BIG SKY, MONTANA

WASTEWATER TREATMENT PROCESS OPTIONS

PRELIMINARY EVALUATION REPORT

HKM Associates, Engineers/Planners

Bozeman, Montana

July 23, 1992
4M357.103/BS002.LTR

Mr. Wayne O. Hill
Chairman, Board of Trustees
Rural Improvement District 305
P.O. Box 57
Big Sky, MT 59716

HKM Associates
Engineers / Planners

20 East Olive, Suite 3D
P.O. Box 1090
Bozeman, Montana 59715
Phone (406) 586-8834

2727 Central Avenue
P.O. Box 31318
Billings, Montana 59107-1318
Phone (406) 656-6399
Fax (406) 656-6398

Dear Mr. Hill:

Attached is a copy of the Wastewater Treatment Process Options Preliminary Evaluation Report prepared by HKM Associates for RID 305. The report consists of two volumes: the written engineering report, and a bound compilation of specific wastewater treatment equipment information supplied to HKM Associates. This material provides detailed descriptions and pictures of treatment processes that are briefly described in the engineering report.

The important findings of the report are summarized below.

1. Preliminary evaluation shows that the Sequencing Batch Reactor (SBR) is the favored treatment process to meet the needs of the Big Sky Wastewater Treatment System.

2. The next phase of the project consists of identifying specific wastewater treatment design criteria. After the design criteria has been developed, specific treatment process performance and cost data can be evaluated, and the best treatment process can be selected for Big Sky.

3. The cost for a 0.5 million gallon per day mechanical treatment plant is estimated to range from 1 to 1.5 million dollars.

Mr. Wayne O. Hill 4M357.103
July 23, 1992

HKM Associates is looking forward to meeting with you and the Board to discuss the report and the project in general at your convenience.

HKM Associates appreciates the opportunity to work with you in solving the existing problems and planning for the future of your wastewater treatment system.

Sincerely,
HKM Associates

John Carstensen
Project Engineer

enclosures as noted

PRELIMINARY EVALUATION REPORT

WASTEWATER TREATMENT PROCESS OPTIONS

Prepared for:

BIG SKY SEWER DISTRICT

RURAL IMPROVEMENT DISTRICT 305

Prepared by:

HKM ASSOCIATES

20 East Olive, Suite 3D
P.O. Box 1090
Bozeman, Montana 59771-1090
(406) 586-8834

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INTRODUCTION

The Big Sky Rural Improvement District 305 authorized HKM Associates to conduct a preliminary evaluation of different wastewater treatment processes that are available to upgrade the existing facility. This report summarizes the findings of the preliminary evaluation.

HKM reviewed existing engineering reports on the Big Sky System, researched current wastewater treatment design criteria and processes, consulted with the System Supervisor, and accumulated information from manufacturers and suppliers for this report. Relevant findings from these investigations, treatment process evaluations, suggested sampling programs, and engineering recommendations developed by HKM during this analysis and evaluation are presented. These preliminary evaluations and recommendations are to serve as guidance to the Board in planning and implementing a treatment system improvements plan.

A bound compilation of information and brochures supplied to HKM by wastewater treatment suppliers and manufacturers is included with this report under separate cover. This information shows pictures and gives detailed process descriptions of treatment systems discussed in this report.

EXISTING SYSTEM

The Big Sky Sewage Treatment System consists of an 8.2 million gallon (mg) lined aerated treatment pond, a 32 mg storage pond, a treated water pump station, a chlorine disinfection system, and a golf course irrigation discharge system. The main problems with the current system are that (1) the unlined storage pond leaks, and (2) the system does not seem to have sufficient hydraulic capacities to handle flows that the Big Sky Sewer District is obligated to accept and treat.

Yearly average daily flows (ADF) based on numbers given in the 1992 Thomas Dean and Hoskins (TDH) report on the Big Sky Sewage Treatment system are as shown in Table 1.

