Port of Portland Headquarters
Portland, OR

LIVING MACHINE SYSTEMS, L3C

Living Machine® Systems, L3C (LMS) - Based in Charlottesville, Virginia - is a social benefit corporation, focused on ensuring lasting water resources for communities across the globe. Our proven ecological wastewater treatment and reuse system is compact, efficient, and cost effective. From Ghana to San Francisco and from schools and office towers to resorts, the Living Machine® system has been installed in dozens of locations around the world.

LMS and its predecessor, Living Technologies, Inc., have designed and refined ecological wastewater treatment systems since 1995. While constructed wetlands and other natural treatment technologies have been successfully utilized for decades, today's Living Machine technology allows a radically smaller footprint and higher treatment performance relative to other natural treatment systems. In comparison to conventional wastewater treatment technologies, the Living Machine system offers reduced energy use and significant savings in both capital and life cycle costs while achieving the highest treatment and reuse water quality standards. LMS designs beautiful, energy-efficient, high-performance wastewater treatment systems that foster water reuse in rural, suburban, and urban areas.

SYSTEM BENEFITS

- The building has demonstrated a 75% reduction in water use.
- The system provides interior and exterior foliage and safely integrates into public space.
- Accepts all wastewater generated by the building's 500 employees and produces high quality water that is reused to flush toilets.
- The Living Machine® system was cited as a key innovative feature on Forbes.com's list of the world's greenest buildings.
- The project attained a LEED Platinum certification by the U.S. Green Building Council.
Design Basis + Architectural Integration

WHY A LIVING MACHINE?
The Port of Portland had multiple objectives for the wastewater system in their new 200,000 square foot state-of-the-art headquarters building. It had to be sustainable, cost-effective, attractive, as well as a teaching tool, but above all, it had to provide advanced wastewater treatment for reuse. The Living Machine® system was the only approach to wastewater treatment that could meet all the criteria.

PROJECT OVERVIEW
Port of Portland chose to unite its two main offices (one previously located in downtown Portland and the other near the airport), consolidating them into a single, united headquarters. Early in the planning stages, Architectural firm ZGF interviewed the Port of Portland staff in an effort to understand their culture - information which helped them create their design.

WETLAND DESIGN PARAMETERS

<table>
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<tr>
<th>Tidal Wetland Cells</th>
<th>Values</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Parameters</td>
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<table>
<thead>
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<th>Vertical Flow Wetland Cells</th>
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ARCHITECTURAL DETAIL
- Four of the tidal flow wetland cells are incorporated into the lobby of the building while the remaining two tidal flow cells and four vertical flow polishing cells provide a landscape feature that wraps a portion of the exterior.
- Materials and plantings for both interior and exterior wetland cells were coordinated with project architect and landscape architects to achieve desired look for the building.
- Drawing from its surroundings, the building was designed to give the impression of a ship’s hull, serving to disguise the integrated parking deck for visitors and staff.

PROJECT PARTNERS
CLIENT Port of Portland
ARCHITECT ZGF Architects
LANDSCAPE ARCHITECT Reed/Mayer
GENERAL CONTRACTOR Hoffman Construction Company
OPERATOR iWater Services
ENGINEERING PARTNER Aqua Nova Engineering

WWW.SUSTAINABLEWATER.COM
Site Plan

Reuse Tank
Polishing + Disinfection Equipment
Control Panel
Port of Portland HQ Lobby

Entry

TFW Cell 1
TFW Cell 2
TFW Cell 3
TFW Cell 4
TFW Cell 5
TFW Cell 6

VFW Zone 1
VFW Zone 2
VFW Zone 3
VFW Zone 4

Exterior Cells
Interior Cells

Aggregate loaded into wetland cells during final construction

Exterior Vertical Flow Wetland Cells
**Plant Community**

**EXTERIOR PLANTS**
- Flowering plants were not used in order to avoid attracting birds in close proximity to the airport.
- Plants are native or naturalized species.

**INTERIOR PLANTS**
- Plants specifically chosen for low light conditions within the lobby.
- Striking foliage and flowers for aesthetic qualities.

*Juncus effusus, Soft Rush*
*Acorus gramineus, Japanese Sweet Flag*
*Spathiphyllum cochlearispathum, Peace lily*
*Colocasia esculenta, Taro*
*Strelitzia reginae, Bird of Paradise*
*Aspidistra elatior, Cast Iron Plant*
**ENGINEERING**

- Wastewater enters the Primary Settling Tank where larger solids settle out, scum floats to the surface and clarified liquid in the “clear zone” flows by gravity to the Flow Equalization Tank. Solids break down in the Primary Tank and the fine particulate material and dissolved organic and inorganic material passes through the tank to be metabolized in the Living Machine system.
- Stage 1 consists of 6 tidal flow wetland cells. The tidal-flow cells remove pollutants from the wastewater, using microbial communities attached to the surface of the wetland media (biofilms). The biofilms oxidize organic material and nitrogenous compounds in the wastewater as it passes over the surface of the media particles.
- Stage 2 consists of a series of vertical-flow wetland cells. The vertical-flow polishing cells remove any remaining organic material, ammonia and TSS. The polishing wetland is a shallow recirculating vertical flow wetland. The water leaving these cells is very clean and requires minimal final treatment/disinfection for re-use.
- Wastewater from the Living Machine is pumped to a cartridge filter followed by 2 stage disinfection with ultraviolet (UV) light and chlorine disinfection. Filtering of the effluent is necessary to remove fine particles that will inhibit UV disinfection.
- Online turbidity, UV transmissivity, and chlorine residual monitoring assures that effluent reuse standards are continuously being achieved.

**PERFORMANCE**

<table>
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<tr>
<th>Units (mg/l)</th>
<th>Influent</th>
<th>Primary</th>
<th>Effluent</th>
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<tbody>
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**SYSTEM OPERATION**

Oregon WPCF Permit requires the following minimum monitoring and recording:

- Daily flow readings
- Annual flow meter calibration
- Annual average daily flow
- Grab samples collected 3x/week for total coliform
- Grab samples collected 3x/week for chlorine residual

**PERFORMANCE MONITORING**

Additional data parameters are monitored to ensure optimal system performance during the first few months:

- Total Suspended Solids (TSS)
- Chemical Oxygen Demand (COD)
- Total Kjeldahl Nitrogen (TKN) and Ammonia (NH₃-N)
- Fecal Coliforms
- Turbidity
Living Machine Process Diagram

Magnetic and ultrasonic flow meters monitor flow.

Stage 1
- Coarse lightweight expanded shale (LESA) treatment media prevents clogging.

Stage 2
- Finer LESA media provides final treatment.

Underdrain system allows cells to drain quickly, allowing rapid cycling.

Settling Tank
- Removal of coarse solids and floating material plus flow equalization.

Living Machine Control Panel
- Web enabled panel allows remote operation and oversight.

Vertical Flow Cells 1-4

Tidal Flow Cells 1-6

Transition media protects underdrain.

Cartridge Filter

Chlorine Tablet Feeder

Online Turbidity Sensor

ORP Sensor monitors disinfection levels.

Reuse Tank provides water for toilet flushing.

www.sustainablewater.com