CASE STUDY

AQUARIUS Technologies LLC

NEBULA®
MultiStage Biofilm System

Nebula® Delivers Worry-Free Performance at a Children's Camp

In 2011, Roundup River Ranch required a wastewater treatment system that could accommodate large variations in flows and loadings, provide permitted quality effluent for discharge into the pristine Colorado River, required minimal maintenance and offered low operating costs.

The consulting engineer for the Ranch, JVA Incorporated, worked with Aquarius Technologies to provide a simple solution. The Nebula® MultiStage Biofilm System plug flow configuration is designed to facilitate a microbial food chain for treatment of wastewater and has proven to be remarkably efficient.

Located near Gypsum, Colorado, Roundup River Ranch offers old-fashioned, pure fun camp experiences for children with serious illnesses and their families. It's part of actor Paul Newman's SeriousFun Children's Network.

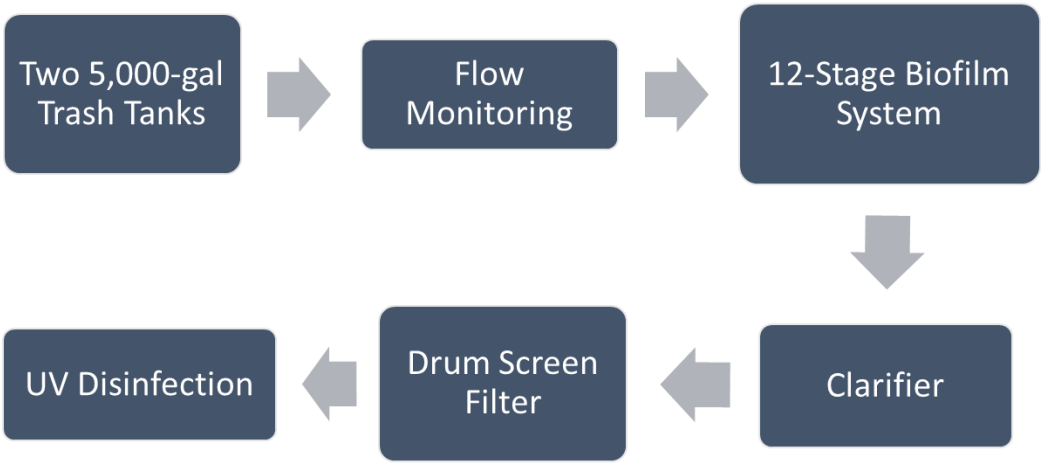
Camp personnel are present year-round, while campers are on-site for five months out of the year. As a result, the camp needed a resilient wastewater treatment system capable of accommodating large swings in influent flows and loadings with low biological sludge yield. Since the camp is in a remote location, ease of maintenance was a key requirement of the consulting engineer and the ranch.

Treatment System Design

JVA Incorporated, Winter Park, CO, worked with the ranch to design its wastewater treatment plant. During their evaluation, they considered suspended growth systems as well as biofilm technology.

For this application, suspended growth systems by design produce more sludge, are less tolerant of variations in flows and loadings and require more operator attention to consistently achieve the permitted treatment objectives.

The Nebula MultiStage Biofilm System was selected based on meeting all of the camp's performance requirements. It also represented the lowest cost of ownership.



The headworks facility includes two 2,500-gallon trash tanks made of waterproof, non-corrosive materials. Here, the raw sewage separates into three distinct zones: scum layer, sludge layer and clear layer. Holes in the tank's baffle walls allow effluent from the clear layer to flow into the subsequent compartments of the tank.

A septic tank filter was installed on the effluent pipe of the trash tank to capture approximately two-thirds of the total suspended solids for storage in the septic tank. The septic tank filter cartridge and the biological solids from the Nebula System are removed annually from these tanks.

From the septic tank filter, trash tank effluent enters the first stage of the Nebula MultiStage Biofilm System and passes through suspended media to the next stage and onward to the last treatment stages. The ultimate plant design is 16,000 gpd, which includes twelve stages with a hydraulic residence time (HRT) of 24 hours.

