Hygienic Pit Emptying with Low Cost Auger Pump

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October 31th, 2012

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What happens when pits fill up?

Low Accessibility and Affordability

http://truck.en.alibaba.com/product/320047428-0/2000_3000L_sewage_suction_truck_used_sewage_truck.html

davidgreen.blogspot.com

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What is the problem?

http://www.livenewsbee.com/wp-content/uploads/2012/07/manual_scavenging-newsbee

http://newspeteast.com/will-patna-drown-in-its-own-sh1t/

Manual waste extraction

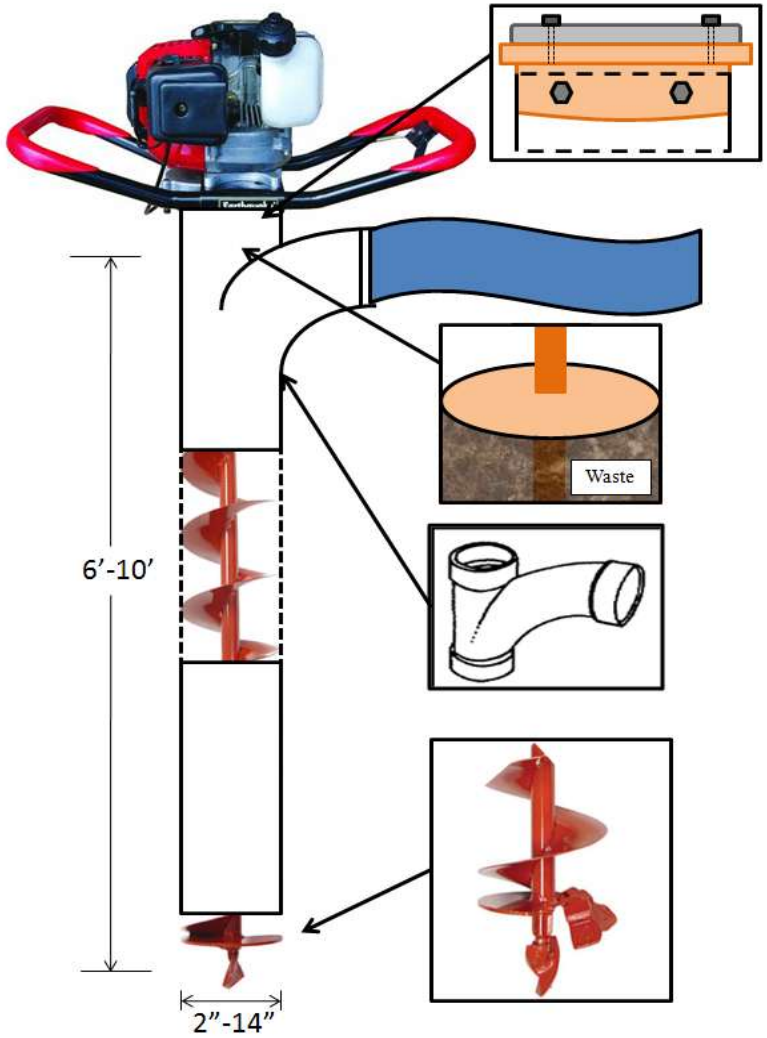
Gates Foundation Request for Proposals

- More pits/day
- Hygiene
- Easy transport in narrow lanes
- 2 person-operation
- Heavy sludge/debris at bottom
- Affordable, robust, and locally available components.
- Low emptying costs per latrine

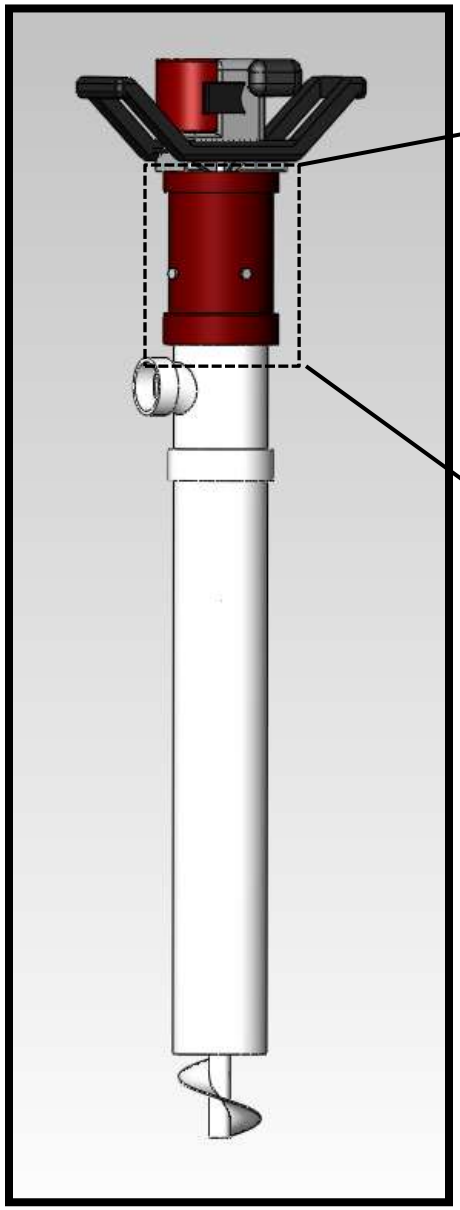
http://www.memoireonline.com/02/07/348/m_sanitation-in-urban-peri-urban-areas-cap-haitien-social-marketing-approach5.html

