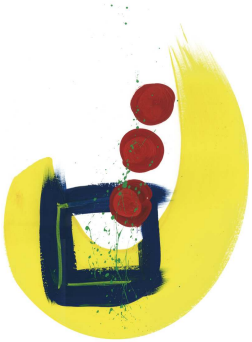
MEDITERRANEAN WORKSHOP ON NEW TECHNOLOGIES OF RECYCLING NON CONVENTIONAL WATER IN PROTECTED CULTIVATION

29th April – 1st May 2008

Wastewater separation as a base for the safe and efficient reuse of water and nutrients

Dipl.-Ing. Steffen Föllner (ttz Bremerhaven)



ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

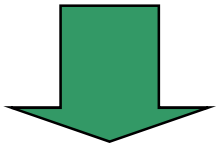
Content

- Introduction
- Terminology of wastewater separation
- Objectives
- Separation systems
- Treatment options
- Conclusions

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Main driving factors for ww reuse

- Increasing costs for water supply (water scarcity, energy costs)
- Increasing water demand for irrigation, growing population & industry
- Increasing costs for mineral fertiliser
- Need for optimising water consumption and reusing nutrients



WW as an unconventional source for irrigation and fertilisation

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Main barriers for ww reuse

- Reuse implies certain hygienic risks
- Legal limitations for ww reuse (setting standards & quality criteria)
- Image problems for crops irrigated with treated ww

IMMENSE TREATMENT EFFORTS BEFORE WW REUSE

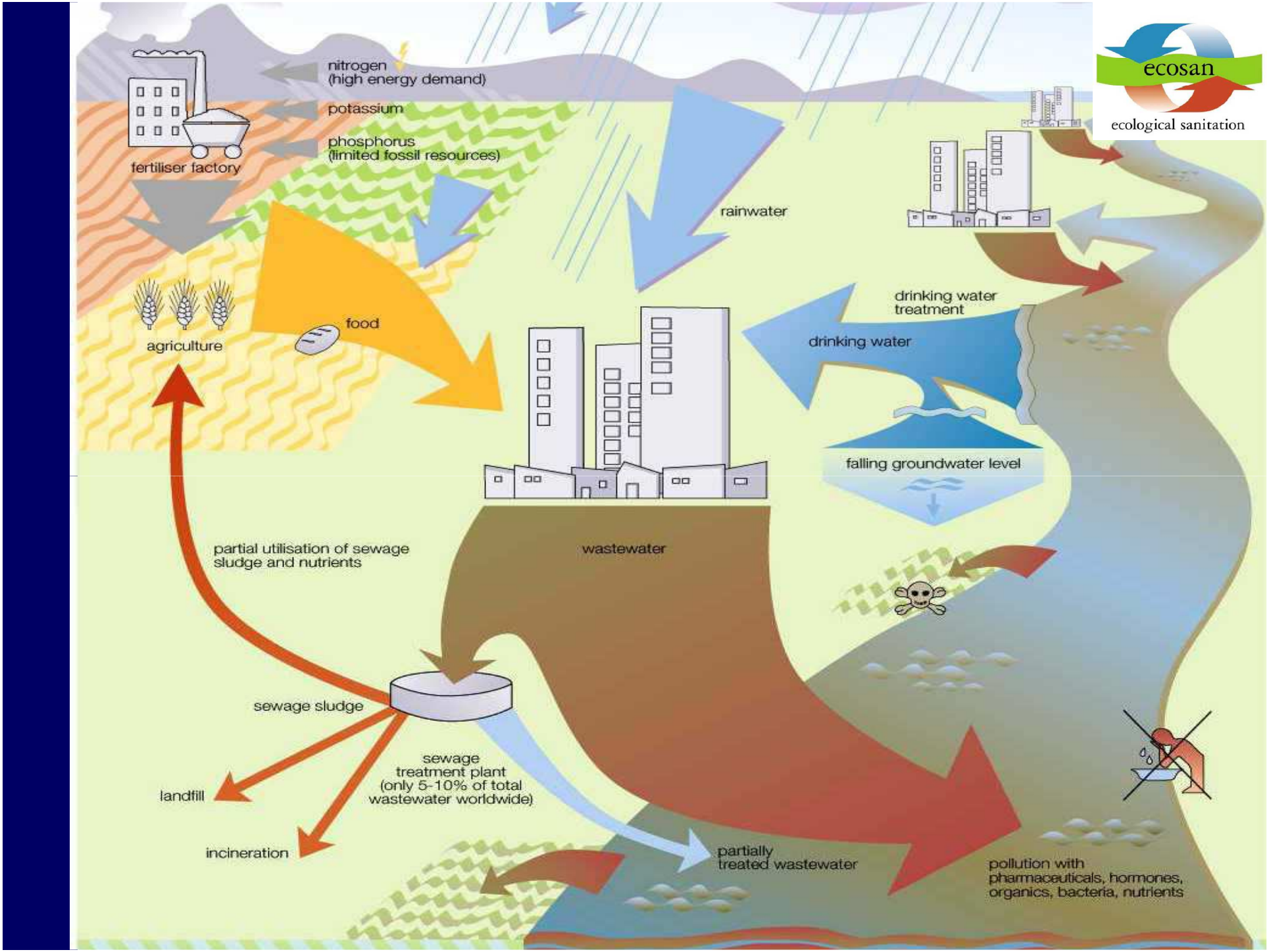
(removal of esp. pathogens, OM, nutrients, org. & inorg. pollutants)

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Current situation in wastewater collection and treatment

- Big contribution to improve hygienic situation in urban settlements
- Reduction of environmental pollution in receiving water bodies
- Characteristics of today's collection and treatment systems:
  - Mixed collection (toilets, kitchen, bathroom, [industry, stormwater runoff])
  - Water intensive flushing toilets (5-10 l/flush)
  - Long transport distances in sewers via pipes and gravity to centralised wwtp (off-site treatment)
  - Cost intensive removal of pollutants/nutrients from water before discharge or optional reuse
  - Sewage sludge production (concentration of nutrients and pollutants)
  - End-of-pipe approach

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader "Future Technologies" (sfoellner@ttz-bremerhaven.de)


ecosan
ecological sanitation
nitrogen
(high energy demand)
potassium
phosphorus
(limited fossil resources)
fertiliser factory
rainwater
agriculture
food
drinking water
treatment
drinking water
falling groundwater level
partial utilisation of sewage
sludge and nutrients
wastewater
sewage sludge
sewage
treatment plant
(only 5-10% of total
wastewater worldwide)
landfill
incineration
partially
treated wastewater
pollution with
pharmaceuticals, hormones,
organics, bacteria, nutrients

Current situation in wastewater collection and treatment

- Effects of mixed wastewater collection in sewer systems:
  - Pollution of clean water (from water companies, wells or rainfall)
  - Dillution of resources (esp. P, N, organic matter)
  - Distribution of pollutants

IS IT AN AFFORDABLE APPROACH FOR THE FUTURE?

