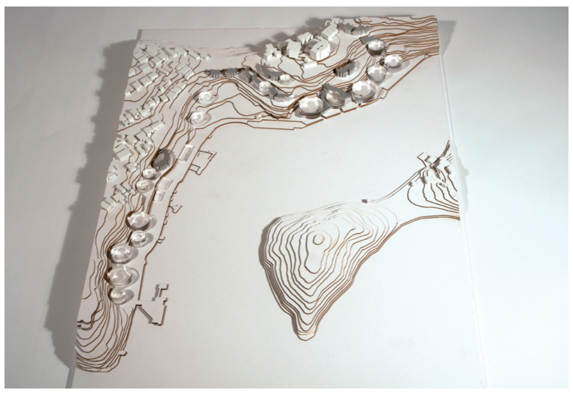
8.7

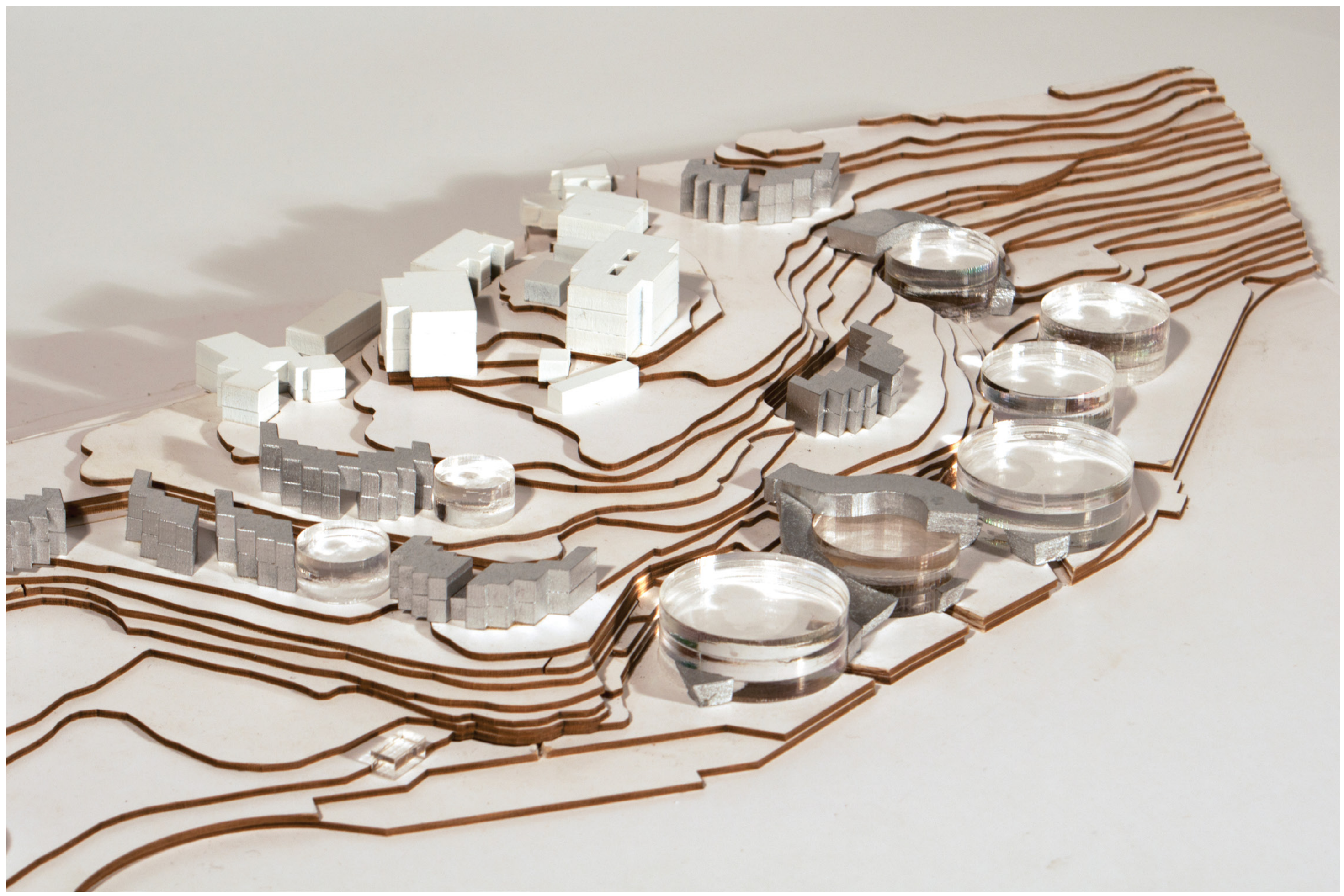
BALLAST POINT PARK, SYDNEY

LOCATION
Sydney, Australia
CONSTRUCTED
1928
FORMER USE
Oil storage
DECOMMISSIONED
2002
REHABILITATED
2009
CURRENT USE
Municipal park
ARCHITECTS
mcgregor+coxall

