CHARACTERIZING OSSF WASTEWATER STREAMS IN TEXAS RV PARKS

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ABSTRACT

The number of Recreational Vehicle (RV) parks has increased dramatically in recent years due to aging populations (i.e., retirees), rapid growth and construction, changes in work-styles, housing shortages, and economic affordability. As a result, RV parks must cater to diverse populations including short-term campers, long-term seasonal visitors, transient workforces, and full-time residents Consequently, the amenities now offered at these facilities range from simple dump stations and basic toilets to complex arrangements of bathrooms with full-flow toilets and showers, laundries, group kitchens, restaurants, convenience stores, recreational water features, and outdoor water attractions. Both the regulated community and regulators in Texas report an increase in On Site Sewage Facility (OSSF) design challenges, compliance issues, and operational malfunctions. The Texas Commission on Environmental Quality contracted with Texas A&M Agrilife Research to monitor and characterize RV park wastewater streams (i.e., flows, biochemical oxygen demand, total suspended solids, etc.) in relation to patron stay-length and park amenities. Representative RV park waste streams, selected based on accessibility, patronage type, and amenity configuration, are being monitored for 30-day periods. Flow meters and automated water samplers are used to collect OSSF influent data. Collected information will be used to characterize the organic loads being generated in modern RV parks in order to design and operate future RV park OSSF.

INTRODUCTION AND BACKGROUND

According to the Texas Commission on Environmental Quality's (TCEQ) Texas On-Site Sewage Facility Grant Program (TOGP), the number of known RV parks in Texas utilizing an OSSF is just over 1,900 and growing rapidly. Modern RV parks no longer cater only to the traditional camper but service several distinct groups with diverse needs. As a result, RV parks now offer amenities far beyond a simple parking space with water and electricity. Most include bathrooms with toilets and showers. Many have full laundry facilities, clubhouses, group kitchens, stores, short-order grills, and water features (i.e., pools). Numerous amenity combinations and configurations exist throughout the state. At first glance, this may not seem problematic however, each added amenity, and associated patron usage routine, has the potential to increase the wastewater treatment burden on the OSSF in terms of increased flow volume and/or organic load. In Texas, RV OSSF are designed and regulated under residential specifications; OSSF must be <5000 gpd and assume between 40-50 gpd per RV space. Given how RV park amenities and patronage types have evolved, understanding their effects on OSSF organic loading is important. *The goal of this project is to measure and report RV OSSF system organic loadings relative to different patron stay lengths and park amenities to support future system design and management.*

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RV ownership:

RV'ing is a form of outdoor recreation that evolved from tent camping and generally refers to living in a temporary, mobile shelter for a short period of time. RV ownership in the United States hit a record high in 2021 with 11.2 million RV owners. This represents a 26% increase over the 8.9 million RV owners reported in 2011 (IPSOS, 2021). Ownership is spread widely across age, gender, income, and education levels. Joppe and Brooker (2013) identified distinct RV owner types ranging across demographics, attitudes, usage habits, and motivations (Figure 1).

