Combining the production of renewable energy with innovative urban drainage systems – The KREIS Project

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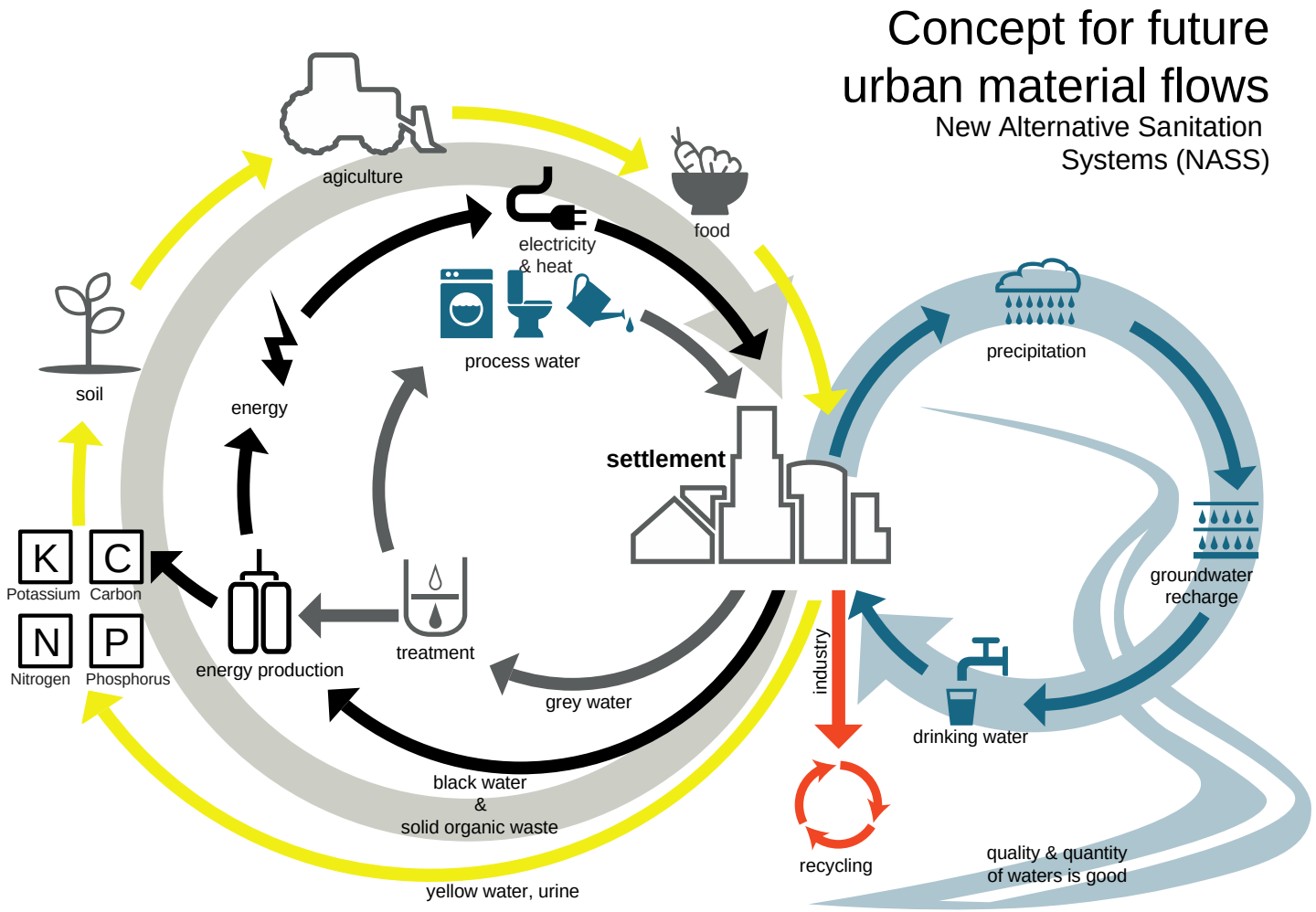
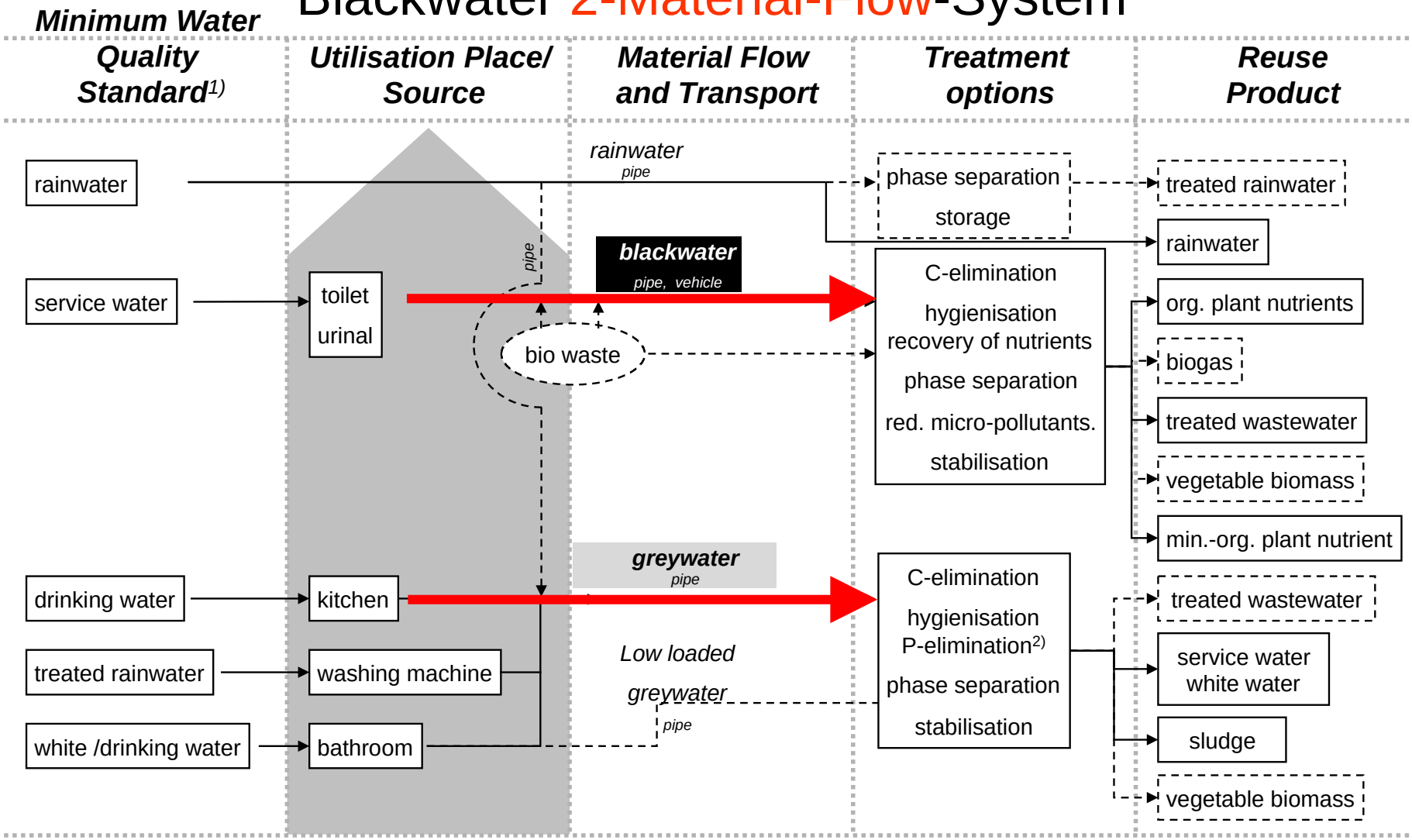
Concept for future urban material flows