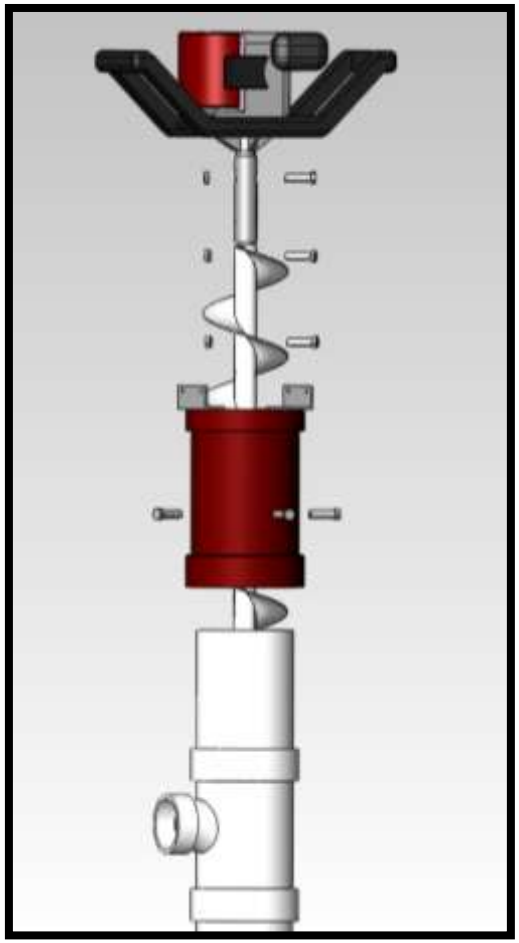
CE 480: Undergraduate Senior Design Course

Typical Power Earth Auger



The Extraction Auger Design





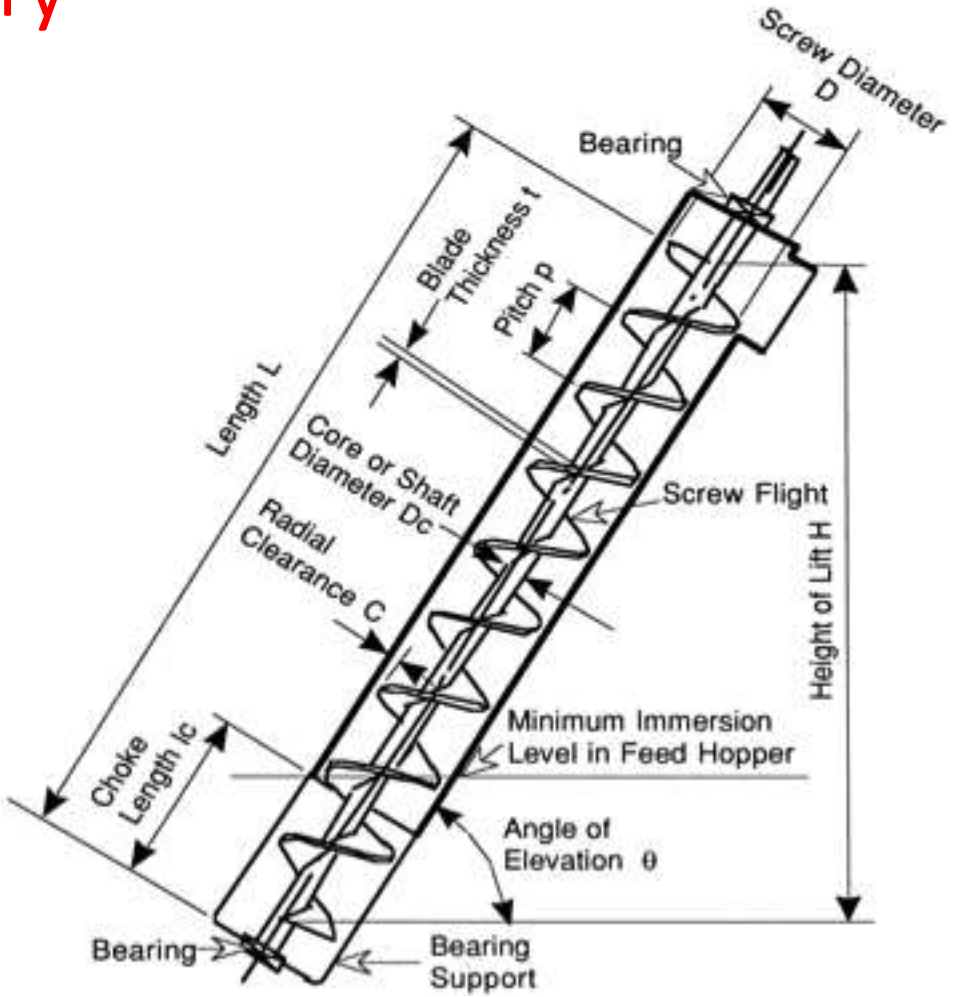
Screw Conveyor Theory

$$Q = \Gamma \omega D^3 \eta_V$$

where,

$$\Gamma = \frac{1}{8}\left[\left(1 + 2\frac{C}{D}\right)^2 - \left(\frac{D_i}{D}\right)^2\right]\left[\frac{p}{D} - \frac{t_s}{D}\right]$$

D	screw diameter (m)
D_i	core or shaft diameter (m)
p	screw pitch (m)
ω	angular velocity of screw (rev/s)
C	radial clearance (m)
t_s	thickness of screw blade (m)



Roberts, A W. "The Influence of Granular Vortex Motion on the Volumetric Performance of Enclosed Screw Conveyors." Powder Technology 104(1999): 56-67. Web. Oct. 2011.

