Blumberg Engineers
Germany

Constructed Wetlands for Treatment of Biogas Plant Effluents

人工湿地处理沼液

GIZ/FECC Training VI on
“Performance and Support Policy of Biogas Energy generating Biogas Plants'
for Biogas Plant Designers and Decision Makers, No.4
16th to 18th May 2012, Nanjing, PR China

by Michael Blumberg

Definition “Ecological engineering” (ecotechnologies)
生态工程的定义

Systematic arrangement and use of naturally existing ecosystems for continuous purposes of production and / or disposal

对自然存在的生态系统进行系统性的设置和利用，从而进行连续的生产或废弃物处置。

Constructed wetland in Germany

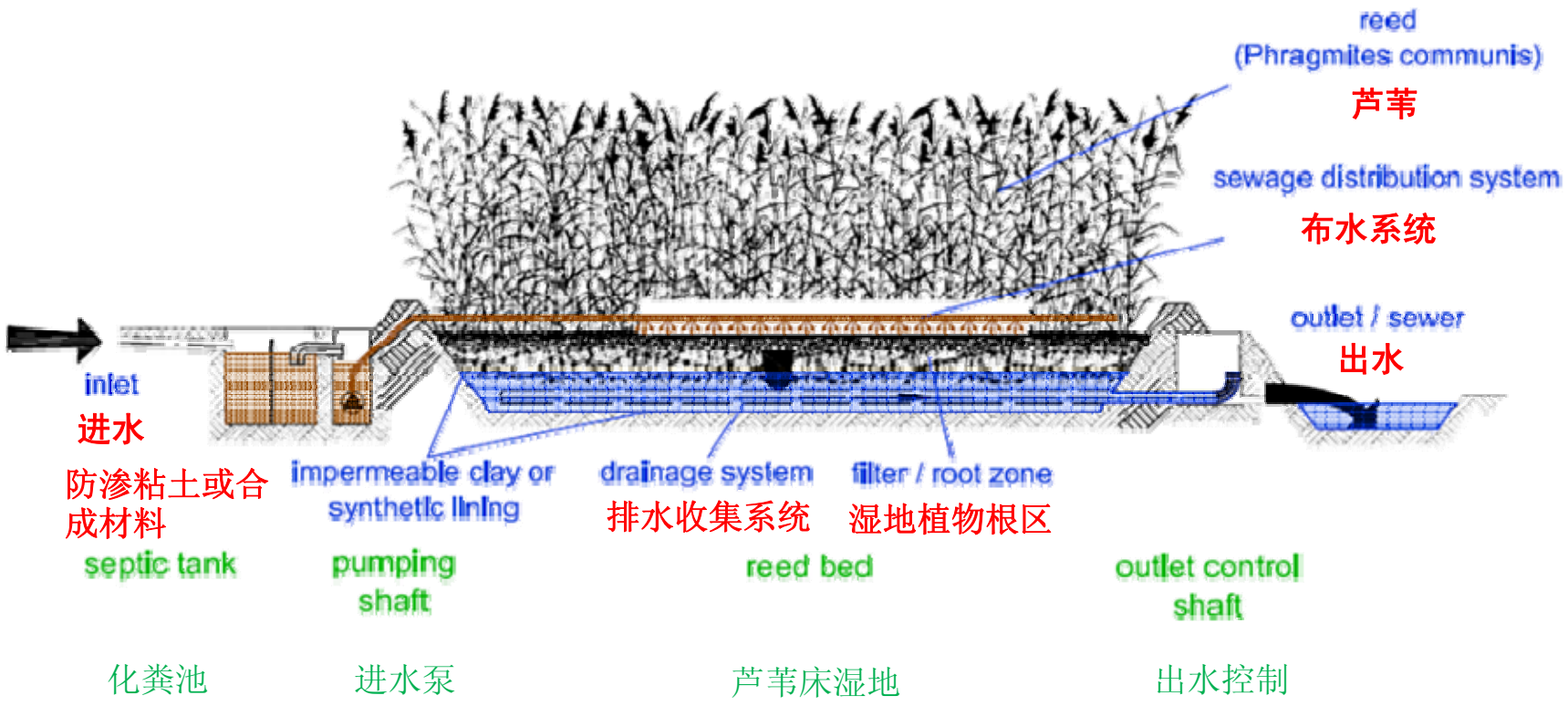
Reed bed treatment system with network of roots and rhizomes flushed out
污水流经拥有复杂根茎的芦苇床湿地系统效果图

(*Phragmites communis)*
芦苇

Oxygen transfer into the soil (rhizosphere)
土壤基质中的氧传输（根区）

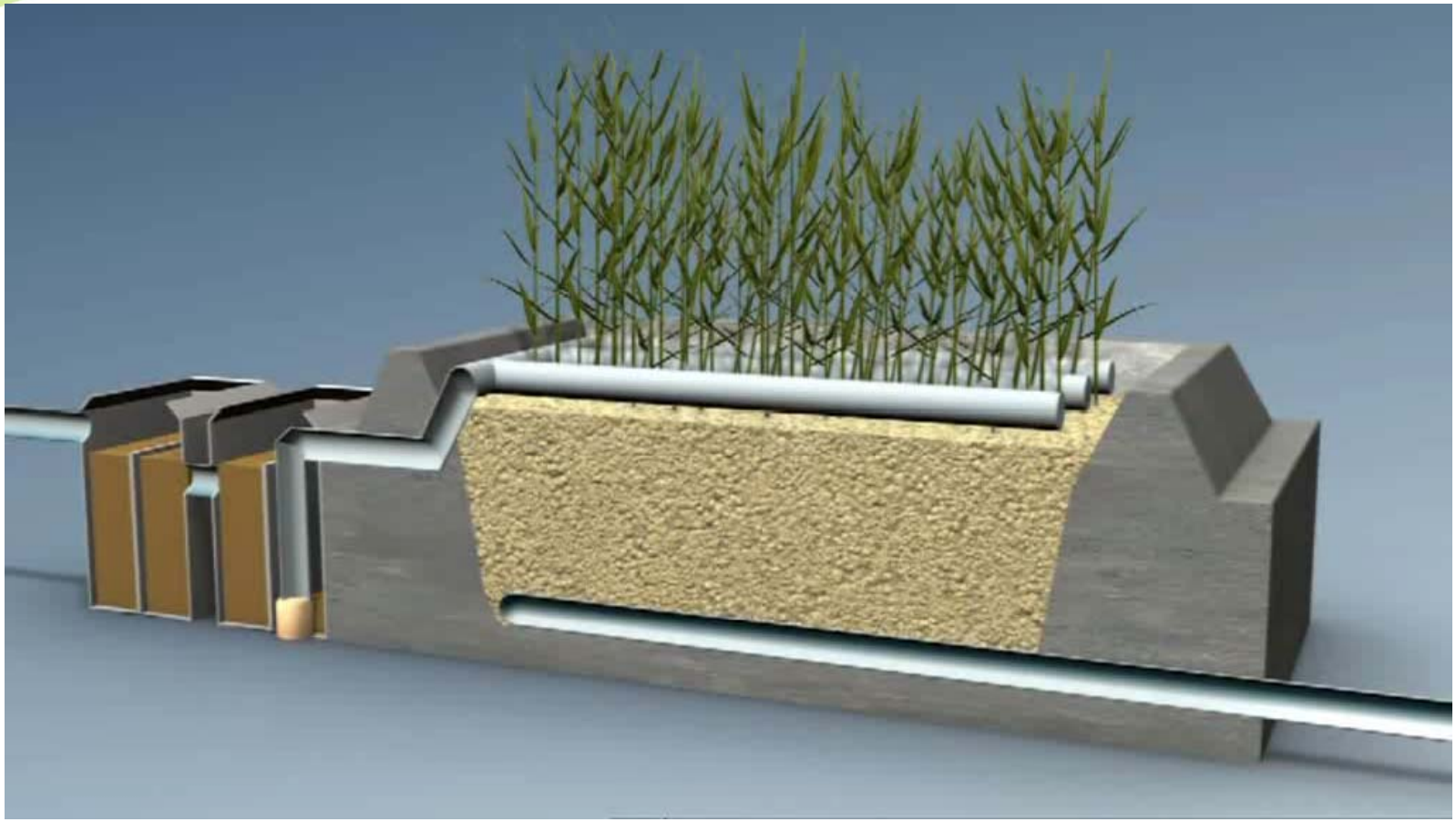
Reed bed treatment system: Vertical subsurface flow

