Small and Decentralized Water System

Lecture 7: Modular Units and Financing:
The Case Sewerage Facilities of Malaysia

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- **PART 2**: Evolution of environmental management
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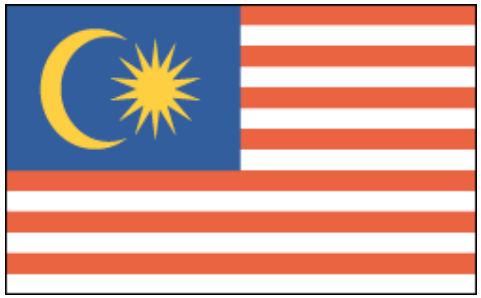
- **PART 5**: Issues

Malaysia in Southeast Asia region



Looks like US flag!

Malaysia in brief

Socio-enviro-economic outlook

- **Population**: 25+ million
- **Race**: Multiracial country (Malay, Chinese, Indian)
- **Religion**: Multi-religions (Muslim, Buddhist, Hindu, Christian etc.)
- **Land area**: Slightly smaller than the size of the UK
- **Economy**: Processed products (petrochemicals, electronics, specialty chemicals, wood-products, services), tourism, commodity (palm oil, rubber, wood), services, petroleum
- **Income per capita**: USD5000
- **Landscape**: More than 40% forest, 40% plantation
- **International Environmental Performance Index 2006**: Malaysia ranked 9 after NZ, Sweden, Finland, Republic Czech, UK, Austria, Denmark and Canada (Japan: 14, Switzerland:16, Germany: 22, Taiwan: 24, Holland:27, USA: 28, Indonesia:79 and China:94).


Santa Maria II
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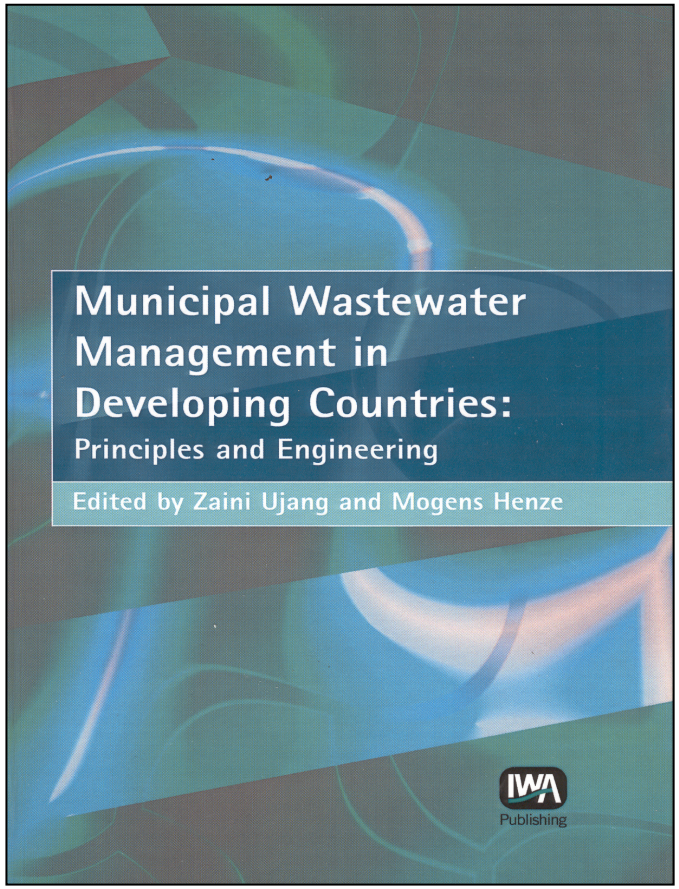
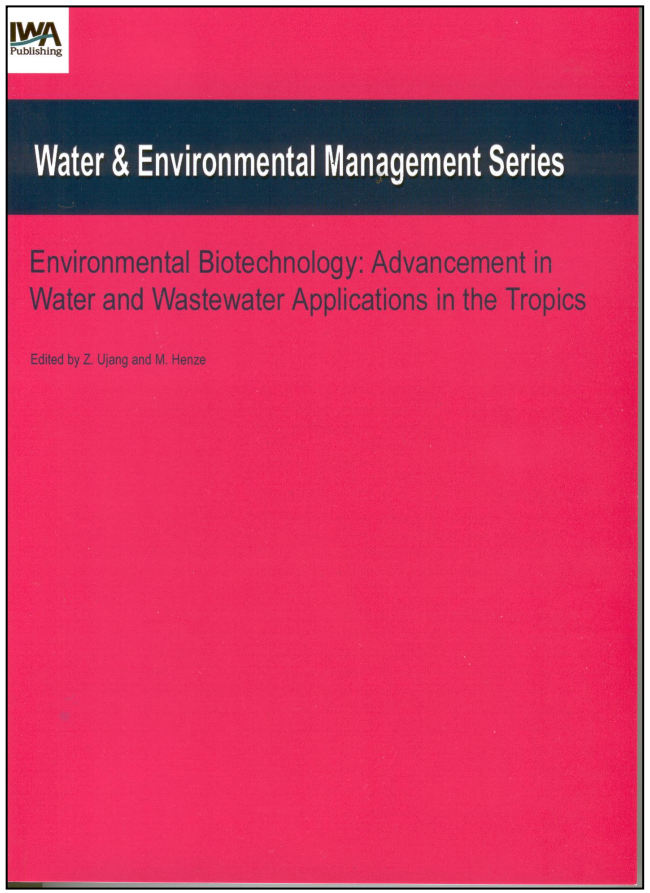
YAMAHA

Books I have co-authored in 2004, 2005

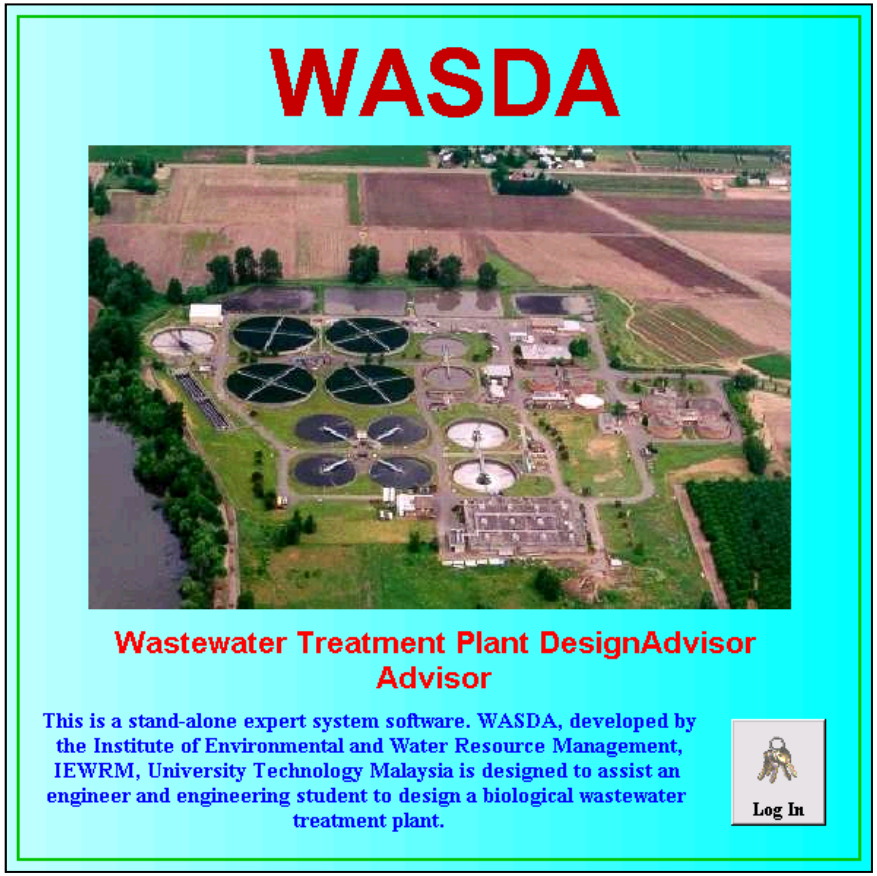
(IWA Publishing, London)





Wastewater Treatment Design Advisor (WASDA)®

- Developed by UTM
- Industrial Design (2003)
- Field tested
- Used by public & private agencies
- Award winning innovation



Major issues in Malaysia (and other developing countries)

- Providing wastewater management facilities
- Financial framework:
  - High income group → Full cost recovery
  - Medium income group → Full cost recovery
  - Poor group → Subsidy
- Environmental protection
  - Sources of water supply
- Operable and maintainable
- Land requirements
- Promotion of local enterprise
- **Eco-tourism**

Evolution and drivers in wastewater management principles, Malaysia

Period	Core principles	Agency / regulator
Pre1974	Public health protection	Department of Health
Post 1974 (sewage)	Pollution control Polluter pays	Local governments
Post 1974 (industrial wastewater)	Pollution control Polluter pays	Department of Environment
Post 1993 (sewage)	Decentralized and modular Environmental control	Department of Sewerage Services
Post 2006 (sewage)	Environmental control Eco-tourism Private financing initiatives	National Water Services Commission as regulator
		Water Asset Management Company as asset owner
		Water companies as operator

Evolution of wastewater management principles in Malaysia

Period	System / Initiatives	Agency	Financing
Pre1974	Individual septic tanks, latrines, VIPs	Department of Health	Individual owners
Post 1974 (sewage)	Small modular systems: WSP, IT	Local governments	Private developers
Post 1974 (industrial wastewater)	Small modular systems: WSP, Biofilm, activated sludge etc	Department of Environment	Industrial premise owners
Post 1993 (sewage)	Small and medium-sized systems	Department of Sewerage Services	Private developers & Federal grants
Post 2006 (sewage)	Small, medium and big-sized systems	National Water Services Commission as regulator	Private developers and Federal grants
		Water Asset Management Comp.	Capital market

Why an ideal system does not work in developing countries

- The regulatory requirement is too good and perfect (e.g. BOD 10 mg/l for discharge standards)
- The system has no local inputs (e.g. trained engineers and research facilities)
- The system has no implementers (e.g. able politicians, trained engineers and skilful operators)
- The system has no legal back up (e.g. acts, legislation)
- The system has a poor financial framework (CAPEX, OPEX)
- The system is efficiently corrupted (political influence, etc.)