(water scarcity, energy costs, investment costs, growing urban population, increasing costs for mineral fertilisers etc)

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Wastewater separation - Terminology

- Separation of wastewater streams already **on household level**
- Separate collection and treatment before reuse/discharge

Excreta	urine and faeces
Faeces	solid human excrement
Urine	liquid human excrement
Mixed WW	including greywater, urine, faeces and flushing water
Greywater	domestic wastewater without urine or faeces
Blackwater	faeces, urine and flushing water
Yellowwater	urine and flushing water
Brownwater	faeces and flushing water

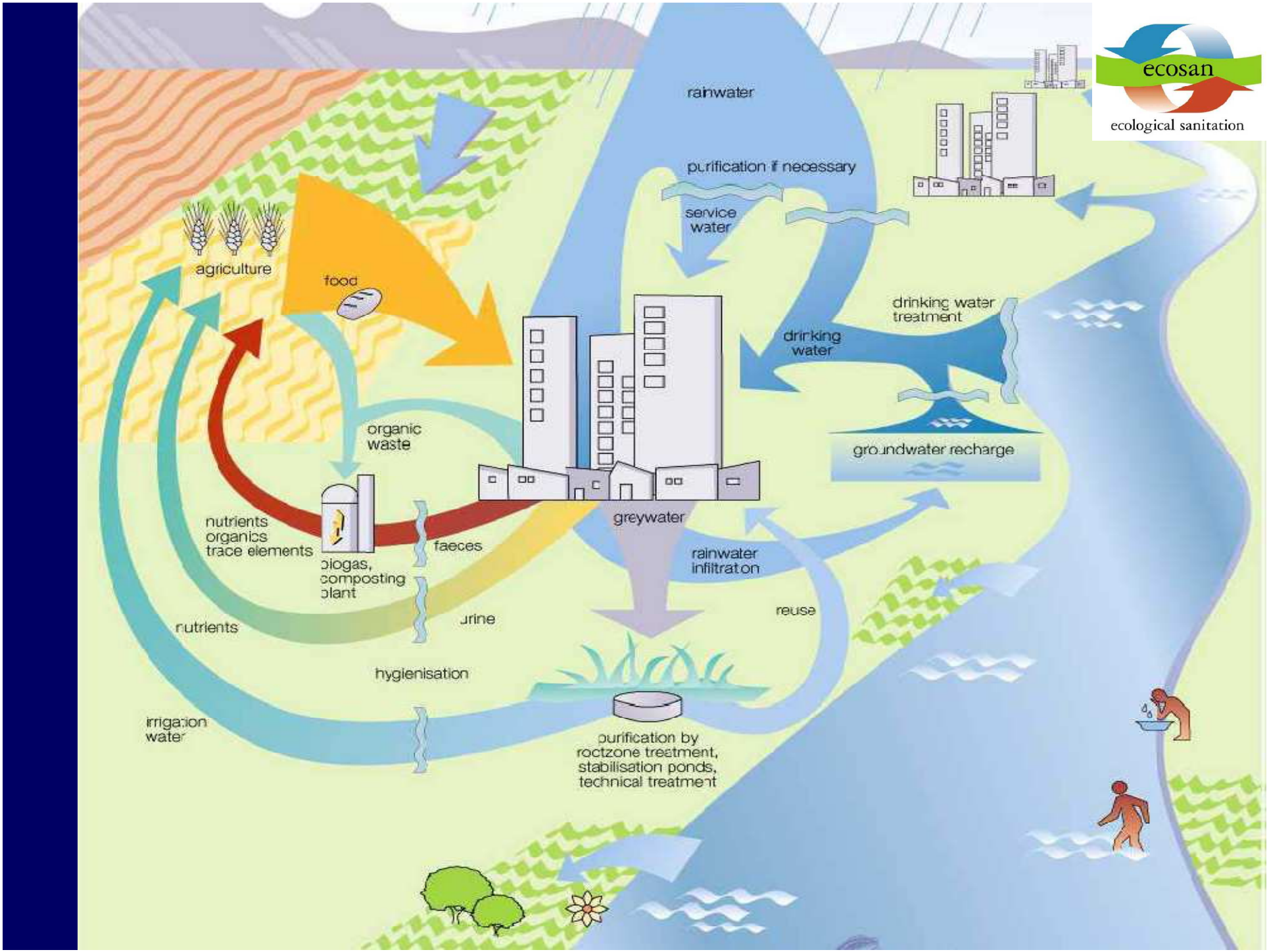
ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Wastewater separation - Objectives

- Implementation of a sustainable material flow management (3R waste management approach – Reduce, Reuse, Recycle)
- Implementation of new sanitation concepts
- Better reusability of resources
- Saving water
- Improved (specific) treatment and disposal of pollutants
- Less pollution of receiving water bodies
- Saving costs for conventional wastewater treatment
- Achievement of international objectives on access to sanitation (MDG, Johannesburg Summit)

ecosan
ecological sanitation

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)


ecosan
ecological sanitation
rainwater
purification if necessary
service water
agriculture
food
drinking water treatment
drinking water
organic waste
groundwater recharge
nutrients
organics
trace elements
faeces
biogas, composting plant
greywater
rainwater infiltration
urine
reuse
nutrients
hygienisation
irrigation water
purification by roctzone treatment, stabilisation ponds, technical treatment

Wastewater separation

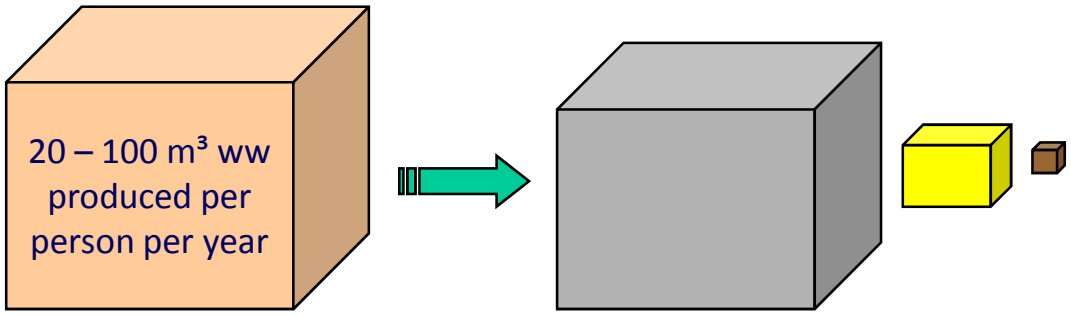
Chemical composition of different wastewater streams (source: OTTERPOHL 2007)

