Wastewater Technical Assistance

Final Report Summary

for the

University of Tennessee

Municipal Technical Advisory Service

& the

Tennessee Division of Construction Grants & Loans

July 1993

PSG PROFESSIONAL SERVICES GROUP, INC.

EXECUTIVE SUMMARY
WASTEWATER TECHNICAL ASSISTANCE
FINAL REPORT

The University of Tennessee Municipal Advisory Service (UTMTAS) by direction of the Tennessee Division of Construction Grants and Loans (CGL), awarded a contract to the Professional Services Group, Inc. (PSG) to provide technical assistance to selected municipal wastewater treatment plants (WWTP). The focus of this contract was to provide recommendations, based upon operational assessments, that could improve the efficiency of wastewater treatment plant operations.

Initially, eight (8) WWTP's were selected to participate in this program. Selection of the candidate facilities was based around small WWTP's that have had documented operation and maintenance (O & M) problems, would be a cooperative and agreeable participant, and was not involved in an enforcement case with the water quality regulating body. The initial WWTP's included the following:

- Carthage
- Englewood
- Friendship
- Sweetwater
- Greenbrier
- Mt. Pleasant
- Ripley
- Dandridge

The City of Friendship was awarded a Community Development Block Grant to make improvements to their WWTP soon after the selection process and elected not to participate in this project.

PSG, a private contract operator of water and wastewater treatment facilities, used its operational expertise to evaluate available data and perform on-site assessments of plant O & M practices. Time constraints with the contract, which was awarded in mid-March and ended on June 30, 1993, did not allow intensive sampling and analytical evaluations to be performed. Therefore, the conclusions derived from these evaluations were primarily based on the operational expertise of the evaluator and the data provided by the WWTP staff.

The overall conclusions obtained from this project indicated that O & M deficiencies can be indirectly related to factors that can not be corrected with operational adjustments in the WWTP. Several of the WWTP's evaluated experienced similar performance limiting factors, the most predominant limitations included the following:

- Lack of appropriate operator training
- Lack of an adequate preventative maintenance program

- Engineering design limitations
- Excessive infiltration/inflow
- Inadequate solids handling and disposal facilities
- Poorly implemented industrial pretreatment programs
- Poor communication between WWTP and municipal officials
- Marginal application of process control methods
- Budget constraints

A technical assistance program of this type can be very effective if an exchange of information is accomplished, because many of the problems experienced at one WWTP are also experienced at another WWTP. Future activities related to this contract should include a means to create a useful data base of problems and associated corrective action. Selection of participating municipalities should include facilities that could have compliance violations that can be corrected with opertional adjustments versus engineering or enforcement.

CARTHAGE WWTP
WASTEWATER TECHNICAL REPORT
FINAL REPORT SUMMARY

INTRODUCTION

Carthage, Tennessee, distinguished home of Vice President Al Gore, is located approximately forty-five (45) east of Nashville in Smith County. Carthage, a town of approximately 2500 people, owns and operates a secondary wastewater treatment plant that is designed to treat domestic and industrial wastewater prior to discharging the treated effluent to the Cumberland River. Mr. Bucky Hardcastle, Chief Operator, provided data and other pertinent information needed to complete an assessment of operations and maintenance at the Carthage Wastewater Treatment Plant (WWTP).

The Carthage WWTP is a secondary activated sludge treatment facility that utilizes primary clarification, biological treatment, final clarification, chlorination, aerobic digestion, sludge thickening, and sand drying beds for biosolids dewatering. This facility, composed of package type treatment units, is designed to treat an average daily flow of 0.5 million gallons per day (MGD). The size and complexity of the Carthage WWTP requires a minimum of a Grade III certified wastewater treatment plant operator in direct responsible charge of daily operations.

NPDES Permit Requirements

The treated effluent from the Carthage WWTP is discharged to the Cumberland River downstream from the Cordell Hull Dam and Reservoir. The National Pollution Discharge Elimination System (NPDES) permit parameters for this facility were based upon the assimilative capacity of the receiving stream or the capacity of the receiving stream to handle treated wastewater discharges. With stream protection criteria established as the rationale for establishing final effluent standards, Carthage received a NPDES permit with the following monthly average parameters:

Parameter	Monthly Average Concentration (mg/l)
BOD_5	30.0
Settleable Solids	1.0 ml/l
Total Suspended Solids (TSS)	30.0
Dissolved Oxygen (D.O.)	1.0 minimum
Total Chlorine Residual	2.0 maximum

This permit also requires a forty percent (40%) minimum reduction of BOD and TSS loading on a daily basis.

Existing Hydraulic & Organic Loading

Operational reports recorded at the Carthage WWTP indicates that this facility treats an average daily flow of 0.5 MGD, which is equal to the plant's average hydraulic design capacity. This data was derived from reports generated from August 1992 through May 1993. Hydraulic loadings of this volume indicate that this facility is near its hydraulic design life. This volume can be associated with infiltration/inflow sources that contribute extraneous water to the collection system. These extraneous flows result in a reduction of treatment plant efficiency as well as increases the relative cost of pumping and treatment. This quantity of flow also impacts the opportunities of having additional treatment plant capacity available to new sewer customers in the future.

The aeration organic loading depicted in Table 1 for biochemical oxygen demand (BOD) averaged 38.80 pounds per day per one thousand cubic feet (lbs/day/1000 ft^3). The typical organic loadings for primarily domestic type wastewater ranges between 20 to 40 lbs/day/1000 ft^3. The sludge age averaged 13.2 days. The typical range for conventional activated sludge processes is 3.5 to 7.0 days. Based on the operational data at the plant, the average food to microorganism (F/M) ratio is 0.15 lbs/day/lb of mixed liquor suspended solids (MLSS). Typical ranges for F/M ratios in conventional activated sludge processes is 0.2 to 0.5 lbs/day/lb of mixed liquor volatile suspended solids (MLVSS). The F/M ratio was calculated by using MLSS because no volatile suspended solids (VSS) were performed, during this period. The values derived for F/M ratio and sludge age indicate that this facility, based upon the operational data available, is operating in a range that approaches typical extended aeration activated sludge operations.

TABLE 1
ORGANIC LOADING
CARTHAGE WWTP

MONTH	AERATION TANK ORGANIC LOADING BOD lbs/day/1000 ft³	FM/Ratio BOD lbs/day/lb MLSS	Sludge Age Days Avg./Month
Aug 1992	47.03	0.14	15
Sept 1992	31.05	0.16	12
Oct 1992	32.99	0.13	13
Nov 1992	40.93	0.13	15
Dec 1992	48.93	0.19	10
Jan 1993	36.10	0.12	13
Feb 1993	34.43	0.21	9
Mar 1993	50.76	0.14	12
Apr 1993	34.51	0.18	10
May 1993	31.36	0.09	27
Average	38.81	0.15	13

SCOPE OF SERVICES

The basic objective of the wastewater technical assistance contract was to provide the Carthage wastewater treatment plant (WWTP) with a professional evaluation of their current operation and maintenance (O & M) practices. These evaluations involved on-site assessments and review of available O & M data. Based on these evaluations, the performance limiting factors were identified and corrective measures were recommended that would optimize and improve O & M at the Carthage WWTP. To achieve the objective of the wastewater technical assistance contract, the following areas were assessed and evaluated:

- Unit Processes
- WWTP Loadings
- Process/Operational Control Practices

- Solids Handling & Disposal
- Maintenance & Equipment
- Laboratory
- Staffing & Training
- General Housekeeping & Safety
- O & M Budget

PERFORMANCE LIMITING FACTORS & RECOMMENDED CORRECTIVE ACTION

Overall, the operation and maintenance practices currently used at the Carthage WWTP do not seriously impact the efficiency of this facility. The recent completion of the additional solids handling processes will provide assurances in an area that limits most activated sludge wastewater treatment plants. There are however, some factors that have been identified at this facility that could prevent optimum operations. The factors described below can be considered areas where operation and maintenance can be fine tuned:

- The current hydraulic loading is 0.5 MGD on an average day. This loading places this facility at it's designed flow rate. Infiltration/inflow is a major contributor to this load. Reduction of major I/I sources should be made a high priority in the collection system maintenance program.

