BILL & MELINDA GATES foundation

WATER, SANITATION & HYGIENE: GRAND CHALLENGES EXPLORATIONS

ROUND 6 REVIEW

ROUND 6 GRANT SUMMARY AND ANALYSIS

The Water Sanitation & Hygiene program collaborated with Grand Challenges Explorations (GCE) in Global Health in 2010-2011 to solicit and fund concepts that can expand access to safe, healthy, and affordable sanitation. The first call for proposals was launched in September 2010, and 26 grants were disbursed in April 2011. The second call for proposals closed on May 19, 2011, and grants will be announced in the fall of 2011.

The Water, Sanitation & Hygiene team took part in the Grand Challenges Explorations program to:

- Generate innovative ideas with the potential to catalyze a next-generation of sanitation technologies across the sanitation value chain, from containment to treatment and reuse
- Expand the range of organizations and individuals that engage in sanitation research

Round 6 Grand Challenges grants in sanitation are demonstrating progress toward these goals:

- Many new researchers and organizations applied for grants. Only six out of 26 grants were made to previous grantees or partners.
- We made grants to a broad range of organizations. Eight grants went to researchers in developing countries (some of whom are affiliated with international organizations), and five were made to organizations in developed countries.
- The private sector was reasonably well-represented. Four grants were made to for-profit companies.
- The mix of projects between upstream and downstream innovation is reasonably balanced. Six grants are for upstream innovations, 17 grants are for applied R&D projects in sanitation, and another four will fund applied projects in related services (menstrual management, hand cleansing, and potty training).

Water, Sanitation & Hygiene

The Bill & Melinda Gates Foundation works with a wide range of partners through its Water, Sanitation & Hygiene program to reduce the burden of water-borne disease and improve the lives of the poor. Our approach aims to expand the use of sanitation that does not connect to a sewer, as this is by far the most common type used by the poor. We invest in effective approaches that help end open defecation and unsafe sanitation in rural communities, and we help develop the tools and technologies that will allow the urban poor access to sustainable non-piped sanitation.

Grand Challenges Explorations

The Grand Challenges Explorations (GCE) initiative is focused on engaging creative minds to work on scientific and technological breakthroughs for the world's most pressing health and development problems. GCE is a grant program that fosters innovative, early-stage research to expand the pipeline of ideas that can lead to those much-needed global health and development solutions.

- Upstream innovation ideas focus primarily on the use of microbial fuel cells (two grants) and related technologies (artificial molecular wires). Another grant from a biotech start-up focuses on engineered algae.
- Notable proposals in the applied R&D category include an idea for an Archimedes screw to seal human waste into pipes with dry organic materials, such as rice hulls and ash, so that flies cannot get in and odor cannot escape. Like a waterless flush, the screws will move waste from the user interface to sealed containers for storage under aerobic conditions; the end product will be safe fertilizer.
- Treatment and containment are both well represented. We funded several proposals that addressed containment

and treatment challenges with a single innovation. Twelve proposals combine treatment and resource recovery innovations, and 11 include containment innovations. The lack of proposals for innovation in transport led us to emphasize delivery in the Round 7 call for proposals.

- Six grants in the containment category rely on source separation of urine and feces. We will continue to explore different approaches to containment as source separation may not be a large-scale solution because so many people use water for cleansing as part of their sanitation practice.

WATER, SANITATION & HYGIENE: GRAND CHALLENGES EXPLORATIONS ROUND 6 GRANTEES

Upstream innovation

1. Technology to Convert Excreta to Valuable Products

Ian Gates and Michael Kallos of the University of Calgary in Canada propose to combine two well-established technologies—anaerobic micro-digesters and micro-combined heat/power thermoelectric generation units—into a single portable unit that can consume human excreta to generate electricity, heat, methane, fertilizer, and water. Each device will be designed to serve a single extended family.

2. Algae for the Effective and Economical Treatment of Waste

Natalie Cookson and colleagues at Quantitative BioSciences in the United States are developing an algae-based waste treatment system. Cyanobacteria (blue-green algae) will treat waste and produce two forms of renewable energy: nutrient-rich fertilizer to enhance agriculture and bio-methane to power the facility and local communities. This development may provide an efficient, easy-to-operate, and novel waste treatment and bioenergy production system by mass cultivating algae using wastewater as the feedstock.

3. Decentralized Next Generation Sanitation for Diarrheal Pathogens

James Blackburn of Southern Illinois University in the United States will test a wind turbine-driven sanitation system for its ability to raise and maintain temperatures in an insulated container that removes pathogens in human waste. The technology could be used in temperate or equatorial zones to reduce the occurrence of diarrheal diseases. This decentralized system is intended for 20-50 people and will test maintenance of the temperatures and timespans required to reduce pathogens.