Annual loads (person/year)	GREYWATER	YELLOWWATER	BROWNWATER
	~ 25 – 100 m³	~ 500 liter Urine	~ 50 kg faeces
Water ~ 25 – 100 m³	~ 97 %	~ 1%	~ 2%
N ~ 4-5 kg	~ 3%	~ 87%	~ 10%
P ~ 0,75 kg	~ 10%	~ 50%	~ 40%
K ~ 1,8 kg	~ 34%	~ 54%	~ 12%
COD ~ 30 kg	~ 41%	~ 12%	~ 47%
Potential Reuse	Irrigation	Fertiliser	Soil conditioner

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

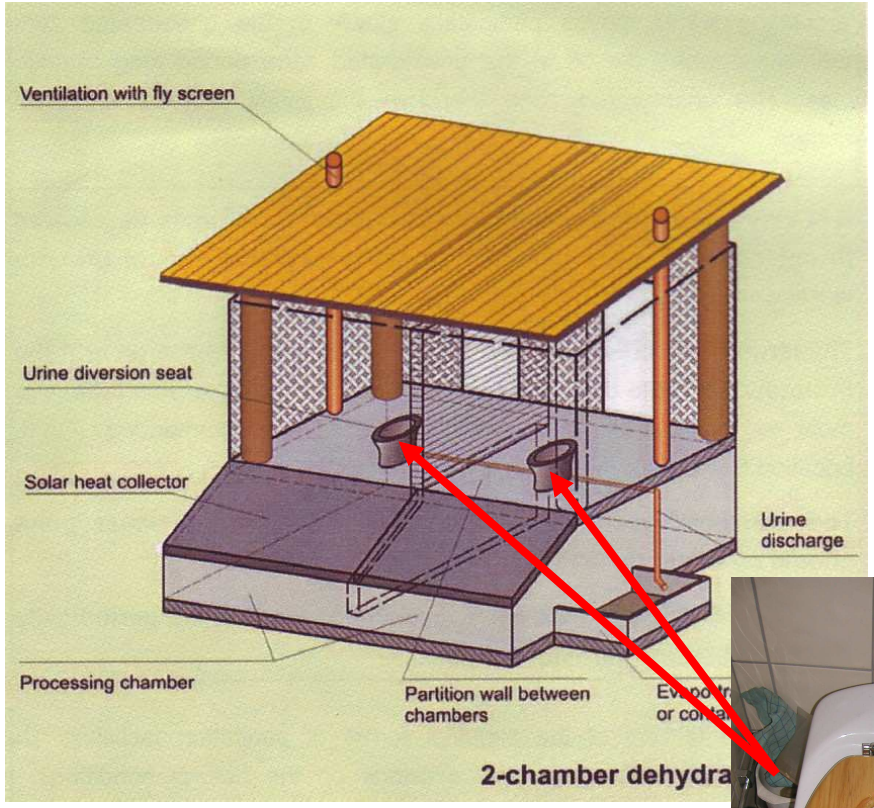
Effects of separation

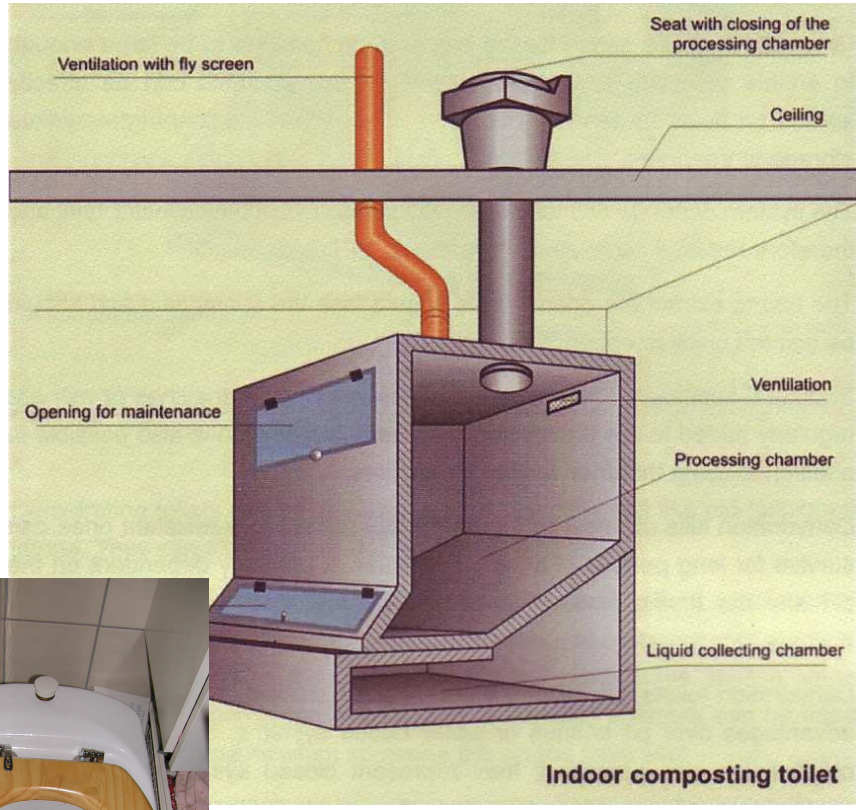
- Urine separation:
  - Removal of largest fractions of pharmaceuticals, hormons
  - Reduces demand for costly nutrient removal in remaining ww
- Brownwater (faeces) separation:
  - Removal of solids (COD) and large fractions of pathogens from ww
  - Low water content → easy treatment (e.g. composting)
- Greywater separation:
  - Easy and safe reuse due to low levels of pathogen contamination



ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader "Future Technologies" (sfoellner@ttz-bremerhaven.de)

Separation systems (toilets, latrines, urinals)





(source: BGR 2007)

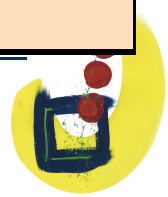
Urine separation systems (urine diversion toilets, urinals)