- Water plant sludge, which is basically inorganic in composition, is not readily biodegradable. This waste essentially increases the cost of sludge handling and disposal. The chemical make-up and pH of this sludge can also adversely impact the activated sludge biomass. The water plant should find an alternative method for disposing of this sludge.

- Consideration should be given to using the primary clarifier not only for settleable solids removal but for dampening potentially high organic loads to the WWTP.

- Develop and implement a basic preventative maintenance program. Begin by locating and centrally housing all equipment manuals and specifications. Then prepare a routine daily, weekly, and monthly schedule to inspect the equipment and perform routine maintenance such as oiling and greasing as needed or prescribed.

- Evaluate the availability of approveable land application sites for present and

future biosolids disposal, with special interest given to compliance with the 503 Sludge Disposal regulations.

- Continue formal operator training and cross-training of employees. Concentration should be given to process and operational control methods and practices.

CONCLUSIONS

The operational practices at the Carthage WWTP can be fine tuned over time. Implementation of a preventative maintenance program can equate to long term cost savings as well as enhancing the operational integrity of the WWTP to treat wastewater within the established standards. Communication with other city officials and services can be an area that is overlooked as a factor that limits operational performance of the WWTP. The Carthage WWTP also experiences limitations common to many small municipalities, small operating budgets.

DANDRIDGE WWTP
WASTEWATER TECHNICAL ASSISTANCE
FINAL REPORT SUMMARY

INTRODUCTION

Dandridge, Tennessee is located approximately fifty (50) miles east of Knoxville in east Tennessee. This municipality owns and operates a secondary wastewater treatment plant that is designed to treat domestic and industrial wastewater flows. This facility became operational in 1973 and discharges treated effluent to Douglas Lake, at river mile 45.5 of the French Broad River. Mr. Herb Norton provided data and other pertinent information needed to complete the assessment of the Dandridge Wastewater Treatment Plant (WWTP).

The Dandridge WWTP is a secondary activated sludge plant consisting of pre-aeration, aeration, clarification, chlorination, aerobic sludge digestion, drying beds, and liquid sludge removal. This facility is an above ground package-type steel structure designed to treat an average daily wastewater flow of 0.4 million gallons per day (MGD). The size and complexity of the Dandridge WWTP requires that at least a Grade II certified wastewater treatment plant operator supervise the daily plant operations.

NPDES Requirements

The treated effluent from the Dandridge WWTP is discharged to Douglas Lake at river mile 45.5 of the French Broad River. The National Pollution Discharge Elimination System (NPDES) permit parameters for this facility was based upon the assimilative capacity of the receiving stream or the capacity of the receiving stream to handle treated wastewater discharges. With stream protection criteria established as the rationale for establishing final effluent standards, Dandridge received a NPDES permit with the following monthly average parameters:

Parameter	Monthly Average Concentration (mg/l)
BOD_5	30.0
Settleable Solids	1.0 ml/l
Total Suspended Solids (TSS)	30.0
Dissolved Oxygen (D.O.)	1.0 minimum
Total Chlorine Residual	2.0 maximum

This permit also requires a forty percent (40%) minimum reduction of BOD and TSS loading on a daily basis.

Existing Hydraulic & Organic Loadings

The Dandridge WWTP treats an average wastewater flow of 0.199 MGD as depicted from operational reports and flow recordings at the plant from April 1992 through March 1993, and shown in Table 1. The maximum daily flow recorded over the same time period averaged 0.268 MGD. Based on the hydraulic loading data, the Dandridge WWTP is loaded at approximately fifty percent (50%) of the design capacity of the plant. It can be assumed from this data that hydraulic impacts associated with infiltration/inflow (I/I) is negligible. This can be attributed to the installation of new PVC pipe in the collection system, according to Mr. Norton.

The organic loading as depicted by the operational reports from April 1992 through March 1993 indicates a slightly higher than typical loading for municipal wastewater treatment plants. Generally, BOD_5 concentrations for raw wastewater are in the range of 200 to 250 mg/l. The average BOD_5 for the Dandridge WWTP is 567 lbs/day or approximately 254 mg/l as noted in Table 1. This concentration can be associated with various industrial waste dischargers as well as the fact that low I/I rates that often provide some dilution of the wastewater stream does not exist. By observation and data, it can be assumed that the BOD_5 loading is relatively soluble and organic in composition. The straggler floc observed in the final clarifier is a good indication that the organic fraction of the wastewater stream is high enough to create a charge neutralization effect on the biofloc, causing repulsion and suspension of small floc particles.

TABLE 1
HYDRAULIC & ORGANIC LOADING
DANDRIDGE WWTP

MONTH	FLOW-MAX	AVG FLOW MGD	LBS BOD/DAY	LBS TSS/DAY
Apr 1992	0.264	0.216	528	312
May 1992	0.310	0.220	734	391
June 1992	0.279	0.203	474	252
July 1993	0.252	01.88	466	241
Aug 1992	0.261	0.196	497	270
Sept 1992	0.221	0.183	523	254
Oct 1992	0.238	0.190	639	238
Nov 1992	0.206	0.172	468	225
Dec 1992	0.270	0.190	677	284
Jan 1993	0.338	0.208	635	338
Feb 1993	0.231	0.190	632	242
Mar 1993	0.350	0.230	633	274
Average	0.268	0.199	567	277

SCOPE OF SERVICES

The basic objective of the wastewater technical assistance contract was to provide the Dandridge wastewater treatment plant (WWTP) with a professional evaluation of their current operation and maintenance (O & M) practices. These evaluations involved on-site assessments and review of available O & M data. Based on these evaluations, the performance limiting factors were identified and corrective measures were recommended that would optimize and improve O & M at the Dandridge WWTP. To achieve the objective of the wastewater technical assistance contract, the following areas were assessed and evaluated:

- Unit Processes
- WWTP Loadings

- Process/Operational Control Practices
- Solids Handling & Disposal
- Maintenance & Equipment
- Laboratory
- Staffing & Training
- General Housekeeping & Safety
- O & M Budget

PERFORMANCE LIMITING FACTORS

Overall, the Dandridge WWTP operations and maintenance practices do not seriously impact the efficiency of this facility. The City has acquired the services of Elrod & Dunson Consulting Engineers to design various upgrade items to help improve the operational efficiency and flexibility of the WWTP. Conversation with Mr. Norton indicated that the proposed modifications may not be the most ideal solutions to address performance limiting factors encountered at the plant. Additional discussions with the consulting engineer are pending. There are some factors that can contribute to limitations of optimum operations at the Dandridge WWTP and are noted as follows:

- Industrial waste discharges from DMS, Inc. and Bayliner, Inc. appear to have some impact on the treatment plant. The DMS facility utilizes an enzyme in their process to remove silver from used and discarded X-rays. Bayliner, a boat manufacturing facility, uses various solvents and fiberglass as part of their manufacturing process. Both of these industries are considered to contribute a high organic load to the WWTP. Quantities of these discharges were not available for evaluation.