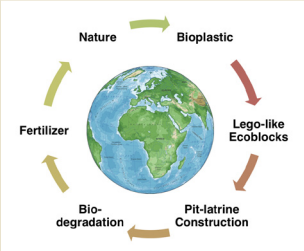
4. Hybrid Anaerobic Digester-Microbial Fuel Cell for Energy and Nutrient Capture

Leonard Tender of the Naval Research Laboratory in the United States proposes to develop a low-cost wastewater treatment system comprised of an anaerobic digester that generates organically rich acids to power a microbial fuel cell. If successful, the technology could reduce the burden of waterborne diseases in the developing world while providing useful energy.

5. Design of Microorganisms with Semiconducting Membranes

Guillermo Bazan of the University of California, Santa Barbara in the United States proposes to introduce artificial molecular wires (AMWs) into a waste treatment system to break down organic contaminants in human waste and catalytically convert the microbial energy into electricity for local needs.

Applied development



6. "Lego-Like" Sanitation System: Pit Latrines Made of Biocompost

Antonio Avila of Universidade Federal de Minas Gerais in Brazil proposes to develop building blocks made from biocomposites that will replace conventional brick/cement constructions for pit latrines. The team will test their strength and their rate of biodegradation to determine their suitability for building latrines that will decompose once the pits are filled, allowing for the eventual reintroduction of the land for farming and other community uses.

7. A Low-Cost Decentralized Sanitary System

Bin Fan of the Research Center for Eco-environmental Sciences in China will seek to develop a decentralized sanitation system that uses a low-cost, waterless, vacuum system to collect excrement and kitchen waste. The combined waste could then be processed into organic fertilizer.

8. Developing Fortified Excreta Pellets for Use in Agriculture

Olufunke Cofie of the International Water Management Institute in Ghana will develop and test fortified fertilizer pellets from treated human excreta for market sale, with a prolonged shelf life to withstand transportation over long distances. If successful, the production at large scale would enhance agricultural productivity in Sub-Saharan Africa while also contributing to a reduction in environmental health risks from untreated human waste.

9. Ecological Sanitation for the Base of the Pyramid

Elmer Sayre of the Water, Agroforestry, Nutrition and Development Foundation in the Philippines will conduct eco-san experiments in alternative small-scale agro-forestry settings.

10. Prototype Microflush-Biofil Toilet Facilities

Stephen Mecca of Ghana Sustainable Aid Project in the United States, along with Ghanaian partners, will develop and field test in Ghana a prototype toilet facility that incorporates an innovative aerobic digester to decompose waste along with a microflush valve that uses minimal amounts of grey water. The field tests will help evaluate cultural, financial, and sanitation factors related to these community facilities.

11. The Earth Auger Toilet: Innovation in Waterless Sanitation

Marcos Fioravanti and Chris Canaday of Fundación In Terris in Ecuador will develop a pedal-operated, low-cost, easy-to-use, odorless, urine-diverting dry toilet, in which feces and urine disappear after each use, dry material is mixed in mechanically, and the end product becomes plant fertilizer.

12. An Energy-Producing Waterless Toilet System

Virginia Gardiner of Loowatt, Ltd. in the United Kingdom will develop a waterless toilet that seals waste into a portable cartridge within biodegradable film for anaerobic digestion. The digester produces fuel and fertilizer, creating valuable resources and business opportunities.

13. Turning Latrines Into Fly Traps

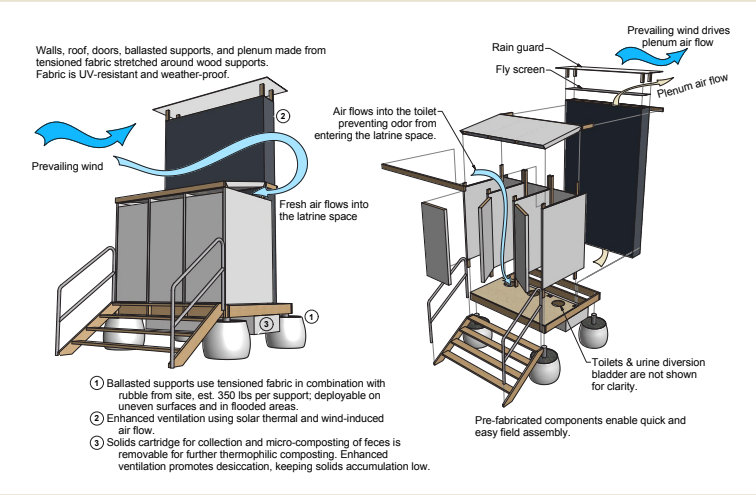
Steve Lindsay of the London School of Hygiene and Tropical Medicine in the United Kingdom will seek to demonstrate that flies are transmitters of diarrheal diseases due to their attraction to fecal matter and food sources. Lindsay proposes to design traps that attract, capture, and kill flies in latrines. If successful, the reductions in flies may reduce diarrheal diseases in local communities.

