13.0
RECLAIMED WATER SYSTEM

> *"We try to make it so that they [the public] feel some sort of affinity to this living thing. Something beautiful always has to be respected and they will resonate with the living things that we present in our system."*
>
> *- Kim Rink, President, ECO-TEK Ecological Technologies, Inc.*

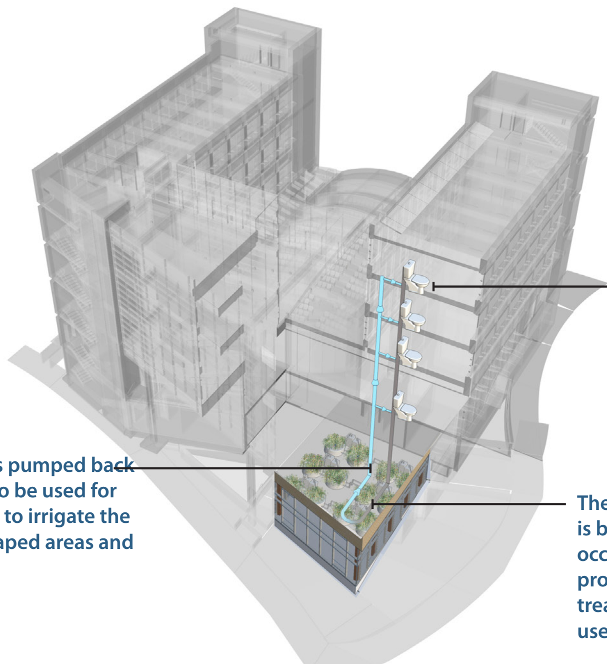

Image 13.1 Reclaimed Water System Diagram

13.1 System Overview

One hundred percent of all reclaimed water used at CIRS originates from the building and the Campus sewer system and is treated onsite and reused within the building. The Solar Aquatic System, designed for CIRS by ECO-TEK, Ecological Technology Inc., is an ecologically engineered system based on processes existing in nature that consume human biological waste to produce clean water. The water is collected from fixtures throughout the building and treated water is reused within the building for irrigation and toilet flushing, creating a closed loop water cycle. The Solar Aquatics System is designed to mimic the purification processes of naturally occurring water systems in close proximity to human inhabitation, such as streams and wetlands.

The Solar Aquatic System is located in an isolated glass walled room in the southwest corner of the building. This highly visible corner is adjacent to Sustainability Street, West Mall and the 'desire line' pedestrian path that runs through the site. The Solar Aquatic System is a very distinctive focal point for the sustainable agenda of CIRS.