- The WWTP has no means to equalize the organic and hydraulic loading to the plant.

- Means for grit removal and removal of settleable solids is not provided.

- The coarse bubble diffusers used for oxygen transfer in the aeration chamber and the aerobic digester is not the most efficient means available for these processes.

- Excessive fluctuations in the aeration chamber MSS concentration does not provide consistent conditions to effectively handle the organic loading to the

WWTP. These fluctuations also negatively impact the settleability of the biomass in the final clarifier.

RECOMMENDED CORRECTIVE ACTION

During the majority of an operational year, the Dandridge WWTP complies with the NPDES permit parameters for discharge to Douglas Lake. There are factors that can limit this facility's ability to consistently comply with final effluent standards. The following corrective measures are suggested based upon the assessment of available data and on-site evaluations of the WWTP:

- Complete Phase II of the industrial pretreatment program and better assess the strength, constituents, and hydraulic loadings associated with major industrial dischargers. Particular attention should be given to DMS and Bayliner.

- Continue with plans to address modifications started by the engineer with emphasis given to the installation of flow equalization and possibly a primary clarifier. These unit processes will provide treatment flexibility as well as a means to dampen and control organic and hydraulic loadings to the aeration chamber. A review of the operability of the proposed modifications is highly recommended before proceeding with final design and construction.

- With the installation of the timers on the air lift pumps and trial and error, determine the best sequence that will provide more steady state levels of MLSS concentration in the aeration chamber. A range of 2,000 to 3,000 mg/l MLSS would be a starting point with adjustments made to handle the organic loadings. A constant range of MLSS will inherently provide better control of the F/M ratio and sludge retention time in the aeration chamber.

- Installation of fine bubble diffusers in the aeration chamber and the aerobic digester will provide more efficient oxygen transfer and subsequent savings in energy costs to operate these processes. However, it should be noted that the replacement cost versus energy savings is not readily apparent in the early years of operations.

- Generally, wastewater treatment plants that experience high organic loadings are sometimes deficient in nutrients. Nutrient deficiency will impair the growth and longevity of the biomass which in turn will reduce its effectiveness to treat and remove pollutants. Analysis of the nutrient concentration, ammonia as nitrogen and phosphorus, should be performed on composite samples of the influent wastewater and compared to the carbon content in the same stream. Typical ratio's for carbon, nitrogen, and phosphorus in wastewater would be 85:12:3 by weight. Addition of a nutrient source may be needed if this ratio is too greatly skewed.

- Consideration should be given to purchasing a dissolved oxygen field probe to allow the operator to monitor the oxygen levels in the aeration chamber, aerobic digester, and the clarifier sludge blanket. These readings will provide valuable information for controlling and optimizing aeration rates and blower operations.

CONCLUSIONS

The overall assessment of the operation and maintenance practices at the Dandridge WWTP indicates that the limitations are closely associated with the design and age of the facility. This treatment plant does not have duplicate units such as final clarifiers and aeration chambers that would provide additional reliability to the treatment plant. Organic loadings attributed to industrial waste discharges can be closely controlled and monitored through an aggressive industrial pretreatment program. Proposed plant modifications will also allow additional operational flexibility, provided these modifications are found to be operable under the existing plant loadings.

ENGLEWOOD WWTP
WASTEWATER TECHNICAL ASSISTANCE
FINAL REPORT SUMMARY

INTRODUCTION

Englewood, Tennessee, located approximately sixty (60) miles northeast of Chattanooga in eastern Tennessee, provides collection and treatment of wastewater for over 1,600 residents at a publicly owned wastewater treatment plant. The Englewood Wastewater Treatment Plant (WWTP) was one of the last wastewater facilities to be upgraded from primary to secondary treatment in the State of Tennessee. The existing oxidation ditch facility began operating in 1987. The Englewood WWTP is managed by the Englewood Utilities Board. Mr. Joe Cline, Utilities Manager, provided data and other pertinent information needed to complete the assessment of the WWTP.

The Englewood WWTP is a secondary activated sludge oxidation ditch treatment facility designed to handle an average of 0.2 million gallons per day (MGD) of wastewater. The complexity and size of this WWTP requires that at least a Grade II certified wastewater treatment plant operator supervise the daily operations. Treated effluent from the Englewood WWTP is discharged to river mile 42.4 of Chestuee Creek.

NPDES Permit Requirements

The treated effluent from the Englewood WWTP is discharged to Chestuee Creek at river mile 42.4. The National Pollution Discharge Elimination System (NPDES) permit parameters for this facility was based upon the assimilative capacity of the receiving stream or the capacity of the receiving stream to handle treated wastewater discharges. With stream protection criteria established as the rationale for establishing final effluent standards, Englewood received an NPDES permit with the following monthly average parameters:

Parameter	Monthly Average Concentration (mg/l)
BOD_5	30.0
Settleable Solids	1.0 ml/l
Total Suspended Solids (TSS)	30.0
Dissolved Oxygen (D.O.)	1.0 minimum
Total Chlorine Residual	0.30 maximum

This permit also requires a forty percent (40%) minimum reduction of BOD and TSS loading on a daily basis.

Existing Hydraulic & Organic Loadings

Based on an evaluation of operational reports recorded from April 1992 through March 1993, the Englewood WWTP treats an average daily flow of 0.231 MGD. The average maximum flow recorded over the same period was 0.420 MGD, with a maximum flow recorded of 0.646 MGD in December 1992. The lowest recorded average flow was 0.140 MGD in May 1992. The yearly average daily flow of 0.231 MGD exceeds the plants hydraulic design capacity by greater than fifteen percent (15%). This facility has been operational for less than seven (7) years and already exceeds its design hydraulic design life, which would typically be twenty (20) years. Because Englewood has not experienced abnormal population growth or possesses any major industrial water users, it can be assumed that these extreme flows are attributed to excessive infiltration/inflow in the collection system. Rainfall data is not collected or recorded at this facility, therefore a direct correlation between rainfall events and flow volumes can not be readily depicted. Monthly average hydraulic and organic loadings at this facility are depicted in Table 1.

The average organic loading at the Englewood WWTP and shown in Table 1 is 275 pounds per day (lbs/day) as biochemical oxygen demand (BOD) or approximately 143 mg/l in concentration. Typical domestic wastewater ranges from 200 to 250 mg/l in strength, measured as BOD_5. The relatively low strength of the raw wastewater in Englewood can be associated with dilution resulting from extraneous I/I flows. The hydraulic and organic loading figures and their influence by excessive I/I is further verified by the treatment plant personnel.