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Separation systems (wet & dry) (Source: NETSSAF 2007)

no.	System name	Waste flowstreams
1	**Wet** mixed systems with on-site or off-site treatment	▪mixed wastewater flowstream ▪faecal sludge flowstream
2	**Wet** blackwater systems (blackwater separated from greywater)	▪blackwater flowstream ▪faecal sludge flowstream ▪greywater flowstream
3	**Wet** urine diversion system	▪urine flowstream ▪brownwater mixed with greywater flowstream ▪faecal sludge flowstream
4	**Wet** urine & greywater diversion system	▪urine flowstream ▪brownwater flowstream ▪faecal sludge flowstream ▪greywater flowstream
5	**Dry** greywater separate system	▪excreta flowstream ▪greywater flowstream
6	**Dry** urine & greywater diversion system	▪urine flowstream ▪faeces flowstream ▪greywater flowstream
7	**Dry** all mixed systems	▪excreta mixed with greywater flowstream

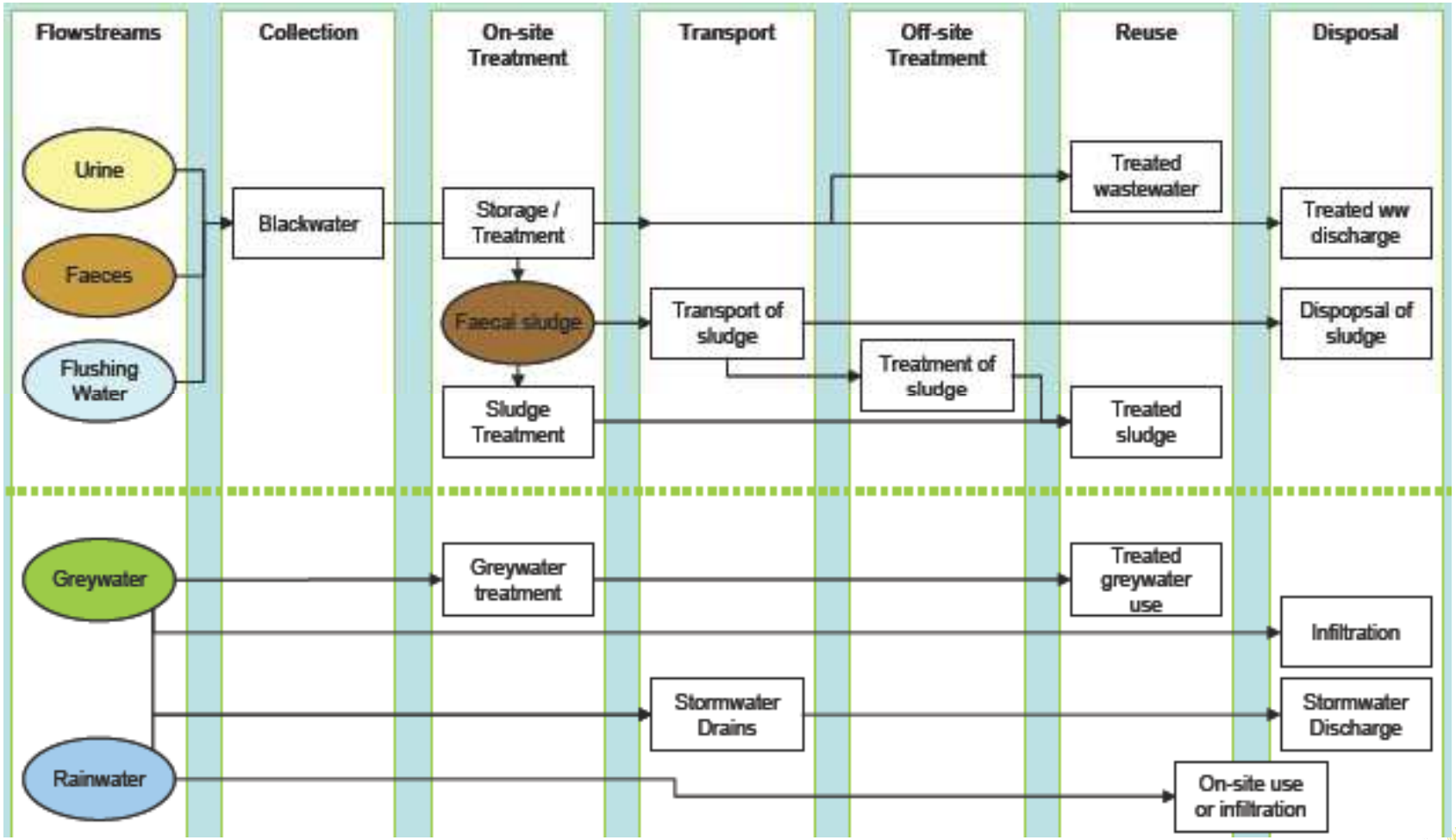
ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)



Wastewater separation - flowstreams

Separated black water system

(source: NETSSAF 2007)