Comparison of water charges and other utilities in Malaysia, 2001

Services	Annual per household, €
Water supply	100
Sewerage services	20
Cell phone	400
Fixed-line phone	100
Solid waste	50
Electricity	180

GDP per cap = € 2,942

What strategy? Why?

- Providing the services to the people who are able and willing to pay the CAPEX and OPEX
- Providing the services to the people who are not able to pay both CAPEX and OPEX (the poor)
- Providing the services to the people who were not able to pay CAPEX, but now able and willing to pay both CAPEX and OPEX (improved socio-economic conditions)
- Providing the services to the people who were able to pay for the basic CAPEX, but now refused to upgrade the facilities to a better system
- Providing the services to people who are not willing to pay OPEX, but able to pay on-site CAPEX facilities

Types of sewerage services & solutions

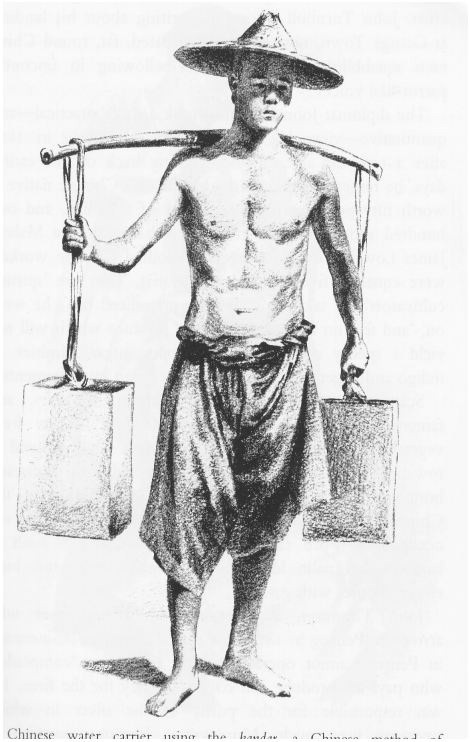
Groups	CAPEX	OPEX	Solutions
Rich, urban	OK	OK	Full recovery
Rich, rural	No	OK	Partly subsidised, decentralised system
Poor, urban	No	OK	Subsidy, centralised or decentralised system
Poor, urban	No	No	Subsidy, decentralised system
Poor, rural	No	No	Subsidy, on-site system
Poor, rural	No	OK	Subsidy, decentralised system
Medium, urban	50/50	OK	Partly subsidised
Rich, medium	Upgrade	OK	Partly subsidised
Poor	Upgrade	OK	Fully subsidised
Poor	Upgrade	No	Fully subsidised

Current solutions in developing countries
(including Malaysia)

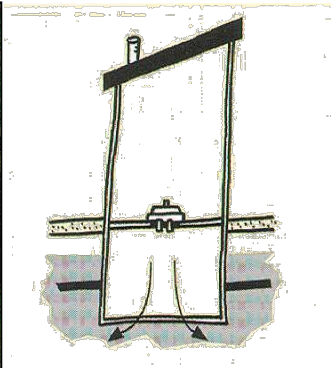
- Individual on-site hanging toilets (without treatment)
- Low cost individual on-site septic tanks
- Low cost communal on-site septic tanks
- Household-centered low-cost sewerage systems
- Decentralized and small mechanical sewerage systems
- Conventional centralized mechanical sewerage systems

Pre 1974

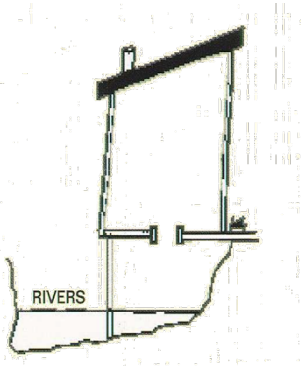
Low cost individual toilets, septic tanks



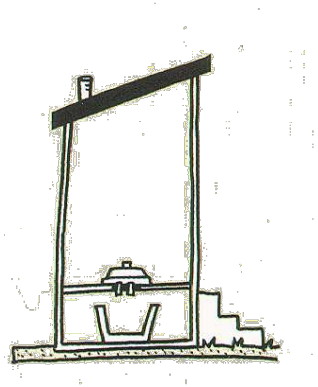
Chinese water carrier using the *bawdar*, a Chinese method of



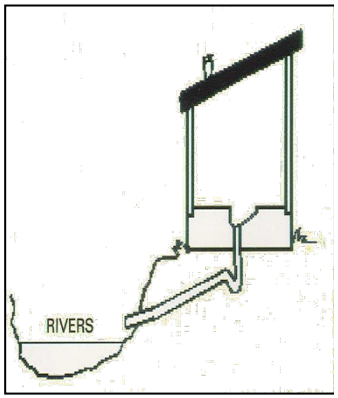
Pit Latrine



Enclosure Over Water

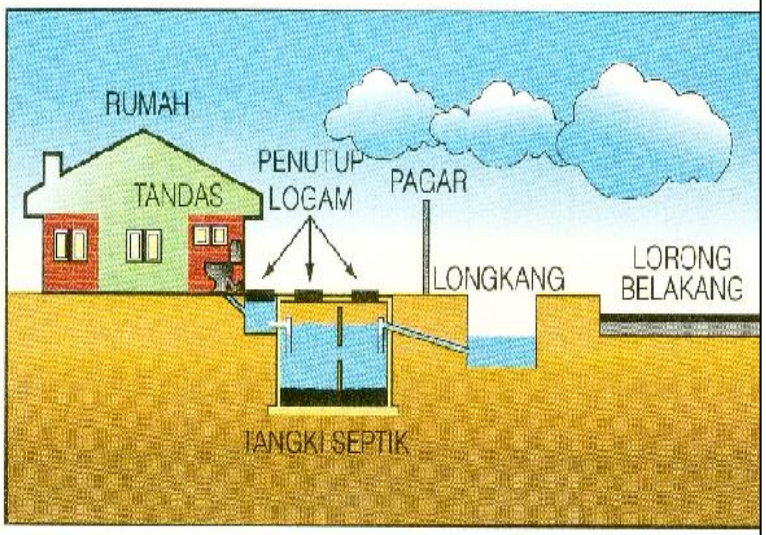


Bucket System



Post 1974

Low cost community septic tanks



Jika kumbahan dari premis anda mengalir ke dalam sebuah tangki septik sebelum menga ir ke dalam longkar g, anda adalah seorang pelanggan perkhidmatan tangki septik.

Tangki Imhof tersebut setelah dibaik pulih oleh Indah Water.