TABLE 1
HYDRAULIC & ORGANIC LOADINGS
ENGLEWOOD WWTP

MONTH	FLOW-AVG MGD	FLOW-MAX MGD	LBS BOD/DAY	LBS TSS/DAY
Apr 1992	0.159	0.262	174	228
May 1992	0.140	0.195	165	232
June 1992	0.206	0.641	242	325
July 1993	0.215	0.405	287	411
Aug 1992	0.150	0.286	184	154
Sept 1992	0.149	0.221	184	201
Oct 1992	0.166	0.303	213	192
Nov 1992	0.284	0.572	348	381
Dec 1992	0.353	0.646	394	471
Jan 1993	0.331	0.568	375	429
Feb 1993	0.215	0.367	298	212
Mar 1993	0.402	0.577	439	298
Average	0.231	0.420	275	294

SCOPE OF SERVICES

The basic objective of the wastewater technical assistance contract was to provide the Englewood wastewater treatment plant (WWTP) with a professional evaluation of their current operation and maintenance (O & M) practices. These evaluations involved on-site assessments and review of available O & M data. Based on these evaluations, the performance limiting factors were identified and corrective measures were recommended that would optimize and improve O & M at the Englewood WWTP. To achieve the objective of the wastewater technical assistance contract, the following areas were assessed and evaluated:

- Unit Processes
- WWTP Loadings

- Process/Operational Control Practices
- Solids Handling & Disposal
- Maintenance & Equipment
- Laboratory
- Staffing & Training
- General Housekeeping & Safety
- O & M Budget

PERFORMANCE LIMITING FACTORS

The Englewood WWTP experiences several areas that can limit this facility's capabilities to consistently achieve compliance with the NPDES discharge permit. Based upon the assessment made during on-site visits and review of available records the following performance limiting factors have ben identified at the Englewood WWTP:

- The budget for this facility is on the low end for a facility of this type and size. Poor maintenance, laboratory controls, and lack of good general housekeeping are indications that additional attention and money needs to be available to adequately operate and maintain the WWTP.

- The on-site operator lacks the training and skill needed to operate and maintain this facility at the level and standard needed to consistently achieve compliance. The use of this individual as a meter reader, impacts the manpower needed to perform the daily functions required at the WWTP.

- Excessive inflow and infiltration contributes hydraulic loadings to the WWTP that exceed the average hydraulic design capacity of this plant. These excessive flows reduces the efficiency and life of the plant as well as increases the cost of treatment.

- All the equipment at the WWTP should be operable. Equipment that is out-of-service reduces the overall effectiveness of the WWTP to treat the wastewater that enters the plant.

- The automatic samplers and the procedures used to sample the wastewater do not comply with specified methods. Poor sampling techniques can adversely impact the outcome of analytical results and reporting associated with the NPDES permit.

RECOMMENDED CORRECTIVE ACTION

The corrective action needed to improve the conditions at the Englewood WWTP revolve around an assessment of the current operation and maintenance practices at this facility. It is apparent that some neglect exists. This may be associated with several factors that are noted as performance limiting. The recommended corrective measures needed to improve the Englewood WWTP are as follows:

- The budget should be reassessed to address the true costs to operate and maintain this facility. Sewer user fees and rate structure should be examined to determine if adequate revenue is available to address budget adjustments in the future.

- The laboratory should be cleaned-up and an inventory performed of existing equipment and supplies. Based on the inventory, equipment and supplies needed to perform NPDES permit and process control tests should be acquired.

- The employee(s) assigned to the WWTP should be properly trained in operations and maintenance of a biological wastewater treatment plant. Emphasis should be given to laboratory procedures and methods as well as incentives for the employee(s) to obtain appropriate operator certifications. The Fleming Operator Training Center in Murfreesboro can provide this type of formal training at minimal cost.

- Personal protection and safety equipment should be made available to all plant personnel. Also, training in safety procedures and use of safety equipment should be stressed.

- Identification and elimination of major infiltration/inflow sources in the collection system should be a part of an aggressive sewer system rehabilitation and maintenance program.

- Implement the WWTP preventative maintenance program and implement action that will make all equipment operational.

- Examine avenues needed to acquire and permit available land for application of waste sludge and eliminate stock piled sludge.

Many of the recommended corrective measures will require additional spending on the part of Englewood Utilities. These measures should not be considered capital expenditures but should be a part of a regular operation and maintenance budget for a wastewater treatment the complexity and size of the Englewood WWTP.

CONCLUSIONS

The Englewood WWTP depicted many shortcomings respective to operations and maintenance. Each of the identified performance limiting factors were indirectly associated to the other. In respect to plant operations, the most significant weakness at this facility is the lack of an adequately trained operator. Lack of an experienced operator, combined with the lack of proper laboratory equipment, deficient maintenance program, and excessive infiltration/inflow compounds the overall problems that this facility is faced with.

GREENBRIER WWTP
WASTEWATER TECHNICAL ASSISTANCE
FINAL REPORT SUMMARY

INTRODUCTION

Greenbrier, Tennessee, located approximately thirty (30) miles northwest of Nashville, owns and operates a secondary wastewater treatment plant. This facility is designed to treat 0.49 million gallons per day (MGD) of domestic and industrial wastewater flows. The existing Greenbrier Wastewater Treatment Plant (WWTP) has been operational for approximately six (6) years and discharges a treated effluent to river mile 0.5 of an unnamed tributary which then flows to river mile 10.3 of Carr Creek in Robertson County. Mr. Tommy Maitland is the Superintendent of the Greenbrier Water and Wastewater System. Mr. Jack Woodard, Chief Operator, provided operational and other pertinent information needed to complete the assessment of this facility.

The Greenbrier WWTP utilizes a sequencing batch reactor (SBR) mode of activated sludge operations where aeration and decanting or sedimentation occurs in the same unit structure. The unit processes incorporated at this facility are similar to conventional type secondary activated sludge facilities and include preliminary treatment, two (2) sequencing batch reactors, chlorination, dechlorination, aerobic digestion, and sludge drying beds. The size and complexity of this facility requires at least a Grade III certified wastewater treatment plant operator supervise the daily operations.

NPDES Permit Requirements

The treated effluent from the Greenbrier WWTP is discharged to an unnamed tributary at river mile 0.5 which eventually flows to river mile 10.3 of Carr Creek. The National Pollution Discharge Elimination System (NPDES) permit parameters for this facility was based upon the assimilative capacity of the receiving stream and an average design flow of 0.49 MGD. The severe seasonal fluctuations in the flows of the receiving stream has resulted in effluent standards that are based upon the associated stream protection criteria for those events. This situation creates seasonal parameters for Biochemical Oxygen Demand (BOD) and Ammonia as Nitrogen (NH_3 -N) in Greenbrier's NPDES permit. Monthly average effluent standards for the Greenbrier WWTP are as follows:

Parameter	Monthly Average Concentration (mg/l)
BOD_5 (5/1-11/30)	10.0
BOD_5 (12/1-4/30)	15.0
NH_3-N (5/1-11/30)	2.0
NH_3-N (12/1-4/30)	4.0
Total Suspended Solids (TSS)	30.0
Dissolved Oxygen (D.O.)	6.0 minimum
Total Chlorine Residual	0.02 maximum

Existing Hydraulic & Organic Loading

The average daily flow to the plant based on the operational data collected and reported by plant personnel from January 1992 through December 1992 is 0.37 MGD. This volume accounts for approximately seventy-six percent (76%) of the average design capacity of the WWTP. Historically, the Greenbrier WWTP's hydraulic loadings were seriously impacted by extraneous water resulting from excessive infiltration/inflow (I/I) sources in the collection system. The operational staff has noted that the replacement of a major sewer interceptor as a result of the highway widening project on U.S. Highway 41 has shown a significant decrease in high flows associated with rainfall events. Also, point source repairs of identified I/I sources are being performed as they are located.