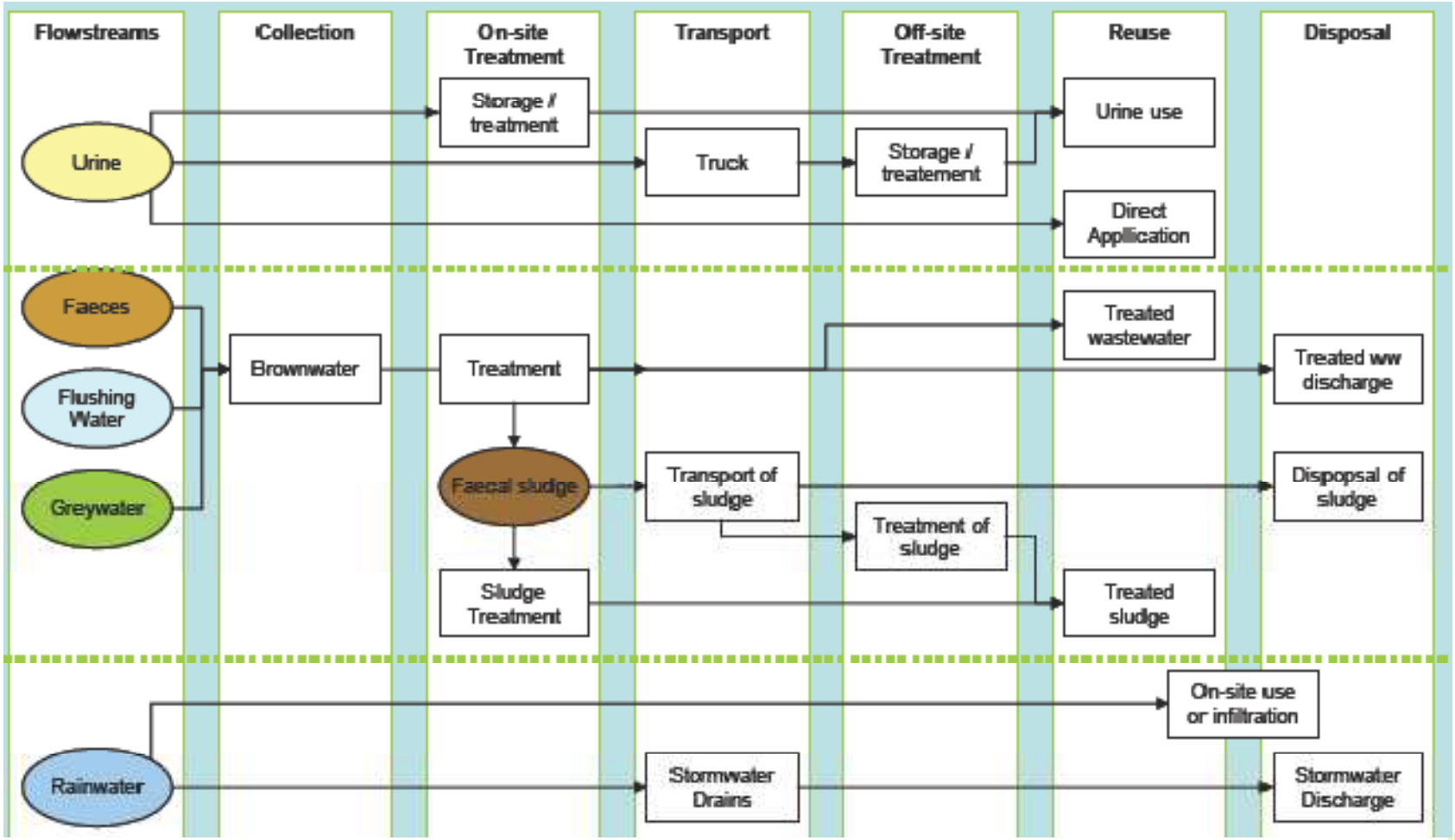


ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Wastewater separation - flowstreams

Wet urine diversion system

(source: NETSSAF 2007)

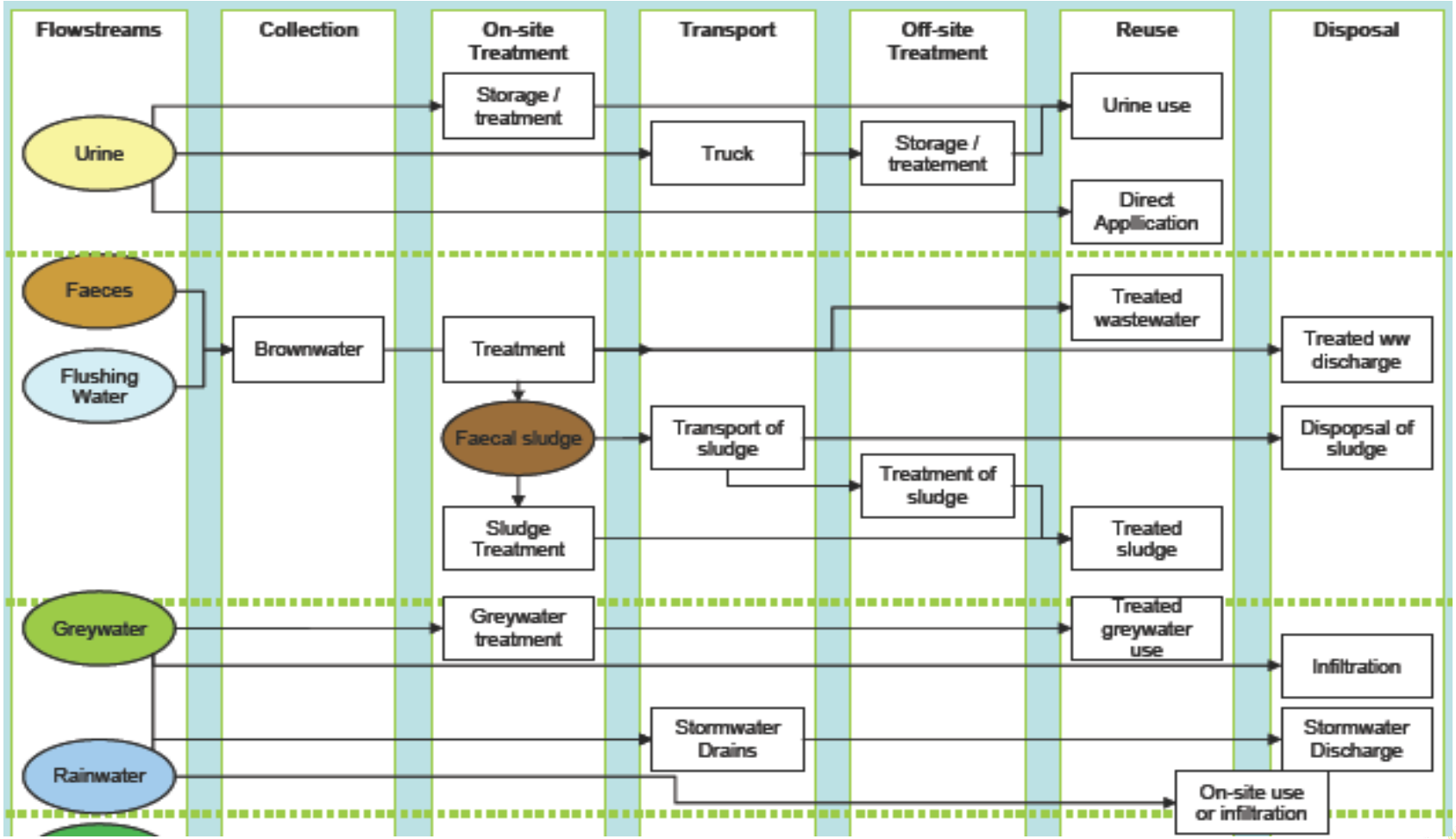


ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Wastewater separation - flowstreams

Wet urine & greywater diversion system

(source: NETSSAF 2007)

