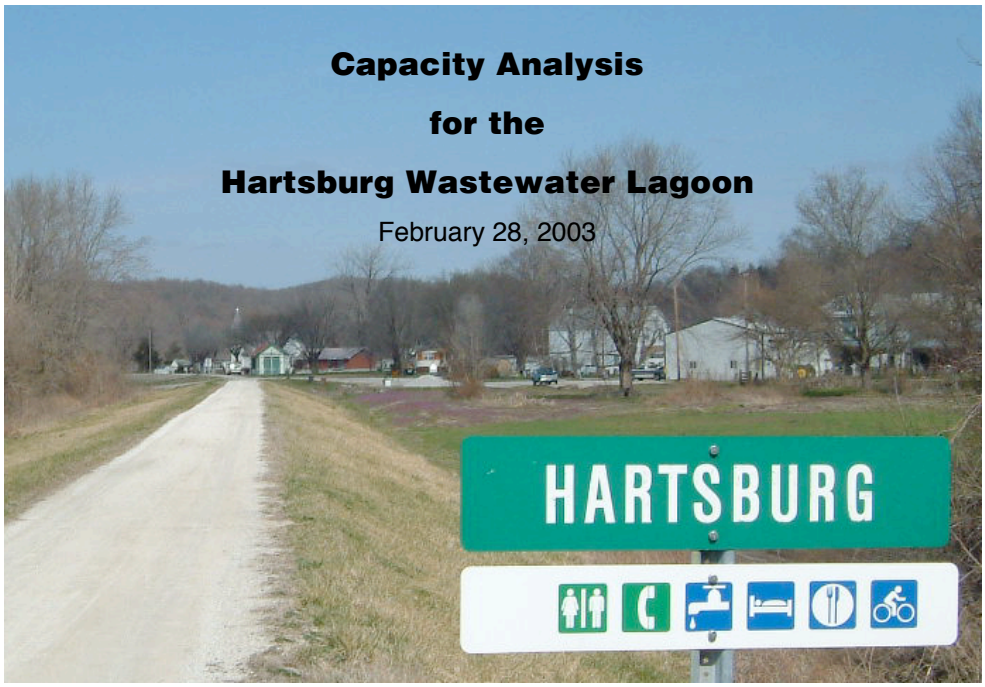
Capacity Analysis

for the

Hartsburg Wastewater Lagoon

February 28, 2003



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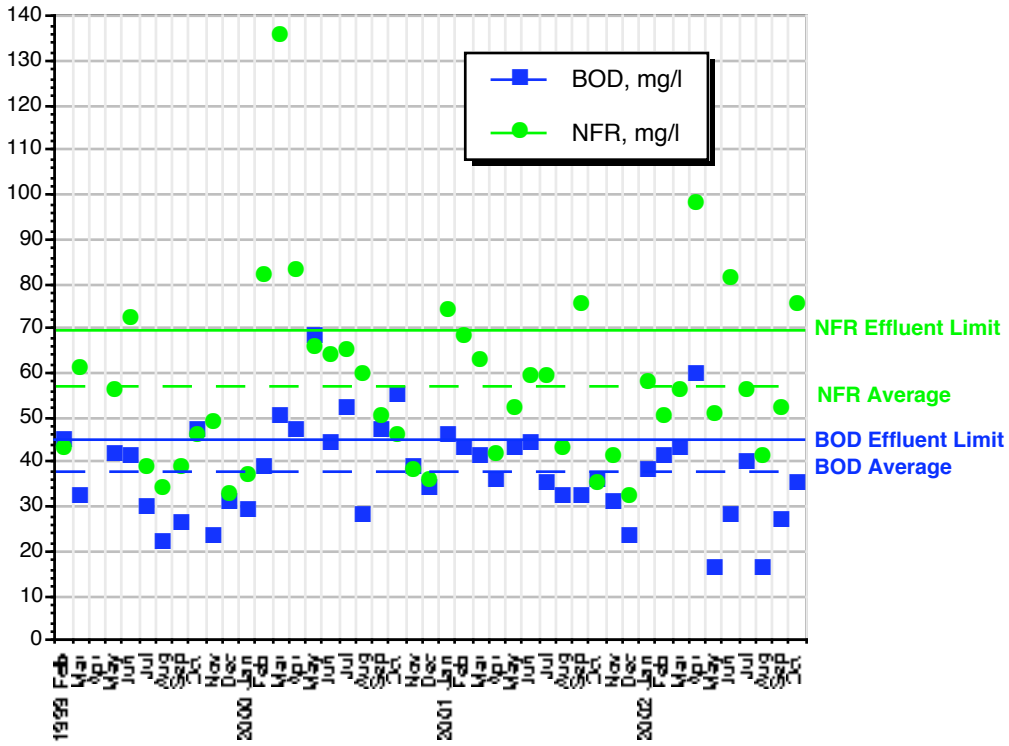
Background

The purpose of this study is to evaluate the Village of Hartsburg's existing wastewater system. On occasion, permitted discharge limits have been exceeded, and the Village intends to be proactive in maintaining compliance now and in the future.