芦苇床湿地系统：垂直潜流人工湿地



Reed bed treatment system: Vertical subsurface flow

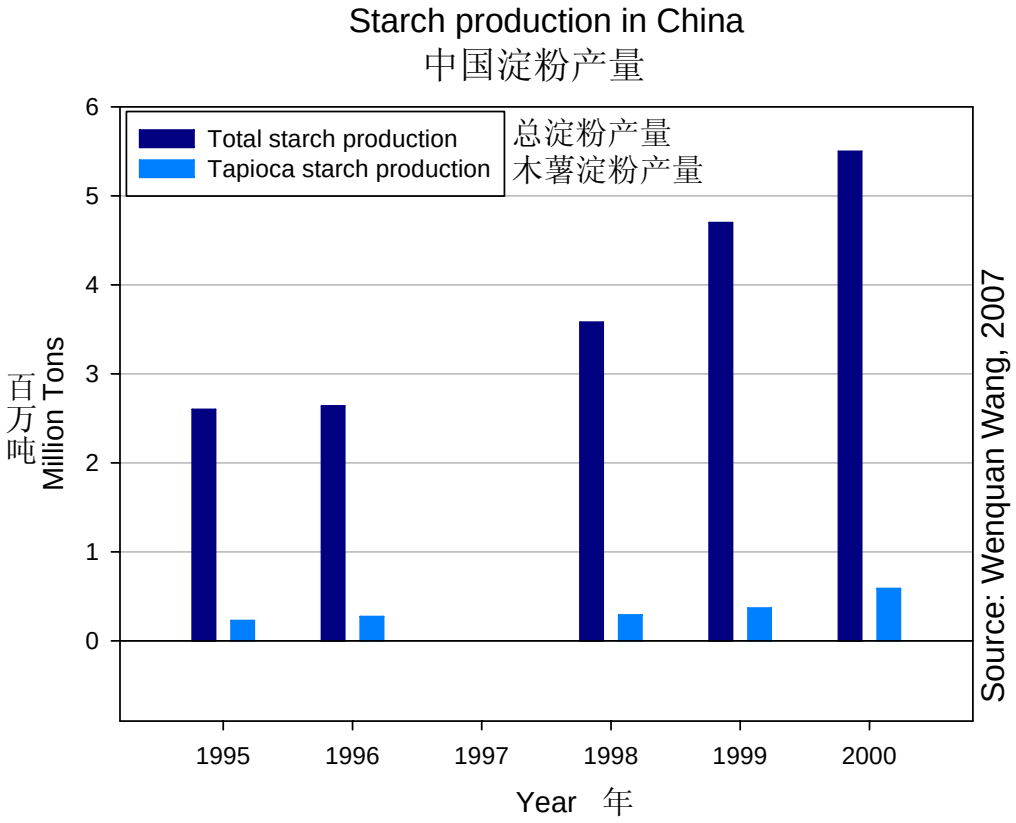
芦苇床湿地系统：垂直潜流人工湿地



Tapioca Industry
木薯产业

China 2007:
• Area for cultivation of tapioca
500,000 ha --> 800,000 ha
2007年中国木薯种植面积：
500,000公顷~800,000公顷

Industrial products from tapioca:
木薯的加工副产品：
• Monosodium glutamate in the food industry
食品工业中的味精
• Fuel additive (alcohol)　食品添加剂（乙醇）
• Biopolymeres　生物高聚物
• Soap, medicines, cosmetics and so on
肥皂、医药、化妆品等



Research Project 研究项目

Treatment of tapioca processing wastewater and sustainable water pollution control management of key economic zones in South Vietnam

越南南方重点经济区域木薯加工废水治理和水资源可持续发展防治

Duration: 2009 – 2012 时间：2009-2012

Funding agency: 经费来源：

- Federal Ministry of Education and Research, Germany

德国联邦教育与研究部

- Ministry of Science and Technology, Vietnam

越南国家科技部

- Ministry of Natural Resources and Environment, Vietnam

越南自然资源与环境部

Project partners: 项目参与者：

- 2 German Universities, 2个 德国大学
- 2 Vietnamese Institutions, 2个 越南研究院
- 3 German Enterprises, 3个 德国公司

Project partners:

Department of Hydrology, Water Management and Water Protection, Leichtweiss-Institute for Hydraulic and Water Resources Engineering (LWI), Technical University Braunschweig (www.lwi.tu-bs.de)

University of Applied Sciences Ostwestfalen-Lippe (www.hs-owl.de)

Ingenieurbüro Blumberg www.blumberg-engineers.com

Hager und Elsässer Company (www.hager-elsaesser.com)

