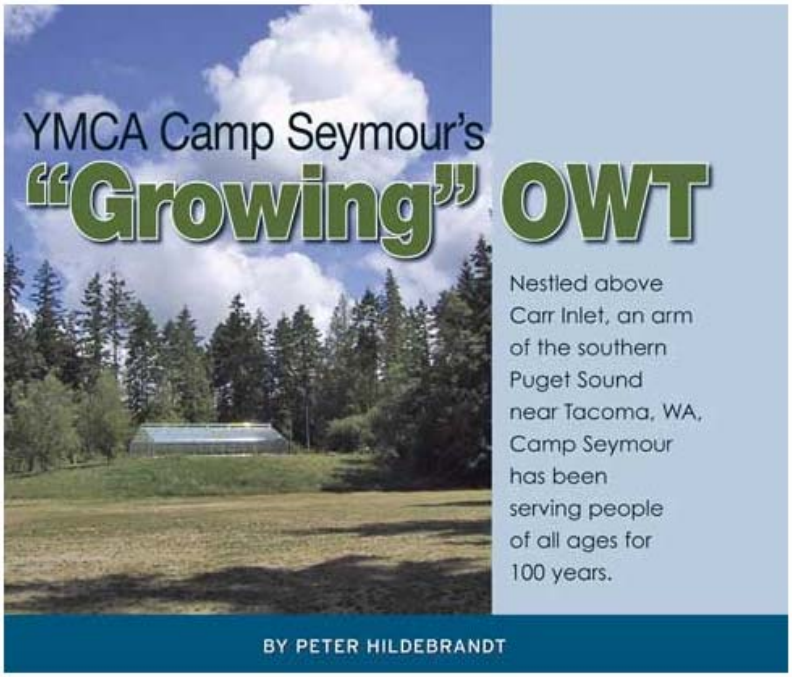
ONSITE WATER TREATMENT
The Journal for Decentralized Wastewater Treatment Solutions



The YMCA camp was founded in 1905 and retains the pristine quality of the surrounding environment much as it did when it first opened its doors to campers. The camp still contains 150 acres of forested hills and a shoreline stretching a half mile along a protected estuary, home to bald eagles, river otters, great blue herons, seals, and salmon. The camp started out with tents to house its temporary residents. In the 1940s, cabins and other structures were added. The camp now serves young people from first grade to high school. And interestingly, one of the attractions at the camp is now its onsite water treatment facility.

With an operating budget of over $1 million, the camp currently serves some 8,000 people annually, ranging from youth and teens to adults. At its peak of operations, the camp can handle 230 people at a time. Expansion over the next few years includes plans to be able to serve up to 350 people.

Because of the location on the Puget Sound, Bob Gratias, facilities manager, was concerned about the impact Camp Seymour would have on this body of water. With a lot of buildings close to the waterfront, he was looking for a way to consolidate their wastewater treatment away from the shoreline. “What was in place consisted of traditional septic tanks and leach fields that were in somewhat disrepair and had limited capacity,” says Gratias. “Nothing was failing, but since we were thinking about expansion down the road, we had to come up with a new system anyway.”

Flag, canna, taro, and other plants are involved in the filtering process.

The camp's primary goals at the start were to consolidate the system, expand it and move it away from the shoreline of the Puget Sound, and at the same time create high-quality water. Since this is at present a year-round residential facility, there was a clear impetus to preserve the area's unique natural setting and resources along with minimizing the human impact on the environment. Remaining true to Camp Seymour's basic philosophy of being an advocate for both education about the natural environment and land stewardship, Gratias started looking into wastewater systems and doing some research. "Because we are also a strong environmental education center for nine to 10 months out of the year, a Living Machine onsite wastewater treatment system seemed a natural fit."

The camp's greenhouse offers an excellent learning environment.

