Is There a Reinvented Toilet in Your Future?

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Today's Presentation

- Development of the ISO Product Standard
- Performance requirements for RTs in the new ISO Standard
- Main technology paths
- Likely applications of RTs in North America
- The emerging regulatory framework

The materials being presented represent the presenters' own opinions, and do NOT reflect the opinions of NOWRA.

From RT Concept to ISO Standard

- 2014-2015: Gates Foundation private standard development
- May 2016: ISO International Workshop Agreement (IWA 24:2016): Singapore
  - NOTE: NRDC participation began at IWA stage.
- Sept 2016: ISO Project 30500 Committee organized
- May 2018: Final ISO PC 30500 plenary: Katmandu
- Oct 2018: ISO 30500 published

What is a non-sewered sanitation system (NSSS) under the ISO Standard?

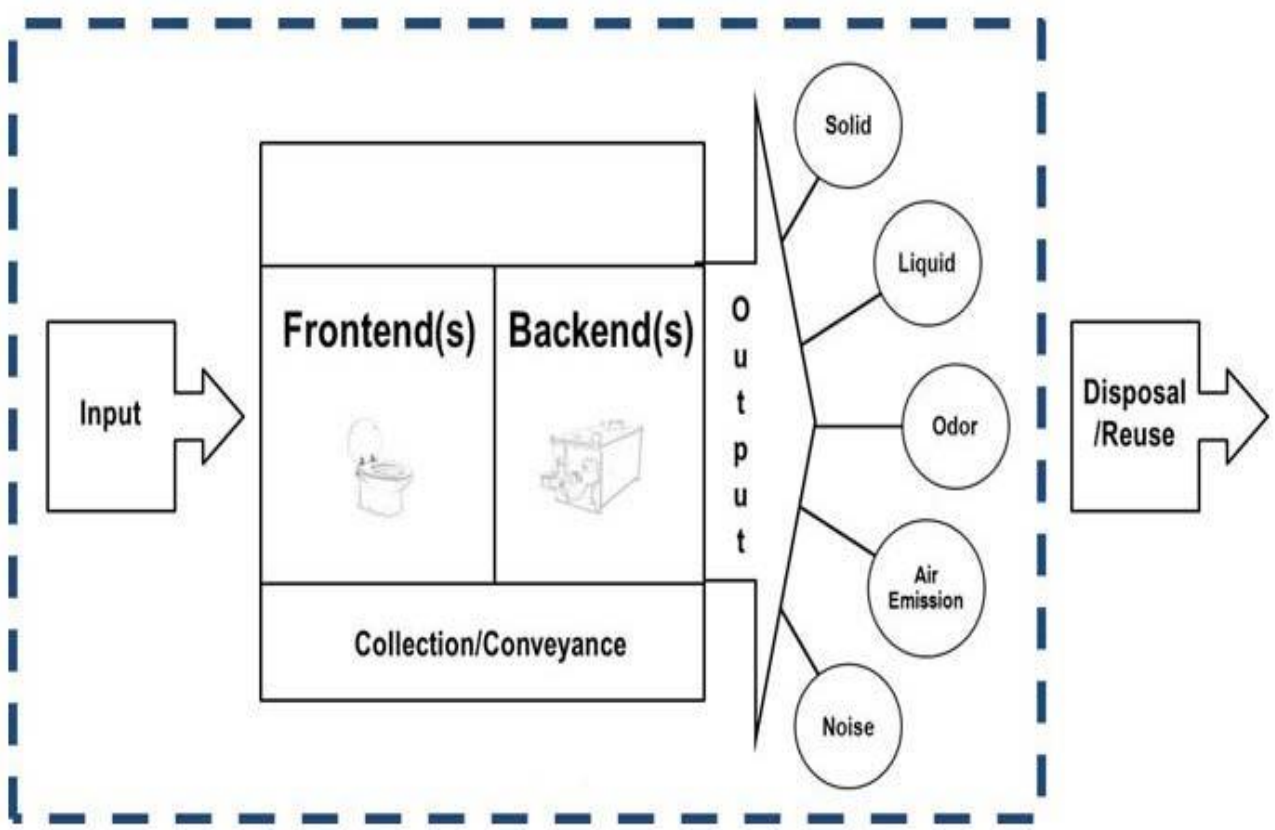


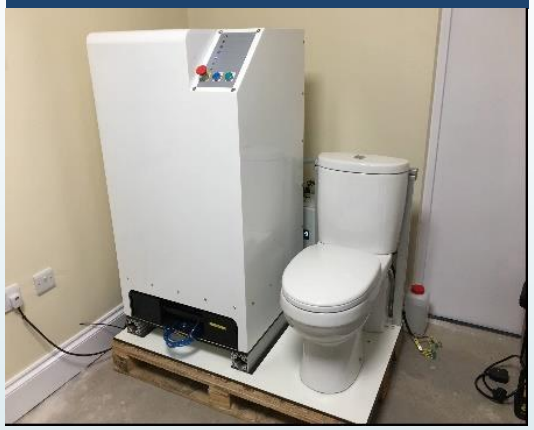
Figure 1: Scope of standard

- A device that isn't connected to a sewage system and collects and fully treats the input (human excrement) into a safely reusable or disposable output
- Packaged, not site-built
- How do they work?
  - combustion
  - electrochemical reaction
  - biological treatment
  - combos of the above

