Waterfront Ecology: Two waterfront design case studies in Auckland N.Z. and Furong New Town, P.R. China.

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New Waterfronts and Historic Urban Landscape Session

Abstract

The contemporary waterfront, a real estate invention of 1970s rust belt Baltimore has proved to be a peculiarly resilient urban trope. The transformation of an industrial waterfront into a consumerist landscape follows a well-worn path that has been duplicated around the world. However this design paradigm cannot always suppress the industrial past. Contaminated soils from industrial poisoning and the discharge of contaminated stormwater from the surrounding catchment are just two of the serious environmental problems that many waterfronts must contend with. Is it possible to foreground the environmental threats and the necessary remediatory regimes as the start of a new waterfront design methodology? The author discussed the possibility of this idea by presenting two waterfront case studies, designed by the author, in Auckland New Zealand and in Furong New Town, Guangdong province, PR China.

Keywords; Waterfront, Stormwater, Environmental Remediation, GIS mapping.

1.0 INTRODUCTION

The world wide structural transformation of ports to waterfronts is well described by Hoyle's development model [1]. Hoyle describes how the European port and waterfront has developed in five-phrases over 700 years; the medieval city port, the expanded city port, the modern industrial city port, the bifurcation of port and city, and the redevelopment of the industrial port into the contemporary waterfront.

The first project that manifests this last stage is the Baltimore Inner Harbour development [2]. The project was driven by the proximity of the old industrial harbour to the CBD. The industrial harbour had silted up, resulting in port operators moving away and abandoning the old port infrastructure. A waterfront master plan was developed in the 1970s; with the first buildings completed in the late 70's.

The building programme was a mixture of public and privately financed projects. The first building constructed was the publically financed Baltimore Convention Centre finished in 1979, followed by the HarbourPlace mall developed by the Rouse company, opened in 1980, then the National Aquarium in 1981, Pier 6, an outdoor entertainment facility, in 1991, the Power Plant, a multi use building with bookshops, restaurants, and a gym, in 1997-8, and the Port Discovery, a children museum, in 1998. Along with this building programme was the construction of eleven hotels and two sports stadium. The buildings along the harbour edge were linked with new public space, promenades, squares, and parks. The success of the Inner Harbour development has been aggressively promoted with claims that the project receives more visitors a year than Disneyland, produces $786 million dollars a year in revenue and has generated 16,000 jobs. The Baltimore model has become codified, especially in North America and has lead to the contruction of hundred of waterfront developments around the world. [3]

The Baltimore model demonstrates two critical influences, the first, a particular planning morphology developed by New Urbanism [4], the second, real estate planning, especially the use of FAR. Most waterfront master plans follow an urban model developed by the new urbanist movement [5]. Based on traditional American urban settlement patterns, new urbanist city planning uses a grid street layout with public spaces determined by an urban typology of square, park, and promenade, all architecturally defined by buildings. The real estate requirements of contemporary urban development are usually expressed as GFA (gross floor area) ratios divided between different real estate functions, typically; retail, entertainment, commercial and residential. These commercial requirements can be expressed in different combination, in simple block models or combination within blocks. Another way of measuring the expected yield of a real estate development is through a floor area ratio (FAR). This is a simple ratio of built footprint to the area of the site. The new urbanist grid plan coupled with real estate development metrics allow developers to accurately measure the expected returns from any development. [6]

