Report
of
Wastewater System
Master Plan

Sherwood, Arkansas
August, 2009



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Summary

The City of Sherwood had experienced a continuous, sometimes almost spectacular, increase in population since its incorporation. At an estimated 2009 population of 28,600, Sherwood currently ranks as the 16th largest city in Arkansas, and the Sherwood area population is projected to increase by another 35 percent over the next 20 years. However, a number of constraints, including other political jurisdictions and an extensive flood plain, serve to confine this growth to the existing sewered areas and areas to the north. Providing proper wastewater service to accommodate this additional growth will require careful planning. This master planning effort has examined the current status of the Sherwood wastewater system with respect to collection and treatment and has estimated future requirements under a number of alternative conditions. The fact that a significant portion of the municipal sewers serving sewer customers within the city limit of Sherwood is owned and operated by North Little Rock and that approximately 75 percent of Sherwood's municipal wastewater is treated by North Little Rock complicates planning for the future.

Commissioned Study

Given the already close association of the Sherwood and North Little Rock wastewater systems, as of this writing, Sherwood and North Little Rock have jointly commissioned a study of the respective wastewater systems with the objective of determining the mutual desirability of a closer association of the two wastewater systems. The outcome of this study could be a recommendation ranging from total separation of the two systems, to complete merger, or something in between. Factors influencing the ultimate disposition of the study typically fall in two principle categories: technical and political. The information developed through this master plan generally fall into the technical category.

Consent Administrative Order

The City of Sherwood was placed under a Consent Administrative Order by Arkansas Department of Environmental Quality effective January, 2009. This DEQ Order addresses the reduction of sewer system wet-weather induced inflows and correction of hydraulic and treatment deficiencies. Sherwood has initiated a comprehensive evaluation study of the entire sewer system. The results of this study will be used to develop repair, rehabilitation, and upgrade programs to correct defects and restore sewer system and pump station capacities. The DEQ

Order also calls for an evaluation of wastewater treatment capacities and capabilities leading to a comprehensive plan for improvements required to ensure permit compliance. The facilities of the North and South Wastewater Treatment Plants were evaluated with respect to condition, serviceability, and continued reuse. Suggested improvements for compliance with the DEQ Order, along with a corresponding implementation schedule for each plant are included.

Wastewater Treatment

A number of alternatives for treating Sherwood wastewater were evaluated on a present worth cost basis. Based on technical merit, the alternative of choice calls for Sherwood's two wastewater treatment plants to be replaced by flow-rate equalization and all Sherwood wastewater to be conveyed to North Little Rock's Five-Mile Creek Plant for treatment.

The extent of improvements necessary for Sherwood's wastewater treatment plants depends upon the future service selected for the respective plants. If it is determined that the plants are not to be retained in the long-term (as with the above alternative), immediate improvements should only be those necessary to comply with the short-term demands of the DEQ Order. Realizing that the majority of the treatment plant facilities could be decommissioned within three to five years, a capital investment beyond the minimum requirement will likely not be recoverable. If the plants are to be retained, improvements necessary to meet the terms of the DEQ Order should be incorporated into a larger project that not only meets the terms of the DEQ Order but also provides treatment facilities to meet anticipated 20-year requirements. Short term treatment plant improvements thought necessary for compliance with the terms of the DEQ Order are presented in Section 10 of this Report. Improvements thought necessary to retain Sherwood's existing treatment plants for the long term are included in Section 6.

Collection System

Collection system improvements and additions thought necessary to serve the North Area are generally described in Section 8 of this Report and are shown on Plate I. According to the plan shown, North Area wastewater will be collected to the existing Brockington Pump Station which will, in turn, pump those wastewater to the North Plant, where the North Area wastewater will be combined with other North Plan wastewater and equalized as necessary. If the North Plant is in operation, treatment will occur there; if the North Plant has been removed from service, tributary wastewater will be equalized and conveyed to the Five-Mile Creek Plant for treatment.

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Master Plan

Sherwood, Arkansas
August, 2009

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Plate I (Bound at back of Report)

Report

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Section 1

Introduction

Sherwood, Arkansas, is a city of the first class located in northeast Pulaski County a few miles north of the Arkansas State Capitol of Little Rock. Sherwood is included in the Little Rock–North Little Rock–Conway Metropolitan Statistical Area. Since its incorporation in 1948, Sherwood has experienced a continuous, sometimes almost spectacular, increase in population. The 2000 decadal census was 21,511. By special election in 2008, Sherwood annexed the neighboring community of Gravel Ridge with a population and area of 3,232 and 1.9 square miles, respectively, Including that of Gravel Ridge, the 2009 population of Sherwood is estimated to be about 28,600, ranking Sherwood as the 16th largest city in Arkansas.

The Sherwood wastewater system includes a collection system with an estimated 346,913 linear feed of gravity sewers ranging in size from six to 24 inches in diameter; ten pumping stations of varying design and capacity; and three wastewater treatment plants including that of Gravel Ridge. A significant portion of Sherwood wastewater is presently treated in North Little Rock's Five-Mile Creek wastewater treatment plant.

The City of Sherwood was placed under a Consent Administrative Order (the DEQ Order) by Arkansas Department of Environmental Quality effective January, 2009. This DEQ Order addresses the reduction of sewer system wet-weather induced inflows and correction of hydraulic and treatment deficiencies. The DEQ Order also calls for an evaluation of wastewater treatment capacities and capabilities as a precursor to development of a comprehensive plan for improvements necessary to ensure permit compliance. Sherwood has initiated a comprehensive sewer system evaluation study to identify sewer system defects and select appropriate sewer repair and rehabilitation methods. Post-rehabilitation flow-rate measurements will be made to assist in the identification of capacity deficient sewers and pump stations.

Sherwood recognized that pursuing the corrective measures called for by the DEQ Order would only be a temporary expedient. Given the growth in Sherwood population experienced over recent decades, Sherwood further recognized the need for planning beyond the immediate and elected to incorporate the requirements of the DEQ Order within a long-term (20-year) master planing effort for the Sherwood municipal wastewater system. The resulting master planning document will position the Sherwood wastewater system to meet projected future requirements as well as meet the immediate demands of the DEQ Order; this Master Planning Report presents the Sherwood wastewater system Master Plan intended to meet these two objectives.

The Master Plan is presented in 10 sections. Section 1, this section, introduces the master planning effort and presents the planning objectives; Section 2 describes the extent and character of the Sherwood planning area; Section 3 gives the estimated 20-year planning area population and the projection on which the estimate is based; Section 4 describes existing wastewater quality and character; Section 5 summarizes existing wastewater treatment facilities, permits, and performance; Section 6 presents the alternatives considered within the 20-year plan for treating planning area wastewaters along with a present worth cost analysis of each; Section 7 describes various options considered for sludge treatment and disposal and gives a present worth cost analysis of each; Section 8 deals with the collection system and pumping stations and suggests system rehabilitations and other improvements; Section 9 reviews current and future system revenues, expenses, and user charges; and Section 10 offers a suggested response to the requirements of the DEQ Order. Appendices provide various references, supporting documents, data bases, and other information.

Section 2
Planning Area

The Sherwood planning area generally consists of the post-2008 annexation city limit of Sherwood. This comprises a total of approximately 19 square miles including 4.8 square miles of land within the 100-year flood plain. A general map showing the Sherwood city limit is included as Figure 2-1. The planning area encompasses a number of sewer improvement districts including Sylvan Hills, Gravel Ridge, Clayton Chapel, Oakbrooke, Holly Hills, and a portion of Rixie. A map, prepared and provided by North Little Rock Waste Water Utility, showing the general extent of the North Little Rock and Sherwood wastewater service areas and the various sewer improvement district boundaries is included as Figure 2-2.

This planning effort assumes that future development within the 100-year flood plain will occur only within a select few areas and that the Sherwood wastewater system will not extend significantly beyond the long-term planning area boundary shown in Figure 2-1. It is also assumed that new development will be primarily residential, multi-family, and light commercial in nature. New residential development beyond that existing should be characterized as small to medium subdivisions with medium to large house sites throughout a semi-rural and suburban landscape. A 2007 (pre-annexation) Sherwood zoning map is included as Figure 2-3.

The Sherwood planning area has a number of physical and political constraints that serve to impede its future expansion beyond certain limits. The planning area is confined on the west by the City of North Little Rock, Camp Robinson, and Runyan Acres (SID 211); on the south by the City of North Little Rock; on the southeast by extensive flood plains; on the east by flood plains and the City of Jacksonville; and on the northeast by the Little Rock Air Force Base. This generally leaves an extensive area to the north for future expansion. However, this north area is separated somewhat from existing developed areas of Sherwood by Kellogg Creek with its wide flood plain. This east/west wetland corridor serves as a barrier to growth because of the expense of providing roadway and utility connections between areas to the north and the metropolitan area to the south.

This Master Plan also assumes development will occur in areas within and immediately contiguous to the existing wastewater service area that can readily be connected to existing wastewater facilities through short extensions to existing gravity sewers or through independent,

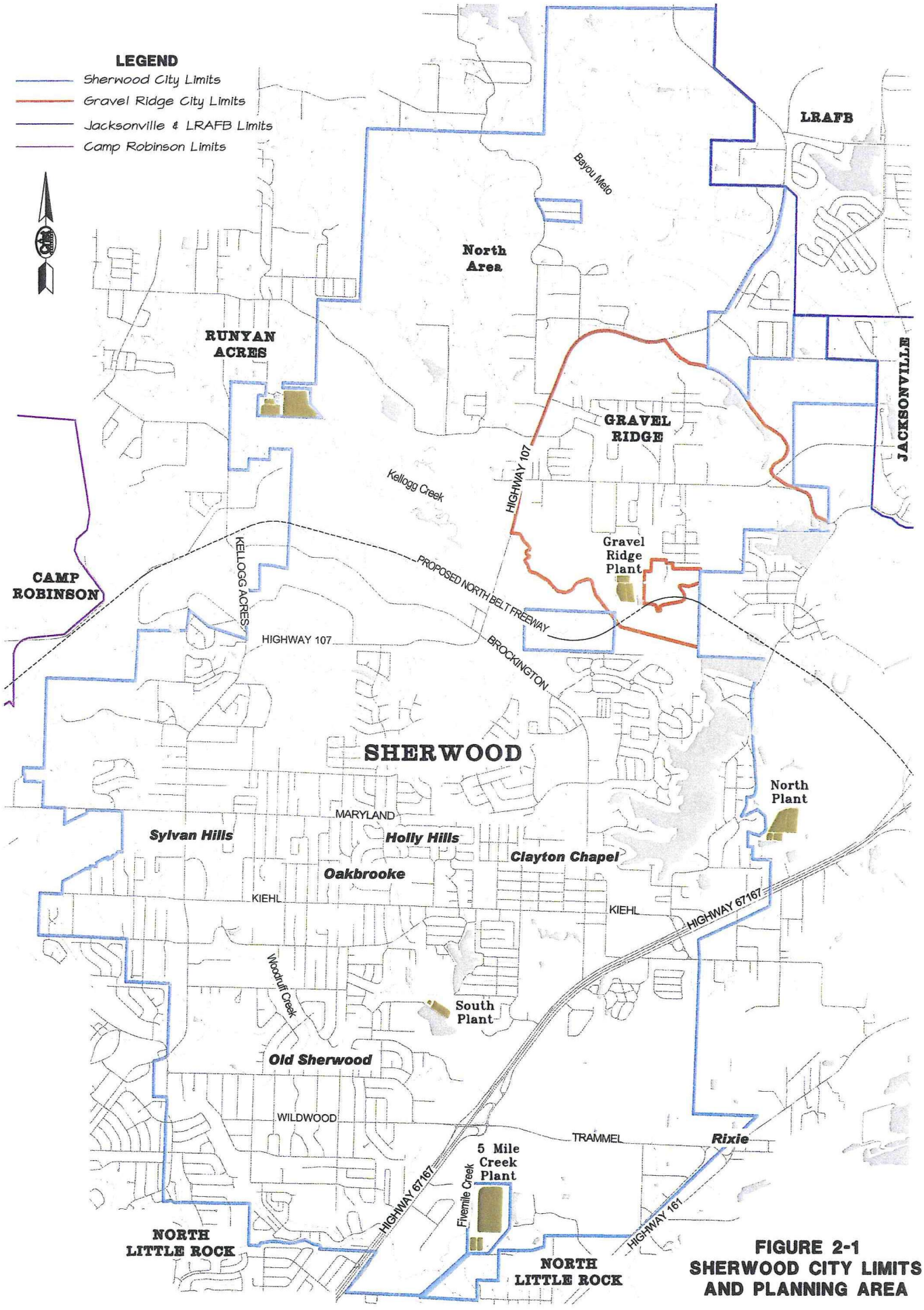
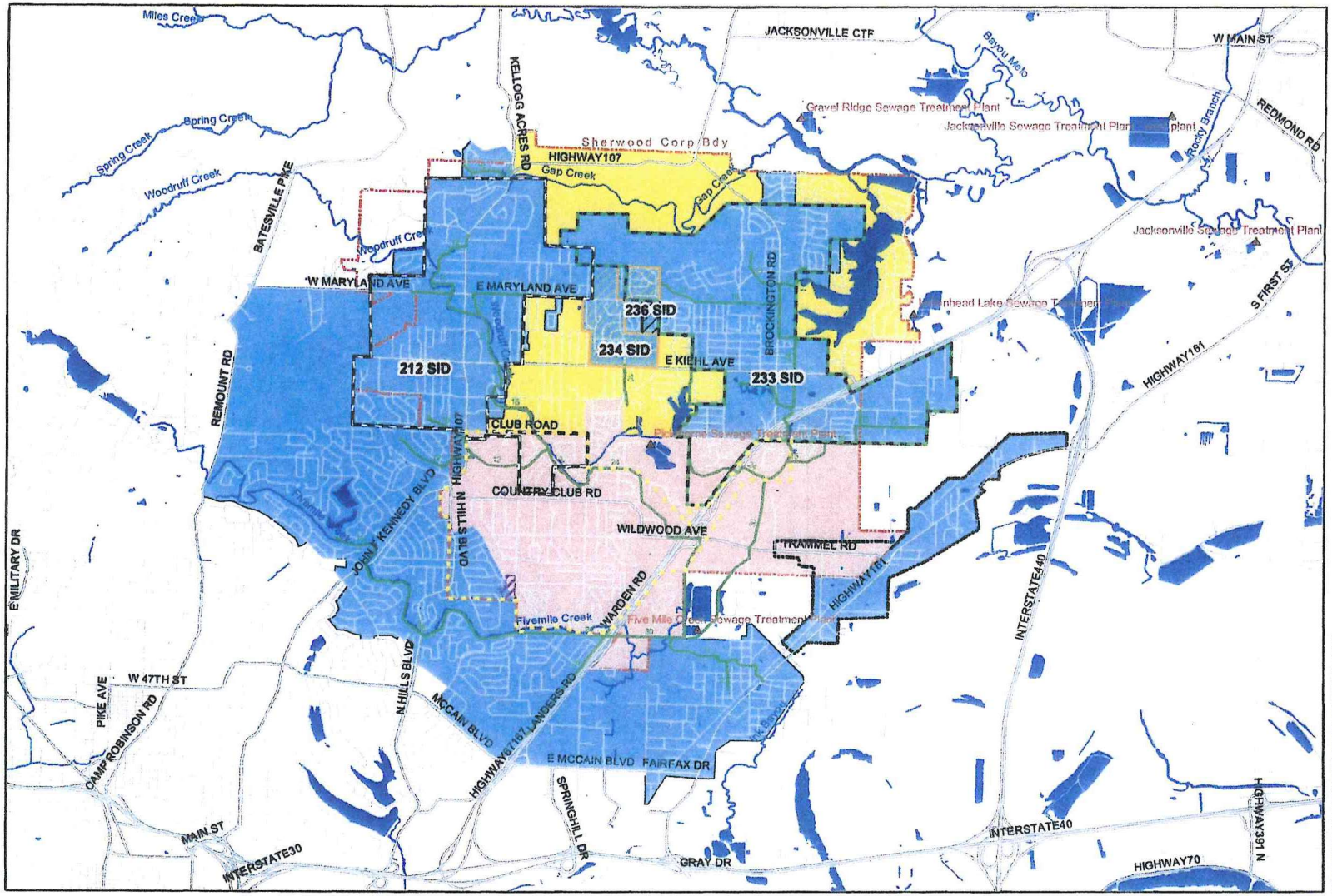


FIGURE 2-1
SHERWOOD CITY LIMITS AND PLANNING AREA

Five Mile Creek Basin
Service Areas



Legend

- Sewage Treatment Plant
- Street Centerline
- Streets - Avenues
- Stream Centerline
- Sewer Interceptors
- SID #212 (Sylvan Hills)
- SID #233 (Clayton Chapel)
- SID #234 (Oakbrooke)
- SID #236 (Holly Hills)
- 1989 Sherwood City Limits
- Rixie SID Boundary
- Old Sherwood (maybe)
- Overbrook Phase 19
- North Little Rock Service Area
- 1989 Court Agreement Boundary
- Sherwood Service
- Stream Edge
- Lake/Pond

The data contained herein was compiled from various sources for the sole use and benefit of the North Little Rock Waste Water Utility. Any use of the data by anyone other than the North Little Rock Waste Water Utility is at the sole risk of the user; and by acceptance of this data, the user does hereby hold the North Little Rock Waste Water Utility and the City of North Little Rock harmless and without liability from any claims, costs, or damages of any nature against the North Little Rock Waste Water Utility and the City of North Little Rock, including cost of defense arising from improper use of the data or use by another party. Acceptance or use of this data is done without any expressed or implied warranties. The geographic data herein was taken from 1997 / 1999 Photography.