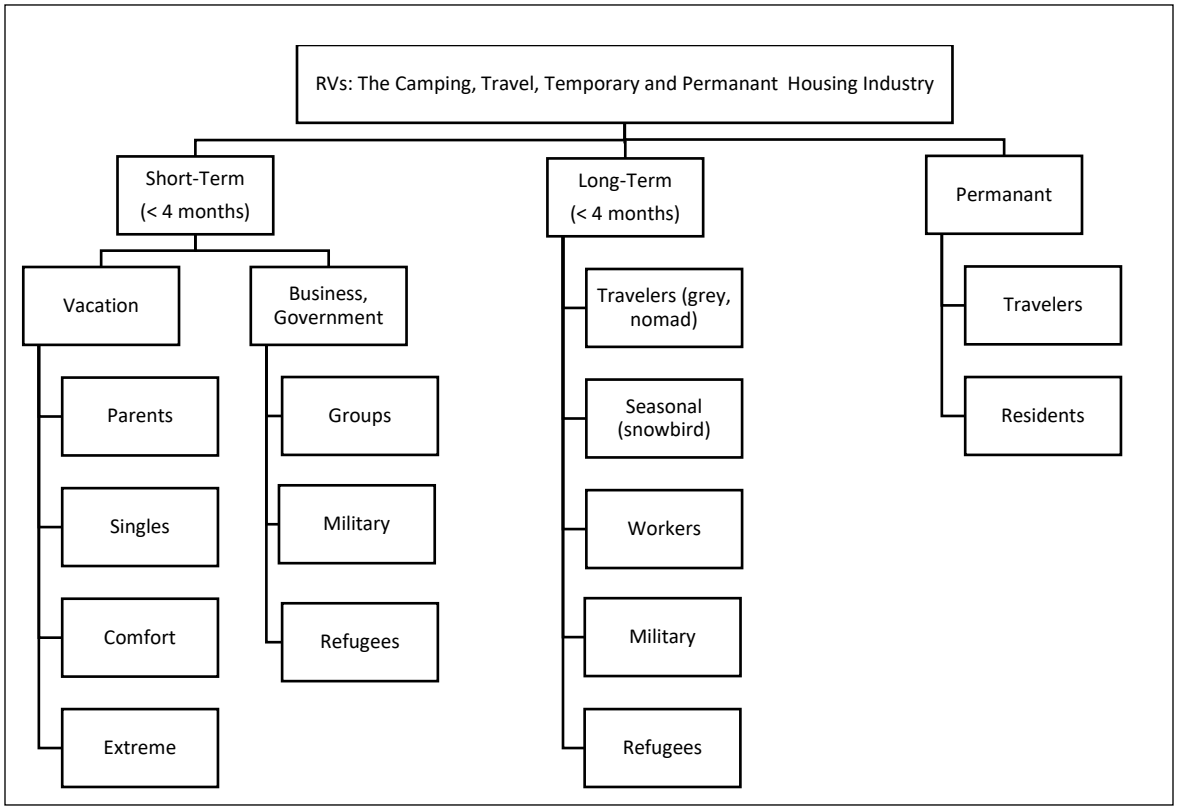

Figure 1. RV hospitality sub-sectors (modified from Joppe and Brooker, 2013)

RV park usage:

The 2021 TOGP call for proposals divided RV usage stay-lengths into two very broad categories, short-term camping, generally <4 months, and long-term camping, generally >4 months. Stay-lengths may range from traditional camping stays of a few days to seasonal stays of a few months, to permanent year-round residential stays. The trend toward longer stay-lengths is increasing and affecting how RV parks are built, managed, and used. From a wastewater perspective, usage trends in RV bathing, laundering, and cooking habits may exert an influence upon OSSF function in terms of organic loading which subsequently affects operation, performance, and maintenance issues.

Short-Term RV'ing:

Primitive camping areas found in national, state, and private parks and lands are most often used

for traditional short-term camping. RV-ing here is at its most basic level with only key amenities such as a parking area, perhaps a freshwater hookup, and sometimes electricity. Water resources in these parks range from none, where the RV camper must be totally self-contained, to only the basics such as toilets and occasionally shower facilities. Campers typically conserve water usage under these conditions as wastewater must be retained in storage tanks on-board the RV until it can be disposed of at a dump station. As a result, the short-term RV-er is unlikely to use the same amount of water per day as someone on a residential OSSF system. Additionally, the short-term camper is unlikely to utilize on-board RV water systems for anything more than only the most basic activities (Pearson et al., 1980). Often, various holding tank additives are used to control odor. These have measurable effects upon OSSF treating dump station waste (Brown et al., 1984; Larsen and Heger, 2020).