Post 1974

Low cost community septic tanks

Desludging of Individual and Communal Septic Tanks

Post 1993

Household-centered low-cost sewerage systems

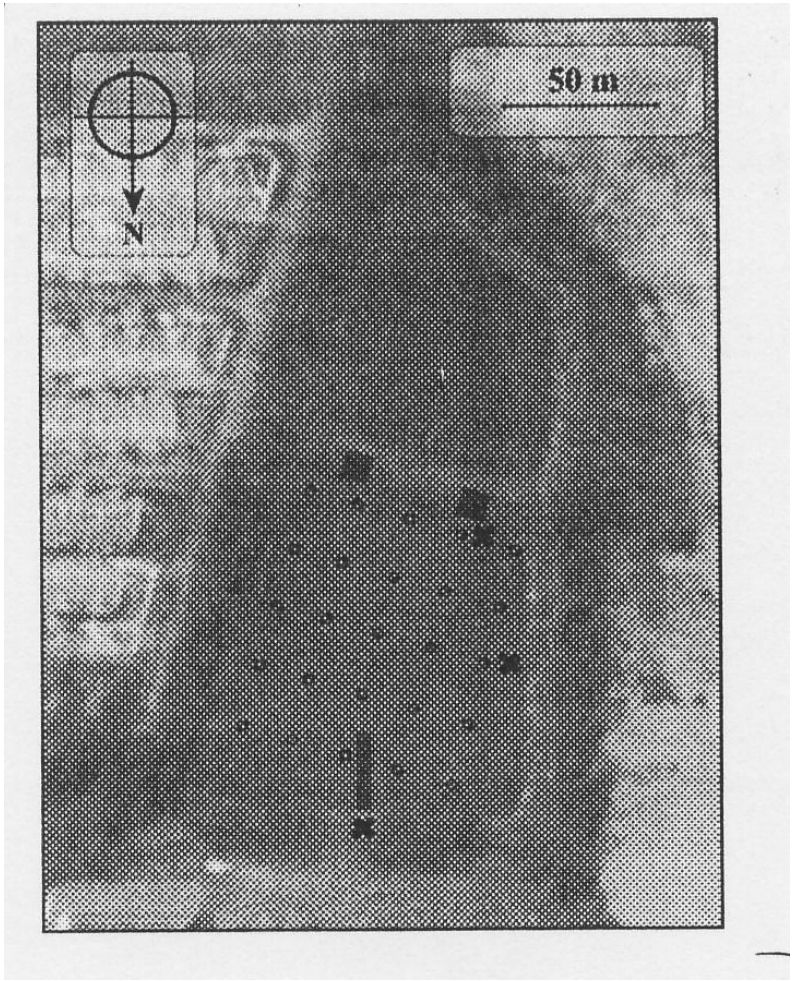
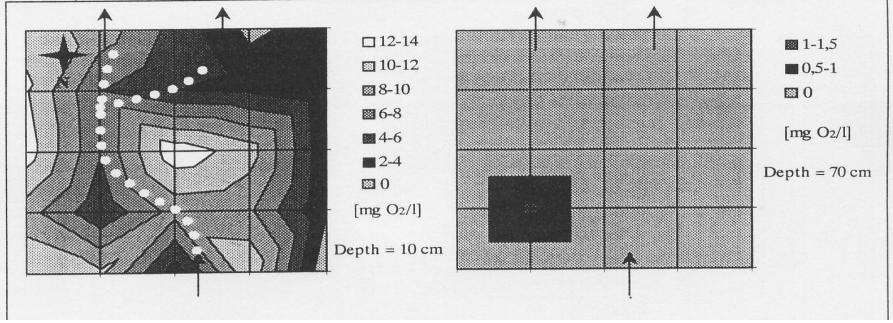


Figure 7.40: DO profiles in the depths 10 cm and 70 cm. The dotted line indicates an observed flow channel through the pond. Data for the profiles were collected the 22nd of November. Note that the intervals of DO are not the same for the two depths.



Post 1993

Decentralized and small mechanical sewerage systems

Aerated Lagoon

Activated sludge plant

Privatization of sewerage services

- Since 1993 where almost all Local Authorities surrendered their sewage plants to **IWK**, a national sewage company
- Mainly on operation and maintenance
- Capital expenditure is paid by house owner and Federal Government
- Separate bill from water supplies
- Based on type of houses
- Individual septic tanks to be discharged every 2 year and paid accordingly by house owner to IWK

Sewerage planning in Malaysia

Phase/Year	Category A (48 major towns)		Category B (96 small towns)	
	Connected	Septic tanks	Connected	Septic tanks
Phase 1(1997)	-	-	-	-
Phase 2(2002)	64%	29%	16%	51%
Phase 3(2007)	76%	19%	18%	50%
Phase 4(2012)	83%	14%	19%	50%
Phase 5(2017)	84%	13%	24%	47%
Phase 6(2022)	84%	16%	30%	70%

Objectives

Small, modular and decentralized wastewater treatment plants

- To protect public health
- To protect receiving water environment from degradation or contamination
- To reduce costs of treatment by retaining water and solids near their point of origin

Wastewater Management Systems and Options

Systems	Options
Individual on-site system PE: 1-10	-Septic tanks -VIP
Communal on-site system PE10-100	-Septic tanks -Imhoff tanks
Household-centered low-cost sewerage systems PE100-5,000	-Waste stabilization ponds -Wetlands, Land treatment -Sea outfall
Decentralized and small mechanical sewerage systems PE5,000-50,000	-Package plants: activated sludge -Packaged plants: biofilm system -Membrane bioreactor
Large size, mechanical centralized system PE50,000-1,000,000	-Conventional activated sludge

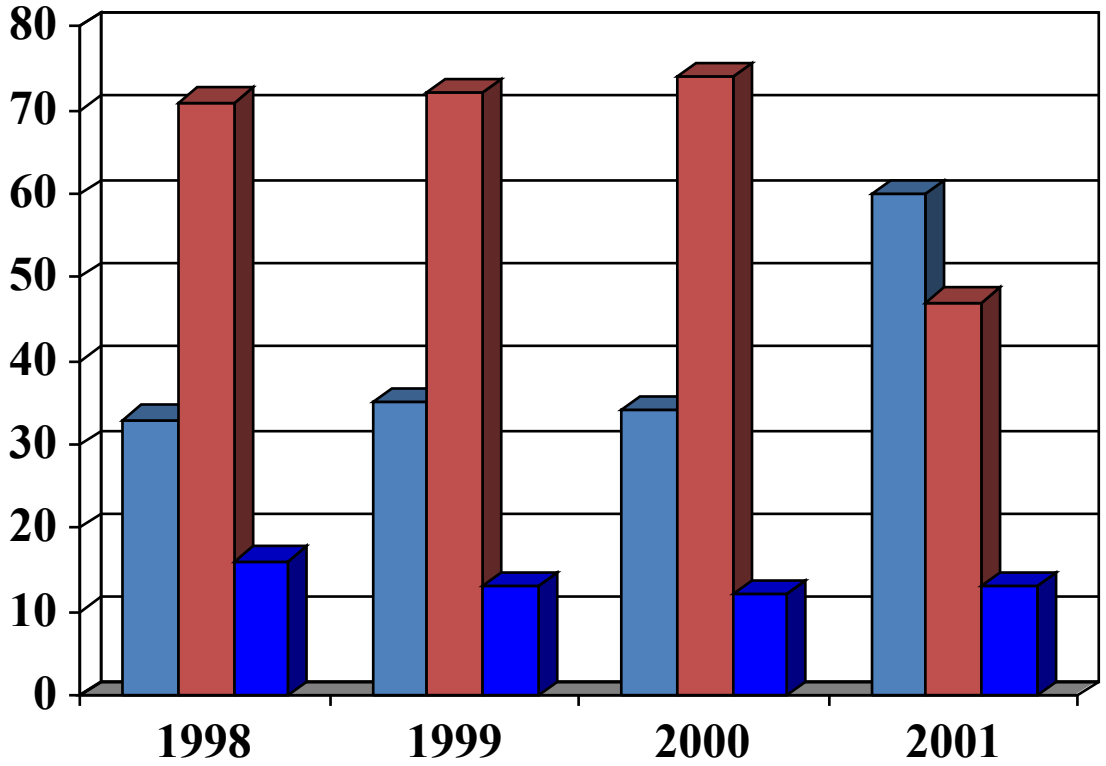
Wastewater Management Systems and Options

Systems	Options	Target Populations
Individual on-site system PE: 1-10	-Septic tanks -VIP	-Rural (poor, medium, rich) -Urban poor
Communal on-site system PE10-100	-Septic tanks -Imhoff tanks	-Urban poor -Government subsidized projects
Household-centered low-cost sewerage systems PE100-5,000	-Waste stabilization ponds -Wetlands, Land treatment -Sea outfall	-Urban poor -Middle class urban
Decentralized and small mechanical sewerage systems PE5,000-50,000	-Package plants: activated sludge -Packaged plants: biofilm system -Package plants: Hybrid system -Membrane bioreactor -New innovations?	-Flats & subsidized projects -Middle class -Resort areas -Business areas -Properly planned housing areas
Large size, mechanical centralized system PE50,000-1,000,000	-Conventional activated sludge	-Clusters of planned housing areas -Business areas, middle and upper class urban

Interim National River Water Quality Standard for Malaysia						
Parameters (units)	**Classes**					
	I	**IIA**	**IIB**	**III**	**IV**	**V**
Ammoniacal Nitrogen (mg/l)	0.1	0.3	0.3	0.9	2.7	>2.7
BOD5	1	3	3	6	12	>12
COD (mg/l)	10	25	25	50	100	>100
DO (mg/l)	7	5-7	5-7	3-5	<3	<1
pH	6.5-8.5	6-9	6-9	5-9	5-9	-
Colour (TCU)	15	150	150	-	-	-
Elect. Cond.# (mmhos/cm)	1,000	1,000	-	-	6,000	-
Floatables	N	N	N	-	-	-
Odour	N	N	N	-	-	

