Water Out Shit In: a new paradigm for resource recovery

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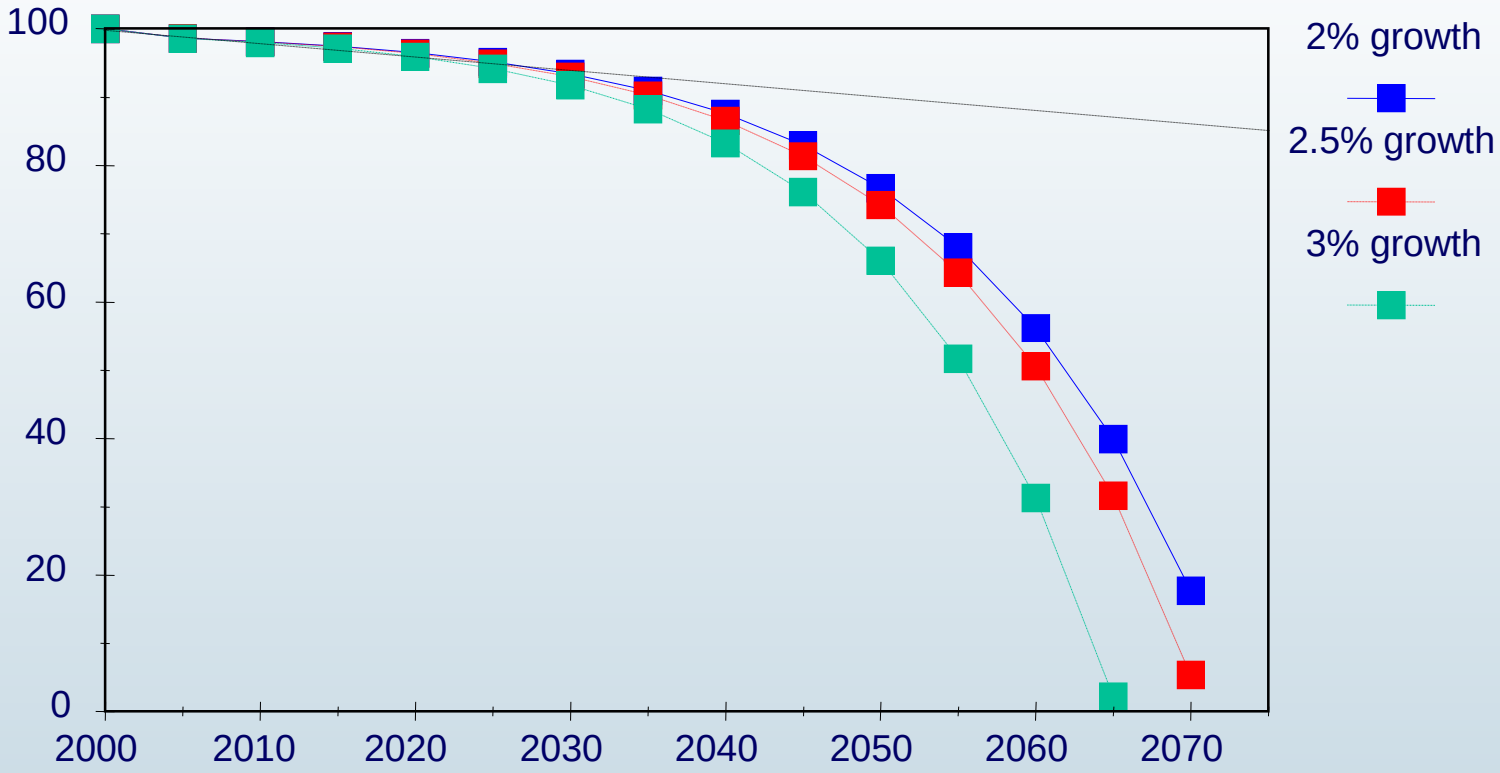
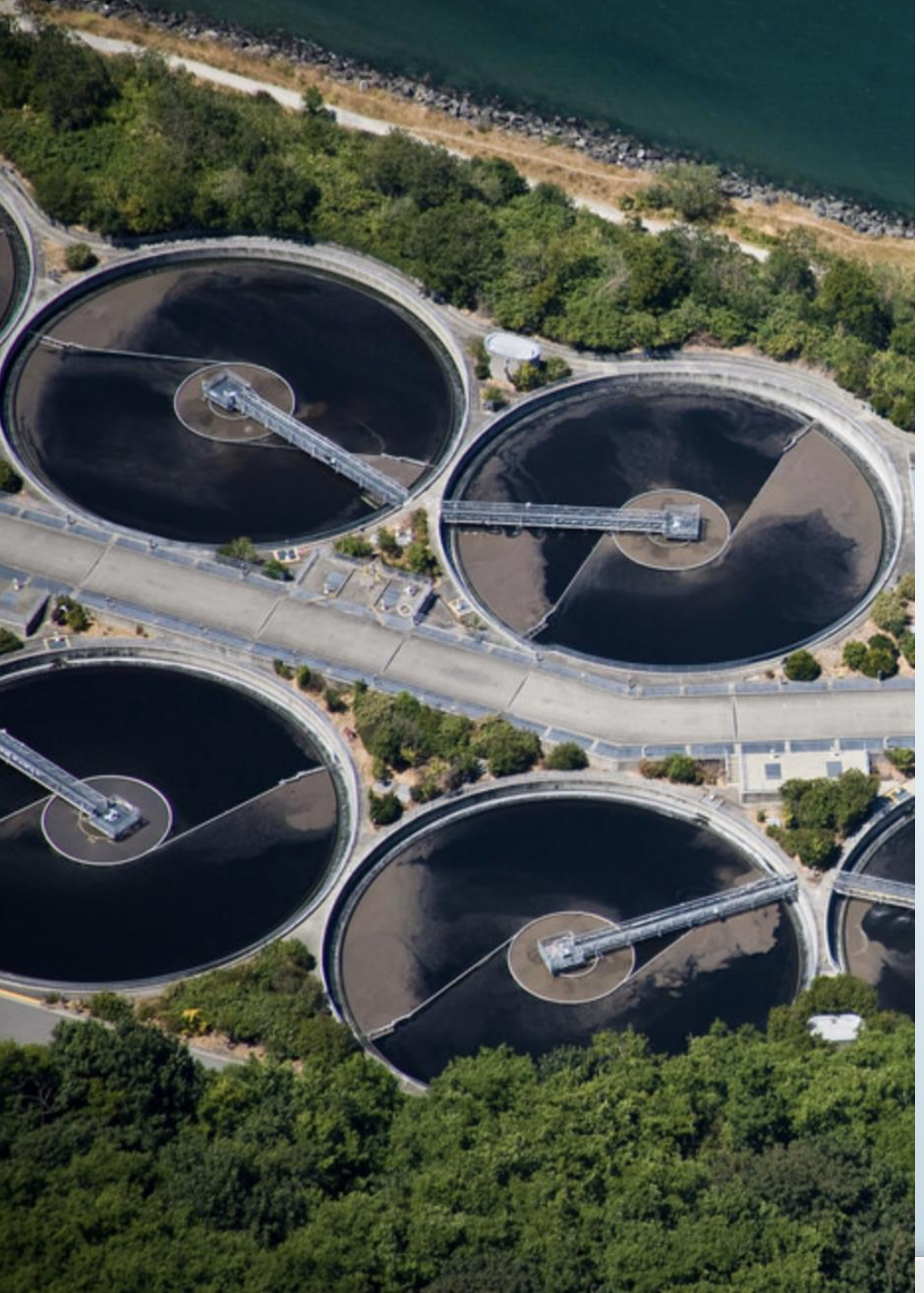
CIB062 Haarlem