0 2,000 4,000 8,000 12,000 16,000 Feet

1 inch equals 4,000 feet

April 22, 2004

drft_5mc_svc_area_shwd_city_lmts_89_crt_agrmt_42204.mxd

Figure 2-2
Wastewater Service Areas

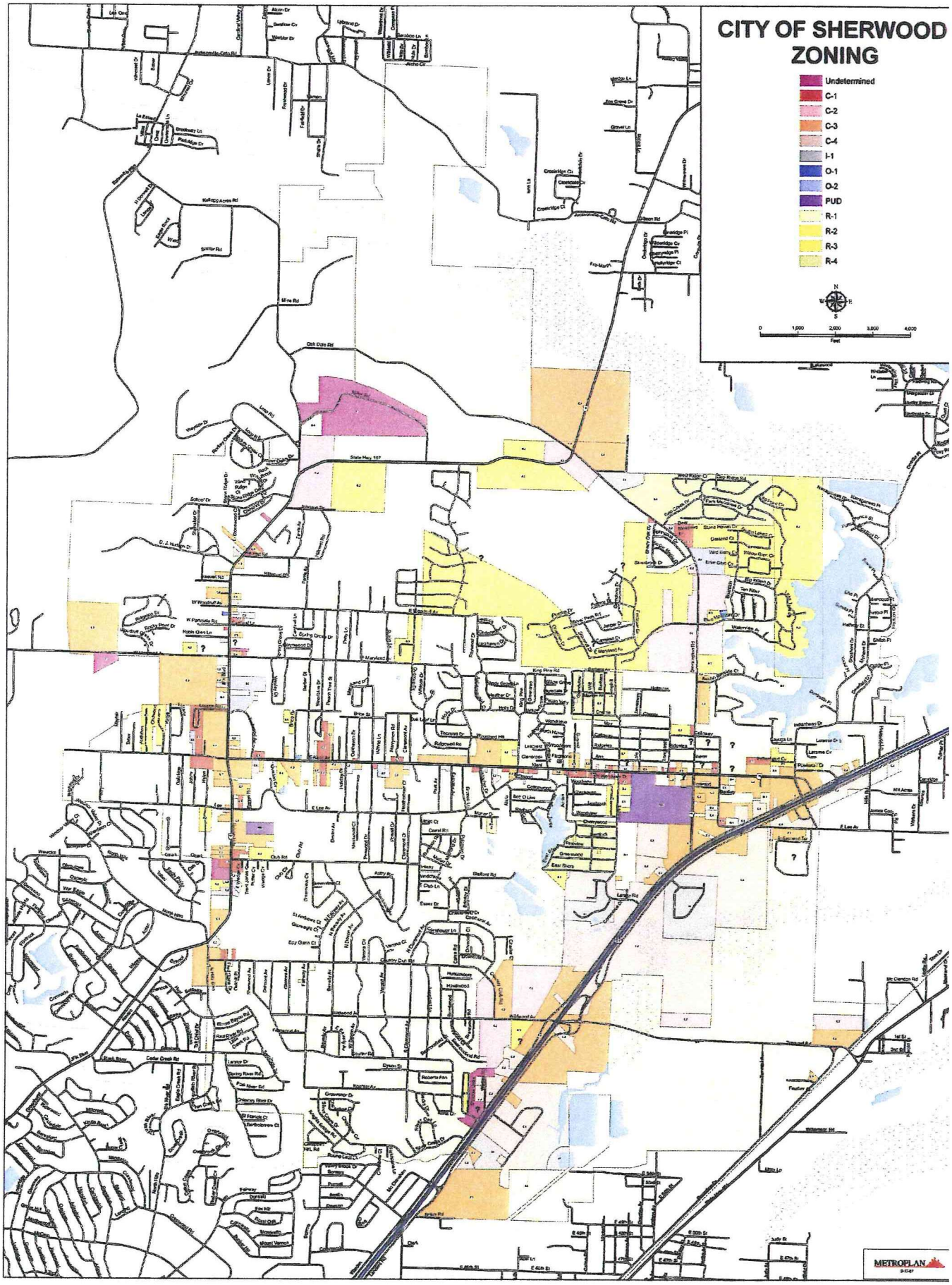


Figure 2-3
Pre-Annexation Zoning Map

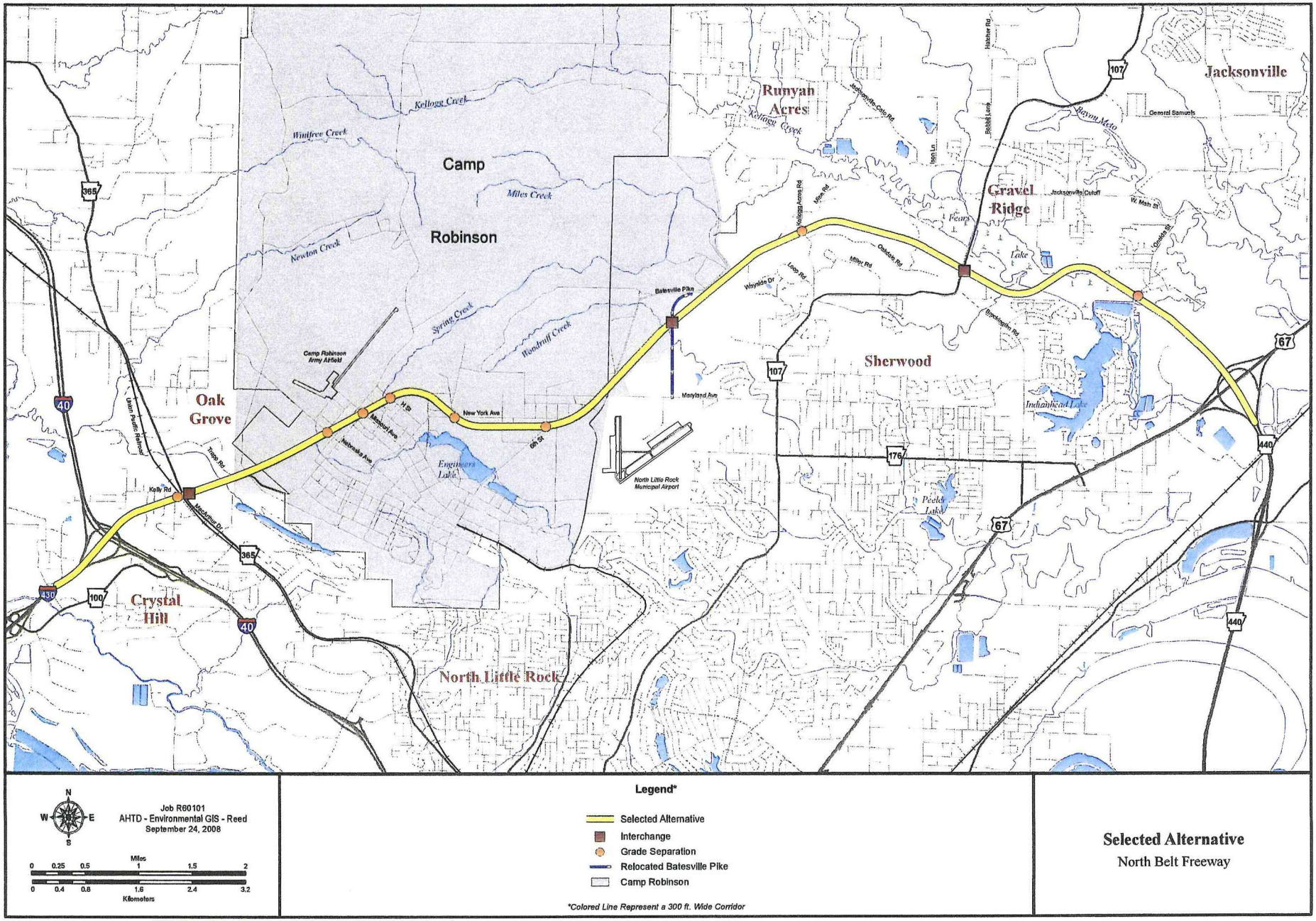


Figure 2-4
Proposed North Belt Freeway Route

small-diameter gravity systems connected to existing gravity sewers by a small wastewater pump station.

State Highway 107 runs generally southwest to northeast through Sherwood, and Highway 67/167 runs generally southwest to northeast through southeast Sherwood. The Arkansas Highway and Transportation Department (AHTD) proposes to construct what is generally referred to as the North Belt Freeway to connect the Highway 67/167–Interstate 40/440 interchange on the east with the Interstate 40/430 interchange on the west. This 13-mile four-lane, divided highway will pass generally through the middle of the Sherwood planning area in an east/west direction along and across the Kellogg Creek floodway. A location map of AHTD's proposed North Belt Freeway is included as Figure 2-4.

Section 3
Population

Population data for the City of Sherwood, as determined by the five most recent U.S. Census Bureau decadal census events, is given in Table 3-1. As can be seen from this historical census data, Sherwood has experienced a continuous, sometimes almost spectacular, increase in population over the five decades of 1950–2000. Sherwood City population more than doubled during the 20 years between 1980–2000. Growth slowed after 1990 with only a 14 percent increase during the 1990–2000 decade. However, Metropolitan Area Planning Commission (Metroplan) estimated the population of Sherwood at the beginning of 2008 to be 25,340. Such a population indicates that Sherwood experienced an 18 percent increase in population over the last eight years. This suggests that Sherwood is once again entering a phase of rapid growth. Because of the quantity of land under limited ownership available for large-scale development in the vicinity, Sherwood should continue to experience rapid growth for some time.

Table 3-1
Census Year Population
Sherwood, Arkansas

Census Year	Population	Change from Previous	
		Population	Percent
1950	717		
1960	1,222	505	70
1970	2,754	1,532	125
1980	10,423	7,669	278
1990	18,893	8,470	81
2000	21,511	2,618	14

These increases in population derive from both annexations and growth. Obviously, such substantial increases in population place a significant burden on municipal services and especially on critical water and wastewater utilities.

For planning purposes, Metroplan has prepared a 20-year population projection (trend) for the Sherwood area with the future area including Gravel Ridge and some land outside the current Sherwood city limit with the likely potential for becoming part of Sherwood within the next 20 years (see Appendix 2). The Metroplan Sherwood area projection is given in Table 3-2. This projection represents an average annual increase of about six percent for the 20-year period of 2010–2030.

Table 3-2
Population Trend (by Metroplan)
Sherwood Area, Arkansas

Year	Population	Change from Previous	
		Population	Percent
2000	30,667		
2010	34,205	3,528	12
2020	36,353	2,148	6
2030	38,501	2,148	6

The population data of Table 3-1 (Sherwood Census Data) and Table 3-2 (Sherwood Area Trend) are plotted against decadal years in Figure 3-1. Figure 3-1 also includes a projection of future Sherwood City population (Sherwood City Projection) based on a least-squares (linear) regression of past six census values. The resulting future population at five-year intervals is given in Table 3-3. Table 3-3 also gives a column where the estimated 2009 Gravel Ridge population of 3,232 is added to the census-based projection. This data (Projection + Gravel Ridge) is also plotted in Figure 3-1.

It should be noted that the resulting 2029 total population value of 37,889 agrees reasonably well with the Metroplan projected 2030 Sherwood area population of 38,501. This seems reasonable since the land area corresponding to the projection of Table 3-3 approaches the area included in the Metroplan projection as the Sherwood area population increases through annexation as well as internal growth. The population values listed in Table 3-3 as "Total" are those selected for purposes of this planning effort.

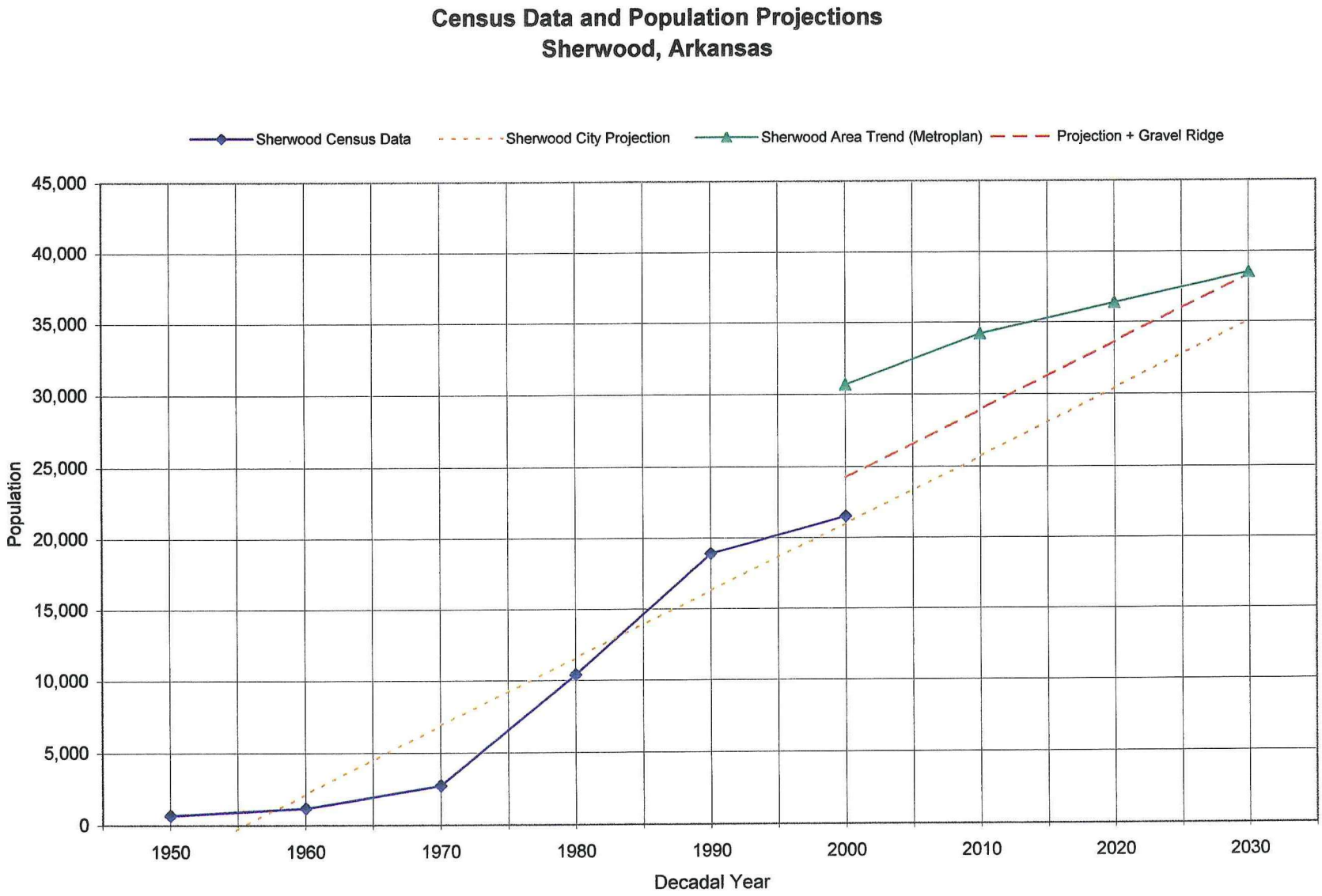

Census Data and Population Projections
Sherwood, Arkansas
Sherwood Census Data
Sherwood City Projection
Sherwood Area Trend (Metroplan)
Projection + Gravel Ridge
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Population
1950
1960
1970
1980
1990
2000
2010
2020
2030
Decadal Year

Figure 3-1

Table 3-3
Planning Area Population
Sherwood, Arkansas

Year	Population	Gravel Ridge	Total
2009	25,248	3,232	28,480
2014	27,600	3,232	30,832
2019	29,952	3,232	33,184
2024	32,305	3,232	35,537
2029	34,657	3,232	37,889

Section 4
Wastewater Quantity and Character

Flow Rates

As they are fundamental to hydraulic design of the various collection, pumping, and treatment facilities, flow rates of the Sherwood wastewater system must be determined as part of the planning effort. Generally, maximum flow rates are used for hydraulic design, while lesser rates are used for process design, but unit treatment processes must still be sized to convey plant maximum flow rates to prevent hydraulic overloading. Five rate categories (including both flow and pollutant loading rates) are considered important in the evaluation and design of wastewater and sludge treatment facilities: annual average (AA); maximum month (MM); maximum week (MW); maximum day (MD); and maximum hour (MH). The annual average rate is the average annual wastewater flow rate to be expected during a given design year. The annual average rate is largely statistical in nature and is generally used in design only as the basis from which to calculate critical design rates; for example, maximum rates (month, week, day, or hour) are typically calculated by applying a "peaking factor" to the annual average rate, and it is these maximum rates that actually determine the required size or capacity of the various components of wastewater facilities. Usually, maximum hourly (or greater) rates dictate pumping requirements, maximum daily and hourly rates dictate plant hydraulics, while maximum monthly and weekly rates govern biological process design and size sludge handling facilities.

Wastewater from customers of the Sherwood wastewater system is currently tributary to one of the following wastewater treatment plants: Sherwood's North Wastewater Treatment Plant (formerly the Indianhead Lake plant); Sherwood's South Wastewater Treatment Plant (formerly the Pickthorn plant); or North Little Rock Waste Water Utility's Five-Mile Creek Wastewater Treatment Plant.

In 1989-1990, a settlement decision of the First Division Chancery Court of Pulaski County (the Court Order), stemming from a lawsuit between the City of Sherwood (through its Sewer Committee) and the City of North Little Rock (through its Waste Water Utility), defined three categories of sewer customers within the City of Sherwood and whose wastewater is tributary to the Five-Mile Creek Plant: Sherwood customers (also sometimes referred to as "Old" Sherwood customers) are those defined as being within a certain land area, the legal description of which is included in the Court Order; District customers are defined as being customers

connected to sewer lines leading to the Five-Mile Creek plant that are within Sewer Improvement Districts 212 (Sylvan Hills), 233 (Clayton Chapel), 234 (Oakbrooke), or 236 (Holly Hills), but are not Sherwood customers as defined above; and, finally, North Little Rock customers are those sewer customers within the City of Sherwood whose service line connects to any sewers leading to the Five-Mile Creek plant or any other North Little Rock sewer system facilities and are not Sherwood or District customers as described above. Salient excerpts from the Court Order are included as Appendix 3 to this Report.

Flow rates for these wastewater sources were developed for planning purposes as follows:

North Wastewater Treatment Plant

Since influent flow rates for the North Wastewater Treatment Plant (North Plant) are not measured and recorded on a continuous basis, but effluent rates are measured and totalized, effluent rates were used as a guide for developing North Plant flow rates and peaking factors for future planning. Average month and maximum day wastewater effluent flow rates for the 12 months of 2007 and the first 11 months of 2008 are shown for the Sherwood North Plant in Figure 4-1 along with corresponding total monthly precipitation as recorded at the North Little Rock Meteorological Station of the National Weather Service.

It should be noted that the total precipitation recorded at the North Little Rock station for 2007 was 49.05 inches, or only 0.14 inches below normal. This makes 2007, on the average, very near normal in precipitation; consequently, it may be concluded that 2007 wastewater flow rates, with respect to rainfall induced infiltration and inflow, are approximately normal. The total precipitation recorded for 2008 was 51.93 inches, or 2.74 inches above normal. This makes 2008, on the average, slightly above normal in precipitation; consequently, it may be concluded that 2008 wastewater flow rates may be slightly above normal with respect to rainfall induced infiltration and inflow. The use of combined 2007 and 2008 wastewater flow rate data should produce slightly conservative planning data.

The annual average, maximum month, and maximum day 2007 and 2008 wastewater effluent flow rate data, along with calculated peaking factors, for the North Plant is given in Table 4-1. The complete data set for the North Plant, as taken from monthly Discharge Monitoring Reports (DMRs), is included in Appendix 4 to this Report.