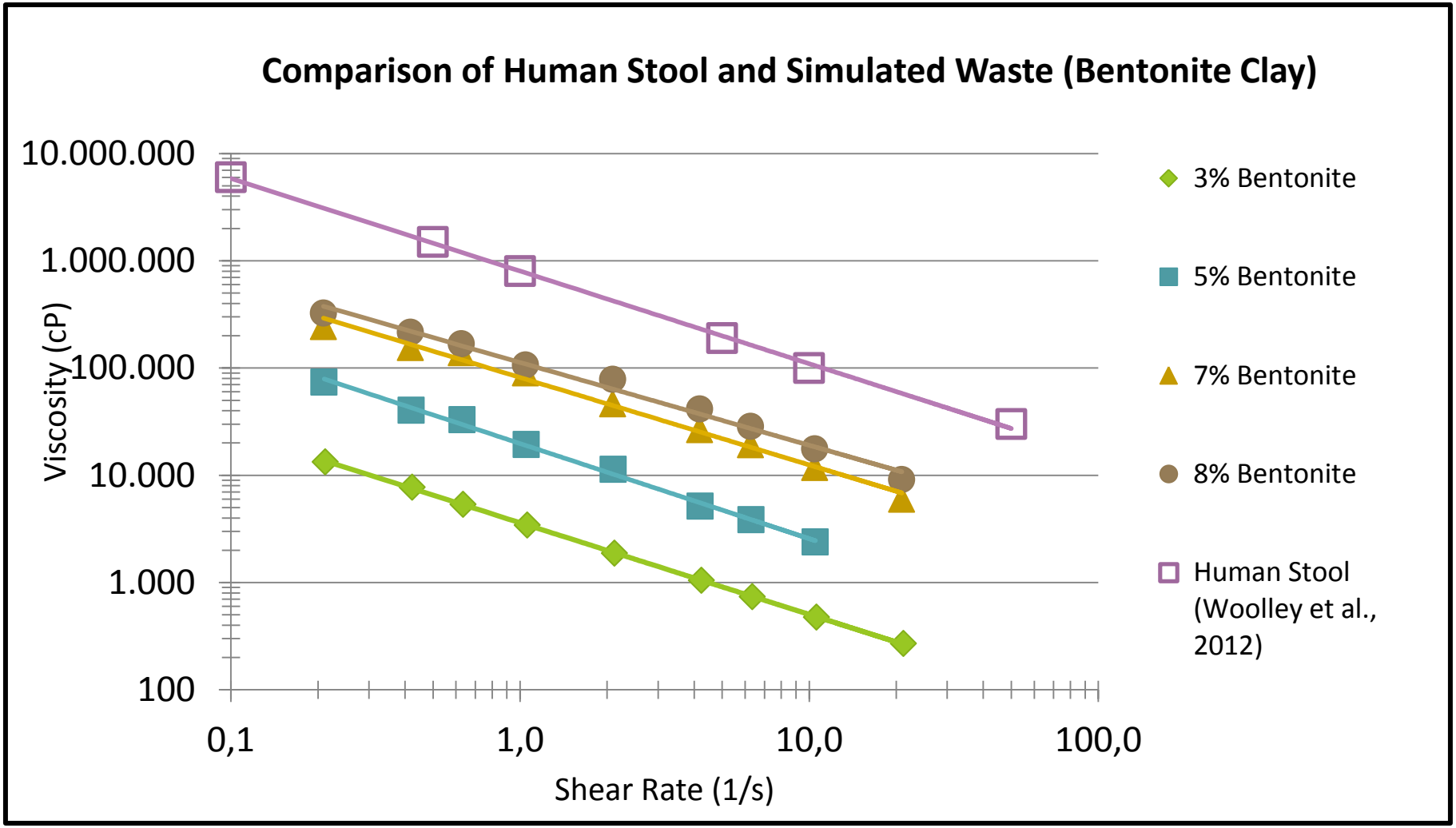
Lab Testing

Design Variables

- Electric Motor for rotational speed control
- Vertical Orientation
- Variables:
  - Submergence
  - Choke length
  - RPM
  - Auger Length
- Data collection:
  - Auger RPM
  - Flow Rate
  - Pressure throughout lift