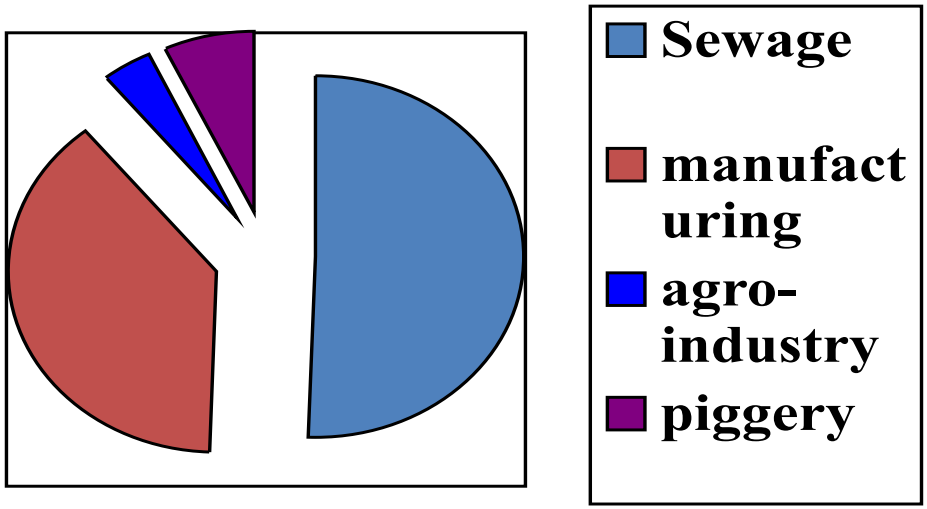
Interim National River Water Quality Standard for Malaysia						
Parameters (units)	**Classes**					
	I	**IIA**	**IIB**	**III**	**IV**	**V**
Salinity# ()	0.5	1	-	-	2	
Taste	N	N	N	-	-	
Total Diss. Solid# (mg/l) Total SS (mg/l)	500 25	1,000 50	- 50	- 150	4,000 300	 >300
Temperature (°c)	-	Normal ±2	-	Normal ±2	-	-
Turbidity (NTU)	5	50	50	-	-	-
F.Colif. (counts/100 ml)	10	100	400	5,000	5,000	-
Tot. Colif. (counts/100 ml)	100	5,000	5,000	(20,000)	(20,000)	

River basin water quality trends in Malaysia (DOE, 2002)



Number of water pollution sources by sector to Malaysian rivers (DOE, 2005)

- Sewage plants (>8000)
- Manufacturing industries (7,086)
- Pig farming (909)
- Agro-based industry (472)



Number of sewage treatment plants by types

(Total number >8000: DOE 2006)

Waste stabilization ponds	>600
Various types of activated sludge plants	>500
Trickling filters	>1000
Rotating biological contactors	>100
Imhoff tanks	>1000
Communal septic tanks	>1000
Other systems	>1000

Socio-economic consideration for development of sewerage services

5 categories:

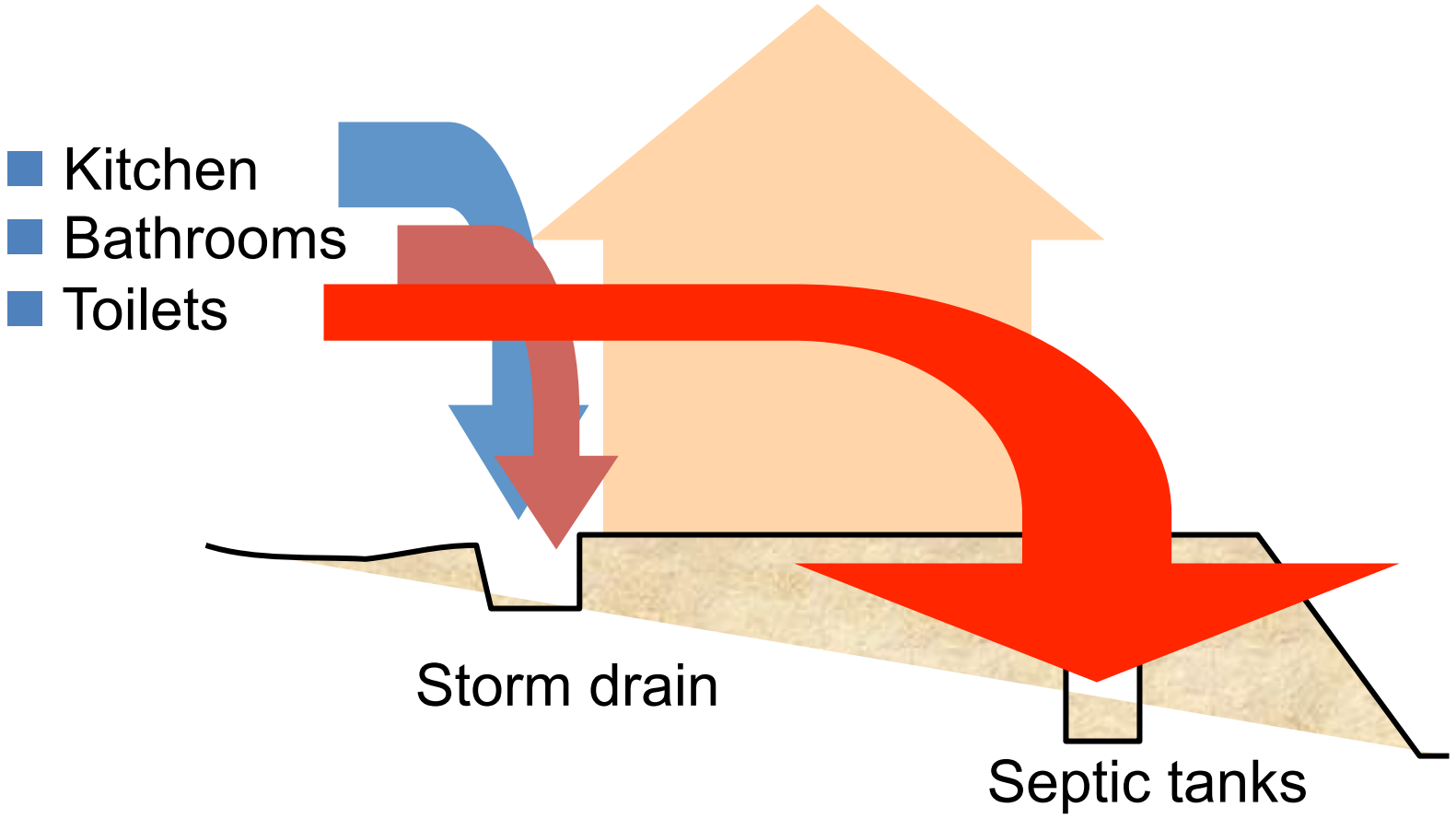
- Rural community (poor and rich)
- Poor peri-urban community
- Rich peri-urban community
- Poor urban community
- Rich urban community

Socio-economic consideration for development of sewerage services

Very much related to
urban planning & housing types

Category 1 and 2:

Sewage management in rural and peri-urban poor community



Category 3, 4, 5:
Institutional, planned-residential, peri-urban & urban
Waste Stabilization Ponds (UTM Skudai)

Category 3, 4, 5:
Institutional, planned-residential, peri-urban, urban
Rotating BioContactors

Category 3, 4, 5:
Institutional, planned-residential, peri-urban, urban
E.g. Activated sludge systems

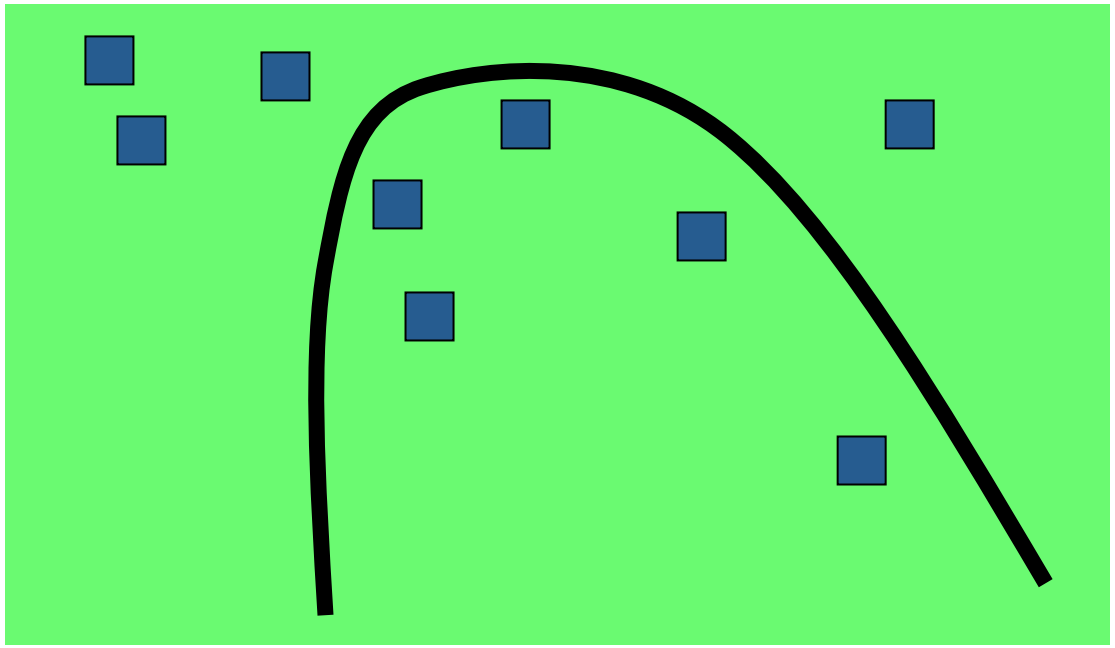
Small and Decentralized WWTP

Criteria, Scenario, Advantages, Disadvantages

- Small in size: PE 5-20 k
- Based on residential and commercial areas
- Numerous – more than 8000
- Developed by housing developers
- Capital cost is included in the cost of the houses
- WSP, EA, IDEA, SBR, RBC
- Hardly meeting Standard A