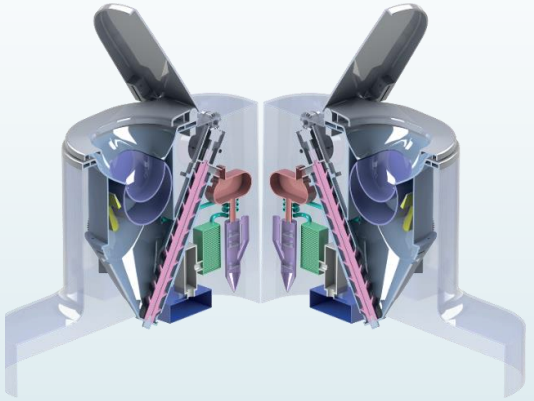
Core Processing Technologies

- **ELECTROCHEMICAL**

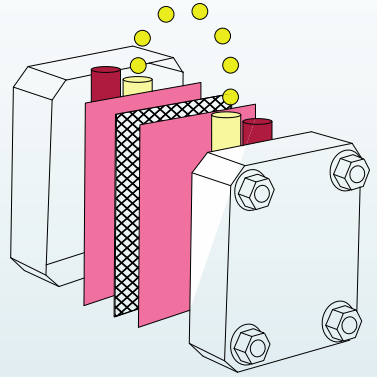
- **WET OXIDATION**



- **DRY COMBUSTION**



- **BIOLOGICAL**



Caltech

helbling

eawag aquatic research

Duke University

University of Toronto

