Development of Ecological Sanitation Projects in Urban Areas

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- **Introduction**
- **Types of the suitable toilets for ecological sanitation systems in urban areas**
- **Treatment processes for different wastewater flows**
- **Case studies**
- **Conclusions**

Domestic wastewater treatment ratio and COD discharge amount in urban areas of China (EPA of China)

Domestic Wastewater Amount in 2006:

29660 Mio. M^3

Treated Domestic Wastewater Amount in 2006:

13040 Mio. M^3

Main treatment process (centralized sewerage system):

Primary treatment + secondary biological wastewater treatment process

Table 1: Domestic wastewater treatment ratio and COD discharge amount per m^3 wastewater in urban areas of China (EPA Data)

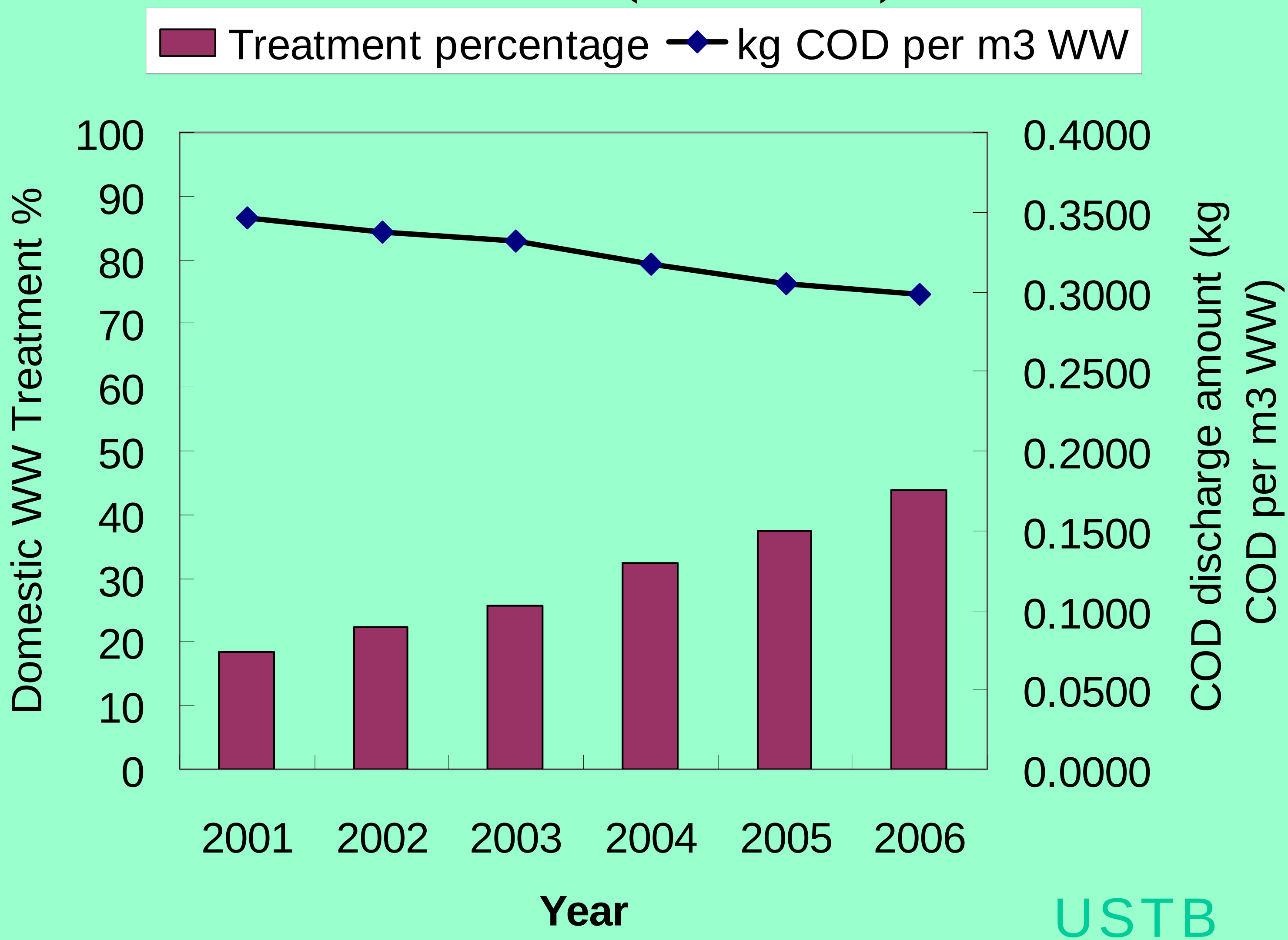

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Table 2: Domestic wastewater treatment ratio and NH_4-N discharge amount per m^3 wastewater in urban areas of China

