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再生水在中国的综合利用
The comprehensive utilization of
reclaimed water in P. R. China

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4	再生水综合管理机制 Integrated management of reclaimed water
5	再生水工程案例 Cases of reclaimed water project



中国水环境面临的问题

China's water environment problems

- **人口和经济发展与水、土地资源供需矛盾越来越突出**
Sharp conflict among population, economic development, water supply and land resources
 - 人均水资源不足全球平均数的四分之一
 - **Water resources per capita less than a quarter of the global average**
 - 水厂, 污水厂选址和占地越来越困难
 - **More and more difficult for the choice of water and wastewater treatment plant site**
 - 满足更高的出水质量标准必须进行处理设施升级改造
 - **Upgrading treatment facilities to meet the need of higher water quality standards**
 - 国家对包括水厂, 污水厂在内的基础设施用地实行有偿使用
 - **Countries ask land use with compensation for water plant and sewage treatment plant**

中国水环境面临的问题

China's water environment problems

- **饮用水安全面临威胁****Drinking water safety**
 - 国家饮用水卫生新指标
 - **National new standards for drinking water**
 - 传统技术不能经济有效地解决“两虫”的问题
 - **Traditional technology can not solve "two worms--- Giardia/Cryptosporidium assay" problem**
 - 满足新标准必须对大部分现有水厂进行升级
 - **Urgently upgrade most of the existing water plant to meet the new standards**

中国水环境面临的问题

China's water environment problems

- **控制水污染——污水处理达一级标准/污水处理回用**
- **Control of water pollution ----- upgrade sewage treatment to meet new standard/Wastewater Treatment Reuse**
 - 全国还有约40%城市污水未经任何处理直接排向自然水体
About 40% of the national urban sewage discharge directly into the natural waters without any treatment
 - 现有的污水处理厂大多不具除磷脱氮工艺或处理程度难以达到一级出水标准
No or low level Phosphorus and Nitrogen removal in most of the existing sewage treatment plant, difficult to achieve new water standard
 - 需要寻求技术可靠、节能、省地、投资少的处理工艺方法, 处理后的水达到回用标准
Need for technical reliability, energy saving, small, less investment and processing technologies and methods
 - 无机盐类的污染已经不可小视
Attention to inorganic salts pollution

七大水系 Seven Waters



Five Lakes 五大湖泊

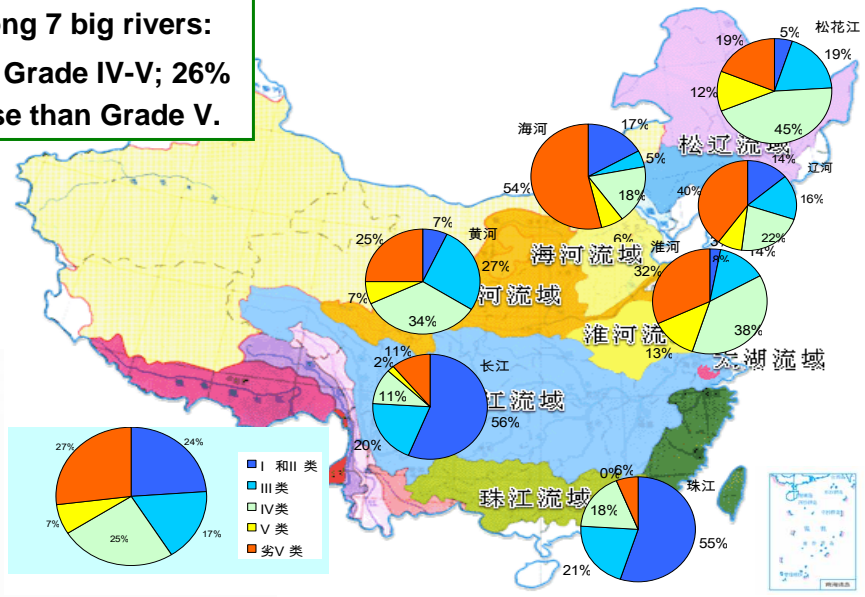
Distribution of Lakes in China



HOLLAND
中国水资源
2000-2010

River Pollution

Among 7 big rivers:
28% Grade IV-V; 26%
worse than Grade V.



HOLLAND
中国水资源
2000-2010

Lake Pollution

Among 200 lakes in Eastern & Yunnan-Guizhou lake areas: 75% eutrophication;



In 2006, 19% Grade V standard, 48% worse than Grade V.