The first three stages provide a high food-to-microorganism ratio (FM), encouraging rapid growth of lower life forms. As treatment progresses a lower FM is established, which favors higher life forms. Minimization of biological sludge is a function of shearing and/or sloughing of microorganisms from the media, which are consumed by higher life forms in the subsequent stages. The process produces minimal biological waste-activated sludge since the majority of biomass is consumed by higher-level micro-organisms.

The operational design for the current capacity of the plant is 8,000 gpd and 12 stages with a total HRT of 34 hours. The space for the remaining three cells required in the 16,000 gpd design is currently being used for settling. No aeration, media or baffles are installed in the empty stages.

Once the effluent is discharged from the basin, it passes through a drum filter, which removes suspended solids and BOD associated with the effluent solids. The final effluent flows through a UV disinfection system prior to discharge.

"The effluent quality is very high, well beyond what the state of Colorado requires," explains Ryan Pendergast, Roundup River Ranch's facilities director. He said the system produces so little sludge that the trash tank only needs to be pumped out once a year. He also cites the durability of its biofilm media. He says he has never had to replace it since the system was installed in 2011.

"*It's a simple system that requires only minimal maintenance. That makes my job easier,"* he adds.

Around May of each year, the number of people at the ranch steadily increases, as staff prepares for campers to arrive, starting in July. "I wouldn't say it's a big spike of people, but certainly steady growth," he says. "***The system accommodates these seasonal changes very well. It also does a good job of handling our weather, which can vary widely here in the mountains of southwestern Colorado."***

Full-Scale Pilot Plant

In 2011, the Nebula MultiStage Biofilm was considered alternative technology by the Colorado Department of Public Health and Environment (CDPHE). CDPHE permitted the Nebula Biofilm System for the Roundup River Ranch treatment facility as a Full-Scale Pilot Plant for evaluation from 2011 to 2013.

Over the past nine years, the facility has operated in compliance with surface water discharge standards and all current statutory and regulatory requirements related to the Clean Water Act.

The system consistently met BOD_5 monthly averages and monthly maximums for the pilot testing period. BOD_5 removal throughout the biofilm system was consistently around 99 percent with effluent BOD_5 concentrations of 2 mg/L or lower, independent of the influent loadings. The 30-day average effluent limit for BOD_5 specified in the state's permit for the plant is 30 mg/L. The maximum effluent BOD_5 measured for the monitoring period was 8 mg/L – less than one-third of the permitted amount.

Operating data show the plant has continued to operate at a very high level of efficiency since then Discharge Monitoring Reports (DMR) from 2012 to 2017 showed BOD_5 was less than 4.5 mg/L, or 15 percent of the permitted limit of 30 mg/L.. The total suspended solids monthly averages were consistently well below the limits of 30 mg/L and 45 mg/L- typically less than 5 mg/L, with only 2 months over 10 mg/L. The total ammonia data for effluent ammonia concentrations rarely exceeded 1 mg/L, which is well below the permitted limit of 50 mg/L.

The energy use of the MultiStage Biofilm System has been nominal and continues to meet Pendergast's expectations.

"The only parts of the plant that use electricity are the blowers for the aeration system, a heater and a drum filter. We could reduce its operating cost even more by installing variable speed drives on the blower motors, but we haven't done that yet," he points out.

Overall, the system has continued to operate at a remarkable level of efficiency. ***"It's a testament that the Nebula MultiStage Biofilm System has been approved by the state. They're very strict about water quality, especially anything discharged into the Colorado River,"*** Pendergast concludes.

2017 DMR Reports

Month	Average Flow GPD	Average Influent BOD mg/l	Average Effluent BOD mg/l	Average Effluent BOD mg/l	Average Effluent NH3-N mg/l
Jan	0.0005	58	1	1	0.00
Feb	0.0009	31	1	3	0.00
Mar	0.0004	76	1	3	0.10
Apr	0.0010	69	2	1	0.00
May	0.0020	62	3	5	5.70
Jun	0.0060	178	2	9	0.10
Jul	0.0056	189	2	8	1.00
Aug	0.0027	146	2	7	0.10
Sep	0.0025	152	2	1	0.10
Oct	0.0022	25	1	1	0.10
Nov	0.0006	218	2	6	0.10
Dec	0.0030	96	1	1	0.03
Permit	0.0080		30	30	50

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