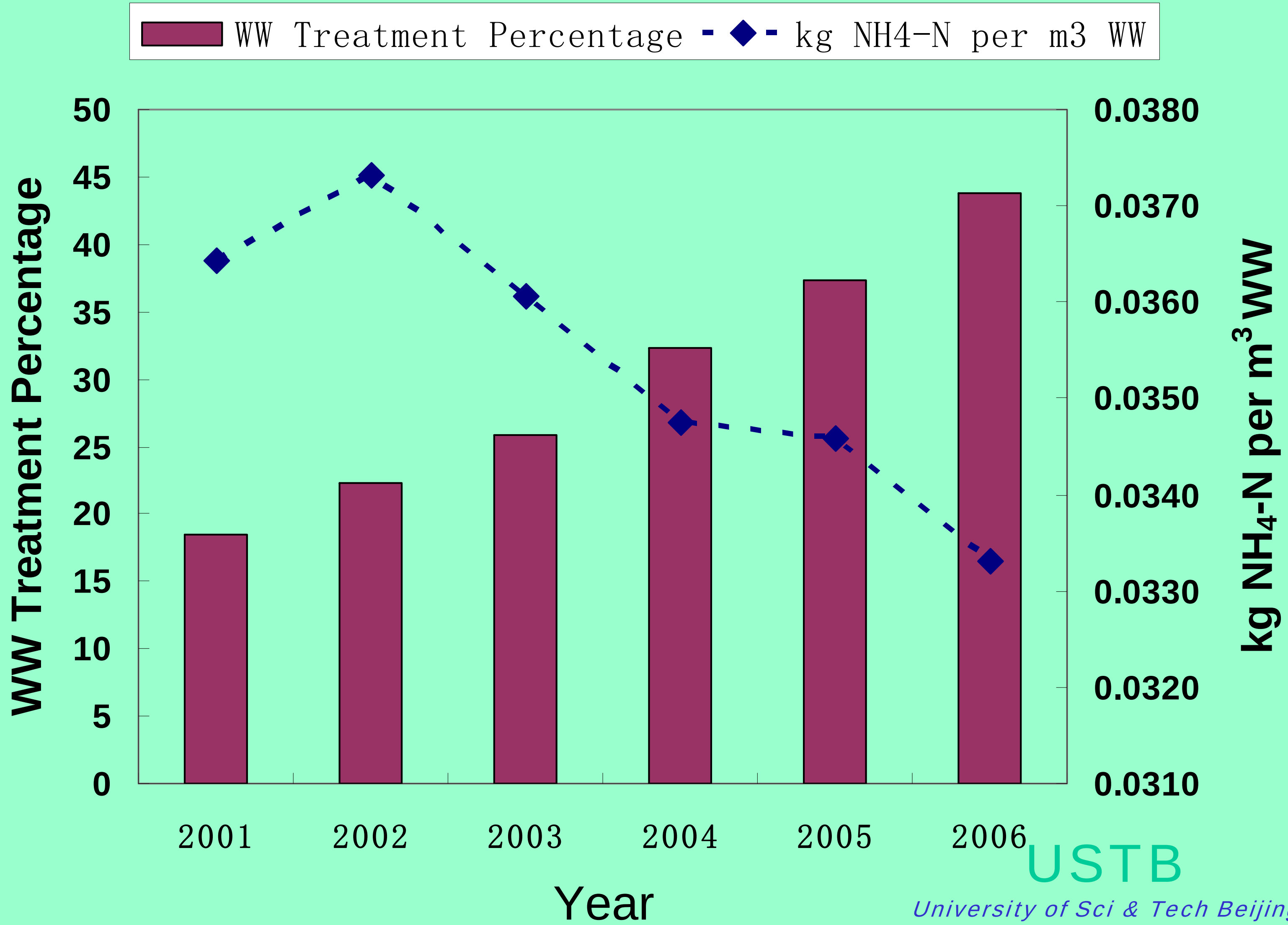

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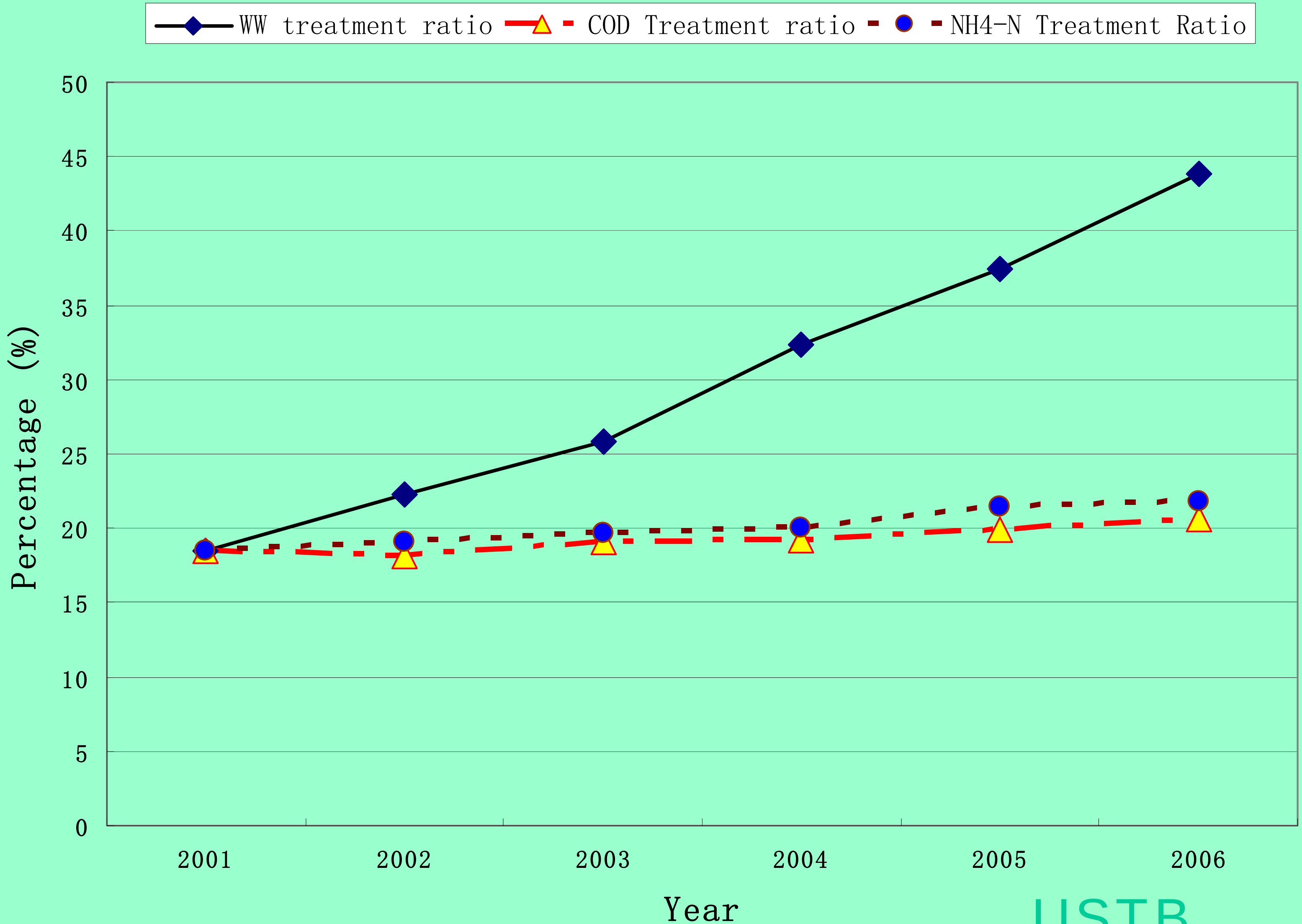
Table 3: Relationships of the treatment ratios among domestic wastewater amount, COD and NH_4-N in urban areas of China



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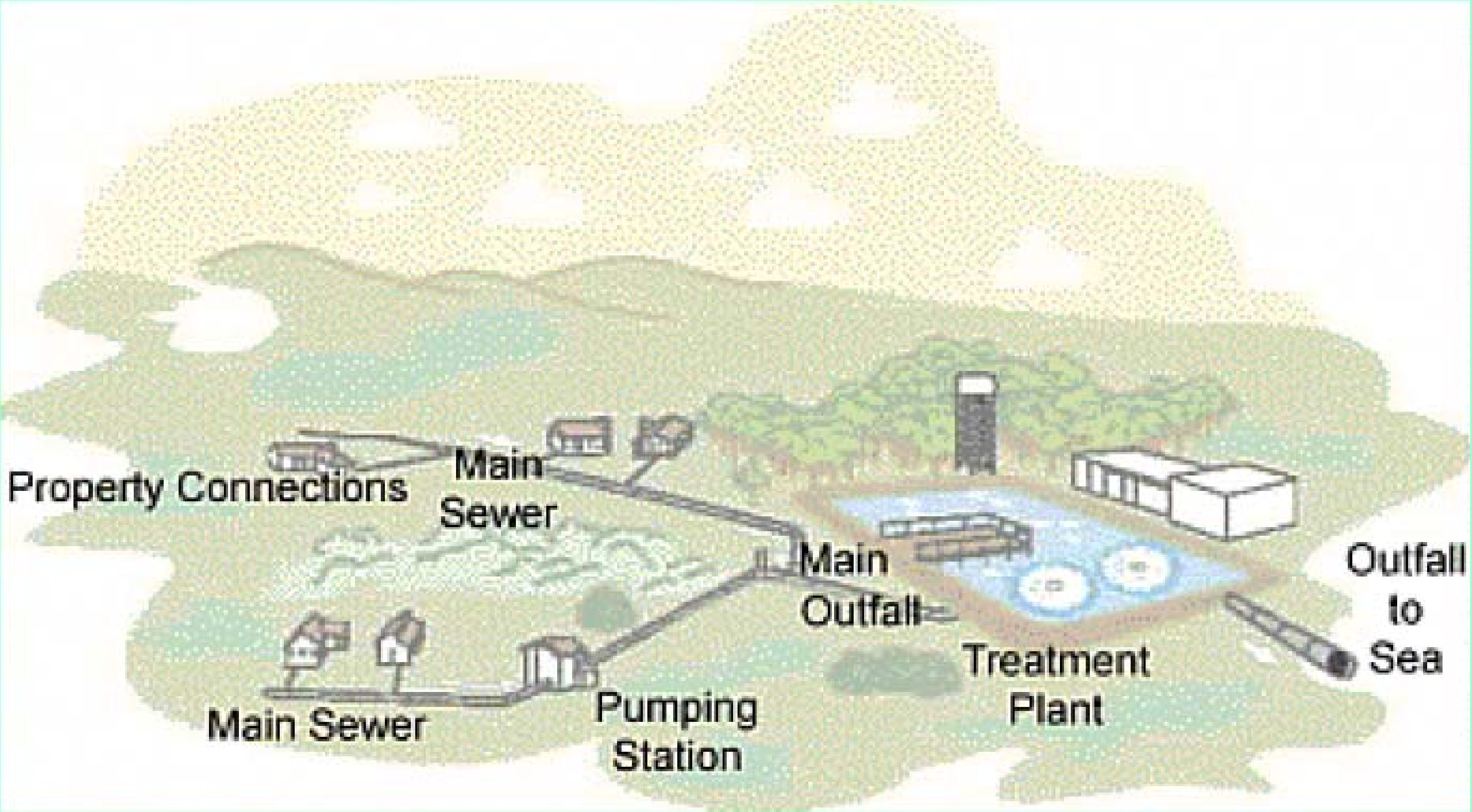

