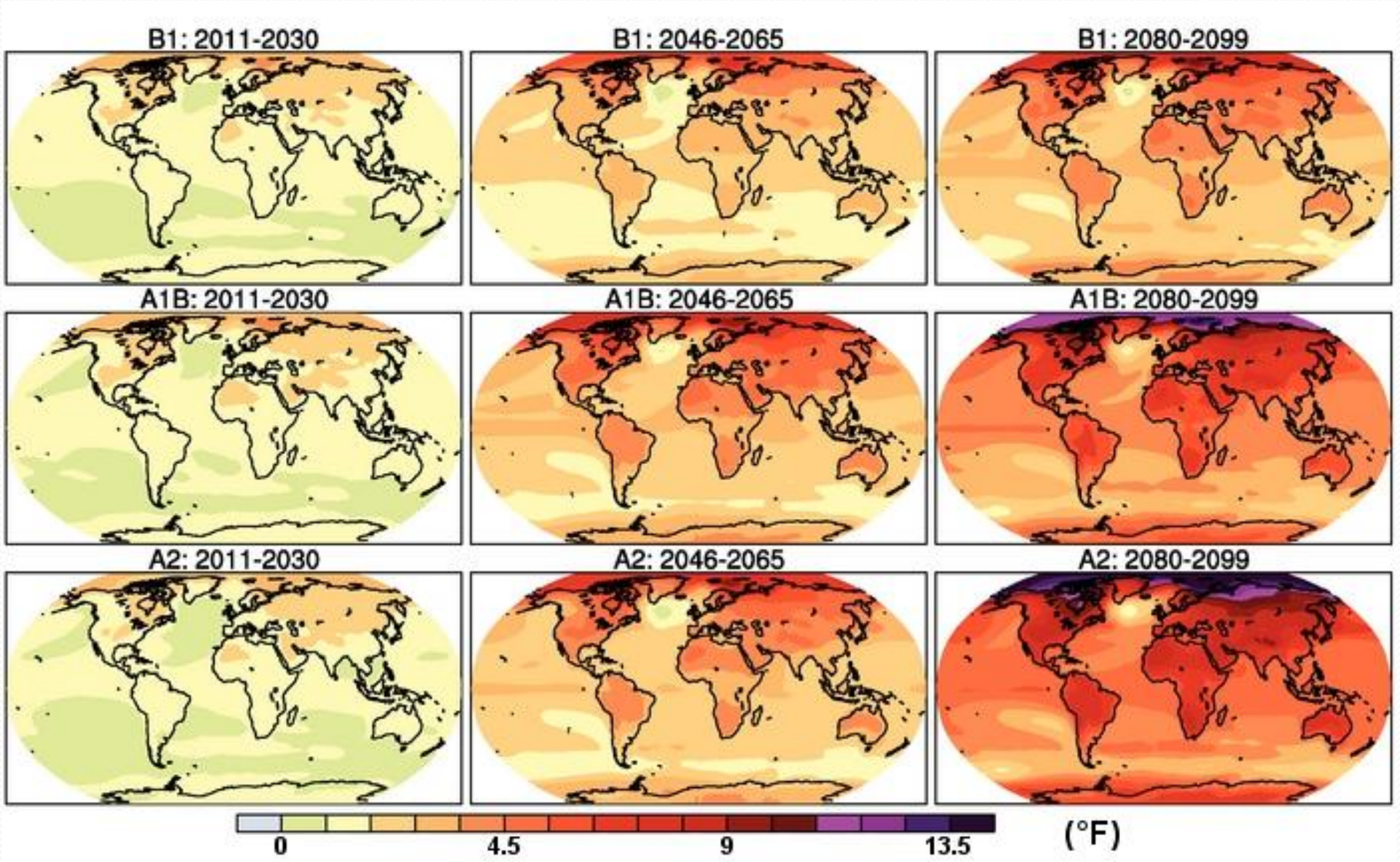
Climate Change Effects on Waste Water Treatment