14. Universal Slum Sanitation With 100% Safe Reuse of Nutrients

Karsten Gjefle of Sustainable Sanitation Design in Norway will design and test a low-cost system to rapidly turn feces into pathogen-free compost for use as fertilizer for farmers. Gjefle and his team hope to create a viable financial market that will remove untreated sewage from urban areas and also provide farmers with recycled, safe, and natural soil improvements.

15. Urban Sanitation Solutions for High-Use, Flooded, and Difficult-to-Serve Areas

Andreas G. Koestler and Andrew Larsen of the Fontes Foundation in Norway will design and conduct a small field test in Haiti of a new modular, knock-down toilet block system that can be erected in high-density, difficult-to-serve communities, such as refugee camps. The system will feature urine-diverting toilet pans, as well as enlarged ventilation areas that could eliminate odors and dessicate feces. The toilets will use recycled billboard fabric as waterproof walls, ceilings, and bladders to store fecal sludge and contain pathogens that can contaminate water supplies.



16. The Lotus Throne: A Self-Cleaning Solution to Sanitation

Kin-Ping Wong of Retina Pharma, Inc. in the United States proposes to test novel UV-resistant, super-water-repellent silica as a coating for toilets, which could reduce the amount of water needed to clean the toilets after use while improving surface sanitation. The silica coating displays the same very high water repellency as the leaves of the lotus flower.

17. Develop a Simple Auger Die Assembly That Treats Fecal Waste

Gary Foutch and A.J. Johannes of Oklahoma State University in the United States propose to develop a small-scale device in which an auger forces feces and other solid wastes through a die, a process that produces high temperatures and pressure that removes water and destroys microorganisms. The device could reduce odor, insects, and surface and ground water contamination.

18. High-Efficiency Sanitary Toilet with Sewage Treatment

Peter Dreher of Livvon, LLC in the United States will develop and test a simple toilet with integrated sewage treatment that employs a hand crank to dessicate feces and turn them into dry, odorless pellets that can be used for fertilizer or fuel. The air-tight system will also control odor and keep out flies and vermin.

19. Integrated Mobile Sanitation Solutions in Peri-urban Setting

Kory Russel and Sebastien Tilmans of Stanford University in the United States are designing a consumer-driven line of latrines that double as containment and transport systems for fecal waste. The latrines will be low cost, mass produced, and easy to ship, enabling sanitation services and collection businesses to develop in suburban and rural communities.

20. Safe Sludge

Kara Nelson of the University of California, Berkeley, in the United States proposes to disinfect fecal sludge in latrines by converting the ammonia naturally found in urine and feces into a powerful disinfectant with an alkaline additive that will raise the pH level. By killing pathogens immediately and turning waste into "safe sludge," all subsequent activities required for fecal sludge management can become safer.

21. Using Cocopeat for Treating Septic Tank Effluent

David Robbins of Research Triangle Institute International in the United States will test a septic tank biofilter made from cocopeat—a readily available byproduct of coconut processing—for its ability to decompose human waste and produce effluents that can be used for crop fertilization and irrigation. If successful, the cocopeat biofilter could be produced locally and aid in solid waste treatment and water conservation efforts.

22. Using Waste to Move Waste

Mark Illian of Nature Healing Nature in the United States will work with rural African communities to design a pour-flush latrine that utilizes urine for flushing and drops of used cooking oil for odor control. Achieving a successful design of these latrines could stimulate more latrine building to reduce open defecation and resulting diarrheal diseases.

Related services

23. The Latrine Training Mat

Clair Null and Silantoi Kisoso with Innovations for Poverty Action in the United States, along with Michael Kremer of Harvard University, are designing a children's latrine training mat made from easy-to-clean plastic that fits over an existing latrine hole. The sturdy but easy-to-move platform has a child-sized hole that eliminates the fear and risk of falling into latrines, promoting good sanitation practices and fostering a lifelong habit of latrine use.

24.Using *Senecio Lyratipartitus* Extract After Anal Ablution

Asafu Maradufu of the University of Eastern Africa, Baraton, in Kenya proposes to produce a gel-based disinfectant from plant extracts of *Senecio lyratipartitus* that can be applied to hands. This disinfectant will reduce contamination associated with the practice of anal washing and wiping in certain communities.

