Vacuum Sewerage and Greywater treatment
Experience of 8 years of operation

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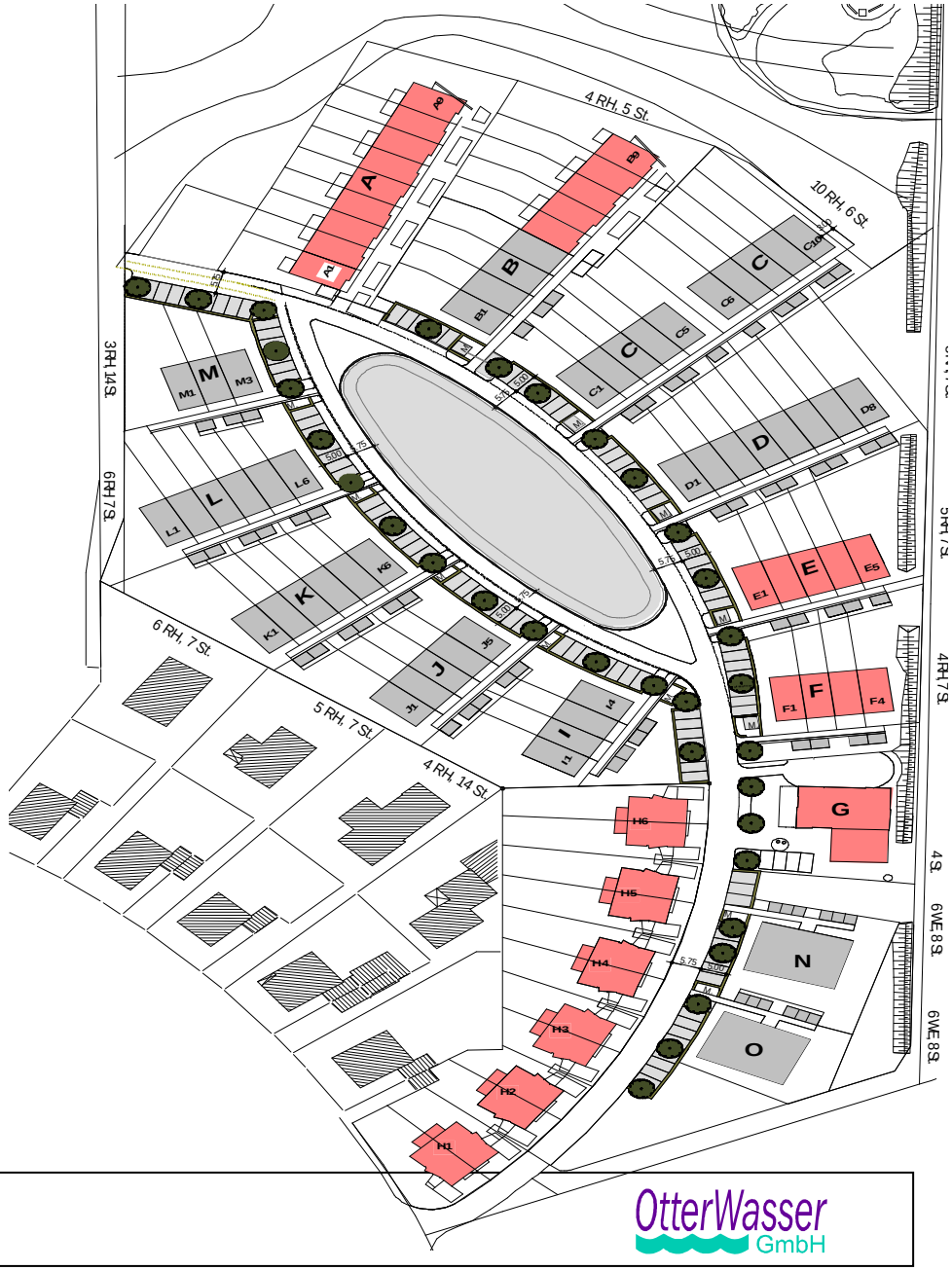
Project‘s History

