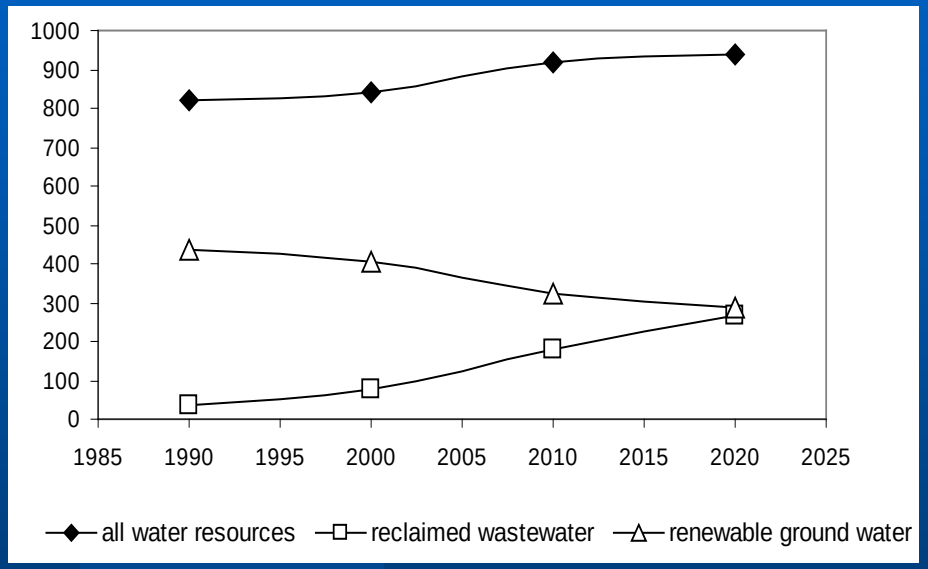
Introduction to Sewage treatment

Maha Halalsheh
Water and Environmental Research and Study Centre (WERSC)
University of Jordan

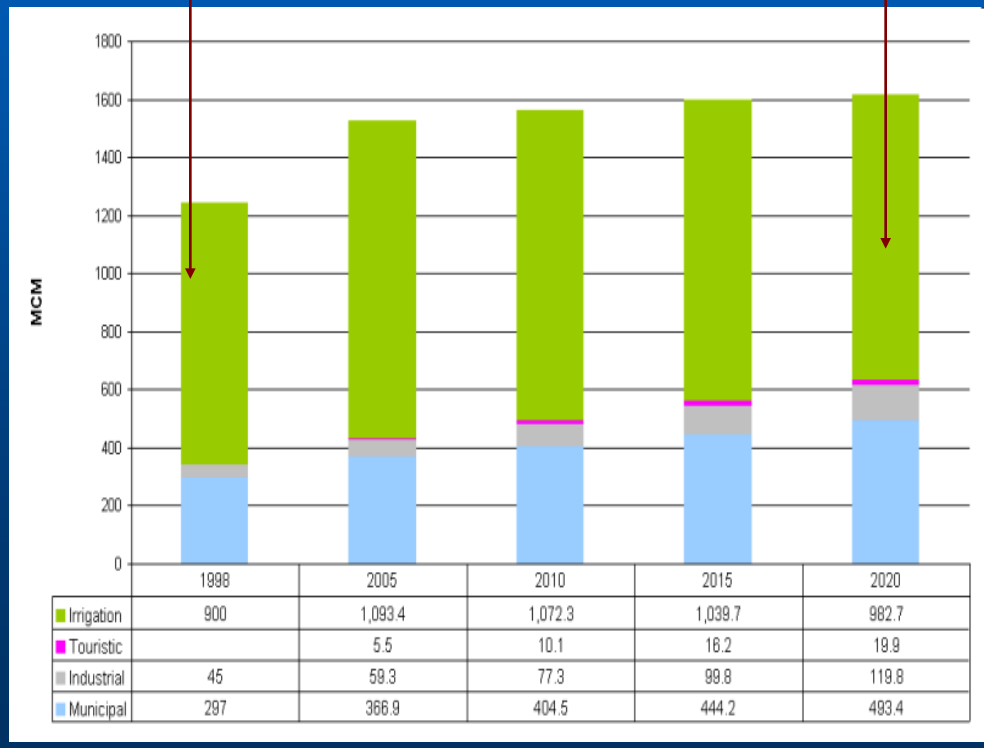
Wastewater is an increasingly important and reliable water source especially in irrigated agriculture