Today, many RV parks in Texas cater to vacationers and offer resort-style amenities. This attracts short-term campers, usually a family or singles spending a weekend, or a week or two, at most. Many of these "resort" or "destination" RV parks provide numerous attractions, entertainment, and water-related features such as pools (Severt and Fjelstul, 2015). RV spaces typically include full hook-ups consisting of water, electricity, and wastewater connections. Water usage patterns may be affected through increased RV cooking and bathing activities. Vacationers may also take advantage of on-site amenities such as laundry facilities and bathrooms with full flows rather than using restricted flow fixtures found in the RV. These activities may increase organic loading of the OSSF. Additionally, the use of heavy-duty cleaning agents in commercial kitchens and bathrooms found in resort parks may negatively affect OSSF function (Berk and Blodig, 2021).

Long-Term RV'ing:

In recent years, long-term RVing has grown, which has in turn has affected RV park usage trends. RV communities today are made up of diverse populations with different travel and residency needs that may utilize RV park amenities and affect OSSF differently. This includes a growing retired community seeking scenery or seasonal change, migrating workforces following construction projects, persons between jobs or homes, disaster workers (i.e., traveling nurses) and disaster refugees, and economically challenged persons seeking low-cost housing (Joppe and Brooker, ibid.). RV parks often cater to specific populations and their specific needs. The effect of long-term camping on OSSF may be increased flows and higher organic loading due to more residential-like water usage compared to short-term RV usage.

Many newly retired persons are taking long-term RV vacations to see the country or escape the weather. The familiar term "Snowbird" refers to the community of northern RV-ers migrating to warmer southern locations for the winter months (Simpson, 2008). Many RV parks in deep south Texas have been catering to this group for decades. They often offer organized entertainment and amenities such as clubhouses with heating kitchens and full bathroom and laundry facilities. Another trend in RV usage is the increase in work-related camping. Although the industry asserts that RVs are not built for year-round use, many RV parks cater largely or entirely to owners of travel trailers, fifth-wheels and motorhomes pursuing construction or other work opportunities.

Perhaps most troubling is the trend of low-income populations turning to RVs for permanent housing. RVs, while comparatively small and under-insulated, have become the new housing of

last resort (Zipser, 2022). The current popularity of "tiny homes", known as "park models" in the RV industry have also become a concern. Without the barriers of a down payment, mortgage interest rates, or high development, land, and operating costs, tiny homes offer an affordable alternative to renting or buying in the traditional housing market (Trambley, 2021). Many RV parks rent park models as "cabins. The effects of long-term RV usage patterns upon RV park wastewater streams are unknown.

Texas RV park OSSF regulations:

In Texas RV parks that treat or dispose of wastewater using an OSSF are regulated by the TCEQ or a local authority. OSSF treating more than 5,000 gallons of wastewater per day (approximately 100 hookups) require an engineered design and a domestic wastewater permit, both of which are expensive to obtain in terms of time requirement and monetary investment. In order to avoid this, many large RV parks plat their land holdings into smaller parcels and install multiple <5000 gpd systems following Texas Administrative Code (TAC) rules regulating RV parks (Tables 1-3).

Table 1. Texas Administrative Code (TAC) - Regulations addressing RV park OSSF and RVs

TAC §285.2.(44) Definitions	On-site sewage disposal system – One or more systems that: (A) do not treat or dispose of more than 5,000 gallons of sewage each day; and (B) are used only for disposal of sewage produced on a site where any part of the system is located.
TAC §285.32.(f) Other Design Considerations	(2) Other high-strength sewage. For situations where sewage as defined in this chapter is expected to be a higher strength than residential sewage, it is the responsibility of the professional designer to justify sewage design strength estimations and properly design a system that reduces the wastewater strength to 140 mg/l BOD prior to disposal unless secondary treatment levels are required. Residential sewage is sewage that has a strength of less than 300 mg/l BOD.
TAC §217.3 Motor Vehicle Titles	(4) Owners of trailers, semitrailers, and house trailers with a gross weight of 4,000 pounds or less may apply for a Texas title. (C) House trailer-type vehicles and camper trailers must meet the following criteria in order to be titled. (i) A house trailer-type vehicle that is less than eight feet six inches in width or less than 45 feet in length is classified as a travel trailer and shall be registered and titled. (ii) A camper trailer shall be titled as a house trailer and shall be registered with travel trailer license plates. (iii) A recreational park model type trailer that is primarily designed as temporary living quarters for recreational, camping, or seasonal use, is built on a single chassis, and is 400 square feet or less when measured at the largest horizontal projection when in the set up mode shall be titled as a house trailer and may be issued travel trailer license plates.

