Alternative wastewater treatment at Þingvellir

Research projects at the University of Iceland

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Overview

- Introduction to research projects
- Wastewater sources and amount
- Treatment and toilet solutions analyzed
- Recommended solutions by the students
- Conclusions

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Research Projects at HÍ

- Course: Water Supply and Wastewater Treatment Systems
  - Civil and environmental engineering students on 3.-5. year
- Group work
  - 11 students, 3 groups
  - Each group focused on different areas within the protection area of Þingvallavatn
- Areas focused on
  - Hakið (Visitor Centre)
  - Information Centre and camping sites (þjónustumiðstöð og tjaldstæði)
  - Cottages

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Treatment and toilet solutions analyzed

Three solutions analyzed by students in hence of **tehnical**, **environmental** and **social aspects**

1. Transportation of wastewater
   a) Drive all wastewater from the area to Klettagarðar treatment plant in Reykjavík
   b) Drive all wastewater to a central treatment plant *within* the area

2. Source separation solutions and/or composting toilets

3. Natural treatment systems and pre-fabricated on-site treatment plants

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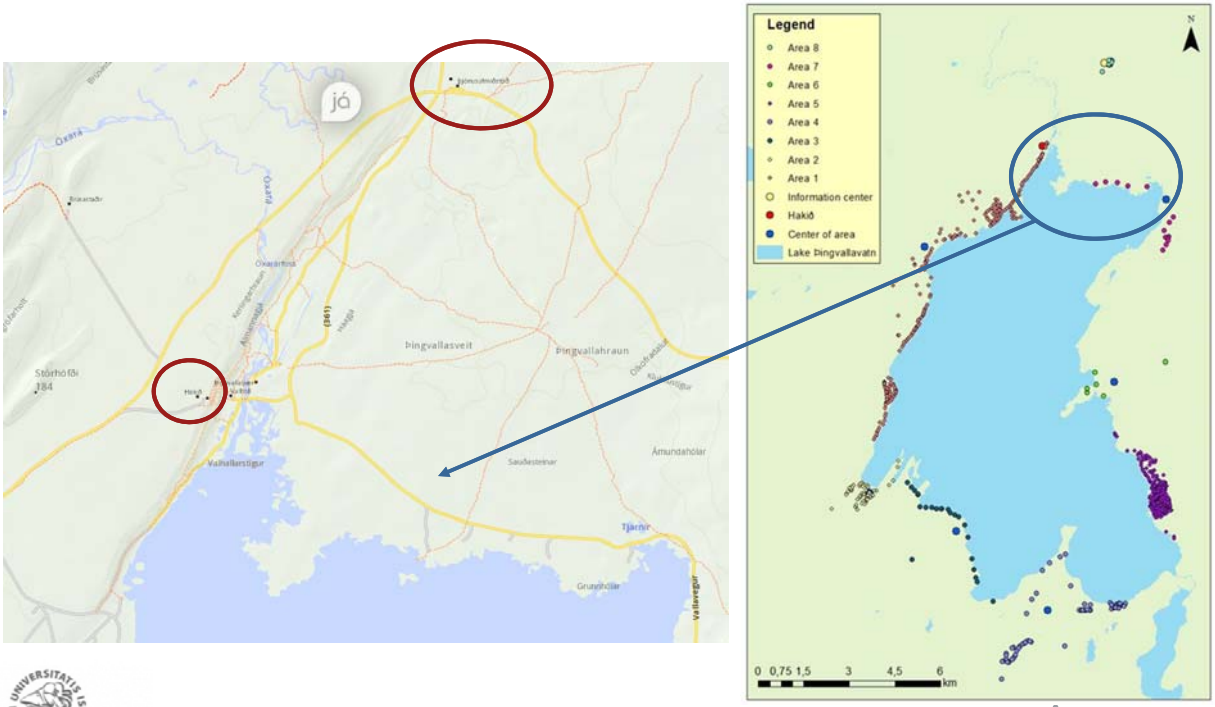
Þingvellir – Sources of wastewater



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Wastewater sources

- **Cottages**
  - Used all year round
  - 629 cottages around Lake Þingvallavatn
  - Different treatment methods
  - Septic tanks in many cases old and/or too small
  - Septic tanks sometimes located within protection zone of drinking water wells

- **Hakið** (Visitor Center)
  - Open all year
  - 22 WC and sinks
  - Tertiary treatment plant