中国再生水利用China's use of reclaimed water

- 我国再生水利用潜力巨大
- **Great potential for the use of reclaimed water**
 - 我国城市污水处理能力突飞猛进的增长，
Rapid growth of urban sewage treatment capacity

2009年一季度，我国已建成并投入运营的污水处理厂共1590座，设计日处理规模已达9000多万 m^3 ，日实际处理量近7000万 m^3 ，年处理污水量将达250亿 m^3 ，约占我国城市供水总量的50%

Up to first quarter of 2009, China has built and put into operation a total of 1,590 sewage treatment plants, designed treatment capacity more than 9,000,000 m^3 /day, and the actual capacity nearly 7,000,000 m^3 /day,

Sewage treatment capacity will reach 25 billion m^3 /year, about 50% of the total urban water supply.



中国再生水利用 China's use of reclaimed water

我国污水再生利用率还相当低

China's water recycling rate is still quite low

- ✓ 按照发达国家的水平计算，污水再生利用率如果能够达到70%，我国每年还有近150亿m³的再生水资源可以得到开发利用，潜力非常巨大

In developed countries, wastewater recycling rate up to 70%

In China nearly 15 billion m³/year of renewable water resources could be used, huge potential

我国大部分城市的再生水利用刚刚起步，甚至还没有启动

Most cities in China has just started using recycled water, not even start,

- ✓ 我国城市再生水资源还有巨大的空间和潜力有待加大力度去开发利用。
- ✓ Great space for renewable water resources and great potential

HOLLAND
中国水务网
www.chinawater.com.cn

中国再生水利用 China's use of reclaimed water

我国急需推广再生水综合利用

● In China urgent to promote recycled water utilization

- 是缓解我国水资源短缺的有效途径
- An effective way to alleviate the shortage of water resources

- 是解决我国水资源短缺，尤其是北方地区缺水状况的重要途径

An important way to solve water shortage, particular in north China,

- ✓ 是开辟新水源的有效措施

Effective measures to open new water sources

- ✓ 是解决农业灌溉缺水的重要途径

- An important means to solve agricultural irrigation water

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www.chinawater.com.cn

中国再生水利用 China's use of reclaimed water

- 是实现水资源循环利用，减轻水体污染的重要环节
- **An impotent step to recycle of water resources and reduce water pollution**
 - ✓ 减少污水的产生和排放量
Reduce waste water generation and emissions
 - ✓ 减少这些污染物进入天然水体的量，减轻水污染
 - ✓ **Reduce pollutants amount entering natural water, and alleviate water pollution**
- 是促进城市水污染治理，改善水生态环境的重要举措
- **An important measures to promote urban water, improve water environment**
 - ✓ 将治理后的中水资源真正利用起来，建立起下游用户对上游水污染治理的倒逼监督机制，促进水污染治理工作的开展
 - ✓ **The downstream user would monitor the water treatment process of the upstream**

再生水的综合利用技术

The comprehensive utilization technology of reclaimed water

- **再生水 Reclaimed Water**
 - 中水，也称再生水，它的水质介于污水和自来水之间，是城市污水、废水经净化处理后达到国家标准，能在一定范围内使用的非饮用水，可用于城市景观和百姓生活的诸多方面
 - **Middle water, also known as reclaimed water,**
 - **water quality between sewage and tape water**
 - **Non-potable water from the treated water of urban sewage, waste water which can be used within a certain range for urban landscape and people's lives**
- 国内再生水资源利用发展情况
- **The development of domestic renewable water resources**
- 再生水利用技术
- **Reclaimed Water Utilization Technology**

● 国内再生水资源利用情况 Utilization of domestic renewable water resources

- 我国早在20世纪50年代就开始采用污水灌溉的方式回用污水
- In the early 50's of the 20th century, began to use water for irrigation
 - ✓ 建设部在“六五”专项科技计划——大连、青岛，成果表明，污水可以通过简易深度处理再次回用，是很有前途的水源。
In the “6-5 Plan” of Ministry of Construction in Dalian, Qingdao, treated sewage could be used through the advanced treatment