Figure 1: Conventional sewerage system

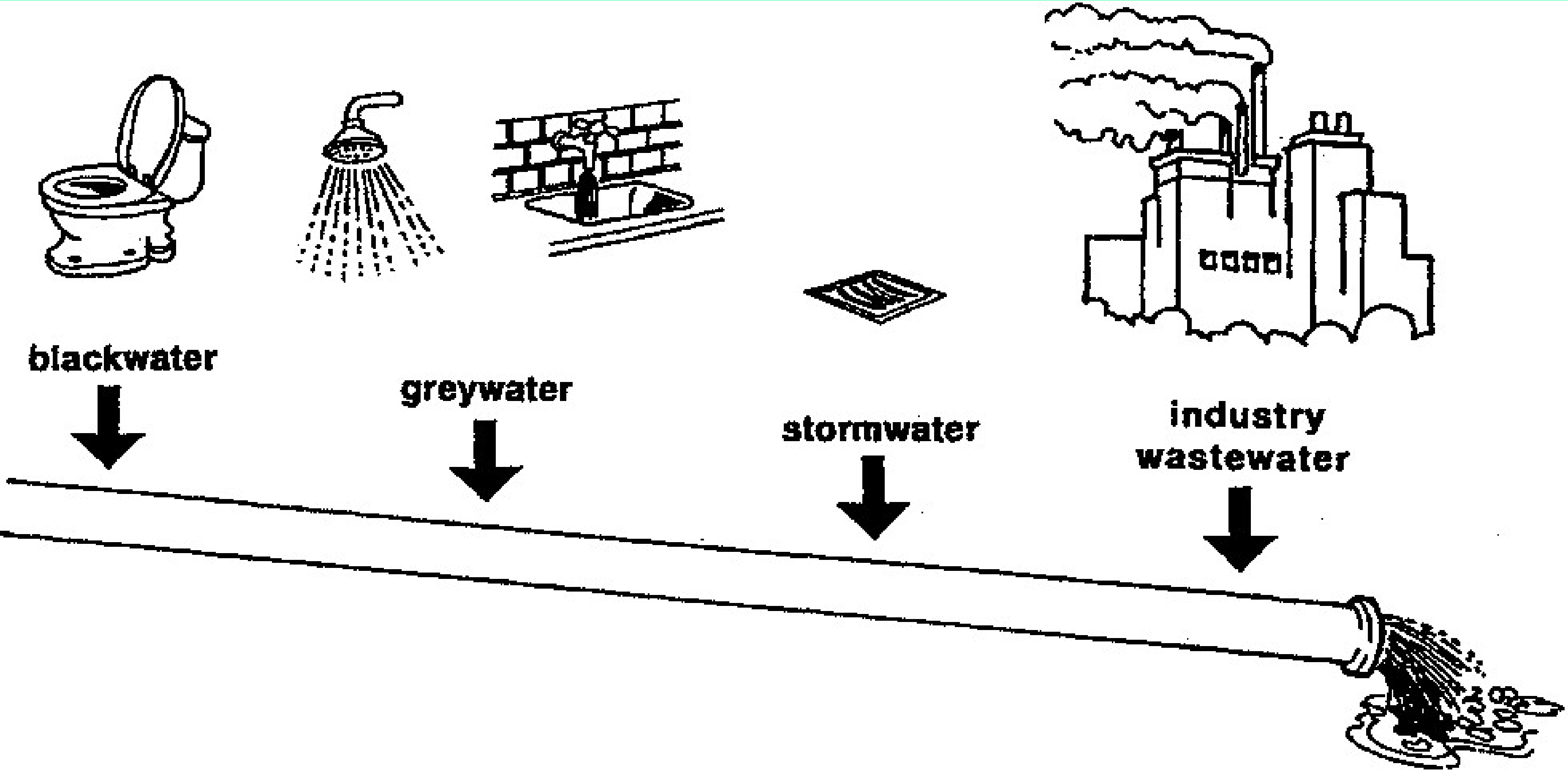

Figure 2: Conventional, “open” system (also called “end-of-pipe technology”)

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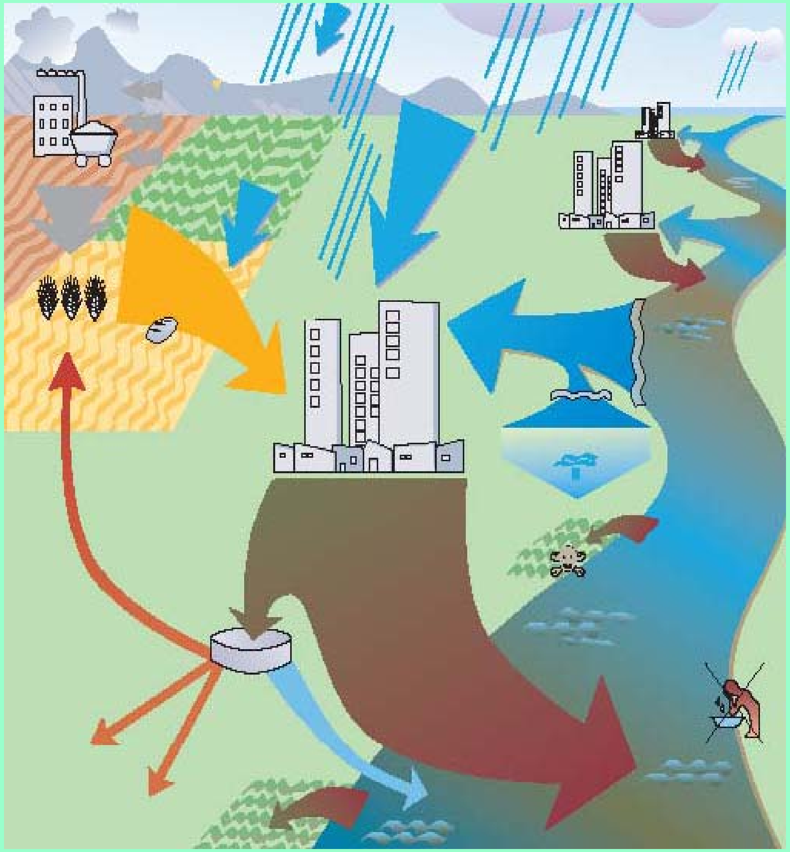
Problems of the conventional sewerage systems in urban areas in the viewpoint of sustainable development

1. high demand for water leads to dilution
2. Mixture of diff. flows
3. Little Recovery ratio, valuable nutrients are destroyed
4. large costs for construction and operation, energy and chemicals
5. management requirements,



What does sanitation system consist of?

1. Excreta management (faeces, urine)
2. Greywater management
3. Solid waste management
4. Drainage (for rainwater / stormwater)

Table 4: Characteristisc of different wastewater flows from household wastewater

Volume l/(P*year)	**Greywater 25.000 -100.000**	**Urine ~ 500**	**Feaces ~ 50** (option: add biowaste)
Yearly Loads kg/(P*year)			
N ~ 4-5	~ 3 %	~ 87 %	~ 10 %
P ~ 0,75	~ 10 %	~50 %	~ 40 %
K ~ 1,8	~ 34 %	~ 54 %	~ 12 %
COD ~ 30	~ 41 %	~ 12 %	~ 47 %
also to be considered S, Ca, Mg and trace elements	Treatment ↓ Reuse / Water Cycle	Treatment ↓ Fertiliser	Anaerobic or aerobic ↓ Soil-Conditioner

Figure 3: Conventional Decentralized Sanitation System in rural areas

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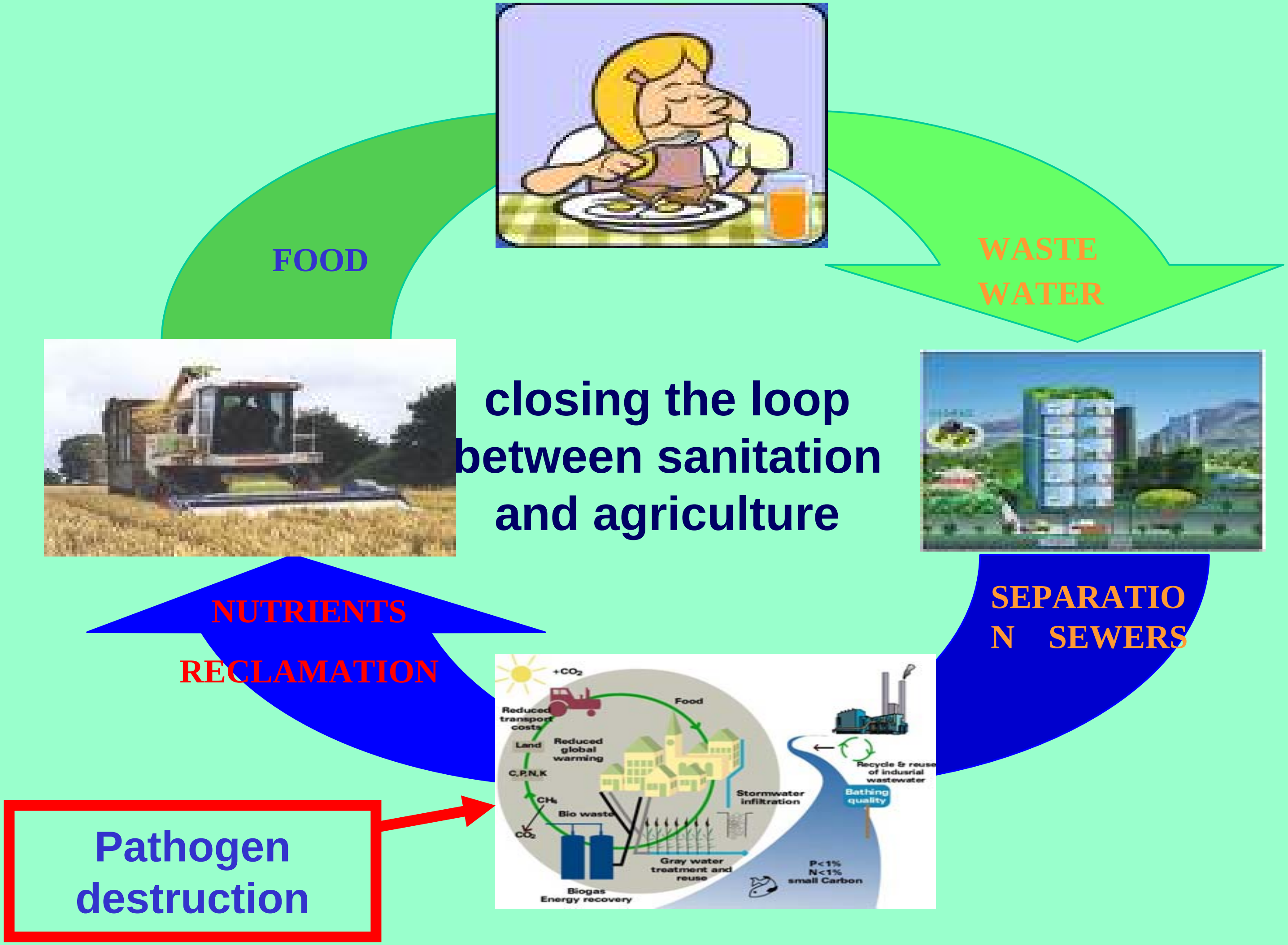