Duke University

RTI International

Cranfield University

SEDRON Technologies

USF University of South Florida

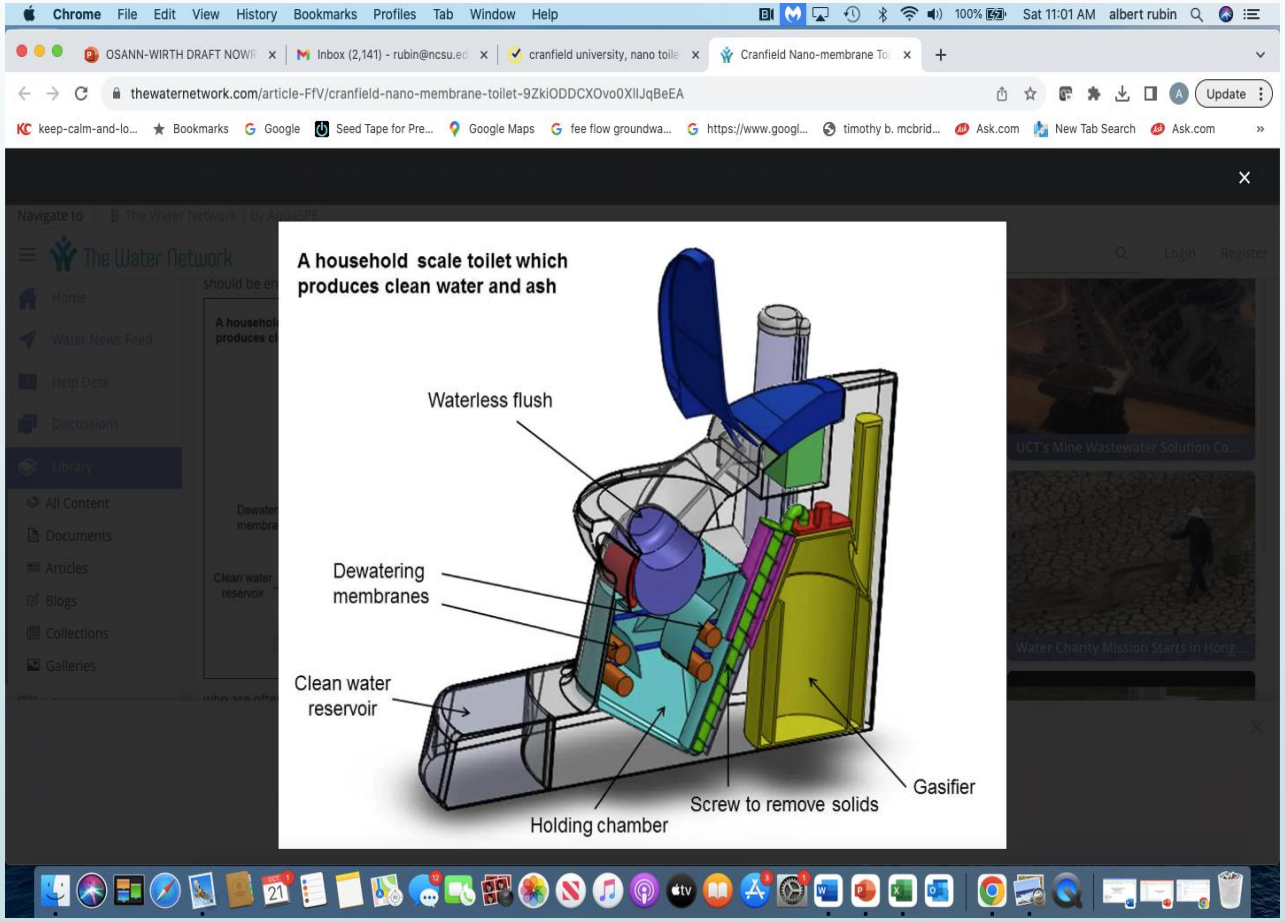
UWE Bristol

Stanford University

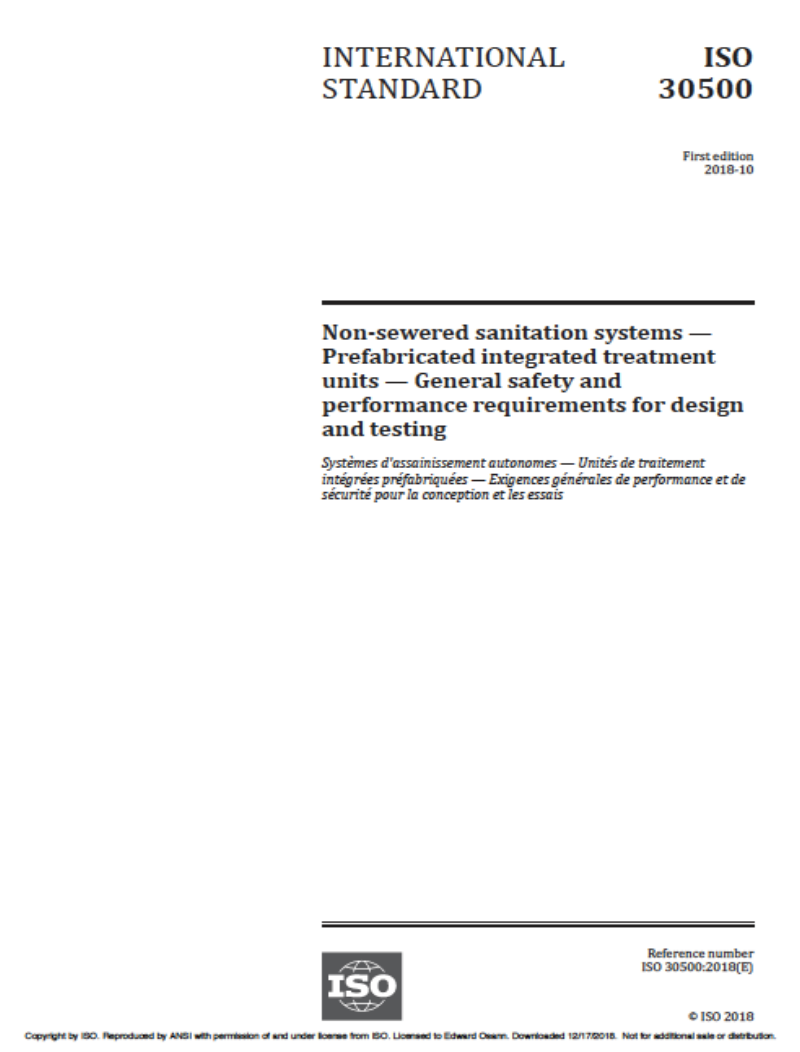
Columbia University in the City of New York