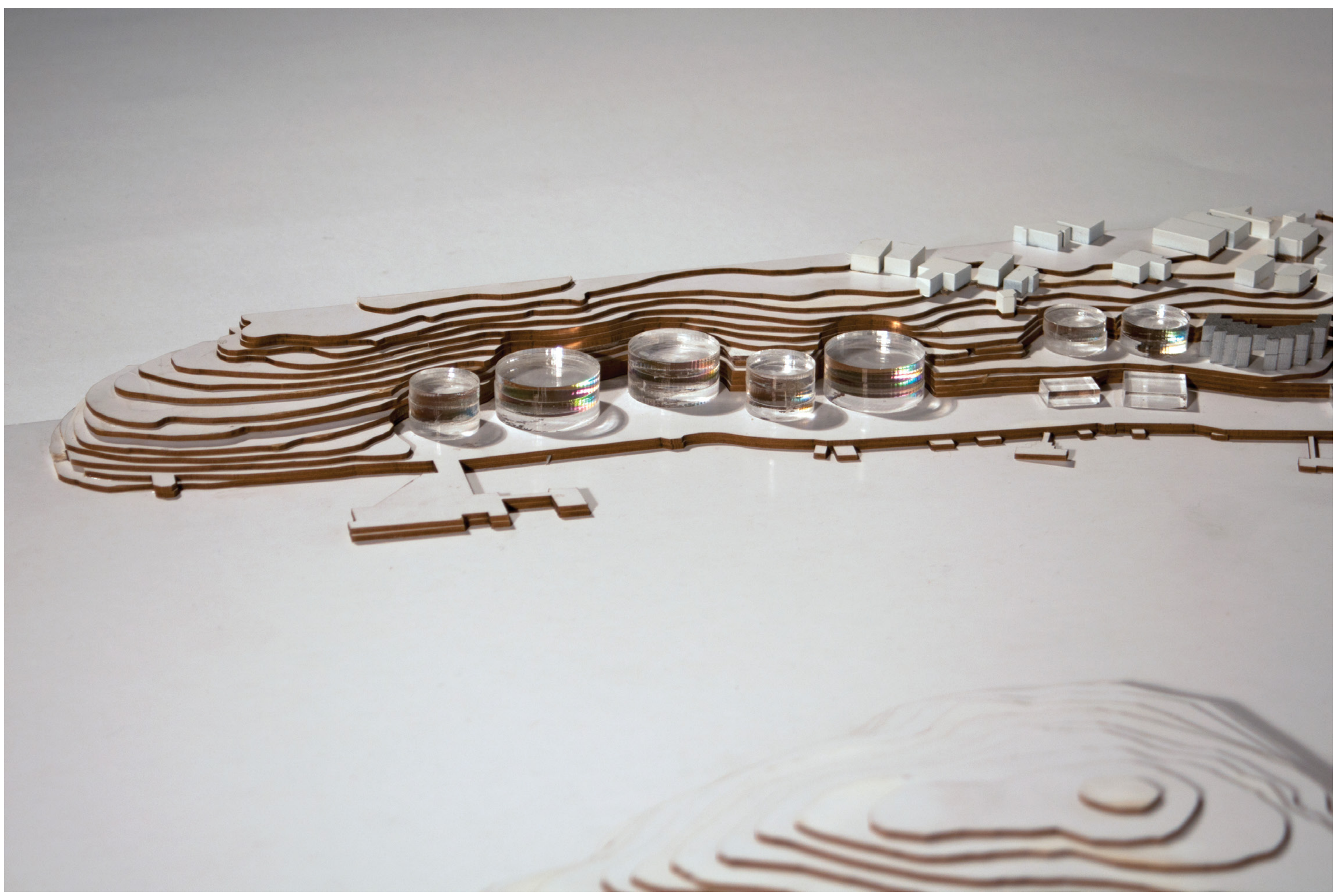
9.0

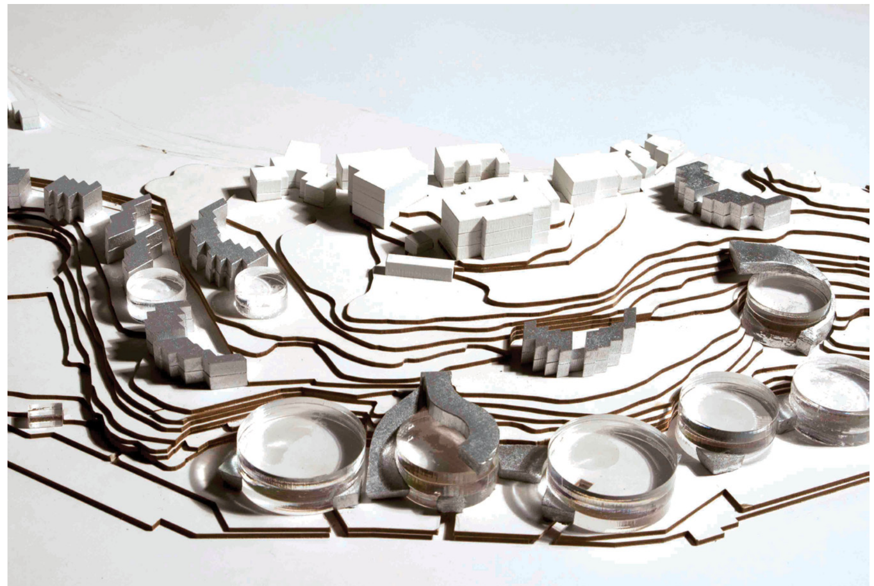
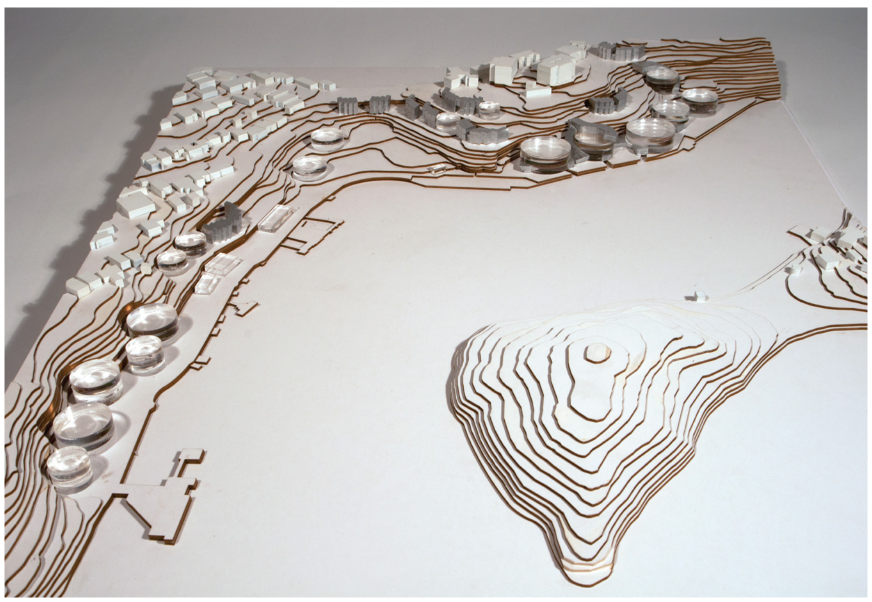
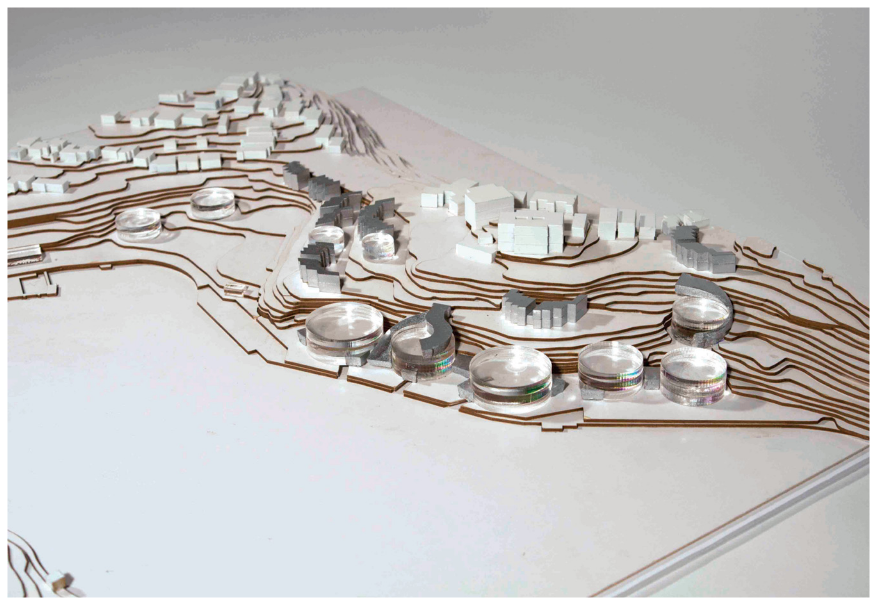
APPENDIX 2: SITE MODEL





To better understand the topography, comparisons in scale between buildings and tanks, and their relationship with the modified terrain they occupy, a site model at a scale of 1:1000 was assembled. This also assisted in the planning of the reuse project and the presentation at an interim design review.



10.0

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