SWIM and Horizon 2020 Support Mechanism

Working for a Sustainable Mediterranean, Caring for our Future

SWIM-H2020 SM Regional Activities 14

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SWIM and Horizon 2020 SM REG-14: Refugee Emergency: Fast track project Design of wastewater

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SESSION-2

FLOW ,LOADS & DISCHARGE STANDARDS

FLOW , LOADS & DISCHARGE STANDARDS
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SELECTION OF DESIGN FLOWS & LOADS

- Design flow & Loads depend on:
  - ❑ Available plant data.
  - ❑ Specific requirements by Client or the regulatory agencies.
  - ❑ Effluent standards.
  - ❑ Population.
  - ❑ Water demand and wastewater generation.
  - ❑ Per capita pollutant loads.
- The design capacity of the plant is stated in terms of the annual average flow(AADF or ADF).
- The quantity of flow received at a wastewater treatment plant varies in response to daily, weekly, and seasonal patterns. Therefore the WWTP must be designed to handle a range of flows and loads.

SELECTION OF DESIGN FLOWS & LOADS

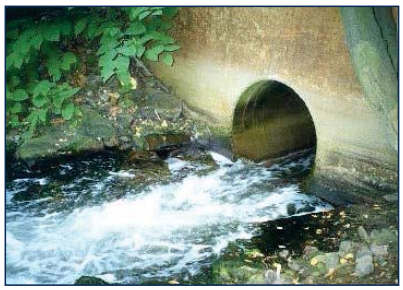
- WWTP upgrade or rehabilitation.
  - Historical flow and loads data are used for developing the basis of design.
- New WWTP.
  - Typical wastewater flow rates, loads and peaking factors from local sources or published values.
    - Population estimate and projection.
    - Per capita wastewater generation.

PER CAPITA BOD ESTIMATION FOR EMERGENCY

Water Consumption l/c/d	Per Capita BOD Generation g/capita/day		
	50	60	70
	BOD Concentration mg/l		
35	1429	1714	2000
50	1000	1200	1400
60	833	1000	1167
100	500	600	700
150	333	400	467
200	250	300	350

DISCHARGE STANDARDS & LIMITS

- Jordanian standards for reclaimed wastewater
  - Probability of occurrence of given limits are not defined. They are assumed to be the Maximum month limits.
- What the limits apply to:
  - Are they average monthly?
  - Are they average weekly?
  - Are they maximum daily for 24 hr composite sample?



- There is a need to define the loading condition for effluent limit.

DISCHARGE LIMITS FOR AS-SAMRA WWTP

- BOD/TSS/TN= 30 mg/l being the maximum value in 80% of one month's 24 hour composite, flow proportional samples.
- Nematode eggs<1 egg/l being the maximum value in 80% of one year's bimonthly 24-hour composite flow proportional samples.
- FC=1000 being the maximum value in 80% of one 3 month's biweekly 24-hour composite flow proportional samples.

JORDANIAN STANDARDS

Jordanian Standard

Parameter	Irrigation				Discharge	
	Cooked vegetables A	Fruit trees Green Areas B	Crops industrial products Forestry C	Flowers	Groundwater recharge	Streams, Wadis & reservoirs
BOD_5	30	200	300	15	15	60
COD	100	500	500	50	50	150
DO	>2	-	-	>2	>2	>1
TDS	1500	1500	1500	1500	1500	1500
TSS	50	200	300	15	50	60
FOG	8	8	8	12	8	8
MBAS	100	100	100	15	25	25
NO_3	30	45	70	45	30	80
NO_3-N	7	10	16	10	7	18
NH_4^+	-	-	-	-	5	-
Total-N	45	70	100	70	45	70
PO_4-P	30	30	30	30	15	15
E.Coli (MPN/100 ml)	100	1000	-	<1.1	2.2	1000
Nematodes (eggs/L)	<1	<1	<1	<1	<1	<1

TUNISIAN STANDARD

Parameter (mg/l)	Max Limits	Category 1	Category 2	Category 3
BOD_5	30			
COD	30			
Conductivity µs/cm	7000			
FOG		20	10	30
NO_3		90	50	90
NO_3-N		20	11	20
NH_4-N		30	1	100
Total-P		0.1	0.05	10
Fecal.Coli (MPN/100 ml)		1000	1000	-
Nematodes (eggs/L)		≤1	≤1	≤1