Land degradation
&
Phosphate scarcity

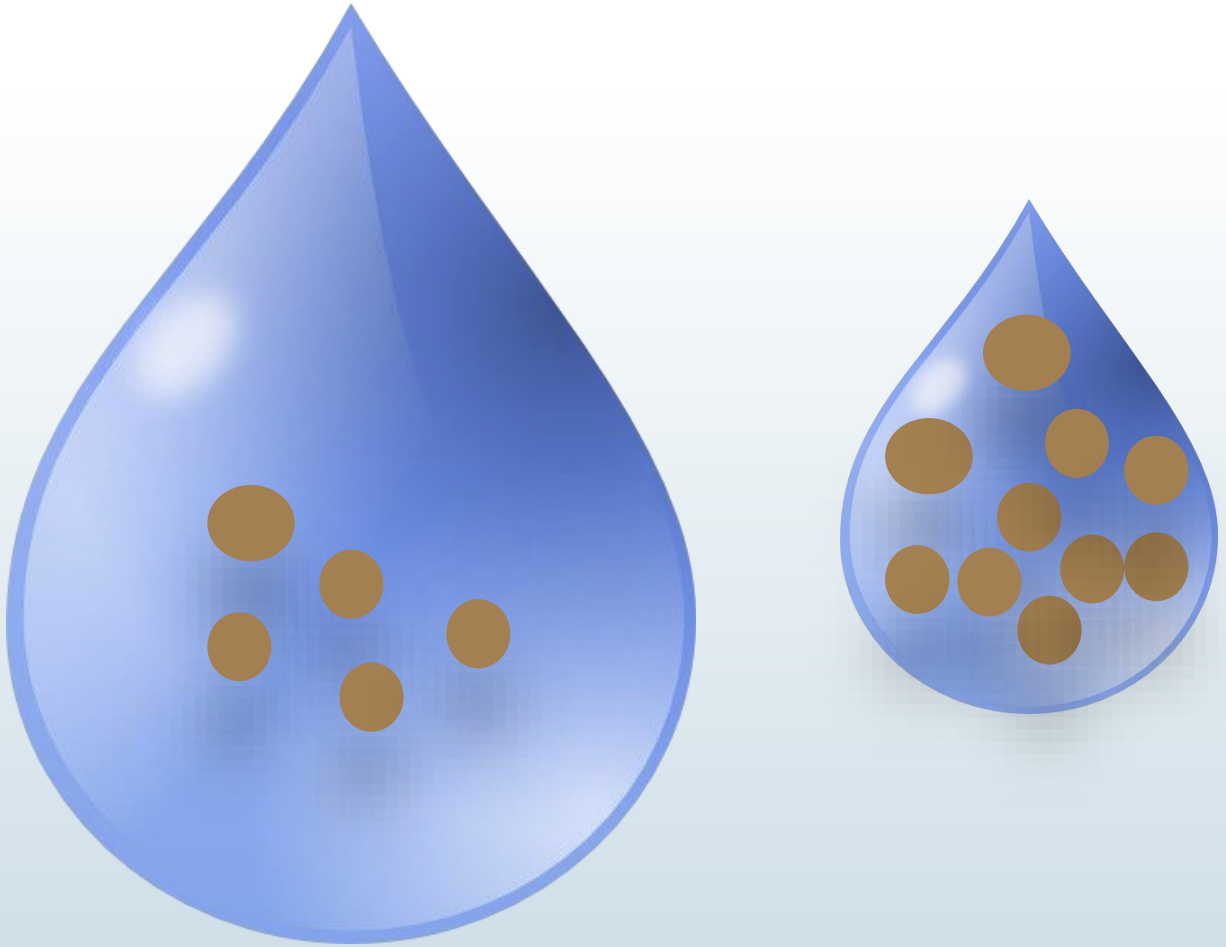


Current wastewater treatment serves

COMFORT & SAFETY!



Concentration v.s. Volume



Water out + Shit in!

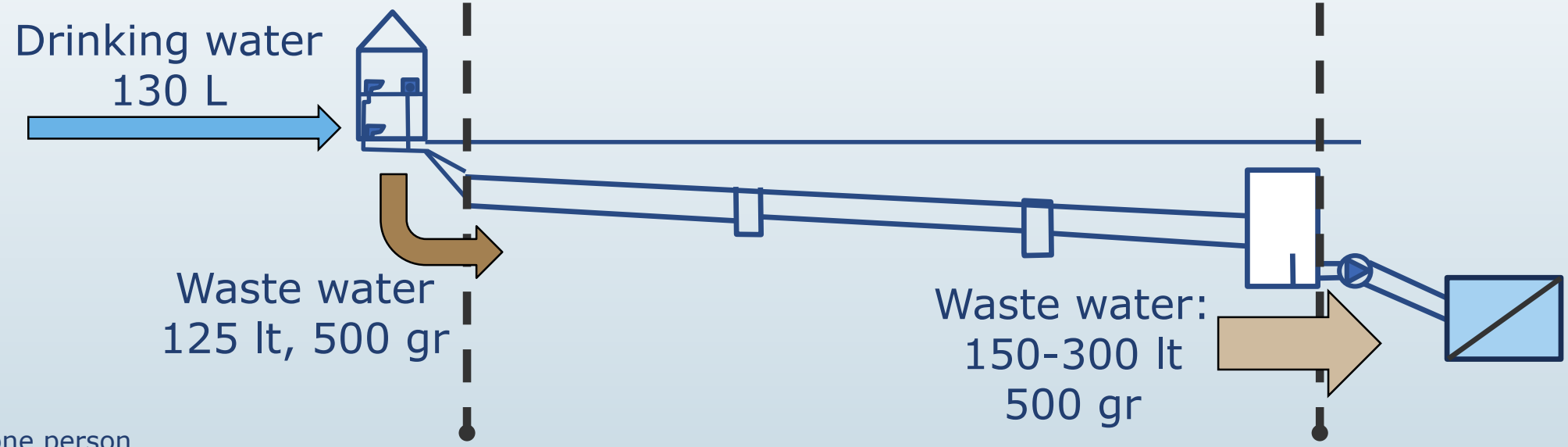
Systematic appraoch is needed!

