Sustainable Practice in China
The Olympic Forest Park, Beijing

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MAN follows EARTH
EARTH follows HEAVEN
HEAVEN follows DAO
DAO follows NATURE

——LAO’ZI
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**How do we negotiate between the human-social needs and the ecological considerations in every part of the design?**

Our conviction in the planning & design of the park is that in order to attain sustainability, we would need to find a way for the human and the ecological systems to find a certain harmony on site, and to do so, we must recognize what each can actively contribute to the relationship on the ground.
Sustainable Development Should Consider:

- Nature
- Culture
2008 Olympic Games has extraordinary significance to fast developing China.

It is a stage for Beijing to show itself to the world, and the center of the stage, is the **Olympic Green** located on the Central Axis.
Location
In 2002, the Beijing Municipal Commission of Urban Planning organized an international competition for conceptual planning and design of Beijing Olympic Green. The Plan of Sasaki Associates, Inc. (USA) won the competition.
In 2003, the **A02 Plan**, designed jointly by **Sasaki Associates, Inc.** and **Beijing Tsinghua Urban Planning & Design Institute** won the competition.

Olympic Green
Olympic Forest Park
Olympic Central Area
Olympic Sports Center
The Olympic Green under Construction

- National Aquatics Centre
  - “Water Cube”
- Olympic Forest Park
- National Stadium
  - “Bird’s Nest”
National Stadium  “Bird’s Nest”
National Aquatics Centre  
“Water Cube”
National Gymnasium
Olympic Forest Park:

- Is 680ha
- Located in the north of urban Beijing
- Is on the historical south-north central axis
- Is in the north of the Olympic Green
Olympic Forest Park Master Plan
Olympic Forest Park is the largest green space ever to be built in Beijing.
• The urban planning and construction of Beijing are outstanding achievements in human history.

• The historical south-north axis is the greatest axis in urban construction history. The ancient structures such as Tian An Men Square, the Forbidden City and Jingshan Park are situated on the axis and establish great importance to the axis.

• The axis has witnessed the changes in the history of Beijing and has carried the symbol and memory of history, culture and politics.

• How to continue history and culture of central axis on the Olympic Forest Park site is the first tremendous challenge that we are facing.
• **Green Olympics, Hi-tech Olympics and People's Olympics** are the three themes of Beijing 2008 Olympic Games.

• With BOCOG Green Commitment to the world, we as landscape architects are challenged to create a Green Olympic based Olympic Forest Park with the application of new environmental protection and energy saving technologies, as well as new materials.
Axis to Nature

1. Culture Considerations
Urban Contexts:

- Rapid Urbanization
- Increasing Population Density
- Large-scale Construction & Development
- Upsurge in Traffic Volumes
- Aging Urban Infrastructure
- Water Shortage
- Diminishing Open Green Space

We have attempted to resolve these issues through modern technological application.

This new green infrastructure is public recreation & leisure environment to benefit all residents and visitors of Beijing.
Olympic Forest Park merges traditional Chinese landscape arts with contemporary design concepts and ecological techniques.

**Functions**

- Urban Green Lung & Ecological Buffer
- Leisure Park for Olympics
- Healthy Forest for Local Residence
Located on the ancient imperial Central Axis of Beijing, the site’s importance and cultural significance has a great influence on the Feng Shui of Beijing.

Our study therefore began with an in-depth historical study and traditional analysis of the Central Axis.
• The principles of traditional Chinese landscape art emphasize on the artificial to appear natural and in which mountain piling and water forming are among the most crucial elements.

• These principles were all examined and interpreted for the planning and design of the Olympic Forest Park.

