

Ningbo – a new sustainable city for China

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Abstract

This paper describes the winning entry in the international competition for planning of the expansion of the city of Ningbo, China, for 350,000 people on a 4000ha site; and the design of its new Centre by HASSELL, with engineering consultant Hyder in late 2002. Shortlisted competition entrants included Obermayer from Germany, Kurokawa from Japan and the Beijing Planning Bureau. The winning scheme blends traditional Chinese practices in sustainable farming, aquaculture and soil and water management evolved over four millennia, with 21st Century technologies, to create a city which is sustainable to a degree greater than most contemporary cities. At the same time, the new city design embodies urban design qualities rarely found in contemporary Chinese cities, and compliments a fine city building tradition which spans 4000 years.

ESD components are woven throughout the fabric of the new city. The largest parks and waterbodies accommodate storm and wastewater treatment and storage for recycling, and sustainable energy generation from wind and wastes; the smaller urban canals and waterways provide drainage and water distribution into wetlands for cleaning. The ESD agenda for the new Ningbo will reduce externally supplied water and energy requirements by half that of a conventional city, while providing a physical environment equivalent to the most advanced contemporary cities. The concept includes a comprehensive public transport system, which minimises incentives for growth of private vehicles and energy use, by providing an excellent standard of service.

HASSELL is continuing its involvement with detail design of the project through the Shanghai and Hong Kong offices of the firm.

1 Introduction

The Ningbo Urban Planning Bureau briefed competition entrants, to provide clear strategies to guide the future expansion of Ningbo beyond the boundaries of



the old city, to encompass the New District of East Ningbo (NDEN). The Brief included a more detailed urban design of a new business and commercial centre on 7km² and urban expansion by 350,000 population over the total 39km² site, and a requirement for a ‘Model Environmental City’.

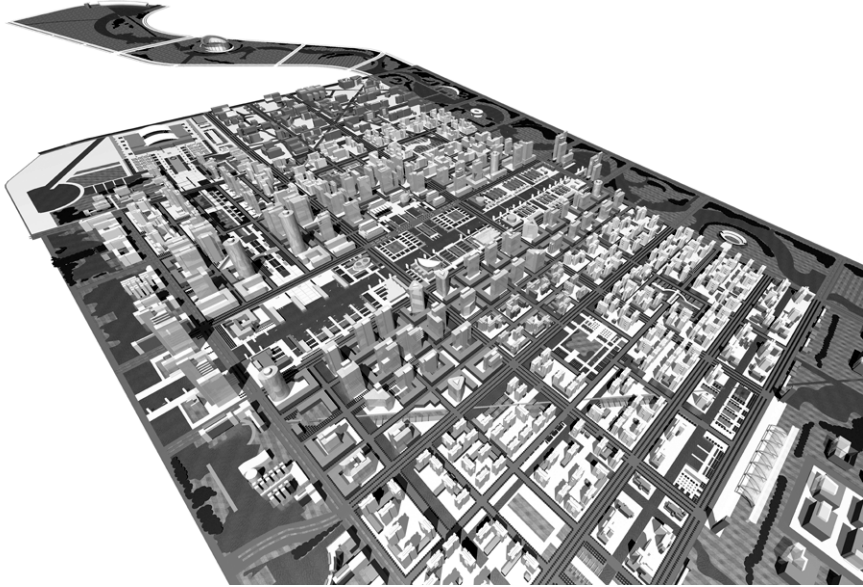


Figure 1: The New City Centre.

2 The legacy and the future

Ningbo is growing and evolving into what will be one of the great cities in China in the 21st century. Ningbo is already the No.2 port in China, has a major export trade in textiles, clothing and other manufactures, and is a major centre for high-tech research and education, banking and finance.

The old city centre of Ningbo dates back to 700AD. It has a unique character epitomised by the scale and design of its older areas, the river system; new parks and plazas within the city and on the riverfront accompanied by well-designed new building complexes.