2.0 ENVIRONMENTAL ISSUES

While the Baltimore model has proved an extremely successful development type, many waterfront sites, particularly post industrial ones, have serious environmental problems [7]. Looking at the contemporary waterfront through the lens of urban water management, one of the biggest problems is the contamination of the waterfront-receiving environment from the discharge of contaminated stormwater. Urbanisation has a radical effect on the cities original hydrological patterns. The construction of urban infrastructure elides the complex network of streams and rivers present in the natural terrain. The construction of impervious surfaces; buildings, roads, footpaths, and urban spaces such as squares and courtyards, increases the rainfall run off [8]. This run off often picks up a number of contaminates present on many urban surfaces before entering the cities stormwater system. Pollutants such as rubber and petrochemicals from roads are common contaminates. Many cities have built complex stormwater systems that assiduously collect this contaminated water and discharge it, in most cases untreated, into the nearest large body of water; river, lake or harbour. There are a number of implications for this pollution; the most common is the build up of contaminated sediment around the discharge point. This sediment has a deleterious effect on marine biota, numerous study have shown deterioration in the life and quality of shellfish populations, and native aquatic flora [9].

3.0 STORMWATER REMEDIATION

There are two categories of stormwater remediation; structural, physical interventions and devices that can treat contaminated run off and non-structural, practices or regimes that limit the production of contaminated stormwater through urban planning.

3.1 Source control /structural methods

There are a number of devises and structural interventions that make use of natural systems and vegetation to both improve stormwater quality and attenuate stormwater flow. These devices are hybrid systems, a combination of conventional architecture or urban construction such as; roofs, pavements, curbs, and landscape; meadows, wetlands, and stream margins. Well-known devices start with small-scale local interventions such as grass swales, porous paving, infiltration pits, green roofs, and rainwater tanks to larger scale interventions like constructed wetlands.

Green roofs are used to minimize runoff from conventional roof surfaces. A green roof can help to delay and reduce the runoff from a storm event. This helps to divert the volume of water that would have been treated by a conventional stormwater system. Water quality can also be improved through the vegetation filtering out pollutants and the soil mix binding pollutants [10]. Buffer strip are usually grassed areas adjacent to impervious surfaces, typically roads and car parks over which run off will travel. Buffer strips are effective at removing sediment and some pollutants. Swales works like conventional curb and channel systems but with an open vegetated channels. The vegetation acts in two ways, one to attenuate the flow of stormwater the other remove a variety of pollutants and trap sediments. Bio retention systems actively treat stormwater in situ by filtering the run off through vegetation and fine media layers. The effect is to slow down runoff flow and to improve stormwater quality. The vegetation layer acts to remove larger sediment while the below ground layers trap certain pollutants. Constructed ponds are dammed water bodies over 1 .5 m deep with a low range of water level movement and marginal vegetation. Ponds help trap sediments and pollutants in silt layers. Ponds are also able to uptake some pollutants through phytoplankton. Constructed wetlands are contained shallow water systems that regularly fill and empty with aquatic vegetation. Wetlands trap sediments and pollutants and the vegetation helps to uptake-dissolved pollutants. [11].

3.3 Non-Structural Stormwater control

Low Impact Urban Design, (LID) is an exmple of a non-structural stormwater methodology developed in NZ that seeks to frame the epistemology of stormwater amelioration within a larger worldview. This work is presented as a hierarchy of three scales of practice [12]. The first scale is at the level of the catchment with the aim to maintain an existing ecosystem. The second scale helps to locate the site within the larger catchment through a series of ecologically derived metrics. Examples include; making the best use of the existing infrastructure, minimizing the effects of the development through site selection, and matching the development to the carrying capacity of the eco system. These goals are developed through the use of specific techniques contained in the third level of the hierarchy. Reducing contaminants through the restoration and protection of the natural landscape, minimizing waste through reduction and reuse of water are some examples of specific ways of working that help the attainment of these goals.

One important technique that van Roon highlights is the goal of maintaining a natural hydrological balance in catchments through the restoration and preservation of existing water systems and through the use of urban planning techniques such as clustering. Van Roon builds on this point by writing specifically about the concept of hydrological neutrality that is the restoration of the existing hydrological system after development. Van Roon suggests that this goal can be accomplished through the use of infiltration and evapotranspiration to retain or restore the condition of the pre development catchment. The specific techniques that van Roon points to are; the use of specific forms of vegetation to aid in transpiration and increased water infiltration through the reduction of impervious surfaces. To attain this goal in urban development, van Roon suggests a reordering of building forms, clustering together houses, to help reduce the amount of impervious surfaces.