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Wastewater sources

- **Information Center** (í. Þjónustumiðstöð)
  - Open all year
  - 16 WC + 4 showers + 2 washing machines for guests
  - Septic tank and leach bed

- **Camping sites**
  - Open during summer (May-August)
  - Camping site 1: 4 WC + 2 showers
  - Camping site 2: 3 WC and hand washing facilities
  - Camping site 3: 2 WC and hand washing facilities
  - Closed tanks (3000-5000 L), emptied when needed

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Wastewater amount – summer

Cottages

- 4 persons each visit
- Occupied 50% of the summer

Hakið

- 80% of visitors in Þingvellir
- 75% visit restrooms

Information center

- 30% visitors in Þingvellir
- 75% visit restrooms

Camping sites

- 6000 overnight stays each summer

Total number of tourists in Þingvellir: Approx. 650,000 pr. year

Summer					
		Amount of wastewater [l/pers/day]		Total [m3/summer]	
	Number of persons	Greywater	Blackwater	Greywater	Blackwawter
Cottages	113896	118.3	1.7	13473.9	193.6
Hakið	216000	11	0.3	2376	64.8
Information cent.	81000	11	0.3	891	24.3
Camping site	6000	52.25	0.9	313.5	5.4
Total				**17054.4**	**288.1**
				17342.5	

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Wastewater amount - winter

Cottages

- 4 persons each visit
- Occupied every third weekend

Hakið

- 80% of visitors in Þingvellir
- 75% visit restrooms

Information center

- 30% visitors in Þingvellir
- 75% visit restrooms

Winter					
		Amount of wastewater [l/pers/day]		Total [m3/winter]	
	Number of persons	Greywater	Blackwater	Greywater	Blackwater
Cottages	103992	118.3	1.7	12302.3	176.8
Hakið	183000	11	0.3	2013.0	54.9
Information cent.	68625	11	0.3	754.9	20.6
Camping site	0	0	0	0.0	0.0
Total				**15070.1**	**252.3**
				15322.4	

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Treatment and toilet solutions analyzed

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1. Transportation of wastewater
   a) Drive all wastewater from the area to Klettagarðar treatment plant in Reykjavík
   b) Drive all wastewater to a central treatment plant *within* the area
2. Source separation solutions and/or composting toilets
3. Natural treatment plants and pre-fabricated mini treatment plants

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Transportation of wastewater

- Aim of the analysis
  - To calculate the amount of wastewater from the different sources
  - To calculate the number of kilometers driven annually
    - Transportation to Reykjavík (Klettagarðar)
    - Transportation to a central treatment plant (location chosen by students)

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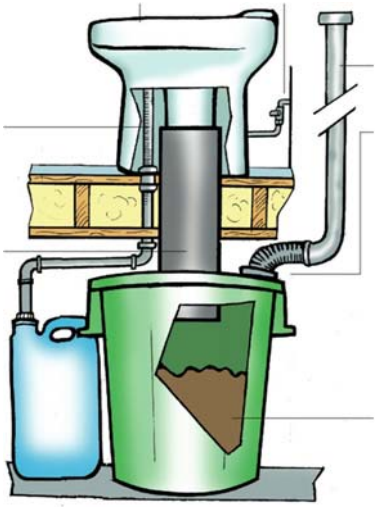
Source separation systems

- Urine diverted from the faecal matter
- Water usage: 0.1-4.0 L/flush
- „Clean“ urine ➔ Reuse of urine
- Minimized risk of odor (comes from mixing of faecal matter and urine)
- Possibility to reuse the human excreta
  - Composted faecal matter
  - Stored urine



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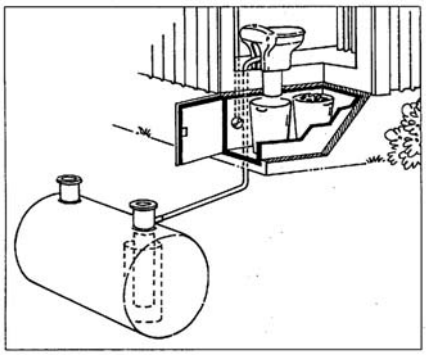
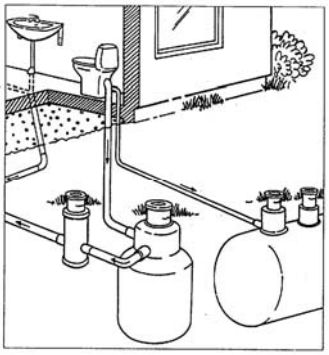
Single and dual flush urine diverting toilets