LESSONS LEARNED

Build client confidence in innovation

Communicate scope of work

Utilize the design/build model

Balance current needs with future growth

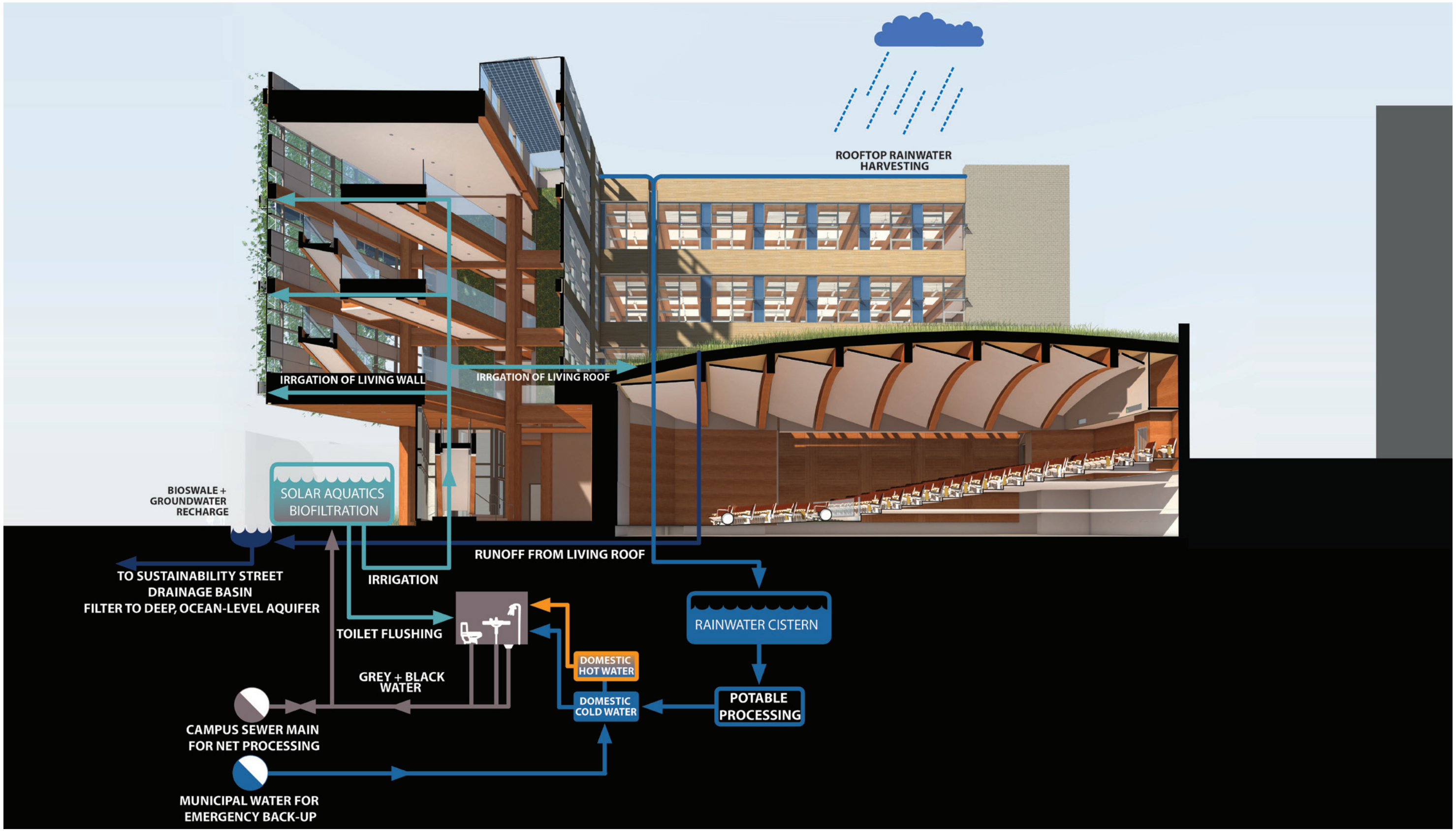

Image 13.2 CIRS Integrated Water Systems Diagram

13.2 System Description

'Mining the sewer' in this manner ensures constant and optimal levels of wastewater enter the system, and ensures a steady supply of water is always available to meet irrigation requirements. In addition, it reduces the burden on traditional infrastructure required to move and treat sewage in a conventional treatment plant.

Step 1 – Collection/Buffer Tank

The system collects all the wastewater from the building, supplemented in times of lower occupancy by the campus sewage system.

Step 2 – Blending Tank

The sewage is collected in a closed tank where added bacteria begin to digest the biological waste. The tank is constantly aerated to keep the bacteria in contact with the waste. Aeration also reduces odour rapidly.

Step 3 – Aeration Tanks

The wastewater, along with some bacteria, is then moved through a series of aeration tanks. These are open tanks populated on the surface with regionally acclimatized aquatic and terrestrial plants. The plants absorb a small amount of the nutrients from the sewage and process carbon dioxide, while most of the work is done by bacteria on the root systems below the surface. The roots provide a perfect habitat for the bacteria. The water in the tank is constantly aerated to promote contact with the bacteria on the root systems. As the bacteria grow and thrive they process the sewage as food.

By the end of the aeration process the nutrients in the water become more available for reuse. Ammonia (from urine) is converted into nitrate and the phosphorous becomes more soluble.

Plants in the aeration tanks are self-propagating. They won't need replacement and can be composted or harvested for use elsewhere, including sale as garden plants or decorative flowers.

Step 4 – Gravity Clarifier

After the aeration tanks, the water moves to a Gravity Clarifier tank. The tank is cone bottomed with no air supply where the bacteria (sludge) settle in the bottom, separating from clarified water. The bacteria are then pumped back to the blending tank to begin the process again.

Step 5- Sand Filter

The clarified water moves from the Gravity Clarifier through a sand filter that mimics how water filters through a column of soil. The fine particles of the sand remove any tiny particles in the water.