Cranfield University, Nano-Toilet

- Multiple Processes
  - Solid/liquid separation
  - MBR
  - Vaporization
  - Condensation
  - Reuse
  - Manual solids removal
- Awarded UK Best of 100 innovation awards
- Market ready



ISO 30500 : Performance Requirements and Test Procedures



INTERNATIONAL STANDARD

ISO 30500

First edition
2018-10

Non-sewered sanitation systems — Prefabricated integrated treatment units — General safety and performance requirements for design and testing

Systèmes d'assainissement autonomes — Unités de traitement intégrées préfabriquées — Exigences générales de performance et de sécurité pour la conception et les essais

Reference number
ISO 30500:2018(E)

- Product definition
- Performance Requirements:
  - Solid output and effluent
  - Odor
  - Noise
  - Air emissions
- Requirements for components and materials
- Requirements for safety and reliability
- Test procedures
- User interface requirements

ISO 30500 :Performance Requirements for Solid Output

Table 4 — Solid output validation thresholds and log reduction values (LRVs) for human health protection

Parameter (Pathogen class)	Human enteric bacterial pathogens	Human enteric viruses	Human enteric Helminths	Human enteric Protozoa
Surrogate	using *E. coli*[b] as surrogate, measured in CFU or MNP	using MS2 Coliphage as surrogate, measured in PFU	using *Ascaris suum* viable ova as surrogate	using viable *Clostridium perfringens* spores as surrogate, measured in CFU
Max. concentration in solids [number/g (dry solids)]	100	10	< 1	< 1
Overall LRV for solid[a]	≥ 6	≥ 7	≥ 4	≥ 6

[a] Log-reduction values (LRVs) were derived from a quantitative microbial risk assessment (QMRA) as described by WHO 2016, assuming 1 g of faecal solids contains approximately the same range of reference pathogens as in 1 l of liquid effluent (for LRVs derived in Table 5). For further information, see Reference [61] and Reference [72].

[b] *E. coli* strain KO11 (ATCC 55124) is selected because it is chloramphenicol resistant. Therefore, this antibiotic may be added to the plating medium to suppress the growth of other, interfering bacteria.

ISO 30500 : Performance Requirements for Liquid Effluent

Table 5 — Liquid effluent validation thresholds and log-reduction values (LRVs) for human health protection

Parameter (Pathogen class)	Human enteric bacterial pathogens	Human enteric viruses	Human enteric Helminths	Human enteric Protozoa
Surrogate	using *E. coli*[b] as surrogate, measured in CFU or MPN	using MS2 Coliphage as surrogate, measured in PFU	using *Ascaris suum* viable ova as surrogate	using viable *Clostridium perfringens spores* as surrogate, measured in CFU
Max. concentration in liquids (number/l)	100	10	< 1	< 1
Overall LRV for liquid[a]	≥ 6	≥ 7	≥ 4	≥ 6

[a] Log-reduction values (LRVs) were derived from a quantitative microbial risk assessment (QMRA) as described by WHO 2016. For further information, see Reference [61] and Reference [72].