Domain 1

Individual Water use

Domain 2
Collection & transport
Municipality/Civil engineers

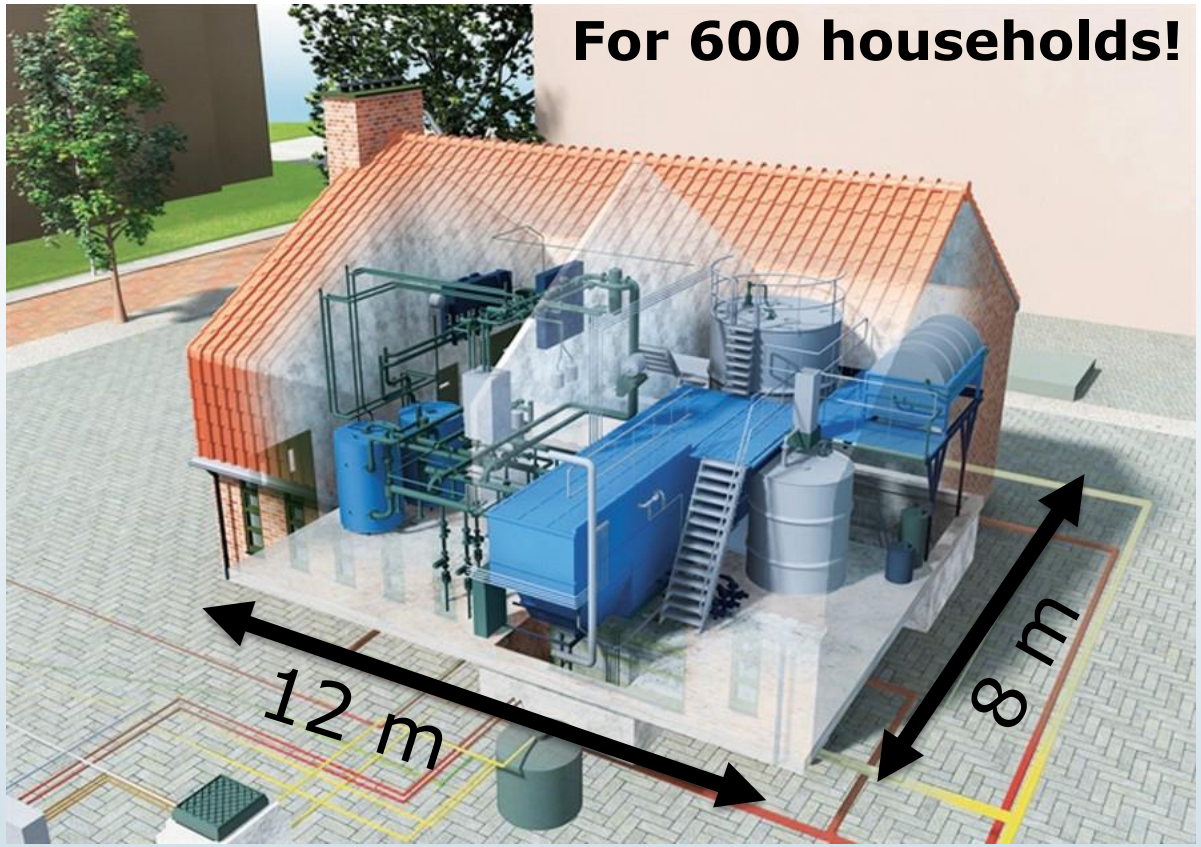
Domain 3
Treatment
Water board/
Civil engineers/
(bio)technologists



