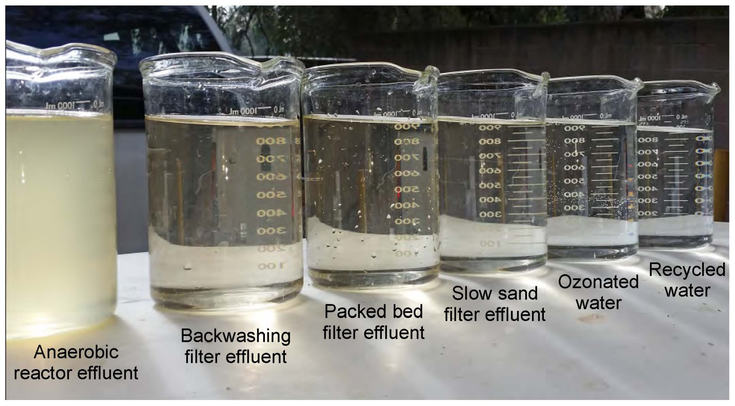
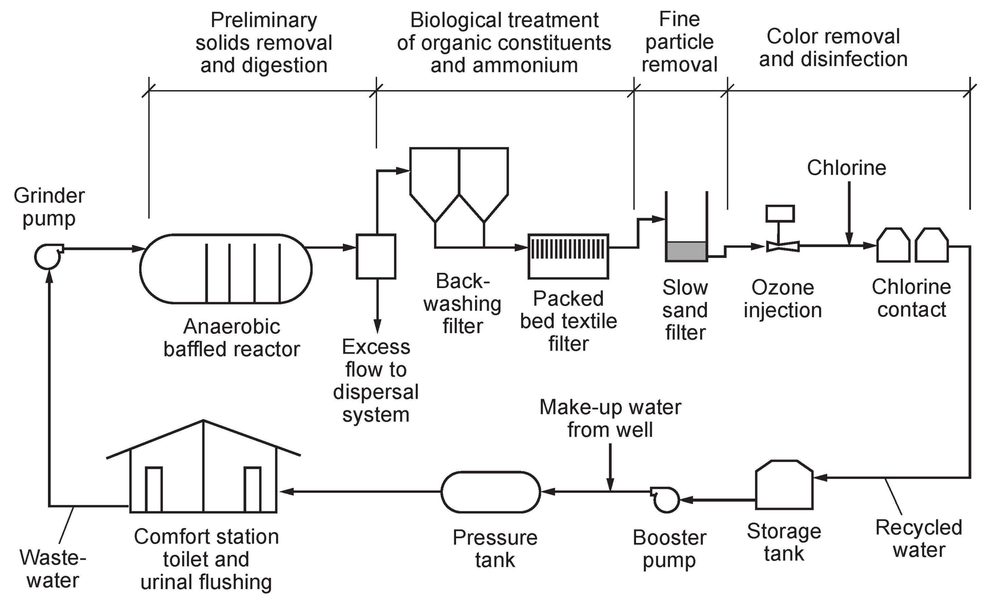
DUNNIGAN SRRA
WATER RECYCLING PILOT PROJECT

JANUARY 2015

Background

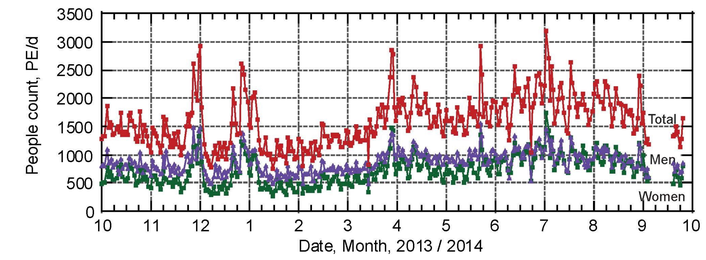
Routine droughts make water conservation an important subject throughout the state of California. To address this issue CalTrans has been investigaing the concept of water recycling at SRRA facilities. Before any water can be recycled, an effective and reliable treatment process is needed to produce recycled water that meets California standards. Based on preliminary results, non-potable water use could be reduced by up to 90 percent with water recycling.