- 从1986年开始，城市污水回用相继列入国家“七五”、“八五”、“九五”重点科技攻关计划。
- Since 1986, urban water reuse have been included in the national “Seven-Five Plan”, “Eighth Five-Year”, “Ninth Five-Year” Key Scientific and Technological Plans
 - ✓ “七五”攻关项目——青岛延安三路污水厂等14个污水，就污水再生工艺、不同回用对象的回用技术、回用的技术经济政策等进行了系统研究。
 - ✓ Seven-Five Plan - 14 sewage wastewater treatment plant, such as Yan'an 3 Road, Qingdao, the wastewater recycling process,
 - ✓ “八五”攻关项目——大连、太原、天津、燕山石化，提供了城市污水回用于工业工艺、冷却、化工、石化、钢铁工业和市政景观等不同用途的技术规范和水质标准。
 - ✓ “Eighth Five-Year” - Dalian, Taiyuan, Tianjin, Yanshan Petrochemical, provided the city sewage for industrial process cooling, chemical, petrochemical, steel and other industrial and municipal landscape specifications for different uses
 - ✓ “九五”攻关项目——一是回用技术集成化研究，二是城市污水地下回灌深度处理技术研究。
“Ninth Five-Year” - The integrated research of recycling technology, and groundwater recharge

再生水的综合利用技术

The comprehensive utilization technology of reclaimed water

- 在“21世纪”——中国将会全面启动污水资源化工程，在未来的几年城市对再生水利用的投资与需求将迅速升温 In the "21st Century" - China will launch a comprehensive water resource project, rapid warming for the demand and investment for the use of recycled water
- 我国近期集中污水处理与回用规划 China's recent planning for treatment of sewage and reuse

城市	污水处理厂	处理规模 / (10 ⁴ m ³ /d)	回用规模 / (10 ⁴ m ³ /d)	回用对象
北京	高碑店	77	20	污水处理厂内用、电厂及污水厂骨绿化、市政杂用、景观河道
	方庄	4	2	
	酒仙桥	2	2	
	清河一期	20	10	
天津	纪庄子	26	10.2	工业及污水厂内用
	东郊	40	7	
大连	春柳河	6	1	化工厂、煤气
	开发区	10	5	
	马兰河	12	4	
西安	北石桥	15	3	工业及市政用水



再生水的综合利用技术

The comprehensive utilization technology of reclaimed water

● 再生水利用技术 Utilization technology of reclaimed water

Inorganic Waste Organic Waste Heavy Metals / Complex Waste

UF + RO

MBR

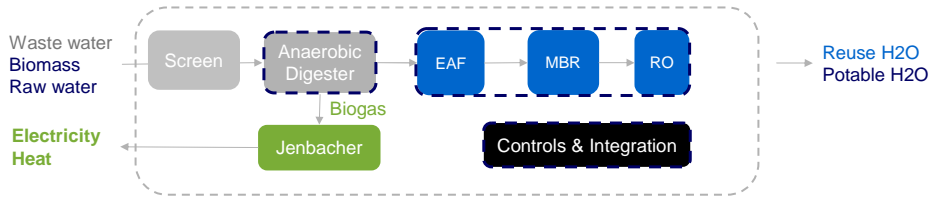
ZLD

UF + EDR



再生水的综合利用技术
The comprehensive utilization technology of reclaimed water

● 再生水利用技术 Utilization technology of reclaimed water



Jenbacher



EAF



MBR

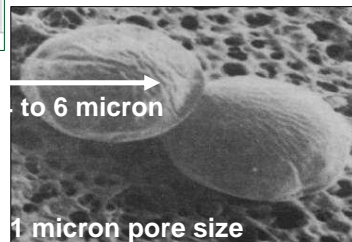
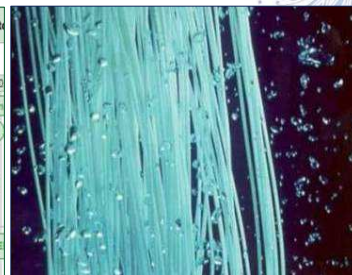