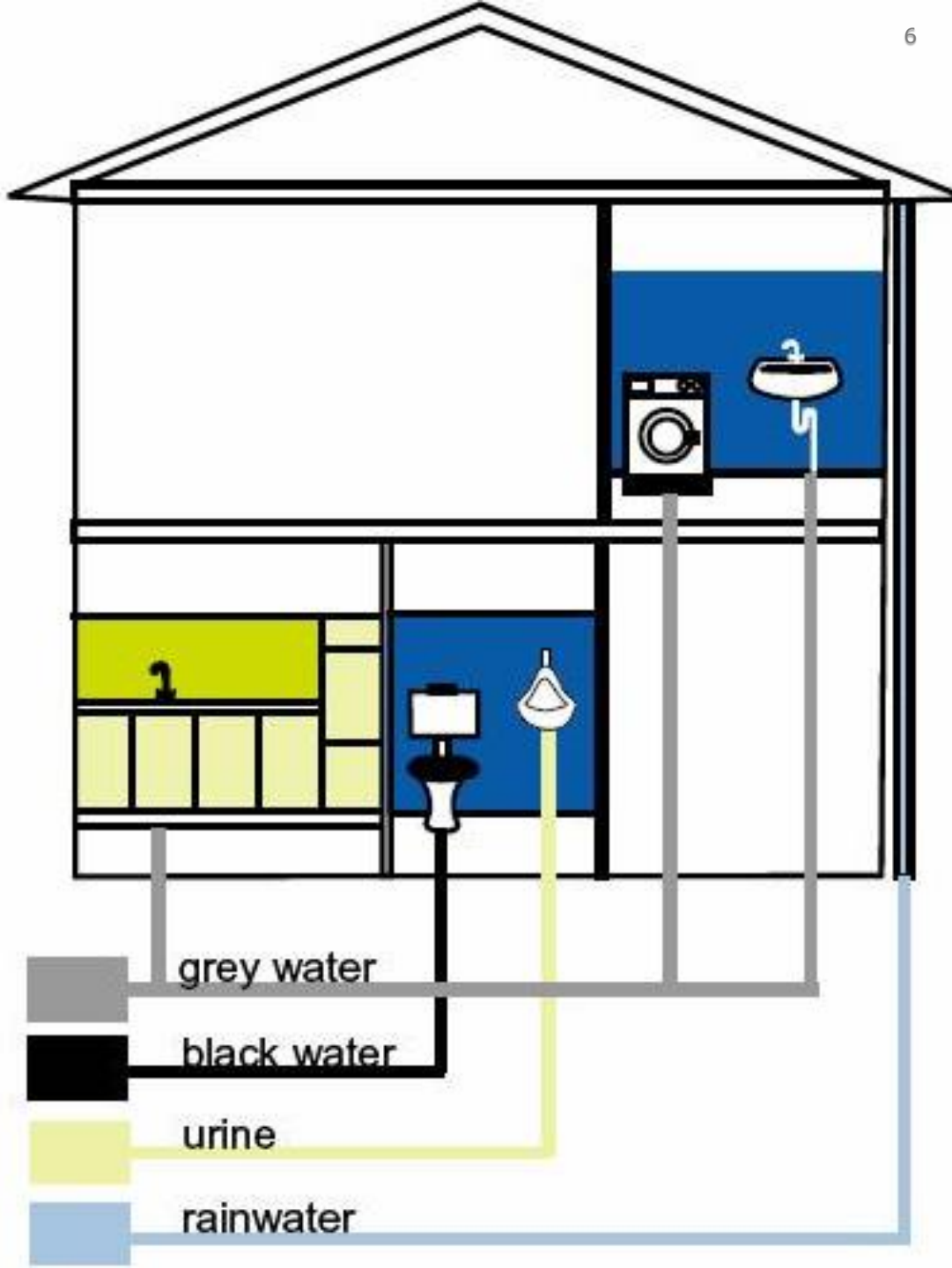
*Data for one person

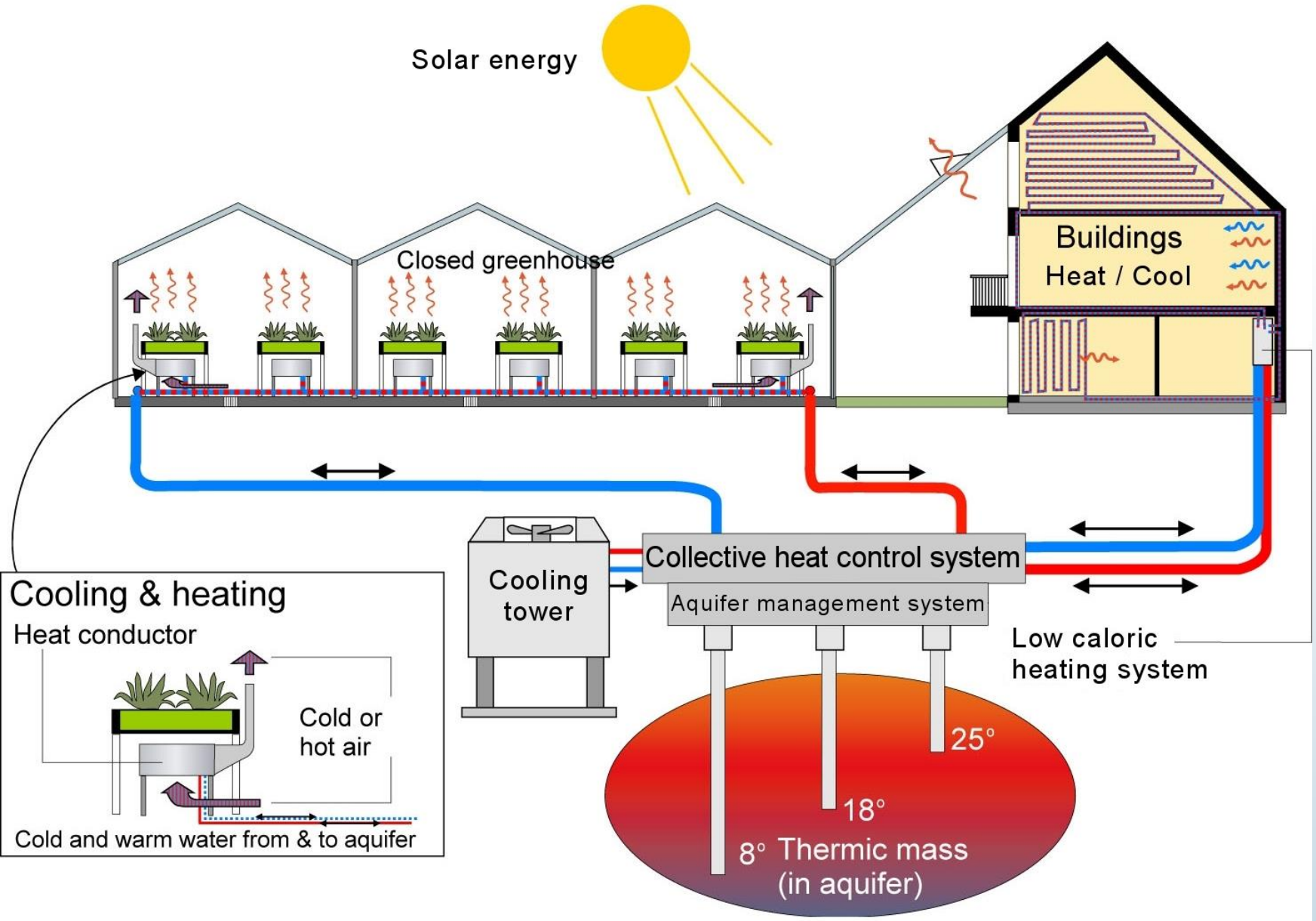
First paradigm shift

Water out by source separation!



Down-scaled WWTP!!





Resource recover & reuse!?

Over-simplified drainage & Use of vacuum

Table 1 – Main characteristics of the references included in the literature review.