Water resources in Jordan and projection

72%

61%

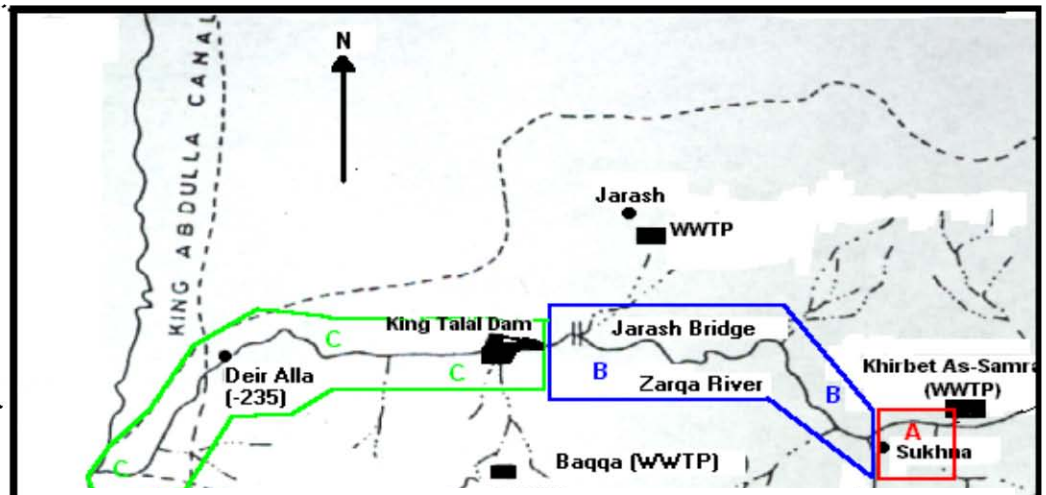


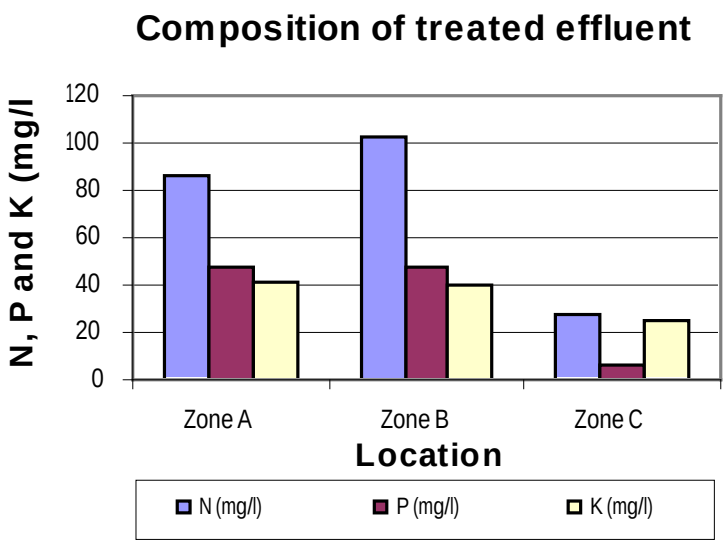
	1998	2005	2010	2015	2020
Irrigation	900	1,093.4	1,072.3	1,039.7	982.7
Touristic		5.5	10.1	16.2	19.9
Industrial	45	59.3	77.3	99.8	119.8
Municipal	297	366.9	404.5	444.2	493.4

Total water demand in 1998 and future demand projection (MCM/a)