Living Designs Group designed a system to take all of the camp's wastewater and pump it up to a site higher on the property. "We came up with a system that fit their needs at that time," says David Maciolek, vice president of engineering for Living Designs Group LLC, based in Taos, NM. "We were transitioning away from the older technology that was based on activated sludge or aerated wastewater treatment. Some of the septic systems onsite were pretty old and some of them were newer, but despite replacement of the tanks, it was the leach fields that were the main problem."

The camp had an existing infrastructure. Living Designs planned to take the collected wastewater and treat it. The projected design flow at the start of operations was approximately 10,000 gallons per day. But the camp wanted to expand this to 14,000 gallons per day. "We designed the system with that in mind," says Maciolek. "The initial goal for the Camp Seymour project was a push to get the septic systems off of the Puget Sound," says Maciolek. "At the inlet, salmon swim upstream to spawn, and there's abundant sea life in the sound surrounding the inlet. The soils close to the sound are both very saturated and in a fairly steep environment, so there was a continuous flow of groundwater into the inlet."

Maciolek says Living Machine Systems are natural wastewater treatment systems that have had a long history of being associated with educational and environmental facilities because they are interesting to look at and contain great ecological diversity. "They are 'friendly' wastewater systems, if you will—friendly and beautiful in many cases." Living Designs Group's architects, engineers and ecologists specialize in the holistic integration of water, energy and green building systems.

The decision to use a Living Machine system was made by the camp's board of directors. Work started on the project in the fall of 2000. The project was installed by AquaCare Environment Inc., based in Bellingham, WA. The onsite engineering of some of the nuts-and-bolts tasks was done by 20-20 Engineering Inc, also of Bellingham. "We now do all that ourselves instead of contracting it out or collaborating," says Maciolek. "But the two companies involved ended up being great partners with us." The Camp Seymour YMCA project was the second project Living Machine worked on with AquaCare Environment. The other project was an environmental camp, originally known as Puget Sound Environmental Learning Center, now it is simply called IslandWood, on Bainbridge Island, also in Washington state.

Staff housing facilities, cabins for visitors, common bath facilities and Camp Seymour's kitchen area are all locations onsite where wastewater is generated. Septic wastes from these areas move by gravity to a network of tanks where coarse solids are removed. The effluent in the tanks is then pumped to an equalization-dosing tank. Here the denitrification of the waste takes place. Waste is then pumped to textile trickling filters in doses. The de-nitrification process, the conversion of ammonia to nitrate, then starts.

Living Machine's third-generation systems will use wetland cells as the primary means of filtration.

After moving through the textile filters, the wastewater is pumped to a series of six open hydroponic reactor tanks located inside the camp's greenhouses. Each of these tanks contains a varied population of both aquatic organisms and plants. In such an oxygenated environment as this, the small ecosystem of microorganisms and macroorganisms function to break down waste and remove leftover dissolved organic matter even further.

The next step after the reactors is the two outdoor wetlands constructed onsite. After flowing through these, the effluent is finally treated with ultraviolet light for a final disinfection. The effluent is now usable and stored for onsite irrigation of Camp Seymour's playing fields. There are plans to further reuse this treated effluent for the flushing of toilets in any future buildings on campus.

According to Maciolek, wastewater treatment can be done in several ways, in the fairly traditional method—mechanical—or in ways using a natural treatment system. Living Machine systems have taken the natural treatment approach but hybridized it somewhat so that, instead of being an outdoor pond or large wetland that is not very approachable, whole natural systems have been organized into smaller components.