CEE Jordan Group Presentation
Kenten Danas, Ban Kurdi, Maggie Stark, Ahmed Mutlaq
September 18th 2012

Global Climate Change



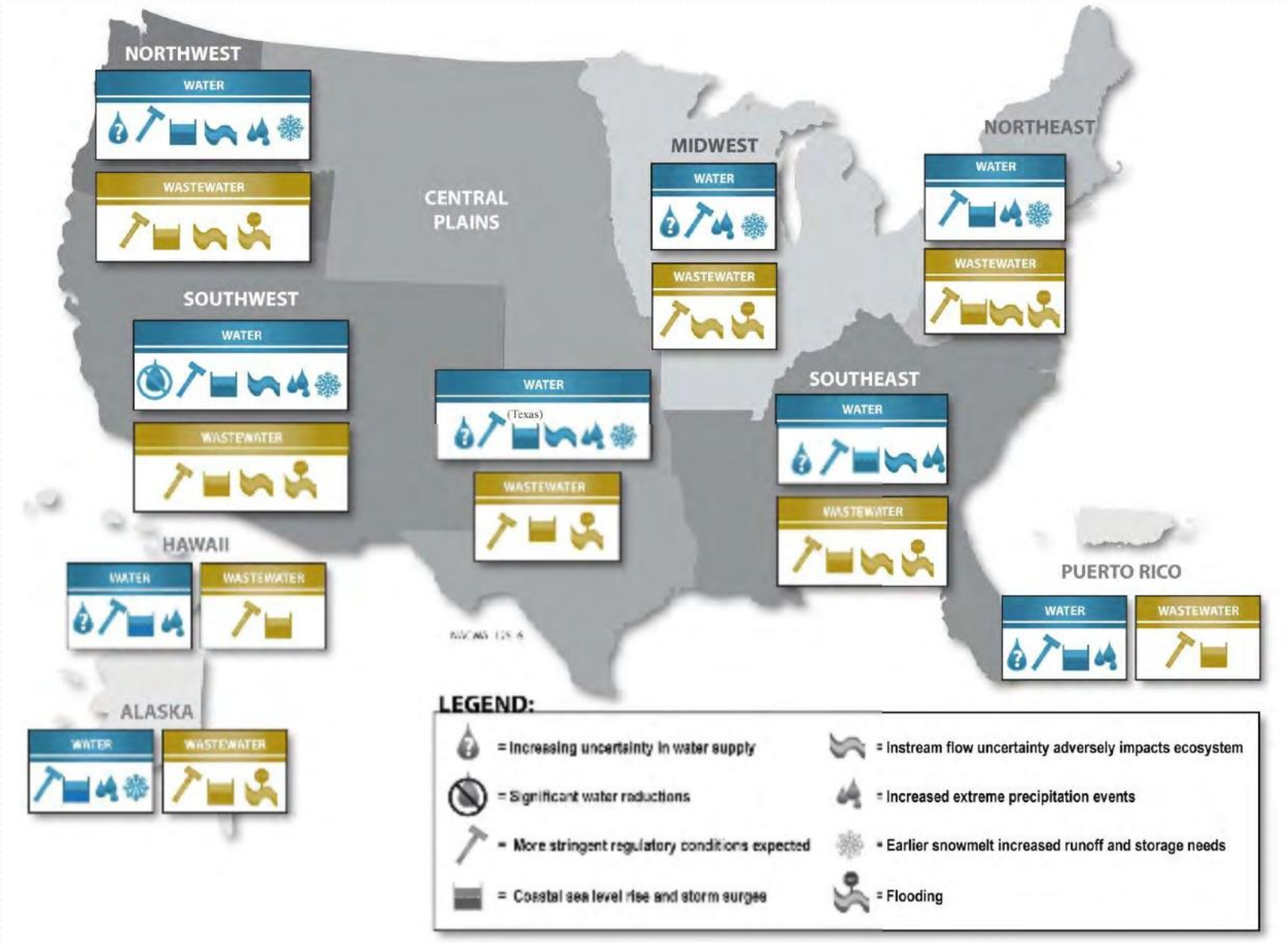
- Due to increasing concentrations of greenhouse gases in our atmosphere, temperatures are expected to rise between 2 and 5 degrees Celsius globally by 2050