Table 1. Yearly Average Daily Flows

1988	0.20 mgd
1989	0.19 mgd
1990	0.21 mgd
1991	0.24 mgd

The ADF for the peak month of May, 1991 was 0.5 mgd. The historical peak daily flow for the system, according to the system operator, of about 1 mgd, occurred during the New Years Day weekend, 1992. The TDH report shows high amounts of inflow and infiltration (I&I), especially in the spring when the snow is melting. The I&I ADF for May, 1991 was estimated at 0.37 mgd and the domestic sewage ADF was estimated at 0.13 mgd. I&I was estimated to account for 44% of the total flow into the Big Sky Treatment System during 1991.

TDH has estimated the future annual flow total at full area development at about 325 mg for a yearly ADF of 0.89 mgd. This estimate is based on estimated population equivalents and occupancy rates.

Estimates of amounts of wastewater effluent discharged through the golf course irrigation system vary significantly in previous engineering reports. The 1988 Kerin and Associates report on the current capacity of the Big Sky Treatment System estimates a total golf course irrigation discharge of 65 mg for a yearly ADF of about 0.18 mgd. The TDH report indicates that this amount is high. Previous estimates were based on theoretical and estimated plant nutrient uptake rates, wastewater effluent characteristics, length of irrigation season, and typical precipitation and evapo-transportation amounts. HKM has not yet developed an estimate of irrigation discharge amounts, but it is apparent that the existing

system does not have the capacity to handle existing or future wastewater discharge amounts. It seems that the most reliable method to estimate irrigation discharge amounts after direct flow measurement would be to determine, in consultation with the golf course greens superintendent, an average application rate. For example, perhaps the grass typically requires an average application of one-half of an inch of water every other day.

TYPICAL TREATMENT PROCESSES

Domestic sewage treatment processes are commonly described in three different treatment levels: primary, secondary, and tertiary. These are briefly described as follows:

Primary Treatment. Typical primary treatment processes include flow measurement, screening of large debris, removal of grit and other inorganic materials, and sedimentation of organic suspended solids.

Secondary Treatment. Secondary treatment of domestic sewage usually consists of the biological conversion of dissolved and colloidal organic into biomass by a variety of processes. The biomass is then removed from the waste stream by a sedimentation process. Additionally, the biomass sludge is sometimes further treated and must be disposed of.

Tertiary Treatment. Tertiary or advanced treatment processes include nutrient removal, additional suspended solids removal, and disinfection. Usually, most systems utilize only secondary treatment, sometimes, stringent discharge limits require tertiary treatment.

TREATMENT OPTIONS

HKM Associates has identified and evaluated the following treatment processes for possible use at Big Sky. Informational brochures for the specific treatment processes are shown in the accompanying bound volume of information. Discharge limits set by the Montana

Water Quality Bureau (WQB) are a key factor in evaluating treatment processes for a treatment plant. These limits are maximum levels of pollutants that a system is allowed to discharge into a surface water or groundwater. The Water Quality Bureau will issue a permit that identifies these limits. Currently the Big Sky System discharges to land application (golf course irrigation) which does not require a discharge permit. The State has developed standards for land application discharge since the Big Sky system was constructed. According to previous engineering reports, the Big Sky system does not meet these standards.

Aerated Lagoons. Aerated lagoon systems, such as the current Big Sky System are often the favored treatment option for small communities in Montana. Both primary and secondary treatment occur in the aerated lagoon. These systems are characterized by low capital costs, low operating costs, and require minimal operator attention. Disadvantages include the large areas required to provide winter storage, lack of process control, and inability to meet low discharge limits.

Conventional Activated Sludge Treatment. These systems are currently used by mid-sized to larger communities that must provide an effluent that meets stream discharge limits. These systems are characterized by separate tanks or reactors for each treatment process. Typically, capital and operating costs are higher, more operational attention is required, sludge disposal is an important consideration, but a good quality effluent is produced.

Rotating Biological Contactors (RBC). These systems are a type of fixed film treatment process. Bacteria and other microbiological species grow as a biofilm on plastic media that look like large drums which rotate in and out of the wastewater. Sedimentation of suspended solids is usually required in the front end and behind the RBC. In the past, RBCs have experienced frequent mechanical shaft failures. These failures often result from excessive weight on the disks caused by large biomass growth

and accumulation. Generally the biomass performance is best under steady hydraulic and organic loading conditions.