Step 6 –Constructed Wetland

From the Sand Filter, the water travels through an area of constructed wetlands where fecal coliform and some metals are removed from the water through contact with bacteria and plants.

Step 7 – Ultra-Filter

The next step is an ultra-filtration system. This is a high-tech but very simple system of nano-materials where the water is filtered to a very high degree through screens of micron fibres.

Step 8 – Disinfection

After filtration, the water is disinfected using a two-step process. First, the water is exposed to ultra-violet light to kill any remaining pathogens. Next a small amount of residual chlorine is added.

Residual chlorine is typically added to municipal water systems, as its presence provides an assurance that the disinfection process is working. Long term system monitoring may be able to demonstrate that the system can clean the water to a satisfactory level without adding chlorine, and eventually eliminate this step.

Step 9 – Storage and Re-use

The cleaned, reclaimed water moves to storage tanks and is then pumped into the building for use as irrigation and toilet/urinal flushing. Flushed water then re-enters the system for treatment.

Step 10 – Compost (future development)

Over time, as bacteria grow and replicate, there will be a build-up of sludge – large active colonies of bacteria - in the system. Typically, a composting process is created to remove and reuse the sludge, as it is rich in nutrients that can be absorbed by plants and returned to the biosphere. Composting is not yet in place for the CIRS treatment system, so excess sludge is simply removed and discarded. However, in collaboration with students and researchers, a composting process will be developed for reuse on campus.

Designed for Adaptation

The Solar Aquatics System at CIRS is designed for ongoing experimentation and testing. It is arranged in two parallel trains, completely separate but identical, to allow for controlled experiments and comparisons, as well as for continued operations if one train requires maintenance or repair. The entire system is monitored at every stage, supporting ongoing measurement of water quality during each step in the process. The system is completely backed up by the municipal water supply and sewage system, with installed safety measures, allowing for a degree of freedom not possible in an isolated context.

AGENTS

Architects: Busby Perkins+Will Architects,

Solar Aquatics Design/Build: Ecological technologies Inc.

Environmental Engineers: NovaTech

Mechanical Engineers: Stantec

Operators: UBC Campus Operations, with support from ECO-TEK

Design Build

The procurement method for the Solar Aquatics System was a design-build process. In this model the same firm does both the design and construction of the system. Eco-Tek worked with the UBC and the design team to develop an appropriate system and to address any concerns on the part of the client or regulators regarding an innovative water treatment system. Once the facility to house the system was completed as part of the base building, Eco-Tek constructed the Solar Aquatic System and attached to the plumbing of the building and the campus sewer. Having the same firm working on the design and construction of an innovative system allows for any potential issues to be address as they arise and provides a certain amount of assurance to a client in terms of cost and responsibility. Eco-Tek will continue to monitor the reclaimed water system over time, providing guidance on any necessary adjustments and participating in experimentation.

13.3 Campus Context

UBC Campus Plan

Currently, potable water is supplied to the UBC's Vancouver Campus by the regional water supply system and wastewater is sent through the municipal infrastructure to the Iona Treatment Plant for primary treatment before being discharged to the Strait of Georgia. UBC seeks to reduce the overall impact of its water use through minimizing potable water consumption, maximizing water re-use and minimizing wastewater transported off-site. As part of the Living Laboratory Infrastructure initiative, the University will support 'resource recovery practices' that maximize the potential value of recovered waste streams from both a campus operations and a research perspective. There will be a particular focus on collaborative opportunities, including projects that demonstrate new approaches and ones that increase understanding of infrastructure and systems by increasing their visibility to the campus community.

> UBC Campus Plan, Section 6.2 Sustainability Practices, Integrated Water System Planning and Living Lab Infrastructure Projects, pg 40

Scalability

The Solar Aquatic System in CIRS is not the ideal size for a system of this type. To achieve an optimal process, with an efficiency of equipment and oversight, a larger system would be better (100 cubic meters rather than 10 cubic meters). This could involve clusters of buildings on one system or, preferably, a campus wide system. A campus wide approach could have the added benefit of creating a resource of reclaimed water and nutrients. The water could be used for landscape irrigation, for the horticultural department, for the UBC Farm, putting nutrients from the water back into the ecosystem and enriching the natural environment of campus.