- Residential area in the city of Luebeck (A_{tot} = 5.4 ha)
- Private operating infrastructure company (operation of wastewater treatment system and operation of all other medias supplying the houses)
- Project started in 1999 designed for 117 units
- Interruption at 30 units in 2000
- Operation of the infrastructure systems since 8 years

Current Situation

- Infrastructure is mainly finished
- 23 terraced houses
  12 twin houses
  Central building with 4 flats
- 116 inhabitants
- All facilities for the technical operation are finished and in operation since 2000

- Ongoing:
  Construction of 42 terraced houses and 12 flats



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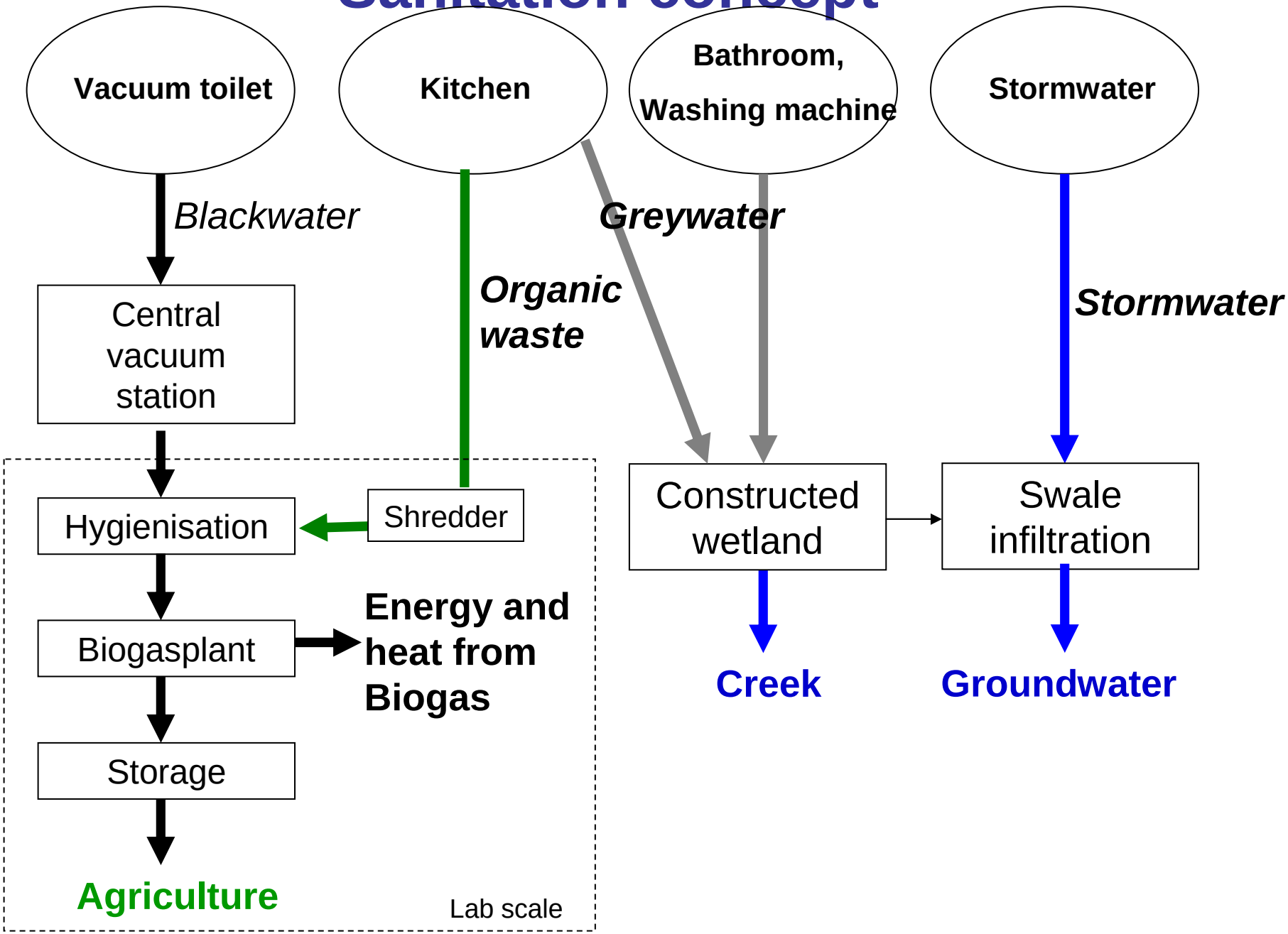
Characteristics