RO

再生水的综合利用技术
The comprehensive utilization technology of reclaimed wa

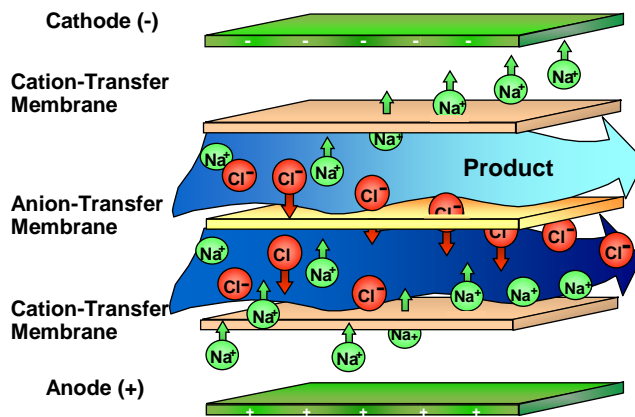
Membranes for Water Treatment

ST Microscope	Scanning Electron Microscope	Optical Microscope	Visible light
Ionic Range	Molecular Range	Macro Molecular Range	Micro Particle Range
0.001 m	0.01 m	0.1 m	1.0 m
100	10 m	100	100
Disolved Salts	Colloids	Giardia Cysts, Human	Suspended Solids
	Virus	Bacteria	Pin Point
		Parasites	
REVERSE OSMOSIS (Nanofiltration)	ULTRAFILTRATION		GRANULAR MEDIA
		MICROFILTRATION	





Electrodialysis Reversal (EDR)



Removes

- Fluoride
- Arsenic
- Nitrates
- Radium
- Uranium

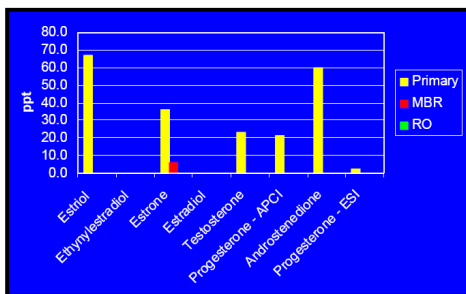
Robust

- Chlorine tolerant
- No silica limit
- Rugged membranes
- Long life

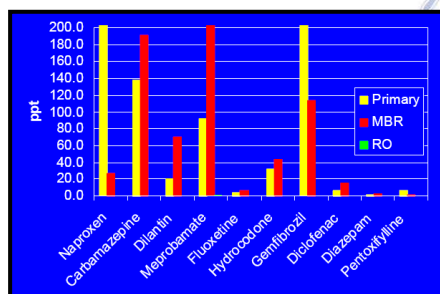


•EDCs

Selected Hormones



Selected Pharmaceuticals

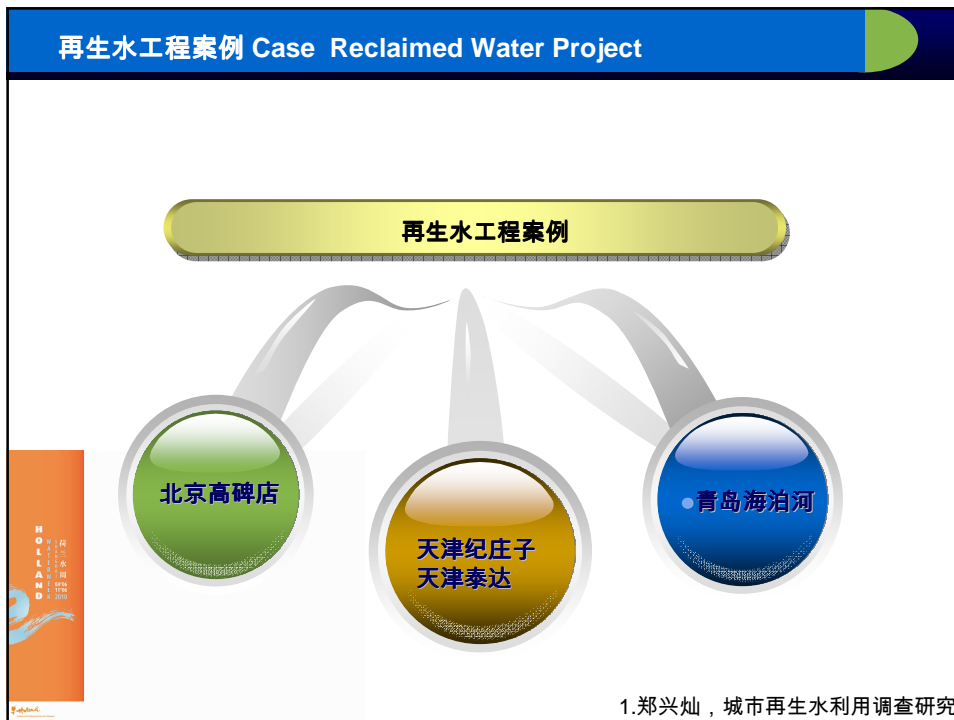


- Primary wastewater treatment not effective
- UF very effective for removing hormones
- MBR / RO very effective for removing pharmaceuticals