Lab Testing

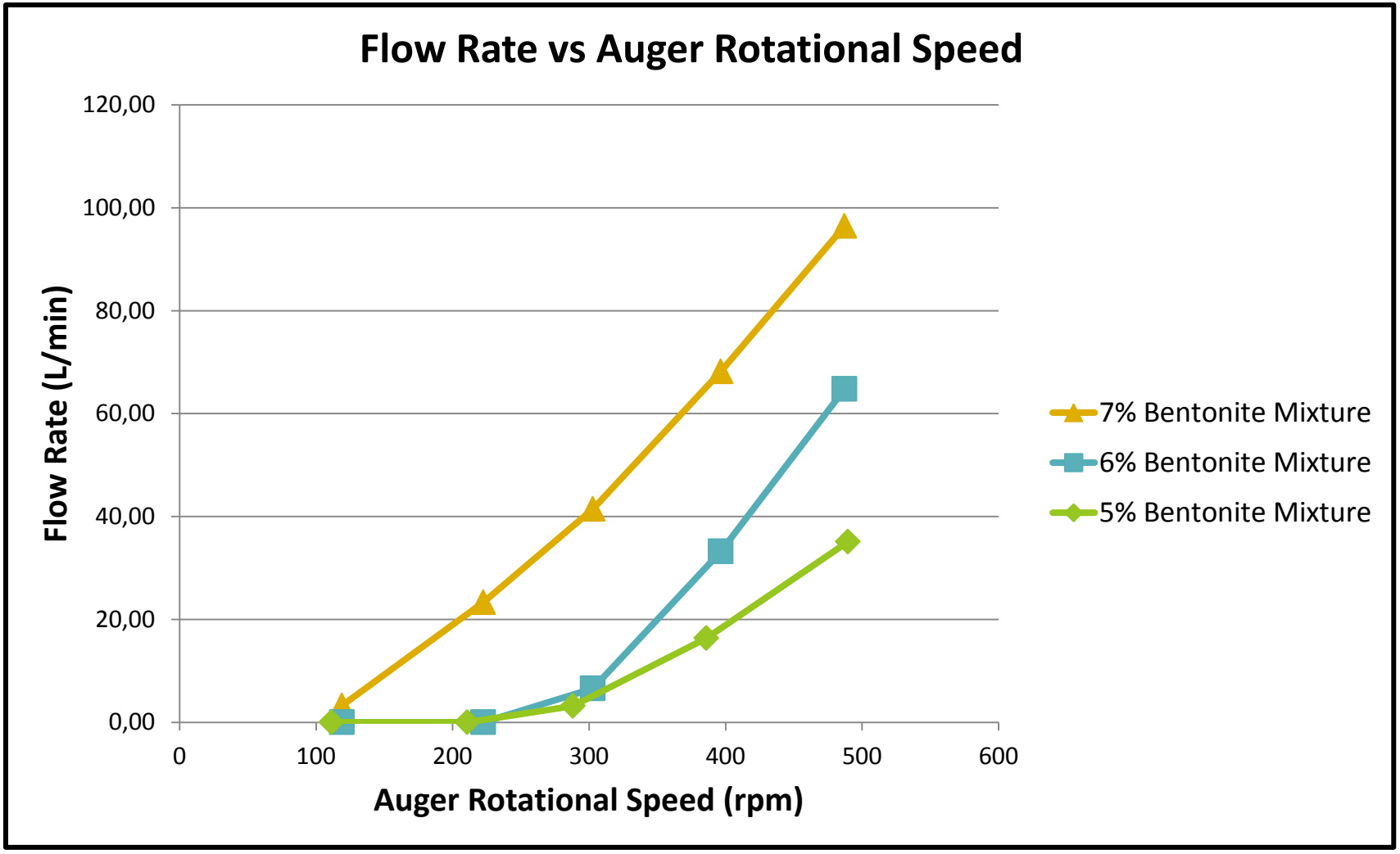
Simulant Waste: Bentonite Clay



Viscosity vs. shear rate for human stool (Woolley et al., 2012) and simulated waste (varying concentrations of bentonite clay)