Ongoing Research/Operations Collaborations

There is a plethora of research opportunities surrounding this type of system, because the CIRS system allows for controls and comparisons as well as focused monitoring. Since the Solar Aquatic System process and ecological technology is a developing field, there are benefits in learning what types of cleaning (types of bacteria and plants), filtration (sand and non-materials), disinfection methods

(UV, chemicals such as chlorine), and processes work best. The system will be run and maintained by campus operations staff and a new position (a Level 4 Operator) is being created specifically for the reclaimed water system. There will be much potential for collaboration between operators and researchers (both faculty and students), that will help turn the building into a living laboratory and provide a demonstration test for possible application elsewhere on campus.

UBC Technical Guidelines

The rainwater to potable water system is covered by a range of Divisions in the UBC Technical Guidelines, and does contain conflicts with the requirements for the Living Building Challenge and the ecological and human health aims of sustainability. Specifically, the Guidelines require the application of chlorine as a disinfectant to the water supply.

Section 02660
Requirement for chlorine disinfection of water supply.

13.4 Goals & Targets

Table 13.1 lists the project goals and targets specifically related to the reclaimed water system. For a complete list of all the goals and targets for CIRS, refer to Section 4.0 Goals & Targets.

Category	Goals	Targets
3 – NET IMPACT	Neutralize ecological impact on site by having a net positive biomass and oxygen provided on-site. Eliminate on-site run-off.	
9 – WASTEWATER COLLECTION, TREATMENT & REUSE	All wastewater will be collected and treated on-site or within the 'sustainability precinct'. Recognize environmental opportunities in the management of human waste.	Zero wastewater output from site.
10 – STORMWATER MANAGEMENT	100 per cent stormwater will be treated, used or infiltrated on-site.	Zero stormwater output from site.
12 – WASTE ELIMINATION	Zero waste.	Zero operational waste.
18 – SEAMLESS DESIGN & OPERATION	The building will seamlessly integrate the design and ongoing operations.	
21 – COMMUNITY & EXTERNAL IMPACTS	Minimize external and community environmental impacts of CIRS's staff and visitors.	
22 – PUBLIC EDUCATION	CIRS will disseminate sustainable design practices, knowledge and experience as widely as possible.	

Table 13.1 Goals and Targets for the Reclaimed Water System

PROCESS

Design Process:

Design of the reclaimed water system began with early concept development and charrettes.

Construction:

The reclaimed water system was onstructed and installed by as a design/build package, towards the end of the building construction

Commissioning:

Operations:

COSTS

Cost: $150,000

Procurement Method: Design/ Build

Operations: TBD ($/per year)

Challenges: Holding cost steady through inflation over long-term project development.

Benefit: Both the client and the design/build consultant benefit from partnering and research opportunities. The project can become a demonstration or 'business-card' for the consultant.

13.5 Benefits

The use of the reclaimed water treatment system at CIRS benefits the project in the following ways:

Utilized the Design-Build Model

- The design-build model provides the continuation of knowledge and experience through design and construction, as well as opportunities for identifying innovative solutions and application for improvement. The design-build procurement also brought cost certainty to an innovative system during the design phase.

Makes Sustainability Visible

- The Solar Aquatic System is located on the ground floor of the building, adjacent to multiple campus circulation pathways that bring students, faculty and campus visitors into visual contact with the treatment system. It is a compelling and living example of the CIRS vision and philosophy, and inspires a sense of stewardship for living systems and natural resources.

Uses Natural Processes

- Reusing the water in the building intensifies the use of that resource and reduces the larger demand on municipal water resources. The closed loop system mimics natural systems and communicates the relationship of human built infrastructure to natural systems.

Engages Inhabitants

- The Solar Aquatic System engages people through the aesthetic appreciation and love of living things. Inhabitants in CIRS will be more aware of the downstream impacts of their use of the water systems and less likely to use it for disposal of non-organic waste and pollutants.

Processes Waste without Odour

- The aerobic bacteria process and the presence of plants eliminate the odours associated with conventional wastewater treatment. The CIRS system will push forward research on bio-mimetic water treatment systems.

Sequesters and Reapplies Nutrients

- Sewage is rich in nutrients typically lost in conventional treatment. The Solar Aquatic system redirects nutrients to the plants, captures nutrients in the form of bacteria sludge for composting and sends clean, nutrient dense water to be used for irrigation.