This leads to a city mixing a thriving business and commercial sector, with an active street life, reminiscent of much larger Chinese cities.

2.1 Urban design concept

The concept for the new center is based on traditional Chinese town planning principles of “the magic square” and the “field of nine divisions” leading to a grid of boulevards aligned to existing and proposed new canals. The grid is centred on the existing grand canal which links to the old city and provides a visual connection to the mountains beyond:



Figure 2: City Centre Grand Canal Axis.

The vision for the NDEN is to reinforce the unique qualities of the old city centre and create a second centre for the metropolitan area. This will allow for central functions to be expanded within the new centre without destroying the unique qualities of the Old City. The express rapid underground transit system is proposed to link the two centres via a 5-10 minute journey, thus allowing shared central functions to be practically realised between the two centres.

The rich intellectual tradition of Ningbo is reinforced through the creation of the Knowledge Axis in the New City, while cultural facilities are located in the Urban Axis, which forms the major transport and green space link between the new and the old city centres.

The concept aims to achieve harmony and balance between the old city centre and the NDEN and to create a unified world city with two complimentary centres.

3 City size and density

By 2020, the Ningbo Urban Planning Bureau estimates that the Three River Division of Ningbo (including the NDEN and the old town) will have 1.5 – 2.6 million people, on 146km² of land. The NDEN portion will have approximately the same density of population as Berlin.

4 Creating a sustainable environment

The project brief called for the new Ningbo to be a model environmental city. The HASSELL approach was to blend traditional Chinese sustainable practices in agriculture, with modern ESD practices and technologies specifically developed for large cities. These are described in more detail in section 10.

5 Making better use of the NDEN site

The site allocated for the eastern expansion of Ningbo, is 39km² of former agricultural land running from the Yong Jiang River in the north, to the agricultural land intersecting the hills to the southeast. The main characteristics of the site which have influenced the concept development are listed below.

Site Element	Planning and Design Response
Existing canals	<ul style="list-style-type: none"> ▪ Adapt, re use and change to an urban role –performing a wider range of ESD functions ▪ Re-use the best where appropriate ▪ Replace the worst where heavy metal or nutrient build-up is excessive ▪ Add complimentary soft edged wetlands, which will provide storage for flood control, drainage, and treatment for re-use.
Existing development	<ul style="list-style-type: none"> ▪ New areas and buildings to be retained where possible ▪ Gradual replacement of poor quality environments ▪ Retention of areas of the best traditional development, such as the town of Quiga. These include canals, streets, and buildings of cultural significance ▪ Retention of new roads and canals, bridges and parks ▪ Ensure incubator buildings have a prominent location in the new plan, as symbols of a high-tech city
Hospitals, Schools and Convention Centre	<ul style="list-style-type: none"> ▪ Retain wherever possible ▪ Integrate within urban design ▪ Incorporate in core area, allow for new hotels and business park adjacent as complimentary uses ▪ Locate main public transport routes and tourist water transport to service these facilities



Soils and terrain	<ul style="list-style-type: none"> ▪ Incorporate soil conservation and reuse program from development sites in allotments; open spaces; urban forestry opportunities, and wetlands ▪ Utilise flat terrain for minimal energy use in transport and efficient storage and distribution of stormwater for the recycling program
Existing Roads	<ul style="list-style-type: none"> ▪ Connect new grid of roads to existing grid to the west and proposed new roads surrounding the site. Incorporate bicycle and public transport routes for staged development, from bus to light rail
Yong Jiang River	<ul style="list-style-type: none"> ▪ Create a new park system and open up views to the river ▪ Recognise the significance of the river by the diagonal axis within the core ▪ Locate a boat harbour and neighbourhood centre on the river front ▪ Conversion of one existing tidal gate to water transport adding locks to allow river connection to old city centre
Hills surrounding to east	<ul style="list-style-type: none"> ▪ Celebrate the hills to the south-east of the site by creation of a diagonal axis within the core area ▪ Allow views down the main canal to frame the hills, as a backdrop to the urban area
Vegetation	<ul style="list-style-type: none"> ▪ Wherever possible conserve the few trees which remain ▪ Schedule major planting programs in boulevards and parks; and the macrophyte establishment programme, for urban waterways
Existing Rail System	<ul style="list-style-type: none"> ▪ Allow for planned expansion at urban and regional level, and incorporate into regional and local public transport system within the Ningbo metropolitan area