Figure 4: Ecological Sanitation System

Types of the applied toilets for Ecosan systems

1、Composting Toilet

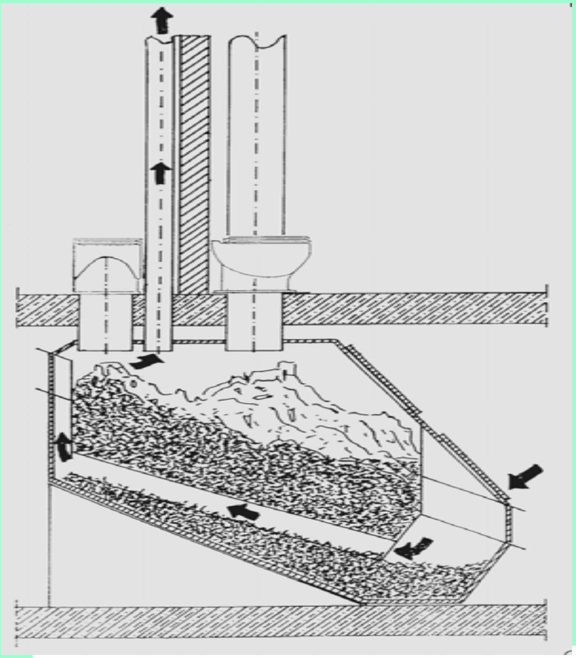
2、Dry Urine Diversion Toilet

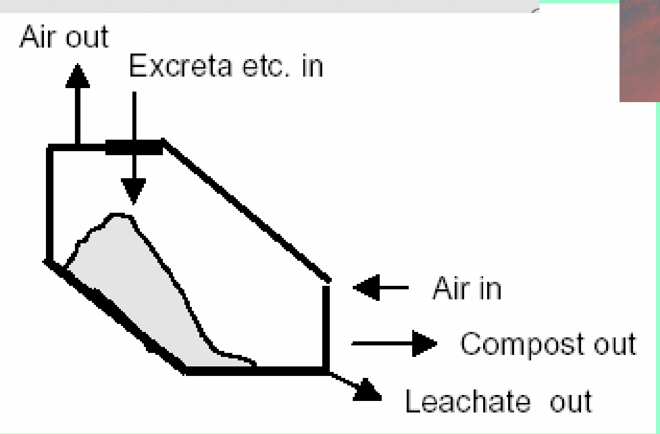
3、Vacuum Toilet

4、Urine Diversion Toilet

Composting toilet

composting toilet, Germany (Berger Biotechnik)





Sweden

Dry Urine Diversion Toilet

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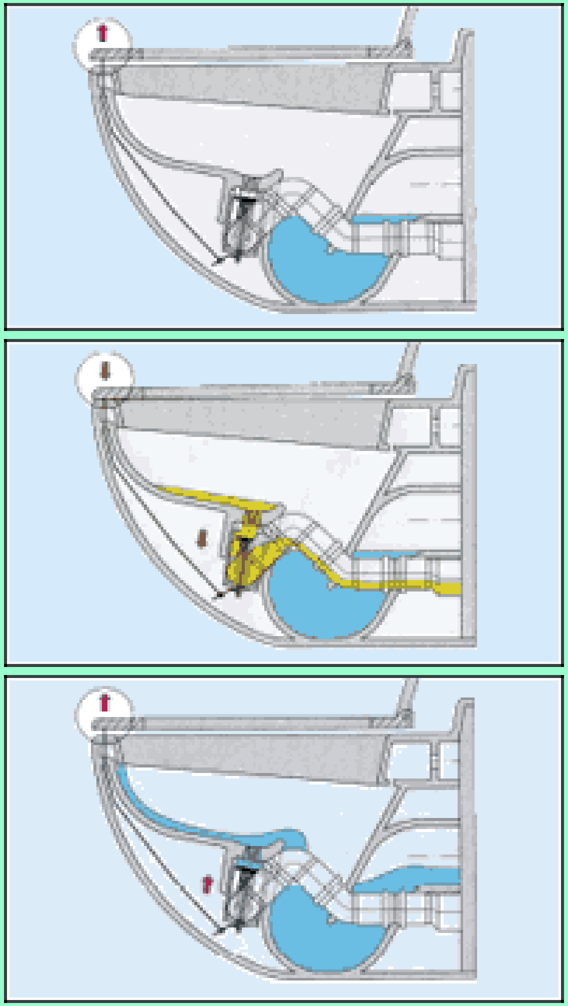
Roediger Sorting-Toilet



Non-diluting Urine collection

Table 5: flush water consumptions daily per capita of different types of toilet

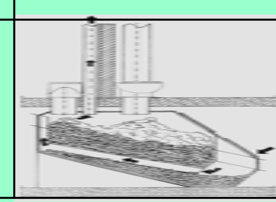
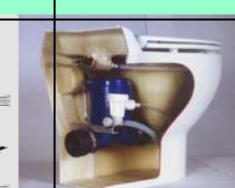
toilet system	**conventional without water saving measurement**	**flush cistern with two different amounts of water**	**composting toilets**	**vacuum toilets**	**Urine separation Toilets with water flushing**
water amount per flush	(9 l)	(9 l or 4 l)	(0,2 l)	(1 l)	(9 l or 0,2 l)
water consumption (l/p*d) - daily one faeces flush - daily four urine flush	45	25	1	5	10
Diagram of toilets					

Table 6: Possible treatment of different wastewater flows

Blackwater	Yellow water	Brown water			Greywater		
•to be treated together with biowaste	•to be treated separately	•to be treated together with yellow water (black water)	•to be treated separately	•to be treated together with greywater	•to be treated separately	•to be treated together with filtrate from composting tank of brown water	•to be treated with filtrate from composting tank of black water (nitrification and denitrification must be included)
•1. anaerobic treatment together with biowaste •2. pre-composting together with biowaste	•1. storage in tank for min. 6 months (adding acid to prevent ammonium from volatilization is possible) •2. concentration or drying processes •(air stripping, reverse osmosis, evaporation etc.)	•1. anaerobic treatment together with biowaste •2. precomposting •together with biowaste	•1. pre-composting •2. anaerobic treatment (biogas reactor)	•Pre-composting	•1. SBR •2. biofilm technology •3. constructed wetlands •4. aquatic treatment •5. lagoons •6. MBR •etc.	•1. SBR •2. biofilm technology •3. constructed wetlands •4. aquatic treatment •5. lagoons •6. MBR •etc.	•not recommended

Case Study: ecological sanitation system applications in urban areas

In last ten years, more and more pilot projects integrated with ecosan concept are being implemented in urban areas all over the world, especially in Europe.

Now there are also some large scale pilot projects which are under construction in China

In the following, some case studies are introduced.

Case Study: ecological sanitation system applications in urban areas

- Case 1: Settlement with 300 inhabitants, Bielefeld, Germany, 1994
- Case 2: 4-storey building with public Kindergarden
- Case 3: GTZ House 1 Renovation
- Case 4: Office building of company Huber
- Case 5: Sino-Sweden Eco-Town Project in Erdos, Inner Mongolia
- Case 6: Ecological Settlement Lübeck-Flintenbreite
- Case 7: Large scale urine collection and utilization in Olympic Forest Park

Case studies - I

Settlement with 300 inhabitants, Bielefeld, Germany, 1994

Family houses with common gardens

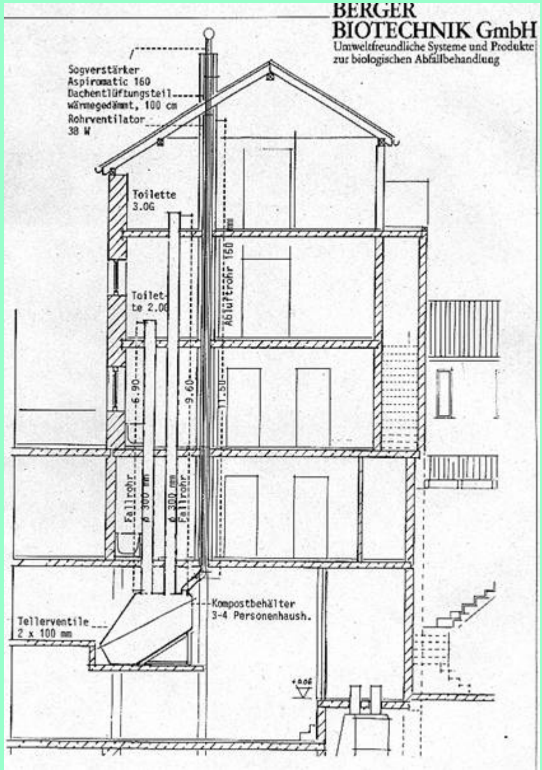
4-storey flat houses

BERGER
BIOTECHNIK GmbH

Sustainable Systems and Products for on site Biological Waste Treatment, Ecological Sanitation and Water Saving