Average Monthly and Maximum Day Effluent Flow Rates and Precipitation
North Wastewater Treatment Plant
Sherwood, Arkansas

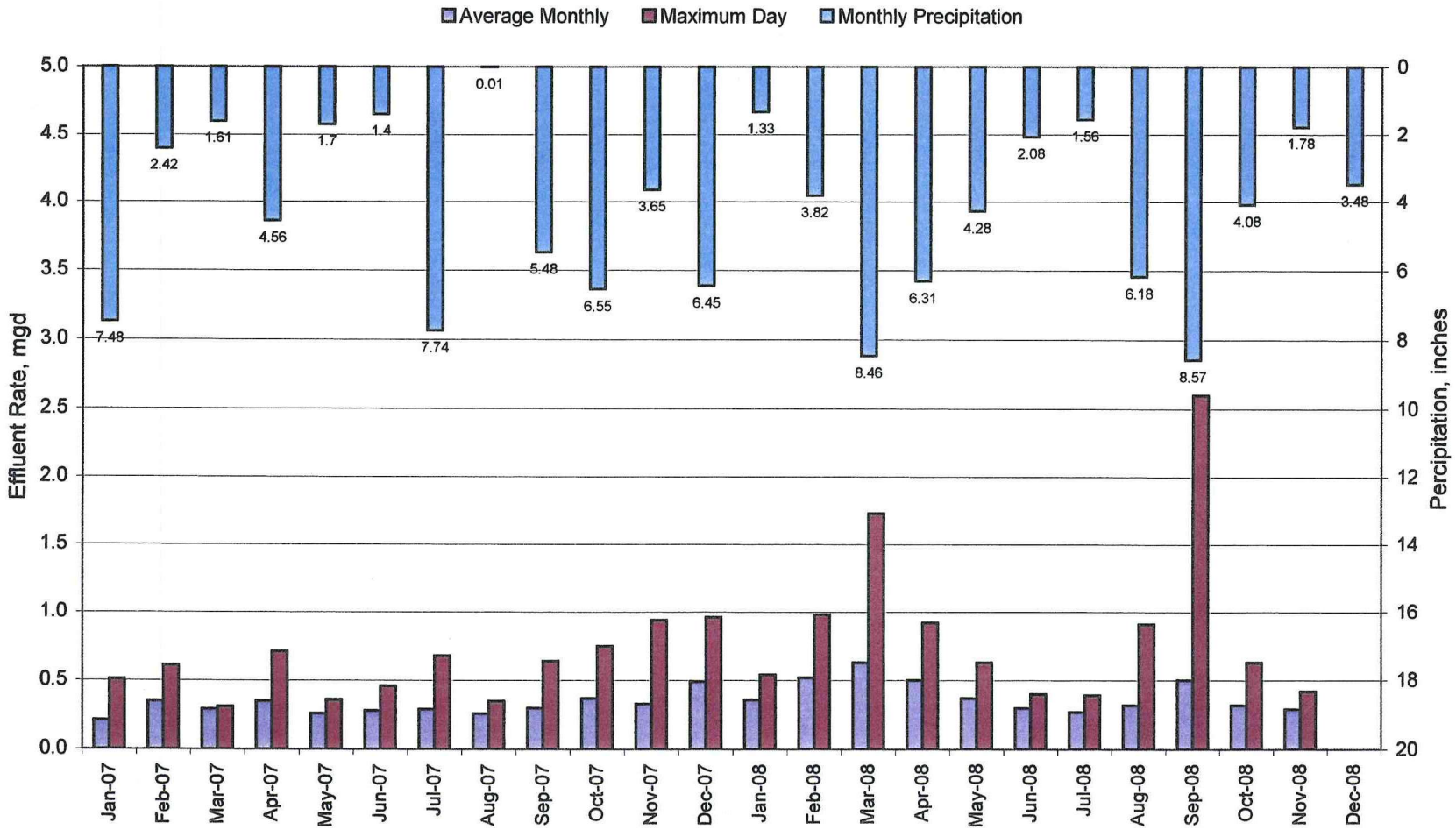


Figure 4-1

Table 4-1
Annual Average, Maximum Month, and Maximum Day Effluent Flow Data for 2007 and 2008
North Wastewater Treatment Plant – Sherwood, Arkansas

Rate	2007		2008	
	Value, mgd	PF	Value, mgd	PF
Average Annual (AA)	0.32		0.40	
Maximum Month (MM)	0.49	1.53	0.63	1.58
Maximum Day (MD)	0.96	3.00	1.73	4.32

The maximum day effluent rate value of 2.60 million gallons per day (mgd) for the month of September, 2008 (See Appendix 4) was discarded from the data set in favor of using the next lower maximum day value of 1.73 mgd as reported for March, 2008. Use of the September, 2008 maximum day rate results in a maximum day peaking factor (PF) of 6.50, which is much larger than it should be based on the data as a whole, and this flow rate value is likely an outlier. It is felt that the September, 2008 maximum day value is likely attributable to the passage of a hurricane remnant through the area and may be considered to be an extreme event. It is also noted that the North Plant flow data is effluent and not influent; as such, the rates shown may be somewhat attenuated owning to the fill-and-draw nature of the treatment process and the storage afforded by the process itself. The average of the 2007-2008 flow rate values of Table 4-1 are given in Table 4-2.

In a study by Munksgaard and Young (1), peak flow rate conditions at several municipal wastewater treatment plants were documented, and equations were developed to relate peak flow rates for various flow-rate categories to average annual flow rates. The column in Table 4-2 with the heading "M & Y" gives peak-to-average rate ratios calculated from the Mundsgaard and Young equations using an average annual rate of 0.36 mgd.

A comparison of actual North Plant flow-rate peaking factors with corresponding factors calculated from the M & Y equations shows general agreement. It follows, therefore, that the "M & Y" equations may be used to help select North Plant flow-rate peaking factors for planning purposes. This is especially true for rate categories, such as maximum hourly, for which actual data is not readily available. The peaking factors given in Table 4-2 under the column heading "PF Selected for Planning" are those selected for predicting future wastewater flow rates for purposes of this planning effort.

Table 4-2
2007 and 2008 Wastewater Effluent Flow Rate Data
North Wastewater Treatment Plant – Sherwood, Arkansas

Rate	Average 2007-2008 Value		M & Y[1] PF	PF Selected for Planning
	Value, mgd	PF		
Average Annual (AA)	0.36			
Maximum Month (MM)	0.56	1.56	1.27 - 1.74	1.6
Maximum Week (MW)	0.65			1.8
Maximum Day (MD)	1.34	3.72	2.03 - 3.41	3.7

1. After Munksgaard and Young (1).

The actual flow rate data suggest that the sewer system tributary to the North Plant may be subject to excessive, rainfall-induced flow rates. As of this writing, Sherwood is in the process of performing an extensive sewer system evaluation survey that should identify sewer system defects leading to such excessive flow rates. This Master Plan assumes that sewer system rehabilitation arising from the evaluation survey results will repair system defects such that future peaking factors will not stray significantly above "typical" values.

South Wastewater Treatment Plant

As is the case with the North Plant, influent flow rates for the South Wastewater Treatment Plant (South Plant) are not measured and totalized; therefore, historical effluent flow rates will be used as a guide for selecting South Plant peaking factors for future planning. Average monthly and maximum day wastewater flow rates for the 12 months of 2007 and the first 11 months of 2008 are shown for the South Plant in Figure 4-2, along with corresponding total monthly precipitation as recorded at the North Little Rock meteorological station. The annual average, maximum month, and maximum day 2007 and 2008 wastewater effluent flow rate data, along with calculated peaking factors for the South Plant, are given in Table 4-3.

Average Monthly and Maximum Day Effluent Flow Rates and Precipitation
South Wastewater Treatment Plant
Sherwood, Arkansas

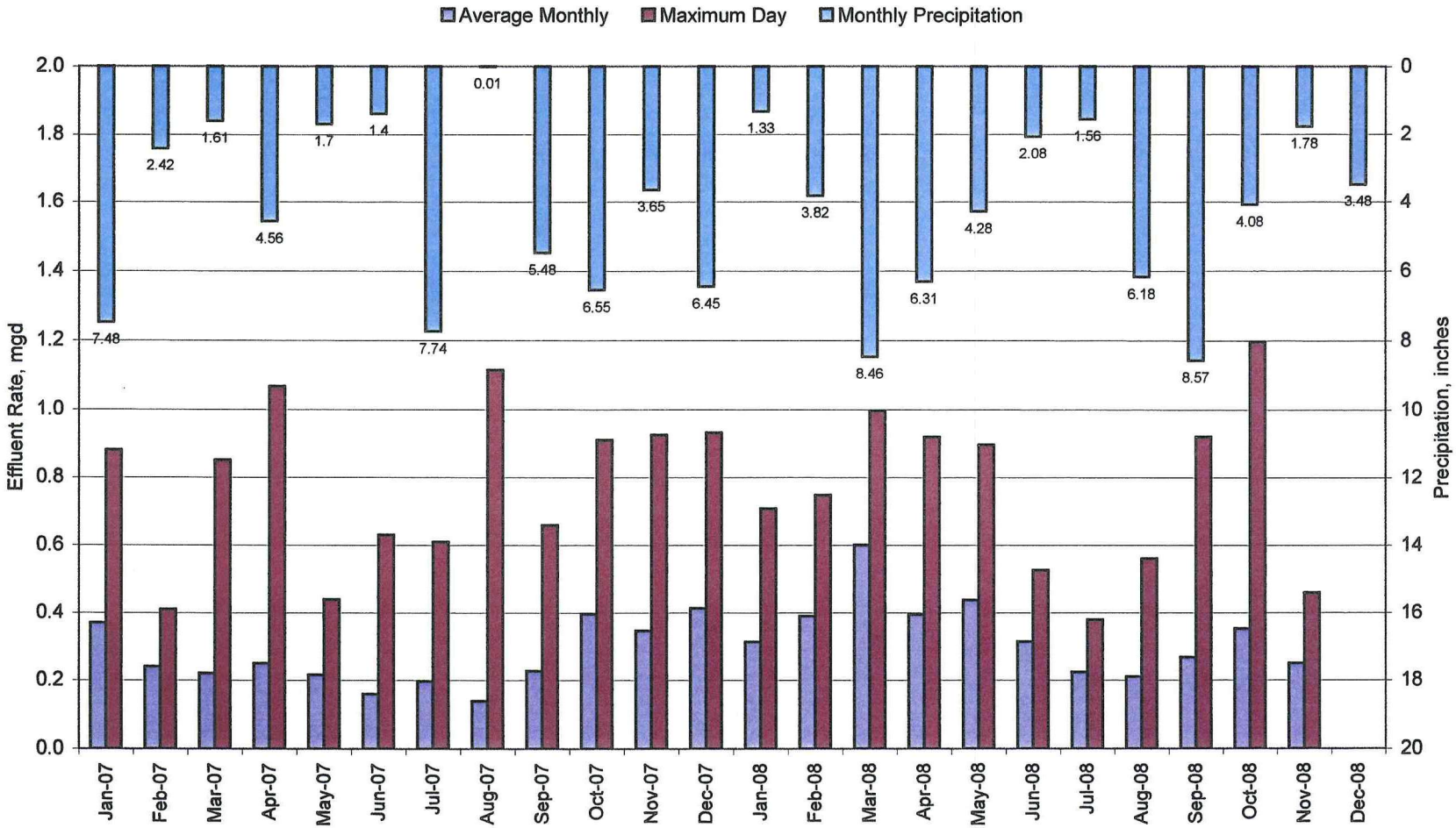


Figure 4-2

Table 4-3
Annual Average, Maximum Month, and Maximum Day Effluent Flow Data for 2007 and 2008
South Wastewater Treatment Plant – Sherwood, Arkansas

Rate	2007		2008	
	Value, mgd	PF	Value, mgd	PF
Average Annual (AA)	0.26		0.34	
Maximum Month (MM)	0.41	1.58	0.60	1.76
Maximum Day (MD)	1.12	4.31	1.20	3.53

The average of the 2007 and 2008 flow rate values of Table 4-3 are given in Table 4-4.

Table 4-4
2007 and 2008 Wastewater Effluent Flow Rate Data
South Wastewater Treatment Plant – Sherwood, Arkansas

Rate	Average 2007-2008 Value		M & Y[1] PF	PF Selected for Planning
	Value, mgd	PF		
Average Annual (AA)	0.30			
Maximum Month (MM)	0.50	1.67	1.28 - 1.75	1.7
Maximum Week (MW)	0.57			1.9
Maximum Day (MD)	1.18	3.92	2.05 - 3.46	3.9

1. After Munksgaard and Young (1).

A comparison of actual South Plant flow-rate peaking factors with corresponding factors calculated from the "M & Y" equations shows some general agreement. It follows, therefore, that the "M & Y" equations may be used to help select South Plant flow-rate peaking factors for planning purposes. This is especially true for rate categories, such as maximum hourly, for which actual data is not readily available. The peaking factors given in Table 4-4 under the column heading "PF Selected for Planning" are those selected for predicting future wastewater flow rates for purposes of this Master Plan.

Five-Mile Creek Wastewater Treatment Plant

Five-Mile Creek Wastewater Treatment Plant (Five-Mile Creek Plant) monthly average influent and effluent wastewater flow rates, along with total monthly precipitation, are shown for the period 2007 through 2008 as Figure 4-3. As can be seen, the effluent flow rate is typically greater than the influent rate, and both rates appear exhibit some relation to precipitation. The higher effluent rates may result from precipitation directly on the surface of the Five-Mile Creek Plant treatment units. Note that the influent and effluent rates were the same at 2.77 mgd for August, 2007, which was an extremely dry month with a total precipitation of only 0.01 inches. Monthly average and maximum day influent flow rates are shown along with total monthly precipitation for the period 2007 and 2008 in Figure 4-4

.

The Five-Mile Creek plant annual average, maximum month, and maximum day 2007 and 2008 influent flow rates, along with calculated peaking factors, are given in Table 4-5.

Table 4-5
Annual Average, Maximum Month, and Maximum Influent Day Flow Data for 2007 and 2008
Five-Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas

Influent Rate	2007		2008	
	Value, mgd	PF	Value, mgd	PF
Average Annual (AA)	4.18		4.12	
Maximum Month (MM)	7.31	1.75	6.83	1.66
Maximum Day (MD)	13.97	3.34	12.60	3.06

The average of the 2007 and 2008 flow rate values of Table 4-5 are given in Table 4-6 along with corresponding peaking factors calculated from the "M & Y" equations. A comparison shows that actual, calculated Five-Mile Creek plant peaking factors are somewhat higher than those derived from the "M & Y" equations for an annual average flow rate of 4.15 mgd.

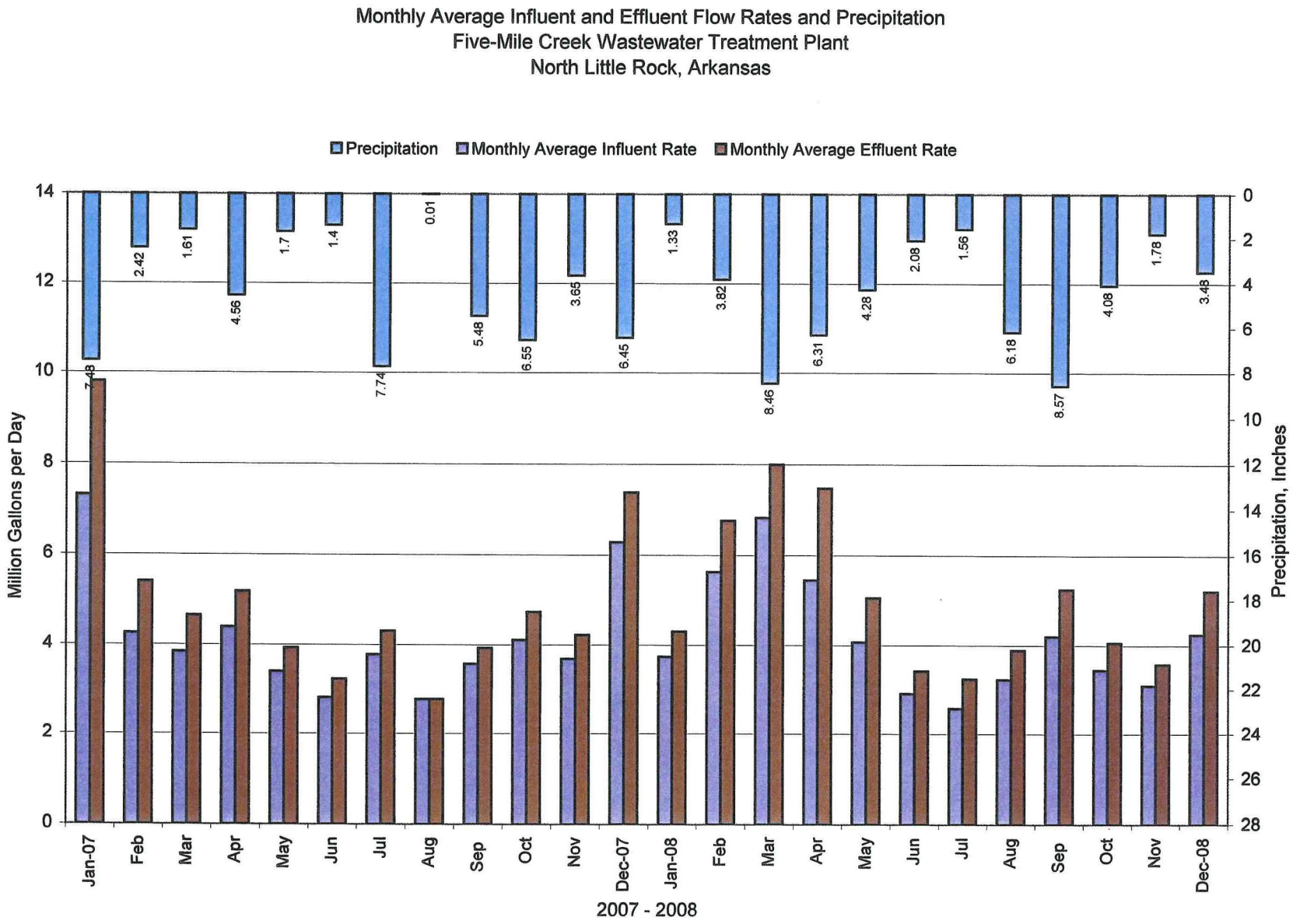

Monthly Average Influent and Effluent Flow Rates and Precipitation
Five-Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas
Precipitation
Monthly Average Influent Rate
Monthly Average Effluent Rate
Million Gallons per Day
Precipitation, Inches
2007 - 2008
Jan-07
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec-07
Jan-08
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec-08
2.42
1.61
4.56
1.7
1.4
7.74
0.01
5.48
6.55
3.65
6.45
1.33
3.82
8.46
6.31
4.28
2.08
1.56
6.18
8.57
4.08
1.78
3.48