Lab Testing

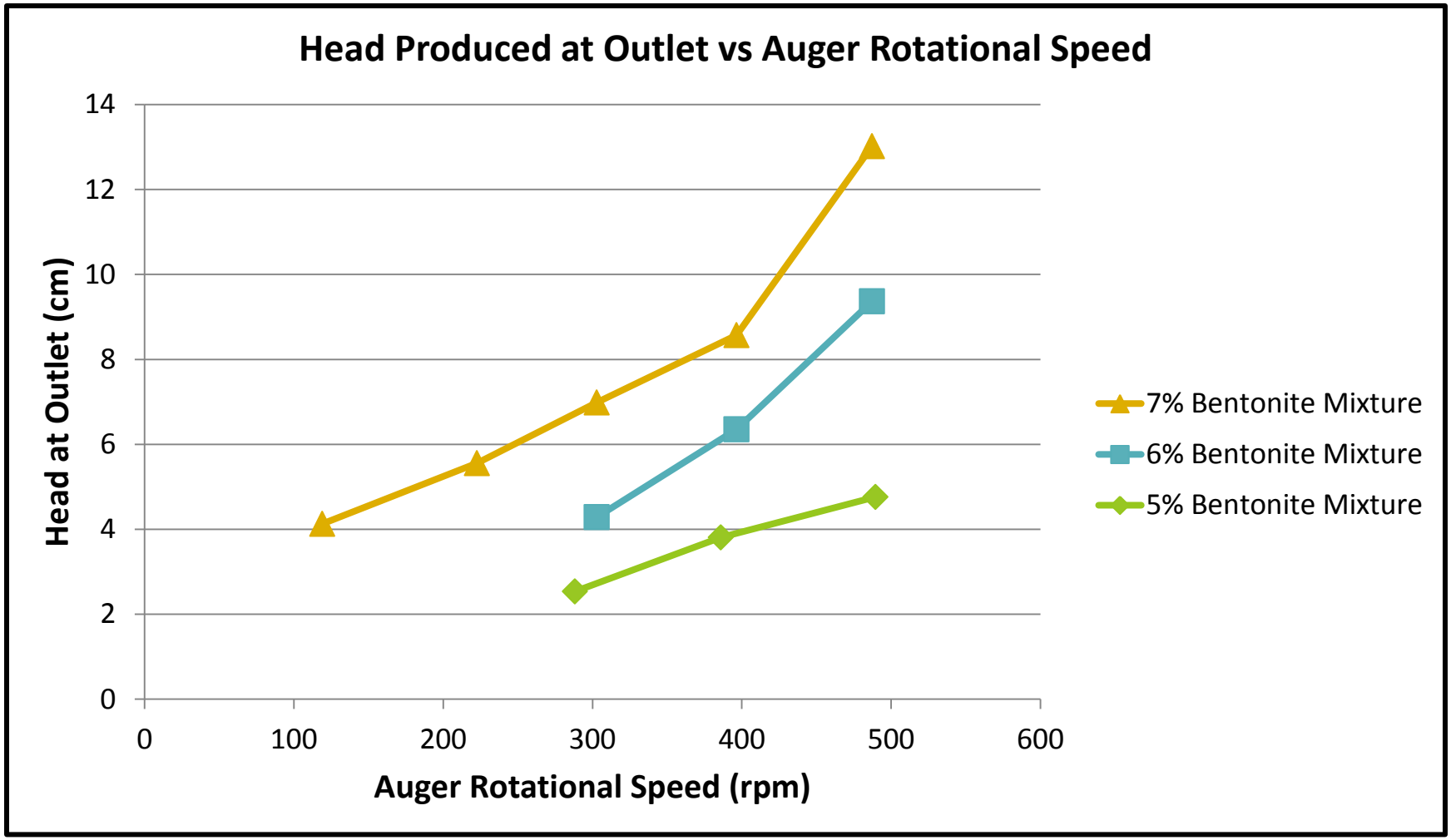
Results



Flow rates produced for varying auger rotational speeds at 22.5% submergence with three concentrations of simulated waste.

Lab Testing

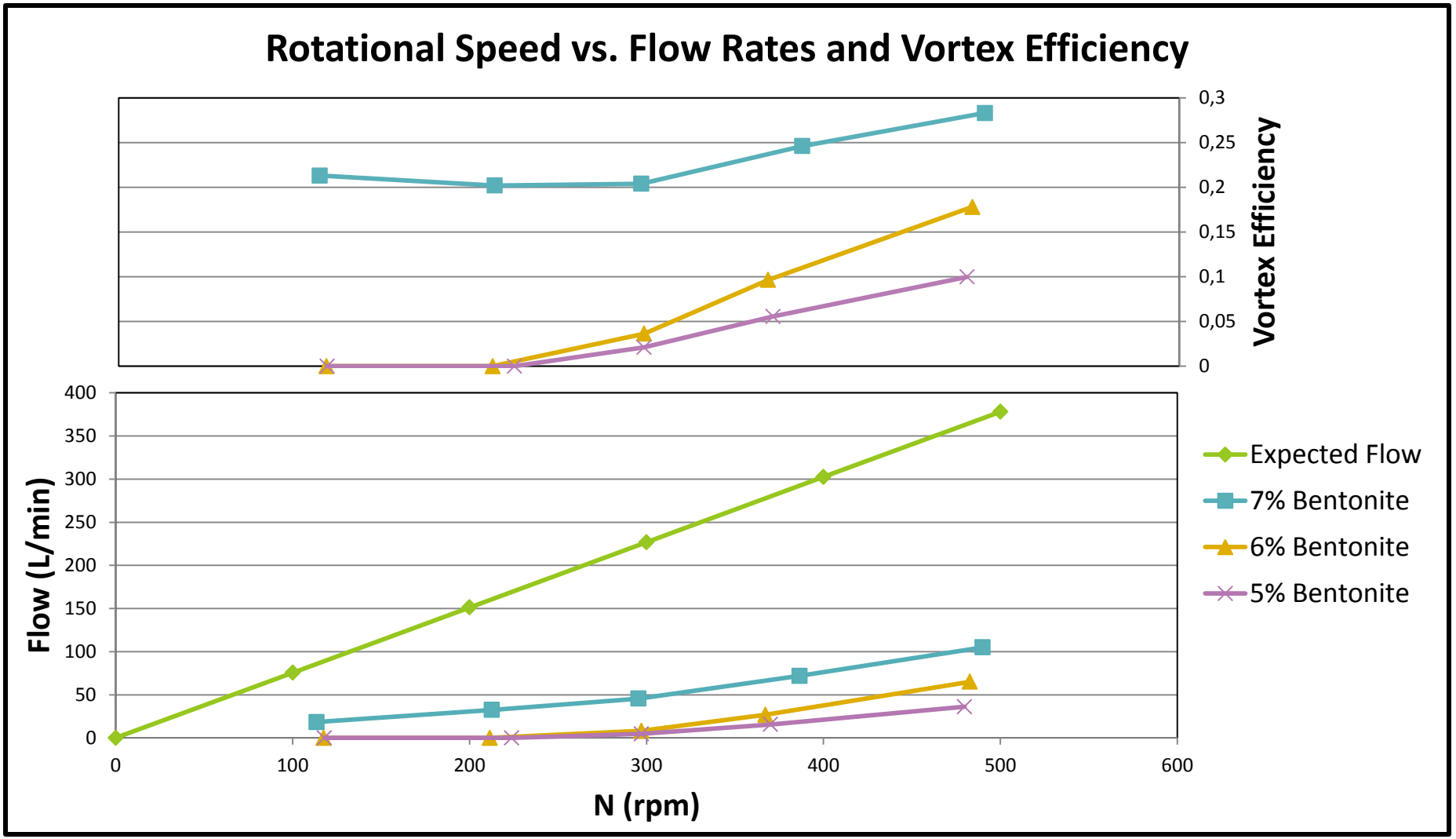
Results



Head produced at outlet for varying auger rotational speeds at 22.5% submergence with three concentrations of simulated waste.