Case studies - II

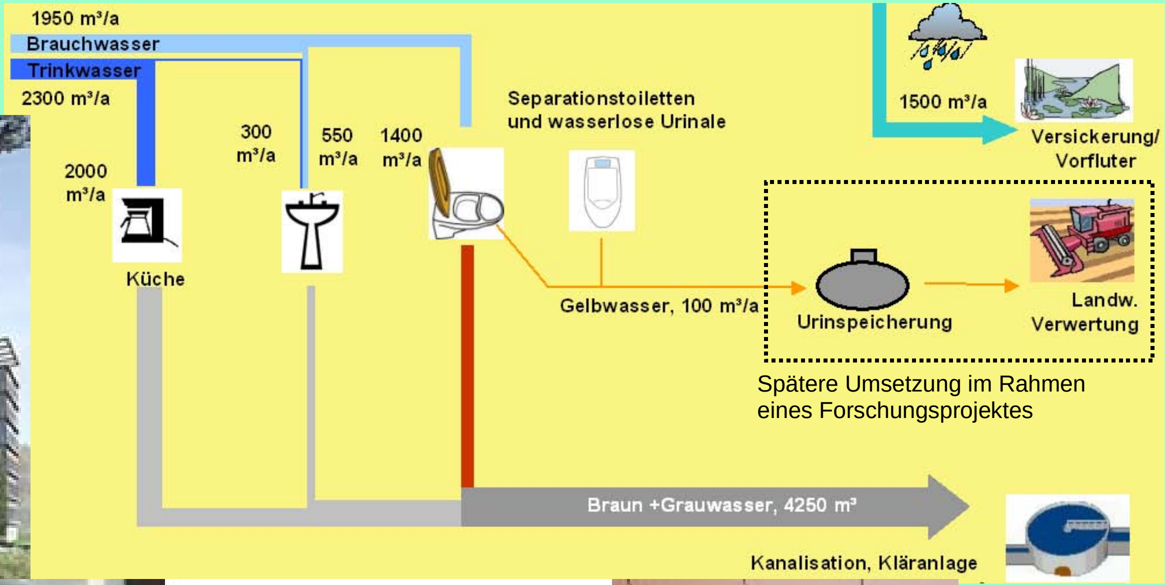
4-storey building with public Kindergarden

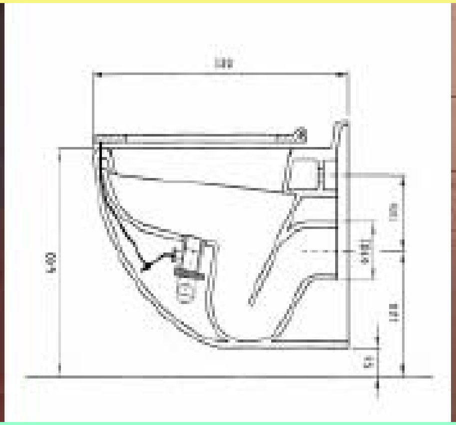


10 m down-pipe with 0,3 m diameter, 14 m exhaust air pipe, 0,15 m diameter, section

Case studies - III

Germany: GTZ House 1 *Renovation*





Urine diversion toilets and waterless urinals

Case studies - IV

wastewater treatment system with separation toilet

(德国琥珀公司办公楼采用的分流处理系统)

Office building of company Huber

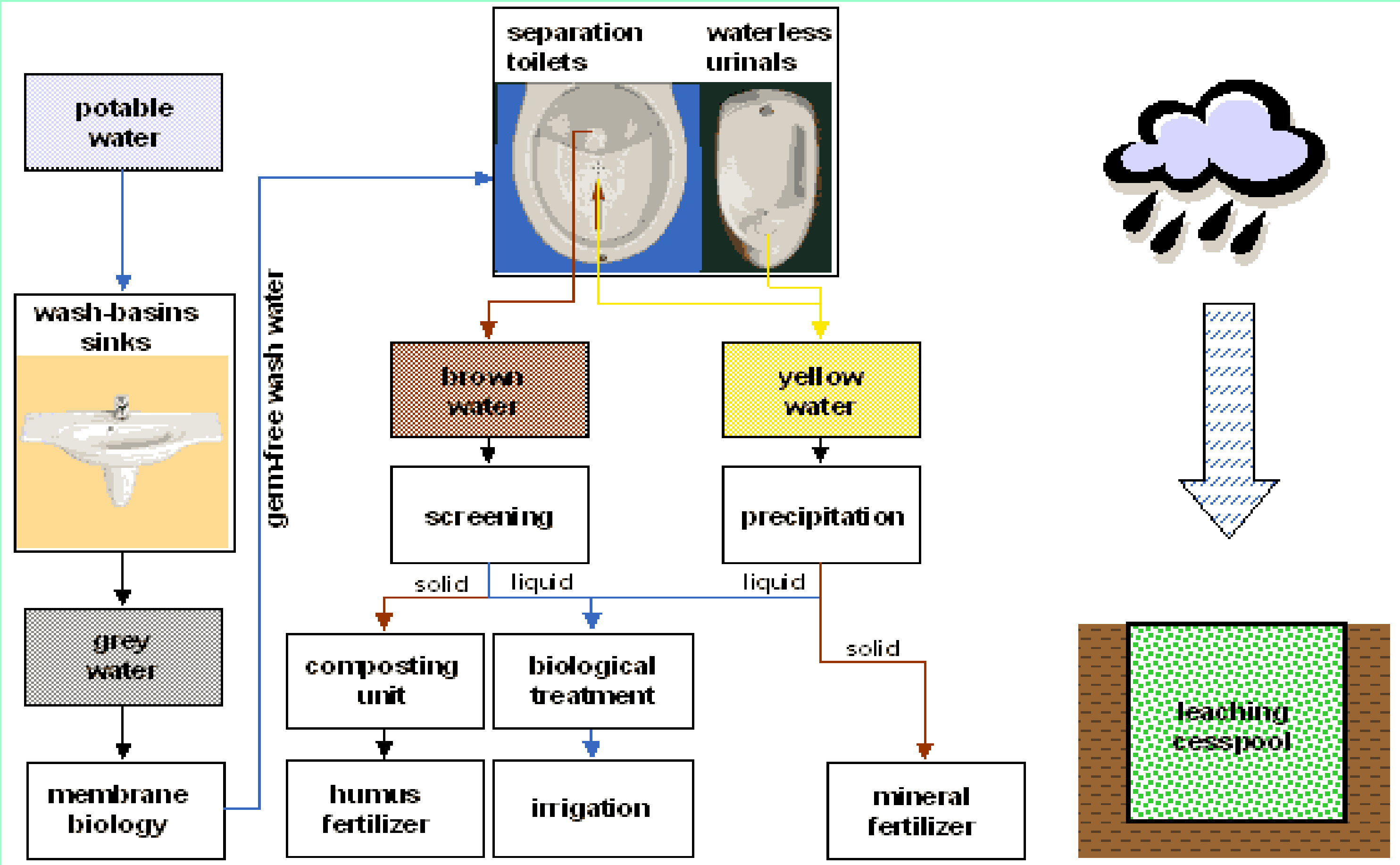
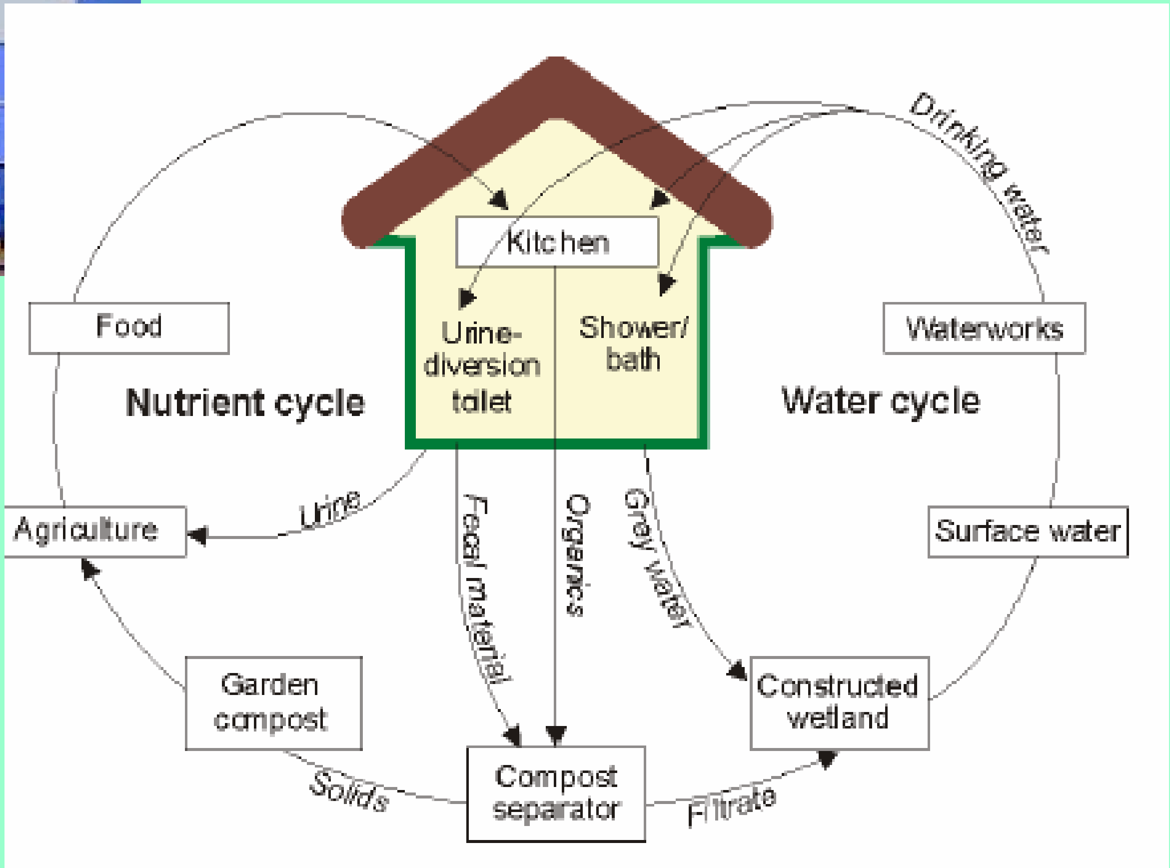