Source: S. Adham, MWH, PNCWA Oct 2004

- **建立相关法规、政策与标准，进行指导与督查**
Establishing regulations, policies and standards, guidance and supervision
- **再生水规划纳入城市总体规划和水资源规划**
Recycled water planning into the overall urban planning and water planning
- **污水处理目标由达标排放转变为再生循环**
Change sewage treatment target from discharged standards into recycling standard

- **国家State**
 - **《再生水水质标准》"Reclaimed water quality standards"**
 - **《再生水回用于景观水体的水质标准》" Quality standard of recycled water for landscape water "**
- **各地.....Around**
 - **北京：北京再生水利用率达65% reclaimed water use rate was 65%**
 - **天津：《天津市再生水设计规范》Tianjin: "design manual of reclaimed water in Tianjin"**
 - **昆明：《昆明市再生水管理办法》Kunming: "Kunming recycled water management approach"**
 - **太原：确保40%的再生水实现回用 Taiyuan: to ensure that 40% of the recycled water to achieve reuse**
 - **宁波：《宁波市城市排水和再生水利用条例》 Ningbo: "Ningbo City water and recycled water use regulations"**



● 北京再生水利用情况 Utilization of reclaimed water in Beijing

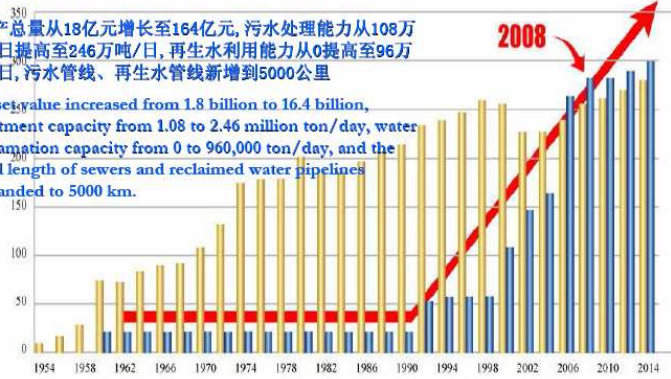
- 到2014年北京城区的8座污水处理厂将全部完成升级改造，每年可生产再生水8亿立方米，出水水质都将达到地表水四类水标准。届时，再生水的使用将占北京年用水总量的20%以上，再生水将真正成为城市的新水源。
- Up to 2014, in Beijing eight sewage treatment plant will be upgraded,
- Reclaimed water capacity being annually 800 million cubic meters of,
- Effluent quality will meet surface water standards IV
- Then, 20% of total water could be used as recycled water in Beijing
 - ✓ 奥运景观湖、北土城沟和清河、凉水河等景观湖面全部实现了再生水补水。 Olympic Landscape Lake, Beitugoucheng and Liangshuihe
 - ✓ 173个再生水洗车点，600多个住宅小区都使用了再生水
 - ✓ 173 car washingshop, 600 residential areas
 - ✓ 颐和园、北海、天坛、玉渊潭等市属11家公园的绿化用水也全部实现再生水化
 - ✓ 11 municipal parks, such as Summer Palace, Beihai, the Temple of Heaven, Yuyuantan

● 北京再生水利用情况

十五年期间 During 10th Fiver Year Plan period:

资产总量从18亿元增长至164亿元, 污水处理能力从108万吨/日提高至246万吨/日, 再生水利用能力从0提高至96万吨/日, 污水管线、再生水管线新增到5000公里