Climate Change's Relation to Water

- Increased evaporation rates
- More extreme weather events (floods, droughts, hurricanes, etc.)
- Earlier snow melt
- Reduced precipitation (heavier but less frequent in some areas)

Impacts of Climate Change on Water in the US

- Both water resources and wastewater will be affected by climate change in all regions of the US



Effects on WW in the Northwest: More Overflows

- Changes in frequency and timing of precipitation events; Washington is expected to have more intense precipitation events, and peak snow melt will shift from May-June to March-April

- More rain and earlier melt off will lead to more untreated sewer overflows, meaning more raw sewage will be dumped into receiving bodies of water

- Overflow infrastructure will need to be adapted

Effects on WW in the Northwest: Increased Flooding and Sea Levels

- With increased storms comes increased flooding which can be harmful to infrastructure since most WWTPs are in low, coastal areas

- Strong waves during storms can be very damaging to effluent pipes, creating more up-keep needs

- Sea levels are expected to rise 7” – 10” in Puget Sound by 2050 endangering the location of many plants

- Rising downstream water levels may make pumping effluent a requirement, increasing energy needs

Effects on WW in the Northwest: Increased WW Reuse

- Snowpack in western Washington is expected to decrease up to 40 % by 2040

- Due to declining water resources wastewater reuse will become more necessary as climate change accelerates

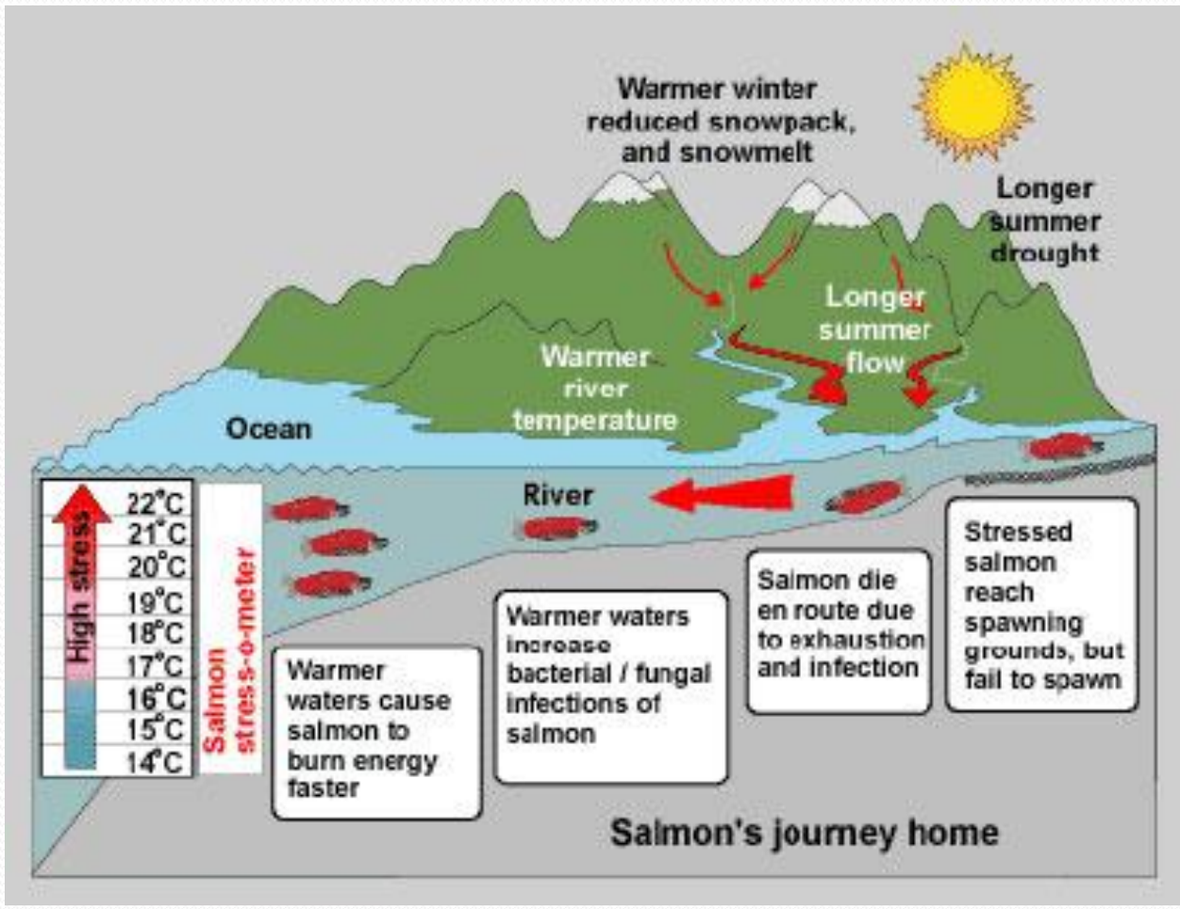
- Effluent will need to be higher quality, putting stress on current processes