Nutrients in wastewater may (at least partly) replace chemical fertilizers

Study area

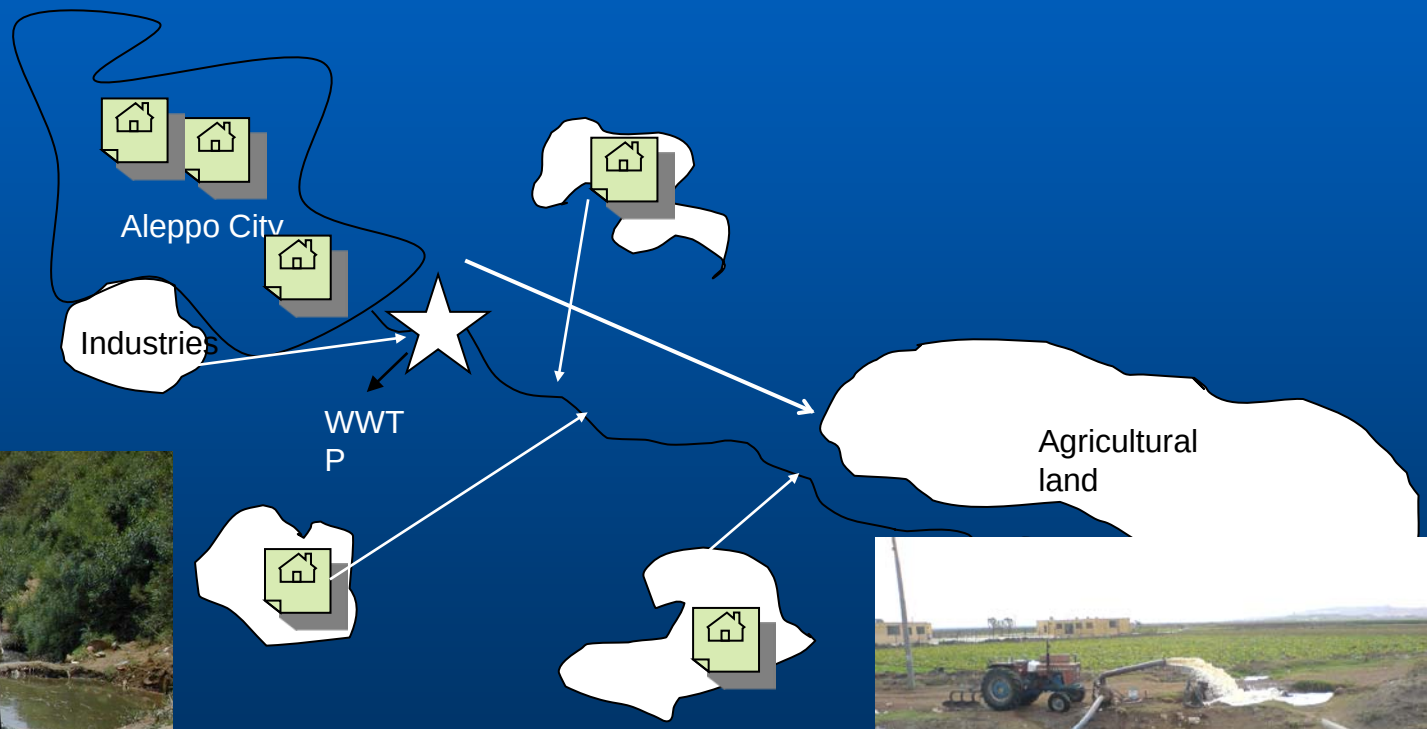




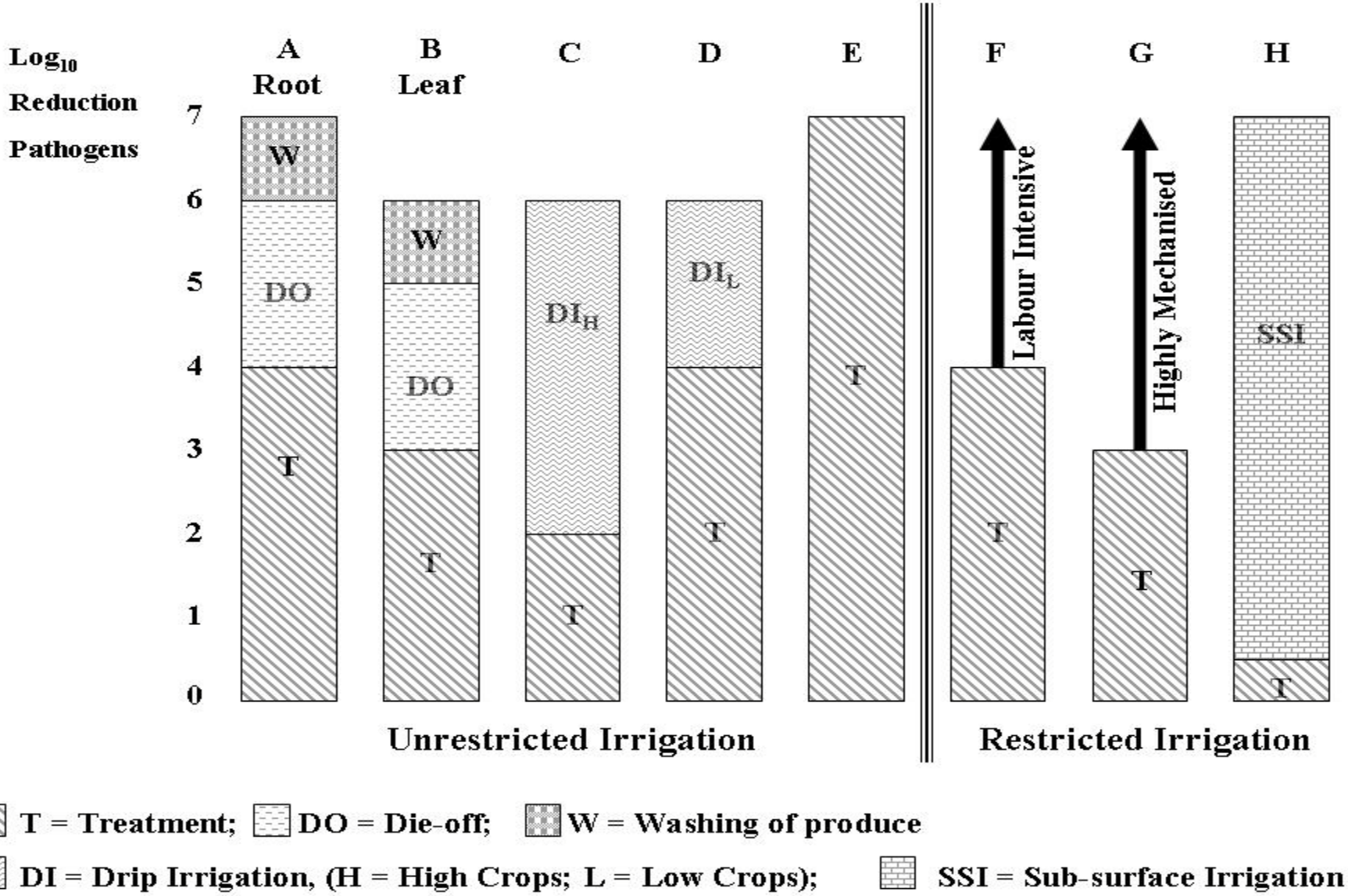
Why do we need sewage treatment

Do we need to produce a standard effluent !!

What is occurring down stream



What is the degree of needed treatment



Pilot scale example on the integrated approach

- No disinfection at the treatment plant

Indicator pathogens in plants

	T.Coliform (MPN/g dry plant)		
	FW	WWTP	UASB-RBC
Leaves	<1	<1	<1
Fruits	<1	<1 (71.57)	<1
	E.Coli (MPN/g dry plant)		
Leaves	<1	<1	<1
Fruits	<1	<1	<1
	Enterococous (MPN/g dry plant)		
Leaves	<1	<1 (24.29)	<1 (2.3×10^3)
Fruits	<1	<1	<1 (20.45)

Do we need to be ‘strict’

When irrigating vegetables eaten uncooked, (Shuval *et al*., 1997) showed that irrigating with wastewater effluent that meets WHO guidelines (1989) with respect to fecal coliform would provide a factor of safety of 1-2 orders of magnitude greater than that used by USEPA for microbial accepted standards for drinking water.