• In accordance with these principles, an artificial mountain has been planned, with its highest point on the Central Axis line, and just south of it, a dragon-shaped body of water and winding system flowing along the axis, has been designed.
As a national landmark project
Olympic Forest Park must respect the balance and integrity of the axis and the other monuments situation along it.
Located at the Northern-most point of the ancient imperial Central Axis of Beijing, the site’s importance and cultural significance has a great influence on the Feng Shui of Beijing, a fact that influenced the formation of the new landforms.
The analysis of other important mountains in Beijing helped to establish the location, orientation, dimensions and design of our new landforms.
Earthwork Comparison with Other Ancient Parks

- Jingshan Mountain: 860,000 M³
- Qionghua Island: 580,000 M³
- Summer Palace: 5,810,000 M³
- Olympic Forest Park: 3,940,000 M³
- Yangshan Mountain: 3,940,000 M³
Elevation Comparison with Other Parks

- **Excavation**: 3.33 Million m$^3$
- **Fill**: 4.83 Million m$^3$
- **Hill Fundus Area**: 42 Ha
- **Hill Gradient**: Lower than 30%
- **Hill Height**: 48 m

Diagram showing elevations and comparisons with other parks:

- Jingshan Mountain
- Beihai Park
- Qionghua Island
- Summer Palace
- Longevity Hill
- Olympic Forest Park
- Yangshan

Elevation:

- +40 m
- +30 m
- +66 m
- +48 m
Why we build an artificial mountain here:

- The mountain was constructed with the construction and excavation for the Olympic Subway, Olympic Avenue and adjacent development area.

- No new soil was brought into the Olympic Forest Park site to construct the mountain.

- The mountain is a new landmark in the north of the city.
Looking South along Central Axis

Jingshan Mountain
Taishan Stones on the South Entrance Plaza
The South Entrance Plaza
Amphitheater as Leisure Lawn
Perspective Rendering of Amphitheater
Tian Jing
(Land of Heaven)

The Peak of Yangshan Mountain

- To Consider Cultural Design Heritage
- To Refer to Chinese landscape Art
- To Express the Harmony between Man and Nature
• Tian Jing is enhanced with tall Chinese pines, scenic stones and a sight-seeing platform.

• Visitors can pause here for a brief appreciation of the views of the Lake and central axis.

• Visitors can linger longer to enjoy the enchanting scenes.
Sketch of Tian Jing
Model of Tian Jing
Selecting Rock Material at Taishan Mountain
Loading Progress
Olympic Volunteers at Tian Jing
Brooks Running down the Forests

Situated at the Southwest of Yangshan Mountain
Water falls from the mountain to form brooks that flow through forests to the main lake.
A series of scenes are designed around the brooks which progressively pass through ecological plant communities of mixed woods, grassland, and lakeside wetlands.
Sketch of Brooks Running down the Forests
Models of Brooks Running down the Forests
Model of Brooks Running down the Forests
Plan of Brooks Running down the Forests
Section of Brooks Running down the Forests
Brooks Running down the Forests
To create a Long-Term Sustainable Eco-System that through research and analysis, can develop a model where tradition meets contemporary ideas and technologies to simulate a natural ecosystem, maintaining regional biodiversity, conserving energy, reclaiming water, and relying as little as possible on municipal services, facilities and resources.
Rich landforms - mountain chain, islands in the Lake, downhill streams and a variety of waterfronts - offer opportunities for diverse eco-habitats to be created.

The analysis of their characteristics set the foundation for identifying plant communities and animal habitats as part of the design.

Offer attractive platforms for traditional activities such as group dancing and tai chi.
We analyzed the effects that diverse terrains and landforms - hilltops, sloping banks, valleys, lakes and wetlands, ecological forests integrated with other landscape types – have on the city in sheltering it from wind and sand, tempering humidity and temperature, increasing storm water detention and collecting precious rainwater.
Located on the central axis, the Olympic Forest Park with its Green language and the grand Shan Shui pattern gives new extension of the axis, and becomes a new landmark in Beijing.

