Living Machine Project at Penn State

May 2004: Ed Corriveau (pointing) from DEP South Central Office visits the future site of the living machine – sloped pasture with a few shrubs and two nice black locust trees. Already the ground is staked…

Late June 2004: earth movers create an artificial mound of earth

August 2004: The greenhouse takes shape on this earthen pedestal

August (above) to September (below)

Above: We met every other week to check on construction progress and solve problems as they arose.

September 2004: The living machine takes on tangible form
Infrastructure needed to bring utilities to the greenhouse and for the forced sewer main for the living machine’s discharge were blamed for the high project costs. Above and right: influent infrastructure

Effluent from the facility is to be discharged here, back to the sewer until a discharge permit can be obtained.

At left, the unfinished head-house: unfortunately not the “green” materials we’d hoped for. Above: view to north side before doors are added. Below: view to south side with “pond” covered with foam and boards to prevent damage

At right: walk-through inspection to check on progress prior to installation of greenhouse plastic
Left: end of September

Right: Seeding the grounds in October

Construction completion by the end of October

Inside (above & right) and Outside (below and lower right), there is a lot to know about the system and set-up!
Influent Central: The first stage of the system is an underground 3000 gallon tank. Understanding how the pumps, floats, alarms and pipes all go together is very important – how to disassemble, troubleshoot and reassemble will be included in the operation and maintenance manual for the facility, under development.

**System Schematic (Overview):** Influent from the underground closed anaerobic tank is pumped into the 2 Closed Aerobic Tanks, then to the series of three open aerobic tanks, then to the clarifier for settling of biosolids. From the clarifier, the liquid enters a distribution line along the east edge where it can trickle (dotted red lines) into the constructed wetlands gravel and by hydrostatic pressure, exit via a similar line on the west edge. This liquid should be clean to tertiary standards, hence (green arrow) can flow to display “pond” and then exit the facility. Until the system is proven effective and a discharge permit is obtained, effluent will return to the sewer and only human sewage will be used as input.
Living Machines Project: Education and Outreach Efforts

Top left: our 25 gal/day model in January 2003, prior to improvements.
Left: Research Assistant Barton Kirk (grad, engineering) gives a tour
Top right: Bart’s calculations showed that additional wetlands were required for the model
Right: The completed wetlands troughs and a new clear tank “display pond” with fish completed the system

Summer 2003: Volunteer Todd Lyall (grad, Mech. Eng) devises a water-refilling system for the model to compensate for evaporative losses.

Summer/Fall 2003: Ag and Bio Engineering student Kelly Collins takes water quality data: pH, dissolved oxygen and BOD levels
Maintenance of 25 gal/day model: thinning the vegetation – no easy task! STS 497D: Projects in Sustainable Living students in fall 2004 do their part

Right: papyrus roots form a thick, dense mat – large pruning shears are necessary.
Below: deciding what to thin in the constructed wetlands

A drain interior to the wetlands trough will clog with organic matter. Daphne Matthews (5th year civil/structural engineering) devises and installs a new external standpipe for the trough to ensure proper water levels and flow to the next wetlands unit.

And re-planting the tanks…
April 2003: Barton Kirk prepares to give a tour and instruction in water-quality testing to students in STS 497D: Projects in Sustainable Living (below, with abundant geranium blossoms)

Spring 2003: Bart Kirk’s improvements to the 25 gal/day system included
- New, appropriately sized aeration system
- New airstones (larger)
- Low-maintenance biogas filter for odor removal
- New water pump more appropriately sized for the system
- Two additional wetlands troughs, one planted with native wetlands vegetation and one unplanted
- A new “display pond”
- Maintenance and operation protocols
- Installation of Hach software and docking station for each of three water-quality testing probes (pH, DO and ammonia/nitrates)
- Water sampling tubes in the wetlands troughs
- Some new plants for the system
- Engineering calculations to back up his design-implementation decisions

Above: Barton Kirk tends the portable 4-chambered “classroom living machine” at the Water Re-Use Symposium in May 2003