Rost G., Maier K., Böhm M., Londong J. (2015). Auswirkungen eines technischen Paradigmenwechsels auf die wasserwirtschaftliche Organisation in strukturschwachen ländlichen Räumen, Raumforschung und Raumordnung, Volume 73, Number 5, Springer, ISSN 0034-0111, pp.343-356

Blackwater 2-Material-Flow-System

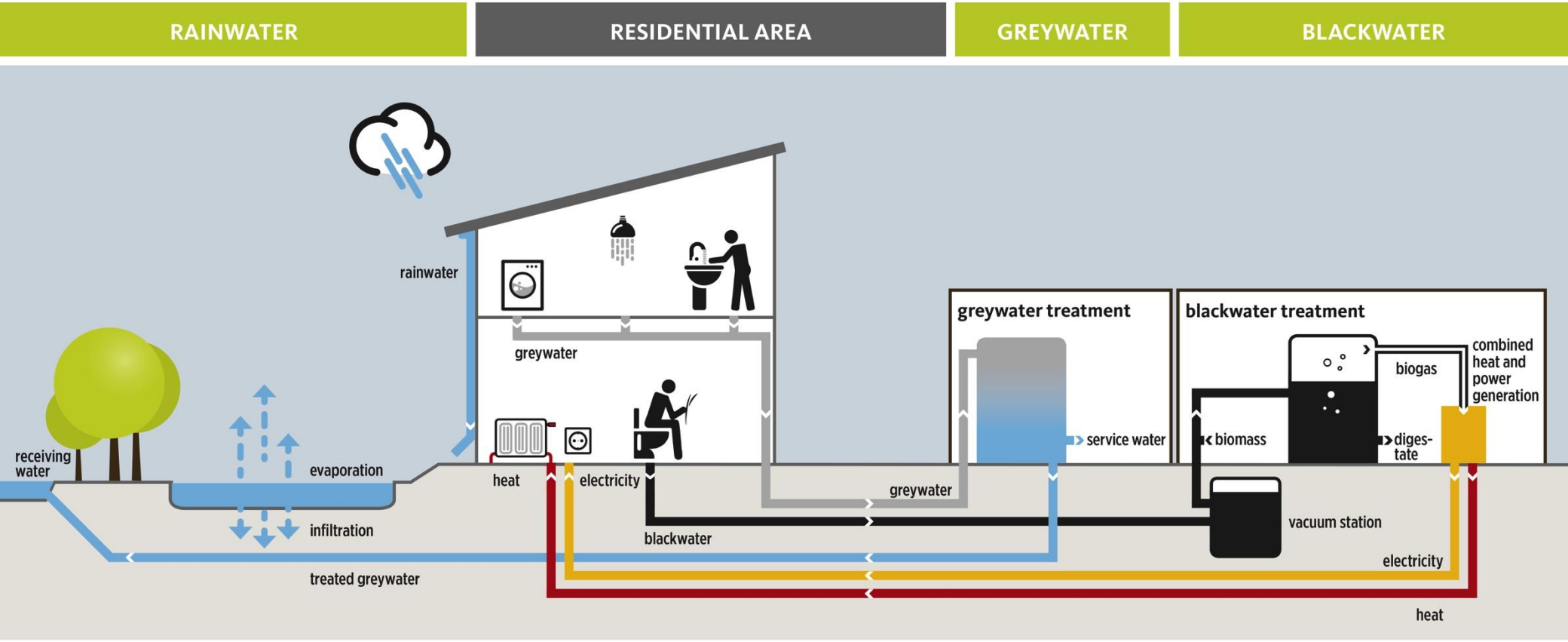


1) higher water quality possible for usage
2) makes sense only for kitchen wastewater

- - - - optional

Source: [DWA, 2008]

HAMBURG WATER CYCLE®



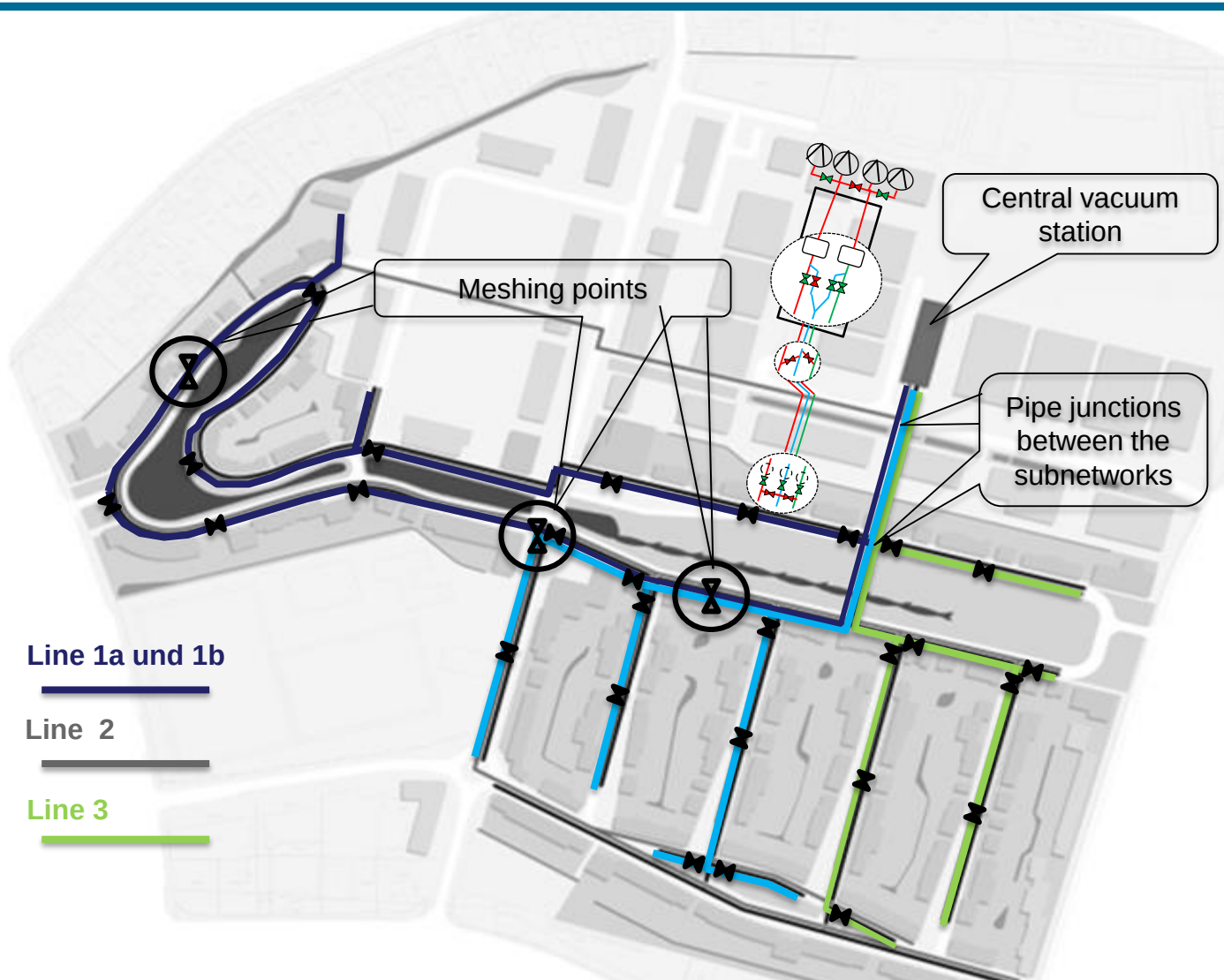
Separation of domestic wastewater for energetic use