The hydroponic reactors at Camp Seymour consist of tanks that have plants growing on them on racks near the surface. Flag, canna lily, taro, giant iris, and other plants in the greenhouse are involved in the filtering process. The plant roots provide biologically active treatment through their root zones. The roots themselves sweep up bacteria that are treating the wastewater. The roots also host other microorganisms that feed on the bacteria. This creates a whole ecosystem in itself. The root zones of the plants also provide a more complex and stable treatment environment. "We are not relying on bacteria that grow in a soup, like the standard activated sludge treatment plant," says Maciolek. "The main feature of those types of systems is a big tankful of aerated bacterial soup called activated sludge. If you get the wrong types of organisms growing in there then the whole thing can go haywire because they rely on a clarifier to keep the system operating properly. In a nutshell, the system requires 'well-behaved' bacteria to help things settle out in a clarifier. If the bacteria are not from the right group or are not well-behaved, the wastewater may end up being discharged cloudy from the system."

The traditional systems also tend to use a lot of air and energy. They also blow off aerosols and odors at times too. "Most people don't want anything like that near them," says Maciolek. "They wouldn't want that in their backyard and certainly not want it in a greenhouse as a part of a classroom."

The greenhouse plants often grow as tall as the rafters before they are cut.

The hydroponic reactors, which are somewhat of a variation on the traditional area tanks, are located in a greenhouse. Those who attend the camp are able to enter the greenhouses, study the system and take ecology classes in that setting as well.

This project represents an early version of the second generation of Living Machine systems. It is what the company refers to as a hybrid hydroponic and wetland system. There are in-greenhouse sections to the system and a special, vertical-flow wetlands outdoors. The wetlands are not standard, subsurface flow wetlands. They consist of a number of cells measuring 20 feet by 30 feet in size. Their smallness is an important advantage to vertical flow wetlands.

Living Design Group's third generation systems have only wetland cells. They are even a further advancement on traditional wetlands. There is one of these systems under construction in Las Vegas, NV, and several in design stages around the country. "There are different ways to approach a particular site's needs," says Maciolek. "These are based on either wetlands or the aerated reactions with plants and the water being processed. The plants thus form a central part of the treatment process by both enhancing it and making it 'friendly'. People relate to plants. If they see plants growing, they not only observe their beauty but also think, 'Well, I see plants growing here, so this can't be all that bad.' One thing I have noticed over the past few years is that Living Machine systems have really opened peoples' minds to wastewater treatment. They see the Living Machine and say, 'Oh, this is cool. This isn't nasty!' That concept summarizes why we install them in so many outdoor environmental education facilities."

According to Maciolek, if a site is able to use the septic tank and leach field approach, people will generally do that. Living Machine, however, tries to take things a step further. In the case of Camp Seymour there was a drive to both improve the water quality and use that water for drip irrigation of a ball field that is below the system. But to do that irrigation the water had to be very clean. "This water that the ball field is using is not quite drinkable," says Maciolek. "But it is essentially one step away from that level of cleanliness."

The recent drought in the Pacific Northwest has actually helped solidify the importance of using the cleaned wastewater on the camp's playing fields. If more potable water had to be used for this function, it would have been less cost-effective and more of a strain on the environment. Now the camp has virtually a guaranteed source of irrigation water.

The YMCA project has definitely met the water quality requirements for discharge and for reuse. In addition to meeting monitoring requirements, the camp itself has been pleased overall with the results that have been obtained by using a Living Machine System.

Living Designs Group has seen its niche in the market for this technology grow from the so-called "boutique" level to the point where, with the generation II and III systems, the technology can be used in many different

settings. Greenhouses are no longer required and their applicability has broadened appreciatively.

One important lesson learned during the course of this project was that vertical flow wetlands are a very powerful treatment tool. Maciolek feels that if this project were to be done again, the company would eliminate the textile filter pre-treatment. It wasn't really needed, as things turned out. Living Designs Group has one of its systems installed at its Taos headquarters, without the textile filter pre-treatment segments of the system in place—and the effluent goes straight from the septic tank to the hydroponic reactors with no problems. "Between the wetlands and the hydroponic reactors, we found that we didn't need the textile filters. Since the YMCA camp was the first commercial system of its kind that we installed, we put on both belts and suspenders to make sure that we had a backup plan," says Maciolek. "It is always better to have too much safety rather than not enough. Subsequently, we have installed systems that have not needed the textile filters."