Table 2. Texas Administrative Code (TAC) - Wastewater Usage Rates

TAC §285.91.(3) - Table III TYPE OF FACILITY	USAGE RATE GPD (w/o Water Saving Devices)	USAGE RATE GPD (With Water Saving Devices)
Travel trailer/RV parks (per space)	50	40
Laundries (self-service per machine)	250	200
Office buildings (no food or showers per occupant) Office buildings (with food service per occupant)	5 10	4 8
Parks (with bathhouse per person) Parks (without bathhouse per person)	15 10	12 8
Stores (per washroom)	200	160
Swimming pool bathhouses (per person)	10	8

Table 3. Texas Administrative Code (TAC) - TAC §217.32(a)(3)Table B.1. – Design Organic Loadings and Flows for a New Wastewater Treatment Facility			
Source	Remarks	Daily Wastewater Flow (gallons/person)	Wastewater Strength (mg/l BOD_5)
Trailer Park (Transient)	2½ Individuals per Trailer	50-60	250-350
Recreational Parks	Overnight User Day User	30 5	200 100

RV park usage variation:

There are many unknowns affecting RV park wastewater streams (i.e., OSSF influent). Most apparent are those affecting quantity and quality through patron bathing, cooking, and laundry usage. Design regulations must make many assumptions which may not adequately address the high variability in RV waste streams, described mostly through circumstantial evidence. For example, design flows may not reflect actual usage of modern RV parks. There are often less than the assumed 2 persons per RV and dilution water supplied by showers and laundry is limited by low-flow devices. Similarly, wastewater quality (i.e., BOD_5 or TSS concentration) may be affected by patron numbers and activity. Even when a park 100% occupied, only 80-85% of people there at peak times and patrons often do not cook full meals but instead rely upon take-out or convenience meals. When considering short vs long-term RV-ers, weekend campers and permanent RV residents may exhibit extreme variation in their water usage behaviors. Additionally, shower and toilet facilities, stores, and other convenience structures may be used by the whole RV park community and individual patron usage may not limited to single OSSF system within the same park. For example, a person staying on Tract-A's OSSF system may use the laundry, or other amenity, on Tract-B's OSSF system, in the same park (see discussion on park platting in regulation section above). There is a need for real-world data documenting these kinds of usage effects upon RV OSSF influent streams to help with future regulatory guidance.

METHODS

As noted earlier, several studies have examined the effects of RV wastewater additives upon OSSF however, few have considered organic loading in relation to RV park amenity and stay-length. AgriLife is cooperating with local OSSF engineers to locate and access RV parks suitable for monitoring based on patron stay length and amenities offered. Figure 2 presents a matrix of RV park types desired, and tentatively identified, for observation. A total of 10 RV parks are planned to be monitored, each for a 30-day period. Daily flow will be determined using available water flow meters. Influent water quality will be assessed for 5-day biochemical oxygen demand (BOD_5) and total suspended solid (TSS) concentrations. Refrigerated automated water samplers (ISCO Avalanche Sampler, Lincoln, NB) will be used to collect 100 mL hourly samples from the influent trash tanks to produce a 24-hour composite samples. Composite samples will be collected daily and transported to the lab for analysis. Flow combined with BOD_5 and TSS concentrations will be used to calculate organic loading. This data will then be considered in relation to the RV park amenity and patron stay-length matrix (Figure 2). Information collected will be used to help guide new RV park OSSF design and management.