Enviplan Company (www.enviplan.de)

Institute for Environment and Resources (Vietnam National University of Ho Chi Minh City) (www.hcmier.edu.vn)

Thanh Vinh Tapioca Company

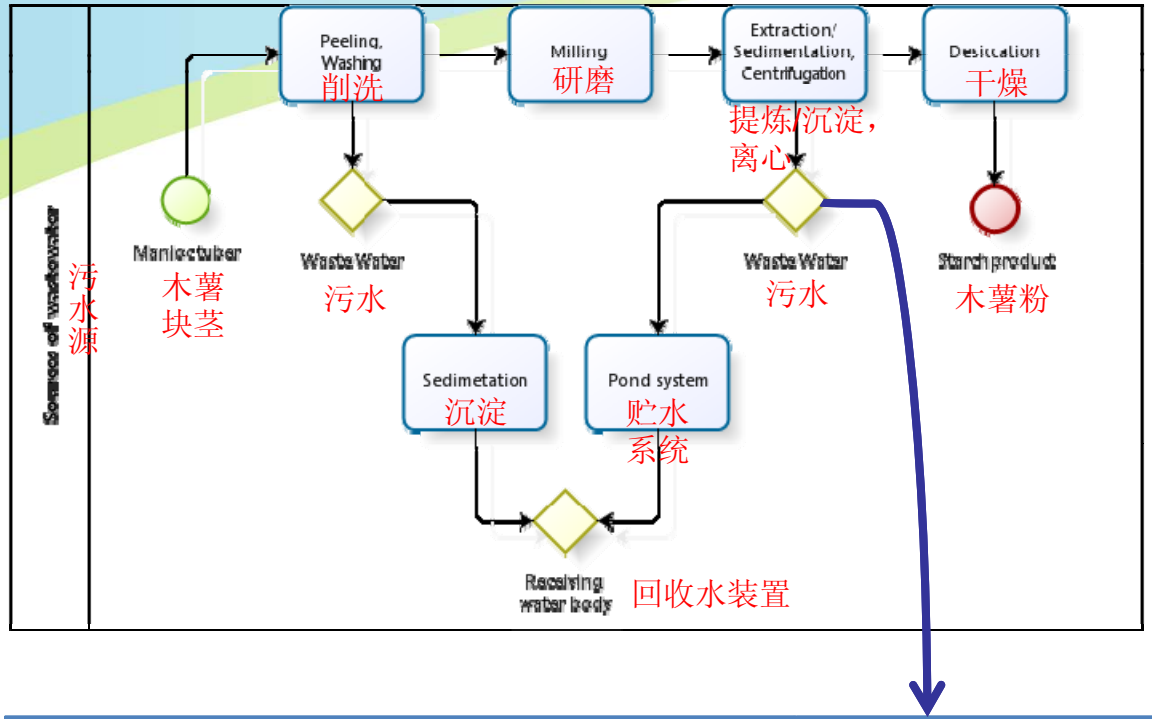
Project agency and sponsorship of the project:

Federal Ministry of Education and Research (www.bmbf.de), Germany

Ministry of Science and Technology (www.most.gov.vn), Vietnam

Project site Tay Ninh, Vietnam

Wastewater from the tapioca processing industry
木薯加工废水的产生途径



Wastewater highly concentrated and thus an important point source for pollution.

经高度浓缩的木薯加工废水是一个重要的污染源。

Water consumption:

Processing of 4 t of manioc tuber

→1 t Tapioca starch

→ 12 – 20 m^3 wastewater

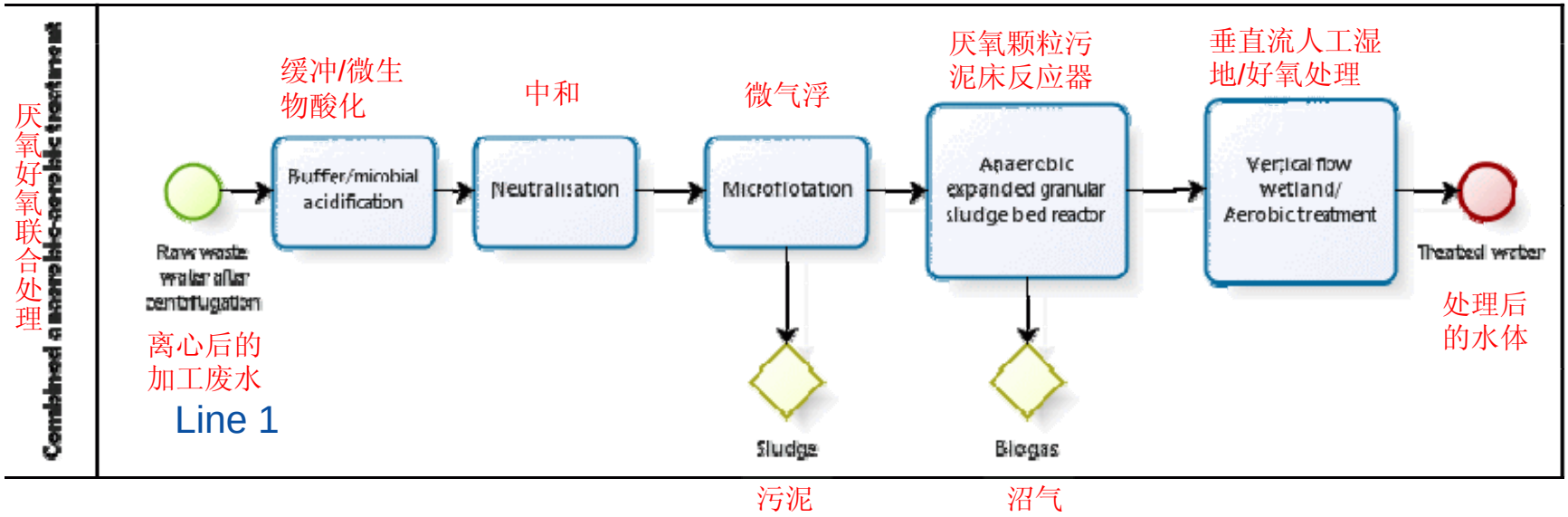
木薯加工废水的产生：

处理4吨木薯块茎得到1吨木薯粉，产生12~20立方米污水

Wastewater after centrifugation 污水离心后成分	Concentration 浓度
Chemical Oxygen Demand, homogenised COD	14,000 – 18,000 mgIL
Biochemical oxygen demand within 5 days BOD5	9,000 – 11,000 mg/L
Total suspended solids TSS	1,500 – 2,600 mg/L
Total Kjeldahl Nitrogen TKN	200 – 400 mg/L
Total Cyanides 总氰化物	20 – 30 mg/L
pH	4 - 5