This realisation of the HWC is the largest demonstration of a resource oriented sanitation concept working with vacuum technology for the collection of concentrated blackwater in Europe.

The Urban Quarter Jenfelder Au

- Revitalisation of a former military site
- 45 ha total area, 35 ha reconstructed
- Realisation: 2012 - 2018
- More than 600 accommodation units about 2.500 inhabitants
- High energy standards
- Commerce and green areas

Blackwater network - reliability & maintainability



The **vacuum drainage** of blackwater was thoroughly examined. Advice on construction and operation of the system was handed out by the KREIS-researcher team, as a system failure would cause a considerable acceptance loss.

Augustin, K., Skambraks A.K., Li Z., Giese T., Rakelmann, U., Meinzinger F., Schonlau H., Günner, C. (2014). Towards sustainable sanitation – The HAMBURG WATER cycle in the settlement Jenfelder Au, Water Science Technology: Water Supply, 14(1), pp. 13-21.
Rohde, R. (2015) Untersuchungen zur Feststoffbildung in Unterdrucksystemen für den Schwarzwassertransport, Dissertation, Schriftenreihe des b.is, Band 31, Rhombos Verlag

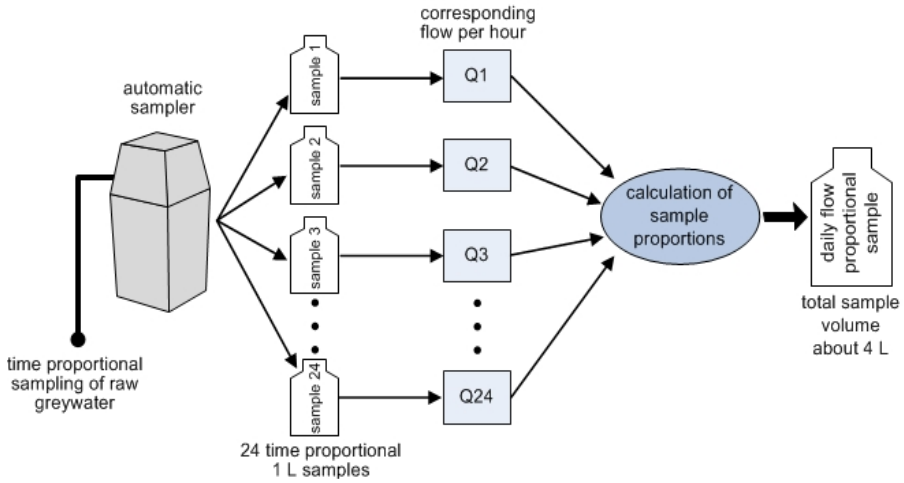

LIEBHERR

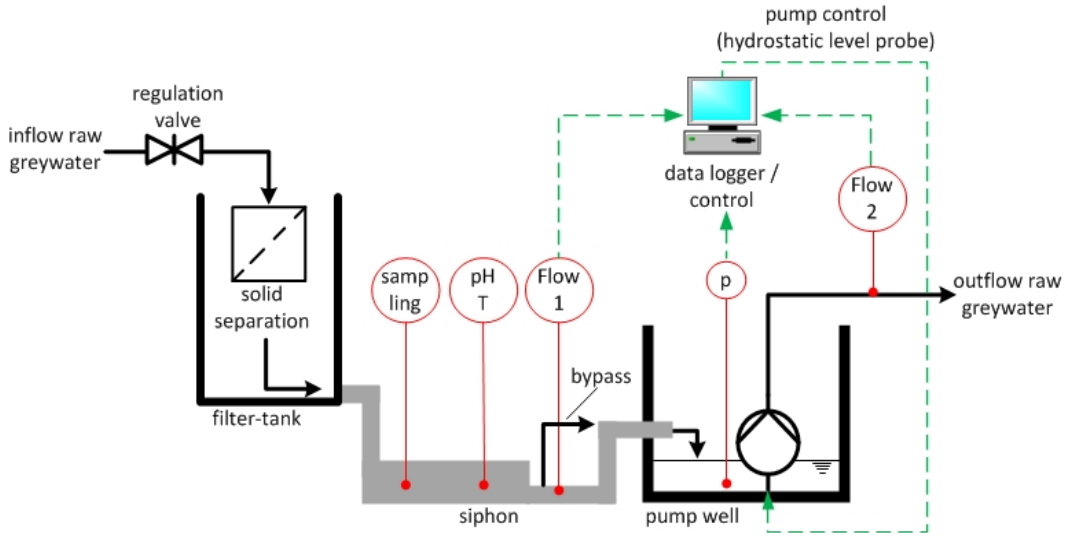

Hagemeister


Kuehnbachring
Jenfelder Allee

Greywater Sampling

Sampling procedure and compilation of daily flow proportional samples





Average loads of greywater sampling campaign Berlin "Block 6"

Parameter		n	Unit	Mean	STD	Median	Range
Volume	Q	17	L/(c*d)	77	16	76	62 -114
org. Matter	TSS	16	g/(c*d)	9			
	VSS	16	g/(c*d)	7			
	BOD_5	15	g/(c*d)	35			
	COD	17	g/(c*d)	66			
Nutrients	TP	17	g/(c*d)	0.4	0.2		
	PO_4-P	17	g/(c*d)	0.1	0.1		
	TN	17	g/(c*d)	1.3	0.3		
	NH4-N	17	g/(c*d)	0.2	0.1		