Lab Testing

Results



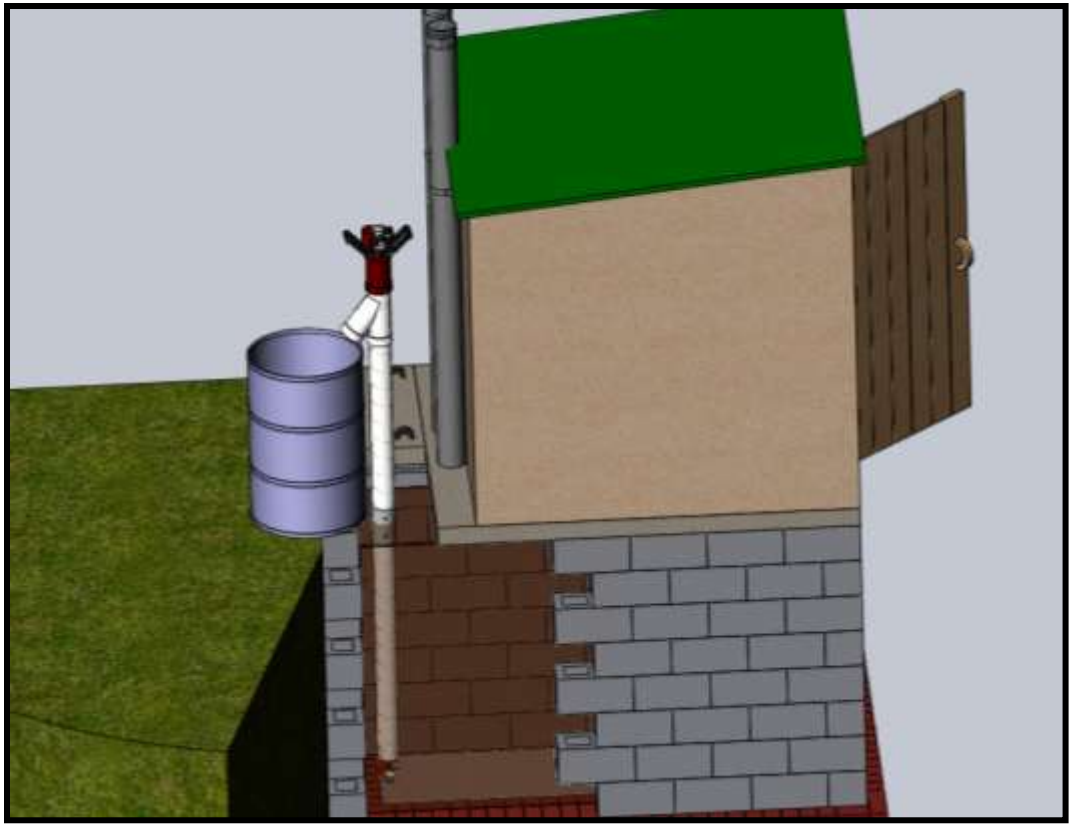
Flow rates and corresponding vortex efficiencies produced for varying auger rotational speeds at 32.5% submergence with three concentrations of simulated waste.

Lab Testing

Results

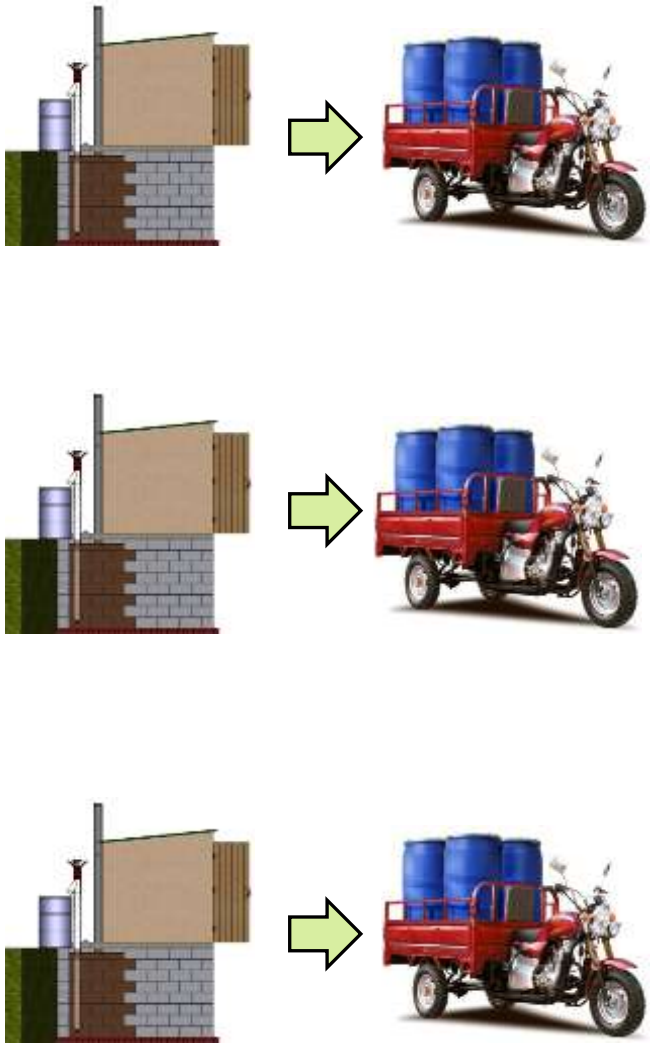
- Flow Rate and Outlet Pressure increase with viscosity and rotational speed.
- **Flow rates of over 50 Liter/ min (13 gpm)** at typical gas engine speed (300 rpm).
- Submergence has small effect on flow rate.
- Pressure produced at outlet is minimal, so waste cannot be pumped uphill.
- **The Extraction Auger can empty a 1 m^3 pit in less than 30 minutes.**