In the future, The Olympic Forest Park along with the growth of time, will bring more benefits for the city of Beijing.
An Axis To The Nature

2. Nature Considerations
To balance Urban Ecology with the incredible strain upon the inner city’s resources and open spaces resulting from mass development, and an upsurge in population over the last decades.
Water System Planning
**Total Water Surface**

- Water Surface of the Main Lake: 20.3 hectare
- Constructed Wetland Surface: 5.71 hectare
- Municipal River Surface: 25 hectare
- Existing Water System: 16.69 hectare

**Total**: 67.7 hectare
The largest technical challenges of Olympic Forest Park involves construction of a self-sustaining and self-regulating water body. Require solutions to problems associated with dry climate and high evaporation rate.

Necessary to ease ecological pressures on the city.
Therefore, studies were necessary to evaluate how to best use the existing natural water on and around the site, how to collect and reclaim rain and flood water, how to plan an effective water purifying and maintenance system, how to optimize the water circulation and irrigation system through recycling waste water.
Different patterns of water circulation have been analyzed and implemented to address the differences between the flood and other seasons.

A hydrological and water quality simulation process (EFDC, WASP) was used to study water system maintenance.

A compound water treatment system of hierarchical processes was established.
Olympic Forest Park is the first domestic urban park overall making use of reclaimed water as the source of water system and recharge for landscape water.
Functions:

- Increase the liability of the entire water treatment system
- Demonstrate a variety of water treatment technologies
- Integrate water treatment functions with scenic effects
- Construct a natural and ecological treatment system
- Provide an educational center for ecological education

The constructed wetland can dispose reclaimed water 2,600 cubic meters a day, circulating water from the Lake 20,000 cubic meters a day.

Treated Water shall reach the Standard of China for Landscape Water.
Reclaimed Water

Circulating Water from the lake

Water Streams and Surface Falling Water

Subsurface Flow Wetland

Green House

Oxidation Pond

Free Surface Wetland

Ecological Pond

Biology Function Zone

Lake
Wetland layout

- Reclaimed Water
- Water Streams and Surface Falling Water
- Circulating Water
- Oxidation Pond
- Green House
- Free Water Surface Wetland
- Mixed-Function Eco Zone
- Subsurface Flow Wetland
- Circulating Water Vertical Wetland

Directional Arrows:
- Circulating Water
- Reclaimed Water
Wetland System for Reclaimed Water

Wetland System for Circulating Water
Subsurface Flow Wetland Planting Plan

- 泽泻 Alisma orientale
- 红蓼 Polygonum orientale
- 千屈菜 Lythrum salicaria Linn.
- 葛蒲 Acorus calamus Linn
- 三棱草 Cyperus iria
- 莺尾 Iris
- 芦苇 Phragmites communis
- 水葱 Schoenoplectus tabernamontani (C.C. Gmel.) Palla
- 小花狐尾莲 Sagittaria minima var. japonica
- 香蒲 Typha orientalis Presl
Subsurface Flow Wetland
Subsurface Flow Wetland
Free Water Surface Wetland
Free Water Surface Wetland
Birds at Wetland
Underwater Corridor

**Functions:**

- Observation of wetland from a different view
- Education for the structure of wetland
- Block off water flow
- Slow water speed
Underwater Corridor
Flowers Terrace

**Functions:**

- Aeration
- Scenic Effects
Greenhouse for Ecological Purification of Water Quality
Functions:

- Reduce pollution content in the water and improve water quality
- Offer a scientific and interest scenic spots for the public
- Show a new and secure sewage water ecological treatment technology
- Provide a design demonstration of urban landscape water purification system
Total Construction Area: 2200㎡

Reclaimed Water Treatment Capacity: 600m³/day

Treated Water shall reach the Standard of China for Landscape Water.