- Buildings designed as low energy consuming houses
- Ecological materials have impact on energy and material flows during buildings life cycle
- All consumption data of the houses are known because of the installation of meters

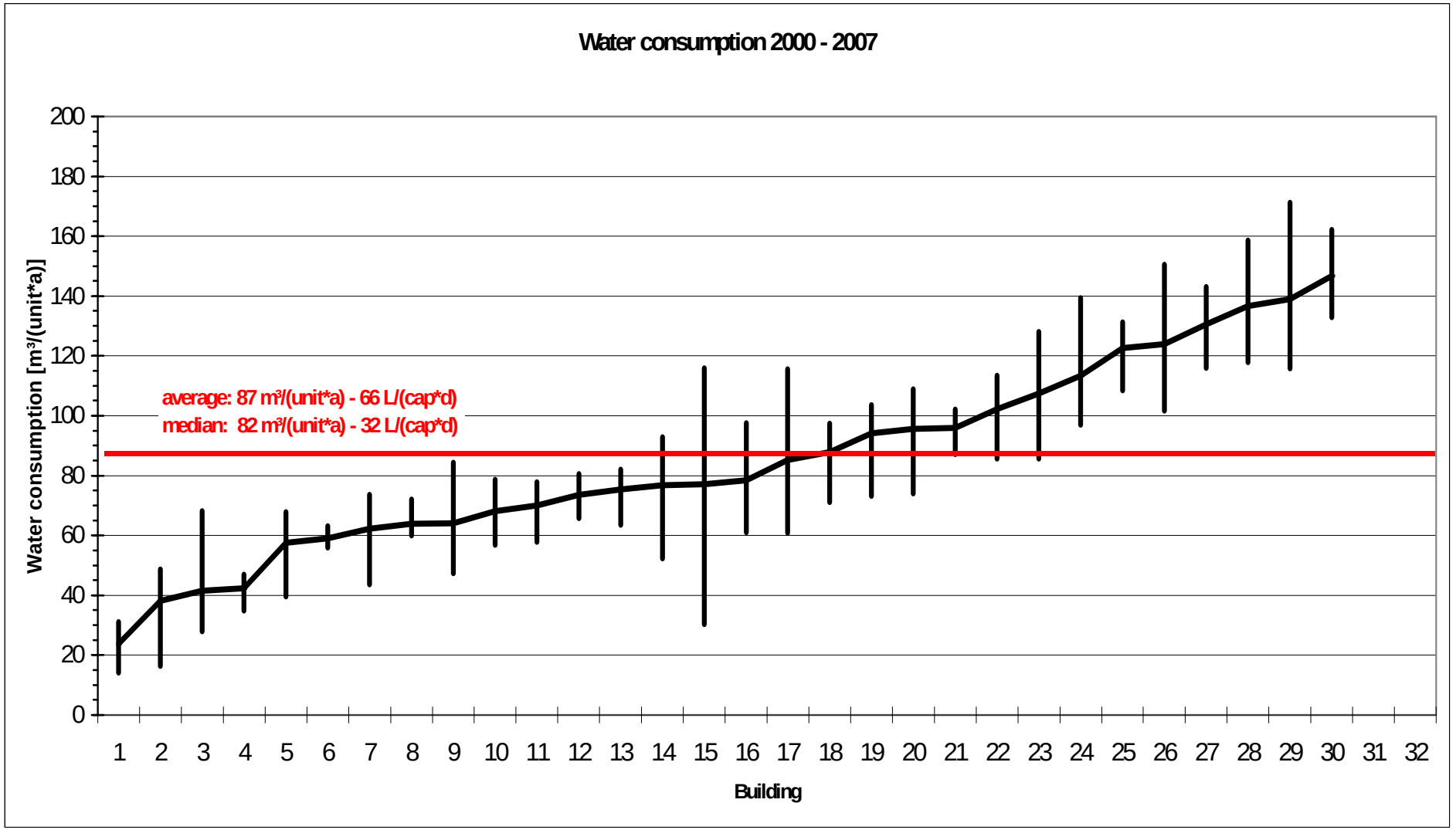
- Infrastructure system is operated by a private company and recharged by fee calculations