Figure 5: Schematic of wastewater treatment system with separation toilet (Company Huber, Germany)

Case studies – V

Sino-Sweden Eco-town project in Erdos, Inner Mongolia Autonomous Region, China



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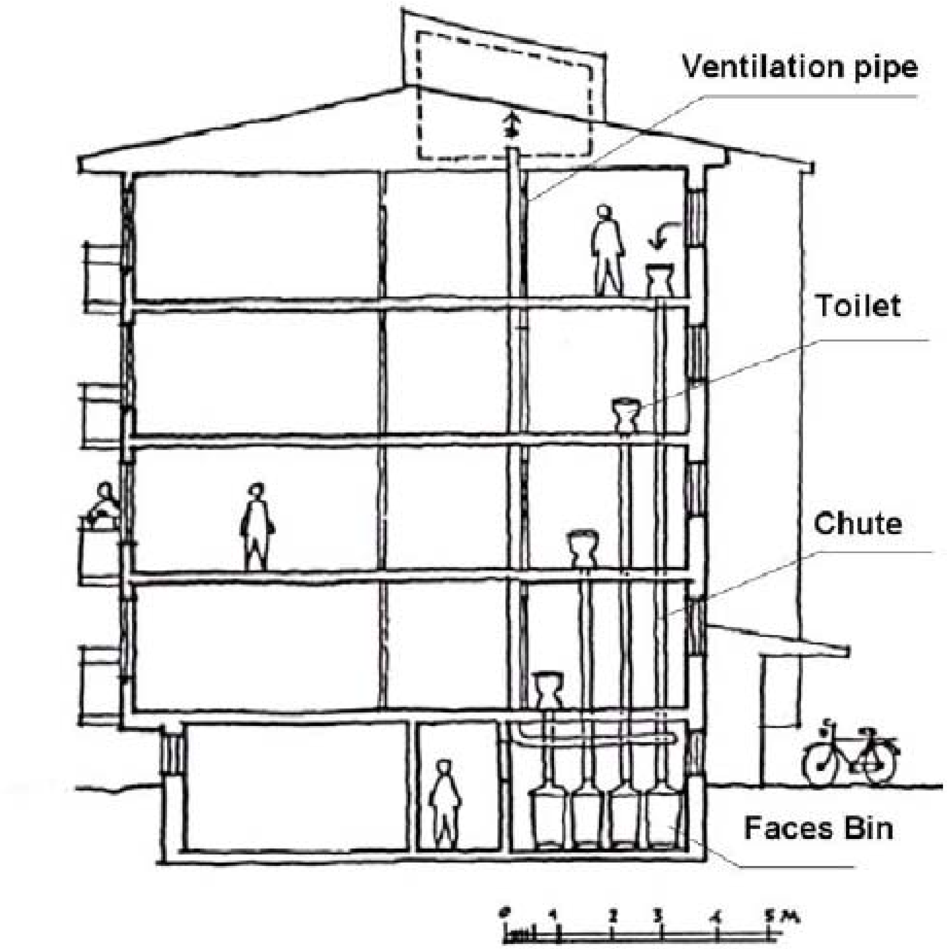

Figure 6: Faces system in Erdos Eco-Town Project

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Figure 7: Urine Transportation Vehicle

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(a) The S-typed trap

(b) The odor isolator

(c) The toilet with an odor isolator

Figure 7: The measures of controlling odor related to urine drainage system

Case studies - VI

Ecological Settlement Lübeck-Flintenbreite

Double-Houses

Terraced Houses

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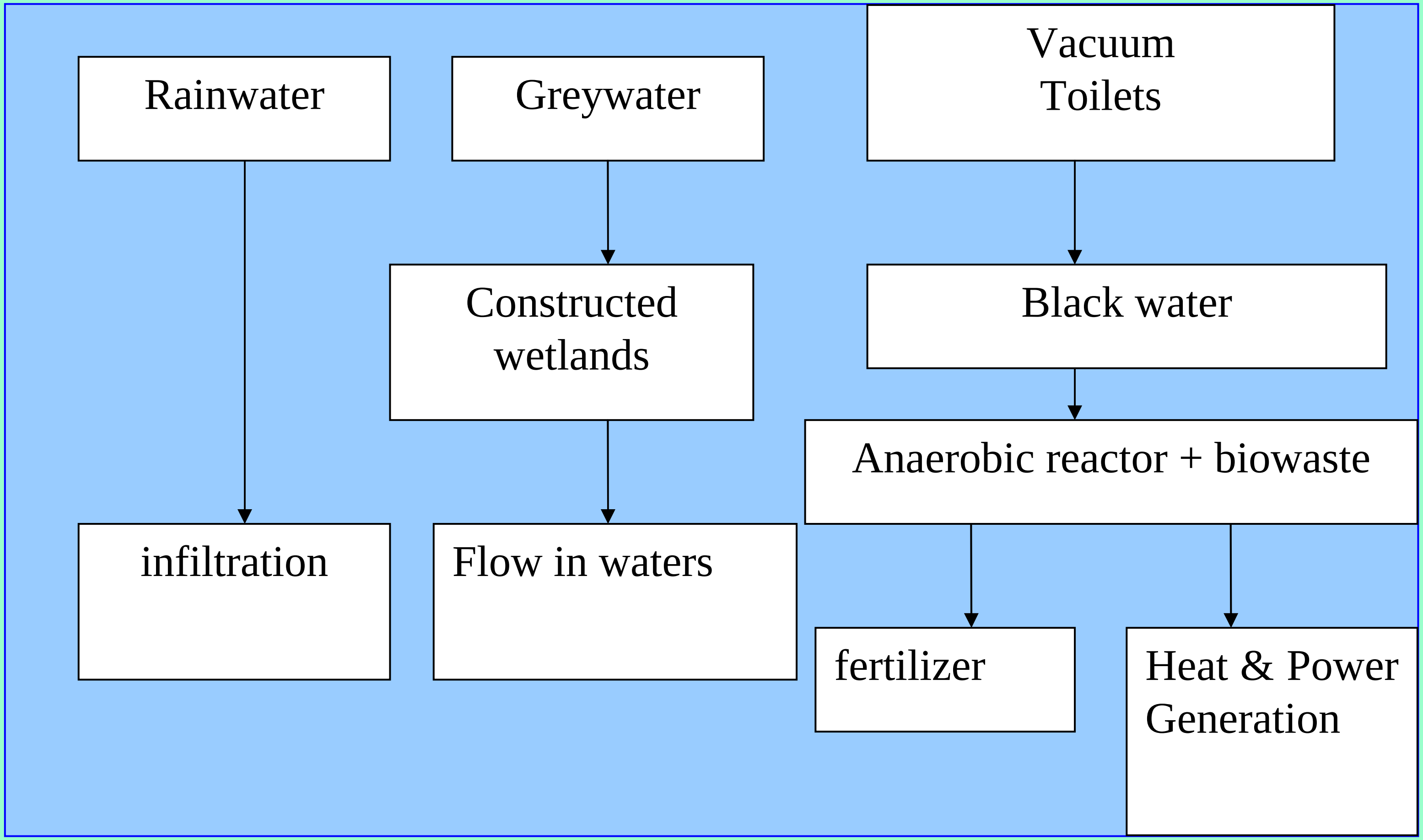
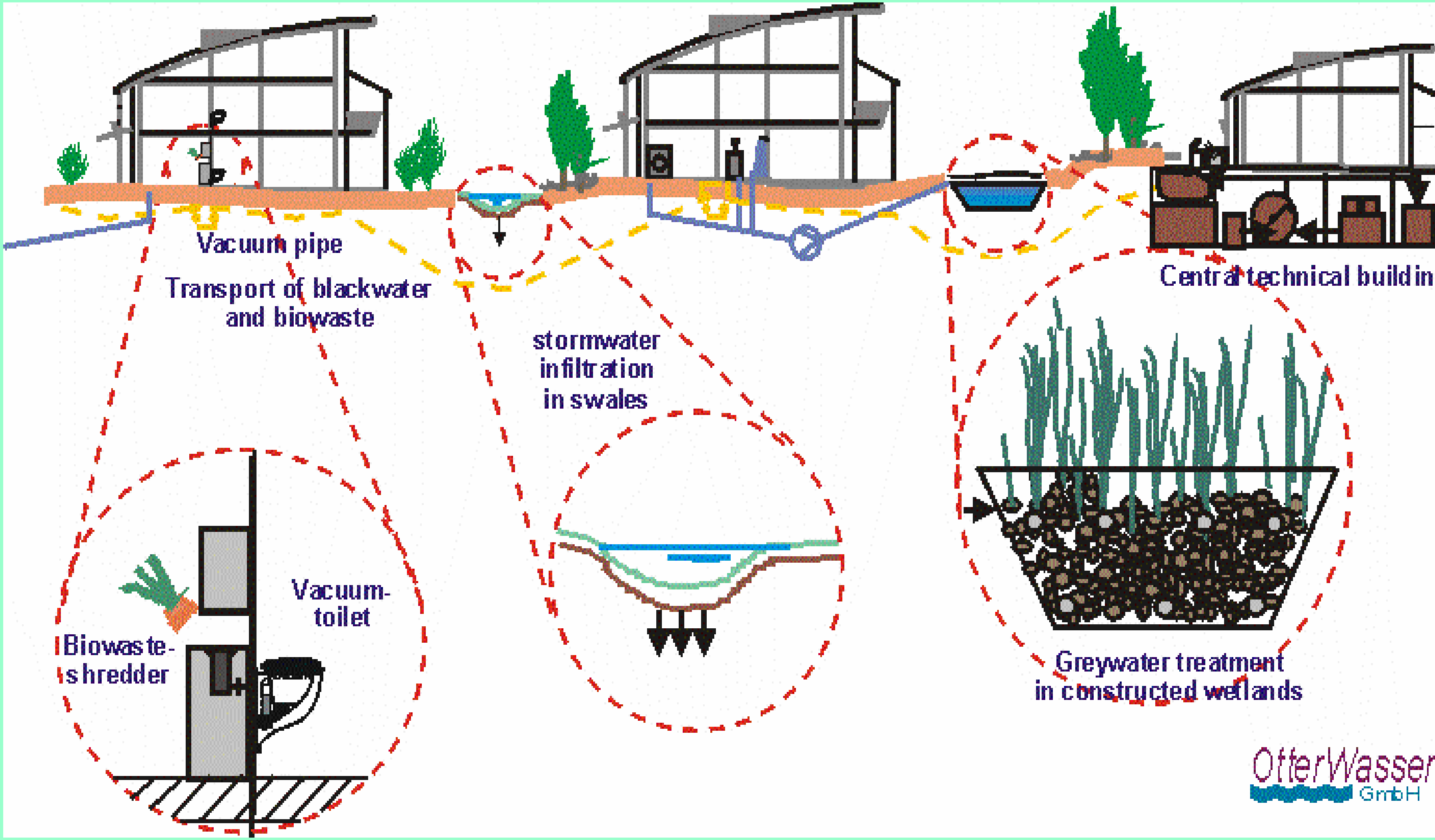