According to operational reports, the organic loading to the SBR units is relatively low for typical conventional activated sludge treatment. As shown in Table 1, the organic loading in terms of BOD averaged 7.10 pounds per day per one thousand cubic feet of reactor (lbs/day/1000 ft^3). This figure is based upon the mixed liquor suspended solids (MLSS) recorded by plant personnel. However, MLSS data is not regularly reported on the monthly operations reports (MOR'S). The calculated BOD loading for this facility indicates an extended aeration operation mode of activated sludge treatment. The food to microorganism ratio (F/M) of 0.5 and the average sludge age of 42.06 days also suggests that this facility is operating in an extended aeration mode of treatment.

TABLE 1
ORGANIC LOADING
GREENBRIER WWTP

MONTH	AERATION TANK ORGANIC LOADING BOD lbs/day/1000 ft^3	FM/Ratio BOD lbs/day/lb MLSS	Sludge Age Days Avg./Month
Jan 1992	7.11		
Feb 1992	11.06	0.05	51.69
Mar 1992	11.91		
Apr 1992	6.40		
May 1992	5.88	0.05	32.42
June 1992	7.52		
July 1992	6.29		
Aug 1992	5.20		
Sept 1992	6.29		
Oct 1992	4.12		
Nov 1992	6.16		
Dec 1992	7.32		
Average	7.11	0.05	42.06

SCOPE OF SERVICES

The basic objective of the wastewater technical assistance contract was to provide the Greenbrier wastewater treatment plant (WWTP) with a professional evaluation of their current operation and maintenance (O & M) practices. These evaluations involved on-site assessments and review of available O & M data. Based on these evaluations, the performance limiting factors were identified and corrective measures were recommended that would optimize and improve O & M at the Greenbrier WWTP. To achieve the objective of the wastewater technical assistance contract, the following areas were assessed and evaluated:

- Unit Processes
- WWTP Loadings
- Process/Operational Control Practices
- Solids Handling & Disposal
- Maintenance & Equipment
- Laboratory
- Staffing & Training
- General Housekeeping & Safety
- O & M Budget

PERFORMANCE LIMITING FACTORS

Overall, the operations and maintenance practices at this facility effectively address the daily needs of the WWTP. Operational adjustments are implemented when needed to insure compliance with the NPDES permit parameters. Factors that would limit the performance of this facility are not directly related to operations. These factors would include the following:

- Excessive inflow and infiltration associated with rainfall events.
- Unexpected mechanical failures.

RECOMMENDED CORRECTIVE ACTION

Most of corrective measures identified at the Greenbrier WWTP revolve around minor

improvements that can be implemented over time without extensive capital costs. The corrective measures noted below primarily concentrate on maintenance and safety matters. Emphasis should be given to providing additional training to employees with a goal to achieve certification of these employees. The corrective action recommended as a result of the evaluation are listed in descending priority:

- Provide additional training and cross training of employees with emphasis on obtaining operator certification.
- Implement aggressive sewer rehabilitation program to identify and reduce major sources of infiltration and inflow.
- Continue eliminating mechanical problems through preventative maintenance.
- Calibrate influent and effluent flow meters.
- Enclose drying beds to further enhance the drying performance during wet periods.
- Build a sludge storage bin to house dried sludge when land disposal can be performed.
- Decrease chlorine residual levels at the chlorine contact basin by determining what dosage levels will provide adequate reduction of pathogens. This will reduce the amount of chlorine and sulfur dioxide needed and will reduce the frequency of chemical purchases
- Place chains across walkways where needed.
- Implement confined space sasfety program.
- Dispose of out-of-date chemicals properly.
- Purchase manlift safety device for confined space entry.
- Perform MLVSS test and log results. This will provide an indication of volatile solids reductions and concentration of viable biological mass available in the biological treatment process.

CONCLUSIONS

The Greenbrier WWTP was well operated and maintained. The operational staff exhibited a very sound understanding of an innovative activated sludge treatment process. Like many other

wastewater systems in Tennessee, the Greenbrier wastewater collection system experiences excessive hydraulic loadings that is attributed to infiltration/inflow. Flows associated with these events can severely disrupt the operations of even the best plants. One available method to dampen the effects of I/I related flows is to implement an aggressive sewer system rehabilitation program that is directed toward identifiying and eliminating major sources. For this program to be effective, it must become a intricate part of the annual collection system maintenace and repair program.

MOUNT PLEASANT WWTP
WASTEWATER TECHNICAL ASSISTANCE
FINAL REPORT SUMMARY

INTRODUCTION

Mt. Pleasant, Tennessee is located approxomatey sixty (60) miles south of Nashville in middle Tennessee. This municipality owns and operates a tertiary wastewater treatment plant that is designed to treat domestic and industrial wastewater flows. Treated effluent from this facility is discharged to Sugar Fork Creek in Muary County. Mr. Mike Holden, Chief Operator, provided data and other pertinent information needed to complete the assessment of the Mt. Pleasant Wastewater Treatment Plant (WWTP).

The Mt. Pleasant WWTP utilizes two stage activated sludge treatment, secondary clarification, tertiary sand filters, chlorination, dechlorination, aerobic digestion, and sand drying beds in their treatment train. This facility is designed to treat an average daily wastewater flow of 0.71 million gallons per day (MGD). The complexity and size of the Mt. Pleasant WWTP requires that at least a Grade IV certified wastewater treatment plant operator supervise the daily plant operations.

NPDES Permit Requirements

The treated effluent from the Mt. Pleasant WWTP is discharged to Sugar Fork Creek at river mile 1.9. The National Pollution Discharge Elimination System (NPDES) permit parameters for this facility was based upon the assimilative capacity of the receiving stream and an average design flow of 0.71 MGD. The severe seasonal fluctuations in the flows of the receiving stream has resulted in effluent standards that are based upon the associated stream protection criteria for those events. This situation creates seasonal parameters for Biochemical Oxygen Demand (BOD) and Ammonia as Nitrogen (NH_3 -N) in Mt. Pleasant's NPDES permit. Monthly average effluent standards for the Mt. Pleasant WWTP are as follows:

Parameter	Monthly Average Concentration (mg/l)
BOD_5 (5/1-11/30)	8.0
BOD_5 (12/1-4/30)	20.0
NH_3-N (5/1-11/30)	1.25
NH_3-N (12/1-4/30)	4.0
Total Suspended Solids (TSS)	30.0
Dissolved Oxygen (D.O.)	6.0 minimum
Total Chlorine Residual	0.02 maximum

Existing Hydraulic & Organic Loading

Operational reports recorded at the Mt. Pleasant WWTP indicates that this facility treats an average daily flow of 0.71 MGD, which is equal to the plants average hydraulic design capacity. This data was derived from reports generated from January 1992 through December 1992. Hydraulic loadings of this volume indicate that this facility is near its hydraulic design life. This volume can be associated with infiltration/inflow sources that contribute extraneous water to the collection system. These extraneous flows result in a reduction of treatment plant efficiency as well increases the relative cost of pumping and treatment. This quantity of flow also impacts the opportunities of having additional treatment plant capacity available to new sewer customers in the future.