The Treatment Process

The Dunnigan SRRA is equipped with an onsite wastewater treatment testing facility where various technologies are being evaluated for process efficiency and reliability. The system consists of natural biological treatment processes using the indigenous microbial community. After more than a year of onsite testing, a successful and reliable treatment system was developed that can be used at safety roadside rest areas across the state.



Usage Data Collection

Visitor traffic monitoring is an important element of this study. A number of car counters and people counters have been set up around the rest area to define the relationship between the number of visitors and the associated wastewater flow so appropriately sized treatment facilities can be developed at rest stops in the future.

Anaerobic baffled reactor

When the wastewater reaches the facility it goes into an anaerobic baffled reactor. This is a multi chambered septic tank that settles out most of the larger organic particulates and treats the wastewater with anaerobic (without oxygen) bacteria. Scum (floatable solids) and sludge (settleable solids) are left behind and the wastewater continues on for further treatment. Gases that are produced in this process are filtered through activated carbon to remove odors.

Anaerobic digestion:

$C_aH_bO_c \rightarrow CO_2 + CH_4$

Backwashing filter

The wastewater then enters the top of a large container filled with crushed pumice stone. A rich biofilm of bacteria that grows on the stone treats and removes carbon based organics and particulates (suspended solids). After the wastewater has been filtered through the crushed stone the pores become clogged. Periodically, filtered wastewater is pushed backwards through the filter to clean off the organic build up. When the backwash cycle is complete the pumice is renewed and ready to again filter wastewater.

Organic constituent removal:

$C_aH_bO_c + O_2 \rightarrow CO_2 + H_2O$

Packed bed textile filter

Next the wastewater goes to a phase known as polishing. At this point almost all of the suspended solids have been removed but some turbidity (cloudiness) and residual ammonium remain. The wastewater is sprayed over fibrous mats. These mats support another biological culture that converts ammonium into nitrates. The wastewater flowing from this phase of the treatment is also very clear and only has some very slight discoloration which is to be addressed subsequently in the process.

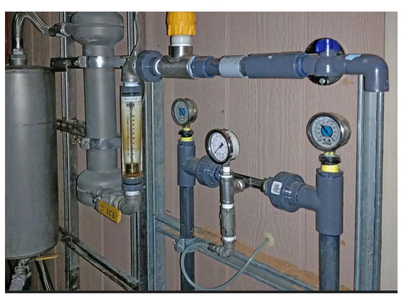
Ammonium removal:

$NH_4^+ + O_2 \rightarrow NO_3^- + H_2O + H^+$

Slow sand filter

The wastewater is then dripped onto a bed of sand through which it slowly percolates down. This sand filter is the final process before disinfection that ensures that any particulate that may still be left in the wastewater is removed. This sort of redundancy ensures that quality filtered wastewater will be produced even if one phase of the treatment system is not operating at peak efficiency. The sand filter must be periodically cleaned of surface layer buildup to continue to function. This regular cleaning ensures that the bed of sand can remain an effective filter for years.

Ozone injection



Ozone gas (O_3) is generated using an oxygen concentrator and corona discharge type ozone generator. Ozone gas is dissolved into the filtered wastewater using a venturi injector. This process mineralizes dissolved chemicals that cause color and yields clear water after treatment. It is also effective as a disinfectant, removing a large portion of residual microoganims present in the wastewater. As an alternative, adsorption on activated carbon is also being investigated for color removal.

Color removal:

$C_aH_bO_c + O_3 \rightarrow O_2 + CO_2 + H_2$

Chlorine contact

After treatment for color removal the recycled water receives a final stage of disinfection. Chlorine is an important final addition to the recycled water because it can remain in small residual amounts and ensures that the recycled water can not become re-contaminated by any microorganisms that it may encounter in the recycled water distribution system, and prevents biofouling of the toilet and urinal fixtures.

Chlorine Disinfection:

$HOCl + H^+ \rightarrow Cl_2 + H_2O$

$NH_4^+ + Cl_2 \rightarrow NH_2Cl$