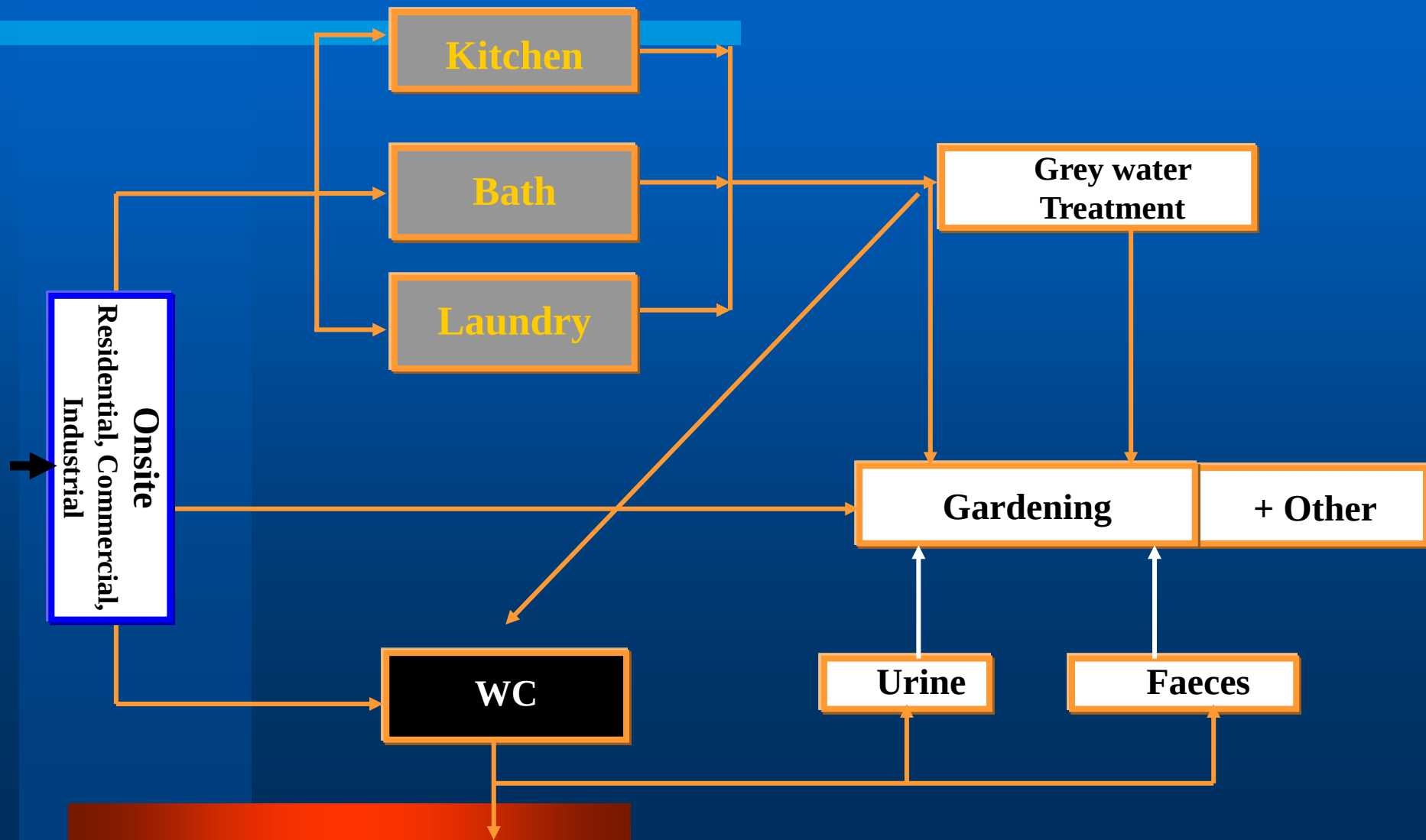
With respect to the quality of surface water used for unrestricted irrigation, it is common to find lenient standards compared with those implemented for irrigation using reclaimed wastewater (Carr *et al*., 2004).

What happen when we do not consider an integrated approach for WW management

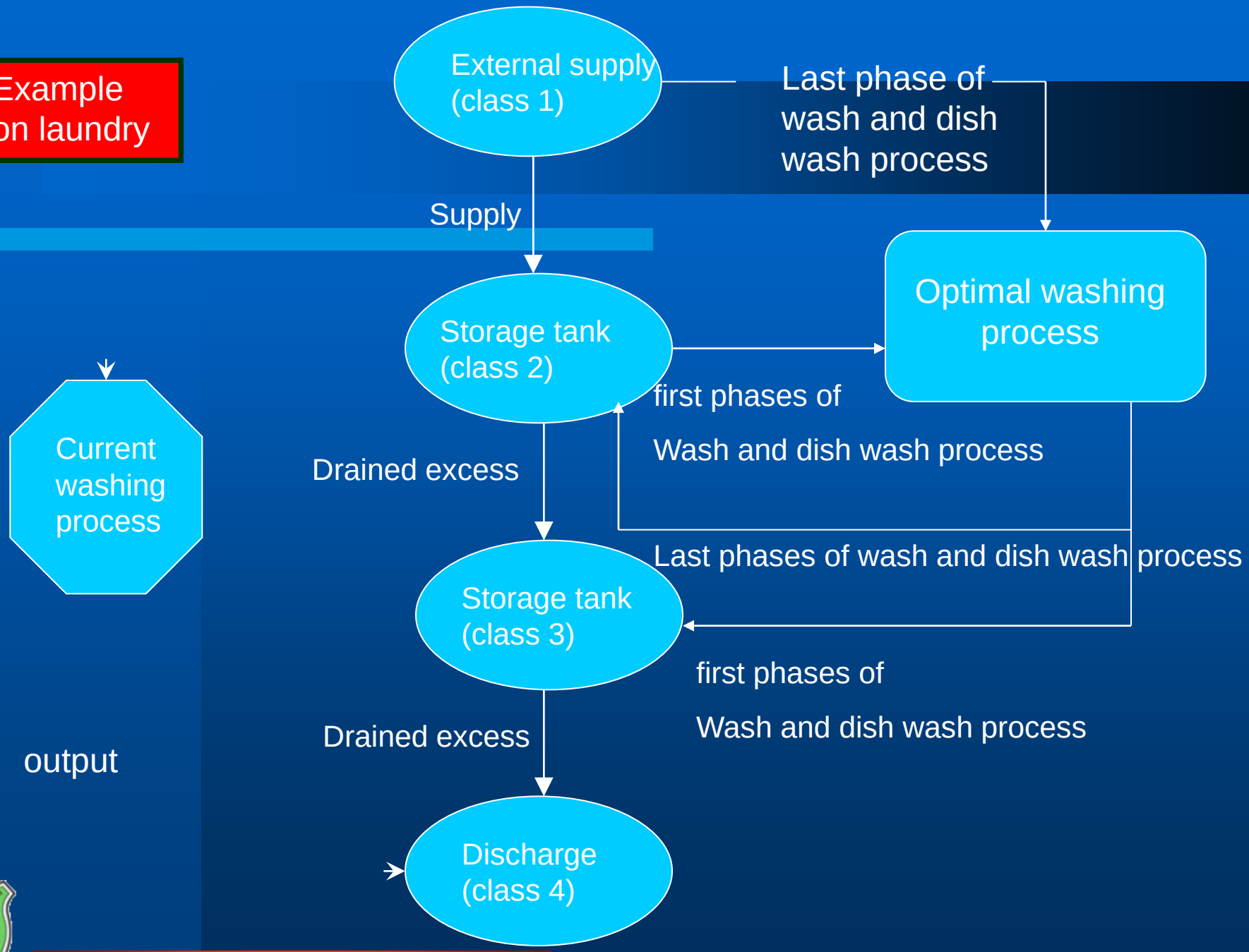
Protection of public health can not be achieved solely at the treatment plant as regrowth of pathogens has been reported especially when chlorine is used for disinfection (Gantzer *et al*., 2001; Tchobanoglous *et al*., 2003)