PALESTINIAN STANDARD

Parameter	High Quality	Good Quality	Moderate Quality	Low Quality
	A	B	C	D
BOD_5	20	20	40	60
COD	50	50	100	150
DO	>1	>1	>1	>1
TDS	1200	1500	1500	1500
TSS	30	30	50	90
FOG	5	5	5	5
NO_3-N	20	20	30	40
NO_3	89	89	133	177
NH_4-N	5	5	10	15
Total-N	30	30	45	60
PO_4-P	15-20	15-20	15-20	15-20
E.Coli (MPN/100 ml)	10	100	100	100
Nematodes (eggs/L)	≤1	≤1	≤1	≤1

STATISTICAL ANALYSIS

- Mean
  - Average
- Median
  - The middle value in the list of numbers.
- Mode
  - The value that occurs(repeated) most often.
- Probability Value(Percentile)
  - The value of a variable below which a certain percent of observations fall.
  - 20^{th} percentile means the value below which 20% of observations may be found.
  - 50^{th} percentile = median

Percentile

COMPONENTS OF WASTEWATER FLOW

- Domestic wastewater.
- Industrial wastewater.
- Infiltration & Inflow(I&I).
- Storm water(for combined sewer systems).

DEFINITION OF FLOWRATE TERMINOLOGY

- **Annual Average Flow(AADF or ADF)**
  - **Total flow over one year period divided by 365 days.**
- **Maximum Day Flow(MDF)**
  - **Maximum flow during 24 hour period during the year.**
- **Maximum Month Flow(Maximum Monthly Average)**
  - **Average daily flow during the maximum calendar month.**
- **Peak Hour Flow(PHF)**
  - **Peak sustained flow rate occurring during a one-hour period.**
- **Average Dry Weather Flow(ADWF)**
  - **The average daily flow during periods without rainfall.**
- **Average Wet Weather Flow(AWWF)**
  - **Average daily flow during rainfall periods.**
- **Infiltration & Inflow**
  - **The contribution to wastewater flows from extraneous groundwater or storm water entering the collection system.**

FLOWRATE AND MASS LOADING FACTORS

Factor		Purpose for Design & Operation
Flowrate		
	Average daily flow	Development of flowrate ratios Estimating pumping and chemicals cost
	Maximum day	Equalization basin sizing Chlorine tanks sizing
	Maximum month	Reporting Chemical storage
	Minimum hour	Low range of plant flow meter
	Peak hour	Hydraulic design Sizing Pumping facilities Grit removal units sizing Sedimentation tanks sizing
Mass loading		
	Maximum day	Sizing aeration system
	Maximum month	Sizing biological treatment
	Maximum week	Solids handling

HOW TO ESTIMATE PEAKING FACTORS FOR FLOW & LOADS

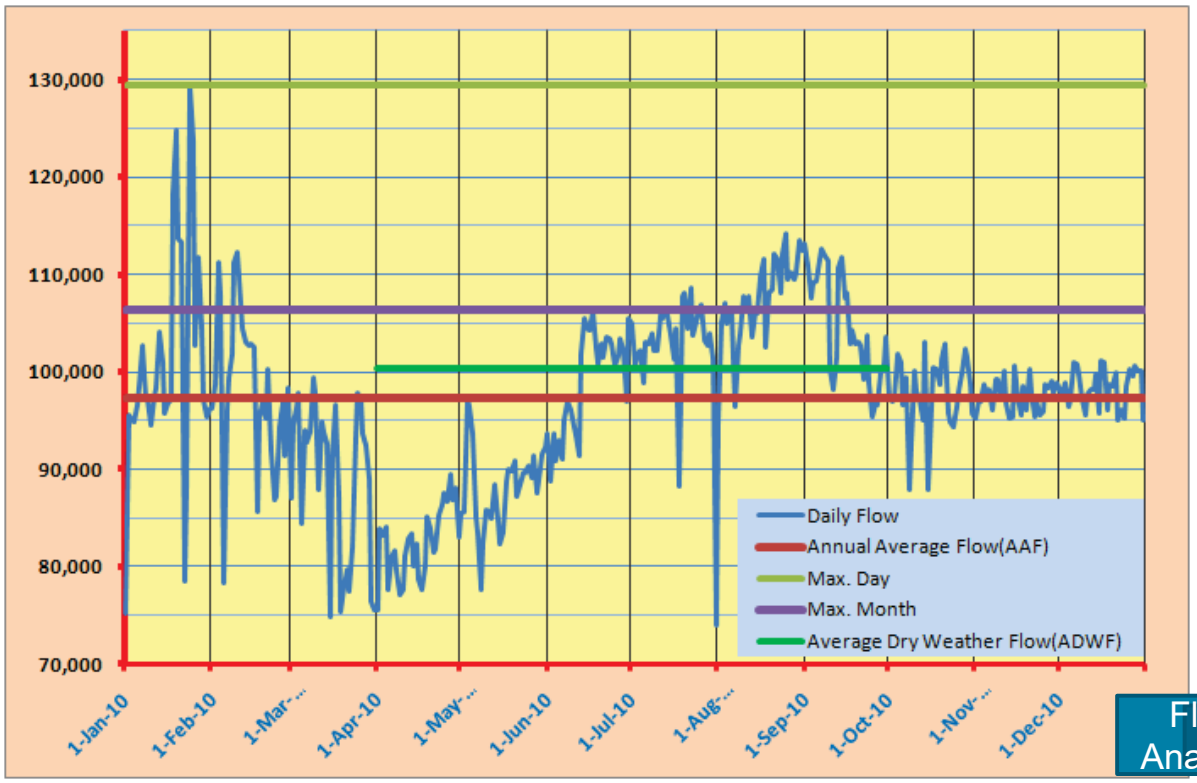
Load Condition		Probability Value
Flowrate		
	Average day	**Average of the daily flow**
	Minimum day	**5th Percentile of the daily flow**
	Maximum day	**95th Percentile of the daily flow**
	Maximum month	**95th Percentile of the 30 day moving average flow**
Mass loading		
	Average day	**Average of the daily mass load**
	Minimum day	**5th Percentile of the daily mass load**
	Maximum day	**95th Percentile of the daily mass load**
	Maximum month	**95th Percentile of the 30 day moving average values**
		90th Percentile of the daily mass load data for irrigular sampling