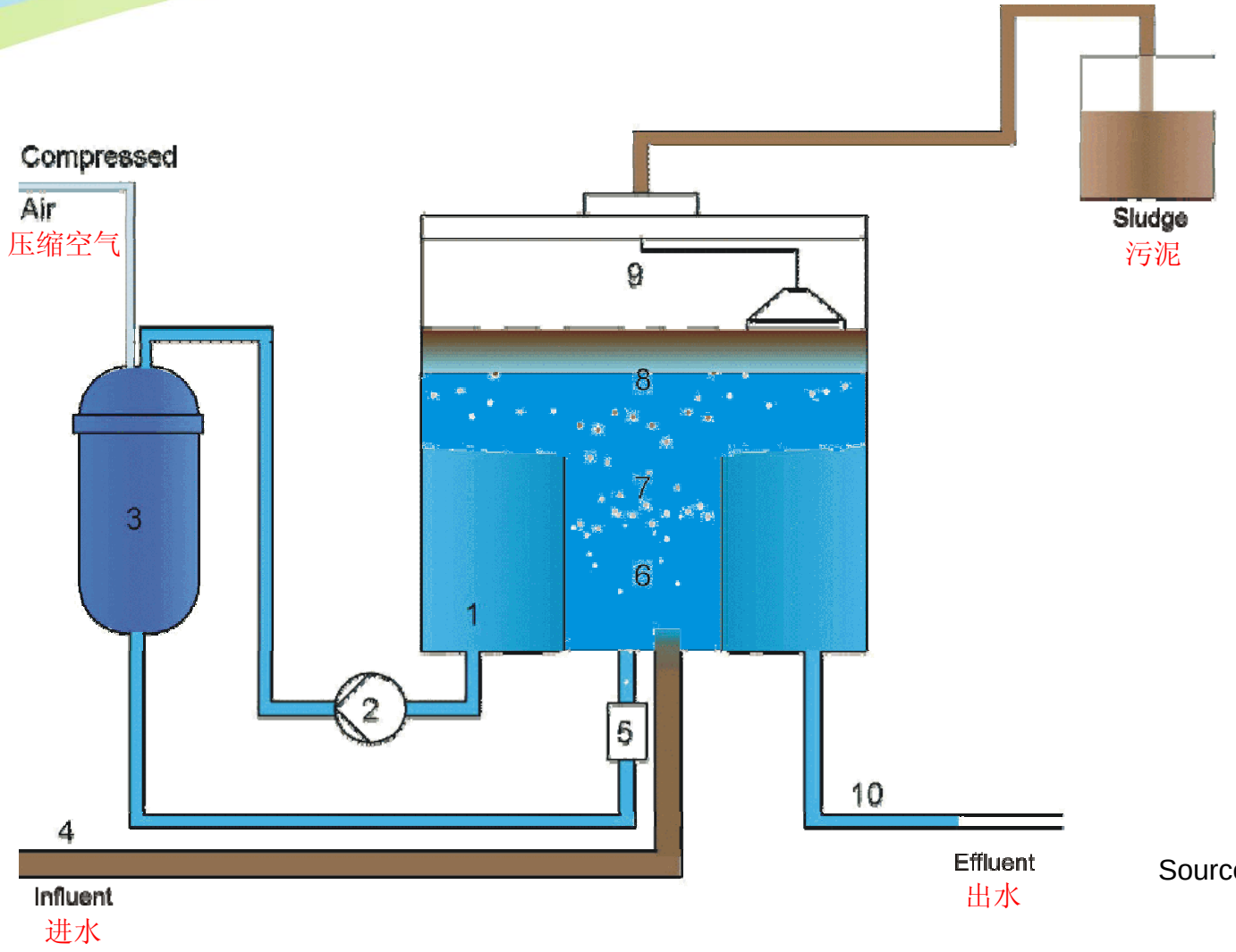
Layout of the Research Plant 研究项目安排

Line 1: Combined anaerobic-aerobic treatment
线路1：厌氧好氧联合处理



Layout of the Research Plant 研究项目安排

Microflotation 微气浮



Source: Enviplan

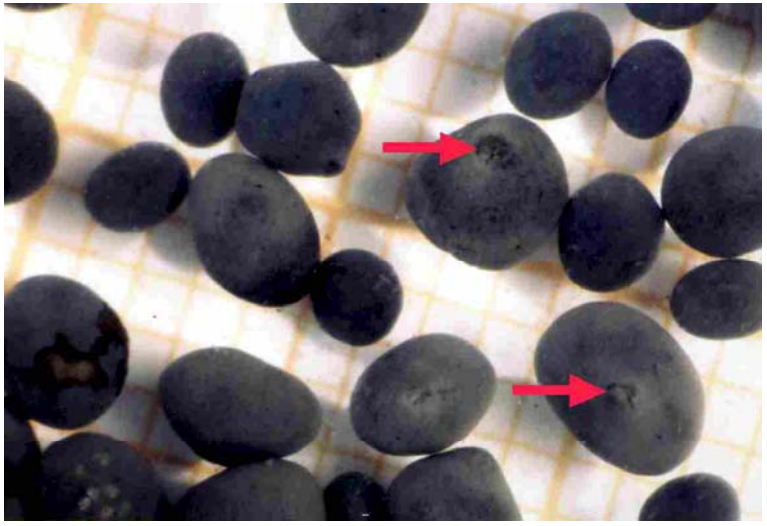
Layout of the Research Plant 研究项目安排

Anaerobic expanded granular sludge bed reactor (EGSB)
厌氧颗粒污泥床反应器

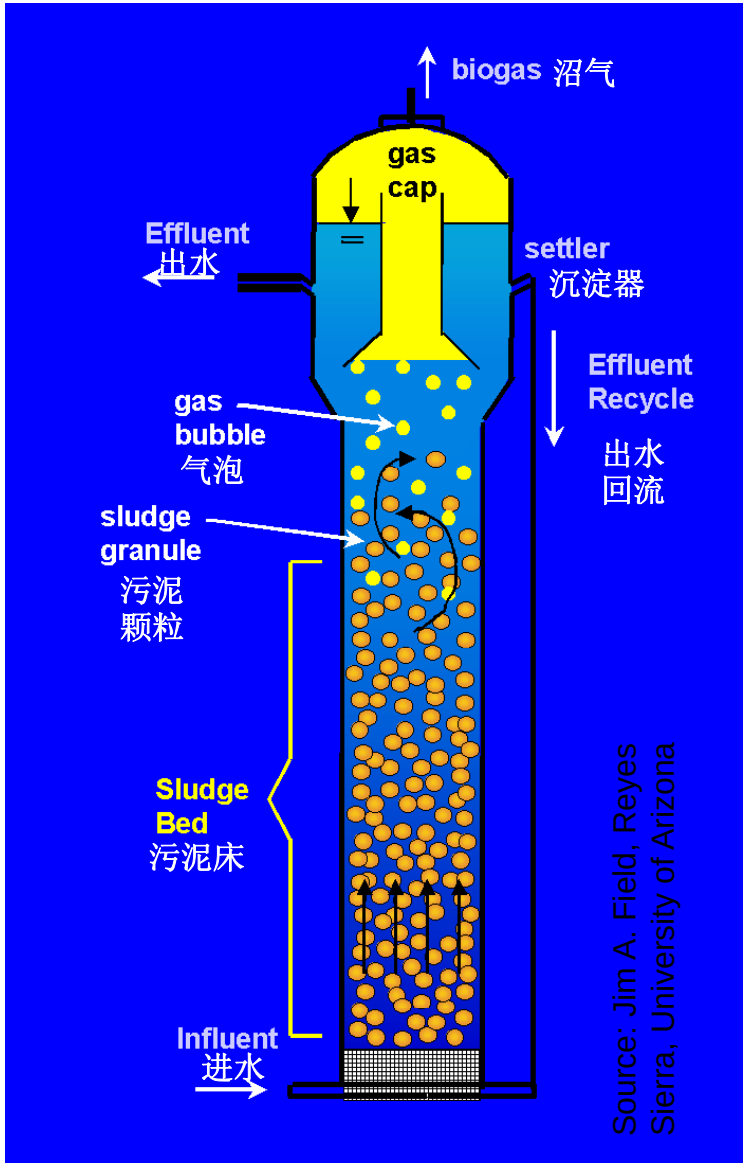
Specific biogas production
沼气生成： 0,44 m^3 沼气/ kg COD （忽略不计）