Extraction Auger Scenario



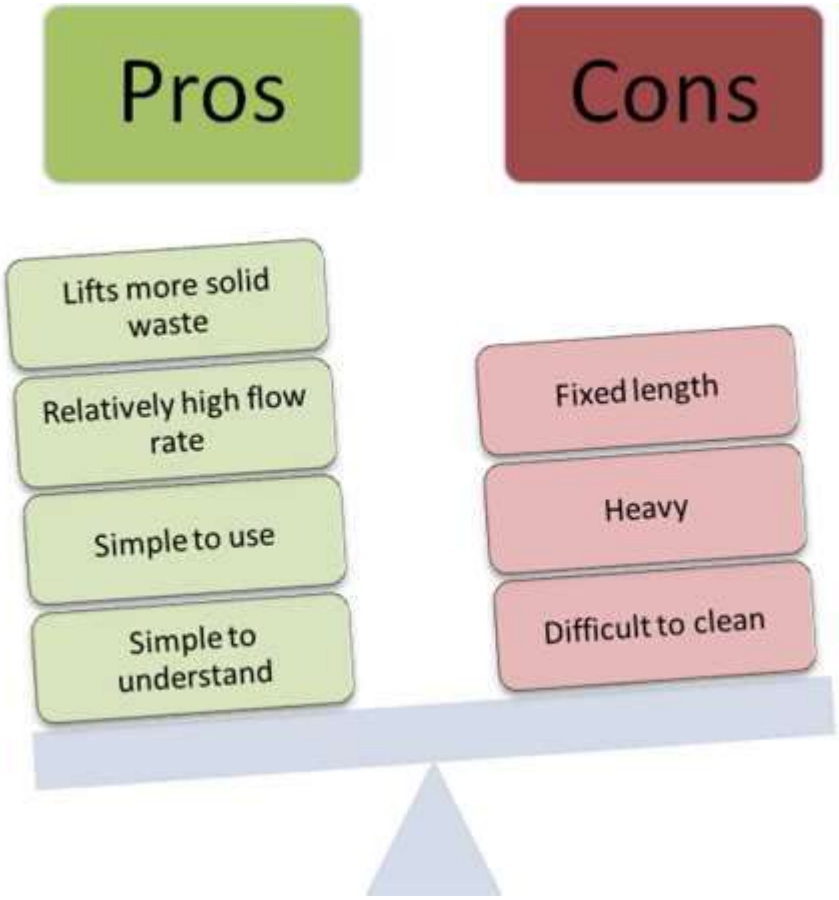
Extraction Auger Schematic

A Sanitation Collection and Treatment Scenario

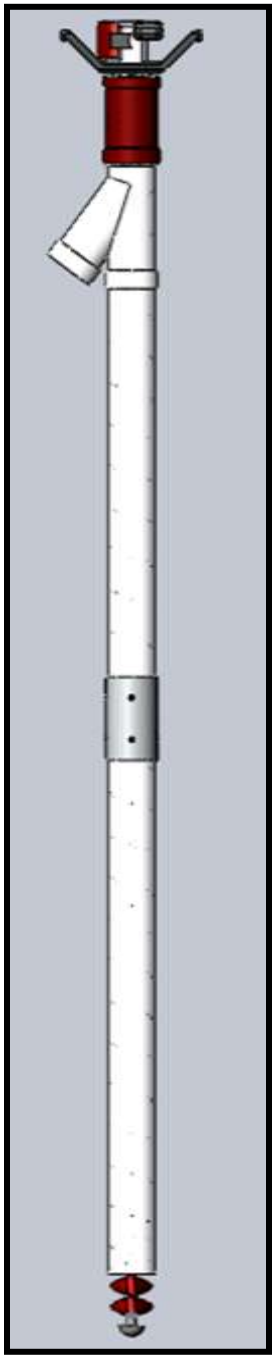


http://www.dep.state.pa.us/earthdaycentral/01/b4wastwat.htm

Current Pit Screw Auger Technology



Still, D., O'Riordan, M. (2012) Tackling the Challenges of Full Pit Latrines Volume 3: The development of pit emptying technologies, Report to the Water Research Commission