The organic loading on the first stage aeration basin and depicted in Table 1, for biochemical oxygen demand (BOD) averaged 45.47 pounds per day per one thousand cubic feet (lbs/day/1000 ft^3). The first stage aeration basins of two stage treatment facilities are generally operated in a conventional activated sludge mode. The typical organic loadings for primarily domestic type wastewater ranges between 20 to 40 lbs/day/1000 ft^3. The sludge age could not be determined due to the extreme low suspended solids values reported in the operational records. Based on the operational data at the plant, the average food to microorganism (F/M) ratio is 0.24 lbs/day/lb of mixed liquor suspended solids (MLSS). Typical ranges for F/M ratios in conventional activated sludge processes is 0.2 to 0.5 lbs/day/lb of mixed liquor volatile suspended solids (MLVSS). The F/M ratio was calculated by using MLSS because no volatile suspended solids (VSS) were performed, during this period. Data was not available for determining the organic loading on the second aeration or nitrification stage of this WWTP.

TABLE 1
ORGANIC LOADING
MT. PLEASANT WWTP

MONTH	AERATION TANK ORGANIC LOADING BOD lbs/day/1000 ft^3	F/M RATIO BOD lbs/day/lb MLSS
Jan 1992	68.32	0.44
Feb 1992	58.77	0.28
Mar 1992	75.47	0.55
Apr 1992	59.34	0.33
May 1992	-	-
June 1992	33.85	0.14
July 1992	33.56	0.15
Aug 1992	23.33	0.09
Sept 1992	37.43	0.18
Oct 1992	36.92	0.13
Nov 1992	31.66	0.14
Dec 1992	41.58	0.17
Average	45.47	0.24

SCOPE OF SERVICES

The basic objective of the wastewater technical assistance contract was to provide the Mt. Pleasant WWTP with a professional evaluation of their current operation and maintenance (O & M) practices. These evaluations involved on-site assessments and review of available O & M data. Based on these evaluations, the performance limiting factors were identified and corrective measures were recommended that would optimize and improve O & M at the Mt. Pleasant WWTP. To achieve the objective of the wastewater technical assistance contract, the following areas were assessed and evaluated:

- Unit Processes
- WWTP Loadings

- Process/Operational Control Practices
- Solids Handling & Disposal
- Maintenance & Equipment
- Laboratory
- Staffing & Training
- General Housekeeping & Safety
- O & M Budget

PERFORMANCE LIMITING FACTORS

A complete and detailed assessment of operations at the Mt. Pleasant WWTP could not be achieved because some pertinent data was not provided by the City. However, the available data, interviews with operations personnel, and on-site observations provided enough information to derive some conclusions respective to factors that can be attributed to limiting the operational performance of the Mt. Pleasant WWTP. The following factors can be considered performance limiting:

- Specific data respective to the industrial pretreatment program was not available for reveiw. According to the Pretreatment Coordinator, Mt. Pleasant does not have a permitted industrial discharger that could adversely impact the WWTP. However, on-site observations of the WWTP noted a petroleum based odor in the activated sludge and an oily film visible on the surface of the nitrification basin. The source of this material was unknown to the operators. It could be attributed to an illegal dumper or possibly a local industry, both of which should be regulated by the pretreatment program. Discharges of this nature are apparently not uncommon and does adversely impact treatment plant efficiency.

- Waste solids handling and disposal is inadequate. The sand drying beds are inefficient to handle the solids inventory on a year around basis.

- Flow patterns in the bioreactors indicate possible short circuitng which reduces the effective hydraulic detention time and treatment efficiency in these units. Organic removal efficiencies are significantly impaired by this condtion.

- The hydraulic loading on an average day is at the design capacity of this facility. Inflow/infiltration and possibly excessive industrial flows can be attributed to this flow volume. Hydraulic overloads adversely effect treatment plant efficiency.

- The tertiary sand filters are not operational. Flow is currently being diverted around these units. A hydraulic back-up is occurring at this point, resulting in the submergence of the weirs in the final clarifiers.

- The air diffusers in both aeration basins depict signs of blockage. Inefficient oxygen transfer and mixing adversely effects the biomass population needed to reduce the organic fraction of the wastewaster and could result in unwanted filamentous bacterial growth.

RECOMMENDED CORRECTIVE ACTION

Significant improvements can be implemented at this facility, many of which are not directly related to operational controls. As with many small wastewater systems, maintenance is an area that commonly needs upgrading. The following are recommendations of corrective action that need to be addressed at the Mt. Pleasant WWTP:

- Evaluate the industrial pretreatment program and incorporate changes that are needed to protect the WWTP from adverse impacts associated with these dishargers.

- Evaluate alternative method for ultimate disposal of waste sludges. Have the sludge analyzed, locate and secure available land application sites.

- Implement aggressive sewer rehabilitation program to eliminate major I/I sources.

- Replace or clean all diffusers on the aeration basins and aerobic digester.

- A preventive maintenance program should be developed and implemented.

- Modify or repair the tertiary filters.

- Correct the short circuiting problems in the aeration basins with additional baffling or effluent baffle adjustments.

CONCLUSIONS

The two stage activated sludge system used at the Mt. Pleasant WWTP is inherently difficult to operate. Some design related problems, such as the tertiary filter controls, limit the operational flexiblity of this plant. Lack of an effective industrial pretreatment program and relatively high influent flows places severe limitations on the operational integrity of this treatment plant and the operational staff.

RIPLEY WWTP
WASTEWATER TECHNICAL ASSISTANCE
FINAL REPORT SUMMARY

INTRODUCTION

Ripley, Tennessee, located approximately sixty (60) miles north of Memphis in western Tennessee, owns and operates a tertiary wastewater treatment plant. This facility, constructed with funds from the federal grants program,began operating in 1988. The Ripley Wastewater Treatment Plant (WWTP) is managed by the Ripley Gas and Water Department which is an intregal part of the Ripley Board of Public Utilities. The following staff members provided information, time, and site visits needed to complete the assessment of the WWTP:

Mr. Cecil Hutchison	Superintendent
Mr. Johnny Land	Plant Supervisor
Mrs. Martha Land	Plant Operator

The Ripley WWTP, designed by EMPE, Inc., has the capacity to treat an average daily wastewater flow of 1.66 million gallons per day (MGD). Approximately six percent (6%) of the wastewater received at the WWTP is attributed to industrial discharges. The Ripley WWTP is a teritary treatment plant that utilizes an oxidation ditch activated sludge process, innovative intrachannel BOAT clarifiers, and tertiary sand filtration. The complexity and size of this facility requires that at least a Grade III certified wastewater treatment plant operator supervise the operations.

NPDES Requirements

The treated effluent from the Ripley WWTP is discharged into Cane Creek at river mile 15.4 in Lauderdale County. The National Pollutant Discharge Elimination System (NPDES) permit parameters for this facility was based upon an average design flow of 1.66 MGD and a receiving stream low flow condition (3Q20) of 0.1 cubic feet per second (cfs). With stream protection criteria established and defined by the Clean Water Act, Ripley received a reissued NPDES permit with the following monthly average parameters that are effective March 31, 1993 through March 30, 1998:

Parameter	Monthly Average Concentration (mg/l)
$CBOD_5$	10.0
Ammonia, N (NH_3N)	2.0
Total Suspended Solids (TSS)	30.0
Dissolved Oxygen (D.O.)	6.0 minimum
Total Chlorine Residual	0.02 maximum

This permit also requires biomonitoring and analyses of total cadmium, total copper and cyanide. Also, eighty-five percent (85%) reduction of $CBOD_5$ and TSS must be achieved on a monthly average basis.

