

## Assignment: Using WAWTTAR software for technology selection

### Case study Asmara



The municipal government in Asmara (Eritrea) intends to construct a wastewater treatment plant and to upgrade and expand the existing combined storm water/waste water collection network (which currently discharges untreated water in two small rivers). The objective is to create a considerable improvement in the sanitary conditions in the city (there is no waste water treatment at this moment), strongly reduce pollution faced by downstream users of the river water and –as an add-on:

facilitate crop irrigation with re-used treated waste water. You are asked to develop different technological solutions for the wastewater of Asmara, using WAWTTAR software.

You have to start up WAWTTAR first and select “Use a different WAWTTAR database file” under “File”. Then you have to open the wawttar.mdb file in the folder wawttar. Hereafter you select “Edit”. How to proceed from here can be found below.

### Collector system data

For this assignment we will focus of the treatment plant only, it is assumed that the collector is already present and needs not to be included.

### Community data

WAWTTAR requires data concerning the community where the wastewater treatment systems are envisioned to be constructed; the main category fields required are information related to demographics, resources, hydro/meteorological data and financial data. All this information was gathered by a combination of interviews, government agencies websites, official databases, and the internet, and can be found in the following tables (for the resources you can assume that everything is present).

General and demographic data	
Base year	2000
Nr. of inhabitants	350000
Population growth rate (%)	4
Population density/km <sup>2</sup>	534
Persons per dwelling	7
Land area growth rate (%)	2
Water use (l/day)	80
Water use growth rate (%)	6.5
Waste water growth rate (%)	6.5
Wastewater rate (l/d)	42

rainfall data (mm)	
Jan	1
Feb	3
March	12
Apr	30
May	42
June	37
July	174
Aug	145
Sept	25
oct	7
Nov	21
Dec	1
Total	501

Temperature	
Average T (°C)	16
Min T (°C)	6

Wastewater quality parameter values	
COD (mg/l)	900
BOD 5 (mg/l)	580
pH	7.9
Ammonia (mg/l)	80
Org. N (mg/l)	25
Tot.N (mg/l)	105.5
Ortho-P (mg/l)	15
Total P (mg/l)	29
TDS TotDissolved Sol (=TS-TSS) (mg/l)	650
TSS (Total Suspended Solids) (mg/l)	350
TS (Total Solids) (mg/l)	1000
TS (Total Solids) (kg/m3)	1
Alkalinty (mg/l)	300
nitrate mg/l)	0.3
nitrite (mg/l)	0.2
salmonella (cfu/100ml)	150
e. coli (cfu/100ml)	1.00E+04
total coliform (cfu/100ml)	1.00E+08

On-site information	
Soil type	loam (sand, silt and clay)
Percolation rate (cm/s)	15 mm/h
Water Table Depth (m)	1
Distance to groundwater source (m)	2000
Water course distance (m)	3000

Financial Data	
Currency name	nafka
Currency exchange	1.00 USD = 15 ERN Eritrean Nafka
Inflation rate	13%
Average annual per capita income	\$403
Interest rate	3%
Land value	142 USD/ha

### Process data

In WAWTTAR many treatment processes are predefined. When you click edit a process you can find the background information about a process. Also, new processes can be added if required.

### Standards

One of WAWTTAR's main functions is to calculate if the effluents produced by the desired treatment systems comply with reuse standards. The software offers different standards from which to choose from or a tailor made standard can be created. For this case no standards will be used.

### Train descriptions

Please use the following 3 different systems, for which you have to design the complete train yourself.

1. Anaerobic pond with oxidation pond,
2. Anaerobic upflow reactor plus wetland
3. Own system

### Calculation

When you finish the calculation you can display the feasible solutions. Run the calculation without standards ("no standard"). If there are feasible solutions, use the 3 following selection criteria:

1. The effluent is discharged on the surface water, and should not exceed TN of 20 mg/l; CBOD5 of 50 mg/l.
2. The effluent is used in agriculture; FC must be lower than 200 CFU/100ml.
3. Cheapest solution (total costs).

Give the solution for each of the selection criteria.

### MCA analysis

Using the WAWTTAR outputs a multi-criteria analysis for the feasible options can be performed, instead of using one criterium. The main goal of such a MCA is to find the most sustainable wastewater treatment technology. With the help of indicators (Muga HE, Mihelcic JR (2008) Sustainability of wastewater treatment technologies, *Journal of Environmental Management* 88: 437-447) three main categories can be evaluated: economic, environmental and societal. Below you will find an example of how weighting values can be determined on the experience gained from the analysis of the situation (MSc work of a student of UNESCO-IHE (Gabriel Patrón Coppel, 2009), entitled *Contested Wastewater Treatment in Spain: Case study comparing centralized and non-centralized wastewater treatment technologies in Almería*. In case of this example, a bigger weight was given to those indicators that have determined the failure of treatment systems in the past. The following table describes the reasoning behind the weighting assigned to each category and indicator. Look at the criteria and their weights. Would you assign the same weight to the particular criteria in the case of Asmara?

<b><u>ECONOMIC</u></b>		
Economic indicators were assigned a bigger weight than environmental and societal ones because they were the most commonly mentioned reason by stakeholders for the lack of success of previous treatment systems.		
Indicator	Weight	Justification
Capital costs	3	1 Getting the funds for construction of treatment systems has not been as difficult as getting the money to maintain them. The European Union has contributed substantially on capital costs of many of the systems.
Operation and management		3 Interviewed stakeholders continuously blamed the lack of funds for O&M as the main reason why the old treatment systems were abandoned.
User cost		0 In this study this indicator makes no difference because the only information available to determine the cost is the User Cost is the Operation and Management costs and this is already take into account on the Operation and Management indicator.
<b><u>ENVIRONMENTAL</u></b>		
Environmental indicators have been given less weight than economic and societal ones because so far the problem with the existing systems has not been one of quality of the effluent, but more of a of lack of money to do proper O&M, added to the inexperience of the personnel and people's opposition to new systems. Moreover, if used properly, the three treatment systems evaluated on both Alternatives would comply with the minimum Spanish standards for effluent quality and reuse.		
Indicator	Weight	Justification
Energy use	1	1 Spain has made a commitment for reducing CO <sub>2</sub> emissions as part of the EUs Energy Policy.
Biochemical oxygen demand (BOD)		2 Mandatory monitoring parameter for urban wastewater treatment facilities effluents.
Total suspended solids (TSS)		2 Mandatory monitoring parameter for urban wastewater treatment facilities effluents.
Nitrogen (NH <sub>3</sub> )		1 Important parameter for agricultural reuse due to its effects as nutrient.
Phosphorus		1 Important parameter for agricultural reuse due to its effects as nutrient.
Pathogens		3 Mandatory monitoring parameter for urban wastewater treatment facilities effluents and crucial for effluent reuse.