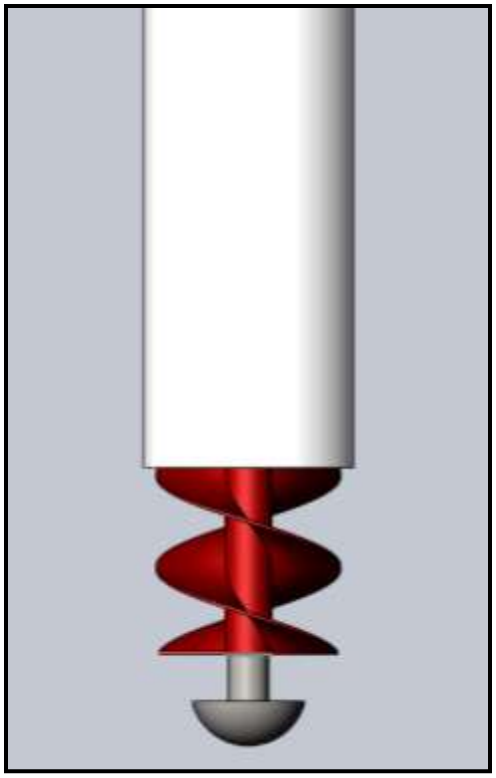


Improving the Extraction Auger

Fixed Length

- Auger and Pipe extensions available
- 1.2 m (4ft) lengths

Extraction Auger Modifications

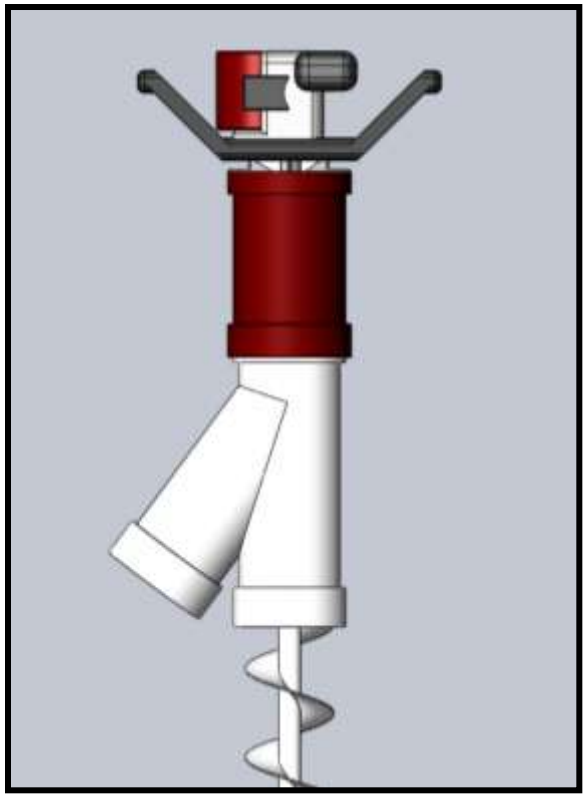


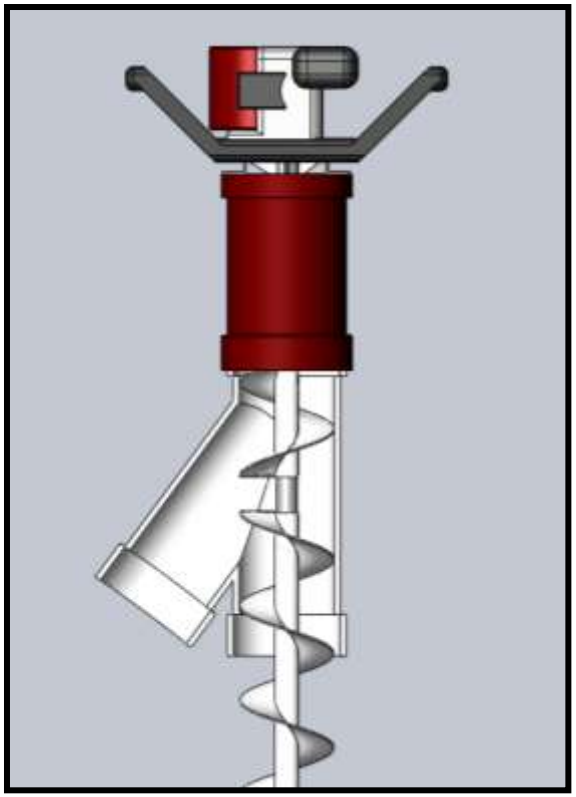
Metal Support Piece

Heavy

- ~ 25 – 40 kg
- Free standing once in pit
- Plastic Auger and Pipe

Improving the Extraction Auger





Difficult to Clean

- HDPE Auger
- Reversible drive

Compaction near top

- Wye fitting
- Reverse flighting

The Extraction Auger's Current Status

- **Ready** for Wet Latrines with small amounts of Rubbish in Early 2013.

- Dry Pits?
- High trash content pits?

Next steps

- Alterations to Current Design

- Partnerships

We are looking for Partnerships with organizations to facilitate:

- ❖ **Field testing in selected regions (Early 2013)**
  - Data collection
- ❖ Eventual implementation of Extraction Auger in these regions
- ❖ Setup of local business or integration into current system

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Extraction Auger Survey

3 ways to take the survey:

https://www.surveymonkey.com/s/ExtractionAuger

Send email to rcborden@ncsu.edu

Paper copies