Flow
BOD
Load

$$Max.\_month\_PF = \frac{Max.\_month\_Flow/Load}{Average\_month\_Flow/Load}$$

$$Max.\_day\_PF = \frac{Max.\_day\_Flow/Load}{Average\_day\_Flow/Load}$$

HISTORICAL FLOWRATE DATA ANALYSIS



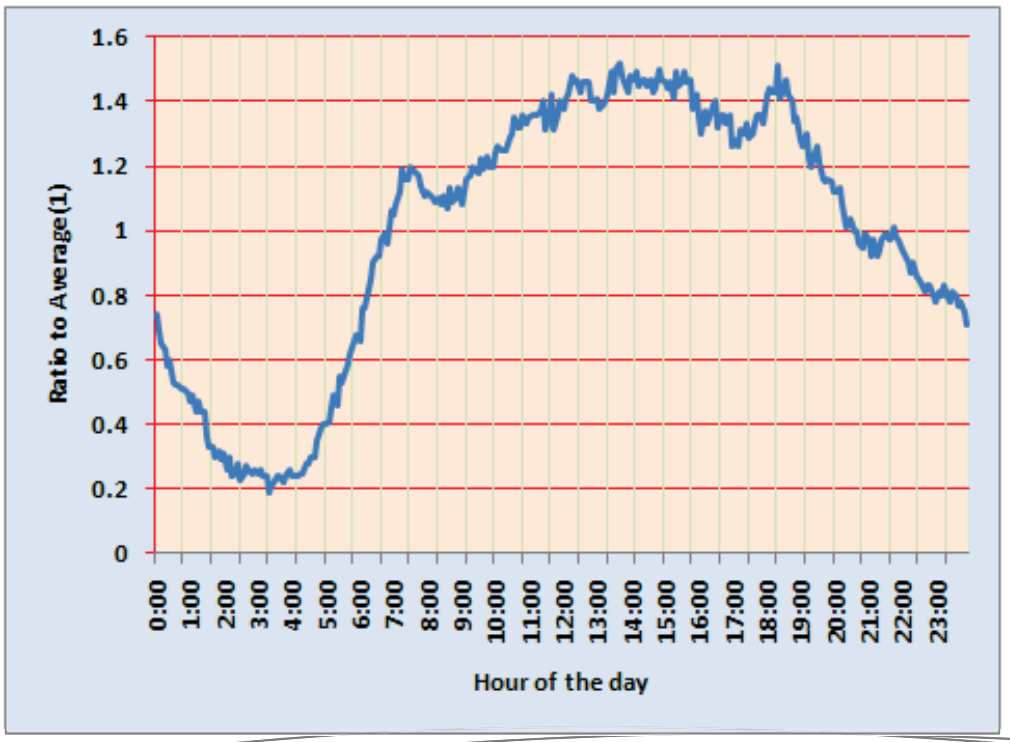
Flow Analysis

AVERAGE WASTEWATER FLOW PROJECTION

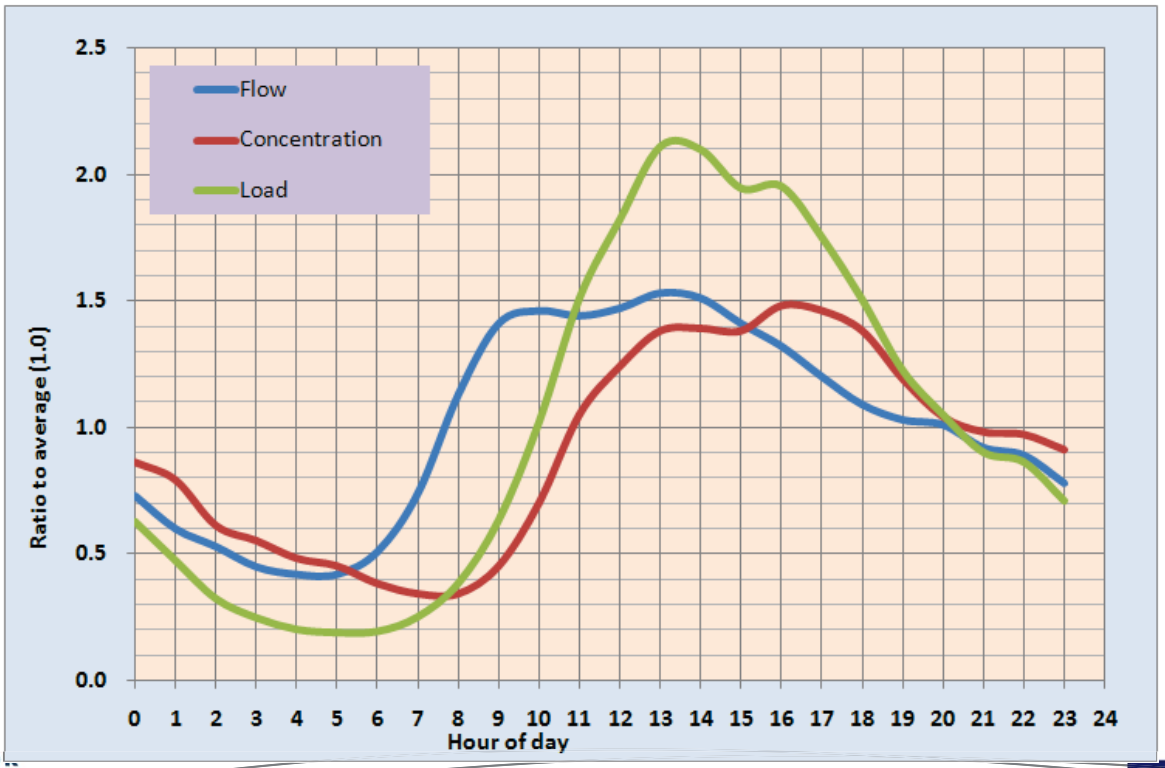
- Project life.
- Served population.
- Per capita water supply.
- Per capita wastewater generation

Year	Population	Per Capita Water Supply l/c/d	Per Capita Wastewater Generation l/c/d	Average Flow m3/day
2010	51,461	85	68	3,499
2015	74,583	100	80	5,967
2020	86,357	100	80	6,909
2025	97,276	100	80	7,782
2030	108,034	100	80	8,643
2035	118,637	100	80	9,491