Implementation of decentralized systems

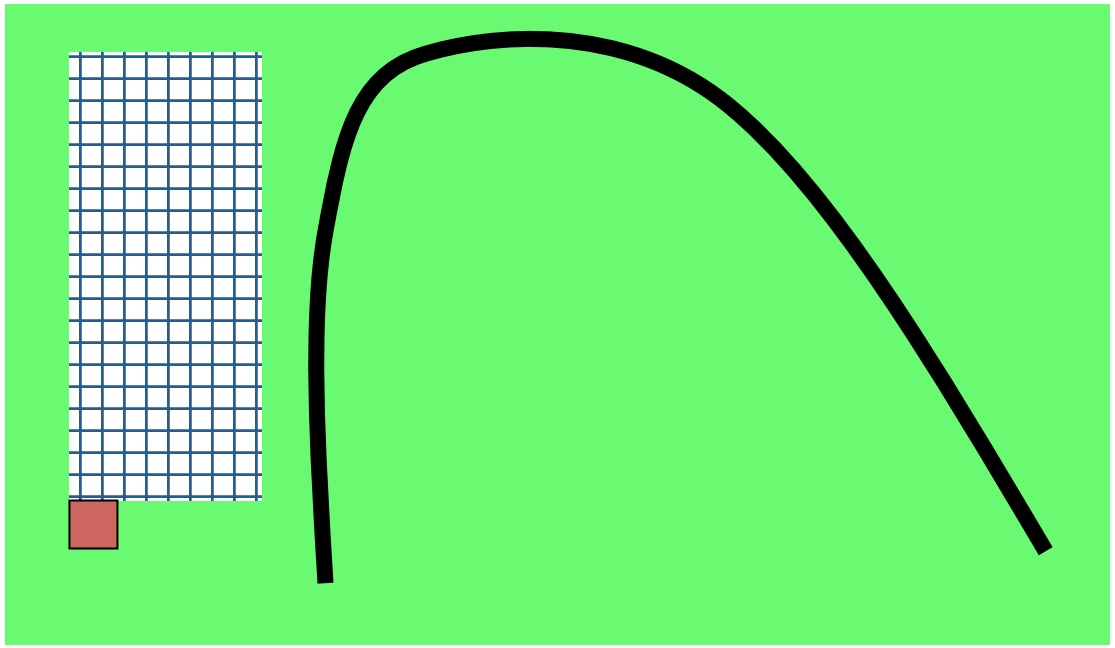
Rural population in Malaysia



- Land owned by individuals
- Houses built based on individual investment
- Water supply pipeline is provided & subsidised by Government
- Road & electricity are provided & subsidised by Government
- Septic tanks are paid by individual owners
- Desludging is done by IWK, paid by owners of houses

Implementation of decentralized systems

Peri urban population in Malaysia



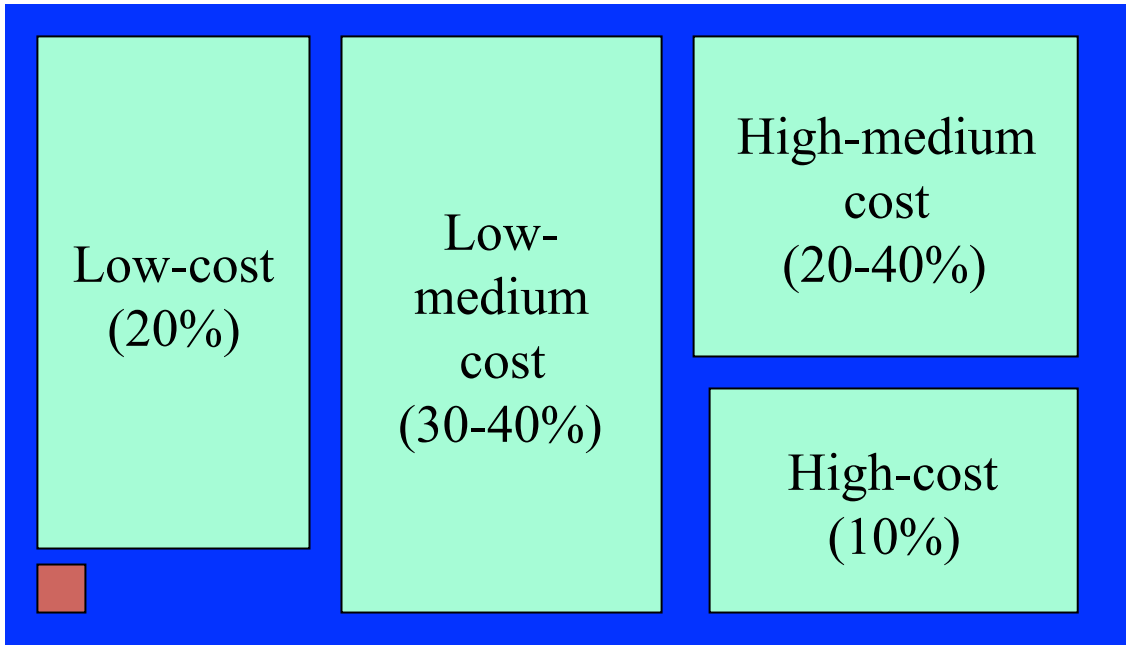
- Land owned by developers
- Houses built based on developers
- Water supply pipeline, road, schools & electricity are provided developers & subsidised by Government
- Sewage plants are paid by individual owners, and operate by IWK
- Upgrading of sewage plants paid by Government

Implementation of decentralized systems

Peri urban population in Malaysia

Implementation of decentralized systems

Peri urban population in Malaysia

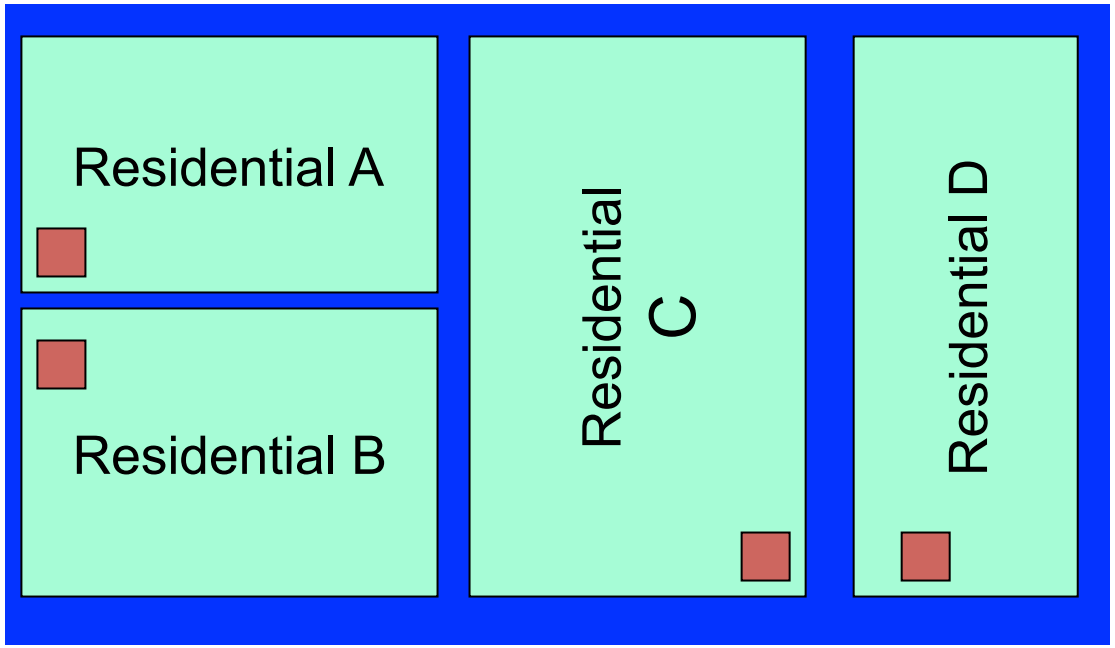


A residential area – peri urban, urban

- Low-cost houses are developed by developers; land is free from Government; facilities are cross-subsidised by other type of houses; price set by Government
- Water supply pipeline, road, schools & electricity are provided developers & subsidised by Government
- Sewage plant is built by developer, paid by individual owners, and operate by IWK