- Here focus only on water and wastewater related issues.

Sanitation concept



Water consumption per unit



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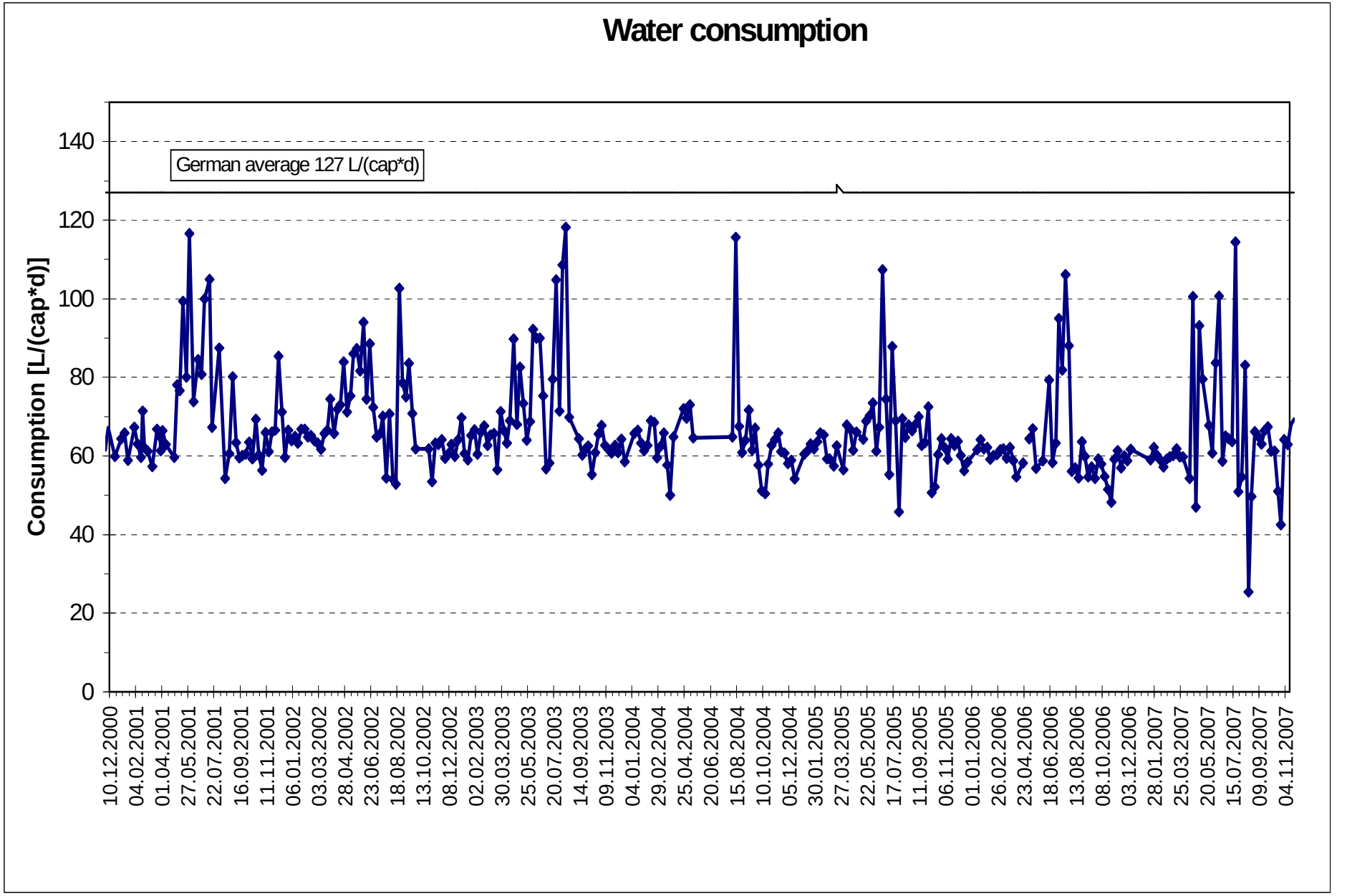
Water consumption per capita