AMMAN DIURNAL FLOW AT AING GHAZAL



DIURNAL FLOW, CONCENTRATION & LOAD VARIATIONS



MASS LOADINGS

$$Mass\_Loading(kg/day) = \frac{Concentration(mg/l, g/m3) \times Flowrate(m3/day)}{1000(g/kg)}$$

$$Daily\_Mass\_Loading(kg/day) = \sum_{1}^{n} \frac{Concentration(g/m3, mg/l) \times flowrate(m3/day)}{1000(g/kg)}$$

CURRENT AVERAGE MASS LOADS, CONCENTRATION & FLOW

- The current plant data is used to determine the design concentrations for the facility upgrade.

INFILTRATION & INFLOW

Infiltration

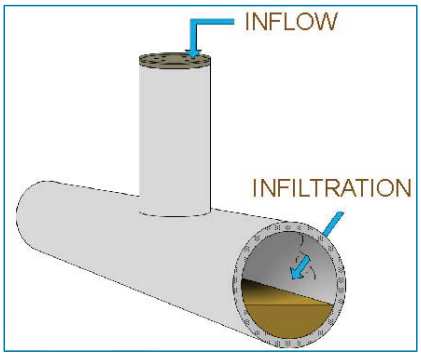
The portion of of the percolating rainfall that finds its way to sewers thorough defective pipes, pipe joints, connections, or manhole walls.