4 .0 CASE STUDIES

Can the two kinds of stormwater remediation regimes be used to develop a model of waterfront development that allows for a commercial return while remediating the serious environmental problems the construction of waterfronts generate?

To explore the effect of how these two types of remediation regimes could influence waterfront development, two test case sites; the Wynyard Quarter in New Zealand and Furong New Town in Guangdong province, PR China are explored. The first case study investigates the way in which structural stormwater remediation measures might be used to determine the design of a new waterfront for a green field city. The second case study explores how the metrics of hydrological neutrality might affect the design of a waterfront and the accompanying urban master plan.

4.1 Furong New Town Waterfront, Guangdong Province, PRC. / Structural stormwater remediation

The author was invited to help prepare a competition entry for the design of a new waterfront in Furong New Town, a planned new city to be built near Shaoguan an existing city in Northern Guangdong Province. The new town is being built as both as an important hub on the new high-speed train link from Guangzhou to Wuhan and an answer to the growing population of Shaoguan were there is little room for the existing city of 3.15 million to expand because of its location along the banks of the Bei Jiang river.

4.1.2 The Site

The site is a large valley catchment roughly orientated north south. The catchment is approx. 2652 ha. Surrounded on three sides by hills, the southern boundary is demarcated by the Bei Jiang river and a large island. The existing landscape can be divided into two types; productive agricultural land, mostly paddy fields, fishponds, and remnant native vegetation. The surrounding hills are not cultivated and are colonised by broadleaf rainforest species, plus exotic species such as pine and eucalyptus.

The existing hydrological system retains the natural hydrological pattern in the surrounding hills but has been completely modified by man made interventions like agricultural fishponds and paddy fields. Recent flood control measures include a concrete flood protection wall along the river and a large dam located upstream of the site.

4.1.3 City Plan

The proposed city plan occupies 1654.02 ha. of the catchment, 565.17 ha. or 34.17% is urban construction land area while non-urban construction land area occupies 1088.85 ha. or 65.83%. The proposed city plan is laid out in a grid, roughly aligned to the cardinal points. The main transport infrastructure system has already been constructed. A freeway infrastructure forms a rough cross shape over the valley. One arm of the cross runs along the western side of the new city to Shaoguan, the other arm runs at right angles, west to east through a tunnel in the eastern edge of the catchment hills to a new administration district to be built on the bend of the Bei Jing River. A new high-speed railway station has been built on the western side of the city. The city grid connects to the river with a 2km long waterfront.

4.1.4 The Waterfront

The proposed waterfront site is approximately 2 km long and 500m wide, about 100 ha. It occupies a broad concave bend in the river and encompasses two small streams from the larger catchment. At the time of the site visit (September 2012) earth stop banks over 2 m were being constructed on the edge of the river. Concrete stormwater chamber where also being built on top of the stop banks, there location lining up with the major roads in the master plan.

The proposed architectural/urban programme for the waterfront is for four building groups. Running west to east; the programme proposes; an open-air shopping mall, a convention centre, the preservation and restoration of an existing village and a resort / hotel. The remainder of the site is the subject of the design competition

4.1.5 Environmental Issues

With the building of the new city, over a third of the catchment will be rendered impervious. This will have the effect of generating two negative hydrological outcomes; urban flooding and the production of contaminated rainfall run off.

4.1.6 Proposition

The ways in which the effects of contaminated stormwater can be remediated are well known. Many waterfront projects have started to incorporate stormwater treatment devices; wetlands, swales, bio retention ponds as part of the design of the waterfront. However these design interventions are often limited in effectiveness by not being able to treat the quantity and contamination of urban stormwater from the greater urban catchment. Complex issues of property jurisdiction and intergovernmental agency responsibility defeat many obvious remediation opportunities.

