AN INVESTIGATION OF ENERGY USE, WATER SUPPLY AND WASTEWATER TREATMENT AT PATAGONIA LAKE STATE PARK, ARIZONA

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Background

Patagonia Lake State Park is located in southeastern Arizona approximately 7 miles southwest of the town of Patagonia, AZ. The park has an on-site water system and wastewater treatment facility. The seasonal weather variability directly affects the influx of visitors and therefore the overall ability to supply potable drinking water and process wastewater. The annual number of visitors to the park has been estimated at approximately 330,000. There are between 10-25 staff members and volunteers that operate the facilities. The park is equipped with 5 restroom facilities, visitor center, gift shop, camping and RV sites, and fish cleaning station. The park has 37 developed RV campground sites with electrical and water hookups, but not with sewage hookups. The park is open all year except for Christmas Day.

WATER

Supply, Pumping and Treatment

The park relies solely upon groundwater, which is provided by a centrally-located well that is equipped with a submersible 5-hp pump (3 phase 220 V). The wellhead is equipped with a backflow prevention device and meter. Annual pumping was measured at 3.7 million gallons in 2007. The daily average pumping is 6000 gallons per day (gpd) with pumping at up to 12,000 gpd during the peak season. The pumping cycles once per day on average with more frequent cycling during times of peak demand. The water is chlorinated at the well site before transmission to storage. The chlorination system is activated by a sensor that detects submersible pump operation. The existing chlorination system presents operational and maintenance challenges to park staff and alternatives are being considered. Monthly water quality testing ensures that the water meets overall Safe Drinking Water Act standards, and chlorine residual levels are measured daily. Arizona's environmental regulations that govern water supply and processing are different for state parks than for municipalities.

Transmission, Treatment, Storage & Distribution

Groundwater is conveyed uphill at a grade of 14% to two 15,000 gallon storage tanks. The vertical elevation change from the wellhead to the tanks is approximately 220 ft. Submersible pump operation is triggered when storage tank water level storage fall below a designated threshold. The stored water in the tanks then supplies the park area by gravity-driven flow. Due to the local topography, system pressures range between 40 psi at the well head to nearly 100 psi at the most-distant and lowest water spigot. Water supplied to distribution is not metered.

WASTEWATER TREATMENT

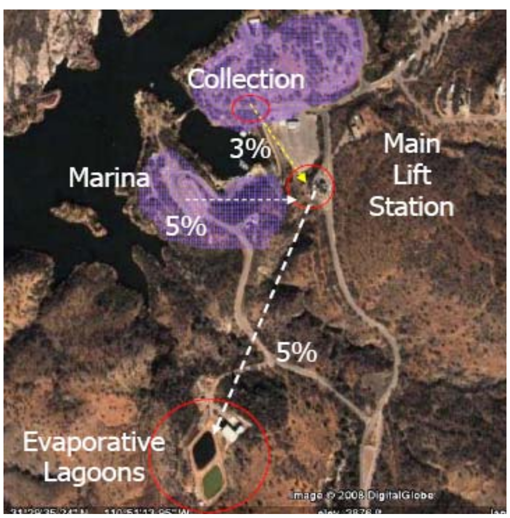

Figure 1: Wastewater System Schematic for Patagonia Lake State Park

The wastewater system includes: collection, chlorine treatment, pumping, and evaporative lagoons (See Fig. 1). The central collection area is located in the northern area of the park and collects waste from the ranger residences, the campground area, RV Park, and three of the five restrooms. The wastewater is transported via gravity flow to a lower collection area that is served by elements of an old contact stabilization waste water treatment plant and aerated in the holding tank before transport to the main lift station. The aeration process has been so effective that all sludge is being consumed prior to pumping to the main lift station. Wastewater is then pumped to the main lift station by two 10-hp pumps, which operate alternately.

Located to the southwest, the Marina area has bathroom facilities equipped with showers and toilets. A fish cleaning station is close by. There is a nearby restroom facility called the Pointe, which is similarly equipped. Wastewater from each of these two areas is pumped directly to the main lift station, by means of a package mini-lift station with a 1-1/2 inch 2 hp grinder pump. Only one of min-lift stations is allowed to operate at a time to avoid introducing too much wastewater into the main lift station. The mini-lift stations do not cycle on unless there is sufficient wastewater generation.