Health protection can be achieved by using a ‘multiple barriers’ approach that interrupts the flow of pathogens to human.

What is occurring upstream



Example on laundry



Sewage management:
A Strategy

Pollution Prevention → **Treat and re-use** → **Dispose**

'self purification'

The 3 - Stage Strategic Approach

Decentralization and centralization

Decentralized wastewater management (DWM) may be defined as the collection, treatment, and disposal/reuse of wastewater from individual homes, clusters of homes, isolated communities, industries or institutional facilities, as well as portions of existing communities at or near the point of waste generation (Crites and Tchobanoglous, 1998).

Centralized treatment systems

Conventional wastewater collection systems (sewers), centralized treatment plant and disposal/reuse of the treated effluent, usually far from the point of origin.

When does decentralization become a necessity?

1. Where the community or facility is remote from the existing sewers.

2. Where localized water reuse opportunities are available.

3. Where fresh water for domestic supply is in short supply. Examples include the use of water saving devices that may affect the conventional sewer systems.

4. Where existing WWTP capacity is limited and financing is not available for expansion.

5. Where residential density is sparse.

6. Geographical reasons

Elements of Wastewater Management

Wastewater pre-Treatment

Centralized systems

Decentralized systems

Wastewater collection

Wastewater treatment

Reuse or disposal

Centralized systems

decentralized systems

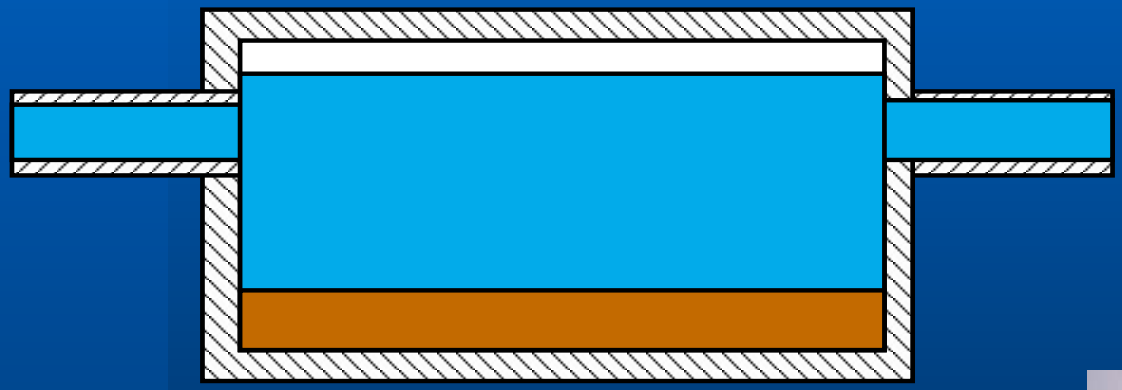
SOME POSSIBLE TREATMENT SYSTEMS


Natural treatment systems: Duckweeds wastewater treatment (Mirzapur-Bangladesh)
Photo: H.Gijzen