Effects on WW in the Northwest: Temperature Increases

- Temperatures in Washington expected to increase 2-5 degrees C by 2050

- Receiving water bodies for waste water effluent have delicate ecosystems that will be negatively effected if the added water is much warmer

- Effluent will likely need to be cooled before discharging, adding cost and energy needs to the process



Effects on WW in the Northwest: Actions and Cost

- Possible changes to infrastructure to solve problems
  - More green and grey infrastructure
  - Implementing increased effluent treatment including cooling
  - Greater recycling and reuse
  - Build new plants at higher elevations

Temperature Effects on WW: Biological Processes

- Bacterial population at different temperatures.
- Nitrifying bacterial population.
- Plant design.

Temperature Effects on Waste Water: Biological Processes - Reaction Rates

Rate of biological reactions is temperature dependent according to

$$k=k_{20}\Theta^{T-20}$$

where:

k=reaction rate constant at temperature T

k_{20}=reaction rate constant at 20C

Θ=temperature coefficient (dimensionless)

T=temperature of biological reaction

Temperature Effects on Waste Water: Biological Processes - Reaction Rates

- Reaction rate change scenarios for different temperature changes for a sample of BOD (300mg/L) 20℃, the $k_{20} = 0.1$/day
  - Current 23C :0.123/day
  - 2C increase:0.142/day
  - 4C increase:0.163/day
  - 5C increase:0.174/day

Temperature Effects on Waste Water: Pipe Corrosion

Minor temperature changes can have significant effects on biological reactions.

Jordan's Climate Change

- Higher average temperature
- Increased evaporation rates
- Reduction in precipitation and water availability (IPCC)
- Patterns of prolonged and severe drought