Demonstrating how the new city plan of Furong is part of an existing hydrological sub catchment area is the first step in rethinking a conventional waterfront design process. Illustrating the differences in the distribution of the rainfall –run off before and after the construction of the new city is an important way to help alert the client to the effect of the new urban construction. To adequately treat the expected hydrological outcomes with conventional structural stormwater remediation techniques the waterfront site is identified as a locus for ameliorative measures.

4.1.7. Process

Contaminated stormwater

Our completion entry suggested using two structural stormwater systems for the treatment of the contaminated stormwater from the urban construction. At the junction of the city grid and the waterfront site, a swale was proposed to accept, attenuate, and treat contaminated stormwater from overland flows from the city. A constructed wetland, occupying most of the waterfront site, was proposed to take stormwater from the existing two streams and the new city piped infrastructure, subject the contaminated water to cleaning, before discharging it into the river.

Flooding

The increase in impervious surfaces will lead in extreme rainfall events to urban flooding. The competition waterfront design proposes that the topography of the waterfront site be transformed through re-grading to create flood retention basins. The required building programme will occupy artificial berms constructed above the flood zone by excavating the existing site and using the fill to build a series of 'islands'. The islands would be linked to each other with a series of paths and bridges, which would be used at different times according to the current hydrological conditions. The existing river flood bank is reconstructed as a soft-planted barrier with links across from the ‘islands’ to the existing island in the centre of the river.

4.1.8 Discussion

The proposed waterfront design privileges the remediation of the hydrological issues caused by the construction of the new city of Furong, over the Baltimore model of waterfront development. The waterfront site becomes a shifting temporal landscape that displays the various hydrological conditions according to the seasons, a dry landscape in winter, a wet landscape in summer. The proposed building programme aligns itself with the new environmentally driven process, becoming part of the new landscape, a set of islands within different water conditions, river and wetland. The islands, like the 14 islands that make up Stockholm City, are urban and recreational. The new waterfront plan also provides an opportunity to restore the native ecology. The entire waterfront zone could become an important eco patch, a link from the native vegetation of the south side of the river to the surrounding hills.

4.2 Wynyard Quarter, Auckland, New Zealand. / Non structural stormwater remediation.

4.2.1 The Site

The Wynyard Quarter is situated on the western side of the Auckland CBD, between the Westhaven marina and Viaduct harbour. This western zone has been undergoing a slow redevelopment from an industrial wharf and tank farm to a new consumerist waterfront over the last 20 years. The Wynyard Quarter started life as reclamation in the 1930s; the site was used for warehousing, the fishing industry and most importantly as an industrial fuel store.

4.2.2 The City Plan

Starting in the early 2000’s, development plans were begun to transform the site. Peter Walker, an American landscape architect, was commissioned in 2003 to develop a master plan. The basis of this plan was the establishment of two axis that connect the site to the city; a north/south axis from the existing Victoria Park to the northern tip of the reclamation and an west/east axis from the WQ to the CBD via Quay street. This plan was modified by a local Auckland architectural practice, Architectus, in a report prepared in 2007. The proposed building programme is contained in the indicative framework section of the report. The Wynyard Quarter is approx. 38.8 ha. Of this area 5.8 ha. is to remain as existing marine related industries, mainly on the Westhaven marina side. The main body of the site is a development zone of approx. 21 ha. The rest of the site is to be allocated as public space. The development site is broken into three zones; the Point Precinct at the northern end of the site is mainly residential. The middle zone, the Jellicoe Precinct, has a more complex social and building programme, which relates to its role as part of a structural urban axis linking the WQ to the CBD. The Central Precinct is the largest zone from Jellicoe Street to Fanshawe Street, a third of this site is owned by another party, Viaduct Holding Group. This zone is devoted to mostly residential and commercial use with small percentage of retail. [13]

4.2.3 The Waterfront

The two main areas of waterfront development are the North Wharf, the WQ end of the west east axis linking the site to the city and the Point Park, the northern end of the north south axis, linking the site to

Victoria Park. The North Wharf consists of a two east / west thoroughfares, the northern one, pedestrian, the southern one, a road that sandwichs an active zone of restaurants, playgrounds, bars and public spaces. The northern zone runs adjacent to the saea forming a pedestrian promenade. The North Wharf precinct was completed in time for the 2011 Rugby World Cup.