Reference	Objective	Boundaries	Process considered	Waste disposal	Phases included	GHG emissions	FU	Impact assessment methodology
(Emmerson et al., 1995)	C techs	D	(1)(2)(ST)(SD)	Yes (Agr)	Op, Const, dem	Direct & indirect	1000 PE, 15 ys	Only inventory
(Roeleveld et al., 1997)	C techs	B	(1)(2)(3)(ST)	No	Op, Const	Direct & indirect	100,000 PE	Not specified
(Tillman et al., 1998)	Water cycle	F	(So)(2)(ST)(SD)	Yes (Agr)	Op, Const	Direct & indirect	1 PE per y	Not specified
(Brix, 1999)	NonC techs	B	(2)(3)	No	Op	No	1 m3	Only inventory
(Mels et al., 1999)	C techs	D	(1)(2)(3)(ST)(SD)	Yes	Op	No	100,000 PE	Only inventory
(Lundin et al., 2000)	Water cycle	H	(So)(2)(SD)	Yes (Agr)	Op, Const	Indirect	1 PE per y	Not specified
(Clauson-Kaas et al., 2001)	C techs	D	(2)(ST)(SD)	Yes (Agr)	Op	Indirect	1 m3	EDIP 2003
(Kärrman and Jönsson, 2001)	Water cycle	H	(DW)(So)(2)(SD)	Yes (Agr)	Op	Indirect	1 PE per y	Not specified
(Lundin and Morrison, 2002)	Water cycle	H	(DW)(2)(ST)(SD)	Yes (Agr)	Op	Indirect	1 PE per y	Not specified
(Vidal et al., 2002)	C techs	C	(2)	No	Op	Direct & indirect	1 Tn	Not specified
(Beavis and Lundie, 2003)	NonC techs	A, G	(2)(3)(ST)(SD)	Yes (Agr)	Op	Direct & indirect	1 ML	Not specified
(Dixon et al., 2003)	NonC techs	C	(2)	No	Op, Const	Direct & indirect	1 PE	Not specified
(Rebitzer et al., 2003)	C techs	F	(1)(2)(ST)(SD)	Yes (Agr)	Op	Indirect	1 PE per y	Not specified
(Clauson-Kaas et al., 2004)	C techs	D	(2)(SD)	No	Op	Direct & indirect	1 L	EDIP
(Hospido et al., 2004)	C techs	F	(1)(2)(ST)(SD)	Yes (Agr)	Op	Direct & indirect	1 m3 per d	CML 2000
(Lundie et al., 2004)	Water cycle	H	(DW)(Sew)(2)(3)(ST)(SD)	Yes (Agr)	Op, Const	Direct & indirect	1 KL	Not specified
(Muñoz et al., 2005)	NonC techs	A	(+)	No	Op	Indirect	1 m3	Not specified
(Tangsubkul et al., 2005)	NonC techs	D	(1)(2)(3)(ST)(SD)	Yes (Agr)	Op, Const	Direct & indirect	1 mL of recycled water	Not specified
(Tangsubkul et al., 2006)	NonC techs	A	(2)	No	Op, Const	Indirect	1 ML per d	Not specified
(Vlasopoulos et al., 2006)	NonC techs	A	(1)(2)(+)	No	Op, Const	Indirect	10,000 m3/d for 15 ys	CML 2000
(Lassaux et al., 2007)	Water cycle	H	(DW)(Sew)(2)(ST)(SD)	Yes (Agr)	Op, Const	Indirect	1 m3	Eco-Indicator 99
(Machado et al., 2007)	NonC techs	F	(2)(SD)	Yes (Agr)	Op, Const, Dem	Direct & indirect	1 PE	CML 2000
(Ortiz et al., 2007)	NonC techs	B	(1)(2)(3)(ST)	Yes	Op, Const, Dem	Indirect	3000 m3/d for 25 ys	CML 2000, Eco-Points 97, Eco-Indicator 99
(Gallego et al., 2008)	C techs	F	(1)(2)(ST)(SD)	Yes (Agr)	Op	Direct & indirect	1 PE per y	CML 2000
(Høibye et al., 2008)	NonC techs	D	(3)(ST)(SD)	Yes	Op	Indirect	1 m3	EDIP
(Hospido et al., 2008)	C techs	F	(1)(2)(ST)(SD)	Yes (Agr)	Op	Direct & indirect	1 PE	CML 2000
(Muñoz et al., 2008)	Impact method	A	(1)(2)	Yes (Agr)	Op	No	1 L	EDIP 97, USES-LCA
(Remy and Jekel, 2008)	Water cycle	H	(So)(2)(ST)(SD)	Yes (Agr)	Op, Const	Indirect	1 PE per y	CML
(Renou et al., 2008)	Impact method	D	(1)(2)(ST)(SD)	Yes (Agr)	Op, Const	Indirect	1 m3 per y	CML 2000, Eco-Indicator 99, Ecopoint 97, EDIP 97, EPS
(Wenzel et al., 2008)	NonC techs	D	(3)(SD)	Yes	Op	Indirect	1 m3	EDIP 2003
(Nogueira et al., 2009)	NonC techs	D	(2)(SD)	Yes (Agr)	Op, Const	Direct & indirect	1 PE	CML 2000
(Pasqualino et al., 2009)	C techs	F	(1)(2)(ST)(SD)	Yes (Agr)	Op	Indirect	1 m3	CML 2000
(Flores-Alsina et al., 2010)	C techs	F	(2)(ST)(SD)	Yes (Agr)	Op	Direct & indirect	753,3 Hm3	CML 2000
(Foley et al., 2010b)	NonC techs	D	(+)(ST)(SD)	Yes	Op, Const	Direct & indirect	2200 m3/d at 4000 mg COD/l over 10 ys	IMPACT 2002+
(Foley et al., 2010a)	C techs	F	(1)(2)(ST)(SD)	Yes (Agr)	Op, Const	Direct & indirect	10 ML/d over 20 ys	Only inventory
(Larsen et al., 2010)	NonC techs	D, F	(1)(2)(3)(+)(ST)(SD)	Yes (Agr)	Op, Const, Dem	Direct & indirect	1 m3	EDIP97
(Stokes and Horvath, 2010)	C techs	H	(1)(2)(ST)(SD)	Yes (Agr)	Op, Const	Direct & indirect	1 Ml	Not specified

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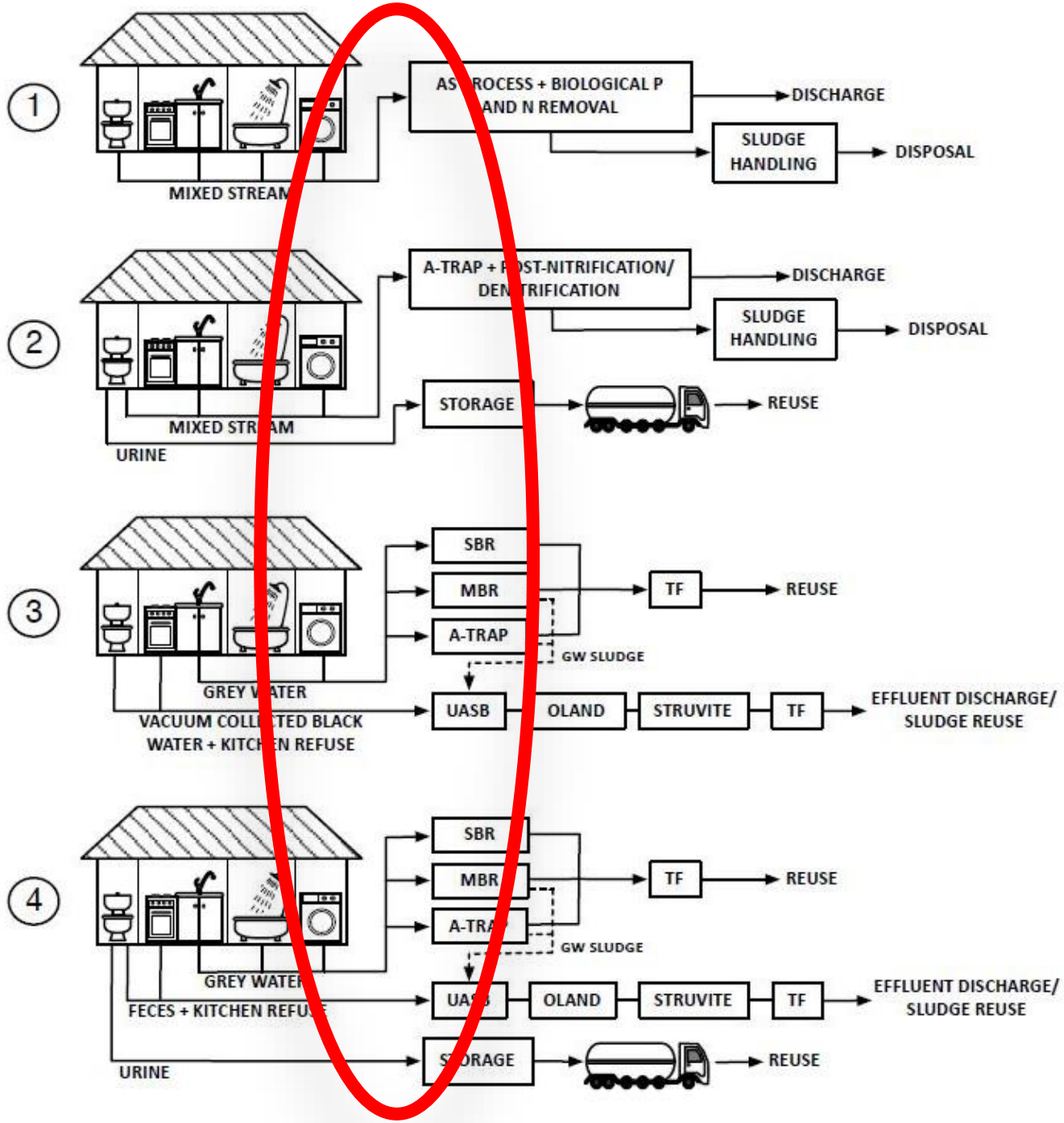