- 0,44 m^3 biogas / kg COD $_{eliminated}$

Composition of the biogas (median values):
沼气成分（平均值）：70%甲烷+30%二氧化碳）
- 70% methane (CH_4)
- 30% carbon dioxide ($C0_2$)

Specific methane yield
甲烷产生量： 0.31 m^3 甲烷/kg COD （忽略不计）
- 0,31 m^3 CH_4/ kg COD $_{eliminated}$



Sludge granules with gas vents
拥有微孔的污泥颗粒



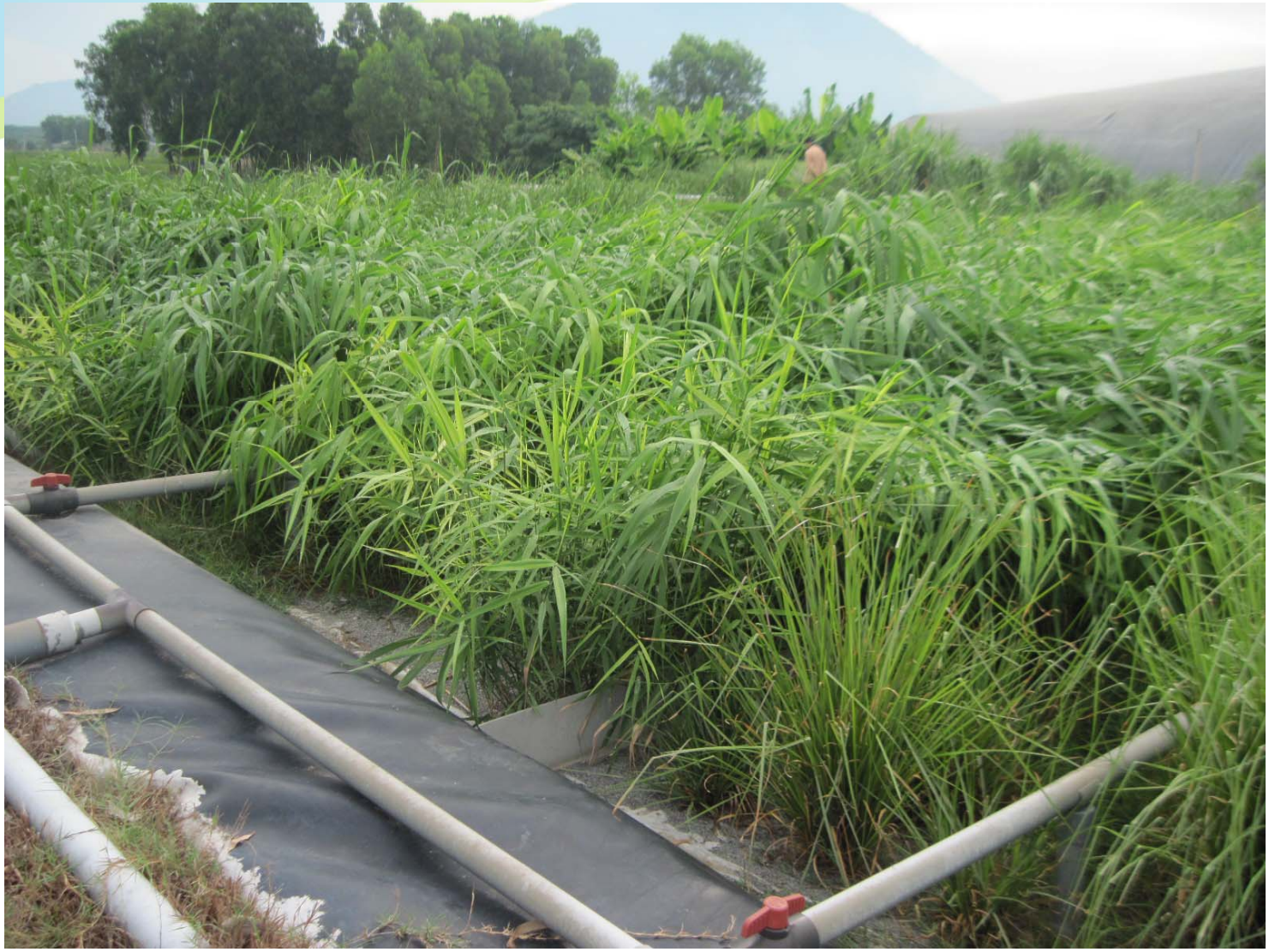
Layout of the Research Plant 研究项目安排

Microflotation and anaerobic expanded granular sludge bed reactor (EGSB)
微气浮和厌氧颗粒污泥床反应器