4.2.4 Environmental issues

The Wynyard Quarter has a number of serious environmental problems. One of the most critical is toxic soil contamination, a legacy of major leakages from petroleum storage tanks; especially toxic was the loss of million of litres of aviation gas from a tank located just south of Jellicoe Street. The discharge of contaminated stormwater is also a major issue for the Wynyard Quarter. While small-scale stormwater remediation wetlands have been installed, these measures only address the local effects of the new urban configuration. The stormwater discharge from the larger Freemans Bay catchment is concentrated in a 4m. by 4m. pipe with a single discharge point under the North Wharf. After heavy downpours there is highly visible harbour contamination that leads to toxic sedimentation around the wharf area [14].

4.2.5 Proposition

The concept of hydrological neutrality offers a metric toward the goal of stormwater remediation in an urban area. Ensuring that the urban development of brown field waterfront site does not contribute to an increase in the discharge of contaminated stormwater, by following this methodology, means ensuring that any urban development has an impervious surface footprint of 15 % or less of the catchment area. However to reach the goal of 85 % permeable surface in an urban situation is extremely difficult, the prevailing existing urban layout in most cities, is a dense infrastructure grid with an intensive building programme. A radical rethink of urban form would be required to attain the goal of an urban development with a total building / road footprint of 15 precent of the catchment. Retrofitting an existing city catchment to achieve this solution means confronting a number of substantive obstacles. Established business / real estate interests inevitably preclude any of the necessary radical building removal to attain this number. However the size of a typical waterfront site does give an opportunity to pursue this idea. Many waterfront development sites are abandoned brown fields and often in large area parcels, so a more radical consideration of urban form is possible than under the normal constrains of contemporary city development.

4.2.6 The Process

The Freemans Bay Catchment

Using ArcGIS and data sets supplied by Auckland Council, the Wynyard Quarter can be rescaled as part of a larger urban catchment system, the Freemans Bay catchment [15]. This site is defined by four ridge roads; on the western boundary, Shelly Beach Road, Jervois Road, Ponsonby Road, and K Road along the southern boundary and returning on the eastern side along Hobson Street. The Freeman Bay catchment area is 303.4 ha. The impervious surface of the catchment is made up of road and pavement coverage 240.4 ha. (46.3 precent) and building coverage 75 ha. (24.9 percent)) Making 71.2 percent impervious surface area for the whole catchment. Using Arc Hydro, a plug in to Arc GIS, a series of sub catchment can be generated with associated overland flow paths. Breaking the site into sub catchments, refocuses attention on the Wynyard Quarter. The GIS analysis helps to reframe the site as an array of smaller catchment basins that follow a topographical logic rather than the existing urban grid. Running the hydrological analysis reveals ten sub catchments are revealed with unique flow paths [16].

Wynyard Quarter

Applying the Van Roon idea of allowing for the maximum footprint development footprint to be15 percent of the 35.5 ha site gives 5. 325 ha of impervious surface to ensure hydrological neutrality. Applying the ratio of building to roading found in the larger catchment, (approx. 47 percent building and 53 percent road/paving) allows for approximately 2.2 ha. for the building programme, and 3.095 ha for roading/paving infrastructure.

Into this reconfigured hydrological landscape, the building programme from the 2007 Wynyard Quarter plan can be inserted. The total GFA proposed is; residential/retail, 76,701.00 sqm. , commercial 586,585.00 sqm. and residential, 453,661sqm. giving a total build out of 1,115,947.00 sqm.