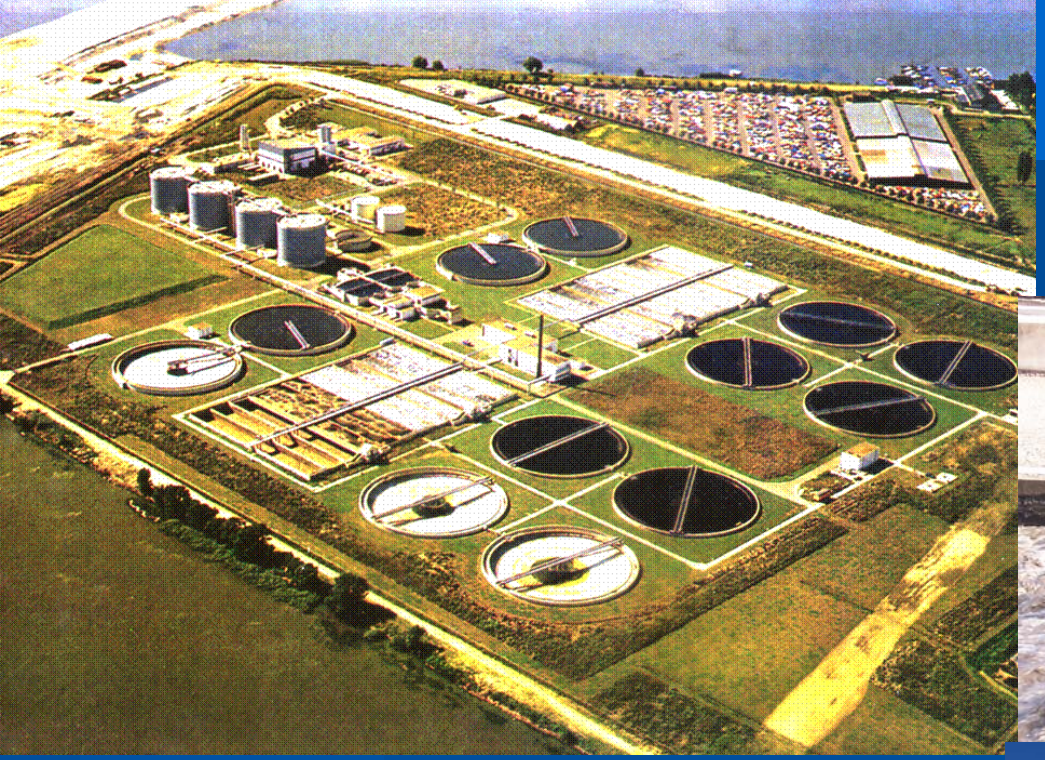
Donald Cameron

1895, England

Septic Tank




Stabilization ponds



Activated sludge treatment plant

Anaerobic treatment systems

Trickling filters

Rotating biological contactors

How do we select the treatment system

Some important factors that must be considered when selecting unit operations and processes

1. Process applicability	Past experience, data from full scale plants, published data and from pilot plant studies. If new conditions are encountered, pilot plant studies are essential.
2. Applicable flow range	Example: stabilization ponds are not suitable for extremely large flow rates in highly populated areas.
3. Influent wastewater characteristics	Affect the type of the process to be used. The presence of inhibiting constituents may limit the application of biological treatment systems.
4. Climatic conditions	Temperature affects the rate of reaction for most biological and chemical processes.

Some important factors that must be considered when selecting unit operations and processes