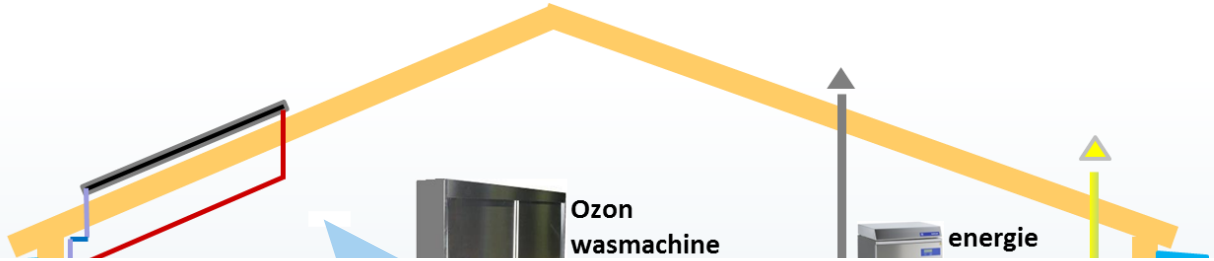
Tervahauta T, Hoang T, Hernández L, Zeeman G, Buisman C. Prospects of Source-Separation-Based Sanitation Concepts: A Model-Based Study. Water. 2013;5(3):1006.
Corominas L, Foley J, Guest JS, Hospido A, Larsen HF, Morera S, et al. Life cycle assessment applied to wastewater treatment: State of the art. Water Research. 2013;47(15):5480-92.

Second paradigm shift

Domain 1, water out by…

Water-saving home appliance

Behavioral change/Climate stress



Top 5 drinkwater in huis (1995-2013)

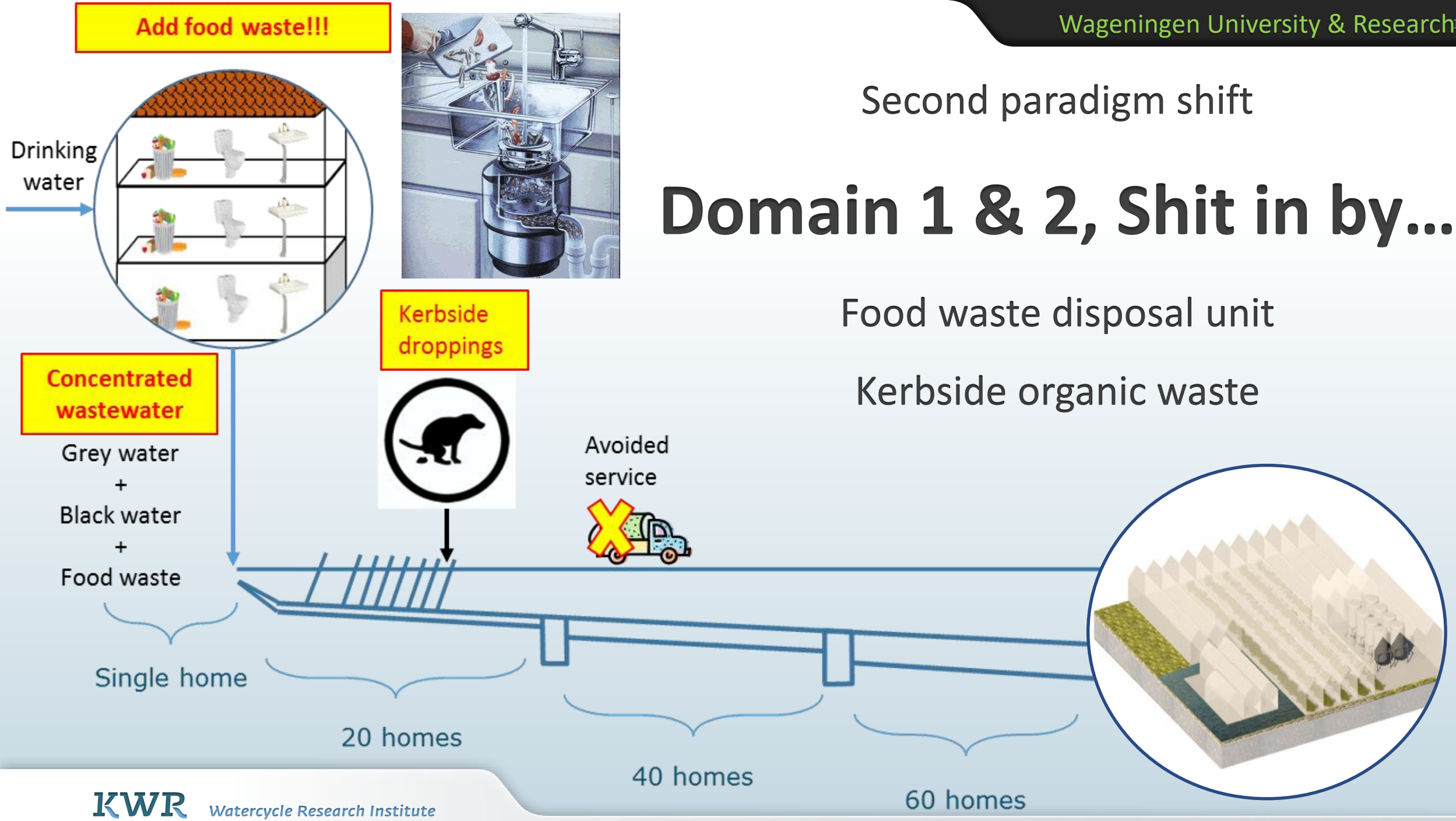
		1995	1998	2001	2004	2007	2010	**2013**
1	Douche	38,3	39,7	42,0	43,7	49,8	48,6	51,4
2	Toiletspoeling	42,0	40,2	39,3	35,8	37,1	33,7	**33,8**
3	Wasmachine	25,5	23,2	22,8	18,0	15,5	14,3	**14,3**
4	Wastafel	4,2	5,1	5,2	5,1	5,3	5,0	**5,2**
5	Afwassen, hand	4,9	3,8	3,6	3,9	3,8	3,1	**3,6**
	Totaal	137,1	131,9	130,7	123,8	127,5	120,1	**118,9**