6 Water transport

City development from 700AD onwards was always closely reliant on trade goods brought by water transport from the region and other parts of China, and then transferred for shipment by sea to other Chinese ports and beyond.

As with many port cities based on rivers, the Yong Jiang River is no longer able to provide the port function for the scale of shipping now generated by Ningbo. Nonetheless, the layout of the old port city has survived 1200 years almost unchanged. Although the main port has moved down river to the open sea due to size of vessels and cargo handling requirements, the legacy of water orientation of the city is a major area of potential interest to visitors to Ningbo. The HASSELL / Hyder concept for NDEN seeks to extend and enhance the experience of water for transport in and around the city.

The main potential water transport routes utilises two east west canals connecting the NDEN site to the old city. With the addition of some locks, the Yong Jiang River becomes a potential for routes between the NDEN and the Old Ningbo centre. The new centre plans show the routes between two urban centres



and docking facilities next to major new cultural attractions on the Urban Axis. As much of the navigable canal routes are in newly constructed waterways, there is an opportunity to ensure depths are sufficient for navigation, and new bridges are designed with sufficient clearance for river craft. Existing canals to be developed, as navigable waterways will require dredging to allow appropriate boat clearances at maximum storage levels required for the water recycling system. Dredging will also remove nutrient rich silts from existing canal floors, minimising risk of algal blooms in the new water system.

7 Waterway function

The existing canal system which is retained for drainage and flood control, has been redesigned to perform the following additional functions:

- Drainage and flood control for an urban, rather than rural runoff
- A transportation network capable of being used by watercraft to connect the new and old centres
- Improved water quality by installing litter and oil traps, to remove pollutants associated with stormwater runoff, prior to entering water ways
- Provision for storage of stormwater for:
 - a) cleansing by removal of nutrients and bacteria in wetlands
 - b) re-use as a substitute for reticulated town water (non potable)

Addition of aquatic vegetation to waterbodies will improve the aesthetics of the canals, as well as removing suspended solids and nutrients, which will result in water quality improvement throughout the entire water system.

Smaller canals will distribute urban stormwater to the new wetland treatment areas, which are distributed around the system to provide an even level of treatment.

8 Sewerage treatment

- A reticulated sewerage system to the New District of East Ningbo will be provided to collect waste effluent from all forms of development.
- Waste will be treated to a tertiary level, suitable for recycling back into the NDEN for use on local garden and landscape watering, non-potable domestic use; and industrial water cooling; or for discharge into the Yong Jiang River.
- Provide for recycling of solid waste (sludge) from the treatment plants, for urban forestry, parks, agricultural uses, and other purposes both on and off site.

9 Landscape and open space

Planning of the landscape and open space system responds to the site in a manner that assists in the achievement of the overall goals. Key components are:-



9.1 The axes

The creation of the axes are both symbolic and functional. They trace the relationship of the site to the river and the mountains. They provide for a system of complex and diverse water bodies. These in turn provide an even distribution of water based ESD initiatives throughout the whole site; and create landscapes of functionality and delight, ranging from broad-scale water bodies, lakes and canals, to formal plazas and the public realm of the urban areas. They also provide the setting for major public facilities and the location of waste and wind power generators.

9.2 The linear parks

The park system performs a number of functions, including a buffer and screen to freeways and roads, opportunities to facilitate aquaculture, urban forestry, garden allotments; and an extension to water treatment methods.