Wastewater Treatment Design

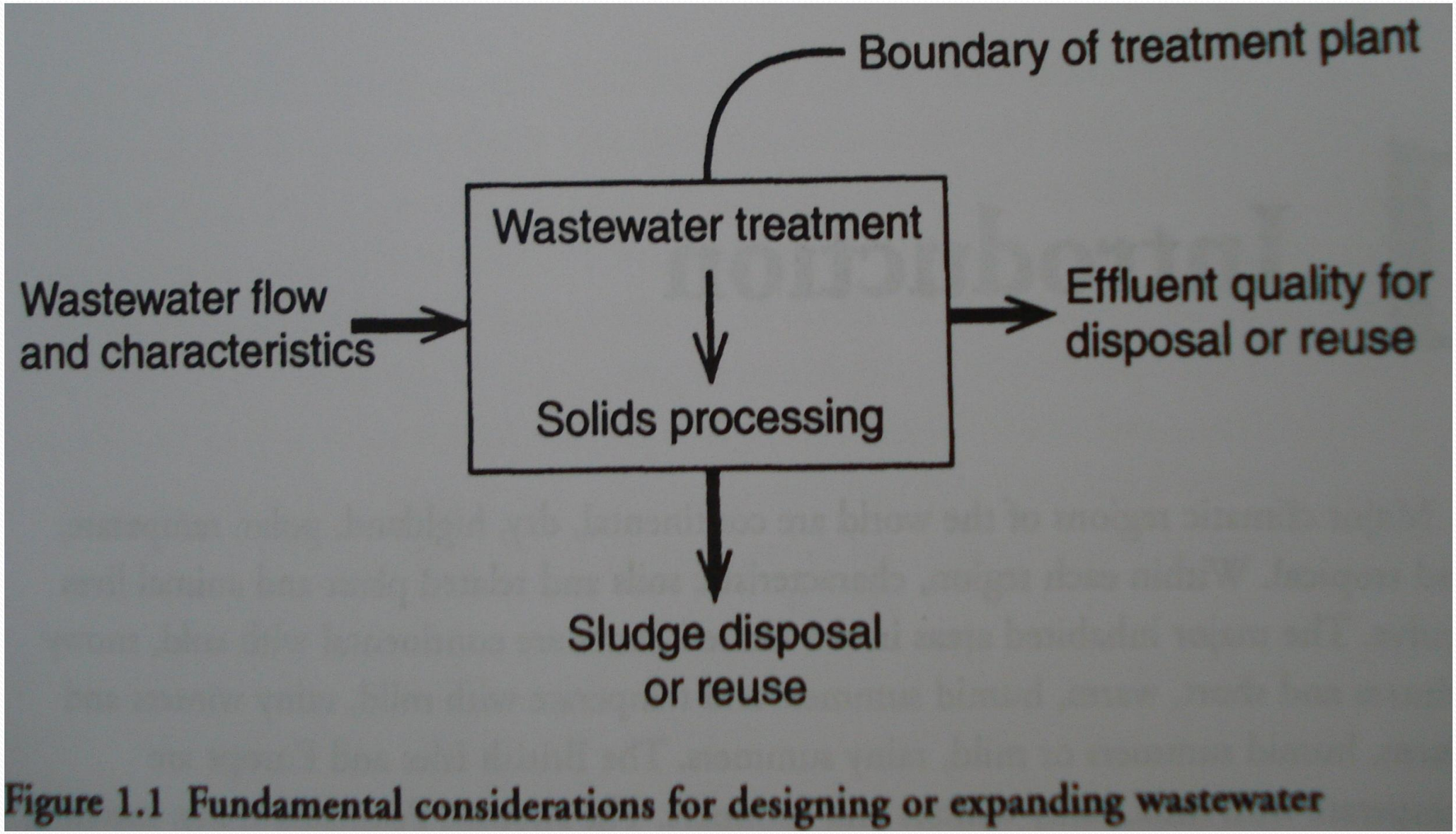


Figure 1.1 Fundamental considerations for designing or expanding wastewater

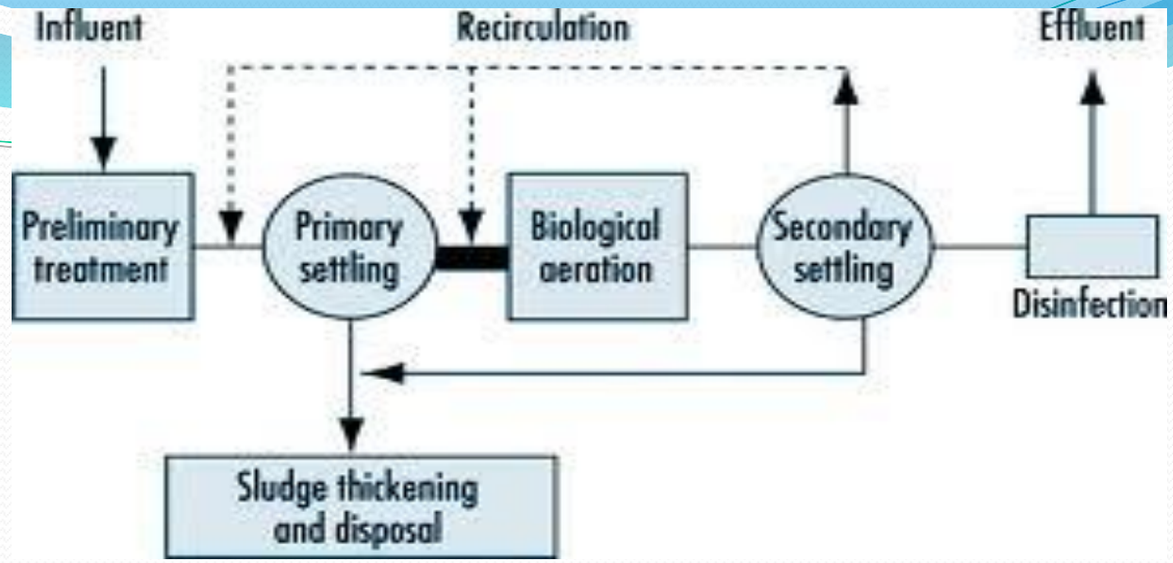
Plants are designed for assumed flows and characteristics when constructed.

Changes in Wastewater Flow

Table 2.3 Average characteristics of raw municipal wastewater from treatment plants in a dry climate.

Parameter	Plant 1	Plant 2	Plant 3	Plant 4
Flow, m^3/d	41 880	38 900	3170	6310
pH	7.4	7.4	7.6	7.8
Temperature, °C	29	33	32	20
BOD, mg/L	220	320	320	520
COD, mg/L	460	400	740	910
Total solids, mg/L	1300	1600	1270	1020
Suspended solids, mg/L	230	300	320	360
Total Kjeldahl nigrogen, mg/L as N	48	71	90	94
Ammonia-nitrogen, mg/L as N	31	53	65	65
Total phosphorus, mg/L as P	9	10	16	14

Effected Processes



- Sedimentation-
  - Warm ww increases he bacterial reaction rate which reduces the density of settled sludge
  - Inflow ww will be more dense so experiments will need to be done.
- Biological Aeration of warm wastewater
  - Increased BOD
  - Activated sludge aeration systems operating at high temperatures support nitrification
- Processing of waste sludge
  - waste activated sludge must be thickened for efficient and effective digestion
- Stabilization Ponds
  - Pros: reliable treatment, and minimal operation/maintenance
  - Cons: land demand, infrastructure, sealed bottoms to prevent groundwater contamination, potential emission of foul odors
- Chlorination

Adaption Considerations

- Cost infrastructure changes
- Need to adapt to new conditions, and consider how often conditions will change
- Work on reducing energy consumption
  - 96% of Jordan's energy is imported

WWT contribution to climate change

- Many gases evolve from waste water treatment that contribute to the green house affect.

Waste water treatment contribution to climate change

- Major green house gases evolved from WWTPs are CO_2, CH_4, & N_20

Waste water treatment contribution to climate change

How these gases are formed in wastewater treatment processes?