How should this building programme be distributed over the site? (While limiting the impervous footprint to 15 % of the total sub catchment) Some criteria that could be adopted might be, not building on the overland flow paths and not building on the coastal edge. Protecting the overland flow paths and coastal edge by establishing a series of buffers based on flow accumulation data could help to delineate possible building footprints. The total area left for possible development after privileging the hydrological conditions is approx. 11.8 ha. , (a considerable increase on the allowable impervious building footprint of 2.2 ha. from the Van Roon analysis). Mapping the footprints over an existing plan helps to remove some of the building sites, such as the ones that overlap Fanshawe Street. By reclassifying the blocks according to area, larger blocks can be identified as possible building footprints. A spinal block in the Point Precinct zone and two large blocks within the Central Precinct area can be identified as building sites. The total footprint of these blocks is 5.2 ha. Extruding the blocks by taking the GFA building programme of the WQ at 1,115,947.00 sqm. and dividing it by 5.3ha. gives an average height for the building blocks of 23 stories or 63m. The next stage, (with a little help from Rhino) is for the outline of the blocks to be smoothed, giving a gross footprint of 4.3 ha. or 25 stories. The result is a spine of 7 mini blocks along the Point Precent with two mega blocks on the west and an east side of the body of the site, the remainder of the site is an undifferentiated field.

4.2.7 Discussion

This experiment is speculative and selective. The way is which water is privileged so that the site is restored toward a hydrologically neural field is a concept that is at odds with our traditional understanding of the city as an dense compact urban network. This project provides a provocation to accepted ideological models of urban development based on the grid and the block and starts to opens up a range of new urban development possibilites that an understanding of hydrological systems can lead to.

5. DISCUSSION

Could the accepted urban form of the contemporary city be challenged by fully exploring the consequences of structural stormwater amelioration techniques? Could non-structural stormwater control goals such as hydrological neutrality, be reached within the design of the contemporary CBD? Can either of these remediatory practices fully engage with the commercial real-estate requirement of contemporary urban redevelopment? What techniques might bridge the gap between the realms of stormwater control and commercial property development?

5.1. The implications of structural stormwater metrics on urban form

Can waterfront design moves away from the Baltimore model to become a soft infrastructure that ameliorates the environmental problems caused by the construction of a new city?? Can the existing urban built programme still be accommodated within the spatial demands of the stormwater and flooding remediation programme?

5.2 The implications of non- structural stormwater metrics on urban form

Could the development metrics produced through a non-structural stormwater control systems be connected to the making of a new urban form? While these systems are primarily addressed to suburban development how could the challenge of achieving 15 % impervious surfaces within the CBD of a new city be achieved by manipulating FAR? [17] One foreseeable consequence of this manipulation could be that the building footprint of a city must shrink drastically while the area of pervious surface must increase. Using FAR, the programme of city development, the amount of build out, could be manipulated to form taller building. A number of speculations could be advanced for the use of the resulting area of pervious land. The new zone could be used as a site for large-scale storm water remediation measures to treat contaminated storm water from the remaining catchment. Techniques such as wetlands and day lighting stormwater pipes that are extremely difficult to apply in conventional urban waterfronts because of the limitations on land availability, are freed up in this new urban configuration. [18] Similarly goals for urban sustainability through the development of specific urban eco systems could be developed. Restoration of native habitats, both terrestrial and aquatic, and positioning of urban habitats patches, [19] a rich series of possibilities are opened up by this radical new urban configuration.

6 CONCLUSION

By considering the formal metrics of stormwater remediation and real estate development returns, the potential of the waterfront to be developed as a site that remediated the environmental problems caused by urban construction can be considered The liberating effect that this possibility opens up for waterfront design could lead to a frank exploration of the ways the form of the city could itself be affected by the provision of a environmentally ameliorative regimes. The next stage for the sustainable design of waterfronts may be a reconsideration of the urban form of the whole city.

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