Figure 8: Schematic of wastewater treatment system with vacuum toilet


Vacuum pipe
Transport of blackwater and biowaste
stormwater infiltration in swales
Central technical building
Vacuum-toilet
Biowaste-shredder
Greywater treatment in constructed wetlands
OtterWasser GmbH


Vacuum-Toilet
0.7 litres/flush
Roediger, Hanau

Existing problems for Ecosan system application in urban areas:

1. systematic closure of local material flow-cycles is still not reached in most pilot projects;

2. Technology problems

3. User acceptances

4. In some cases, construction quality and management have alos some problems which have a negative effects for promoting Ecosan project.

Large scale urine collection and utilization in Olympic Forest Park

Total area of 700 ha in Olympic Forest Park

Annual produced waste amount in Olympic Forest Park

It is estimated:

- Wastewater amount: **121980**M^3;
- Yellow water (urine): **3230**M^3;
- Sludge amount with 90% water content from septic tanks: **3912**M^3,
- Sludge amount with 70% water content from septic tanks: **1304**M^3
- rubbish from trees and grasses in the south part of the Park: **3000**M^3

Source control system

Applied different kinds of urine diversion toilet as well as waterless urinals

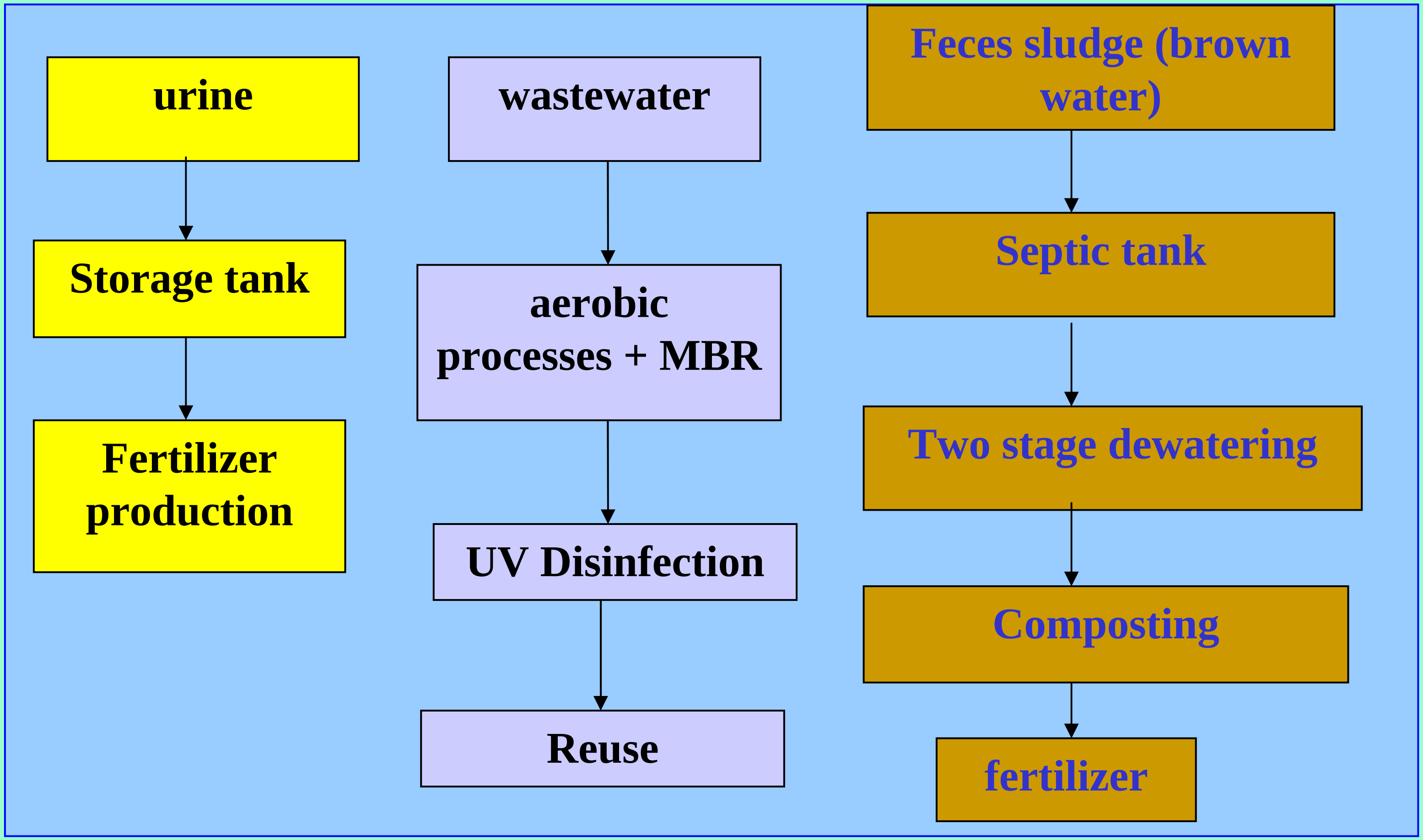
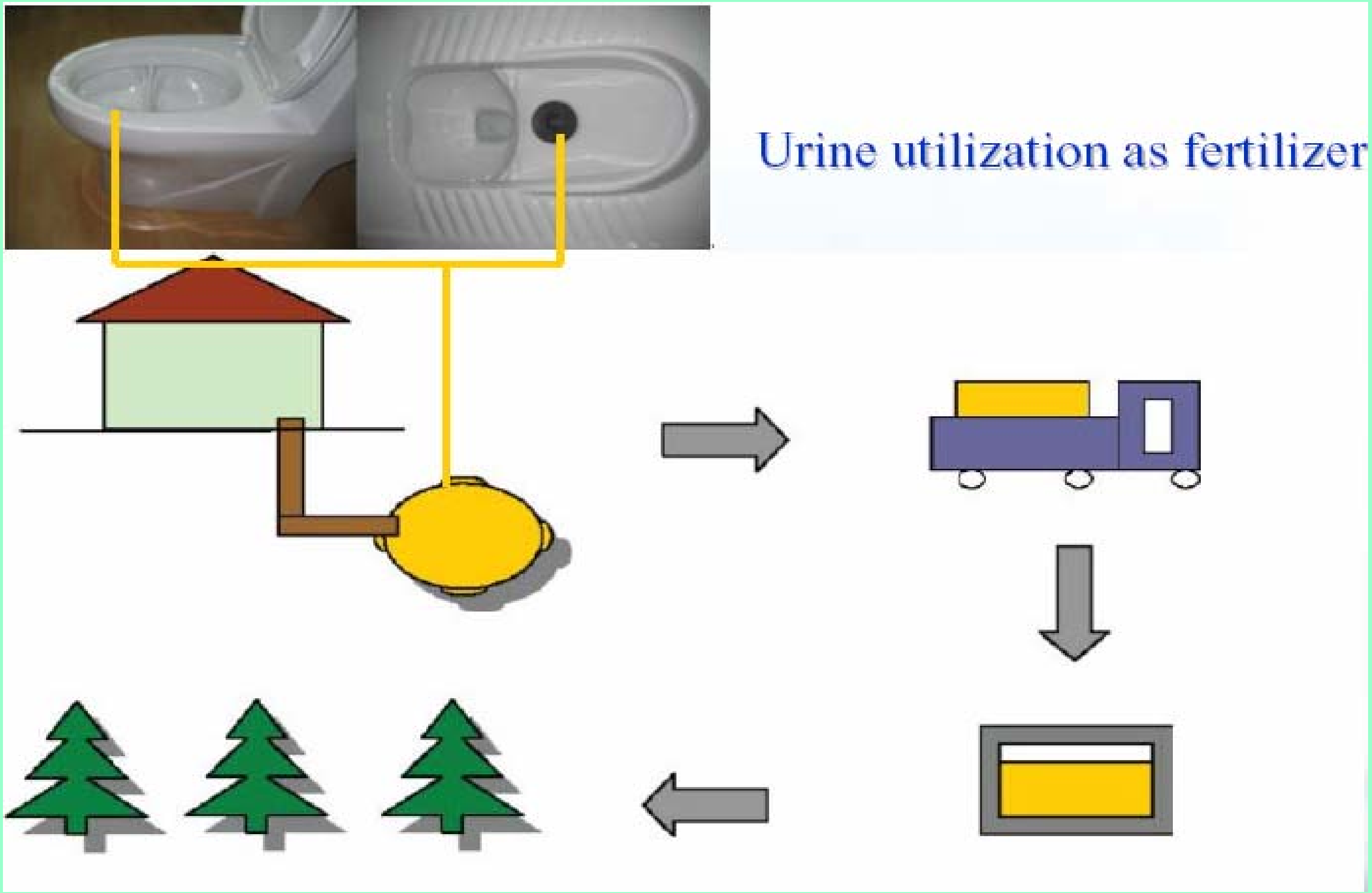
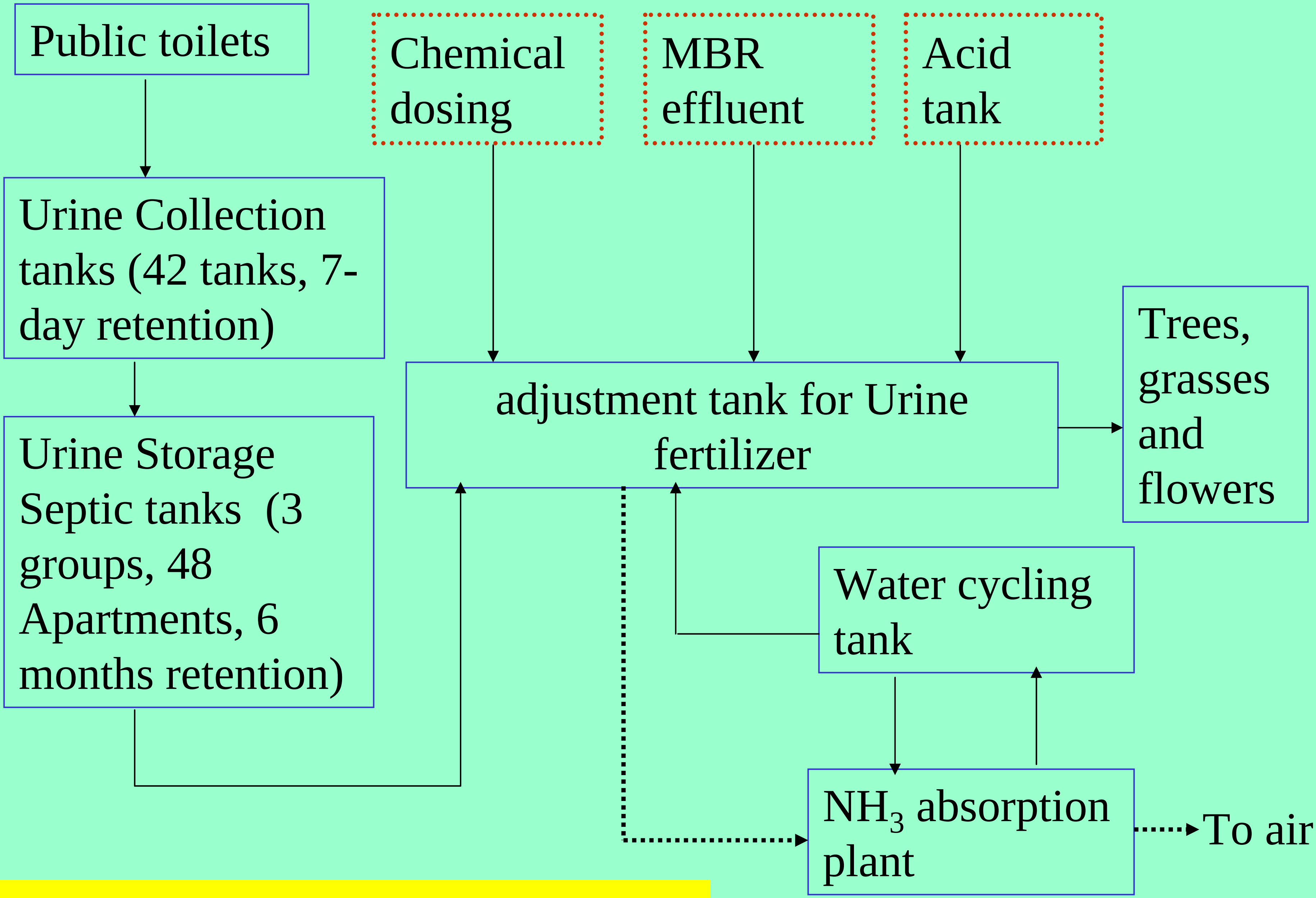