The riverside parkland marks the importance of the river in the history of Ningbo, and the site. It aims to redress practices of the recent past, in which the river had become visually and physically inaccessible, so great has been the pressure of commerce and industry in the last decade of development of Ningbo.

9.3 The canal system

Smaller linear parks are proposed along the canals, which distribute water from development into the main water bodies for treatment and storage. These will be augmented by a still smaller system of canals and water bodies, developed within each development super lot. Smaller canals will be incorporated in the neighbourhood open space of each housing development, and be the responsibility of the building developer, rather than part of public infrastructure provision in the first instance. The penetration of the waterways into every part of the city will encourage their stewardship by the whole population.

9.4 Recreation facilities

Main sporting facilities will be provided as part of the major facilities programme. Other facilities such as walking and cycle tracks, playgrounds, pavilions and picnic areas, will be incorporated into smaller parks, and small sporting venues within neighbourhood centres and nodal points.

10 ESD strategy - preliminary performance assessment

10.1 An ESD agenda for Ningbo

Our objective has been to challenge the conventional wisdom traditionally adopted when planning large urban developments, by using ESD as a key driver in the design process. This approach will help deliver the model environmental city required in the brief.



The following project initiatives were suggested with performance indications:

10.2 ESD initiatives

10.2.1 Green power

50% of all electrical energy used in the new city is proposed to be green power harvested on site. Wind, solar and tidal energy sources, are considered and located on the ESD plan.

For wind power, up to 500 cylindrical wind turbines are proposed, located in:

- A. The Knowledge axis
- B. Within the eastern freeway buffer zone

Each wind turbines is rated at 800kw. The power produced will be approximately 1,750,000 megawatt hours/year. New technologies in compact, cylindrical wind turbines have demonstrated high efficiencies with the lower wind speeds prevailing in Ningbo, as well as reduced noise and visual intrusion.

10.2.2 Energy recovery from municipal wastewater

Two anaerobic egg digestors are to be installed as part of each existing wastewater treatment facility in order to produce power from biogas (predominantly methane).

Energy generated will provide power requirements for the wastewater treatment facility, with excess power being fed into Ningbo's electricity grid. A total of four Eggs are proposed as noted on the ESD plan.

10.2.3 Brown power: cogeneration

50% of the power is to be generated through a number of high efficiency gas fired cogeneration plants. Waste heat will be recycled for industrial heating and the heating of residential buildings.

10.2.4 Urban stormwater management

When all initiatives are complete, water usage from external sources in NDEN, will fall by 50% of existing levels in other urban areas of Ningbo.

ESD initiatives have been proposed for every part of the water cycle: -

The volume of stormwater that can be stored within the canal system is 2.5 million m³. This is 3.8% of the total volume available from rainfall. More water can be stored during the dry season when flood protection requirements are reduced.

Approximately 50% of the total rainfall volume can then be recycled, depending on the future detailed design and operation of the system.

The existing 373ha of canals are to be reformed, with a proposed water area of 367ha that will include canals, waterways and wetlands.

Approximately half of the new water area will be in the form of soft edged water bodies, with peripheral emergent macrophyte plants: submerged macrophytes in deeper areas.

The catchment of the urban development area will produce approximately 40,000,000 m³ of water per year.



Gross pollutants and petrol/oil traps will minimize entry of oil, litter and nutrient laden sites to waterways.

The improved water area will provide:

1. Storage for urban stormwater for cleansing, using natural ultra violet light and absorption of nutrients by macrophytes
2. Supply of treated stormwater for irrigation of nearby parklands and other non potable uses in urban development
3. Navigable water bodies which will connect the Old City Centre to the NDEN Centre and environs
4. Use of parts of the water bodies for aquaculture in adaptation from traditional Chinese practices, for the production of ducks, fish and water plants, and to encourage a fish population to predate mosquitoes

A third pipe system will be added to urban infrastructure to supply recycled water to all water consumers separate from potable water, with on-site ancillary treatment of recycled stormwater using UV and high rate filtration, after withdrawal from the wetland system.