Once the wastewater is received at the main lift station, which is approximately 150 ft above the Marina/Pointe and central collection area, it is further pumped to two evaporative lagoons. The vertical elevation change from the main lift station to the lagoons is approximately 75 feet. The main lift station is equipped with dual 10 hp alternating lift pumps. Due to the effectiveness of the simple aeration process, discussed above, minimal sludge has been introduced into the lagoons since 1994.

Sensors that monitor the wastewater levels at the main lift station and the lower collection area control the entire system. The park management has the option of discharging from the lagoons (Fig. 2) to Patagonia Lake. However, that has occurred only once in the past 20 years. The discharge is chlorinated before being introduced to the lagoons. There is no daily monitoring because Arizona State

Figure 2: Evaporative Lagoon at Patagonia Lake State Park

Parks fall under a different monitoring classification than municipalities. However, monthly samples are taken and tested at an off-site University of Arizona lab. The wastewater flows are not directly measured because the park does not have flow meters that measure the amount of inflow into the evaporative lagoons. For the purposes of our evaluation, the wastewater flows were estimated at 2/3 of the total groundwater pumping.

SYSTEM METRICS

The system metrics shown in Table 1 were developed from utility billing records. These metrics are based on the year 2007 to obtain a snapshot of the Park's current operations. The estimates for potable water pumping were based on annual figures provided by Park personnel. Natural gas consumption figures were not considered because these data were not made available.

RECOMMENDATIONS/SUGGESTIONS

Patagonia Lake State Park has demonstrated several best practices in the design and operation of their wastewater treatment including the simplicity of the WWTP operation. Presently, park management and staff are considering a small generator at the Patagonia Lake dam outlet to offset high energy costs. Presented below are some best practice recommendations and suggestions from our qualitative evaluation.

Patagonia Lake State Park Water System (2007)	
Number of Gallons Pumped	3,730,739
Annual Park Visitors	230,000
Gallons Pumped per Day	10,211
Gallons Pumped per Person per Day	16.2
Annual kWh Usage	8,125
kWh/kgal	2.2

Patagonia Lake State Park Wastewater Treatment Plant	
Gallons of Wastewater Processed	2,487,159
Annual Park Visitors	230,000
Average Gallons Processed per Day	6,814
Gallons Processed per Person per Day	10.8
Annual kWh Usage	29,074
kWh/kgal	11.7

Table 1: Water Distribution and Wastewater Treatment Plant Metrics

NO OR MINIMAL COST

- Balance revenue and expenses.
- Understand how water and energy are utilized throughout the system. Energy density for wastewater treatment, at nearly 12 kWh/kgal, appears high, although this may well reflect the heavy dependence on lift stations. Still, improvements in this regard may be possible.
- Review system plans, specifications, and records before considering upgrades/improvements.
- Secure operations and maintenance guides and training for park staff when new systems/components are installed.

LOW TO MODERATE COST

- Evaluate pumps, blowers, and motors for upgrade to either high-efficiency or VFD, if appropriate.
- Conduct an energy audit of all pumps and blowers.
- Retrofit facilities with energy efficient lighting, using high-efficiency ballasts and bulbs, as appropriate.
- Develop a cost analysis and implement capital improvement planning.
- Repair/replace the problematic chlorination unit with a unit that is easier to operate and maintain.
- Reduce leakage through pressure management.
- Utilize off-peak power usage strategies.
- Adequately ventilate or sunshield all electrical and mechanical equipment in warm weather.
- Take measurements and evaluate the data prior to making future improvement plans.

MODERATE TO HIGH COST

- Install a flow meter at the lagoon site to monitor the influent.
- Install flow metering devices within the park area to develop water audits and implement leak detection programs.
- Install an extra storage tank to supplement the needs of the park during the peak seasons.
- Reduce friction/energy losses in pumps, fans, pipes, valves, and production wells.
- Utilize renewable energy wherever possible.

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