25. Reusable Self-Decontaminating Sanitary Napkin

Josef Schneider of LAAMScience, Inc. in the United States will develop a hygienic, reusable menstrual napkin using light-activated anti-microbial technology to reduce the incidence of reproductive tract infections.

26. Novel Materials for Low-Cost Sanitary Pad Production

Lawino Kagumba and Megan White of American Friends of ZanaAfrica in the United States will work with collaborators in Kenya to develop and test sanitary pads that utilize an agricultural by-product as an alternative absorbent material. If successful, women and girls across Kenya will have access to locally produced, affordable feminine hygiene products through a process that can be easily replicated in other countries.

GCE ROUND 7 TOPICS—WINNERS TO BE ANNOUNCED NOVEMBER 2011

1 Hygienic manual or mechanical emptying equipment for urban areas.

Technological solutions funded will enhance business opportunities for emptying fecal sludge and improve the quality and safety of service. Solutions/innovations should make emptying a hygienic activity with low operation and maintenance costs that allow emptying fees to be affordable to the urban poor (i.e., $5-20 per latrine). Solutions should allow easy extraction of the consolidated heavy sludge accumulated in dry latrines or at the bottom of septic tanks. An advanced solution may allow safe filtration/separation of the solids fraction of fecal sludge on site during an emptying operation. Ideally, sludge transported to a designated disposal/processing site should have a high solids concentration.

Solutions should aim to meet as many of the following conditions as possible:

- Increases the number of pits that can be emptied per day
- Provides hygienic protection of the operator
- Allows for easy navigation and operation in narrow lanes
- Can be operated by maximum of two persons
- Sludge can be safely emptied into a receptacle suitable for at least 5-15 km of transport
- Removes heavy sludge/debris from the bottom of latrines/septic tanks
- Mechanical equipment should aim to access latrines as far as 50m away
- Separates solids/liquids on site (i.e., dewatering)
- Allows for potential on-site or "en route" treatment of evacuated liquids and/or solids for safe local disposal
- Based on affordable, robust, and locally available components

2 Sludge processing for community energy generation in urban areas.

Technology solutions funded will process sludge in a manner that generates energy that is ready to use by communities at a decentralized scale (block to district level) and that eliminates the contamination of remaining effluents and/or solids.

Solutions should aim to meet as many of the following conditions as possible:

- Low life-cycle costs, robust, and locally available components
- Easy to operate, maintain, and service during productive life
- Small land/space footprint at point of production and short processing/retention times (proposals should include quantitative estimates)
- Capable of processing highly variable sludge inflow qualities and quantities
- Addresses odor nuisance
- High rate of sludge elimination, energy conversion efficiency, and effluent decontamination in the energy production process (proposals should include quantitative estimates)
- Value of energy product generated should aim to cover operating costs of technology employed at a minimum (proposals should include quantitative estimates)
- Energy end-product should be market and user friendly and not require expensive or new investments at the point of use
- Relevant for low-security settings
- Safety/backup mechanism in the case of system failure
- Proposals must explicitly and quantitatively articulate expected advantages of the proposed work relative to existing energy recovery technologies in the field

3 Appropriate sanitation solutions for flooded zones (e.g., communities that face seasonal flooding, high groundwater tables, riparian or tidal communities, floating communities, etc.).

Technologies should improve upon or develop new sanitation technologies that cope with wet-environment conditions.

Solutions should aim to meet as many of the following conditions as possible:

- Provide robust and safe containment during heavy rain and flood events
- Function in tidal, riparian, or floating communities
- Low lifecycle costs, robust, and locally available components
- Easy to operate, maintain, and service during productive life
- Incorporate user-centered design elements that are appropriate for women, children, and "washer" communities and that are affordable for the ultra-poor (<$1/day)
- Proposals should articulate clearly how the innovation improves upon existing technologies for these areas in terms

of reduced cost, increased community/user appropriateness, increased robustness, or other critical factors

- Proposals should articulate clearly the type of water-challenged environment being targeted (e.g., tidal, seasonal flooding, etc.)
- Individual excreta bagging solutions will not be considered for this call

4 Easy cleaning and affordable pan / squatting platform suitable for connection to an offset pit.

Attractive technologies that enhance latrine cleanliness and that have one or more of the following features:

- Easy to clean and smooth
- Attractive and offering a user experience and desirability similar to a ceramic pan
- Able to be mass produced
- Lightweight and robust
- Durable
- Affordable