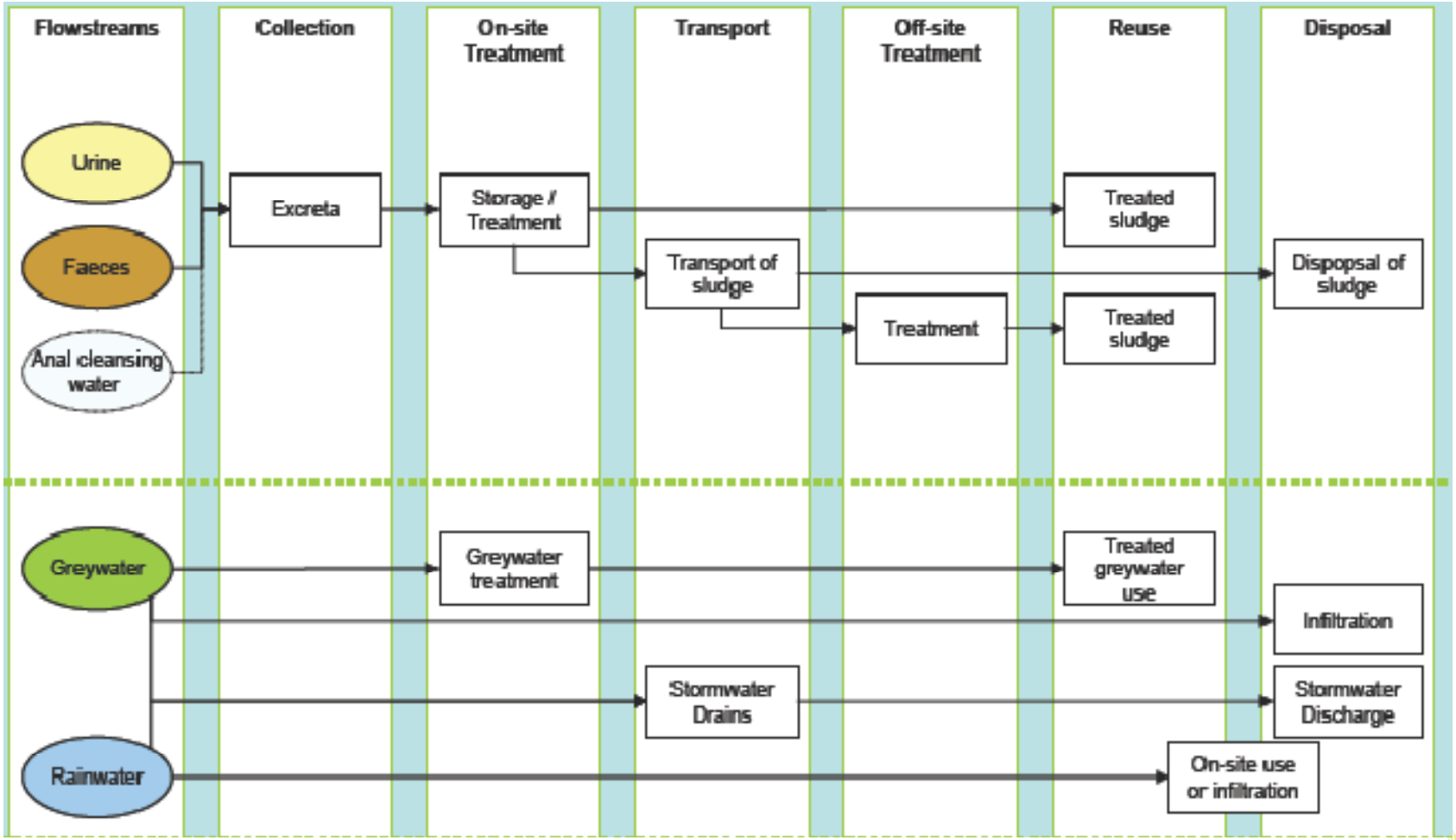


ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Wastewater separation - flowstreams

Dry greywater separation system

(source: NETSSAF 2007)

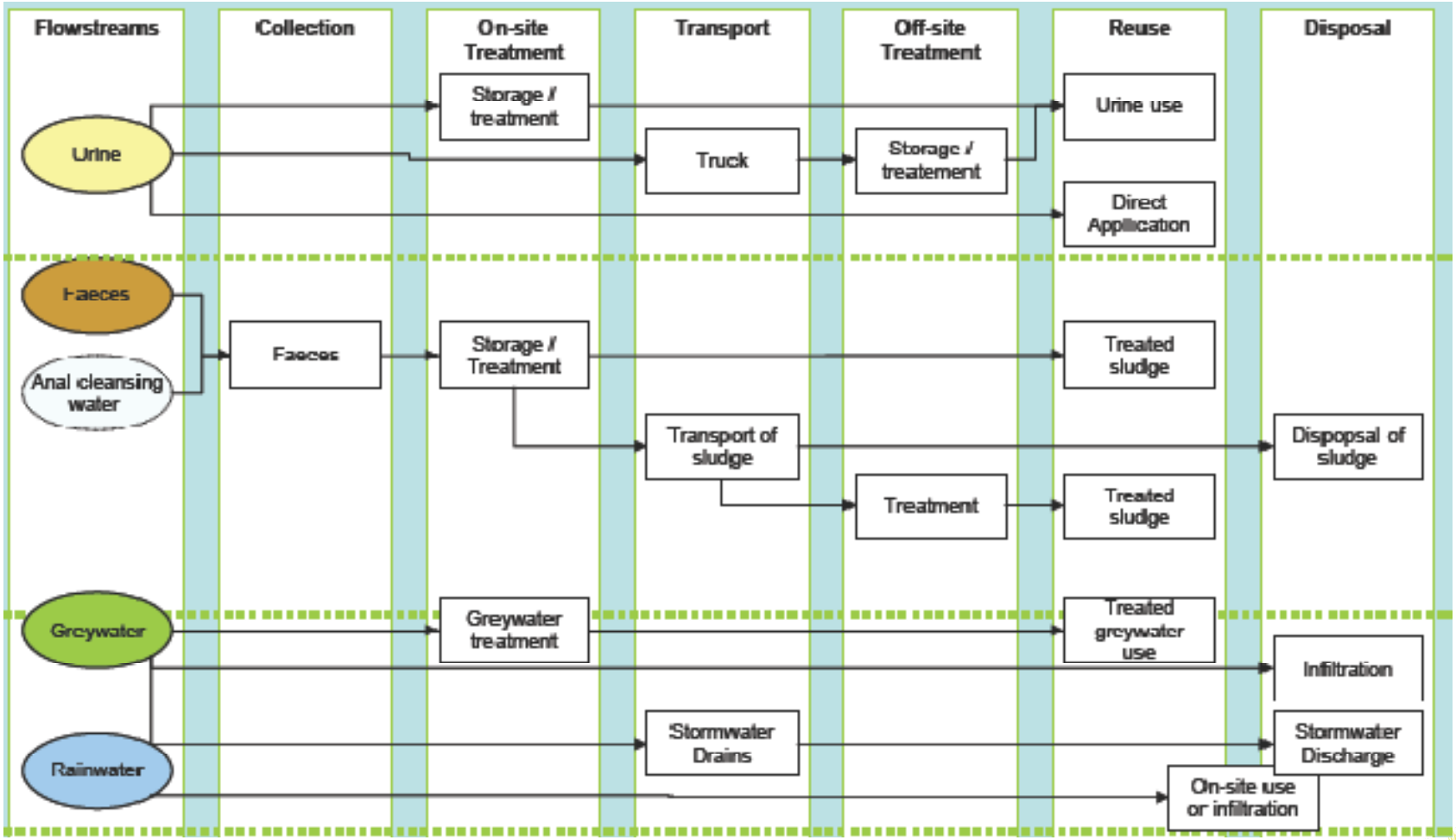


ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Wastewater separation - flowstreams