Effluent Monitoring Data

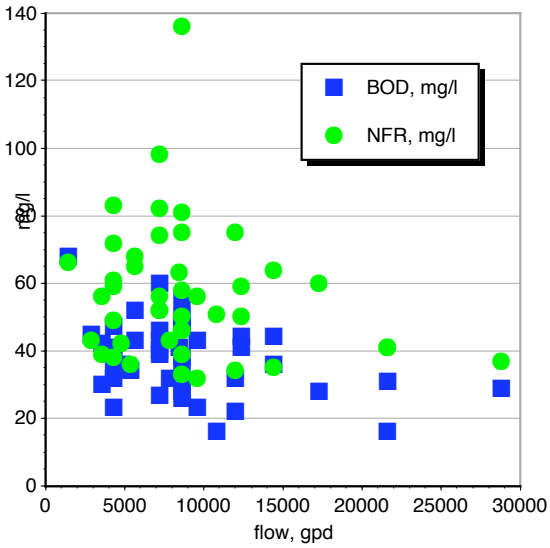
Approximately four years of flow and monthly discharge monitoring data were reviewed and analyzed. Receiving stream effluent limits for five-day biochemical oxygen demand (BOD_5) and non-filterable residue (NFR) are 45 and 70 mg/l, respectively. Over 36 months, BOD_5 exceeded the permitted effluent limit (45 mg/l) nine times and NFR also exceeded the limit (70 mg/l) nine times. Despite these occasional exceedances, the average values for both BOD_5 (37.7 mg/l) and NFR (56.7 mg/l) were below the permitted effluent limits.



Effluent Quality vs Flow

Reported values for effluent flow ranged from 1,440 to 28,800 gallons per day and averaged 8,933 gpd.

BOD and NFR were plotted as a function of flow through the lagoon. The effluent limits were more often exceeded during a low flow period.



Infiltration and Inflow

The average flow of 8,933 gpd divided by the current population of 108 equals approximately 83 gallons per person per day. Since a rule of thumb for domestic wastewater production based on population is 100 gallons per person per day, it would seem that Hartsburg's collection system does not suffer from significant infiltration and inflow.

State Inspections

MDNR reports for the last three wastewater inspections were reviewed.

date	*inspector*	*compliance*	*issues*
3/19/02	Tucker Fredrickson	yes	algae in lagoons; effluent violations: 1/02, 9/02
12/10/99	Jerry Croy	yes	color and odor; faded signs
4/3/97	Larry Teson	no	duckweed in lagoon; effluent violations (BOD): 11/96, 12/96, 1/97

Despite minor effluent violations, state inspectors considered the Hartsburg wastewater system to be in compliance during the two most recent inspections.

Duckweed and algae have been noted in the lagoons. Algae is a concern because it contributes to NFR. If necessary, algae can be controlled by the application of copper sulfate. Duckweed is frequently introduced to lagoons in order to control algae. If duckweed control measures are deemed necessary by the state, they should be undertaken in April and May. Duckweed control measures include physical removal and chemical treatment with Diquat as per the chemical manufacturer's specifications.

Present and Projected Wastewater Treatment Needs

1990 Census data reported the population of Hartsburg to be 131. 2000 Census data reports the population as 108, which is consistent with the recent average wastewater effluent flow (1999-2001) of 8,933 gallons per day (83 gpd/person). According to the operating permit, the wastewater treatment facility had an original design flow of 14,400 gallons per day based on a projected population of 144. These records indicate that the design flow of the existing facility is adequate to accommodate the current population. With no major development in the foreseeable future, it is not anticipated that Hartsburg's population will increase significantly within the next decade.