Additional uses of recycled stormwater and cooling water will include: Fire fighting; wash down; industrial use and toilet flushing.

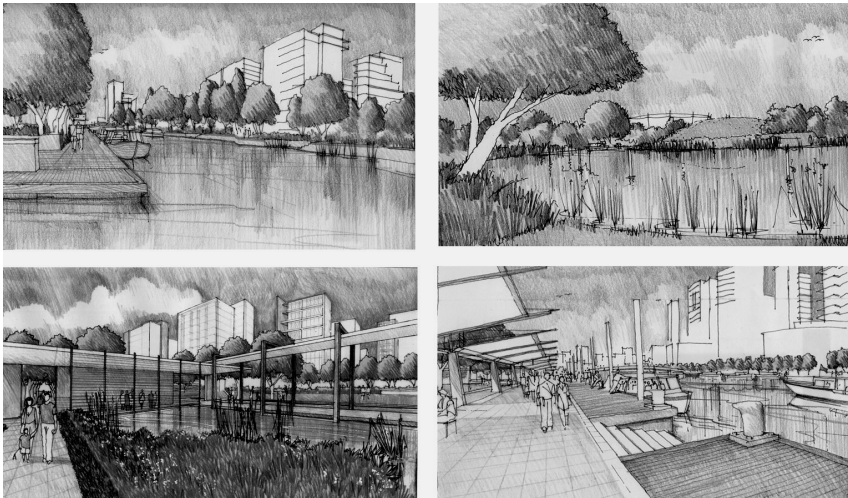


Figure 3: New urban waterways.

10.2.5 Topsoil conservation

Topsoil has been gradually improved over several thousand years of traditional Chinese agriculture in the Ningbo area. The aim is to minimise waste and misuse of topsoil.

Proposed conservation measures:

1. Strip and store for reuse prior to construction or landfills
2. Avoid mixing topsoil with subsoil or other contaminants

3. Reuse on site in parks, wetlands, urban forestry, and productive allotments, as well as development of open spaces in residential areas, and outside site for agriculture

10.2.6 Land allotments

Land allotments will maximise the opportunities for residents to produce food in the city and will be provided in some residential areas. Reuse of topsoil and recycled water will be practiced in these areas.