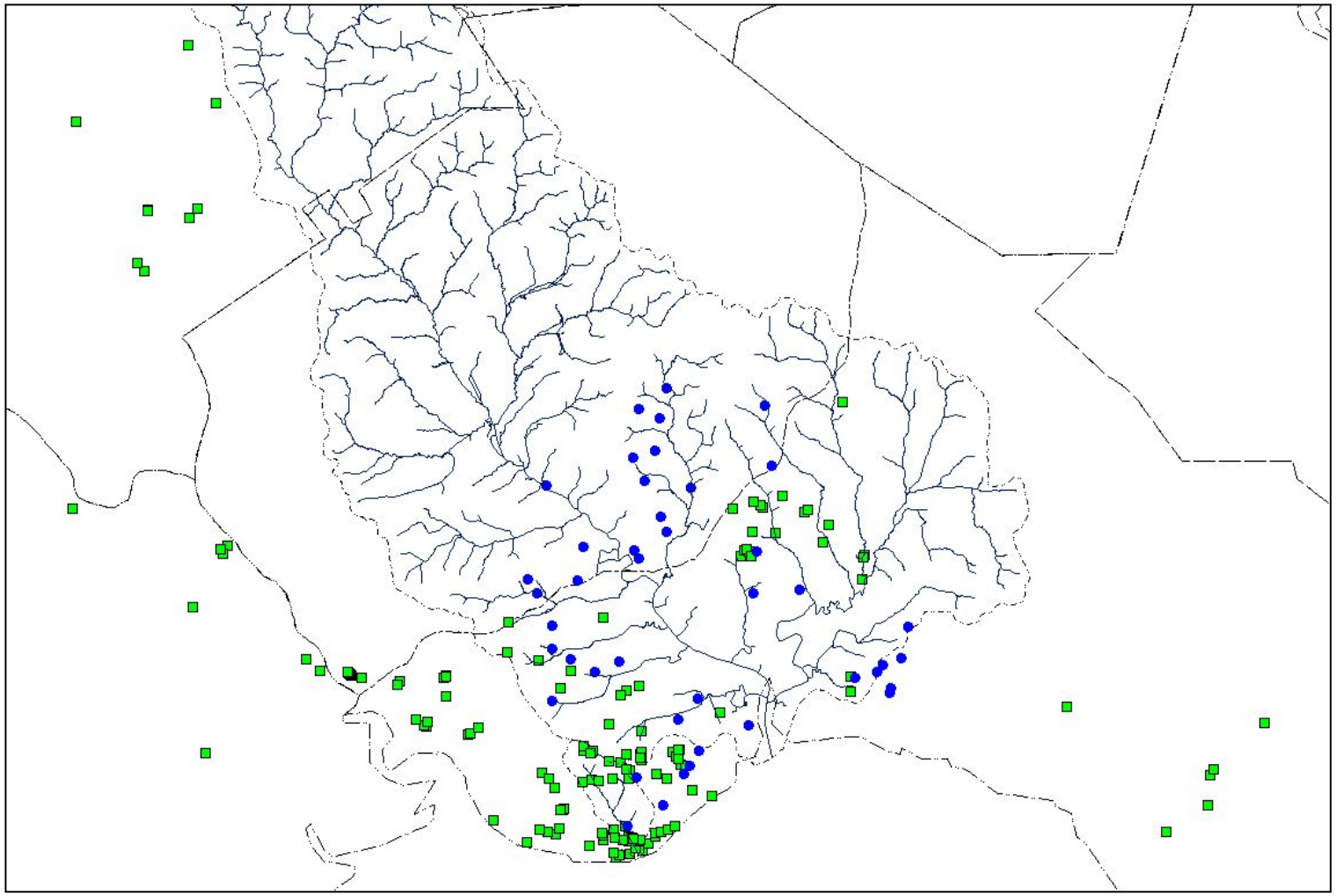
Implementation of decentralized systems

Peri urban & urban population in Malaysia

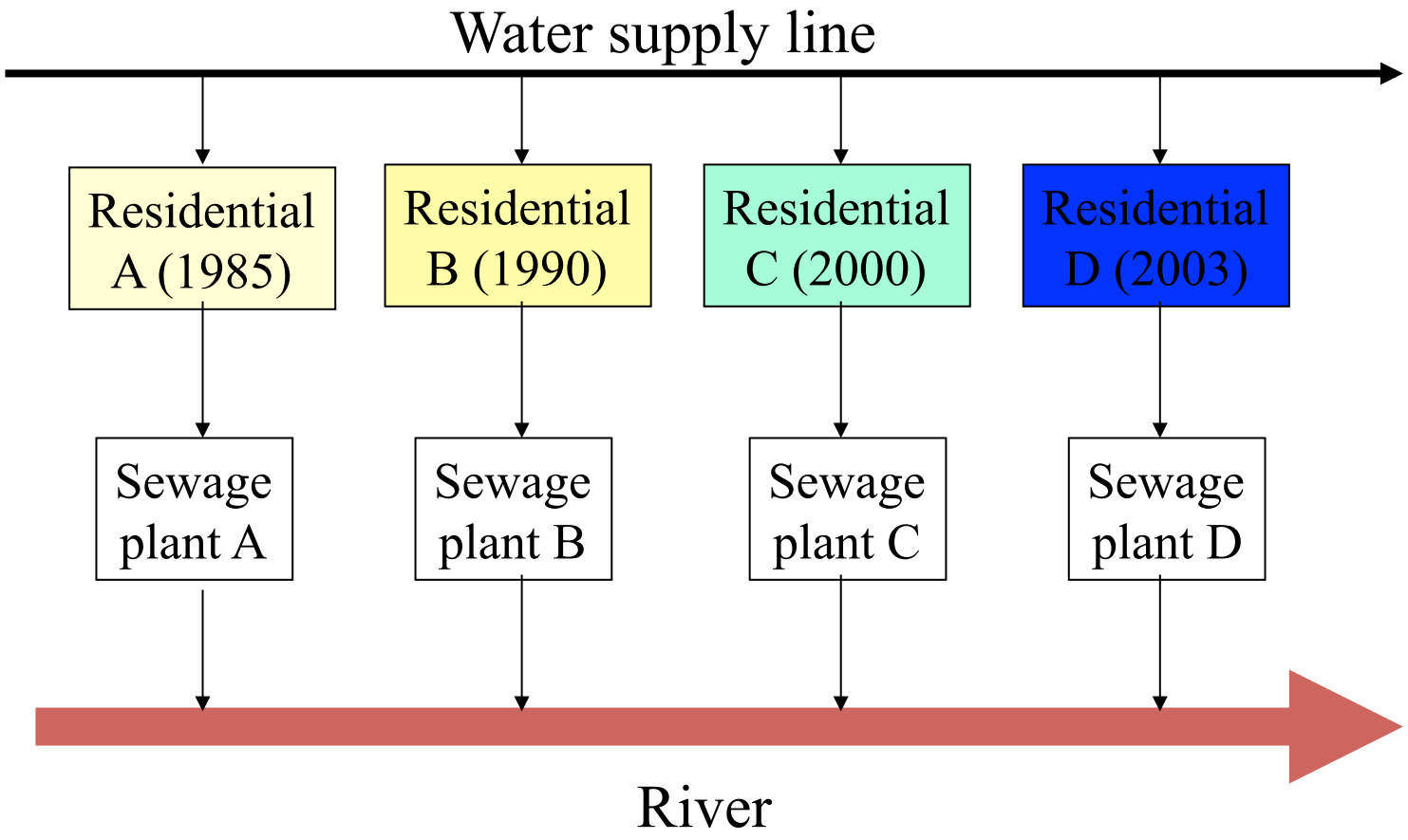


- Numerous sewage plants in certain areas
- Difficult to maintain
- Sustainability??
- Upgrading schemes are subsidised by Government