Reed bed treatment systems under construction
芦苇床人工湿地系统（建造中）

Reed bed treatment systems under construction
芦苇床人工湿地系统（建造中）

Constructed wetlands 1 and 2 after plant growth
1号和2号两块人工湿地实景

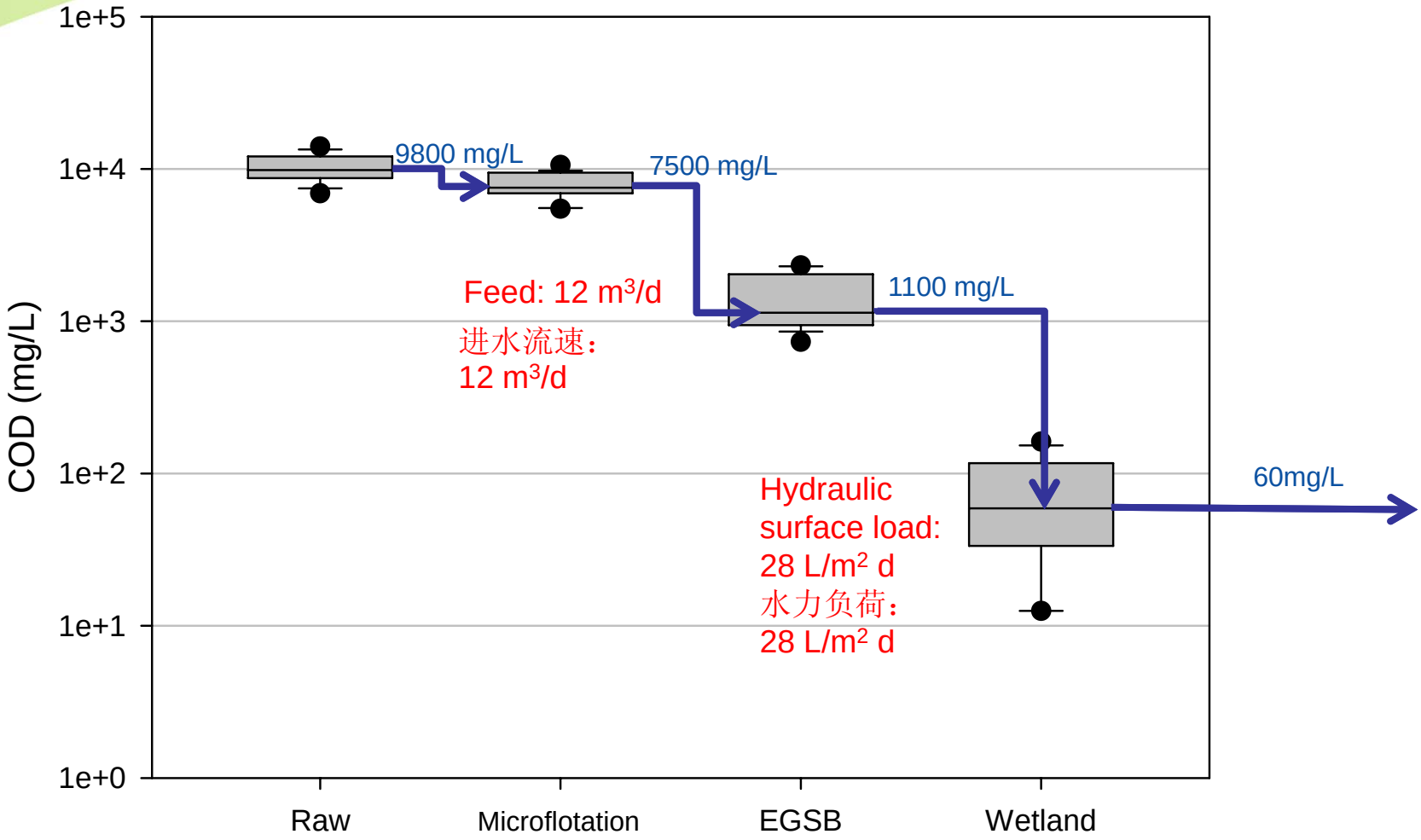


Constructed wetlands 1 and 2 after plant growth
1号和2号两块人工湿地实景

Constructed wetlands 1 and 2 after plant growth
1号和2号两块人工湿地实景

Results Line 1　线路1结论

Combined Anaerobic/Aerobic Treatment
厌氧好氧联合处理

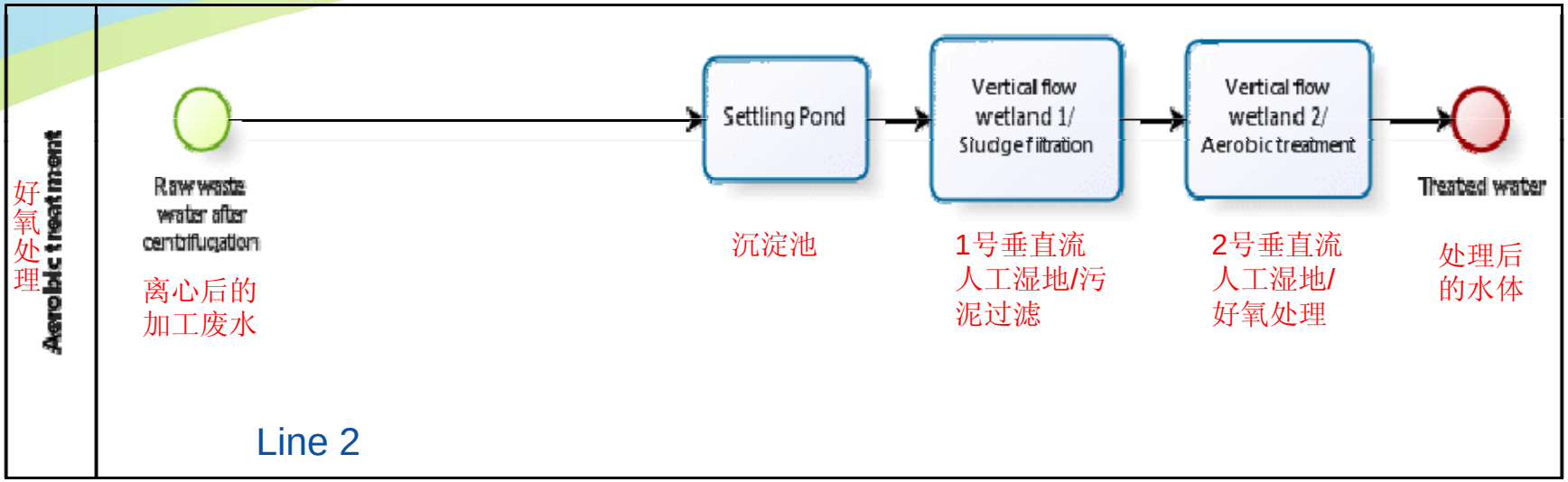


Sedimentation pond with floating islands
浮岛沉淀池

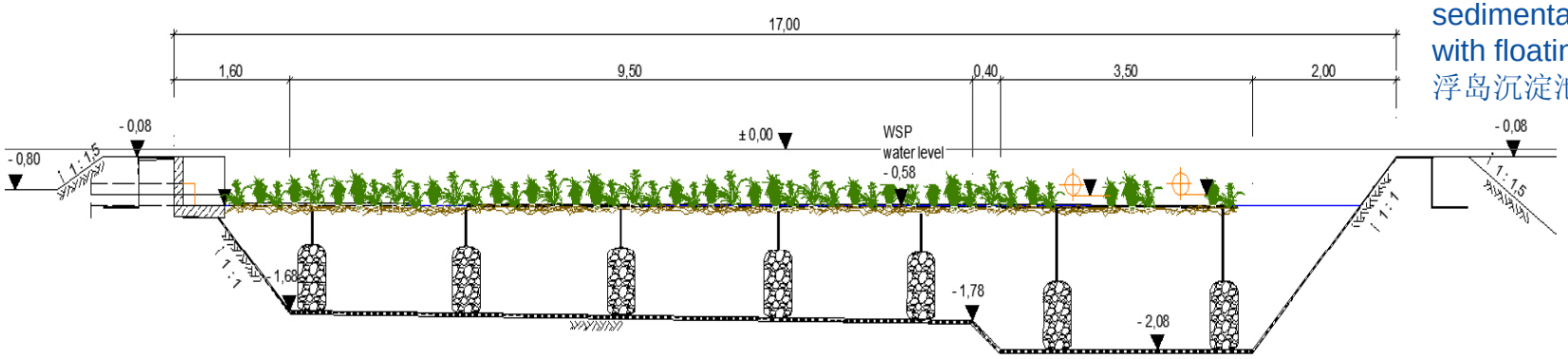
Constructed wetland 3 for final polishing
经最终优化处理的3号人工湿地