Dry urine & greywater separation system

(source: NETSSAF 2007)

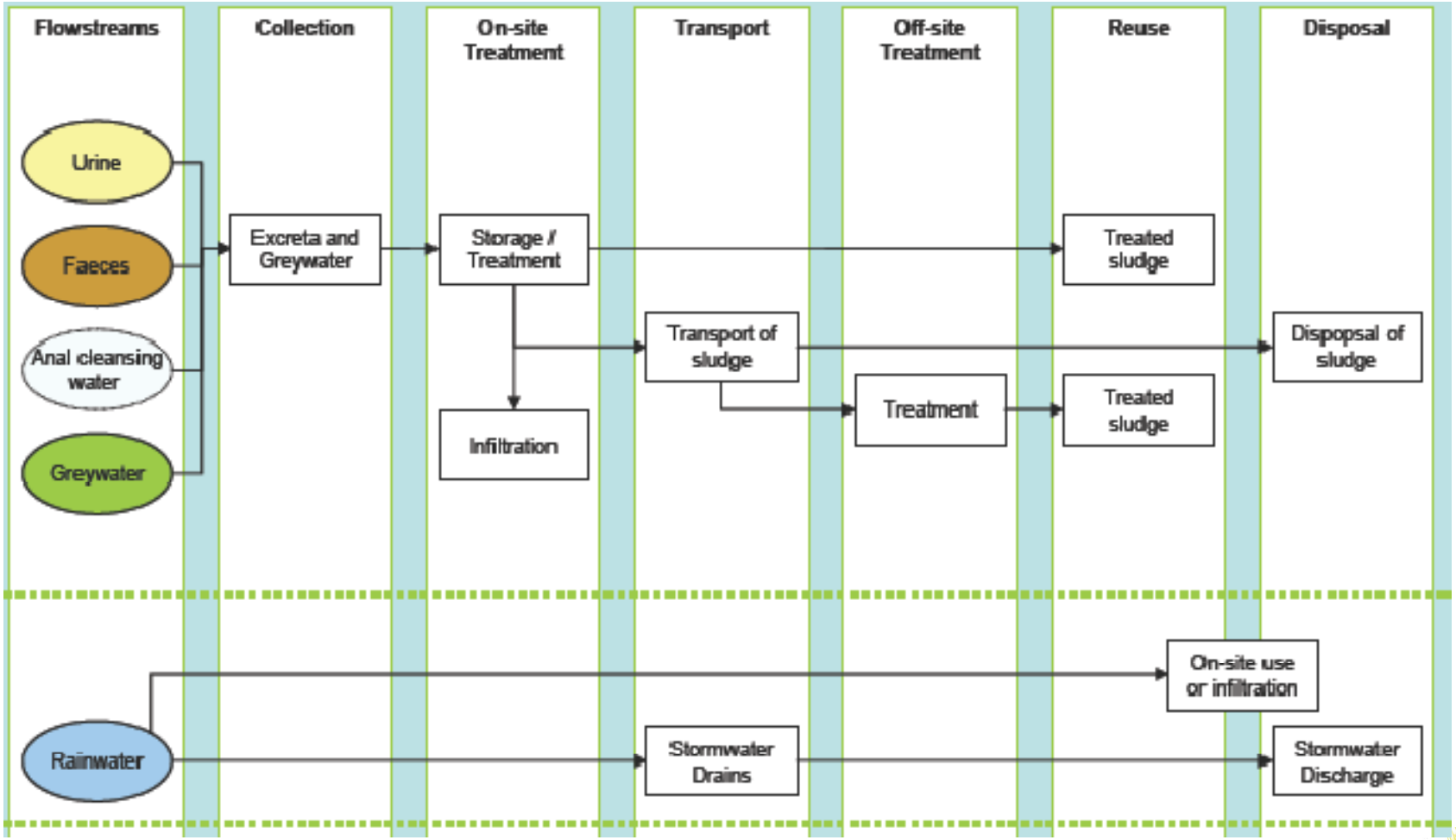


ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Wastewater separation - flowstreams