50% of organic load of wastewater in greywater

10% of nutrient load of wastewater in greywater

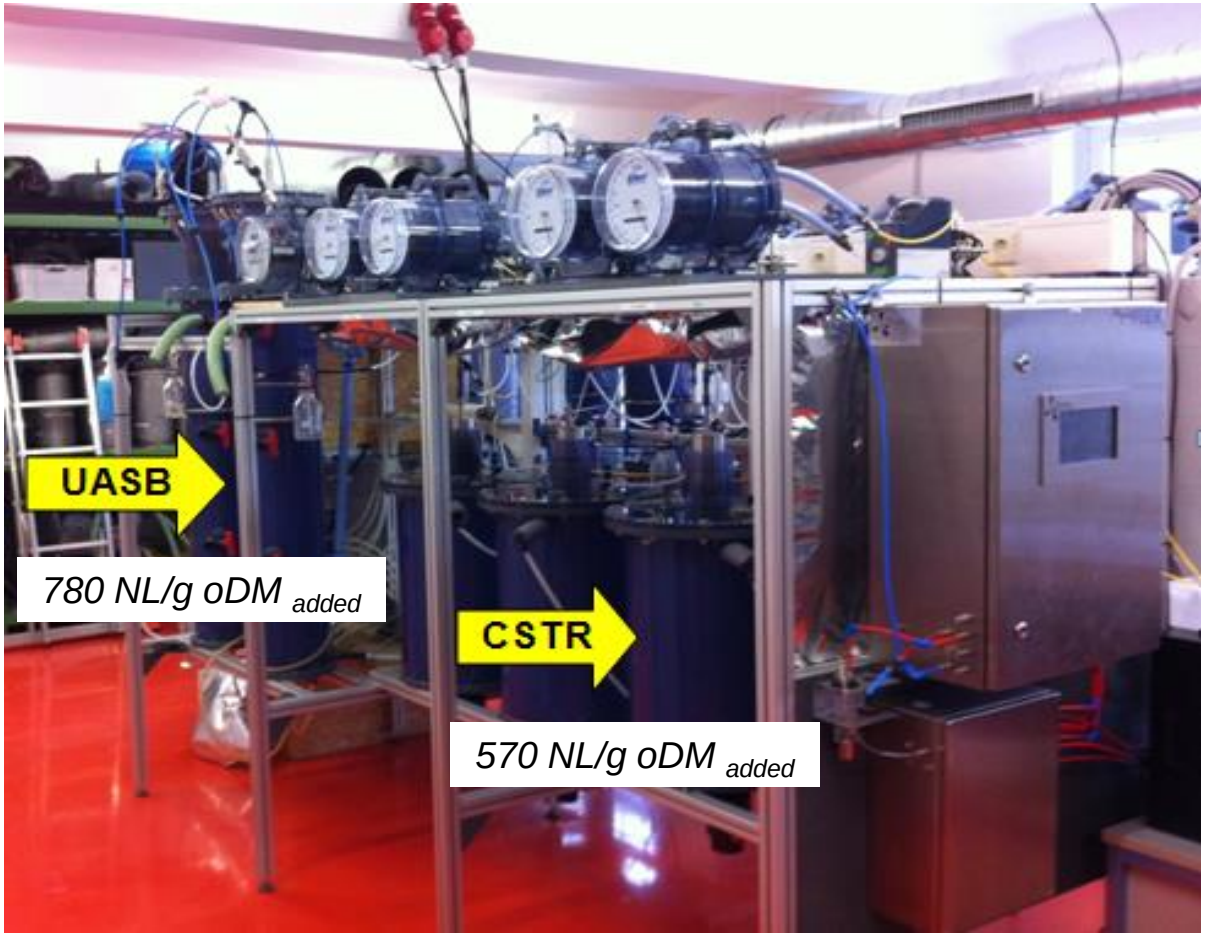
Sievers, J.; Londong, J.; Albold, A.; Oldenburg, M. (2014). Characterisation of Greywater – Estimation of Design Values In J. Lohaus, ed. Proceedings of 17th International EWA Symposium "WatEnergyResources – Water, Energy and Resources" Hennef, European Water Association

Average concentrations of blackwater in Lübeck “Flintenbreite”

Parameter		n	Unit	Mean	SD	85%-
org. matter	acetic acid	10	mg/l	429.6	244.8	690
	propionic	10	mg/l	168.9	123.5	295.4
	DOC	11	mg/l	1027	314	1420
	DIC	11	mg/l	918	94	1332
	TOC	7	mg/l	2510	1100	3645
nutrients	TP dissolved	7	mg/l	74.1	7.6	82.2
	TN dissolved	7	mg/l	1412	108	1486

Wätzel, T.; Seböck, S.; Kraft, E. (2013): Anaerobic digestion of separated blackwater - An innovative wastewater treatment step with the option for a specified degradation of pharmaceuticals. Conference Proceeding of the 2013 International Environmental Engineering Conference and Annual Meeting of the Korean Society of Environmental Engineers (IEEC2013)