According to the principle of "low cost and high efficient, ecological coordination, and environmental friendly", the greenhouse adopted All-weather eco-system for water purification.
Treatment Process

Inlet

Enhanced Denitrogenation Wetland

Water Plants Purifying Units

Restraining Algae Units

Outlet

Biological Units Providing Carbon

Enhanced Solar Power Dephosphorization Units

Disinfecting Units
Stormwater Utilization System
Design Principles

1. Make use the conditions of topography, hydrology and municipal storm water.
2. Make use of municipal river-ways and lake water system to collect rain water.
3. Make use of the collected water to irrigate and to wash the roads.
4. Make use of green lands in the park to increase the permeability of hard paving.
Drainage Conditions Analysis
The measures to prevent soil erosion making use of the technology of soil and water conservation
Recharge Trench Schematic Section
Infiltration Trench Schematic Section

- Width not over 2500mm
- 300mm high, 80mm
- 1000mm long
- Rubble or stone slab
- 1000mm high above ground
- 6000-8000mm long
- Spacing 5000mm

Infiltration Trench

Recharge Trench

Width not over 2500mm
All the roads in north park use graded sand gravel with 100% permeability.

The roads in south park adopt different measures according to the grades.

Car park Area: 122825m²
Grass Car park
Zero Sewage Discharge in the Park
Sewage Discharge in the Park (Prediction)

Tourists of the OFP: 5,300,000 per year
Staff of OFP: 4280
Quantity of Prediction Drainage: 86400m³/year
The Designed Sewage Discharge: 1590.91m³/d

The Characteristics of Drainage

- dispersed layout and various functions of buildings;
- changing landform;
- no existing municipal pipeline;
- Unstable tourists flow leads to obvious seasonal changing drainage.

Therefore, waste water need to be discharged within the park.
**Goals**

Zero discharge and reclamation ensures **zero pollution** to environment

**Main Techniques**

1. Membrane Bioreactor  （MB）
2. Fast Bio-degradation Treatment  （FBT）
3. Bio-Degradation of Dejection Treatment  （BDT）
Distribution of the buildings that adopt sewage treatment techniques

48 buildings
Planting and Biodiversity Design
Investigation & Modeling of Beijing Indigenous Plant Community

Value of Indigenous Plant

Living Conditions

Conditions in OFP

Modeling in OFP

Tolerance Capability
Eco-efficiency
Biological Features
Aesthetic Value
Natural
Semi-natural
Artificial
Site Conditions
Transport
Geology & Hydrology
Vegetation
Landscape Consideration
Zoning of Planting
Plant Community Modeling
Planting Design Classification

Trees + Shrubs + Grasses
Trees + Grasses
Waterfront + Forest Edge
Waterfront
Wetland
Grassland
<table>
<thead>
<tr>
<th>Area of Green</th>
<th>Quantity of Trees</th>
<th>Shrubs</th>
<th>Groundcovers</th>
</tr>
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<tbody>
<tr>
<td>&gt;450 ha</td>
<td>&gt;530,000</td>
<td>&gt;60 species</td>
<td>&gt;80 species</td>
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Diagram of Planting Space
Ecological Contributions to Beijing

- Annual output of Oxygen: 5400t
- Absorption of CO2: 7200t
- Annual absorption of SO2: 32t
- Annual dust detainment by trees: 4905t
- Annual recharge of water: 67.5m³
- Forest Humidity: 27% higher than the other place
- Forest Temperature: 3-5°C lower in Summer,
  2-4°C higher in Winter
Ecological Consideration Design
Apus apus pekinensis

• Beijing local bird specie
• An indicators of the urban environment quality
• Important to the biodiversity within the city, and to urban pest control
• Nest mainly on buildings
• The observation tower can be combined with the existing resources of the Forest Park to provide them with an ideal habitat
Nests of Swift

- Location: 4-45m, average of 10.18 +/- 8.0m
- Weight: 12.49+6.53g
- Outer Radius: 11.13+1.46cm
- Inner Radius: 8.74+1.29cm
- Height: 2.69+1.03cm
Three Challenges of Tower Design