Figure 7: Schematic of sanitation system in Olympic Forest Park of Beijing



Totally about 3000 – 4000 m3 urine will be collected and treated as fertilizer



Urine management system

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The urine storage tanks are under construction

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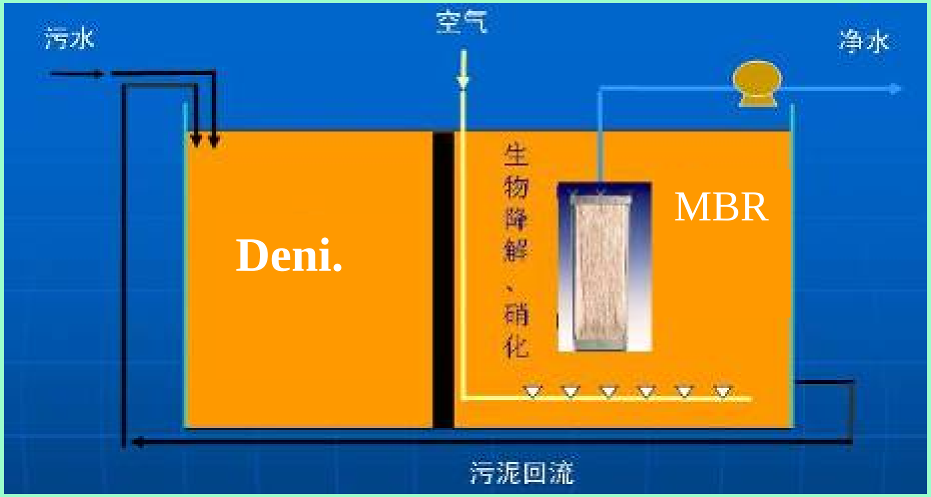
MBR Biological Wastewater Treatment:



Conclusions and suggestions:

1. Ecosan systems have good chances and great potentials for application in urban areas;

2. For a successful application, proper design, construction, operation and maintenance play important roles;

3. Users should be educated and the acceptance by users is also very important;

4. Technology improvement and development are also very important for Ecosan system application in urban areas in order to make it more competent in consideration of convenience, maintenance, etc. for users.

5. Generally, Ecosan system have a lot of advantages. In the pilot projects, these advantages like heath safety, economical competence, technology advance and robust should be easily perceivable by users.

6. Demonstration projects should be constructed based on the different conditions and usage purposes, the closed loop system should be demonstrated.

Thank You Very Much For Your Attention!

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