Blackwater Digestion

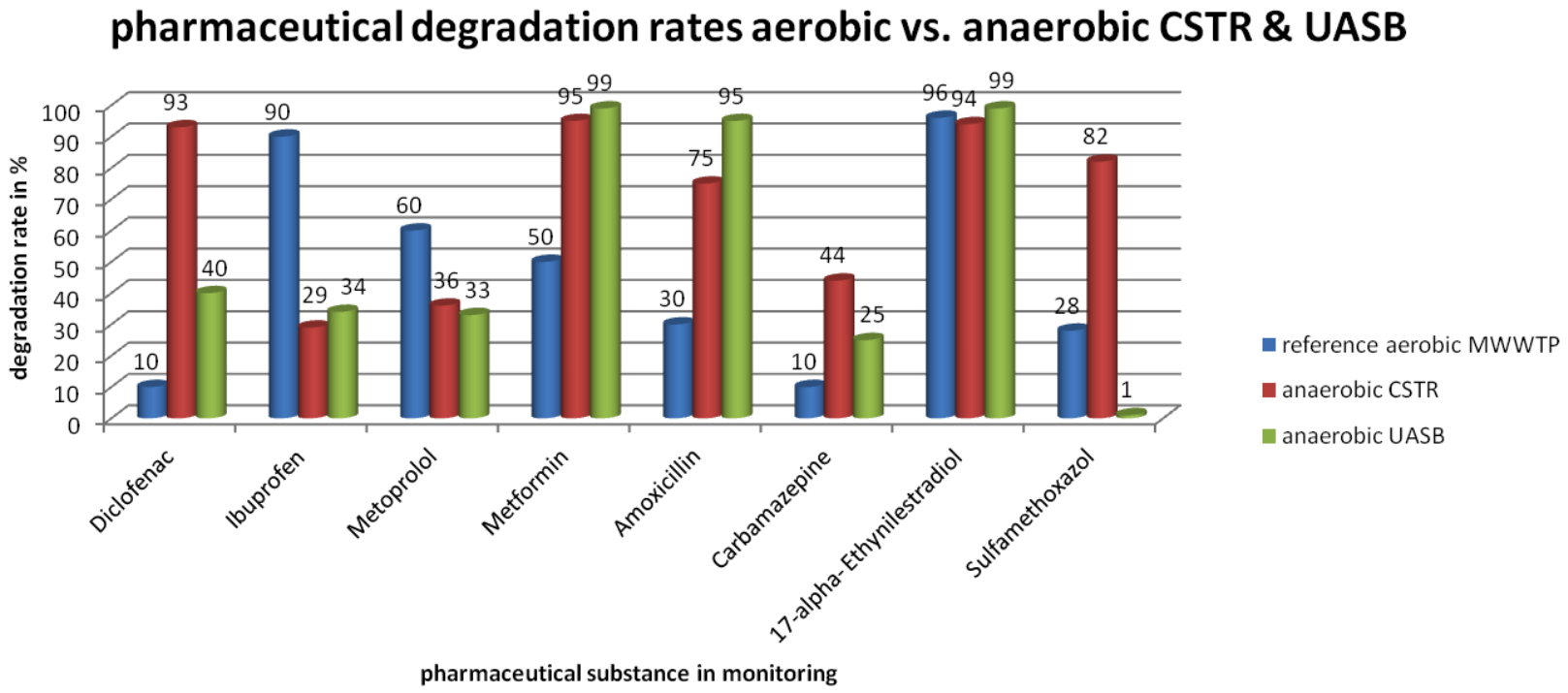


- 8 CST- reactors,
- 4 UASB- reactors,
- Volume 40 L each
- Online-measurement of gas quantity and quality (CH_4, CO_2, O_2, H_2, H_2S)
- Continuous feeding ~2kgCOD/m³

The CSTR operated in stable conditions with volumetric loadings of up to 5 kg COD/m³ reactor volume*d.
For the UASB it was possible to increase the volumetric loading to 12 kg COD/m³ reactor volume*d.

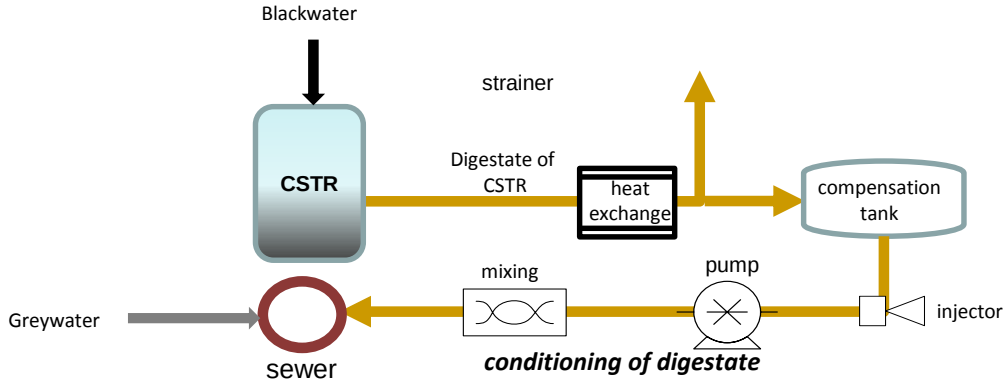
pharmaceutical products in blackwater and degradation

	Diclofenac	Ibuprofen	Metformin	Metoprolol	Amoxicillin	Carba-mazepine
mean [µg/l]	11.6	290.2	1082.4	42.1	596.5	119.3
standard deviation [µg/l]	13.3	111.3	934.8	10.6	451.1	32.2
median [µg/l]	3.35	305	835	41	460	120



Wätzel, T.; Kraft, E. (2014): Specified, anaerobic degradation of pharmaceuticals and digester gas recovery: A comprehensive study. In: 17th International EWA Symposium "WATEnergyResources - Water, Energy and Resources: Innovative Options and Sustainable Solutions", during IFAT 5-9 May 2014, Munich.