Figure 4-3

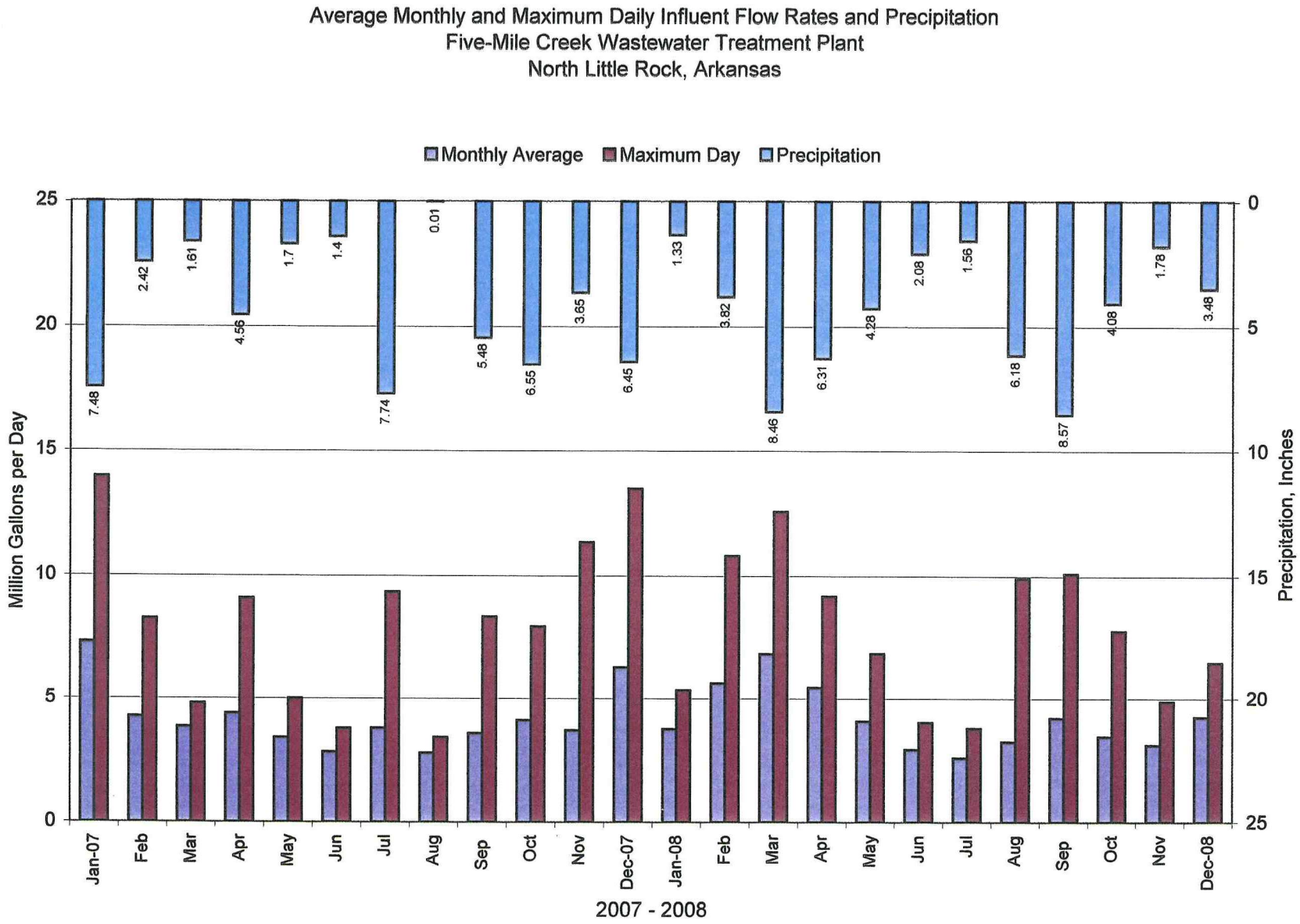

Average Monthly and Maximum Daily Influent Flow Rates and Precipitation
Five-Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas
Monthly Average
Maximum Day
Precipitation
Million Gallons per Day
Precipitation, Inches
2007 - 2008
Jan-07
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec-07
Jan-08
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec-08
7.48
2.42
1.61
4.56
1.7
1.4
7.74
0.01
5.48
6.55
3.65
6.45
1.33
3.82
8.46
6.31
4.28
2.08
1.56
6.18
8.57
4.08
1.78
3.48

Figure 4-4

Table 4-6
2007 and 2008 Wastewater Influent Flow Rate Data
Five-Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas

Influent Rate	Average 2007-2008 Value		M & Y[1] PF
	Value, mgd	PF	
Average Annual (AA)	4.15		
Maximum Month (MM)	7.07	1.70	1.24 - 1.53
Maximum Day (MD)	13.28	3.20	1.86 - 2.76

1. After Munksgaard and Young (1).

The Five-Mile Creek Plant influent flow rate derives from three categories of customers defined in the Court Order, namely, Sherwood customers, District customers, and North Little Rock customers. North Little Rock Waste Water Utility prorates Five-Mile Creek plant costs between customer categories according to water billed by Central Arkansas Water (CAW) to each customer category. Table 4-7 presents a summary of such billing for the years 2007 and 2008. This proration method assumes that wastewater is contributed to the Five-Mile Creek Plant in the same proportion as drinking water is billed by CAW. Since the wastewater of these three Five-Mile Creek plant customer categories is not measured separately, for planing purposes, the percentage that each customer class is billed by North Little Rock Waste Water Utility will be used to estimate the wastewater flow rate attributed by each customer category. This estimate is given in Table 4-8. Again, for planning purposes, the peaking factors for the Five-mile Creek Plant (as a whole) and given in Table 4-5 were used to estimate maximum wastewater flow rates for each customer category as given in Table 4-7.

Using the customer-based percentages of Table 4-7, the Sherwood customer category flow rate to the Five-Mile Creek Plant may be estimated as given in Table 4-8.

Table 4-7
Customers, Water Consumption, and Contribution by Customer Category for 2007-2008
Five-Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas

Five-Mile Creek Plant Customer Category	Average Number of Customers		Water Billed, Gallons per Customer per Month		Percent of Five-Mile Creek Plant Total	
	2007	2008	2007	2008	2007	2008
NLR	3,967	3,885	9,172	9,087	43.10	41.63
Sherwood	2,331	2,386	6,663	6,855	18.38	19.29
District	6,120	6,375	5,310	5,195	38.51	39.09

Table 4-8
Total Plant Influent Flow Rates and Sherwood Customer Component
Five-Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas

Total for Five-Mile Creek Plant			"Sherwood" Customer Category	
Influent Rate	Value, mgd	PF	2-Year Avg %	Value, mgd
AA	4.15		18.75	0.78
MM	7.07	1.7		1.33
MD	13.28	3.2		2.49

According to 2000 census data and information provided by Metroplan, the average Sherwood household size is 2.42 persons. If this size is also taken to be the sewer customer size, the average annual per capita Sherwood wastewater contribution to the Five-Mile Creek Plant may be calculated as follows:

$$\textit{Average Number of Customers} = \frac{(2{,}331 + 2{,}386)}{2} = 2{,}358$$

$$\textit{Average annual per capita wastewater rate} = \frac{780{,}000}{2{,}358 \times 2.42} = 137 \text{ gpcd } \textbf{(use 140)}$$

Loadings

Historical influent wastewater quality in the form of five-day biochemical oxygen demand (BOD5), total suspended solids (TSS), and ammonia nitrogen (NH3-N) concentrations is not available for the North or South Sherwood wastewater treatment plants; however, such influent data is available for the Five-Mile Creek Plant. Influent pollutant loading data for the Five-Mile Creek Plant for the years 2007 - 2008 is given in Table 4-9.

Table 4-9
Annual Average Influent Flow Rate and Pollutant Loading Data
Five-Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas

Year	Flow Rate, mgd	BOD5		TSS		NH3-N	
		mg/L	lbs/day	mg/L	lbs/day	mg/L	lbs/day
2007	4.18	159	5,543	148	5,159	17	593
2008	4.12	163	5,601	157	5,395	19	653
Average	4.15	161	5,572	152	5,277	18	23

The average Five-Mile Creek Plant influent pollutant loadings are related to customers on a per capita basis in Table 4-10.

Table 4-10
Average Pollutant Loading Rates
Five-Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas

Pollutant	lbs/day	Customers	Household Size (persons/customer)	lbs/capita/day	Ten-States Standards[1] lbs/capita/day
BOD5	5,572	12,532	2.42	0.184	0.17 - 0.22
TSS	5,277			0.174	0.20 - 0.22
NH3-N	623			0.021	

1. After Reference (2).

Table 4-10 also includes a column giving BOD5 and TSS unit (per capita) loadings recommended by Ten-States Standards (2) for design of domestic wastewater treatment facilities. As can be seen, the calculated Five-Mile Creek Plant unit BOD5 loading value of 0.184 pounds per capita per day is in general agreement with the Ten-States Standards value range, while the calculated TSS unit loading rate is somewhat less that the Ten States Standards value range. The BOD5-to-NH3-N ratio for the calculated Five-Mile Creek plant unit loadings is 8.8. This ratio compares favorably with similar calculations using values found in the literature (4). Based on the limited availability of site-specific information and the reasonable agreement of available information with published typical values, the unit pollutant loadings (pounds per capita per day, ppcd) given in Table 4-11 are selected for planning purposes. Table 4-11 also gives peaking factors as derived from Reference (1).

Table 4-11
Unit Wastewater Pollutant Loading Rates and Peaking Factors Selected for Planning
Sherwood, Arkansas

Rate	BOD5		TSS		NH3-N	
	ppcd	PF[1]	ppcd	PF[1]	ppcd	PF[1]
AA	0.184	--	0.200	--	0.021	--
MM	0.276	1.5	0.320	1.6	0.032	1.5
MW	0.368	2.0	0.500	2.5	0.038	1.8
MD	0.497	2.7	0.900	4.5	0.048	2.3

1. After Reference (1).

Section 5
Existing Wastewater Treatment

Sherwood wastewater is treated in three different wastewater treatment plants: the North Plant, the South plant, and the North Little Rock Five-Mile Creek Plant. Sherwood residents whose wastewater is treated in the Five-Mile Creek Plant may be sub-divided into three classes of customers as defined in the Court Order: Sherwood customers, District customers, and North Little Rock customers. The estimated distribution of Sherwood residents within these customer classes for 2008 is given in Table 5-1.

Table 5-1
Distribution of 2008 Sewer Customers by Class and Treatment Plant
Sherwood, Arkansas

Plant	Customer Class	Customers	Estimated Population	Percent of Total
North	Sherwood	1,054	2,551	10
South		1,460	3,533	14
Five-Mile Creek	Sherwood	2,386	5,774	23
	District	5,571	13,482	53
Total		10,471	25,340	100

As can be seen from Table 5-1, it is estimated that about 76 percent of Sherwood residents who are sewer users are served by North Little Rock's Five-Mile Creek wastewater treatment plant, leaving about 24 percent to be served by the two treatment plants owned and operated by Sherwood.

North Plant

What is now the Sherwood North Plant was first permitted in 1977 as the wastewater treatment facility for the Indianhead Lake sewer improvement district. The City of Sherwood assumed control of this facility in 1996, and an improvements project was completed in 1997.

This 1997 project converted the plant to a secondary (biological) treatment plant with the addition of an influent pump station with equalization basin; headworks with manual bar screen, mechanical bar screen, and screenings conveyor; a two-basin sequencing batch reactor (SBR); post-aeration basin; ultraviolet effluent disinfection facility; and effluent flow-rate measurement flume. The effluent receiving stream is an unnamed tributary of Kellogg Creek. Excess sludge from the biological reactor is wasted to an adjacent sludge lagoon.

The average design flow rate of the 1997 plant is reported to be 0.35 million gallons per day (mgd) with a maximum rate peaking factor of 1.71. The design effluent characteristics for the 1997 improvements project plant are reported to be 10/15/5, milligrams per liter (mg/L), five-day biochemical oxygen demand (BOD5), total suspended solids (TSS), and ammonia nitrogen (NH3-N), respectively.

The North Plant was upgraded in 2004 with the addition of a second headworks facility with manual bar screen, mechanical bar screen, screenings washer–compactor, influent flow-measuring flume, grit trap and grit classifier; two-basin SBR: post-aeration basin; ultraviolet effluent disinfection facility; and effluent flow-rate measurement flume. Upon completion of this upgrade, the headworks, SBR, post-aeration, and effluent flume installed in the 1997 project were removed from service. Excess biological sludge from the 2004-project SBR is wasted to the existing sludge lagoon.

The average design flow rate for the 2004 upgrade is reported to be 0.83 mgd with a maximum rate peaking factor of 3.17. Design effluent characteristics for this 2004 upgrade are reported to be 10/15, mg/L, BOD5 and TSS, respectively. An aerial view of the North Plant is included as Figure 5-1. As it turns out, this aerial photo was taken during construction of the 2004 upgrade project. A plant flow sheet is included as Figure 5-2.

Permit

The North Plant is operated under the authority of National Pollutant Discharge Elimination System (NPDES) permit AR0037176 as issued by the Arkansas Department of Environmental Quality (ADEQ). This permit has a effective date of February 1, 2007 and an expiration date of January 31, 2012. The effluent limitations included in this permit are given in Table 5-2.

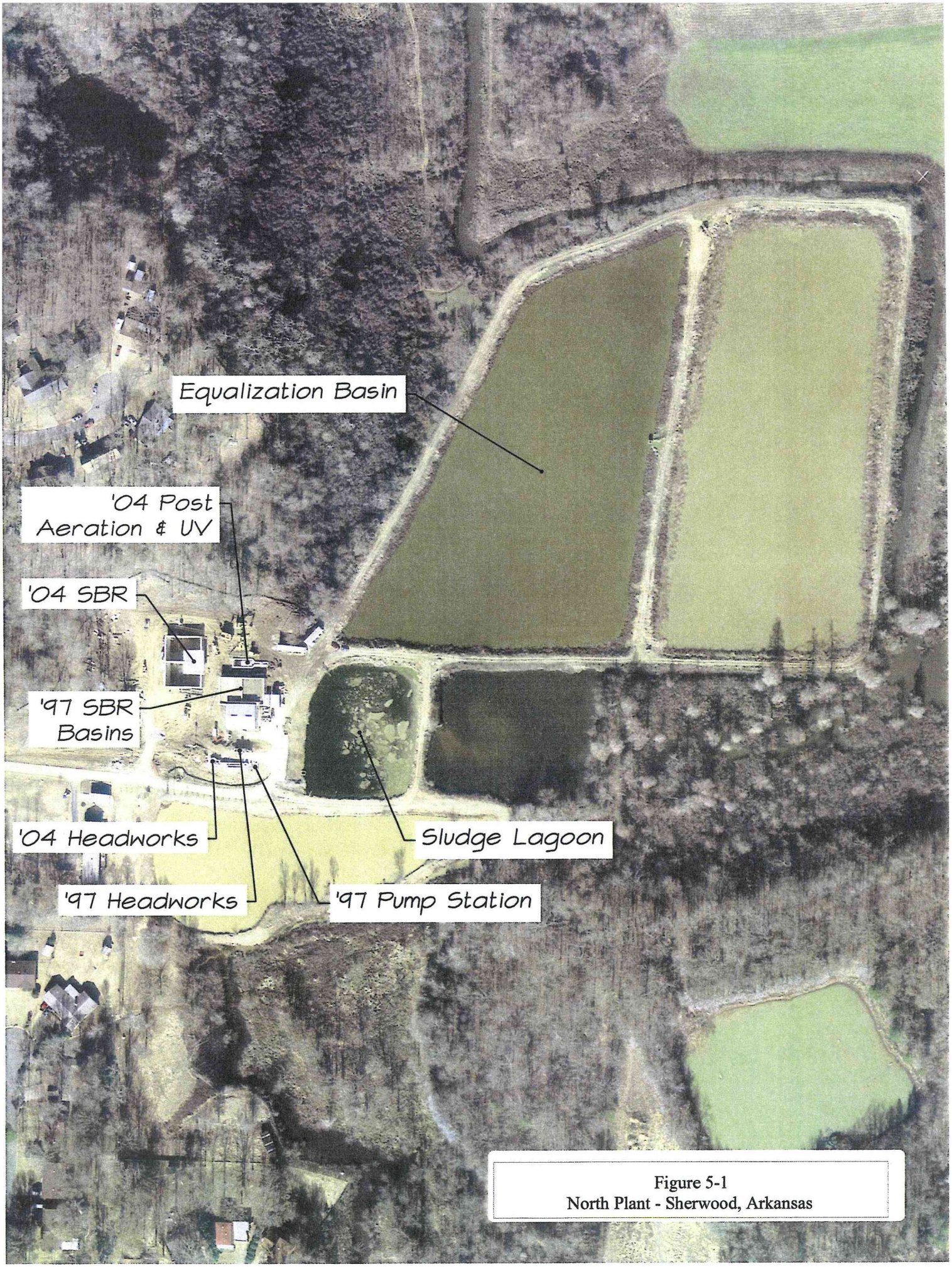
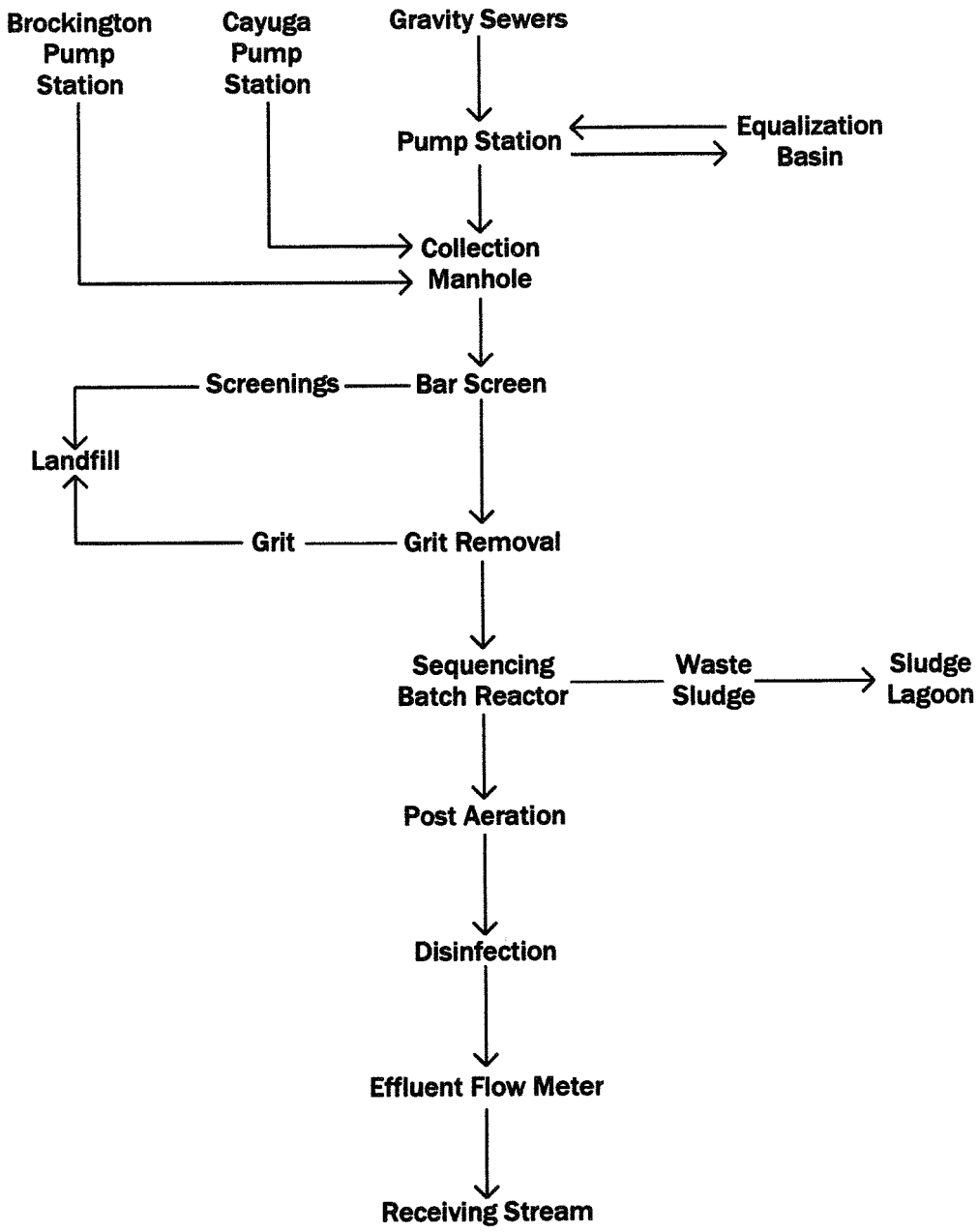


Figure 5-1
North Plant - Sherwood, Arkansas



NORTH PLANT FLOW SHEET
SHERWOOD, ARKANSAS

Figure 5-2

Table 5-2
Effluent Limitations
NPDES Permit Number AR0037176-North Wastewater Treatment Facility
Sherwood, Arkansas

Effluent Characteristics		Discharge Limitations			
		Monthly Average		7-day Average	Other
Carbonaceous 5-day BOD		15 mg/L	147 lbs/day	22.5 mg/L	
Total Suspended Solids		20 mg/L	196 lbs/day	30 mg/L	
Ammonia Nitrogen	Apr – Oct	2.2 mg/L	21.6 lbs/day	5.6 mg/L	
	Nov – Mar	5.0 mg/L	49.0 lbs/day	7.5 mg/L	
Fecal Coliform Bacteria, geo mean		1000/100 ml		2000/100 ml	
Dissolved Oxygen, monthly average minimum					5.0 mg/L
Chronic Biomonitoring					once/quarter
pH					≥6.0≤9.0
Flow					Report

Performance

The average monthly and maximum day effluent flow rates for the North Plant as taken from the discharge monitoring reports (DMRs) are shown along with total monthly precipitation as recorded at the North Little Rock Meteorological Station of the National Weather Service for the period 2007–2008 in Figure 5-3. Note that the largest maximum day effluent rate shown for the 2007–2008 period was 2.60 mgd occurring during the month of September, 2008; note also that this maximum day rate essentially equals the plant peak design rate of 2.63 mgd.