Sewage Treatment Plants in Johor Bahru, Malaysia



Wastewater Treatment Plants in UTM Campus, JB



Issues

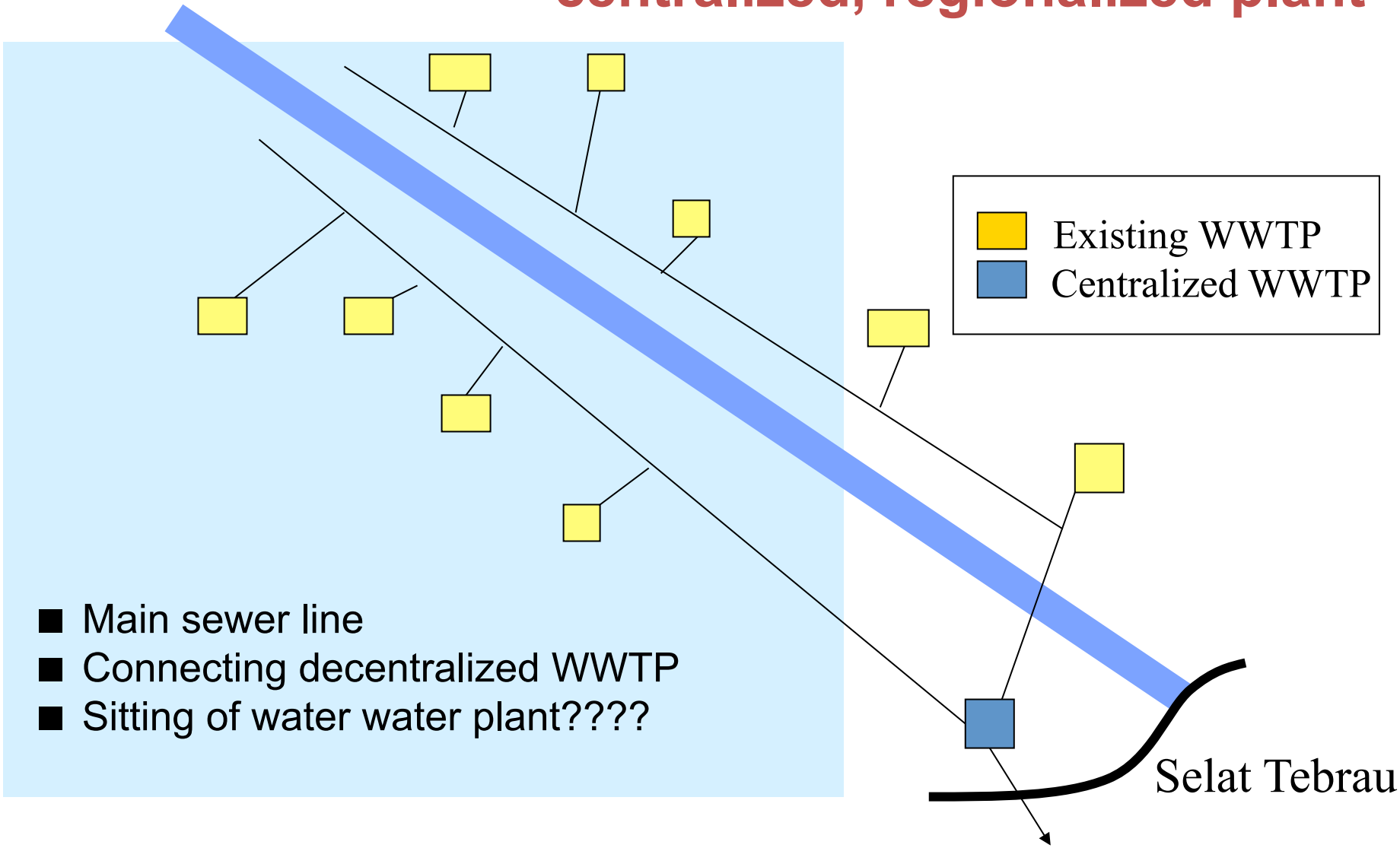
- Operating and maintenance cost
- Upgrading old modular plants
- Upgrading without subsidy?
- Options for upgrading schemes
- Higher compliance, higher quality

Issues

Management Issues

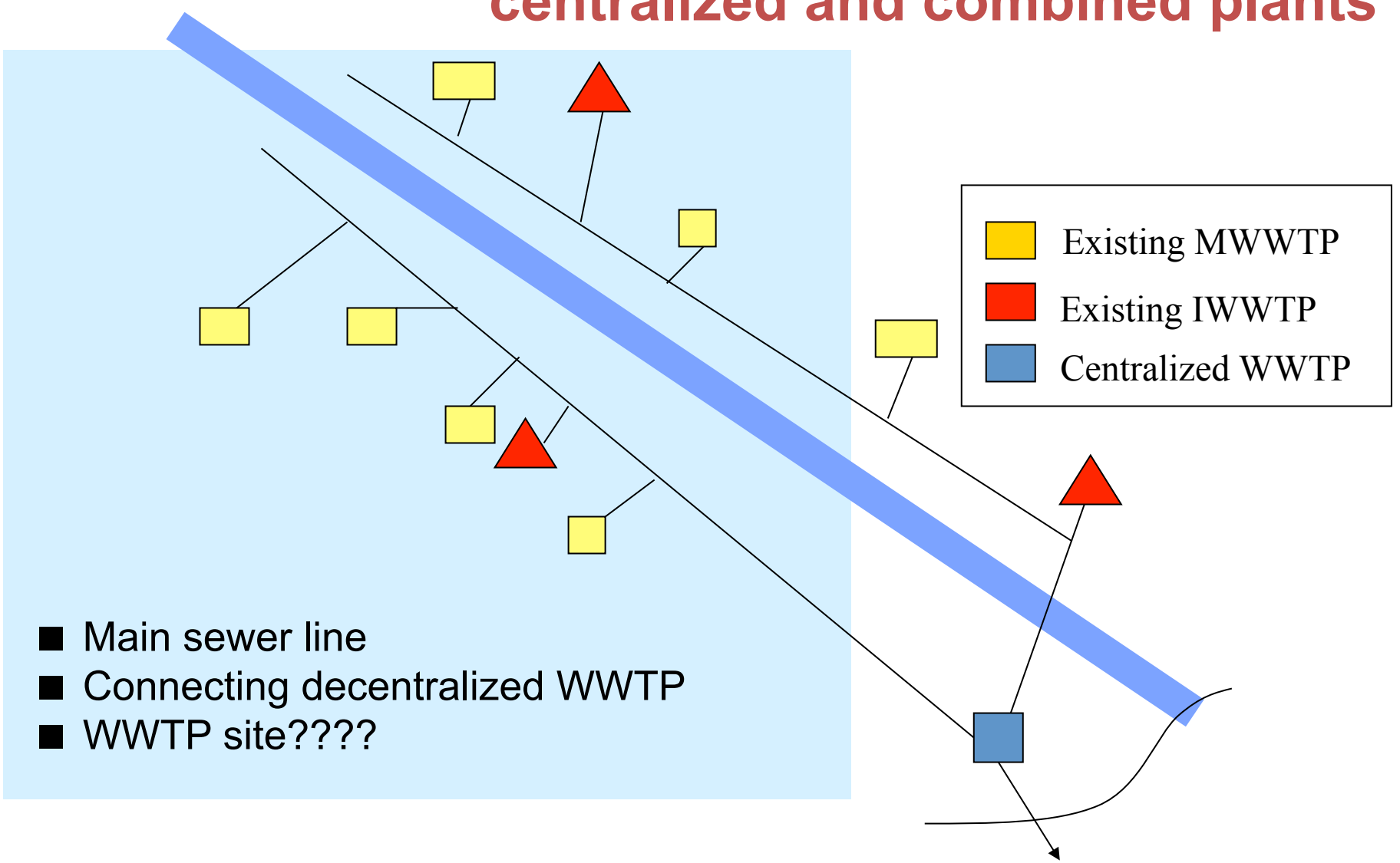
Cost for small and decentralized systems

Upgrading the modular plants to centralized, regionalized plant



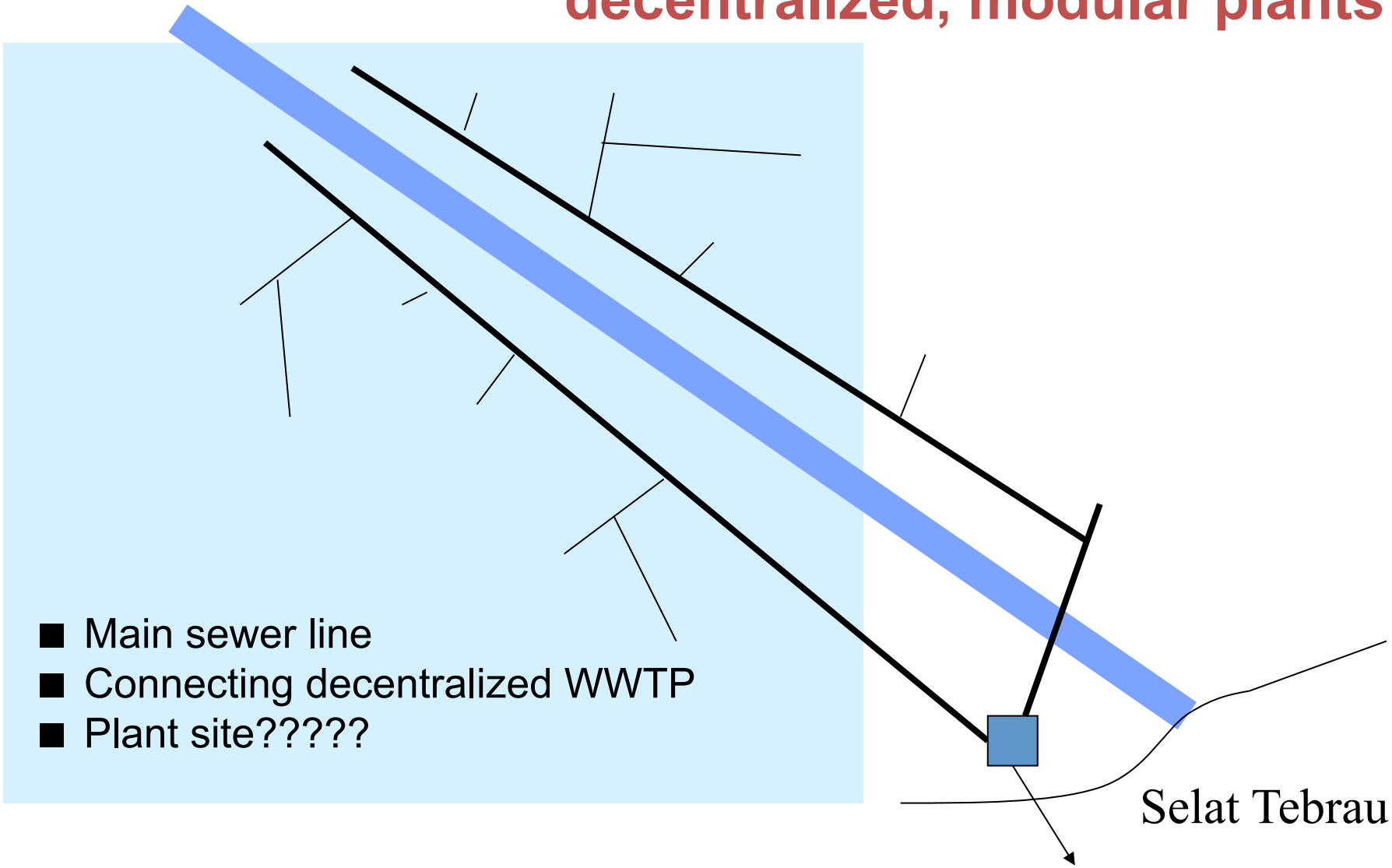
- Main sewer line
- Connecting decentralized WWTP
- Sitting of water water plant????