Single flush system



Dual flush system

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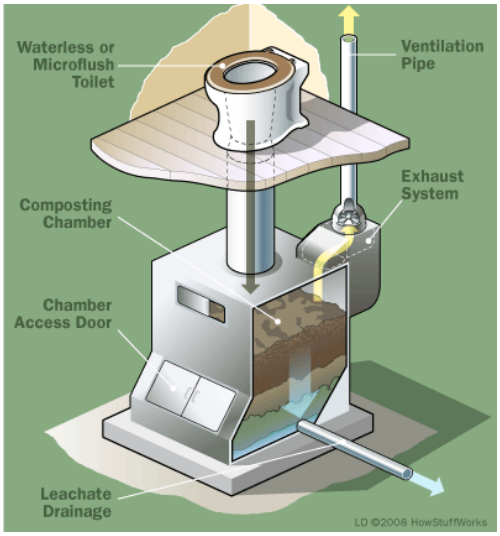
Composting toilets

- Urine not diverted from the faecal matter
  - Mixing of faecal matter and urine
  - Urine drainage afterwards
- Water usage: 0,1-1,0 L
- Ventilation important
- Composting in cold climate is slow
  - External heating an advantage
- Waste reduced to 10-30% of original volume



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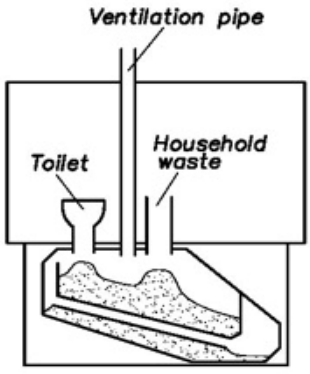
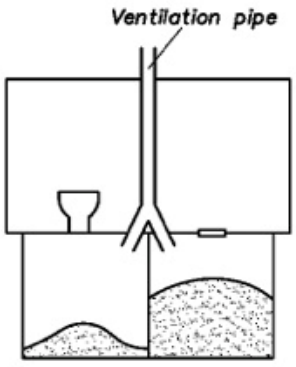
Composting toilets





A: Single chamber B. Dual chamber C: Removable compartments

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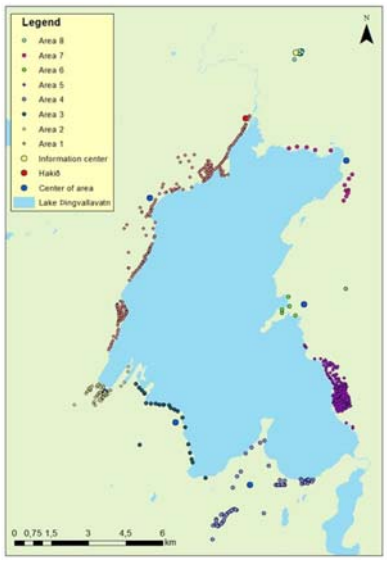
Transportation of wastewater to Klettagarðar, Reykjavík

- Exchange of septic tanks for closed tanks would be needed

- Travelling distances
  - Area divided into eight smaller areas
  - Distance from each area to Hakið (chosen locality by all groups) and Klettagarðar measured
    - Addition of 6 km due to smaller roads

Distance to a central treatment plant at Hakið:
272.234 km/year
Distance to Reykjavík:
892.696 km/year



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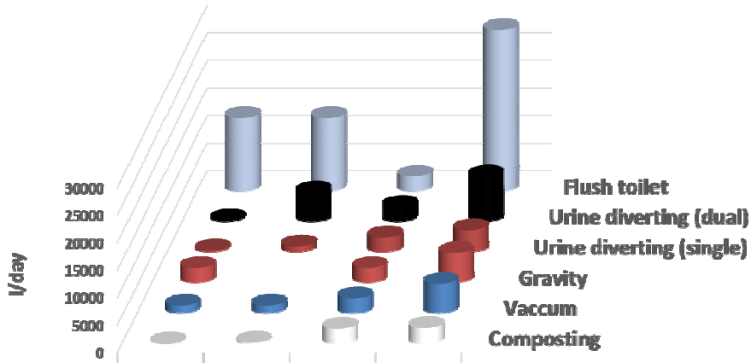
Recommended solutions
Hakið (Visitor Centre)