Sequencing Batch Reactors (SBR). The SBR process is a variation of the conventional activated sludge process. As a batch process, most of the of the treatment steps occur in a single reactor. First, the reactor fills, followed by biological treatment (secondary treatment), followed by sedimentation. The treated effluent is then removed from the basin. SBRs provide a high quality effluent at lower capital costs than conventional activated sludge systems as fewer reactor tanks or basins are required. The SBR allows the operator to control the treatment processes to meet differing treatment requirements. SBRs can provide some nutrient removal to meet discharge limits, if required. Suppliers recommend some primary treatment, screening and grit removal, but secondary clarifiers are not required.

Oxidation Ditch (Carrousel System). The Carrousel System is a proprietary plug flow oxidation ditch treatment process. The wastewater is aerated at one end of a racetrack channel configuration. See accompanying treatment equipment information for a detailed description. These systems are characterized by low capital and operating costs, the systems are mechanically simple and require little operational attention. These systems are considered to be very good cold weather systems. A building for cold weather protection is not required. Carrousel Systems do require secondary clarification to remove suspended solids (sludge). Sometimes, these clarifiers are covered for cold weather operation.

TREATMENT OPTION RECOMMENDATIONS

Evaluation Criteria. The following criteria are essential to the reliable evaluation of potential treatment processes.

1. Discharge limits. In order to realistically assess the various treatment options, stream discharge limits must be

obtained or an alternate discharge option chosen. The benefits of certain treatment options and costs are very much dependent on the discharge limits. For example, if the Water Quality Bureau Permit Section sets very low nutrient discharge limits, then some treatment options can be rejected immediately.

2. Hydraulic Design Flow. The extreme fluctuations in influent flows that result from I&I and increased resort occupancy at peak periods make it very difficult to estimate future flows. Additionally, there is on-going litigation over the legal obligation of the District to provide service to undeveloped subdivisions. The WQB will require analysis and consideration of future demands before giving plan approval. The hydraulic design flow is a critical factor in determining costs for possible treatment options.

3. Wastewater Characterization. The strength of the wastewater must be determined in order to evaluate and provide cost estimates for possible treatment options. Important parameters include BOD, suspended solids and nutrient levels.

Treatment System Costs. Both capital (initial construction costs) and annual operating costs must be considered when evaluating treatment system options. Sometimes excessive operating costs result from too much emphasis on reducing capital costs.

As the costs for specific system process options depend so greatly on undefined discharge limits, hydraulic flows, and to a lessor extent on the wastewater characterization, HKM has determined that accurate cost estimates for each treatment process cannot be determined at this time. As a general rule, the cost for smaller systems on a per million gallon per day cost basis is higher than the costs for larger systems. The cost for a mechanical plant to upgrade the current system will probably range from $2.00 to $3.00

per gallon per day of treatment capacity. Thus, a 0.5 mgd plant will cost from 1 to 1.5 million dollars.

Recommendations. HKM has developed preliminary treatment process recommendations based on the following assumptions. Cost comparisons are based on common sense evaluations, for example, a treatment process that requires three reactor basins will cost more than a process requiring a single basin.

1. Design Flows. The design flow to meet future needs is estimated to be 1 mgd. Ideally the system could be built in two phases, a 0.5 mgd facility constructed in the near future and the other 0.5 mgd module constructed when needed. An aggressive I&I reduction program will be needed for this design flow to be practical, generally, I&I reduction is less expensive than treating the clean water.

2. Wastewater Strength. The Big Sky wastewater is assumed to show waste strength characteristics in the range of those typically found in domestic sewage.

Evaluations are given for the following broadly described stream discharge limits.

1. Relatively Strict Limits with Some Nutrient Removal Required. The sequencing batch reactor (SBR) process is thought to be best suited to meet these criteria for the Big Sky System. The process can meet the discharge limits, capital costs are relatively low. The process allows operational control to meet the varied conditions found in Big Sky. However, this increased flexibility also requires more operator attention (increased operating costs). The Carrousel System should also remain under consideration.