Upgrading modular plants to centralized and combined plants

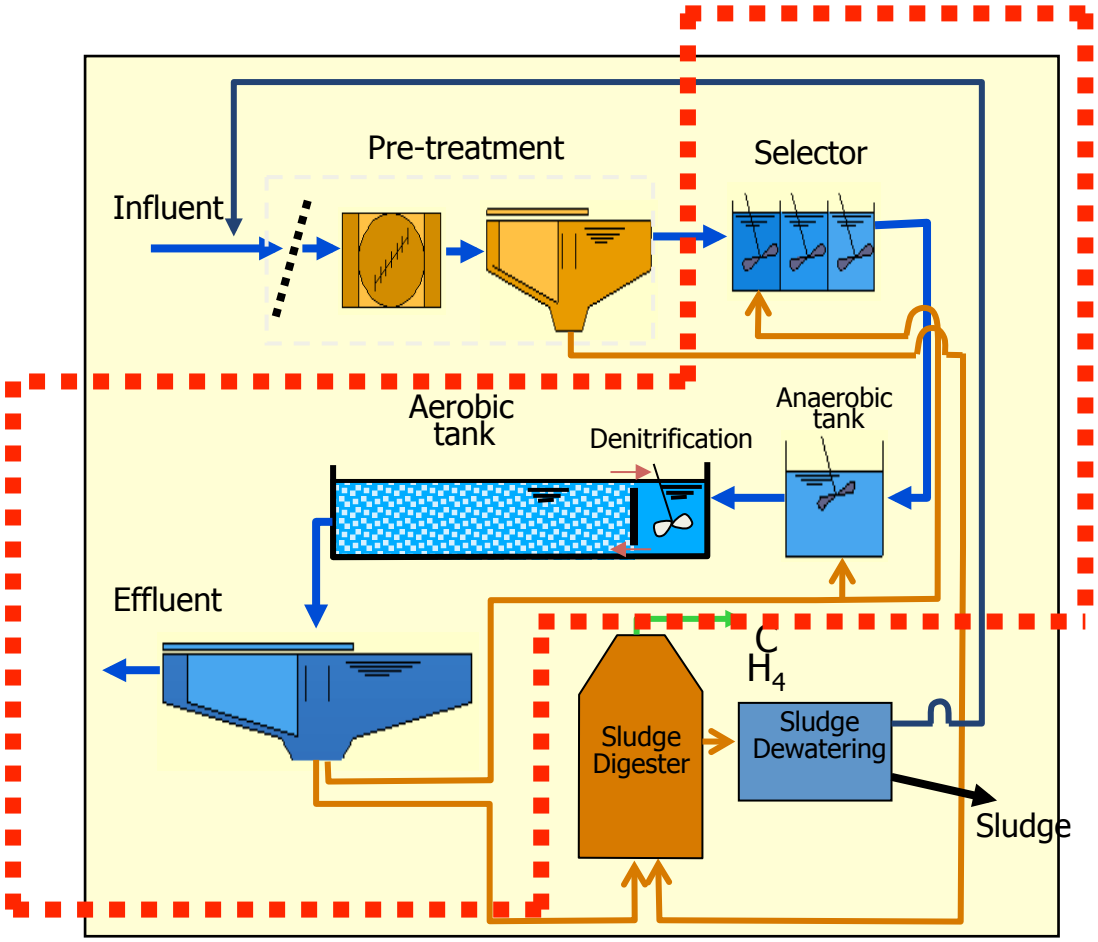


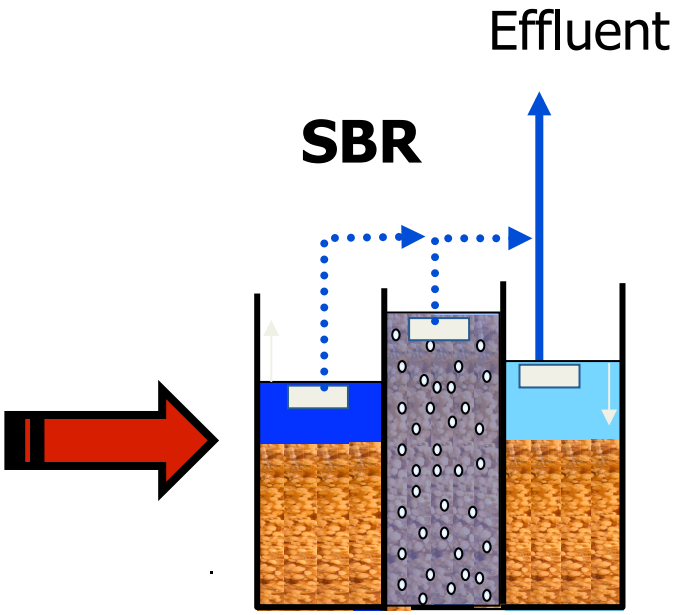
- Main sewer line
- Connecting decentralized WWTP
- WWTP site????

Centralized plant and abolished decentralized, modular plants



New innovation using granular sludge



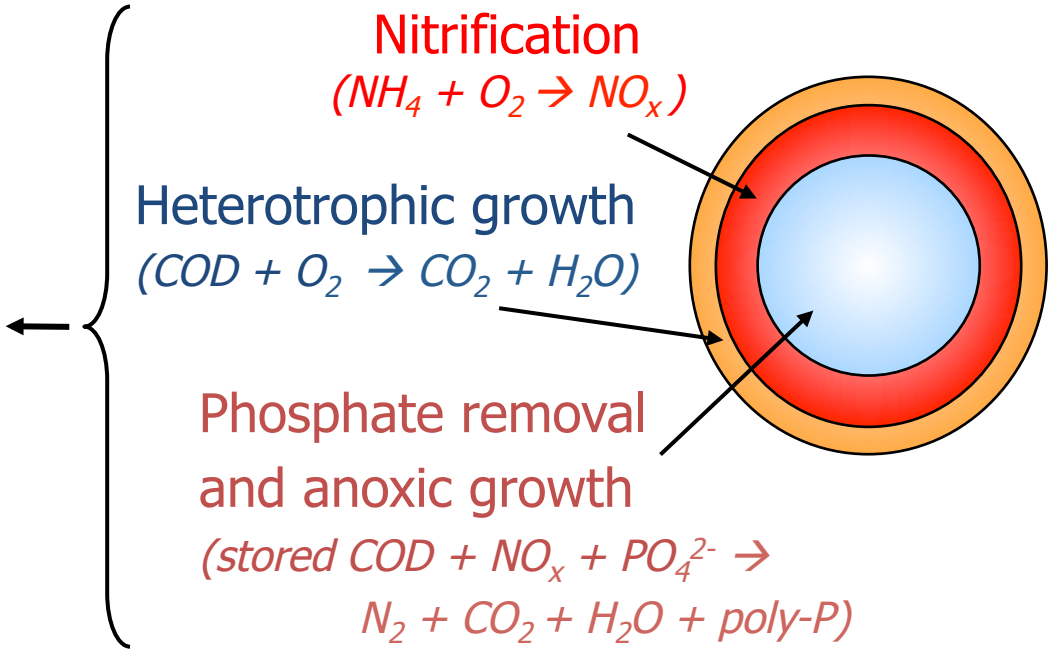


Aerobic Granular Sludge Reactor

Why aerobic granular sludge reactor?

- Straightforward (no return sludge, less sludge handling)
- Small area requirement
- Simultaneous N,P and COD removal in one reactor
- High-speed unit process
- More efficient treatment system

C, N and P removal (as well as settling and thus biomass effluent separation) in one reactor



Thank You!

Terima kasih
Tak!