Plant average 30-day and average 7-day effluent BOD5 concentrations, as taken from DMRs, are shown along with permit limits for the period January, 2007–November, 2008 in Figure 5-4. As can be seen, the plant met permit effluent BOD5 requirements for the period covered. Plant average 30-day and average 7-day effluent TSS concentrations, as taken from DMRs, are shown along with permit limits for the period January, 2007–November, 2008 in Figure 5-5. As can be seen, the plant met permit effluent TSS requirements for the period covered.

Average Monthly and Maximum Day Effluent Flow Rates and Precipitation
North Wastewater Treatment Plant
Sherwood, Arkansas

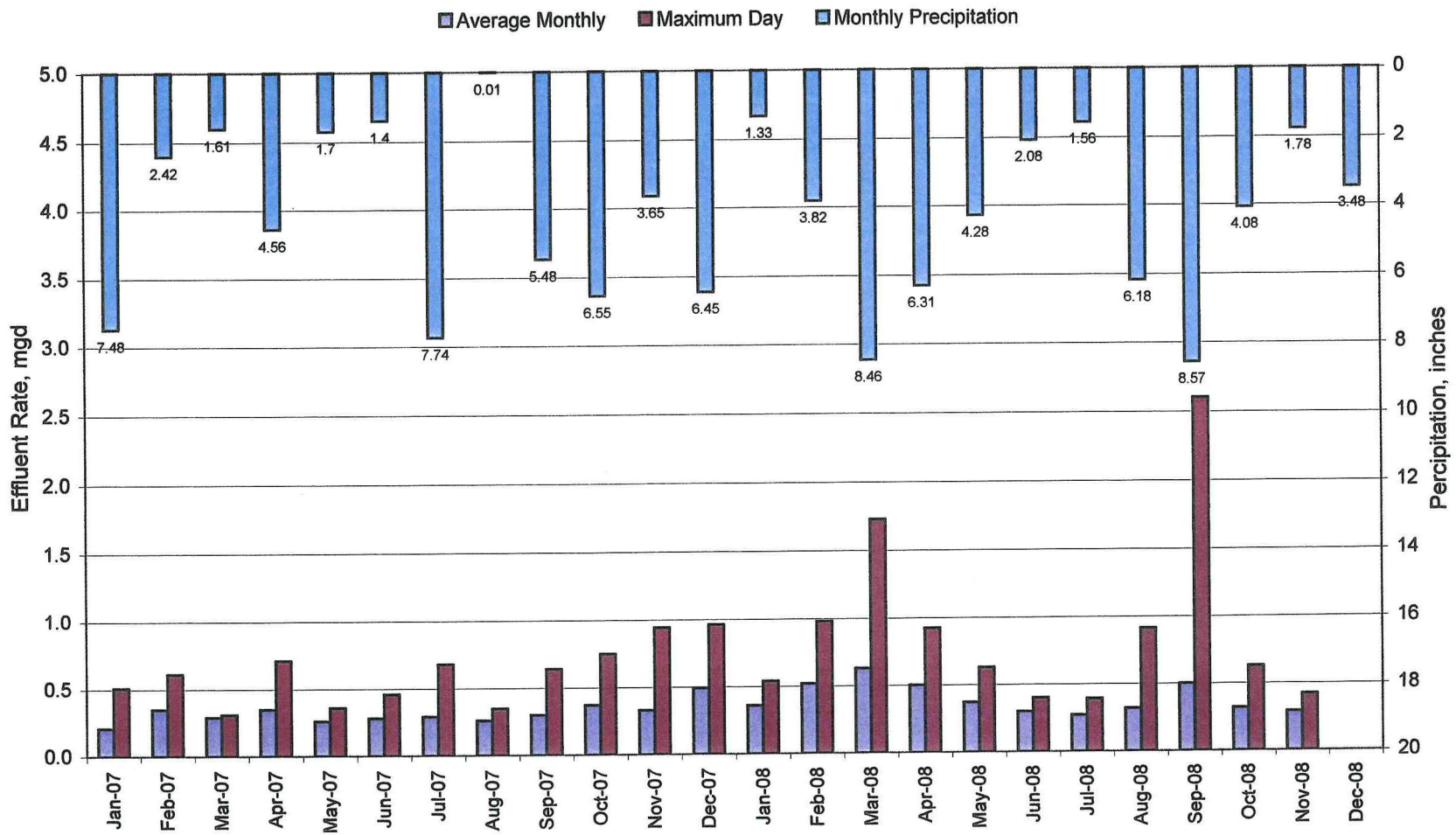


Figure 5-3

Effluent Five-Day Biochemical Oxygen Demand
North Wastewater Treatment Plant
Sherwood, Arkansas

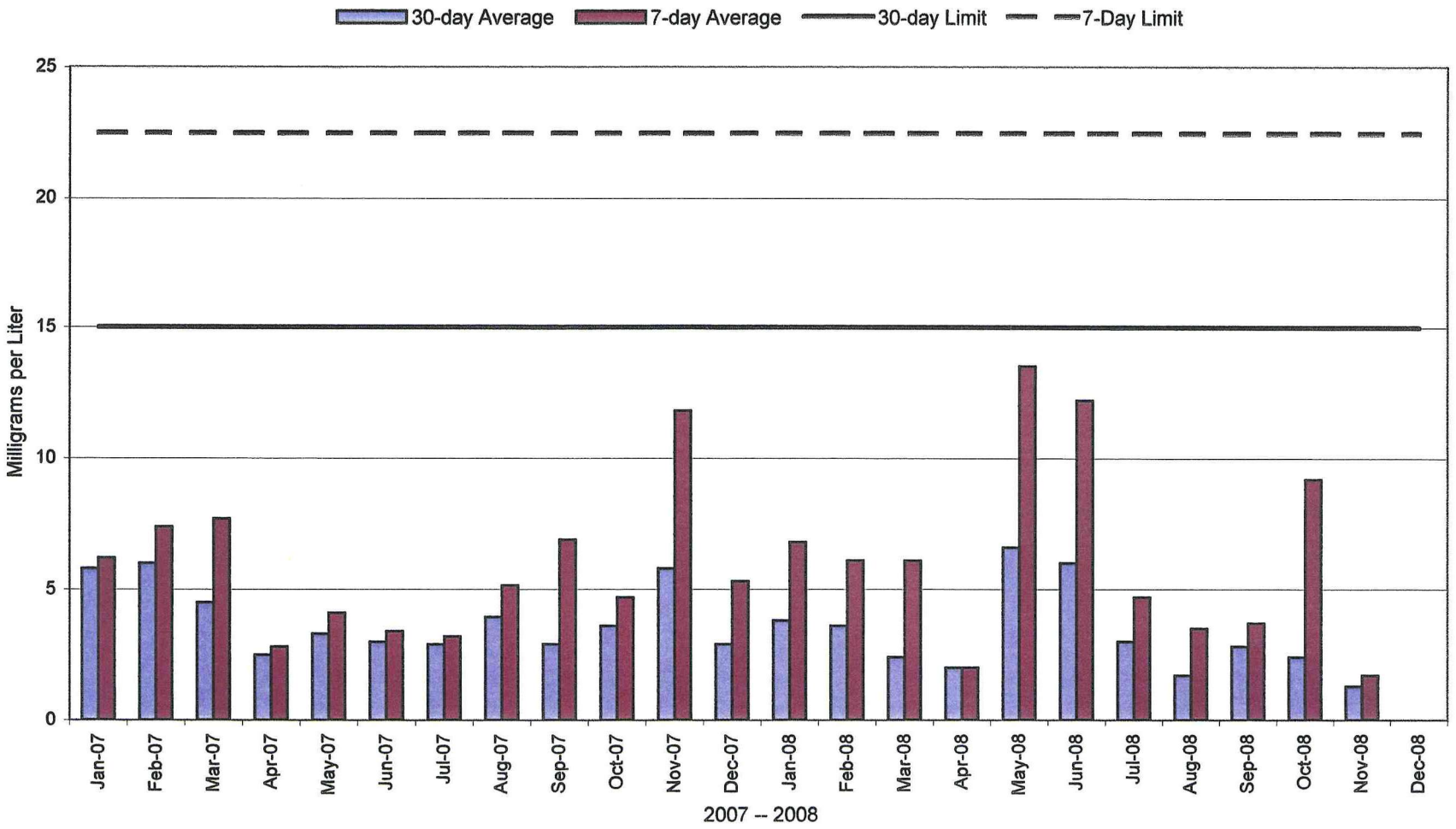


Figure 5-4

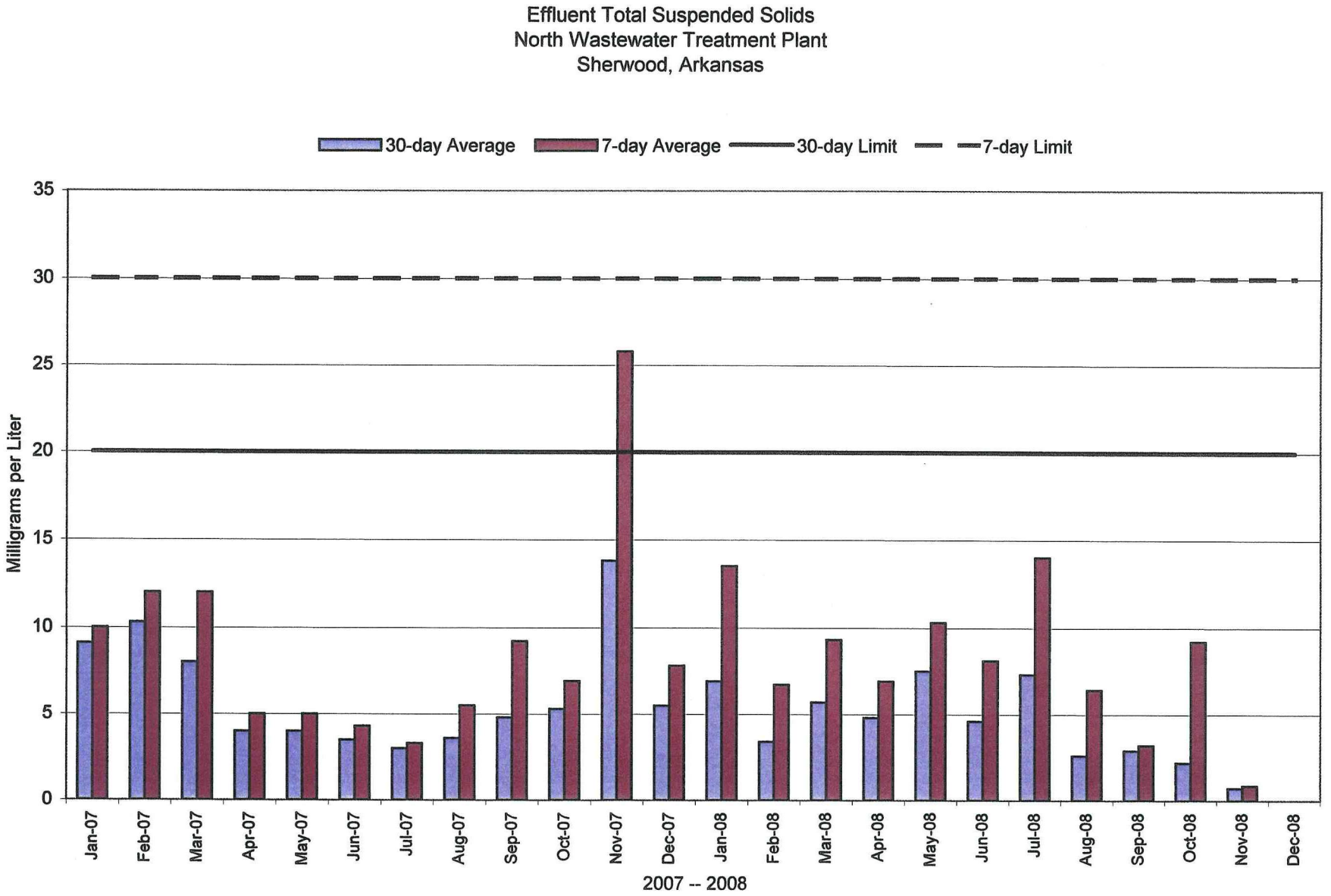

Effluent Total Suspended Solids
North Wastewater Treatment Plant
Sherwood, Arkansas
30-day Average
7-day Average
30-day Limit
7-day Limit
Milligrams per Liter
35
30
25
20
15
10
5
0
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
2007 -- 2008

Figure 5-5

Plant average 30-day and average 7-day effluent NH3-N concentrations, as taken from DMRs, are shown along with seasonal permit limits for the period January, 2007-November, 2008, in Figure 5-6. As can be seen, the plant had some difficulty meeting its NH3-N limits; however, it should be noted that the plant has met its NH3-N limits since June, 2008 and this included the month of September, 2008, with a maximum day flow rate approaching the plant design rate.

Plant average 30-day and average 7-day effluent fecal coliform bacteria (FCB) geometric mean concentration, as taken from DMRs, are shown along with permit limits for the period January, 2007–November, 2008, in Figure 5-7. As can be seen, with five exceptions, the plant generally met permit requirements with respect to FCB during the period covered. The effluent data set for Figures 5-4 through 5-7 is included in Appendix 4.

South Plant

What is now the Sherwood South Plant was initially constructed as the wastewater treatment facility for the Central Arkansas (Pickthrone) sewer improvement district. The plant features a proprietary wastewater treat system called the Biolac Wastewater Treatment System. The term "Biolac" is an acronym for "Biological Aeration Chains" and is a registered trademark of the Parkson Corporation. A key component of the Biolac system is the aeration device, which is assembled as a floating aeration chain where a series of diffuser assemblies are suspended from a "chain" of floats stretched across the basin or lagoon surface. The Biolac system as utilized within the South Plant operates as a flow-through aerated lagoon. A second feature of the Biolac system as applied in the South Plant is an integral clarifier. Excess sludge is removed from the clarifier by means of an air-lift and wasted to an adjacent sludge lagoon. Other plant features include an equalization basin, a headworks with manual screen, mechanical screen with screenings conveyor, ultraviolet effluent disinfection facility, post aeration basin, and effluent flow-rate measuring flume. The plant effluent receiving stream is Woodruff Creek, a tributary of Kellogg Creek.

The average design flow rate for the South Plant is reported to be 0.5 mgd with a maximum rate peaking factor of 3. Design effluent characteristics are reported to be 10/15/7, mg/L, BDO5, TSS, and NH3-N, respectively. An aerial view of the South Plant is included as Figure 5-8. A plant flow sheet is included as Figure 5-9.