Inflow

The portion of surface run-off that finds its way directly into the sewer system from such sources as roof leaders, basement drains, yard and area drains, manhole covers and cross connection from storm sewers.

Infiltration & Inflow depend on:

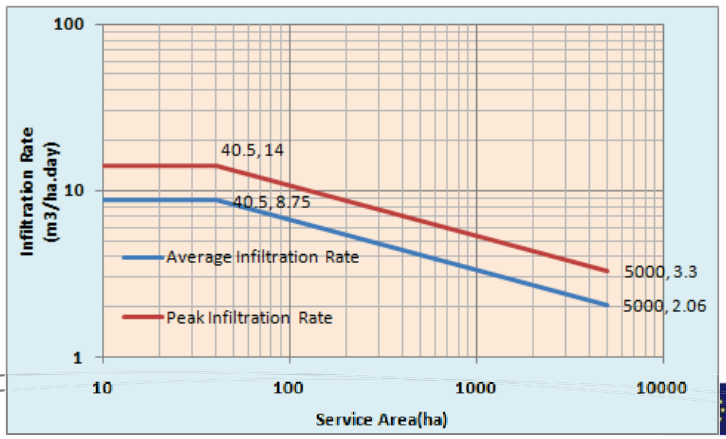
- Unsealed parts /openings to the sewer network.
- Pipeline lengths
- Number and type of joints.
- Age.
- Rainfall intensity and duration.
- Topography.
- Vegetation cover.
- Soil type.



ESTIMATION OF INFILTRATION & INFLOW

Diameter (mm)	Infiltration Lower Limit			Infiltration Upper Limit		
	m3/d.km.mm	l/s/Km	Quantity for 1 Km Network (m3/day)	m3/d.km.mm	l/s/Km	Quantity for 1 Km Network (m3/day)
200	0.01	0.02	2	1.00	2.31	200
300	0.01	0.03	3	1.00	3.47	300
400	0.01	0.05	4	1.00	4.63	400
500	0.01	0.06	5	1.00	5.79	500

WAJ has imposed regulation to prevent the connection of surface water drainage to the wastewater network.



Source: Wastewater Engineering: Collection & Pumping of Wastewater, Metcalf & Eddy.

HISTORICALL WASTEWATER POLLUTANT ANALYSIS

- Purpose to find peaking factors for max day and max month pollutant loads.

Historical Data Analysis

DESIGN LOADS IN AMERICAN PRACTICE

- Each facility component or process is designed for the design flow/load that are critical for the specific component.
- The American practice is to use the following basis of design:
  - Maximum month load to size the biological reactors.
  - Maximum day loads to size the aeration system.
  - Maximum week load for solids treatment.
  - Minimum day loads to check turndown for aeration system.
  - Maximum day flow and peak hour flow for secondary clarifiers.

RESULTS FOR WWTP FLOW & LOADS

INFLUENT CHARACTERIZATION		
Average Influent Flow	m^3/d	**134,300**
Influent BOD_5	mg/L	**390**
Influent COD	mg/l	**750**
Influent TSS	mg/L	**360**
Influent TKN	mg/L	**75.0**
Influent TP	mg/L	**10**

PEAKING FACTORS		MIN	ADF	MM	MD
Hydraulic	---	**0.5**	1.00	**1.20**	**1.30**
BOD_5 Loading	---	**0.5**	1.00	**1.20**	**1.30**
COD Loading		**0.5**	1.00	**1.20**	**1.30**
TSS Loading	---	**0.5**	1.00	**1.20**	**1.30**
TKN Loading	---	**0.5**	1.00	**1.20**	**1.30**
TP Loading	---	**0.5**	1.00	**1.20**	**1.30**

INFLUENT CONDITIONS		MIN	ADF	ADMM	MD
Flow	m3/day	67150	134300	161160	174590
Influent BOD_5	kg/d	26,189	52,377	62,852	68,090
	mg/l	390	390	390	390
Influent COD	kg/d	50,363	100,725	120,870	130,943
	mg/l	750	750	750	750
Influent TSS	kg/d	24,174	48,348	58,018	62,852
	mg/l	360	360	360	360
Influent TKN	kg/d	5,036	10,073	12,087	13,094
	mg/l	75	75	75	75
Influent TP	kg/d	672	1,343	1,612	1,746
	mg/l	10	10	10	10

Flow & Loads

APPENDIX

For further information

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Thank you for your attention.

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