[b] *E. coli* strain KO11 (ATCC 55124) is used because it is chloramphenicol resistant. Therefore, this antibiotic may be added to the plating medium to suppress the growth of other, interfering bacteria.

ISO 30500: Air Emission Requirements

Table 11 — Indoor air emission thresholds

Parameter and Emission thresholds (average levels over indicated timeframe)

- CO (ppmv) 1 h: 28
- NOx (ppbv) 1 h: 99
- SO2 (ppbv) 1 h: 6.8
- CO2 (ppmv) 1 h: 1 000
- H2S (ppbv) 30 min: 4.6
- VOCs (ppbv) 1 h: 187
- PM2,5 (µg/m3) 1 h: 25
- NH3 (ppmv) 1h: 25

Table 12 — Outdoor exhaust or vent air emissions thresholds

Parameter and Emission thresholds (1 h average)

- CO (ppmv) 80
- SO2 (ppmv) 68
- NOx (ppmv) 195
- VOC (ppmv) 12
- H2S (ppmv) 1.9
- PAH (ppmv) 0.001
- PM2,5 (mg/m3) 10
- NH3 (ppmv) 50

Other Key Requirements

- Odor – Using pre-screened panelists, a max of 10% of reports are rated "unpleasant" and a max of 2% are "unacceptable"
- Noise – an average of 60 dbA over 24 hrs and a max of 85 dbA at any time
- Visibility – No visibility of any accumulation of feces from previous users
- User manual – required, along with any specialized tools needed for maintenance
- Maintenance – product designed to allow users without technical expertise to perform routine user maintenance

ISO 30500: Test Procedure Overview -- Laboratory and Field Testing Required

Laboratory Testing

- 32-day test period
- Use of actual human waste, spiked as necessary with surrogates for human pathogens
- Normal loading and challenge loading
- Includes stop and start sequences simulating usage patterns
- Energy shut-off
- Overload protection

Field Testing

- 30 days for non-biological systems
- 5 months for biologically-based systems
- Input to be collected and analyzed for one week in advance of testing for reference
- Tested weekly while in actual use by intended users
- Testing for three pathogens: helminth requirements deemed met by protozoa requirements

Non-sewer-based Sanitation Technology Commercial Status - 2023

Technology Category	Commercial Supplier	Product Status
Public/Community RT	Clear (China)	Ready for market
	EcoSan (China)	Ready for market
	EnviroLoo (South Africa)	Ready for market
	Eram [liquid] (India)	Technology licensed
	SCG (Thailand)	Ready for market
Household RT	Cranfield (UK)	Technology licensed
	EcoSan [gray & black wtr] (China)	Ready for market
	Huatie (China)	Technology licensed
	Prana [liquid] (South Africa)	Ready for market
	Rossi (South Africa)	Technology licensed
	SCG [liquid] Thailand	Ready for market

Next Steps Toward Commercialization in the US

- Identify demonstration sites and stakeholders in the US
- State and local adoption of RT-ready plumbing codes
- Encourage state health agency leadership (3 to 5 states) in policy development
- Develop model language for health agency permitting, by use case.

Building toward Scale Potential in the US Market in 2024-2026 Period

Early Demonstration and Data Collection Opportunities

- Portable sanitation, i.e., construction sites, fairs and festivals, other temporary venues
- Academic institutions (e.g., Cape Cod Community College))

Early Deployment of Proven Devices

- Expanding the fleet within the portable sanitation industry
- Non-profit NGOs serving disaster zones and dislocated populations
- Park and public lands agencies

EcoSan Demo Unit at Cape Cod Community College

- In operation since Fall of 2022
- Supplements conventional toilets
- Design capacity of 10-15 uses per day, but accepts more.
- 2 county inspections per year
- Signage to discourage unacceptable waste
- Operated 9 months before first pumping of residuals
- Maintained by college's own staff

Rural Sanitation Needs in the US: Disadvantaged Households & Communities

Nearly ¼ of US households now rely on onsite systems, many of them failing

Lack of effective sanitation plagues many marginalized rural communities

While the need is great, authentic partnerships must be established.