2000 Census Data
Hartsburg town, Boone County
Population: 108
Housing units: 59
Total Area in square miles: 0.08
   Water area: 0.00
   Land area: 0.08
Population density per square mile of land area: 1,327.0
Housing units per square mile of land area: 724.9

Existing Wastewater Treatment Facility Capacity

Hartsburg's wastewater treatment facility consists of an approximately 280,000 gallon aerated lagoon and a 127,000 gallon settling lagoon, for a total system capacity of approximately 407,000 gallons. At the current average flow rate of 8,933 gallons per day, detention times are 31.3 days and 14.2 days in the aerated and settling lagoons, respectively. At the design flow rate of 14,400 gallons per day, detention times are 19.4 days and 8.8 days in the aerated and settling lagoons, respectively.

Aeration is provided via a 2 horsepower motor and a blower. There is also a backup. Diffusers appear to be coarse-bubble units manufactured by Air-Aqua. The discharge pressure on the blowers reads 6.5 psi. The 8' of water above the diffusers accounts for 3.4 psi, and the rest is due to resistance from the piping and the diffusers. This indicates that the existing diffusers are partially fouled and resisting the flow of air. The northernmost diffuser appears to be almost completely clogged.

Required Detention Time

From the MDNR Wastewater Design Guide (10 CSR 20-8.200):

> (D) Aerated Lagoons. ...the aerated lagoon design for minimum detention time may be estimated using the following formula:
>
> $$t = E / [2.3\ K_1 \bullet (100-E)]$$
>
> where:
> t = detention time in the aeration cell in days;
> E = percent of BOD_5 to be removed in an aerated pond; and
> K_1 = reaction coefficient aerated lagoon, base 10.
> For normal domestic sewage the K_1 value may be assumed to be .15 per day for Missouri conditions.

Assuming an average influent BOD of 250 mg/l and effluent target of 45 mg/l, BOD removal should be 82%. The minimum detention time, t, then calculates out as 13.2 days, which is significantly less than the present detention time of 31.3 days. By this standard, the volume of the aerated lagoon should be sufficient for a community of 212 people.

Air Requirements

The MDNR Wastewater Design Guide calls for 1,500 scf of air per pound of BOD removed. Although this number is intended for the activated sludge process, it is often borrowed for aerated lagoons. Based on a raw wastewater BOD value of 250 mg/l, the calculated air requirements are 20.8 scf/min (at present average flow) and 31.3 scf/min (at design flow). Assuming a 1:1 drive ratio (1723 rpm), the existing blower configuration provides a generous air flow of approximately 70 scf/min. To reduce power costs, it is possible that the drive ratio could be modified by placing a larger pulley on the blower.

Power

Ameren UE provides electrical service at the Hartsburg wastewater lagoon (contact: David Spratt, 573-681-7526). Presently, only single-phase, 110-volt electrical service is available onsite. The existing transformer is 25 kVA. In case of greater power requirements, this could be upgraded to 50 or 100 kVA at a cost of approximately $2,000 to $5,000. In order to bring in three-phase service, additional lines would need to be run to the lagoon site at an estimated cost of $20,000.

There does not appear to be a compelling reason to upgrade the existing power supply at the lagoon site at this time.

Lift Station Pumps

The existing lift station contains two Flygt model CP-3102 pumps rated at 100 gpm @35 feet of head. While there have been problems with the lift station pumps in the past, pump failure has not been as common in recent years. This is possibly due to improvements in the reliability and quality of the supply of electricity to the lift station site. At present, pumps in the lift station have sufficient capabilities for foreseeable future flows and are performing adequately, and there is a third backup pump ready in the event of pump failure.

When pump replacement becomes necessary in the future, the new pumps should be true single-phase pumps. The existing Flygt pumps are basically three-phase pumps that have been capacitor-modified to use a single-phase power supply.

Control Panel and Alarm

The pump control panel has been plagued with problems, possibly due to damage sustained in the 1993 flood. Motor controls (particularly starters) have been unreliable.

Additionally, the present alarm system is audiovisual only, consisting of a horn and red light signifying an alarm condition. The alarm should be upgraded to include a telephone dialer that would call BCRSD.

BCRSD staff have recommended a replacement control panel (Time Mark model 403) which can be installed for a total cost of $1500. This replacement should be undertaken as funds become available.

Potential Treatment Improvements

While the Hartsburg wastewater treatment system is adequately sized, the occasional exceedances of permitted discharge limits warrant a discussion of possible improvements to the treatment process.