Protection: Protect Beijing Swift Species and Biodiversity

Combination: Ideal Habitat and Special Landscape

Creation: Scientific Techniques and Artistic Form
The First Swift Tower in China
Ecological Corridor

**Location:**
Over the highway known as the 5th Ring Road, which divide the Forest park as a northern and a southern part.
Functions:

- To link southern part and northern part of Olympic Forest park.
- To provide pathway for the movement of animals.
Geothermal Pump System

Advantages:

- Clear Energy
- Environmental Friendly
- Efficiency
- Low-energy Consumption
Measurement and Position

Pipeline Installation

Drilling
Distribution of the Buildings Used Geothermal Pumps

21 Buildings
Optical lighting

**Advantages:**

- Application of Nature Light
- No Cost of Electricity
- Durable
Solar Photovoltaic Panels

**Advantages:**
- Non-polluted
- Educational
- Environmental benefits

Area: 950 m²
Power: 80Kw
Annual Electricity Generation: 80,000 ℃
Solar Photovoltaic Panels Combination with Landscape Furniture
Application of Wood-Plastics Composite

Advantages:

- Plastifying
- Economic
- Environmental Protective
- Recycling
Recycling and Reuse
System of Solid Waste

The first domestic urban park to make use of recycling solid waste
The prediction of Annual Sewage and Waste product

According to the prediction of annual tourists as 5,300,000 and staff as 4280 to calculate as follows:

- Annual Sewage Product: 121980M³;
- Annual Recycling Yellow Water: 3230M³;
- Sludge of 95% Moisture Content: 7860M³;
- After Dehydration Sludge of 70% Moisture Content: 1304M³
- Reusable Green Plant Waste in Southern Park: 3000M³
**SOURCE SEPARATE :**
Life wastes are separated in the discharge source and then were treated separately and effectively. It’s a different treatment technique from environmental protection projects in the past which treating at the end of the process.

**RECYCLING :**
Turn the materials rich in organic matters such as life and garden waste, into fertilizer and spread in the park after processing hazards. This not only solves the visual impact of waste and other environmental problems, but also formats the a virtuous circle of biomass resources in situ use.
Classification of Waste Discharge and Environment Problems

- Sewage – 49 buildings, the designed maximum treatment per day: 1696 m³
  
  With the usual sewage treatment technique, N and P can not reach the national standard of landscape water

- The sludge from Septic pond is reach to 7800t/year
  
  High transportation fee and resource waste

- Huge green waste, only south park 3000t/year
  
  Separate compost fertilizer products low
Objectives:

- Collection
- Reuse of Green Fertilizer
- Low Operation Costs
- Garbage-obturation Process
- Participating the Ecological Recycling
Urine Treatment Center  Green Waste Treatment Center

Waste Recycling and Reuse Center
Process
Source Separation Toilet

“Yellow Water” Collection & Transportation Truck

**Functions:**
- Transport the collected yellow water to Urine Treatment Center
- Transport the liquid organic fertilizer to the trees
• **Sarah Liao Sau Tung**, (left) who was former Secretary for the Environment, Transport and Works of the Hong Kong Special Administrative, visited Olympic Forest Park.

• **Achim Steiner**, (right) who is UN Undersecretary General and Executive Director of the UNEP, visited Olympic Forest Park.
Germer, the delegate from GTZ organization investigated on Olympic Forest Park site and had meeting with designers together.

GTZ, the international cooperation enterprise for sustainable development with worldwide operations.
Changing With Time

From 2001 to 2008
Apr. 2001

Olympic Forest Park

Olympic Green
Sep. 2003

Olympic Forest Park

Olympic Green
Oct. 2006

Olympic Forest Park

Olympic Green
Evaluations and Prizes
GTZ, the international cooperation enterprise for sustainable development with worldwide operations have evaluations to OFP based on their report:

- In accordance with the Green Olympics motto the park symbolizes the need to take care for a healthy sustainable environment. The plentiful vegetation, the comprehensive closed loop ecosanitary system and the lake fed with recycled water from a nearby waste water treatment plant are to convey the green message to the visitors.
The OFP sanitary system and nutrient reuse strategy is new and unique.