Composition of greywater

			Influent		Effluent	
Parameter		**Unit**	**Average**	**Range (min-max)**	**Average**	**Range (min-max)**
Volume		L/(cap•d)	**60**	50 - 120		
Organic matter	BOD_5	g/m³	**156**	136 – 194	**6**	1 – 14
Organic matter	COD	g/m³	**426**	258 – 584	**41**	6 – 73
Nutrients	N	g/m³	**11**	8 – 17	**3.6**	1.2 – 5.7
Nutrients	P_{tot}	g/m³	**6.2**	4 – 10	**4.5**	1.2 – 6.8
Nutrients	PO_4-P	g/m³	**5.0**	3 - 8	**3.9**	2.8 – 5.1

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Sludge from greywater

- Greywater contains sludge
- Solid removal important for biological treatment
- Colour:
  upper part: white – grey
  lower part: dark
- Sludge volume:
  approx.
  42 l/(cap*a)
- Desludging interval:
  5 – 6 years

Composition of blackwater

Parameter		Unit	Average	Range (min-max)
Volume		L/(cap•d)	**6**	
Organic matter	COD	g/m³	**10,496**	3,640 – 29,230
	TC	g/m³	**3,716**	1,820 – 7,821
	MLSS	g/m³	**9.0**	3.5 – 23.9
	VSS	%	**66**	45 – 63
Nutrients	N_{tot}	g/m³	**1,505**	1,050 – 1,920
	NH_4-N	g/m³	**1,081**	790 - 1,510
	P_{tot}	g/m³	**202**	98 - 377

Elements of vacuum system

- Vacuum toilet

- Vacuum pipe (Ø 40 - 50 mm)

- Temporary Buffer storage (8 L)
- Vacuum pipe (Ø 50 – 63 mm)