Layout of the Research Plant 研究项目安排

Line 2: Complete aerobic treatment
线路2：完全好氧处理

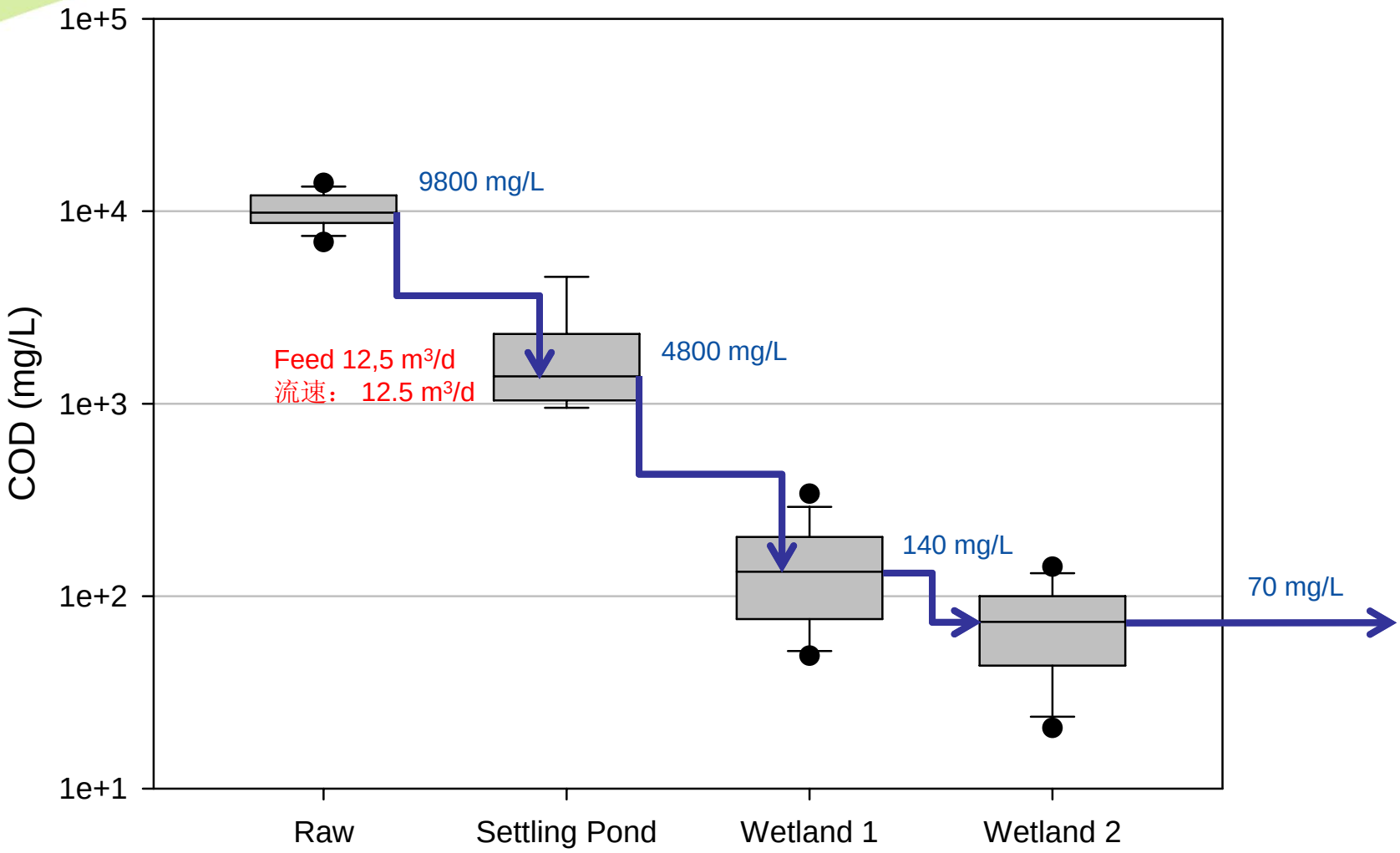


Cross section of the sedimentation pond with floating islands
浮岛沉淀池平面图

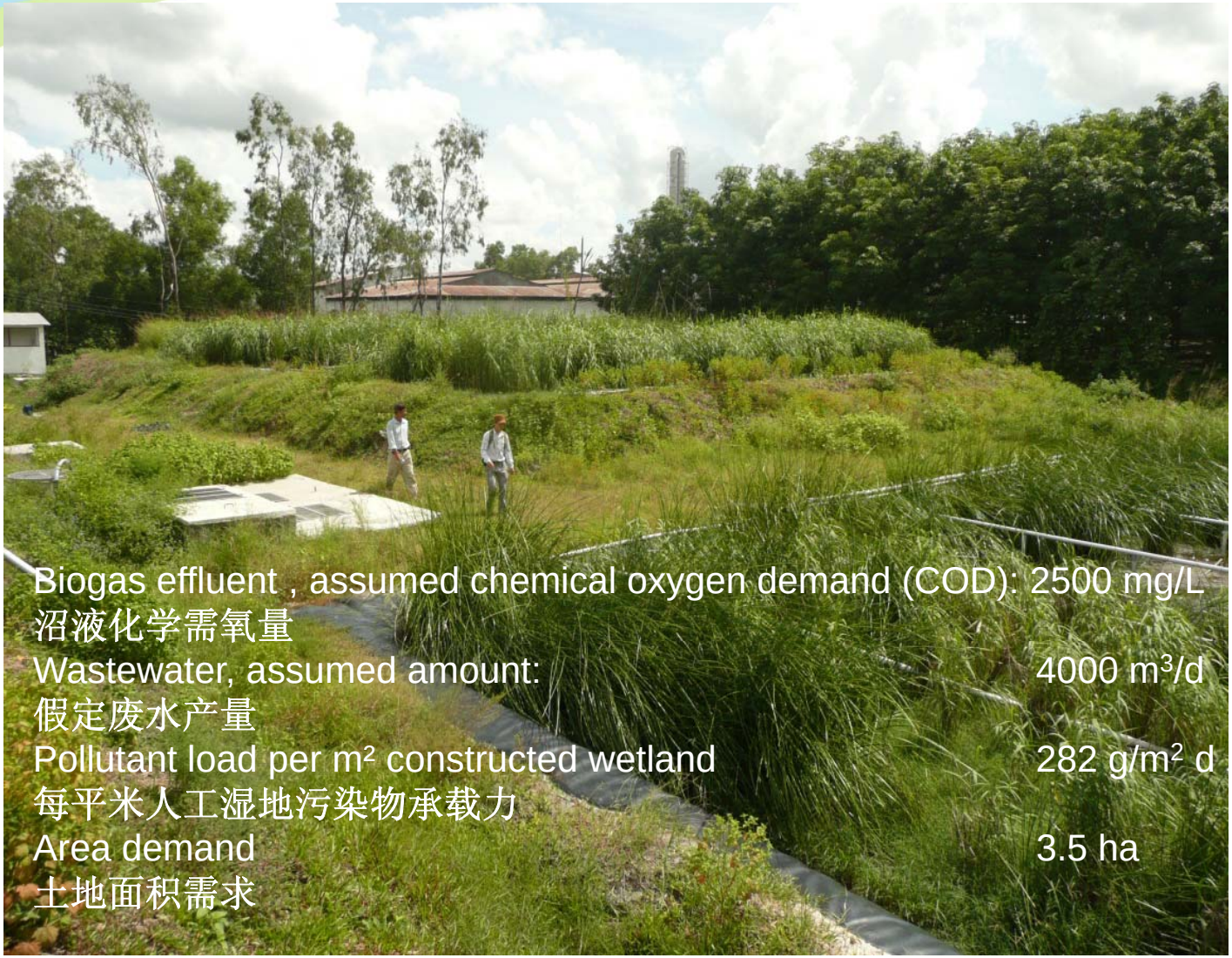


Results Line 2: 线路2结论：

Complete Aerobic Treatment 完全好氧处理



Design Approach for Biogas Effluent Treatment
沼液处理方法设计



Structure of a close-to-nature treatment cascade for polluted surface run-off of biogas plants

一种接近自然的污水处理系统处理被沼气工程污染的地表径流

Structure of a close-to-nature treatment cascade for polluted surface run-off of biogas plants

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Structure of a close-to-nature treatment cascade for polluted surface run-off of biogas plants

一种接近自然的污水处理系统处理被沼气工程污染的地表径流

暴雨过后沼气工程地区的径流污水

Polluted run-off from paved areas after rainfall

被人工浮岛包围的沉淀储存池（处理效率能达到50%）

Sedimentation and storage ponds covered with floating islands (treatment efficiency ca. 50 %)*

Free gravity flow
仅重力作用流动

In case of no downward slope 如果没有斜坡

Stetator

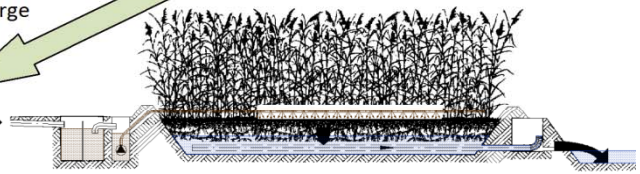