Local research institutions would profit from the fact that they do not need to invest into trial establishment as with the OFP sanitary concept is already set up. Further, cooperating institutions will work with innovative technology that is apt to have a significant future impact on national and international level.

Beyond basic research tasks including in-depth nutrient flow analyses, hygienic safety and environmental impact, the OFP provides an incomparable research ground for all eco-sanitary questions: From acceptability studies, over sanitary installation improvement to cutting edge micro-toxin research.
The UNEP's report praised the city for waste management, cleaner transport systems, water treatment capabilities and creating urban green belts including the 580-hectare Olympic Forest Park.

"These things not only benefit Olympic athletes but are also a legacy for the citizens of Beijing. Most importantly, these are a demonstration of where other cities in China and many parts of the world should strive to move in the years ahead"
The Greenpeace gave evaluation on Beijing 2008 Games Environmental Performance:

- Olympic Forest Park: Geothermal heat pump technology is in use throughout 43 buildings in the Forest Park, covering an area of 59,976 m² of construction area.

- Olympic Forest Park: A small solar photovoltaic power station with an area of 1,000 m² and a generation capacity of 65kW. 79 is currently being constructed at the south main gate of the Forest Park for energy provision and educational purposes and is scheduled to be completed in time for the Games.
A number of new Olympic venues and refurbished venues such as the national Stadium (Bird’s Nest), the Olympic Green, and the Olympic Forest Park include water saving design including rainwater collection, water efficiency, water re-use and water recycling features to reduce water demand during and after the Games.

The Park contains an advanced enclosed water circulation system. Official figures say that about 1.34 million m³, or about 95% of rainwater inside the park can be reused for irrigation. This system will also support an ecological wetland area designed for educational purposes.
During drought periods, reused water will come from the Qinghe Wastewater Treatment Plant. Sewage and human waste derived from visitors are treated using advanced composting and source separation methods that allow the waste to return to the park as fertilizer. All park toilets will make use of these advanced technology.

Selective venues at the Games have undertaken zero-waste approaches to waste management. The Olympic Park produces 5000-7000 tons of green waste a year, which includes grass, leaves and branches that are produced by plant life in the park. The treatment center at the north end of the Park can process about 3000 tons of waste per annum. There will also be a unique “yellow water” treatment system that will process human waste to allow these waste products to return to the park as fertilizer.
Olympic Forest Park Project  Won
Torsanlorenzuo International Prize 2007——
Landscape Design and Protection 1st Prize
(Section B: Urban Green Spaces)
Olympic Forest Park Project Won
2008 IFLA Asia – Pacific Region Award Program
Landscape Planning Category
President’s Award
To fulfill Beijing’s Olympic commitment, we have organized a large expert advisory team. Through our untiring efforts, the Olympic Forest Park has been put into reality.

**Main Design Team**
Planning & Design Branch of Landscape Architecture
Beijing Tsinghua Urban Planning & Design Institute

**Chief Designers**
Hu Jie, Wu Yixia, Lu Lushan, etc.

**Consultants**
Sasaki Associates, Inc. (USA)
Meng Zhaozhen, Chen Jining, Yin Zhi, Laurie Olin, etc.
Cooperation Companies and Institutes:

China Research Center of Landscape Architecture Design and Planning
Beijing Top-Sense Landscape Design Limited Co.
Beijing Beilin Landscape Architecture Institute Co. Ltd
Beijing Institute of Landscape and Traditional Architecture Design and Research

Branch of Urban and Architectural Ecology Research, THUPDI
Branch of Environment and Infrastructure, THUPDI
Branch of Lighting Design & Research, THUPDI
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