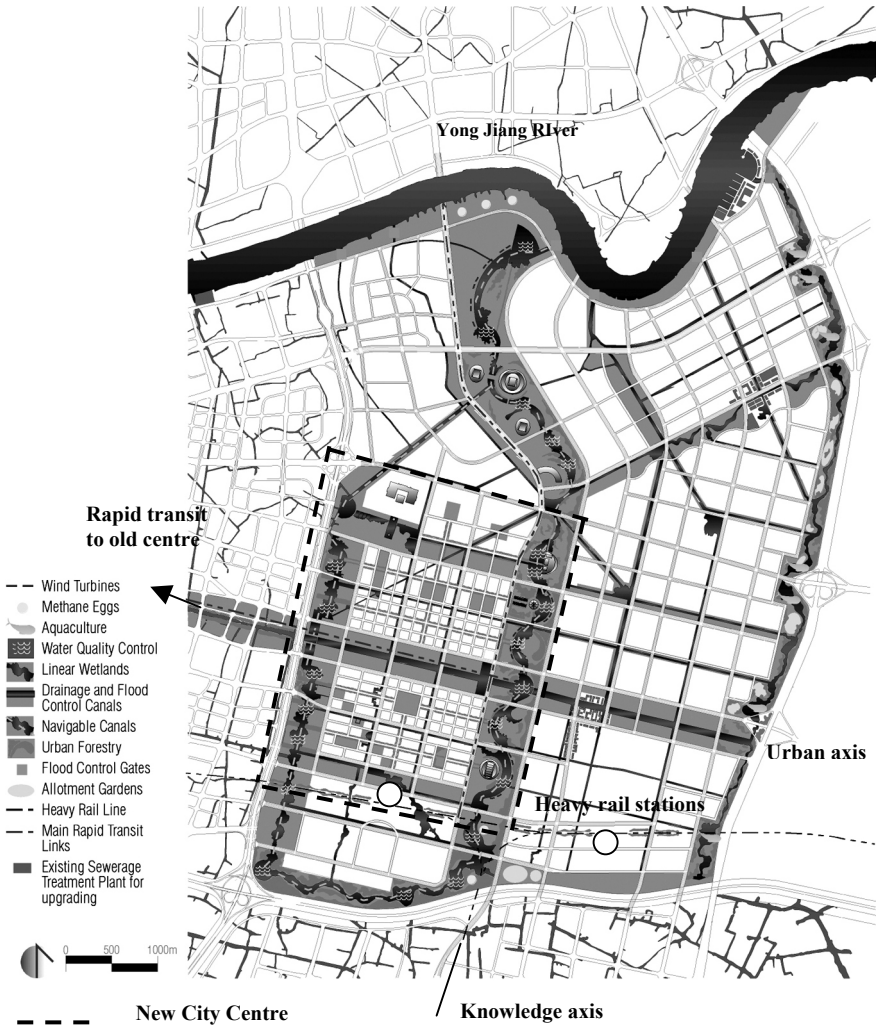


Figure 4: New District of East Ningbo- ESD Framework.

10.2.7 Urban forestry

Urban forestry will be incorporated to provide the following benefits:

1. Buffer zones along freeways
2. Disposal of composted sewage and other wastes
3. Reuse of topsoil and recycled water, and other composted wastes
4. Noise absorption, air purification and visual screening. Harvesting of forests may be considered on a periodic basis.

10.2.8 Transport modes

Ningbo presently uses high levels of cycling (60%) and walking (20%) for journeys to work, by comparison with most major cities outside China.

Western cities utilise higher non-renewable energy levels on transport. New systems for Ningbo will minimize the increase in private car use, as community living standards improve.

As more mechanical transport is demanded, utilisation of public transport will be maximized by bus and lightrail routes in main road reservations; and the underground rail line along the Urban axis, the Rapid Transit Line linking the two urban centres, and the heavy rail centre and regional connection.

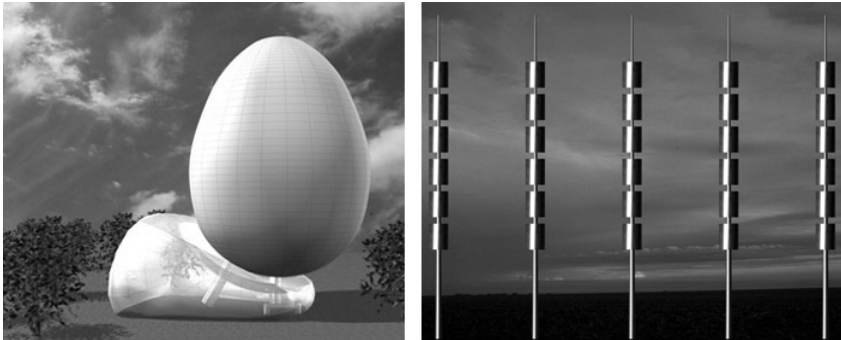


Figure 5: Methane eggs and wind turbines.

10.2.9 ESD building design

A detailed schedule of ESD initiatives to be incorporated in individual developments was developed to compliment citywide ESD planning and infrastructure set out above.

11 Conclusion

The speed and quantum of China's urbanisation is unparalleled with 500 million additional population planned for cities by 2020. Modern sustainable systems for cities relate strongly to Chinese tradition and culture. The pattern of future growth of China's new cities, and the degree to which they can be made sustainable will affect all our futures.

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