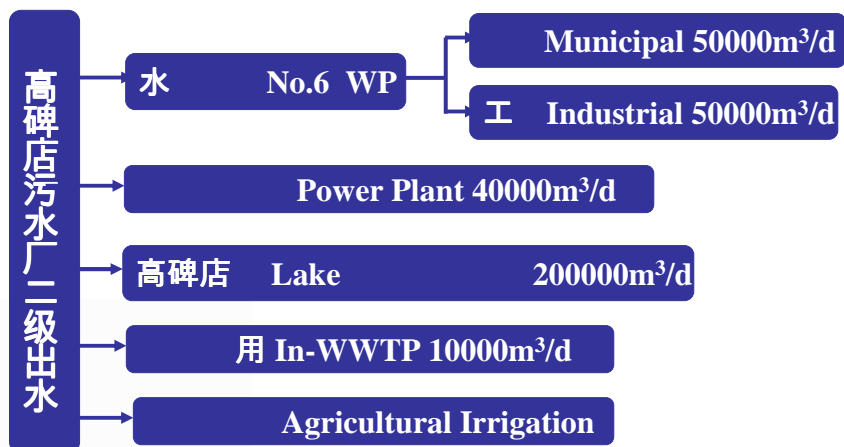
Asset value increased from 1.8 billion to 16.4 billion, treatment capacity from 1.08 to 2.46 million ton/day, water reclamation capacity from 0 to 960,000 ton/day, and the total length of sewers and reclaimed water pipelines expanded to 5000 km.



北京市中心城污水处理能力增长图
Growth of treatment capacity in Beijing urban districts

污水量 Total wastewater 污水处理能力 Treatment capacity

北京高碑店 Gaobeidian, Beijing



北京高碑店 Gaobeidian, Beijing

厂内再生水利用
In-WWTP WRP



厂内再生水生产
In-WWTP WRP



石灰法中试
Lime Treatment Testing



草地灌溉
Lawn irrigation



北京高碑店 Gaobeidian, Beijing



排入河道
Receiving river



北京高碑店 Gaobeidian, Beijing



天津 Tianjin

天津纪庄子
Jizhuanzi

混凝沉淀+微滤膜+臭氧, 2万m³/d
Flocculation and microfiltration membrane + ozone, 20 000 m³ / d

混凝沉淀+过滤, 32万m³/d
Flocculation and filtration, 320 000 m³ / d

天津泰达Taida

微滤 (3万m³/d) MF+反渗透 (1万m³/d) RO

天津居民景观和小区杂用水
Residents area landscape and miscellaneous water



天津纪庄子Jizhuanzi

混凝沉淀
Coagulation/Sedimentation



膜滤
Microfiltration



再生水厂
WRP



天津泰达新水源Taida

国产微滤膜装置



反渗透处理装置



天津居民景观和小区杂用水

Resident area landscape and miscellaneous water

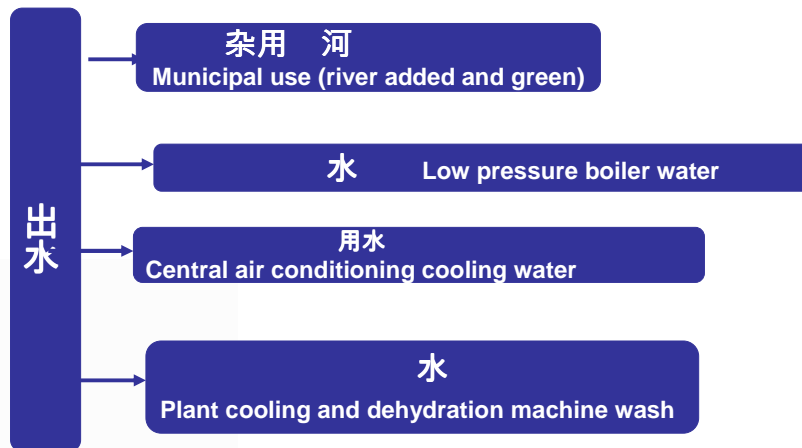


居住区景观水体 Resident area landscape



青岛海泊河 Haibo River, Qingdao

+ + 4 m³/d
Flocculation + sedimentation + filtration



青岛海泊河Haibo River, Qingdao

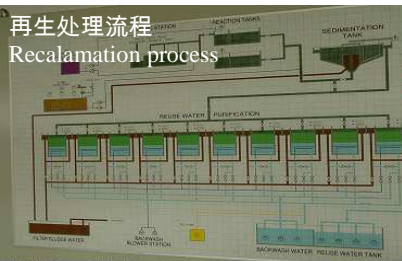
再生水中试系统Pilot Plant



再生水厂滤池WRP Filtration



青岛海泊河Haibo River, Qingdao



青岛海泊河Haibo River, Qingdao

- 海泊河公园与河道补水Haibo River Park and the river water supplement