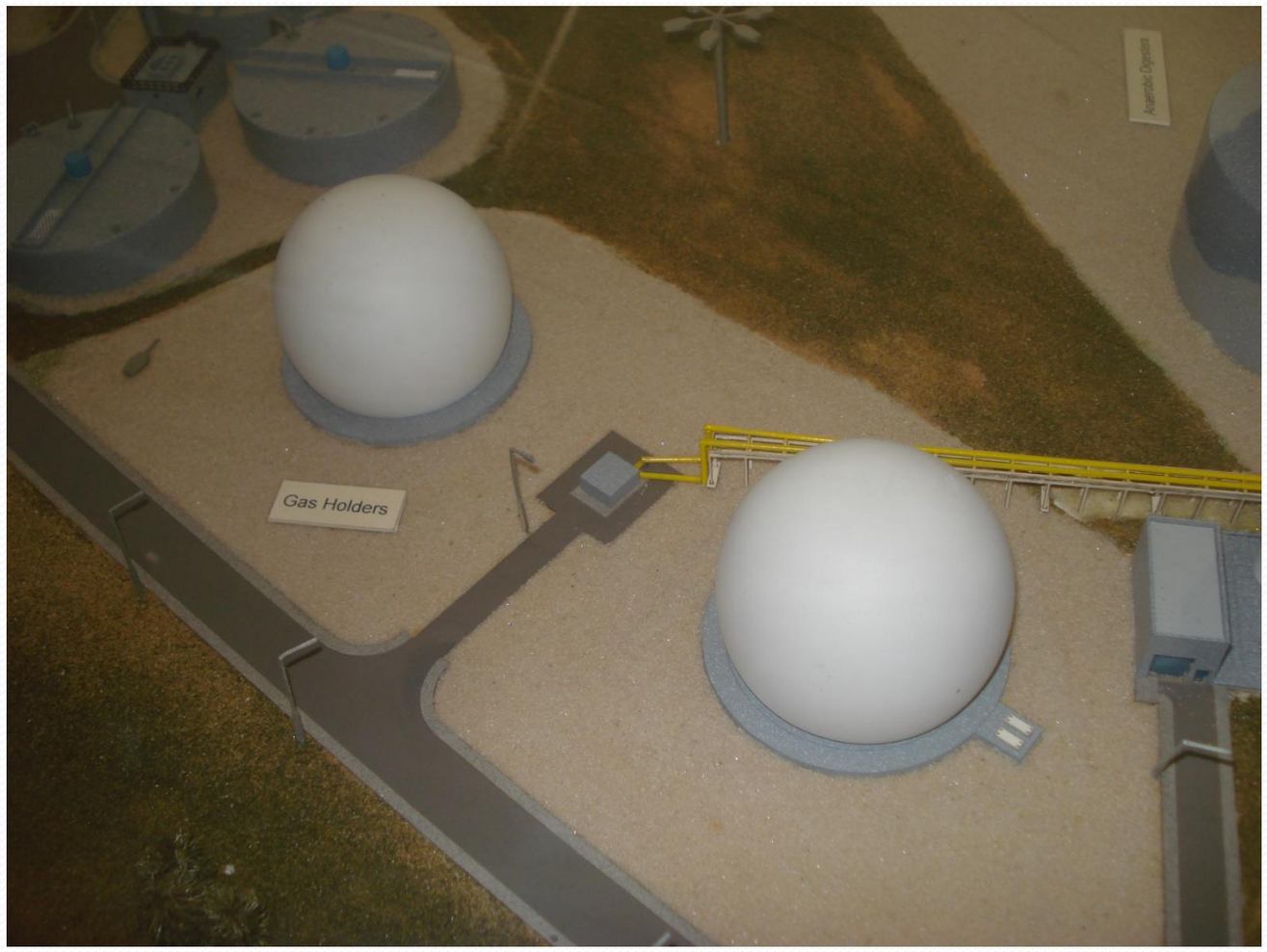
CH_4 and CO_2 are formed from the anaerobic decomposition of organic matter

N_2O is formed in nitrification and denitrification processes that are becoming more prevalent as the industry moves toward more complete nutrient removal.

Waste water treatment contribution to climate change

Compared to the same mass of CO_2 released to the atmosphere, CH_4 has 21 times and N_2O has 310 times as much global warming impact.

CH_4 and N_2O represent about 3.6 percent of the total greenhouse gas (GHG) emissions on a CO_2 equivalent basis. Within this 3.6 percent, only 0.6 percent is due to wastewater treatment .



Waste water treatment contribution to climate change

As climate change is a major concern, alternatives should reduce both greenhouse gas emissions and power consumption, making anaerobic treatment a more attractive component of novel approaches to treatment processes.

Conclusions

- WWT effects Climate Change
- WWT is greatly effected by Climate Change
- More research needs to be done on specific processes to develop plans for efficient adaptation

شكرا لاهتمامكم وحسن استماعكم

الاسئلة

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