- Vacuum station

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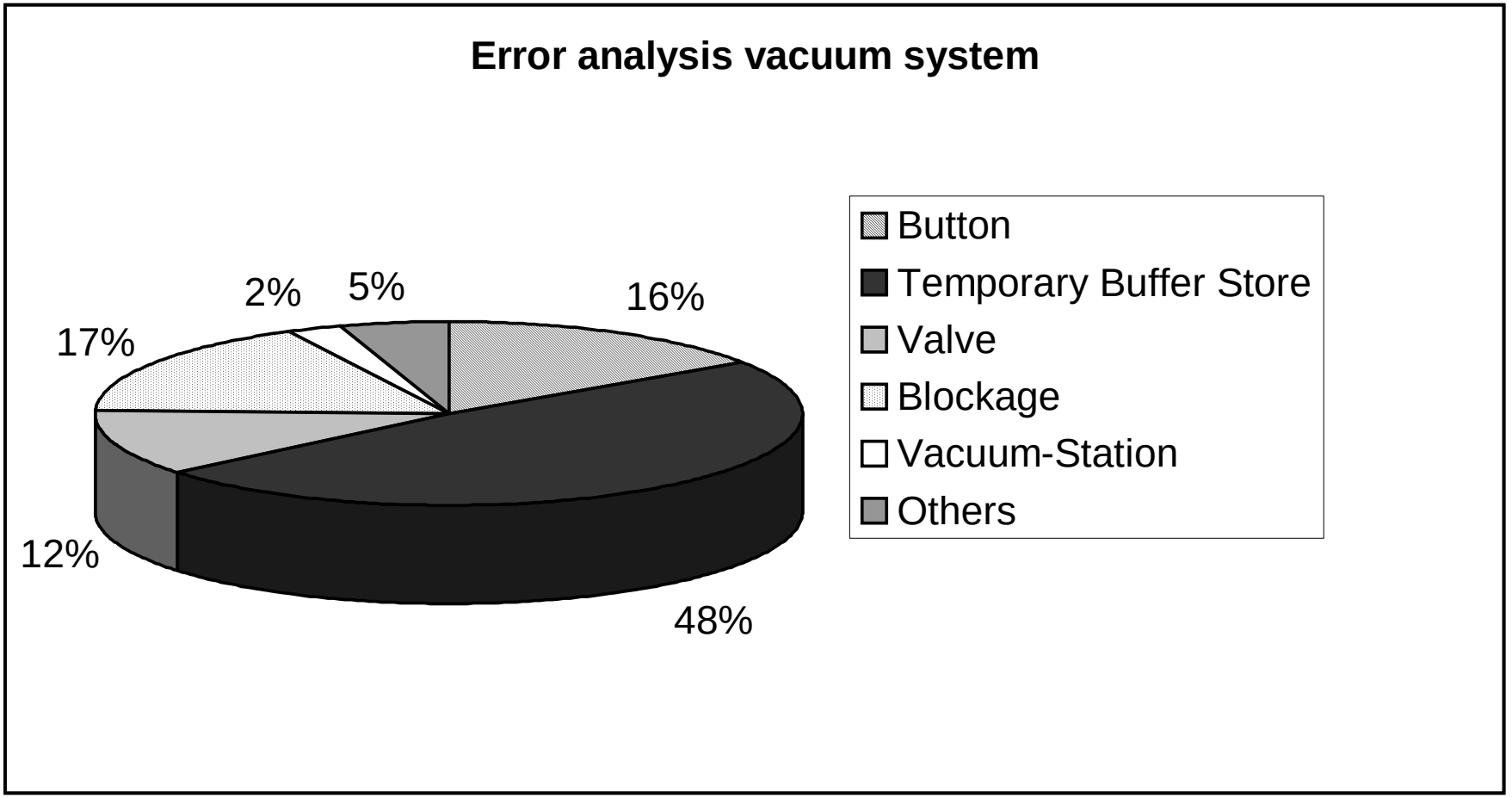
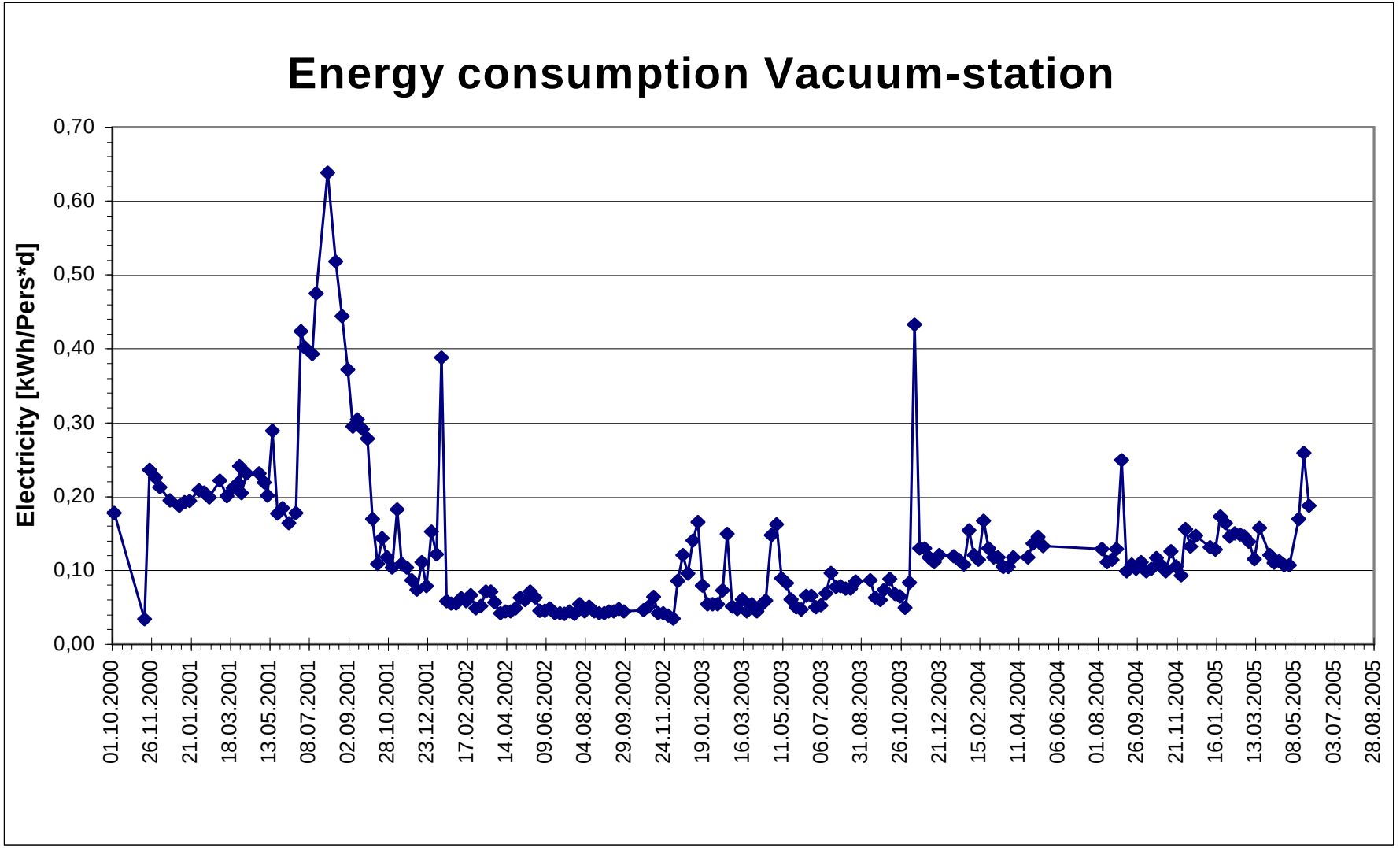
Operation Vacuum System