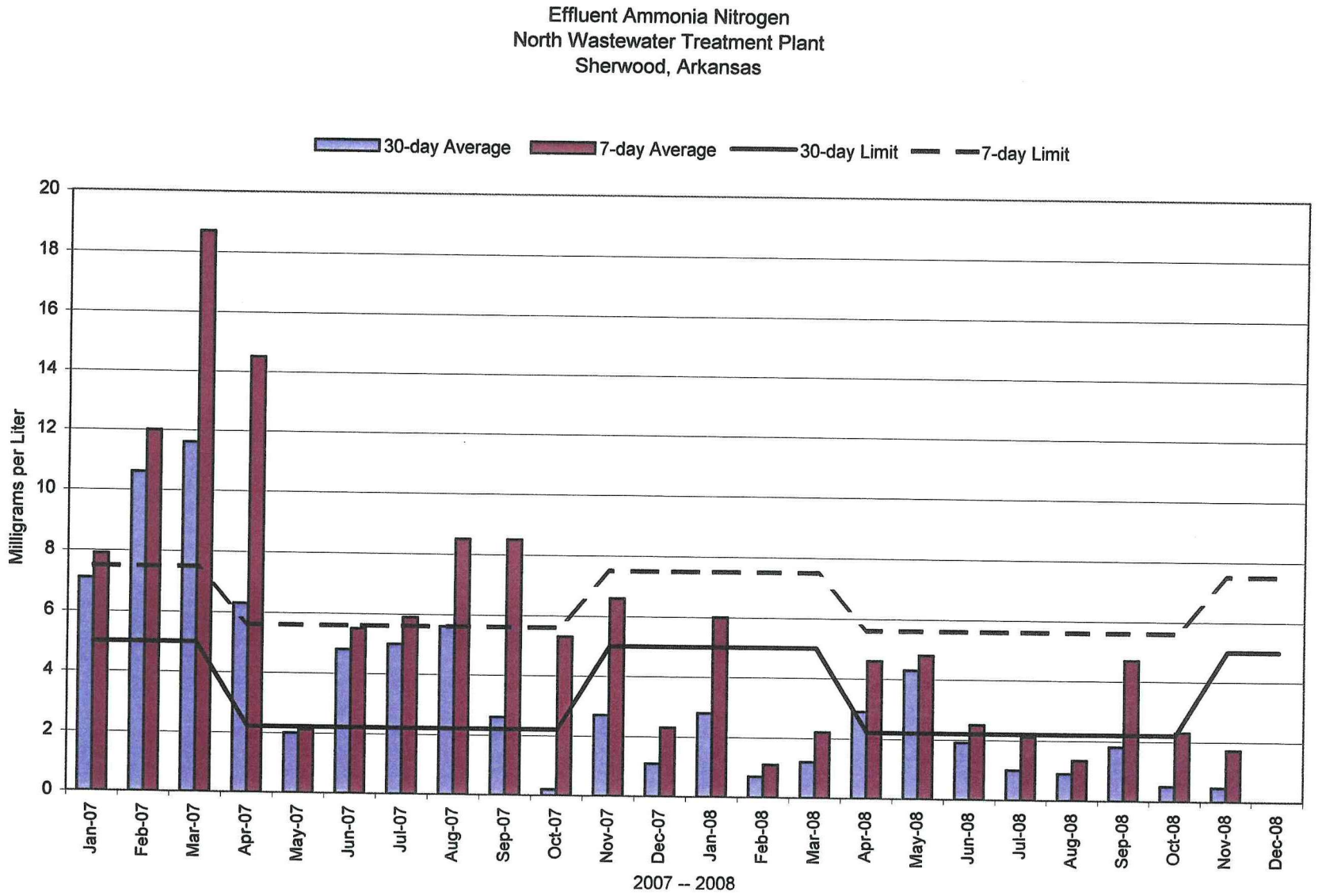

Effluent Ammonia Nitrogen
North Wastewater Treatment Plant
Sherwood, Arkansas
30-day Average
7-day Average
30-day Limit
7-day Limit
Milligrams per Liter
20
18
16
14
12
10
8
6
4
2
0
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
2007 -- 2008

Figure 5-6

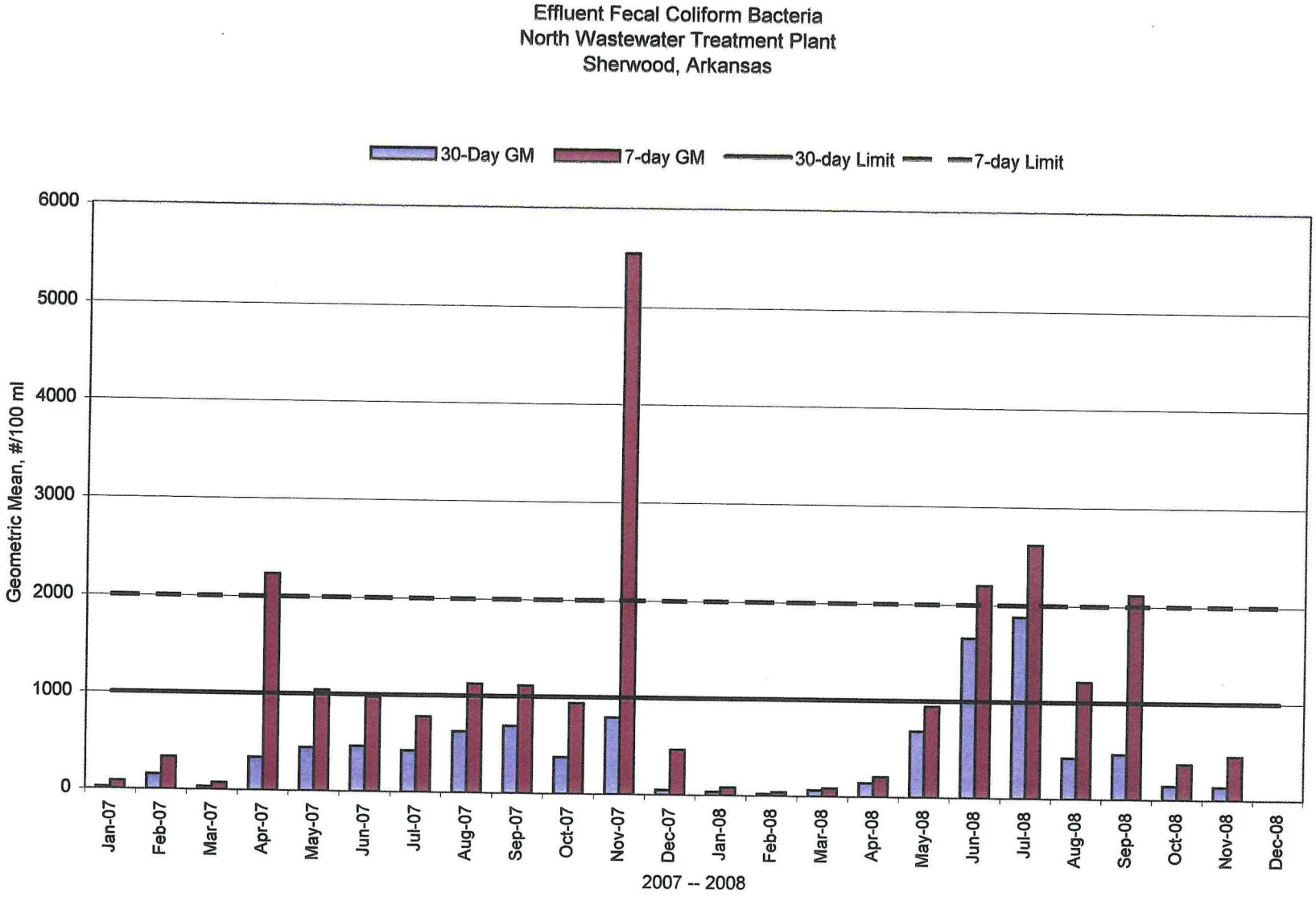

Effluent Fecal Coliform Bacteria
North Wastewater Treatment Plant
Sherwood, Arkansas
30-Day GM
7-day GM
30-day Limit
7-day Limit
Geometric Mean, #/100 ml
6000
5000
4000
3000
2000
1000
0
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
2007 -- 2008

Figure 5-7

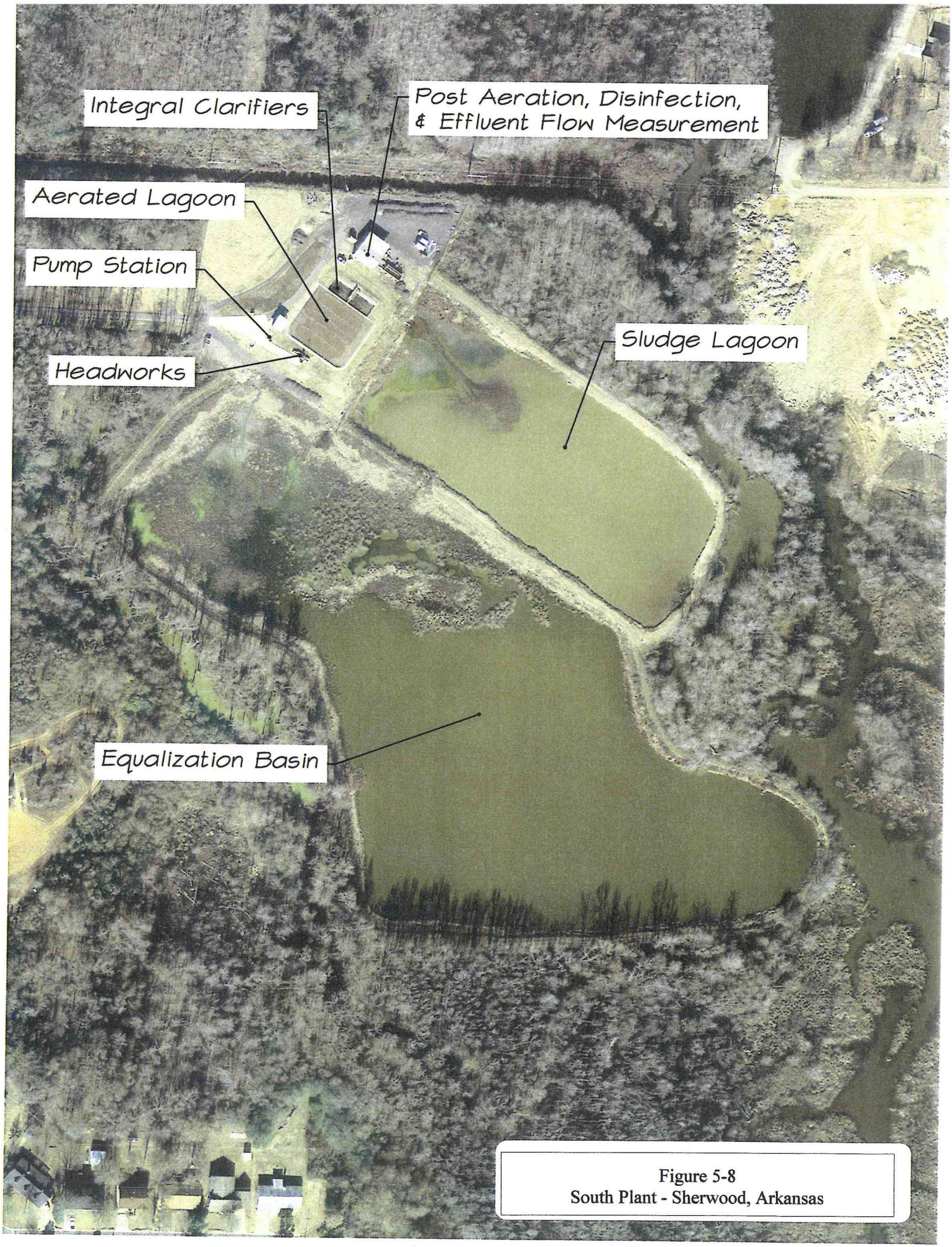
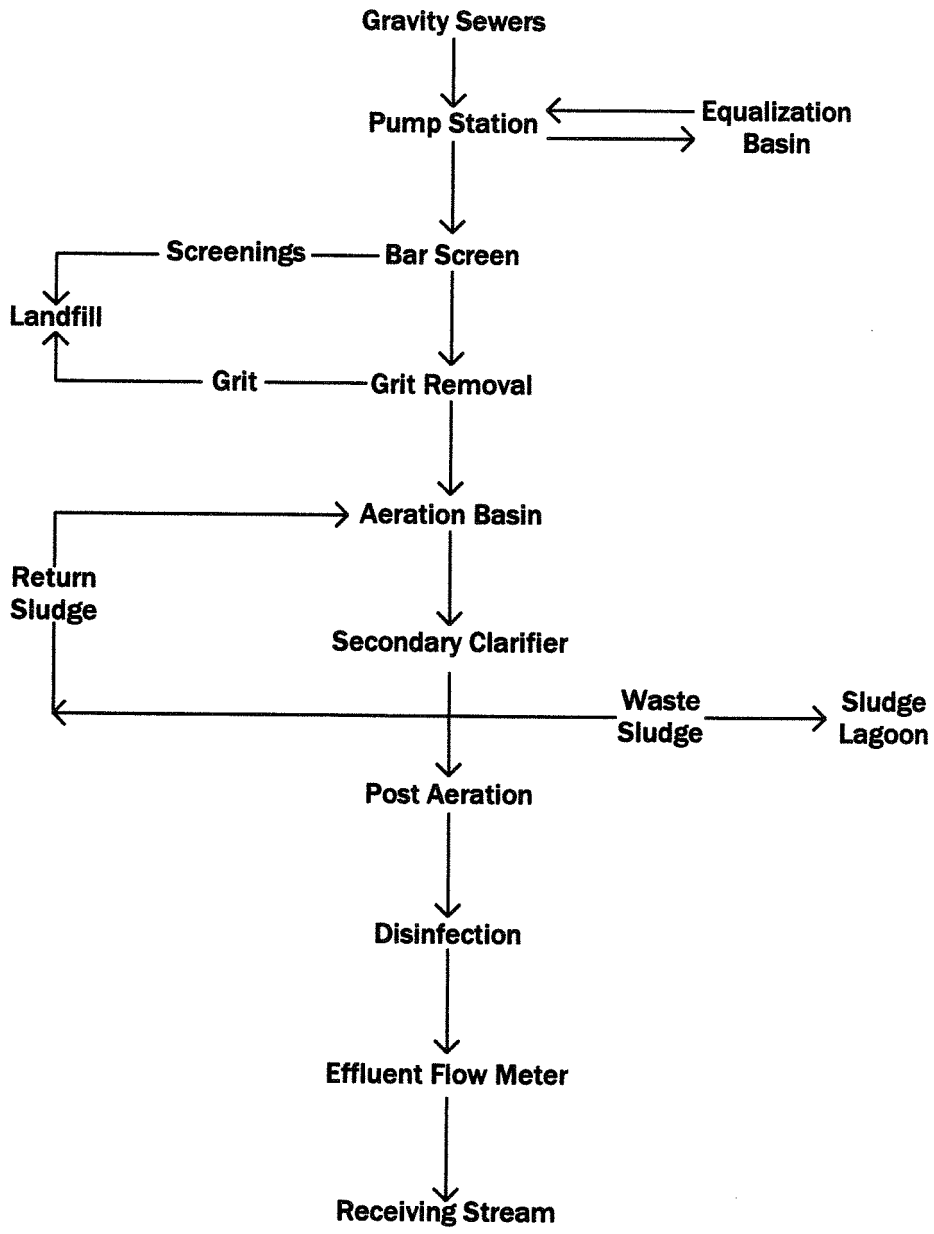


Figure 5-8
South Plant - Sherwood, Arkansas



SOUTH PLANT FLOW SHEET
SHERWOOD, ARKANSAS

Figure 5-9

Permit

The South Plant is operated under the authority of NPDES permit AR0045608 as issued by DEQ. This permit has a effective date of March 1, 2005, and an expiration date of February 28, 2010. The effluent limitations included in this permit are given in Table 5-3.

Table 5-3
Effluent Limitations
NPDES Permit Number AR0045608-South Wastewater Treatment Facility
Sherwood, Arkansas

Effluent Characteristics		Discharge Limitations			
		Monthly Average		7-day Average	Other
Carbonaceous 5-day BOD		10 mg/L	50 lbs/day	15 mg/L	
Total Suspended Solids		15 mg/L	75 lbs/day	23 mg/L	
Ammonia Nitrogen	May – Oct	7 mg/L	35 lbs/day	11 mg/L	
	Nov – Apr	8 mg/L	40 lbs/day	12 mg/L	
Fecal Coliform Bacteria, geo mean		1000/100 ml		2000/100 ml	
Dissolved Oxygen	June – Oct	3.0 mg/L (minimum)			
	Nov – May	6.0 mg/L (minimum)			
pH					≥6.0≤9.0
Flow					Report

Performance

Average monthly and maximum day effluent flow rates for the South Plant, as taken from DMRs, are shown along with total monthly precipitation for the period January, 2007-November, 2008 in Figure 5-10. Note that the largest maximum day effluent rate for the 2007–2008 period was 1.2 mgd occurring during the month of August, 2007; note also that this maximum day effluent rate approaches the reported plant design peak rate of 1.5 mgd.

Plant average 30-day and average 7-day effluent BOD5 concentrations, as taken from DMRs, along with permit limits are shown for the period January, 2007–November, 2008, in

Average Monthly and Maximum Day Effluent Flow Rates and Precipitation
South Wastewater Treatment Plant
Sherwood, Arkansas

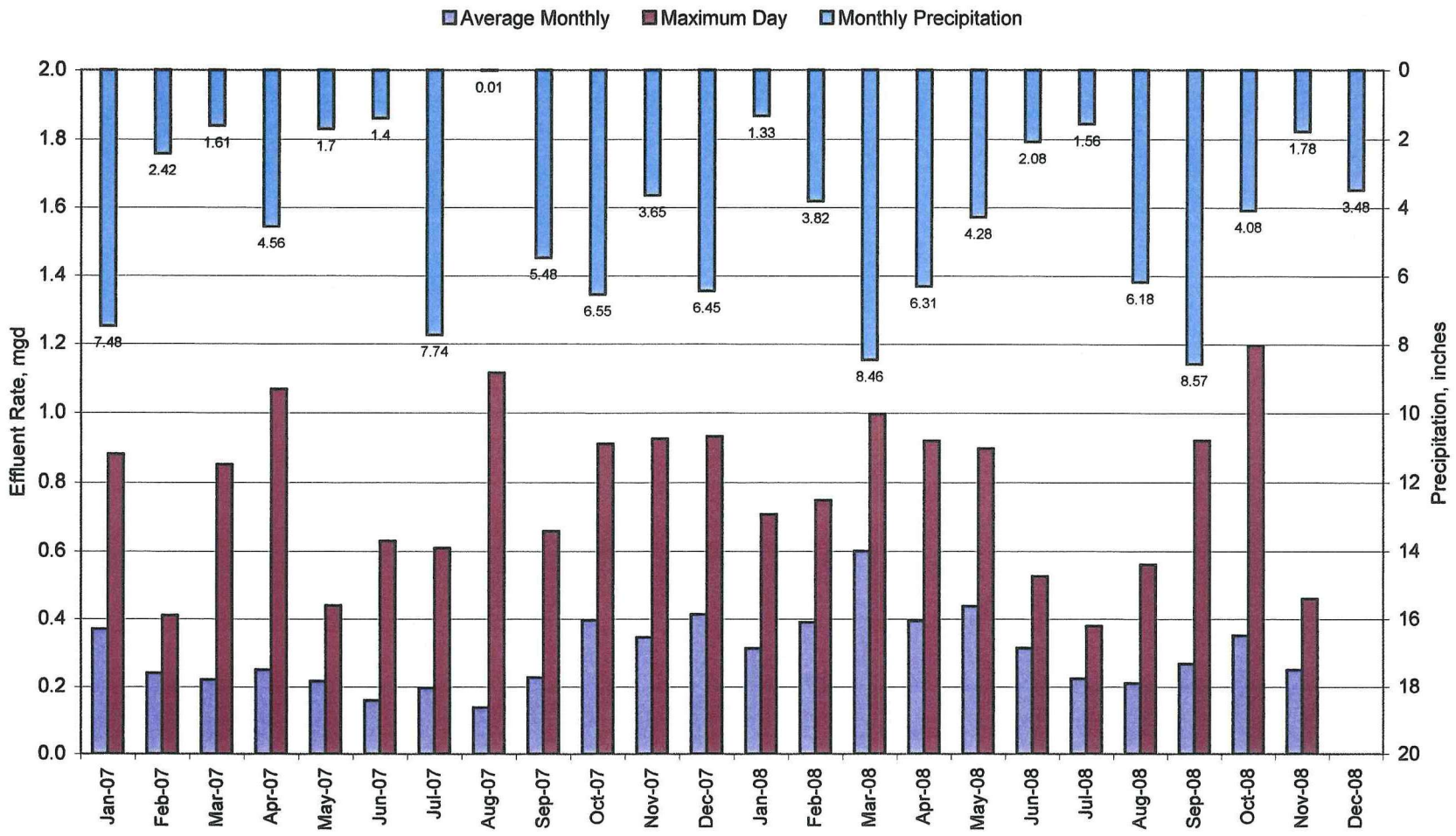


Figure 5-10

Figure 5-11. As can be seen, the plant met permit requirements during the period covered. Plant average 30-day and average 7-day effluent TSS concentrations are shown along with permit limits for the period January 2007–November, 2008 in Figure 5-12. As can be seen, with the exception of May, 2008 the plant met permit requirements during the period covered. Plant average 30-day and average 7-day effluent NH3-N concentrations, as taken from DMRs, are shown along with seasonal permit limits for the period January, 2007–November, 2008 in Figure 5-13. As can be seen, the plant met permit requirements during the period covered.