Facilitates Research and Collaboration

- The small system with controlled input, comprised of two parallel trains, is an ideal opportunity for research and testing of new ideas and processes and opens the door for collaboration between operators and researchers.

Mining the Sewer

- Typically, sewage is considered as a waste stream that is of no value and requires extensive treatment. At CIRS, the wastewater in the municipal system is considered a high-valued resource. By mining the municipal sewer, it changes conventional ideas of waste from unwanted and low-value, to that of a high value resource. Research at CIRS will have the potential for application at a broader scale to the sewer system as a resource.

Creates a Self-perpetuating System

- While the system will be continually monitored and modified for optimal effectiveness, it is generally part self-perpetuating. The plants will continue to propagate, the bacteria will continually replicate and the system will continue to treat wastewater from CIRS.

13.6 Challenges

The use of the reclaimed water treatment system at CIRS was challenging for the project in the following ways:

Mitigating Perception of Risk

- Significant effort was spent mitigating the perceived risk associated with the treatment system. The design team had to build confidence among all project partners by educating and demonstrating successful implementation elsewhere.

Regulating Innovation

- While a Solar Aquatic System can treat water to achieve high quality without adding chemical treatment, the local health authority (Vancouver Coastal Health) required that a chlorine residual be added as a precaution.

Bridging Gaps in Scopes

- Scope gaps can occur when multiple consultants are working on the same system or building component without a clear understanding of each other's contractual obligations and limitations. Close collaborations between design team and the design-build contractor helped mitigate the gaps in scope and address problems when they arose.

Finding Sustainable Alternatives

- Sourcing products that do not contain materials or substances on the LBC Red List (See Section 10.0 Building Materials) in their sub-components or small parts was challenging for the reclaimed water system. Alternatives had to be found for many common components.

Wasting Nutrients

- Over time, the reclaimed water will accumulate nutrients (such as nitrate and phosphorous) as it cycles through the building and the Solar Aquatic System. These nutrients will be wasted if not returned to ecosystems. Finding an alternative outlet or other end users that would benefit from the nutrient dense water is desirable and will become a priority as the system ages.

RATING SYSTEMS

The reclaimed water systems helped CIRS achieve the following LEED credits and Living Building Challenge imperatives. For more information see Section 19.0 Building rating Systems.

LEED

Water Efficiency Credits:

- *1.1 & 1.2 – Water Efficient Landscaping*
- *2 – Innovative Wastewater Technologies*
- *3.1 & 3.2 - Water Use Reduction*

Living Building Challenge

05 – Net Zero Water

06 – Ecological Water Flow

10 - Biophilia

19 – Beauty & Spirit

20 – Inspiration & Education

RELATED SECTIONS

RESOURCES

- *Schematic Drawings: DWG# or link*
- *ECO-TEK: www.ecotek.ca*

13.7 Lessons Learned

The experience gained through the use of the reclaimed water treatment system for CIRS provided valuable lessons to apply to future projects. Some key lessons are:

Build Client Confidence in Innovation

- Client reticence in accepting an uncommon and unfamiliar system can be overcome through presenting prior projects, and describing the challenges encountered in those situations, common problems and the effective solutions developed in response. Past proofs of success build understanding and confidence in the system.

Communicate Scope of Work

- Facilitate coordination and communication between consultants (as well as the design team, project managers and clients) to ensure that everyone understands clearly not only their own contractual scope of work, but also that of their partners. Design team leaders and project managers need to ensure that all aspects of the work are covered by responsible parties.

Utilize the Design/Build Model

- The design/build model helps streamline the design and construction process of non-standard systems by providing a continuity of knowledge and experience and increases opportunities to dentify potential problems and immediately address them during installation. This model also reduces risk and provides additional confidence for the client by having the same consultant take complete responsibility for the system, provide one package for a set cost, and bring along all of their previous experience to this project.

Balance Current Needs with Future Growth

- There is an optimal scale to most systems. This scale includes considerations of functional efficiency, cost of construction, cost of operation and continual labour requirements. The design of a system must balance the initial needs and costs with potential future growth or replication.

13.8 Future Learning

Additional lessons learned over the operational life of the building will be added at periodic intervals