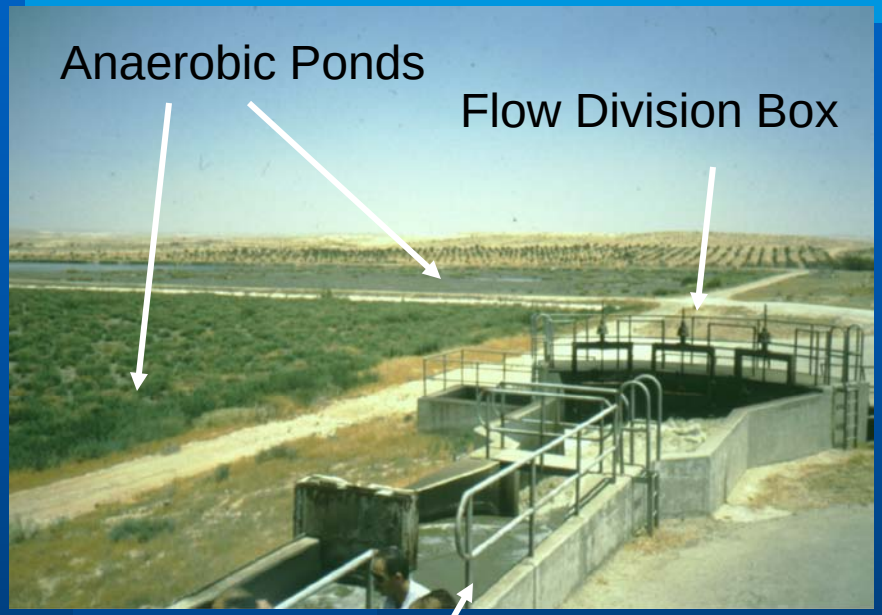
5. Process sizing based on reaction kinetics or process loading criteria	Reactor sizing is based on the governing reaction kinetics and kinetic coefficients. Data on kinetics are obtained experimentally. Data on loading rates are based also on kinetics but can be obtained from pilot studies.
6. Performance	Needed effluent quality is important in determining the required treatment system.
7. Sludge production and processing	Are there constraints that would make sludge processing and disposal infeasible or expensive.
8. Environmental constraints	Environmental conditions such as prevailing wind direction and proximity to residential areas may restrict the application of some processes. Proximity to water bodies may require removal of some constituents such as nutrients.

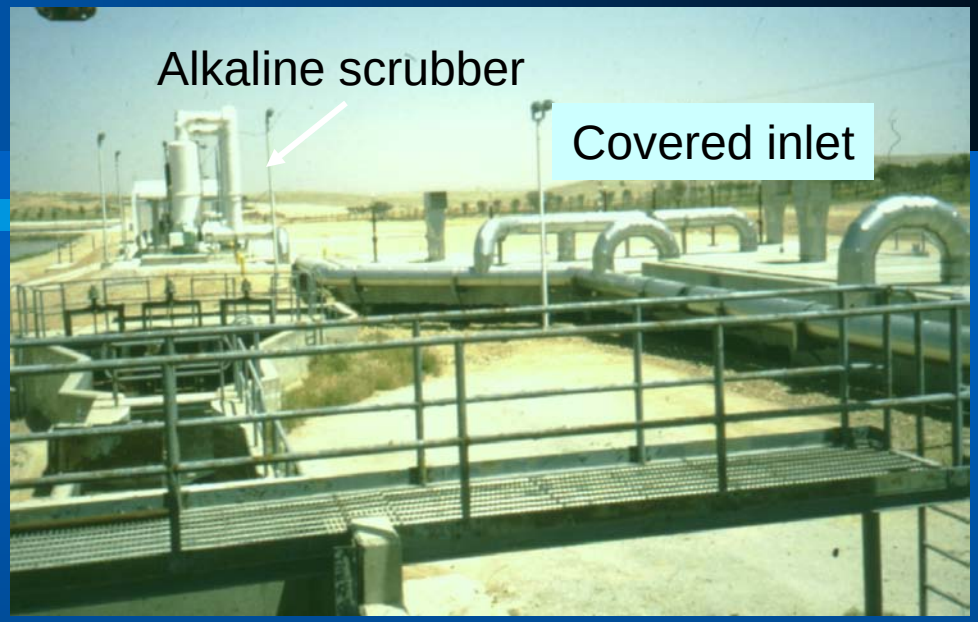
Some important factors that must be considered when selecting unit operations and processes

9. Chemical requirements or any other resources requirements.	What effects might the addition of chemicals have on the characteristics of sludge and what is the cost of the chemicals.
10. Energy requirements	Energy requirements and future energy cost must be known for cost effective treatment systems.
11. Personnel requirements	How many do need for operating the systems and do they have the skills.
12. Flexibility	Can the unit operation be modified when needed to meet future requirements.

Upgrading inlet of “Khirbet As Samra” Pond System

Former inlet works





System closed after 1 month due to too high operational costs

Surface Aerators in Maturation Ponds

'Experimental' set-up:1/3 of maturation ponds are served.

Installation required high-voltage line from nearest city

Yearly energy costs: 1.10^6 US dollars
Summer (25ºC) BOD 170 $\rightarrow$ 30-40 mg/l
Huge sludge production

Other two lanes are not served
Currently: The whole system was replaced with AS teatment plant