Existing Conditions

The Ripley WWTP treats an average daily wastewater flow of 1.202 MGD as depicted from operational reports and flow recordings at the plant from January 1992 through March 1993, and shown in Table 1. This average flow consumes approximately seventy-two percent (72%) of the plants average design capacity. The maximum average flow over the same time period was 1.698 MGD which depicts a less than three percent (3%) deviation from the plants hydraulic design. However, maximum flows recorded during this time period showed a peak flow as high as 2.296 MGD in March 1992. Peak hydraulic loadings that exceeded the average hydraulic design capacity are clearly related to months where rainfall generally exceeded three (3) inches. This correlation can be related to infiltration/inflow in the collection system.

Based upon the raw influent $CBOD_5$, the organic loading of the Ripley WWTP is very typical of primarily domestic wastewater strengths. From January 1992 through March 1993, this facility received an average $CBOD_5$ loading of 169.25 mg/l, ranging from 130 mg/l to 266 mg/l for an average month. The raw ammonia loading for the same period depicted typical concentrations of approximately 15 mg/l. These values are shown in Table 2.

TABLE 1
HYDRAULIC LOADING
RIPLEY WWTP

MONTH/YEAR	RAINFALL (in)	AVG FLOW (MGD)	MAX FLOW (MGD)
January 1992	2.25	1.091	1.637
February 1992	1.90	1.107	1.596
March 1992	5.88	1.325	2.296
April 1992	2.05	1.110	1.471
May 1992	4.58	0.938	1.138
June 1992	6.74	1.203	2.008
July 1992	4.45	1.027	1.432
August 1992	3.83	1.081	1.607
September 1992	1.96	1.085	1.439
October 1992	2.18	1.032	1.284
November 1992	3.88	1.057	1.342
December1992	3.26	1.095	1.891
January 1993	4.66	1.189	1.663
February 1993	1.36	1.308	2.441
March 1993	3.05	1.213	2.052
Average	3.47	1.202	1.698

TABLE 2
ORGANIC & SOLIDS LOADING
RIPLEY WWTP

MONTH/YEAR	$CBOD_5$ (mg/l)	TSS (mg/l)	NH_3N (mg/l)
January 1992	191	302	9.54
February 1992	201	273	9.38
March 1992	206	315	9.69
April 1992	266	353	13.85
May 1992	253	380	15.90
June 1992	245	348	11.53
July 1992	217	297	13.55
August 1992	220	252	13.40
September 1992	231	301	16.59
October 1992	263	349	16.79
November 1992	219	274	18.14
December1992	153	281	15.71
January 1993	165	368	21.15
February 1993	160	247	18..14
March 1993	130	167	11.75
Average	169.25	275.30	14.76

SCOPE OF SERVICES

The basic objective of the wastewater technical assistance contract was to provide the Ripley wastewater treatment plant (WWTP) with a professional evaluation of their current operation and maintenance (O & M) practices. These evaluations involved on-site assessments and review of available O & M data. Based on these evaluations, the performance limiting factors were identified and corrective measures were recommended that would optimize and improve O & M at the Ripley WWTP. To achieve the objective of the wastewater technical assistance contract, the following areas were assessed and evaluated:

- Unit Processes
- WWTP Loadings
- Process/Operational Control Practices
- Solids Handling & Disposal
- Maintenance & Equipment
- Laboratory
- Staffing & Training
- General Housekeeping & Safety
- O & M Budget

PERFORMANCE LIMITING FACTORS

Overall, the operations and maintenance practices at the Ripley WWTP can be commended. Limitations to the operational performance at this facility revolve around some inflexibilities of unit process design, poor equipment applications, and minimal physical controls of unit processes.

As noted in the text of this report, the final clarifiers at this facility are intrachannel BOAT clarifiers. Operations of these units rely heavily upon strict control of the biomass or MLSS settleability and flow-through hydraulics. These parameters allow little room for error and cannot be readily adjusted. One problem encountered at this facility was clogging of the lower solids inlet ports of the BOAT clarifiers. The six (6) inch diameter ports allow upflow of the mixed liquor and a clarified effluent, provided the upflow velocity is not turbulent or greater than the solids settling velocity and the horizontal velocity of the mixed liquor under and around the BOAT. According to the operators, these ports become clogged when the MLSS concentration is greater than an identified value of 3,000 mg/l. Cleaning of the ports is manpower intensive and results in significant disturbance of the effluent quality.

This problem appears to be associated with the velocity of the mixed liquor around and underneath the BOAT clarifiers. A visit to BOAT clarifiers installed in Hammond, Louisiana was made to compare applications of this technology. Significant differences were noted between the facilities. The operational staff in Hammond did not appear to have the problems noted in Ripley. The following differences are noted in installation of the Hammond 1.5 MGD oxidation ditch, BOAT clarifier system:

- The approach channel was longer and straighter, whereas the bow of the BOATS in Ripley are close to the turn in the ditches.
- Greater channel distances exist between the BOAT wall and the ditch walls on both sides.
- An angled steel baffle was installed prior to the bow of the ditch to direct flow toward the bottom of the BOAT.
- A propeller mixer was installed prior to the baffle but actually provided little or no velocity increases over and above the brush aerators.
- No tuning vanes were available.
- Operational MLSS levels were 1,200 to 1,500 mg/l with similar organic and TSS loadings.

It appears by observing and comparing the Ripley and Hammond BOAT clarifiers that the differences in operations may be due to the velocity of flow around the BOAT. Though the Hammond operators indicated fewer frequency of problems, they still noted clogging of the inlet ports and subsequent sludge clumps to be periodic occurrences.

The sludge holding basin also provides limited operational flexibilities. Aside from poor mixing and aerator performance, the flat bottom does not allow optimal means to remove concentrated solids without being manpower intensive. Additionally, direct wasting of sludge to this basin from the oxidation ditches results in a lower concentration waste sludge which will require more frequent decanting operations in the sludge holding basin.

RECOMMENDED CORRECTIVE ACTION

The operational practices of the Ripley WWTP staff effectively address the needs of the facility to meet effluent standards. The performance limiting factors previously noted are associated directly or indirectly with inflexibilities of the design, application of the equipment, or installation of the unit process. In respect to the BOAT clarifier, velocities around the BOAT may not be great enough to provide continual movement of MLSS under the inlet ports. Recommended action to address this issue are:

- Contact the manufacturer and discuss adjustments of the tuning vanes located near the bow of the BOAT clarifiers. The manufacturer indicated that these devices were set at start-up and should never be adjusted. Characteristic changes of the biomass and mechanical operations are not the same now as they were at start-up and would warrant tuning vane adjustments.

- Utilize a sludge judge to determine if any sludge buildup exists under the BOAT inlet port. This would indicate low horizontal velocities.

- Make tuning vane adjustments needed to achieve adequate horizontal velocities.

- Improved solids removal in the BOAT clarifiers will reduce the operational cost of tertiary sand filters. However, the limited operational flexibilities associated with the BOAT clarifiers make the sand filters a vital part of Ripley's compliance.