2. Average Discharge Limits. The SBR and the Carrousel System (oxidation ditch) are both attractive

options. Both produce quality effluent and relatively low capital costs. The extra cost for the clarifiers required for the Carrousel System would seem to be slightly less than the cost for housing the SBR in a building. The Carrousel System has a larger footprint requiring larger land areas, but also has lower operational costs and operator time requirements as compared to the SBR.

3. Very Strict Discharge Limits. If the WQB establishes very strict limits with difficult nutrient removal requirements, the SBR process with tertiary nutrient removal may be the best option. Alternate discharge options should also be explored. Perhaps expanding the irrigation system to handle increased flows and enlarging and repairing (lining the storage pond with geomembrane) the existing system may be the preferred and least cost option.

SAMPLING PLANS

HKM has developed the following sampling plan for initiating the stream discharge permit process and determining the strength of the Big Sky wastewater (characterization of influent wastewater). HKM recommends that the following plan be submitted to the WQB for review as soon as possible. HKM has arranged for the use of a composite sampler so that sampling can begin soon.

Stream Discharge Permit Sampling Plan

Sampling Parameters

BOD_5
PO_4 AS P
NO_3+NO_2 AS N
pH
Temperature

Sampling Schedule

July 1992
July 20 through July 27
October 1992
(similar to July)
February 1993
(similar to July)
May 1993
(similar to July)

The quarterly samples consist of taking composite samples for one week each quarter.

The samples should be taken upstream from the existing plant.

Wastewater Characterization Sampling Plan

Sampling Parameters

BOD_5
Total P
PO_4 AS P
Total N
NH_3 + NH_4 AS N
NO_3 + NO_2 AS N
pH
Temperature

Sampling Schedule

August 1992
- Tuesday, August 4, 1992
- Thursday, August 13, 1992
- Saturday, August 22, 1992
- Monday, August 31, 1992

November 1992
- (similar to August)

March 1993
- (similar to August)

June 1993
- (similar to August)

The quarterly sampling procedure consists of using a composite sampler to collect samples for one day per week for one month per quarter.

The influent flow rates should be recorded concurrently with the sampling.

The wastewater sampling plan may be expanded if the results of the first set of samples shows wastewater parameters outside of the range of typical domestic sewage values.

ENGINEERING RECOMMENDATIONS

Based on the preliminary analysis and evaluation of the existing Big Sky Wastewater Treatment System and available treatment processes and equipment, HKM Associates provides the following recommendations to the Big Sky RID 305 Board members.

1. Initiate stream discharge permit process.

2. Initiate wastewater characterization sampling program.

3. Install new ultrasonic flow measuring and recording equipment on the existing open channel flume located at the influent to the lagoons. This equipment is estimated to cost from $2,000 to $3,000 and can be incorporated into any new system improvements. It is very important to have accurate flow data for existing and future engineering analyses.

4. Install flow measurement and recording equipment on the golf course irrigation pumping system. The flows to the golf course are a large unknown factor and subject to varying estimates. Again, these flow measurements are very important.

5. Develop aggressive I&I reduction program.

6. Preliminary evaluation favors the SBR process for Big Sky. HKM has received information from three suppliers of SBR equipment. When design flows, discharge limits, and wastewater characterization studies have been completed, in-depth analysis and cost estimates can be prepared for SBR and other applicable treatment processes.

The Carrousel System is the second ranked treatment process and should remain under consideration for use at Big Sky.

7. After the design criteria has been established, suppliers and manufactures should be asked to submit cost and treatment efficiency proposals. This competitive process will provide the information for the selection of the best least cost option for upgrading the Big Sky system.

8. HKM has received reports that the Big Sky Golf Course has scheduled some major renovations. The District should work with the golf course so that irrigation standards developed by the WQB are met as part of the current renovation plan. If possible, the District should develop an agreement with the golf course on the minimum and maximum amounts of treatment effluent that the course will discharge. These amounts will determine the quantities that must be stored in ponds and discharged in the stream. A dual discharge system will require careful planning and operation by the System Operator as flows increase with future development at the resort.