During the course of construction, a load of gravel that hadn't been properly washed was delivered to the camp for use in the system. As a result, some of the gravel in the wetlands had to be replaced. It is crucial that gravel is completely—essentially triple-washed—clean before installation, or the fine dirt will wash down and clog portions of the wetland. Also, turbid water will be produced by the wetland as long as the system is operating. Vertical flow wetlands tend to be less prone to biological clogging because they oxygenate between doses. The air goes down through the wetland, and the bacteria feed on themselves and other food and keep the wetland from fouling with biofilms. The wetlands are flat. A series of networks of pipes dose water on the top, and that trickles down through the system to under-drain pipes on the bottom. "In a way, it's like a planted biological filter," says Maciolek. "This technology is still relatively new despite the evolution of the idea back in the 1970s."

From Living Design Group's end, it was rewarding to see things work as well as they did on this first-of-its-kind project. Maciolek says things went as well or even better than expected for the company. The plants in the greenhouses grew to be tremendous and of especially stunning beauty, a result not anticipated at first.

The single large greenhouse, roughly 36 feet by 72 feet in size, contains six hydroponic tanks with 8-foot diameters. The tanks stick out of the ground about 4 feet. "These give the students an opportunity to see a real visual representation of what's going on with the treatment," says Gratias. "We also do a lot of education around sustainability. The plants are huge by the fall, reaching the rafters. Then we will cut them back around 60% for the winter, so you can actually see into the tanks once again. The plants at that time are not over 4 feet tall."

Gratias also cuts back bulrushes and other emergent plants in the outdoor wetlands. "We do have a lot more maintenance now than when we were simply septic tanks," says Gratias. "But it's maintenance I actually enjoy doing. I greatly prefer going in a greenhouse that smells good to prune plants versus having to pop lids on septic tanks!"

Another YMCA camp in southern California is looking into a system similar to the one at Camp Seymour. One is already in operation in Canada as well. Gratias was in contact with that camp quite a bit during the planning stages for his system. The camp's water treatment system on Bainbridge Island was the first such system in the state of Washington.

"Overall, things have worked out really well since the system has been installed and put into operation," says Gratias. "Developing curriculum was an interesting challenge for our naturalist staff. But they came up with some great ideas."

A permanent dry meeting space has been a secondary benefit of the system, which is at quite a premium in the drizzly climate found along the Puget Sound. "Our greenhouse was made oversized for a good reason. Our kids can go in there and have classes or meetings," says Gratias.

After doing the research on the system to understand the facts as they were presenting them, the naturalists had to come up with some creative ways to present those facts. In the greenhouse the naturalists give a workshop for grades five and six in which they break them up into groups, give them water that's colored with a dye and several resources to clean that water. This is followed by a quick demonstration of the water resources of the world, using a gallon jug. After allotting the different amounts to what is taken up by ocean, glaciers, groundwater, and, finally, what is usable by man, there are only a few drops remaining in a capful by the end of this exercise. "They have come up with several great ideas such as this to show the kids various ways that we have direct interactions and impact on our limited water resources," says Gratias.

Because of the Living Machine system, Gratias has found expansion of the camp to be possible. Another benefit has been cost. Just over two-thirds of this project was paid for by grants that reduced the camp's actual expense for expanding its system, thus making it substantially less than the cost of a traditional system. These grants were mostly from private foundations. "There are a lot of foundations in our area that support clean water," says Gratias. "We even had a partial grant from the Bonneville Power Administration that explored the energy-efficiency of this type of a system.

"I can see this working well in all sorts of smaller facilities, and for the appropriate-sized facility I think it's great," says Gratias. "Small developments, condos, or these sorts of things would be perfect for such a system, especially an integrated design system where they are incorporating it into buildings. I personally and philosophically like the idea that we are working with nature, instead of trying to force nature inside of a box."

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