1. Improved Aeration. Aeration could be improved by the replacement of the existing diffusers. This should improve oxygen transfer and mixing, thereby reducing BOD and NFR. The existing air lines should be retrofitted with Environmental Dynamics Incorporated's (EDI) FlexAir fine bubble diffusers, which cost $120-$150 each. There may also be additional costs for ballast plates and connectors. Two men with a boat should be able to complete the retrofit in less than one day, although there may be difficulties encountered with retrieving the existing diffusers and physically connecting the new diffusers to the air lines. Therefore, prior to attempting to replace all of the existing diffusers, the work crew should start by retrieving the clogged northernmost diffuser and examining its condition and physical connections. Additionally, the in-ground valve boxes for each diffuser's air line should be cleaned out and fitted with lids after confirming that the valves are operational.

Information from EDI is appended, including drawings of the Flexair 42SX Magnum diffuser assembly. Additionally, EDI has offered a plan for a new aeration system designed to work in conjunction with a baffle that would include three floating laterals and seven diffusers. The price of this system is $5,000, which would include freight and two days of field supervision but not installation.

2. Baffles. Baffles serve to direct the flow of water through the lagoon and prevent short-circuiting. Modeling analysis from EDI predicts a BOD reduction of 47 to 74%. The cost of installation of a single baffle through the center of the aerated lagoon is estimated at $4,000. The need for baffling should be considered after the benefits from improved aeration are observed.

Other Recommendations

The Village of Hartsburg should consider adopting and enforcing an ordinance dealing with grease trap inspection and maintenance. While Boone County's building inspection unit would require a grease trap in a new or modified restaurant or other commercial facility, there is no mechanism to ensure the proper operation and cleaning of the grease trap. A related excerpt from the MDNR Wastewater Design Guide is appended.

The lift station control panel should be replace with a more modern, simple, reliable design that includes a telephone dialer alarm in addition to audiovisual indicators. BCRSD staff have identified a unit that can be purchased and installed for $1500.

Future Regulations and Alternatives

At some point in the future, the state may require ammonia removal and/or effluent disinfection. However, potential regulations in these areas are not developed enough to discuss in any detail.

Eventually, it is also likely that a regional wastewater system alternative will be available to Hartsburg. It is presently unknown when this might become a possibility or what the costs and benefits of such a system might be.

Grease Traps

From the MDNR Wastewater Design Guide (10 CSR 20-8.200):

(A) Grease Traps. Grease traps shall be provided on kitchen drain lines from institutions, hotels, restaurants, school lunch rooms and other establishments from which relatively large amounts of grease may be discharged to the treatment facility.

1. Grease traps should be located as close to the fixtures being served as possible and should receive only the waste streams from grease-producing fixtures. Sanitary waste streams, garbage grinder waste streams and other waste streams which do not include grease should be excluded from passing through the grease traps. Grease traps must be cleaned on a regular basis and must be readily accessible for this purpose.

2. Sizing of grease traps is based on wastewater flow and can be calculated from the number and kind of sinks and fixtures discharging to the trap. In addition, a grease trap should be rated on its grease retention capacity, which is the amount of grease (in pounds) that the trap can hold before its average efficiency drops below ninety percent (90%). Current practice is that grease-retention capacity in pounds should equal at least twice the flow capacity in gallons per minute. The following two (2) equations may be used to determine the capacity of grease traps for restaurants and other types of commercial facilities:

A. Restaurants.

D x Gl x Sc x Hr/2 x Lf = Size of grease trap in gallons,

where:
D = Number of seats in dining area;
Gl = Gallons of wastewater per meal, normally 5 gallons;
Sc = Storage capacity factor, minimum of 1.7;
Hr = Number of hours open; and
Lf = Loading factor,
1.25 interstate highways
1.0 other freeways
1.0 recreational areas
0.8 main highways
0.5 other highways.

B. Hospitals, nursing homes, other type commercial kitchens with varied seating capacity.

M x Gl x Sc x 2.5 x Lf = Size of grease trap in gallons,

where:
M = Meals per day;
Gl = Gallons of wastewater per meal, normally 4.5;
Sc = Storage capacity factor, minimum of 1.7; and
π = Loading factor,
1.25 garbage disposal and dishwashing
1.0 without garbage disposal
0.75 without dishwashing
0.5 without dishwashing and garbage disposal.

3. Grease traps shall be provided with a manhole or opening of sufficient size to permit inspection and cleaning. When the grease trap is located below ground, the access opening shall be extended to grade. The opening shall be fitted with a tight fitting cover which will prevent the entrance of insects and vermin.

4. The grease trap should be constructed of materials similar to septic tanks and be properly baffled on both the inlet and outlet.