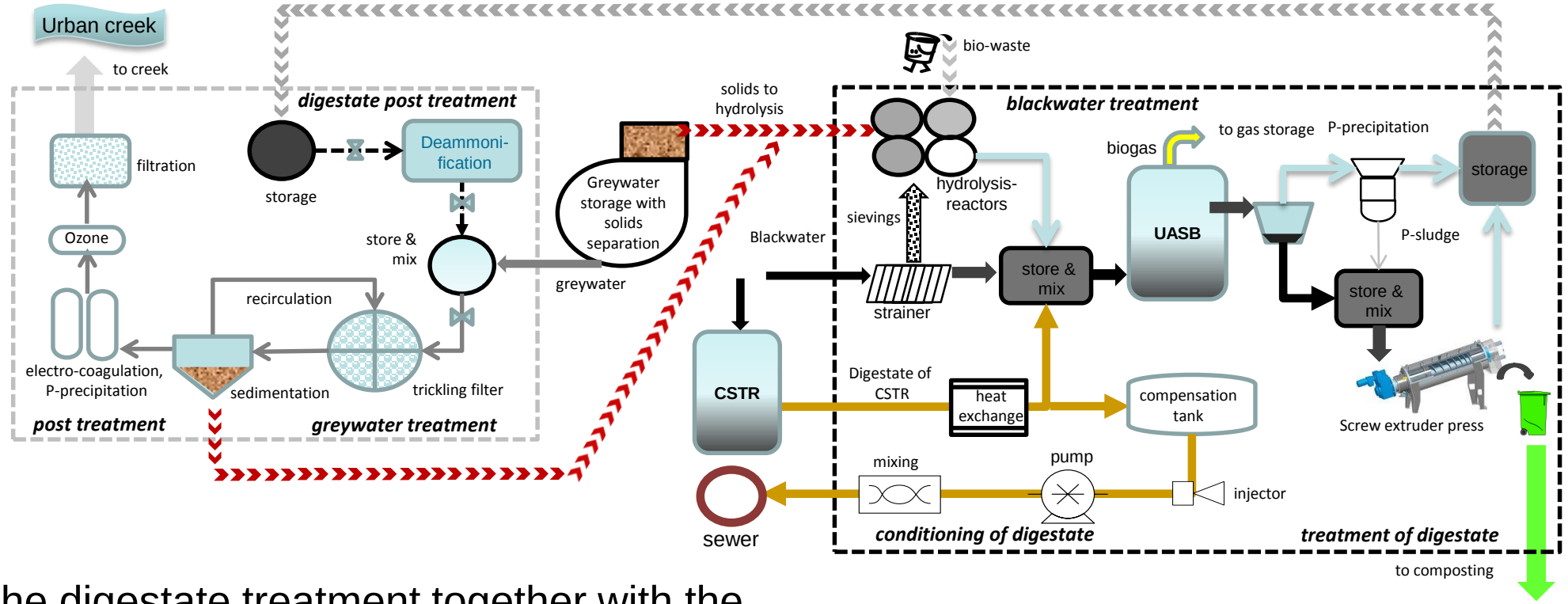
Actually constructed part of the treatment



Blackwater and greywater treatment concept at Jenfelder Au

KREIS Versorgung durch Entsorgung

To avoid transportation costs and annoyance of residents, the liquid phase should be treated and recycled locally.



The digestate treatment together with the greywater after prior removal of nitrogen (deammonification) and phosphorus (precipitation) will be investigated in further research projects.

In order to generate usable products, the digestate must be separated into a low-solids phase and a muddy, solids and phosphate-rich phase.

organisational and institutional aspects

The KREIS project has determined the necessary **coordination** needs that are to be expected during the realization and operation on the quarter level.

Early **cooperation management** is necessary.

The **acceptance** of the system and of its compounds will be evaluated during the operation phase starting in 2017, based on methodologies developed in the KREIS-project.

Schramm, E.; Giese, T.: Kerber H. (2015). Kooperationsmanagement zur verbesserten Umsetzung von neuartigen Sanitärsystemen auf Quartiersebene. Energie Wasser/Praxis, 04/2015.

Conclusions

- Extracting recyclable materials and elimination of pollutants in source separated municipal wastewater of an urban quarter will be demonstrated in Hamburg Jenfelder Au.
- In the preparatory research project KREIS, knowledge about volumetric quantity, concentrations and specific loads of grey- and blackwater was generated.
- On the basis of these data and lab-scale experiments, valuable information for the large-scale implementation of the HWC could be gained.
- Methods for cost analysis and investigations of acceptance were adapted to the project boundaries.

KREIS
Versorgung durch Entsorgung

This fairy tale will never come true…

but

we can work on it !

Düsseldorf, Germany