Second paradigm shift

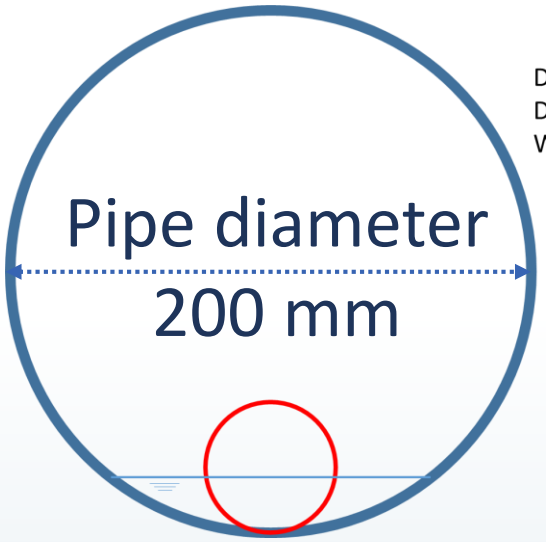
Domain 1 & 2, Shit in by…

Food waste disposal unit

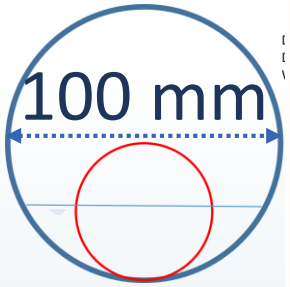
Kerbside organic waste

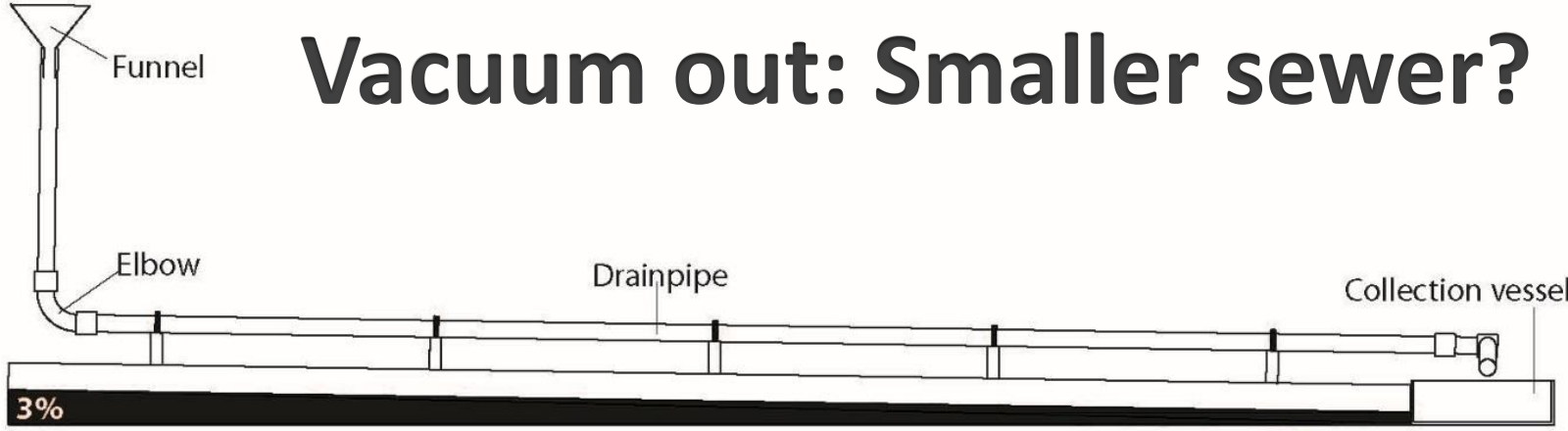


Vacuum out: Smaller sewer?