Systems must be affordable AND reliable.

Engagement should begin soon.

Reinvented Toilet Systems: Addressing Septic System Limitations

- Removes blackwater from the waste stream.
- Lowers the BOD in domestic wastewater by about 4.3 grams per person.
- Hydraulic loading from toilets is removed.
- Extends service interval.

Photo: Cranfield toilet, about the size of a clothes washer.

Progress on Policy: 2024 Model Plumbing Codes

2024 editions of the national model plumbing codes will be **RT ready**.

Both major code bodies have approved language allowing installation of ISO-compliant RTs in the major model codes, including --

- Uniform Plumbing Code (IAPMO)
- International Plumbing Code (ICC)
- International Residential Code (ICC)
- International Private Sewage Development Code (ICC)

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The 2024 IPSDC is **RT Ready**

Section 1101.2 of the 2024 International Private Sewage Disposal Code will read as follows:

- **1101.2 Residential wastewater treatment systems.** The regulations for materials, design, construction and performance shall comply with NSF 40 or with IAPMO/ISO 30500.

“Known Unknowns” about RTs

- Availability
- Price
- Warranty
- Consumer acceptance
- Servicing requirements
- Repair history
- Business model for sales and installation
- Business model for maintenance and replacement

Potential Applications in North America

- National and provincial/state parks and forests
- Mobile/temporary sanitation at construction sites or public events
- Rural/low density populations in
  - Arid lands
  - Poorly drains soils
  - Permafrost areas
- Any jurisdiction prone to water curtailment or sewage treatment capacity constraints
- **Any home not served by sanitary sewers**

Thank You

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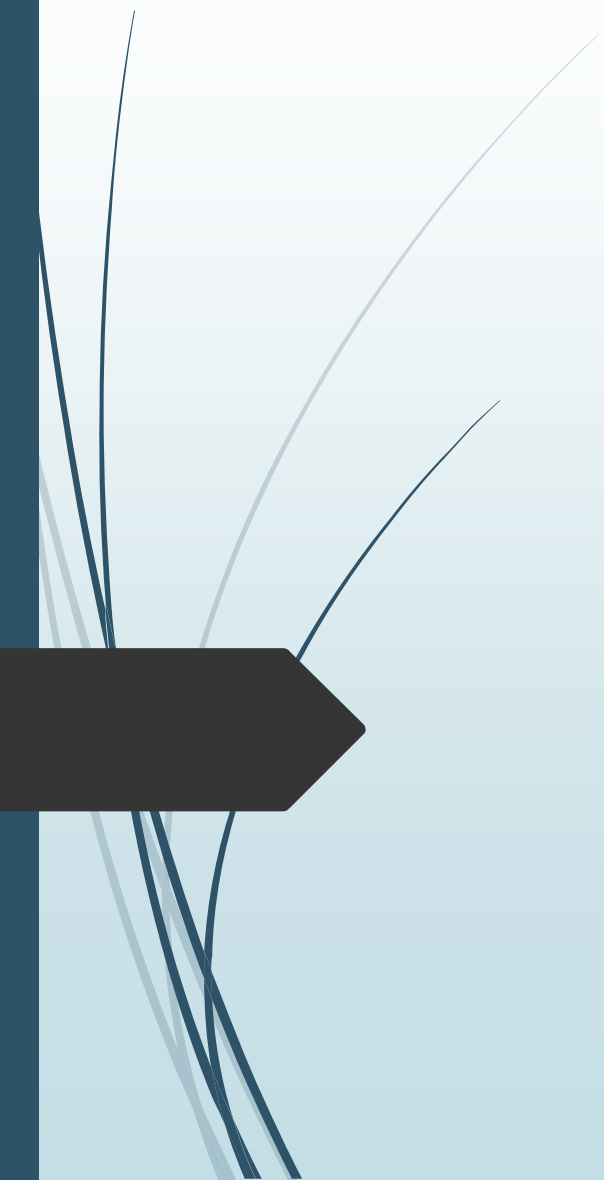

Questions

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