Energy consumption Vacuum



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Operation vacuum system

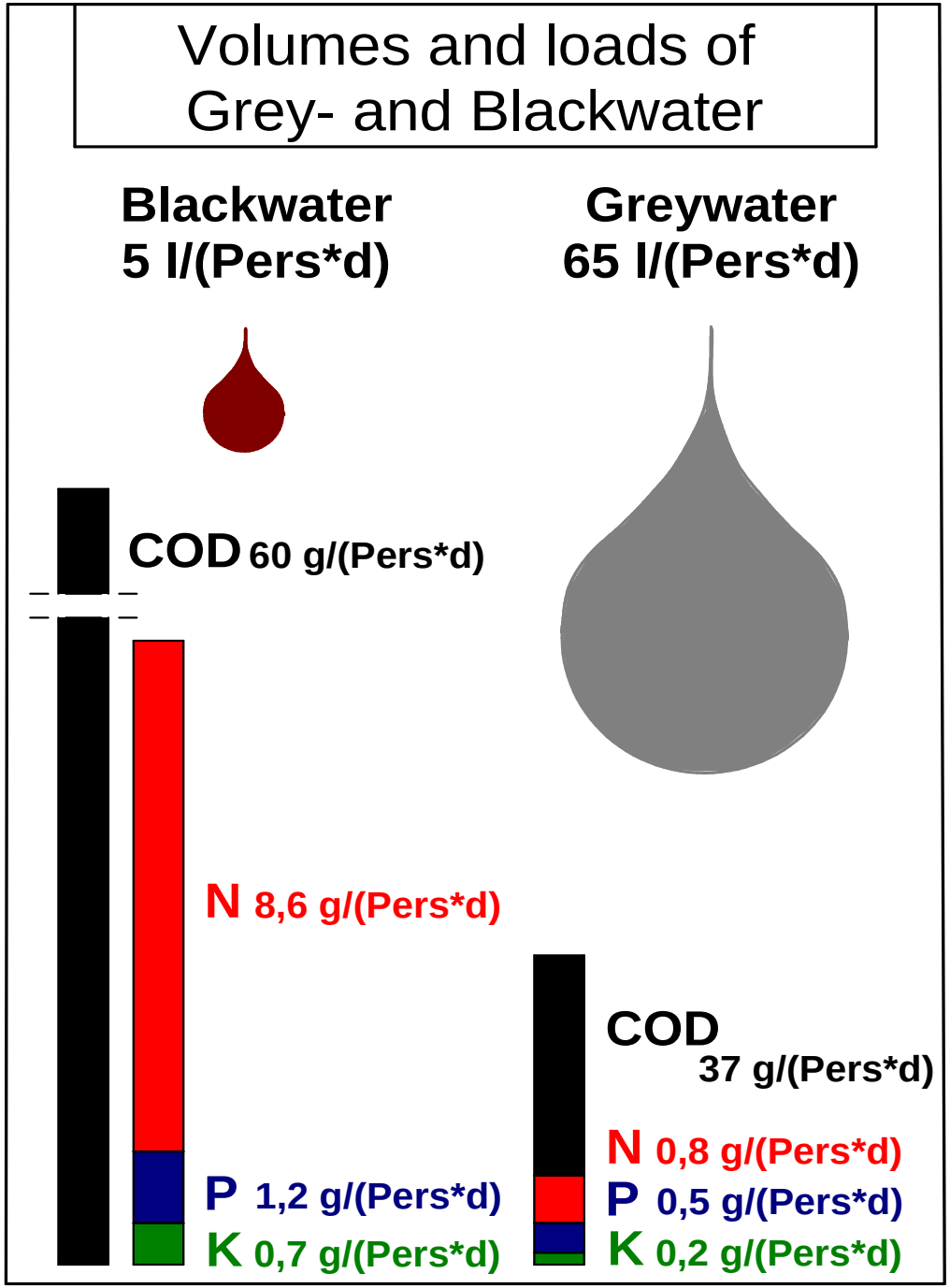
- Blockage caused by misuse mainly in the beginning of the operation
- Flush button accident-sensitive
- Clogging of air control tubes with fibres
- Temporary buffer store equipped with bypass meanwhile
- Toilet valves have higher lifetime than expected
- Pipes has to be cleaned with acid after 6 years of operation to remove blockades caused by hardness precipitation
- Monitoring of energy consumption of vacuum station can identify air leakages

- All maintenance is done by staff of the operation company not by the residents.

Lessons learned

- Temporary buffer storage is not necessary
- High ammonia concentrations can be noticed by opening of the pipe system
- Treatment of exhausted air necessary (biofilter)
- PE-pipes for vacuum pipes recommended
  no steel or galvanised steel pipes (cleaning may hurt inner surface and makes corrosion possible)
  high ammonia concentrations may cause corrosion
- Because of high water hardness regular treatment of pipes with acid is necessary (every 5 – 6 years)
- Energy consumption for vacuum: 45 kWh/(cap*a)

Volumes and loads of Grey- and Blackwater



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Conclusion

- Source separation very effective
- Most of the inhabitants recognize the benefits of the vacuum toilet-system; development of the toilets is wanted
- Experience may decrease the effort for maintenance
- Minor technical modifications of the vacuum system have been necessary
- Operation costs of integrated infrastructure system approx. 20 % lower than for conventional system