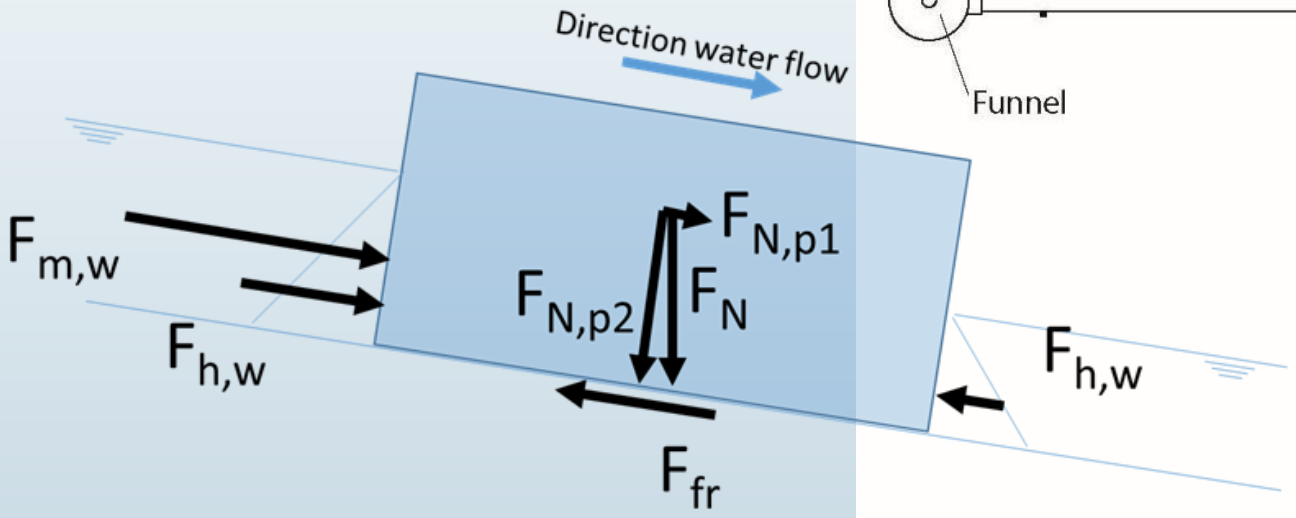


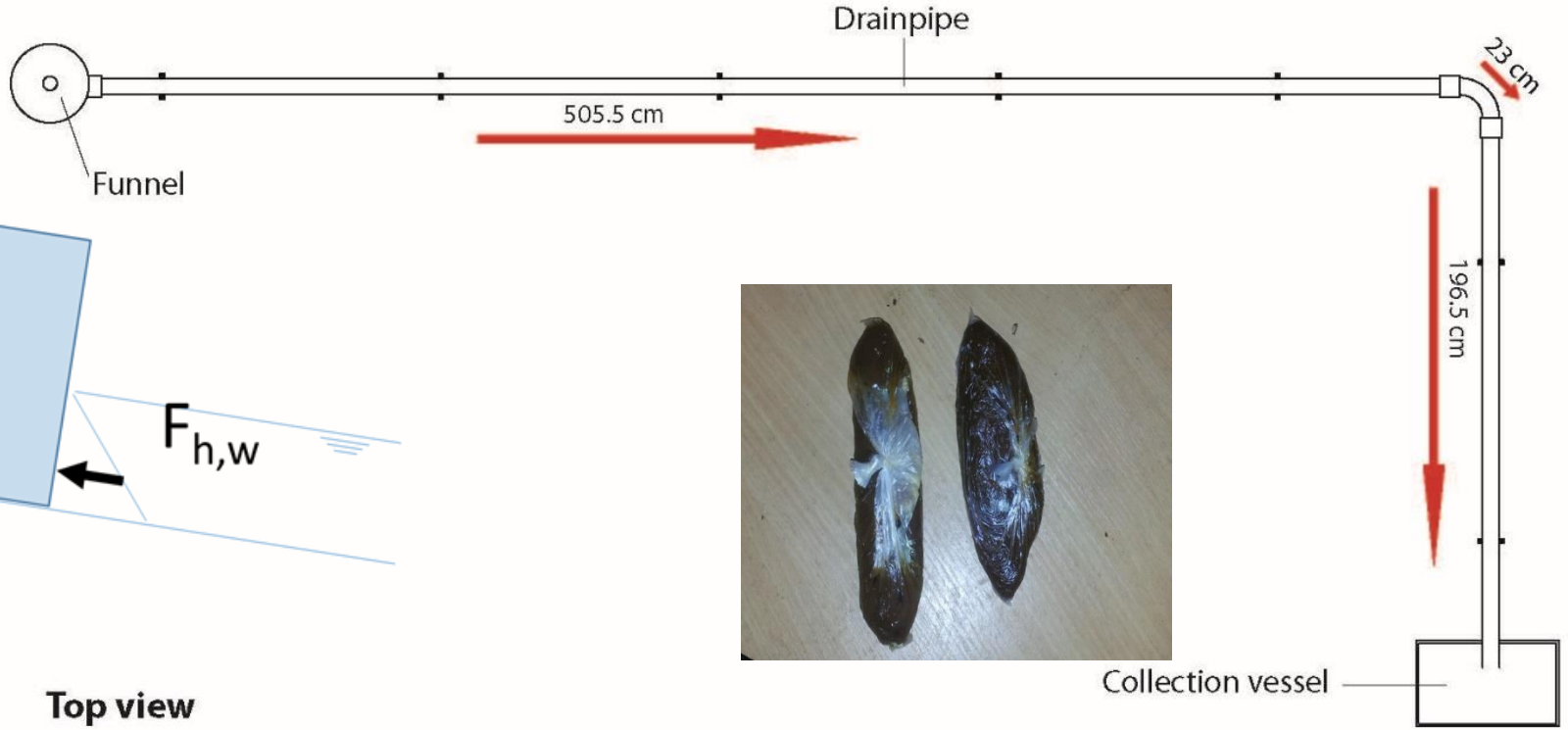
Diameter leiding: 200
Diameter object: 50
Waterdiepte: 21,5





Side view



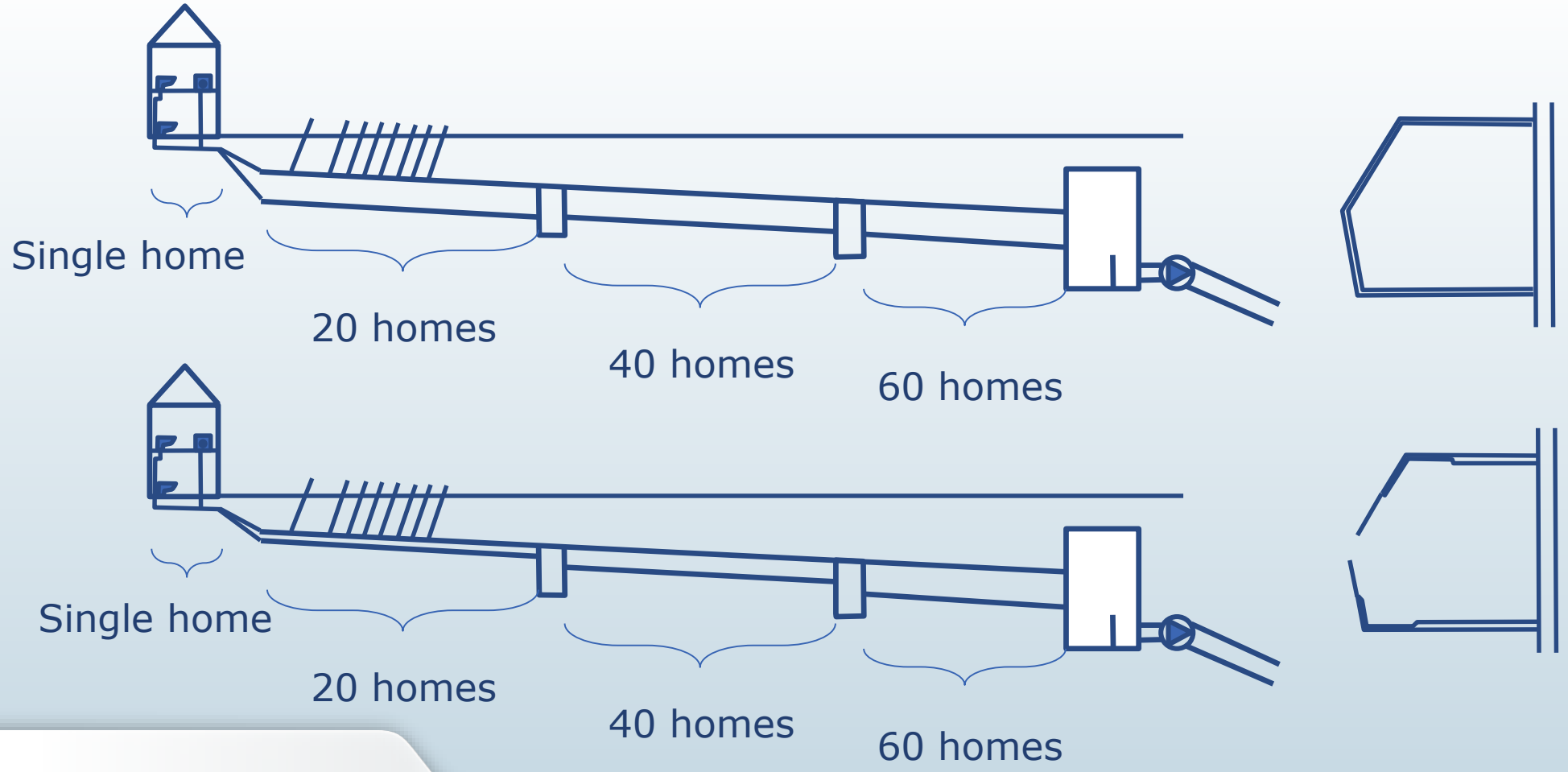


Top view

Rationally re-designed the sewer!

Bigger & looped v.s. Smaller & branched!

Disconnect rain water → Different size, less misconnection!



The Future Street: a boulevard for urban innovations!

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Summary & Future work

- Needs for resource recovery → Waste volume and conc. matter!
- Scale down the resource cycle → bring RECOVER & REUSE to USE!

- Smaller sewer → Better transport, less misconnection & cheaper?
- 1L flush toilet → Still needed to avoid vacuum!
- On-going living lab → Embrace & test more urban innovations!

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