Plant average 30-day and average 7-day effluent FCB geometric mean concentrations, as taken from DMRs, for the period January, 2007–November, 2008 are shown along with permit limits in Figure 5-14. As can be seen, with three exceptions, the plant generally met permit requirements with respect to FCB during the period covered. The effluent data set for Figures 5-11 through 5-14 is included in Appendix 4.

Five-Mile Creek Plant

The North Little Rock Five-Mile Creek wastewater treatment Plant was initially constructed in 1971 and consisted of headworks including a manual and a mechanical bar screen with screenings grinder; influent pump station and flow meter; two aerated ponds operated in parallel; a 22-acre polishing pond; and discharge to a local creek. A 1986 improvements project added effluent disinfection and an effluent pump station with a discharge force main to the Arkansas River. A 1995 improvements project replaced the 1971 bar screens with two mechanical screens with screenings conveyor; modified the existing influent pump station wet well and added new influent pumps; added an influent flow meter; converted the polishing pond to a partial-mix aerated lagoon; and added effluent disinfection and disinfectant removal facilities; other added facilities included a disinfectant scrubber and effluent flow meter. The average design capacity of the present plant is reported to be 6.6 mgd. An aerial photo of the Five-Mile Creek Plant is included as Figure 5-15.

Permit

The Five-Mile Creek Plant is operated by the NLRWWU under the authority of NPDES permit AR0020302 as issued by DEQ. This permit has an effective date of January 31, 2007 and an expiration date of January 31, 2012. The plant effluent limitations are given in Table 5-4.

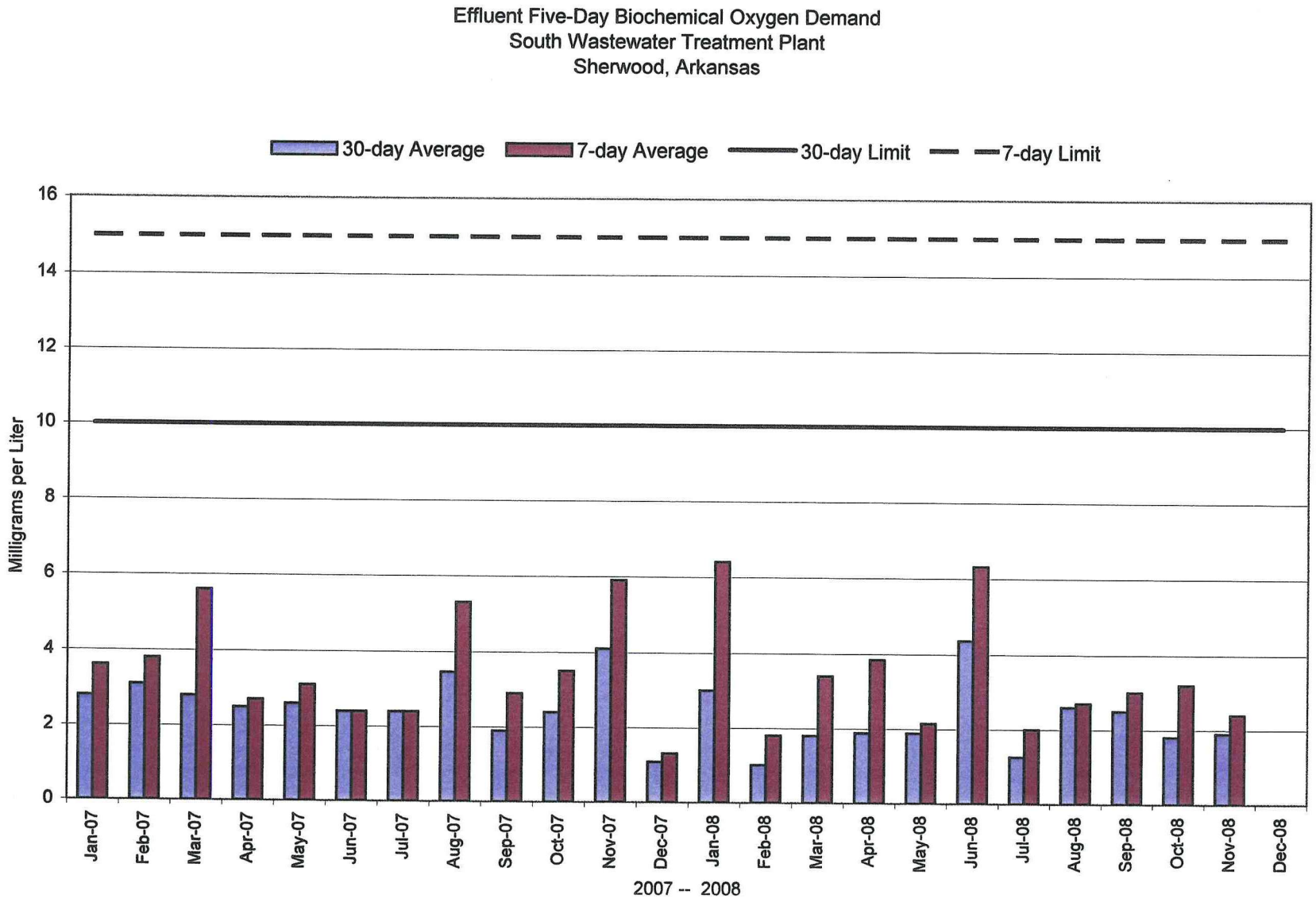

Effluent Five-Day Biochemical Oxygen Demand
South Wastewater Treatment Plant
Sherwood, Arkansas
30-day Average
7-day Average
30-day Limit
7-day Limit
Milligrams per Liter
16
14
12
10
8
6
4
2
0
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
2007 -- 2008

Figure 5-11

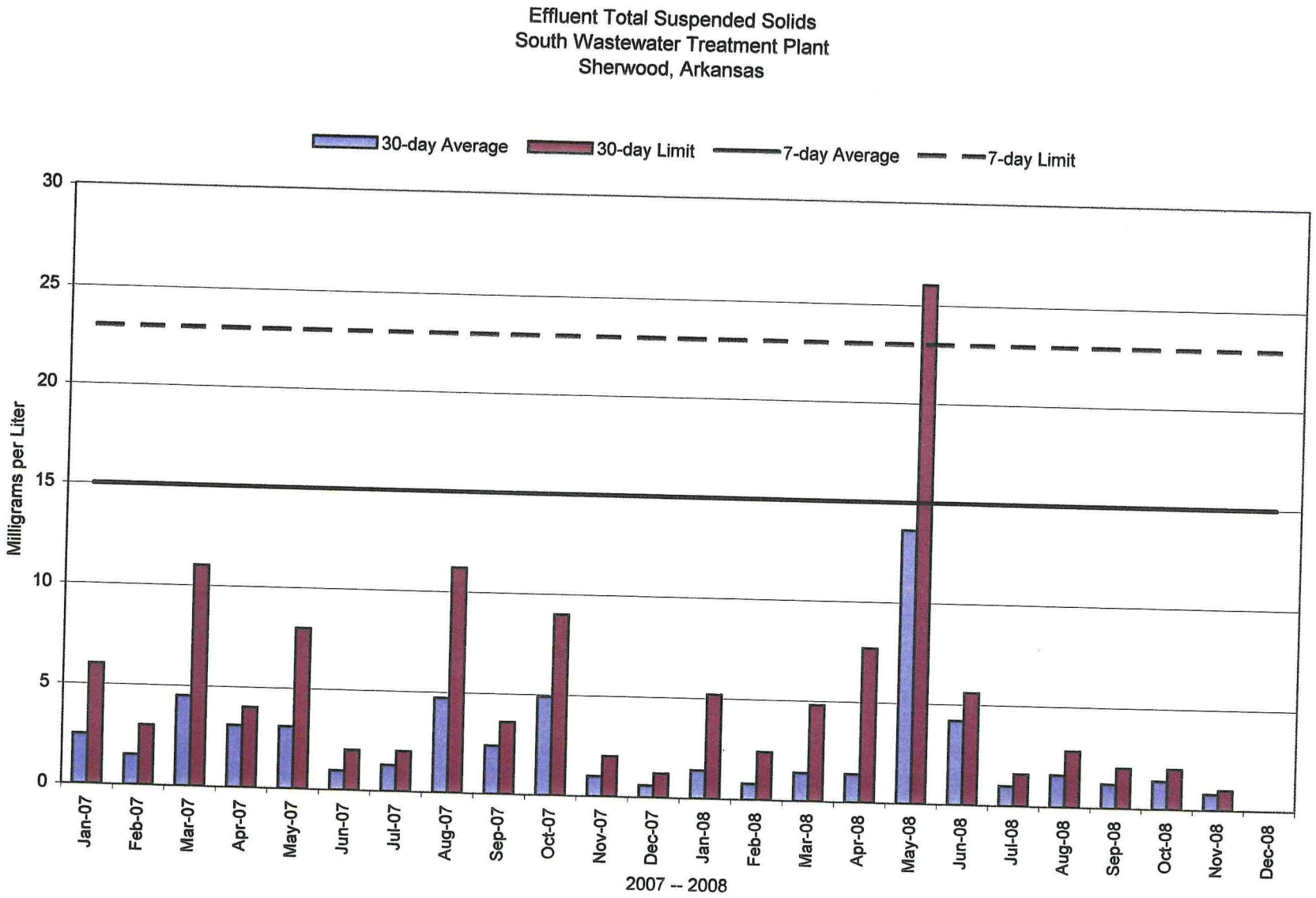

Effluent Total Suspended Solids
South Wastewater Treatment Plant
Sherwood, Arkansas
30-day Average
30-day Limit
7-day Average
7-day Limit
Milligrams per Liter
30
25
20
15
10
5
0
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
2007 -- 2008

Figure 5-12

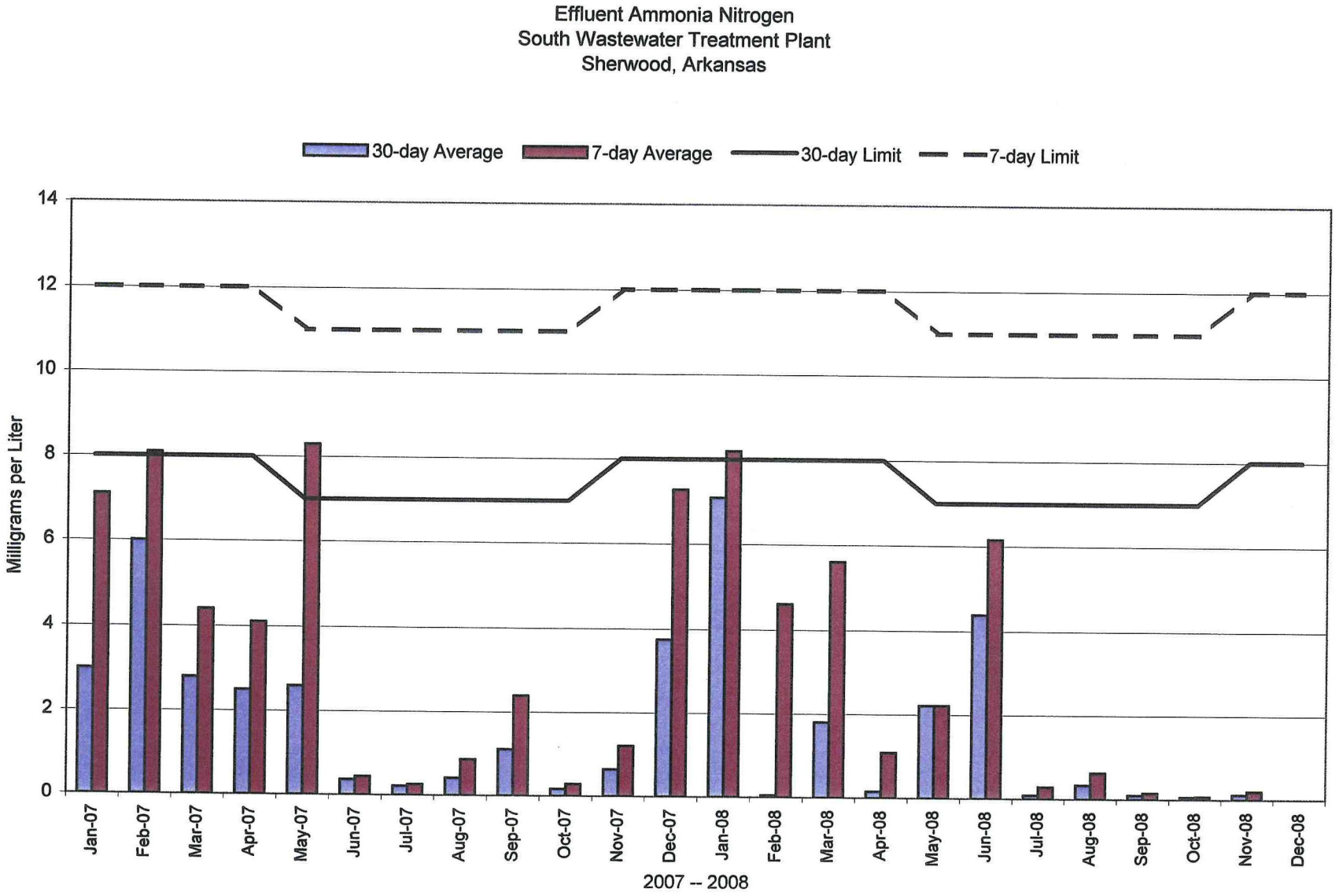

Effluent Ammonia Nitrogen
South Wastewater Treatment Plant
Sherwood, Arkansas
30-day Average
7-day Average
30-day Limit
7-day Limit
Milligrams per Liter
0
2
4
6
8
10
12
14
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
2007 -- 2008

Figure 5-13

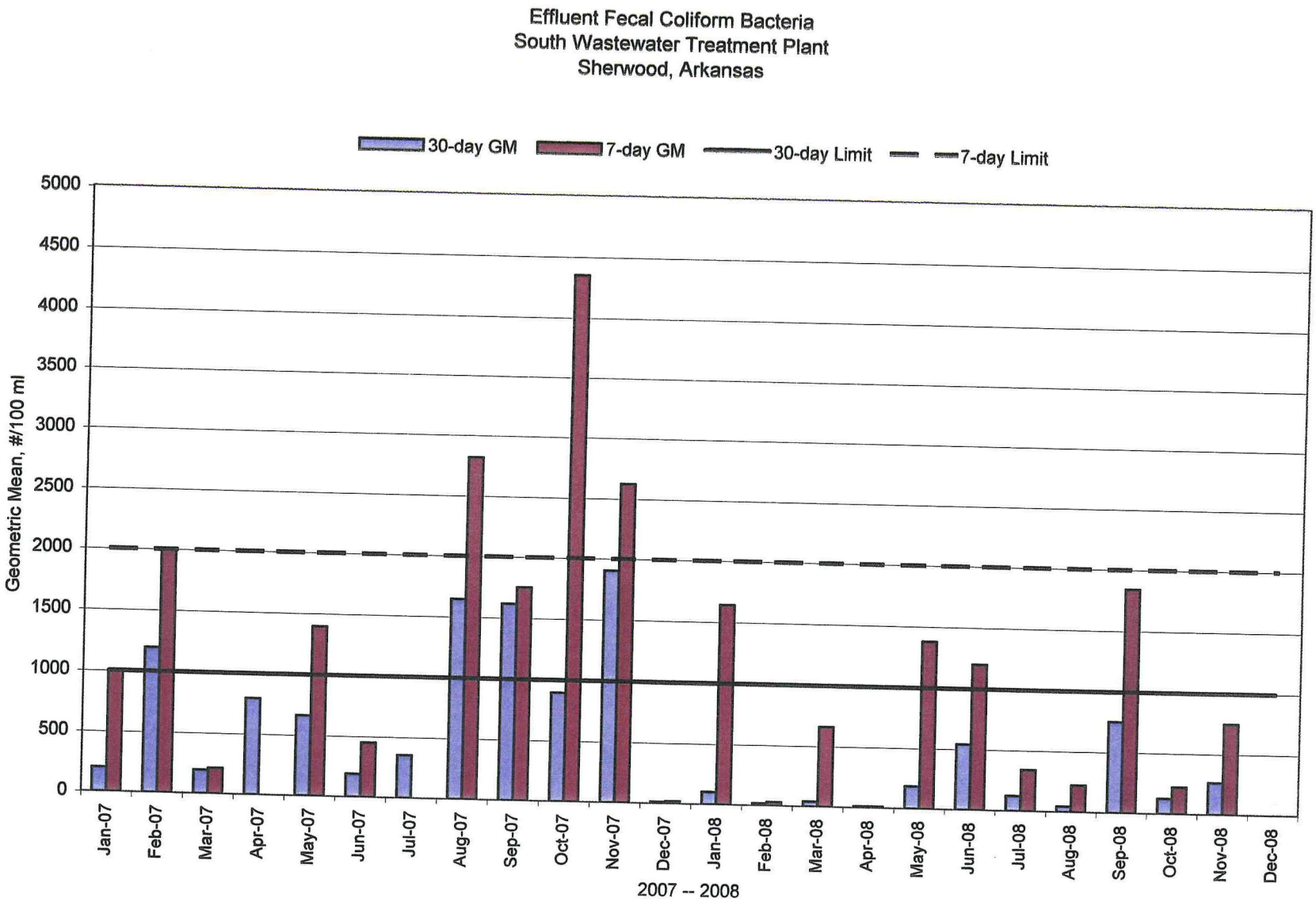

Effluent Fecal Coliform Bacteria
South Wastewater Treatment Plant
Sherwood, Arkansas
30-day GM
7-day GM
30-day Limit
7-day Limit
Geometric Mean, #/100 ml
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
2007 -- 2008