	1	2	3	4
Composting	0	133	2664	2797
Vaccum	1332	1332	2664	5328
Gravity	2664		2664	5328
Urine diverting (single)	266	1066	2664	3996
Urine diverting (dual)	266	5328	2664	8258
Flush toilet	13320	13320	2664	29303

Brownwater, yellowwater, greywater, total

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Recommended solutions
Hakið (Visitor Centre)

- Recommended to use a combination of
  - Single flush urine diverting toilets, and
  - Waterless urinals

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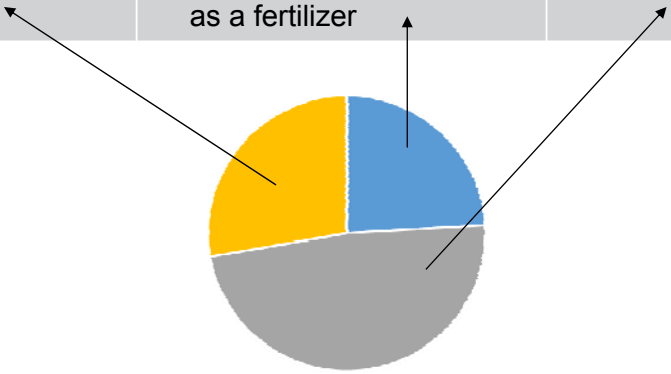
Recommended solutions
Hakið (Visitor Centre)

Yellowwater	Brownwater	Greywater
• Collect in tanks and use it as a fertilizer (if allowed by the authorities)	Collect in tanks • Can be transported to Reykjavik wastewater treatment plant • OR composted and used as a fertilizer	• Relatively clean • Use filters (sand, bio, etc) • Released directly back to environment



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Recommended solutions
Hakið (Visitor Centre)

- **Advantages**
  - Little water for flushing
  - Separation of grey, brown and yellow water
  - System resembles regular toilets
  - Environmentally friendly
  - Keeps the image of Iceland as “environmental friendly country”
- **Disadvantages**
  - New toilet and collection systems have to be installed
  - Toilets not available in Iceland
  - Possible odor problems (?)

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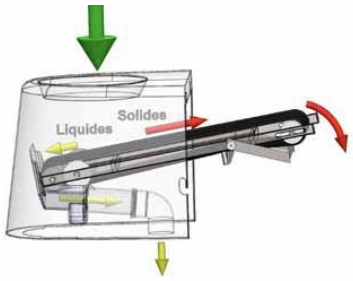
Recommended solutions
Information Centre and Camping Sites

- Dry composting toilets recommended due to
  - Low cost
  - Strong sustainability credentials
  - Long term solution if well maintained
  - Easy to use
  - Eliminates flushing water requirement
  - Social aspects: Explanations needed for users unfamiliar to composting toilets



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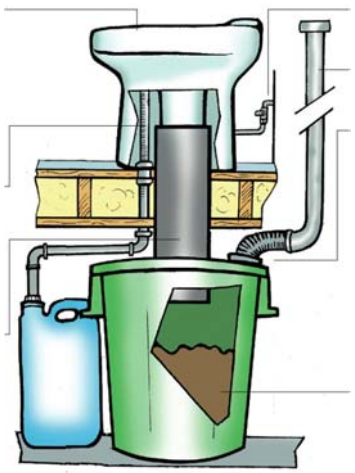
Recommended solutions
Cottages

- Blackwater
  - Recommended to use single flush urine diverting toilets
  - Reuse of urine (stored) and compost within or outside the area
- Greywater
  - Treated in septic tanks
  - Most of the impurities gone
  - Discharge to leach bed



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Recommended solutions
Cottages

Single flush urine diverting toilets

Technical aspects
- Installation for cottage owners
- Ventilation / Heating system

Social
- Adjustment for cottage users
- Dry toilets unusual
- Odor

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Conclusions

- Transportation not recommended by any of the groups
  - High diesel cost
  - Road damages
  - Increased traffic within a sensitive area ➔ Increased release of greenhous gasses

- **Information Center and camping sites:** Dry composting toilets recommended
- **Hakið:** Single flush urine diverting toilets + waterless urinals recommended**.** Filtration for grey water.
- **Cottages**: Single flush urine diverting toilets for blackwater. Septic tanks for grey water.

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Conclusions

- Difficult to find pre-fabricated on-site treatment plants that fulfil the treatment criteria

- Uncertain if natural treatment systems can be used in the area ➔ Further studies on soil conditions etc. are needed

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