	Stay Length			
	Short term (Camper-Vacationer)		Long term (Migrant-Resident)	
Amenity	Representative Park	OSSF Type	Representative Park	OSSF Type
RV's Only	Campground-Style RV Park Dump station only	Anaerobic + evaporation pan	Workforce-Style RV Park 16 RV's with full sewer hookups	Aerobic + Drip Irrigation
Public Bathrooms	Campground-Style RV Park, RV slots with sewer hookups, restrooms with toilets and showers	Aerobic + Surface Spray Irrigation	Workforce-Style RV Park Sewer hookups (11 RV's), office bathrooms (toilets, showers), 4 machine laundry	Anaerobic + Leaching Chamber
Group Kitchen	Resort- Style RV Park, 9 park models (i.e., cabins) and office with 2 bathrooms with showers and group kitchen	Anaerobic + leaching chamber	Permanent Residence style RV Park, 41 RV's (sewer hookups), clubhouse group kitchen and 1 restroom (toilet and shower)	Aerobic + Surface Spray Irrigation
Laundry Facility	Resort-Style RV Park, 12 park models (i.e., cabins), 8-machine laundry facility with one bathroom	Anaerobic + leaching chamber	Workforce RV Park – 19 RV's (sewer hookups), bathhouse with 2 bathrooms (toilets and showers), 5 machine laundry.,	Aerobic + Drip Irrigation
Cabins/Tiny Homes	Resort-Style RV Park 20 RV's (sewer hookups), 9 Park Models (i.e., cabins), office with 2 bathrooms, clubhouse with warming kitchen	Anaerobic + leaching chamber	Permanent Residence-Style RV Park, 76 RVs (sewer hookups), 24 park models (i.e., Tiny Homes) and office with bathroom (toilet only).	Aerobic + Surface Spray Irrigation

Figure 2. RV park type amenity by stay length matrix. Selections based on accessibility and monitoring feasibility.

PRELIMINARY RESULTS AND DISCUSSION

Monitoring equipment has been installed on two separate OSSF systems at a workforce-style RV park (Figure 3). The park contains 5 OSSF systems servicing RVs and an office with two full bathrooms (i.e., toilets and showers) and a four-machine laundry facility. One set of monitoring equipment was installed on a system servicing 16 individual RVs only. The second set of equipment is installed on a system servicing 11 RVs and the clubhouse. Each OSSF system has a flow meter installed between the effluent pump tank and drip irrigation field from which water usage may be deduced and used to estimate organic loadings needed for comparisons.