- The mixing aerators in the sludge holding basin need to be replaced with a more reliable process. This can be achieved by either installing a blower with a coarse bubble diffuser network placed on the bottom of the basin or utilizing another type of floating mixer/aerator such as OTA Aerotor. Aeration and mixing and mixing is imperative to minimize septicity and odors as well as provide additional aerobic digestion of the waste sludge.

CONCLUSIONS

Operation and maintenance practices at the Ripley WWTP conform with the daily needs for this facility. However, constraints associated with various design and construction aspects of this facility, prohibit overall effectiveness of the staffs O & M efforts. The intrachannel clarifiers, an innovative design, is operationally inflexible to handle the constant changes that are encountered in daily wastewater operations. These clarifiers have exhibited the capability to perform as designed but are very sensitive to fluctuations in the biomass concentration and velocity of the MLSS in the oxidation ditches. Because of this, the clarifiers have become a manpower intensive operation. Because of design related problems as those experienced at the Ripley WWTP, consideration should be given to require operability reviews as part of the engineering design process.

SWEETWATER WWTP
WASTEWATER TECHNICAL ASSISTANCE
FINAL REPORT SUMMARY

INTRODUCTION

Sweetwater, Tennessee, located approximately fifty (50) miles southwest of Knoxville in east Tennessee, owns and operates a secondary wastewater treatment plant. This facility is designed to treat domestic and industrial wastewater flows prior to discharging a treated effluent to river mile 19.4 of Sweetwater Creek. Mr. Doyle Prince, Plant Operations Superintendent, provided data and other pertinent information needed to complete the assessment of the Sweetwater Wastewater Treatment Plant (WWTP).

The Sweetwater WWTP is a fixed film biological facility that utilizes primary clarification, trickling filter, final clarification, chlorination, dechlorination, anaerobic digestion, and sand drying beds to treat wastewater. The WWTP is designed to handle an average daily wastewater flow of 1.5 million gallons per day (MGD). However, the primary clarifiers are designed for only 1.0 MGD and the final clarifiers are designed to treat 2.0 MGD. The complexity and size of this secondary wastewater treatment plant requires at leasta Grade III wastewater treatment plant operator supervise thedaily plant operations.

NPDES Permit Requirements

The treated effluent from the Sweetwater WWTP is discharged to Sweetwater Creek at river mile 19.4. The National Pollution Discharge Elimination System (NPDES) permit parameters for this facility was based upon the assimilative capacity of the receiving stream and an average design flow of 1.5 MGD. The severe seasonal fluctuations in the flows of the receiving stream has resulted in effluent standards that are based upon the associated stream protection criteria for those events. This situation creates seasonal parameters for Ammonia as Nitrogen (NH_3 -N) in Sweetwater's NPDES permit. Monthly average effluent standards for the Sweetwater WWTP are as follows:

Parameter	Monthly Average Concentration (mg/l)
$CBOD_5$	25.0
Total Suspended Solids (TSS)	30.0
NH_3-N (5/1-11/30)	5.5
NH_3-N (12/1-4/30)	6.2
Settleable Solids	1.0 ml/l
Dissolved Oxygen (D.O.)	6.0 minimum
Total Chlorine Residual	0.06 maximum

Existing Hydraulic & Organic Loadings

The average daily flow at the Sweetwater WWTP, based on plant data generated and depicted in Table 1, from May 1992 through April 1993, is 1.311 million gallons per day (MGD). The average daily maximum flow, based on the same time period, is 1.842 MGD. The actual hydraulic loading (GPD/ft2) to the trickling filter cannot be calculated because the recirculation rate is unknown. With an estimated recirculation rate between 150% to 300%, the hydraulic loading averages 198.5 gpd/sq ft; well within the design parameters of a high rate filter (100-1,000 gpd/sq ft). The organic loading is duringthe same reporting period 19.7 pounds of biochemical oxygen demand per one thousand cubic feet (lbs BOD/1,000 ft^3), lower than design criteria for a high rate filter (50-300 lbs BOD/1,000 cu ft).

TABLE 1
HYDRAULIC & ORGANIC LOADINGS
SWEETWATER WWTP

MONTH	FLOW MGD	FLOW MAX	lbs BOD/day/ ft^3	LBS TSS
May 1992	0.981	1.225	22.1	1244
June 1992	1.087	1.777	21.4	1704
July 1993	1.192	1.819	24.5	1740
Aug 1992	1.013	1.345	15.3	929
Sept 1992	0.986	1.221	18.7	1003
Oct 1992	1.043	1.581	15.5	1209
Nov 1992	1.428	2.272	22.8	1358
Dec 1992	1.663	2.472	18.3	1290
Jan 1993	1.713	2.203	19.4	857
Feb 1993	1.355	1.727	20.8	1096
Mar 1993	1.706	2.425	18.1	1650
Apr 1993	1.550	2.034	19.0	1416
Average	1.310	1.842	19.7	1291

SCOPE OF SERVICES

The basic objective of the wastewater technical assistance contract was to provide the Sweetwater WWTP with a professional evaluation of their current operation and maintenance (O & M) practices. These evaluations involved on-site assessments and review of available O & M data. Based on these evaluations, the performance limiting factors were identified and corrective measures were recommended that would optimize and improve O & M at the Sweetwater WWTP. To achieve the objective of the wastewater technical assistance contract, the following areas were assessed and evaluated:

- Unit Processes
- WWTP Loadings

- Process/Operational Control Practices
- Solids Handling & Disposal
- Maintenance & Equipment
- Laboratory
- Staffing & Training
- General Housekeeping & Safety
- O & M Budget

PERFORMANCE LIMITING FACTORS

From an operational perspective, the Sweetwater WWTP is operated at a level needed to consistently achieve compliance with effluent discharge standards. The inherent design, construction, and age of the facility limits the operational flexibility of the WWTP. There does exist a few factors that can indirectly affect daily operations. These factors include the following:

- A formal industrial pretreatment program has not been implemented. Uncontrolled or unmonitored industrial discharges can create serious operational and compliance problems at the WWTP.

- The recirculation rate for the trickling filter is controlled by one of two single speed pumps. Therefore, the recirculation rate can not be adjusted with changes in the influent flow rate, causing severe fluctuations in application rates to the trickling filter during a 24-hour period.

- The anaerobic digester has not been cleaned since it was placed into operation in 1958. The scum blanket in this process consumes greater than fifty percent (50%) of its volume. This situation severely limits the operability and performance of the anaereobic digester.

RECOMMENDED CORRECTIVE ACTION

Various corrective measures can be considered at the Sweetwater WWTP. The most significant recommendation centers around the completion of the industrial pretreatment program. Identified areas of where corrective action could be beneficial to plant operations include the

following:

- Complete and implement the required industrial pretreatment program. Phase I should be completed by July 31, 1993. Phase II should be completed by December 31, 1993.
- Install a variable speed pump controller for trickling filter recirculation.
- Install flow meter on recirculation.
- Clean digester.
- Repair sampler refrigerator.
- Base sludge removal from clarifiers on sludge blanket depth instead of manual intervals.

CONCLUSIONS

The age of the Sweetwater WWTP and its realtivley consistent compliance record, would indicate that a well operated and maintained wastewater treatment plant can provide long term savings in major capital expenditures for a new plant. Improvements can be made to provide more operational flexiblity. However, the cost benefit of improvements such as the installation of variable speed recirculation pumps may not be justifiable.