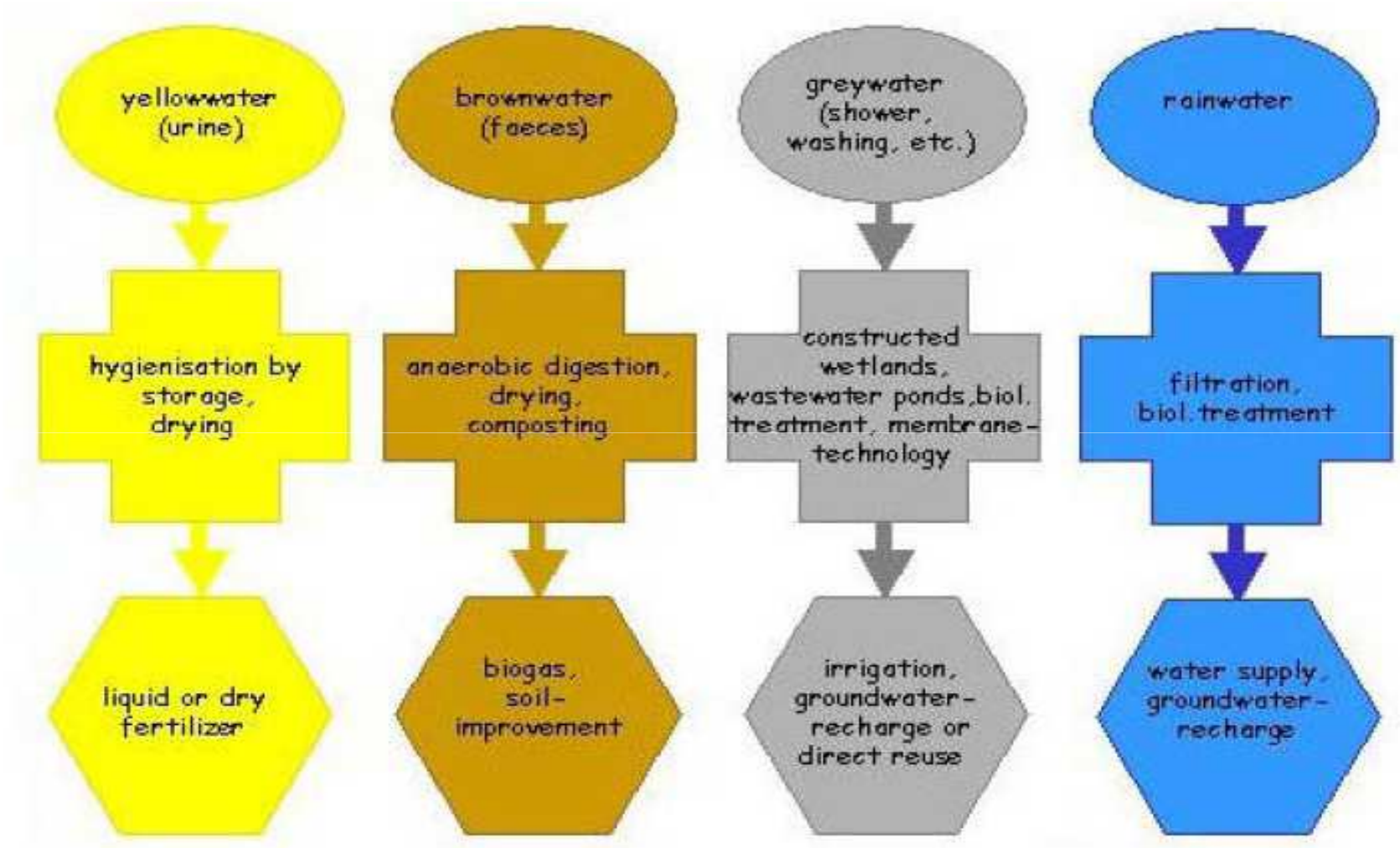
Dry system with mixed flowstream

(source: NETSSAF 2007)



ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Pre-treatments before reuse



ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Treatment of urine

- Long time storage in hermetical storage tanks (1-6 months) for hygenisation

- Desiccation (reuse of dried crystals)

- MAP-dissipation (conversion of liquid urine into powder)

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

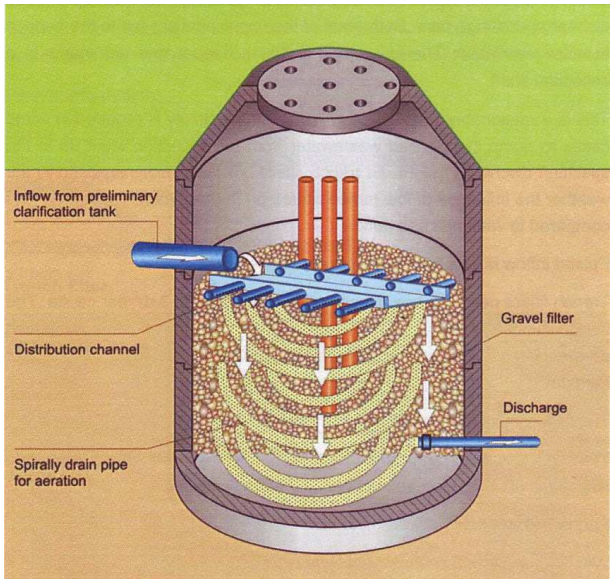
Treatment of faecal sludge, faeces & excreta

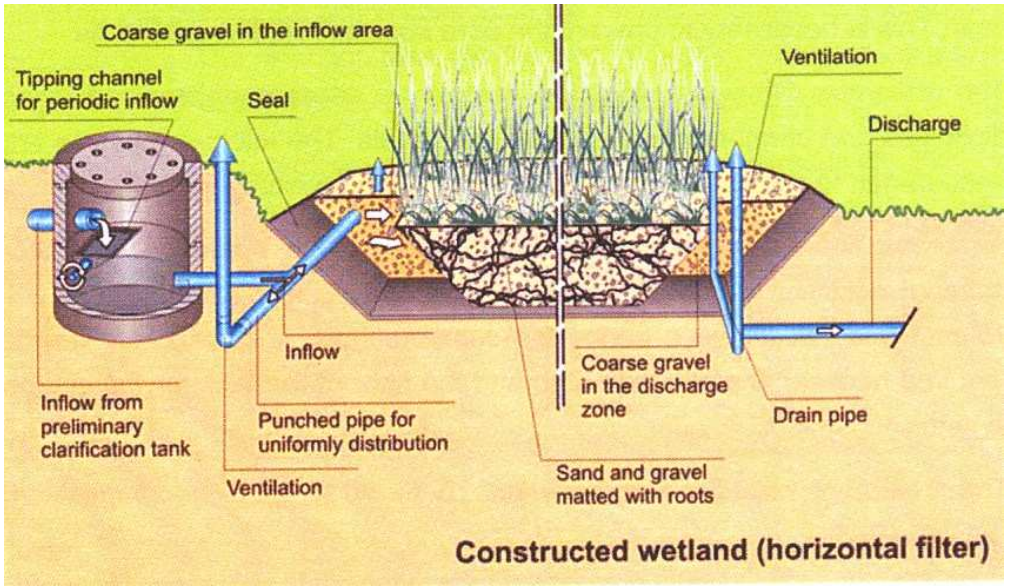
- Dewatering (drying beds, presses, centrifuges, thermal)
- Aerobic digestion (open digesters)
- Composting (windrows, static piles, closed reactors)
- Anaerobic digestion (closed biogas reactors)
- Hygienisation (thermal, chemical)

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Treatment of greywater

- Floatation – grease trap
- Slow sand filtration
- Constructed wetlands (horizontal/vertical flow)





(source: BGR 2007)

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Conclusions - Strengths

- Water and energy saving technologies
- Concentration of nutrients → Better reusability of resources
- Improved (specific) treatment and disposal of pollutants
- No mixing with industrial effluents
- Better traceability of pollution
- Saving costs for conventional wastewater treatment
- Less investment and maintenance costs for new sewer systems
- New business concepts for SMEs (sanitation services)
- Achievement of international objectives on access to sanitation (MDG, Johannesburg Summit)

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Conclusions - Weaknesses

- Higher investment costs for separation technologies
- Low public awareness of such a new approach → Reluctances
- Decentralised monitoring and control of proper treatment

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)

Thank you for your attention!

ttz Bremerhaven - Environmental Institute - An der Karlstadt 6 - 27568 Bremerhaven/Germany
Phone: (+49) 471 9448 772 - Fax: (+49) 471 9448 722 - Info: www.ttz-bremerhaven.de
Contact: Steffen Föllner – Team leader “Future Technologies” (sfoellner@ttz-bremerhaven.de)