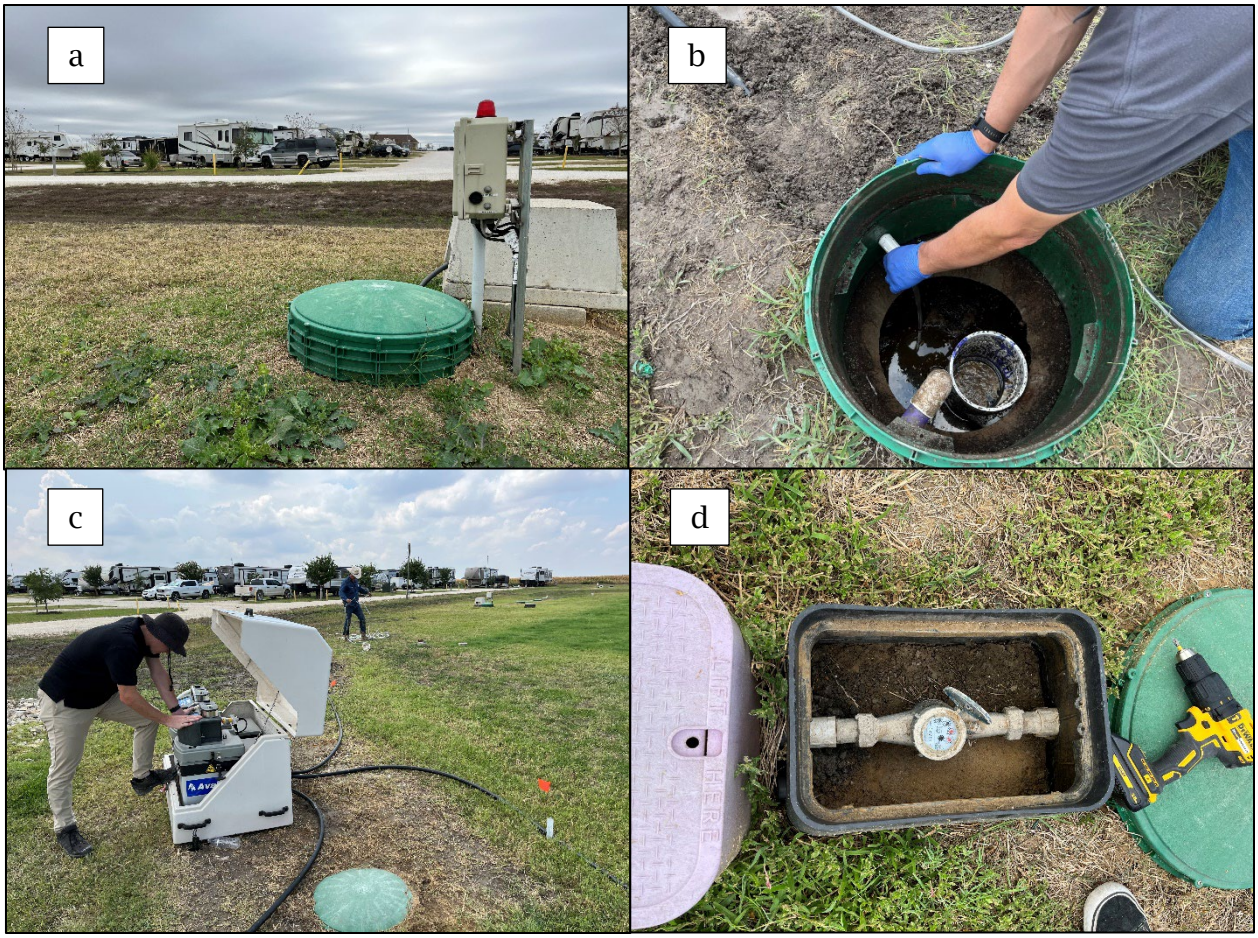

Figure 3. RV park OSSF monitoring configuration: a – Aerobic Treatment Unit with drip system, b – sample intake line installed at wastewater influent point, c – ISCO refrigerated water samplers, d – flow meter.

Preliminary results:

Water quality sampling has not yet commenced at the time of writing due to contract delays. However, flow records have been accessed and provide an interesting glimpse of water usage patterns at this park (i.e., wastewater processed by OSSF). Table 4 shows average monthly wastewater influent flows to individual OSSF (i.e., System A and System B) as percentage of total source (i.e., RV units only vs RV units with clubhouse containing baths and laundry).

Table 4. Monthly water usage as percentage of total from two wastewater streams (A & B) at a workforce-type RV park with different configurations. System A contains only RVs, System B contains RVs and a clubhouse.

System	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
A - RVs only	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
B - RVs	50%	54%	28%	20%	20%	13%	53%	34%	62%	38%	57%	52%	40%
B - Clubhouse	50%	46%	72%	80%	80%	87%	47%	66%	38%	62%	43%	48%	60%

Because each RV, or amenity, does not have a separate flow meter, total effluent flows from System A were divided by the number of RVs on the system to determine the average RV usage. System B, with the clubhouse, RV usage amounts were estimated based on System A values. The clubhouse usage was then estimated by subtracting the RV usage from the total. On average, 60% of the flows on System B are attributable to clubhouse usage while 40% are attributable to the RVs. This pattern changes throughout the year with the summer months seeing much higher clubhouse water usage than RV water usage. This is only a preliminary look at available data which may be interpreted in many ways, each requiring many assumptions. As more data is collected, separating the different water usage patterns attributable to RVs, and individual park amenities, may be determined with greater certainty. This real-world data will ultimately be used to help with regulatory guidance and future RV park OSSF designs.

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