Pumping station

泵站

Equalization of discharge

垂直潜流人工湿地系统

Vertical subsurface flow constructed wetland

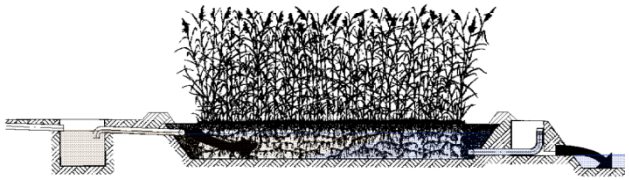


For biological treatment of wastewater, treatment efficiency

污水的生物降解

Optional
选择

Horizontal subsurface flow constructed wetland **
水平潜流人工湿地系统



Discharge to a river or seepage into the ground
排放进河流或渗透进土壤

* solids settling down as sludge, floating waste solids (scum) being retained, the meshwork of roots below the floating islands covered with marsh plants intensifies the microbial degradation of organic pollutants (COD, BOD reduction) and prevents bad smell. Qualitative and quantitative buffering of influent fluctuations.

** option only necessary in case of rigorous discharge limits.

杂质沉淀形成污泥残留在床体中，浮岛下覆盖着沼泽地的是发达的植物根系，这加强了微生物对有机污染物的降解，阻止了异味的扩散。

Treatment of surface run-off from biogas plants
沼气工程表面径流污水处理

Treatment of surface run-off from biogas plants
沼气工程表面径流污水处理

Thank you for your attention!
感谢您的关注！

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