Figure 5-14

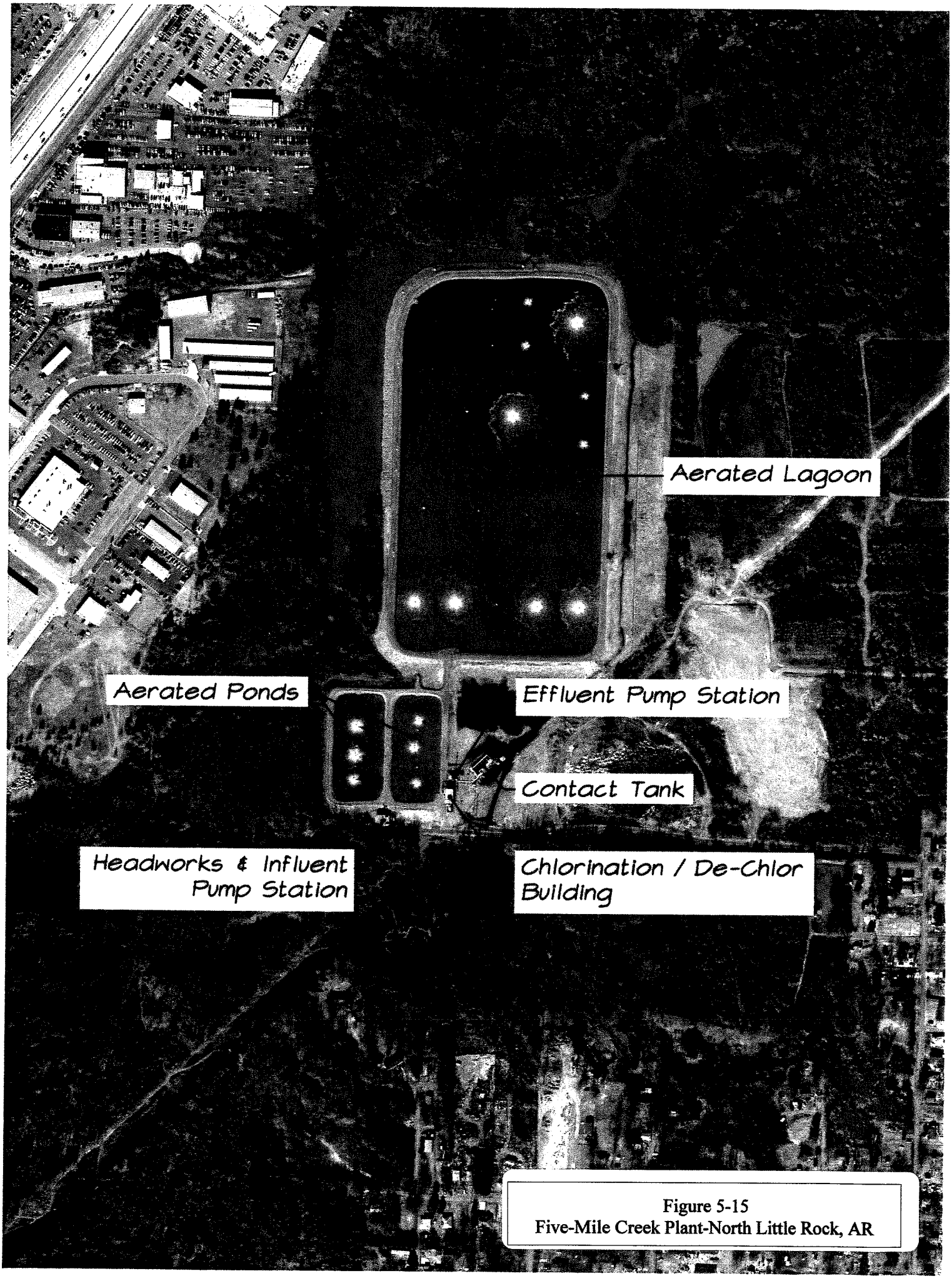


Figure 5-15
Five-Mile Creek Plant-North Little Rock, AR

Table 5-4
Effluent Limitations
NPDES Permit Number AR0020320-Five-Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas

Effluent Characteristics		Discharge Limitations			
		Monthly Average		7-day Average	Other
Carbonaceous 5-day BOD		30 mg/L	1,651 lbs/day	45 mg/L	
Total Suspended Solids		90 mg/L	4,954 lbs/day	135 mg/L	
Fecal Coliform Bacteria, geo mean	Apr – Sep	200/100 ml		400/100 ml	
	Oct – Mar	1,000/100 ml		2,000/100 ml	
Chronic Biomonitoring					once/quarter
pH					≥5.0≤9.0
Flow					Report

Performance

Average monthly influent and effluent flow rates for the Five-Mile Creek Plant are shown along with total monthly precipitation for the period 2007-2008 in Figure 5-16. As can be seen, the effluent flow rate is typically greater the influent rate, and both rates appear to exhibit some relation to precipitation. The higher effluent rates may result from precipitation directly on the surface of the 22-acre lagoon. Note that the influent and effluent rates are the same at 2.77 mgd for August, 2007 which was an extremely dry month with a total precipitation for the month of only 0.01 inches. Average monthly and maximum day flow rates for the Five-Mile Creek Plant are shown along with total monthly precipitation for the period 2007-2008 in Figure 5-17. Again, it would appear that there is a direct relationship between Five-Mile Creek Plant influent flow rates and precipitation. Monthly average effluent BOD5 and TSS in mg/L are shown in Figure 5-18 for the period 2007-2008. Except for one excursion in April, 2007 the Five-Mile Creek Plant generally met permit requirements.

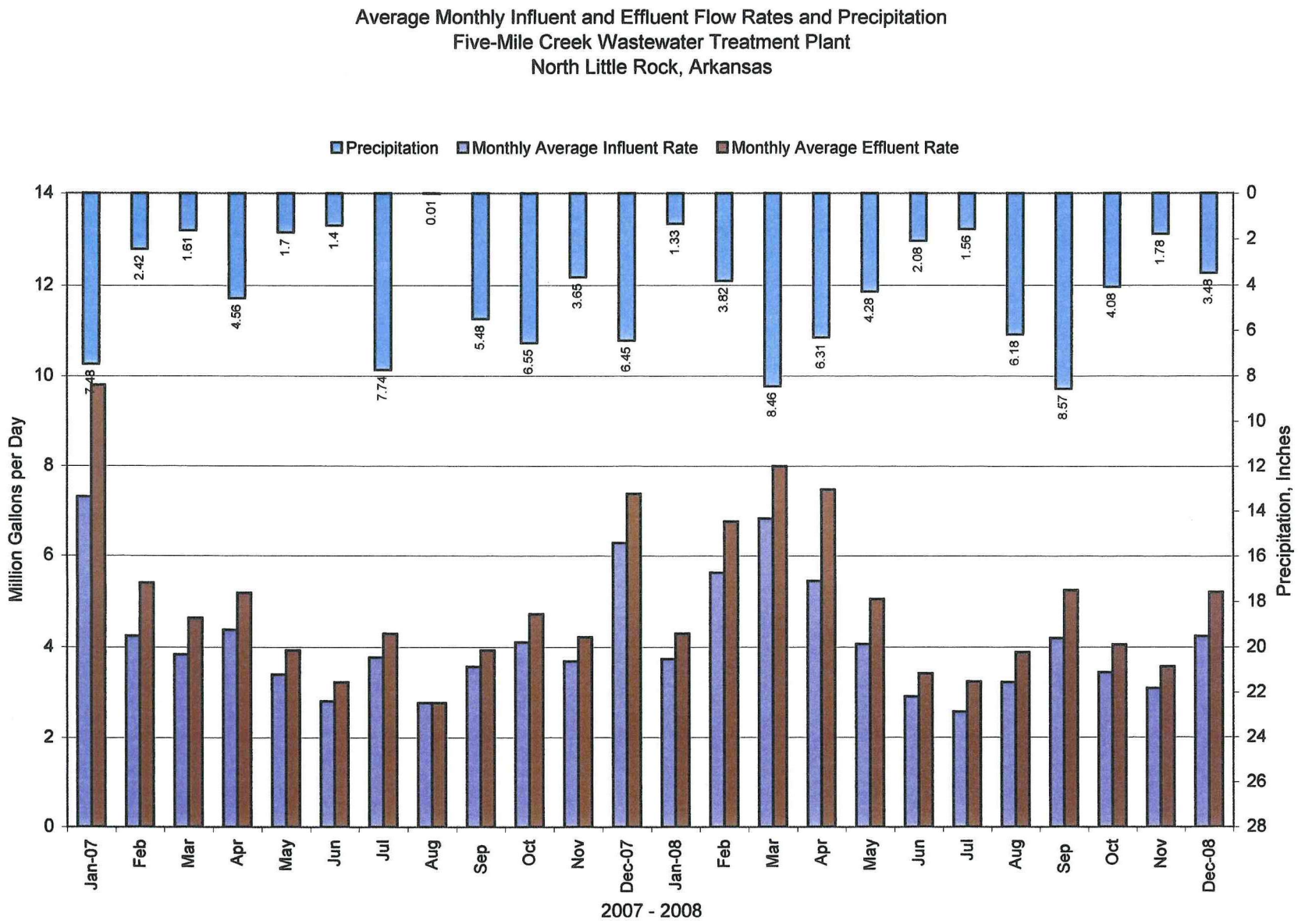

Average Monthly Influent and Effluent Flow Rates and Precipitation
Five-Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas
Precipitation
Monthly Average Influent Rate
Monthly Average Effluent Rate
Million Gallons per Day
Precipitation, Inches
2007 - 2008
Jan-07
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec-07
Jan-08
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec-08
7.48
2.42
1.61
4.56
1.7
1.4
7.74
0.01
5.48
6.55
3.65
6.45
1.33
3.82
8.46
6.31
4.28
2.08
1.56
6.18
8.57
4.08
1.78
3.48

Figure 5-16

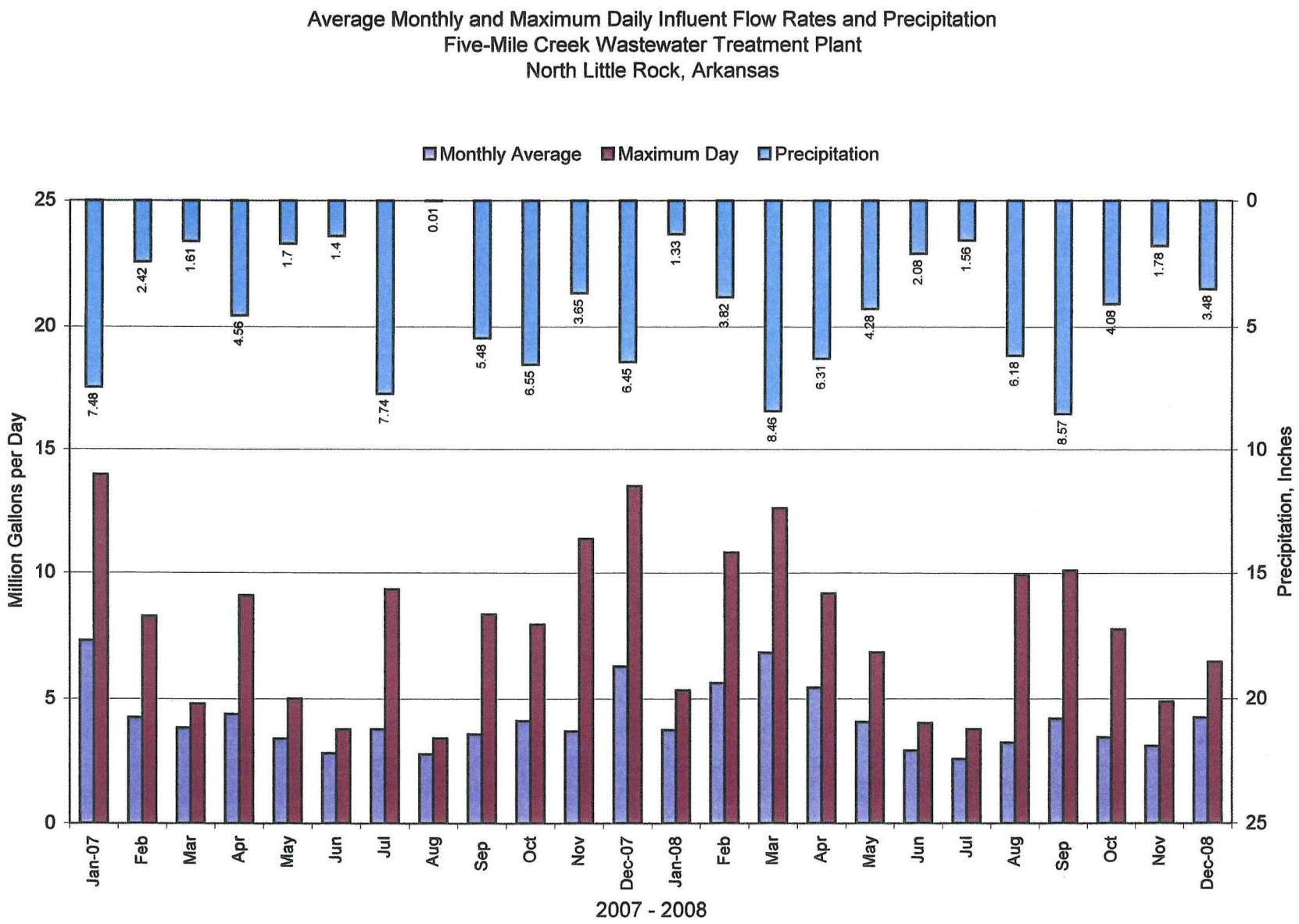

Average Monthly and Maximum Daily Influent Flow Rates and Precipitation
Five-Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas
Monthly Average
Maximum Day
Precipitation
Million Gallons per Day
Precipitation, Inches
25
20
15
10
5
0
0
5
10
15
20
25
7.48
2.42
1.61
4.56
1.7
1.4
7.74
0.01
5.48
6.55
3.65
6.45
1.33
3.82
8.46
6.31
4.28
2.08
1.56
6.18
8.57
4.08
1.78
3.48
Jan-07
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec-07
Jan-08
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec-08
2007 - 2008

Figure 5-17

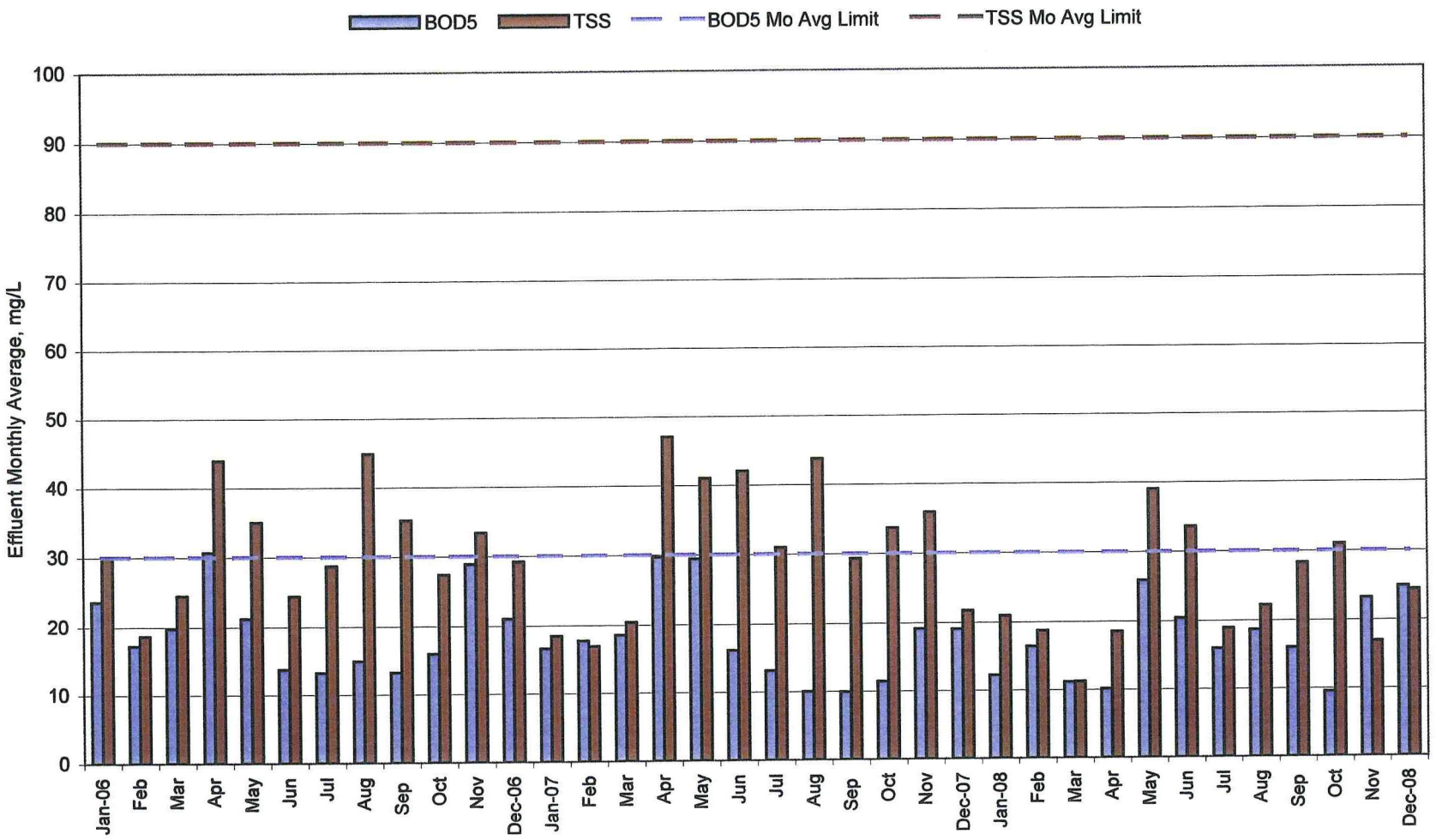

Monthly Average Effluent 5-day Biochemical Oxygen Demand & Total Suspended Solids
Five Mile Creek Wastewater Treatment Plant
North Little Rock, Arkansas
BOD5
TSS
BOD5 Mo Avg Limit
TSS Mo Avg Limit
Effluent Monthly Average, mg/L
100
90
80
70
60
50
40
30
20
10
0
Jan-06
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec-06
Jan-07
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec-07
Jan-08
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec-08

Figure 5-18

Attainable Limits

Using a set of plant effluent data, permit writers estimate attainable limits from the statistical formula for 95 percent confidence using the standard deviation for the normal distribution as follows:

$$daily\ maximum\ limit = (mean) + 1.645(standard\ deviation)$$

This calculation, of course, assumes that the 30-day averages of effluent pollutant measurements for a wastewater treatment plant can be modeled by the normal distribution.

Applying this relationship to the date used to develop Figures 53- through 5-6, 5-9 through 5-12, and 5-16 yields attainable limits given in Table 5-5.

Table 5-5
Estimated Attainable Effluent Pollutant Concentrations and Discharge Limits
Using the 2007-2008 Effluent Data Sets for
Wastewater Treatment Plants Treating Sherwood Wastewater

Pollutant		North Plant		South Plant		Five-Mile Creek Plant	
		Attainable	Limit	Attainable	Limit	Attainable	Limit
BOD5	30-day	6.1	15	3.8	10	27.8	30
	7-day	11.3	22.5	5.9	15		45
TSS	30-day	10.2	20	7.1	15	44.3	90
	7-day	16.8	30	14.3	23		135
NH3-N Apr-Oct	30-day	6.0	2.2				
	7-day	10.9	5.6				
NH3-N Nov-Mar	30-day	11.4	5.0				
	7-day	16	7.5				
NH3-N May-Oct	30-day			3.2	7.0		
	7-day			6.4	11.0		
NH3-N Nov-Apr	30-day			6.2	8.0		
	7-day			9.5	12.0		

As can be seen from the results of Table 5-5, in general all three plants are capable of meeting their respective permit requirements except, in would appear, for the North Plant effluent ammonia-nitrogen limits. However, the problems leading to the North Plant permit excursions have apparently been corrected as the plant has been in compliance since late 2007. The fact that the Five-Mile Creek Plant effluent rate occasionally approaches its design rate and the attainable effluent BOD5 concentration of Table 5-5 approaches the permit limit suggests that the Five-Mile Creek Plant may be due for an upgrade.

Section 6
Wastewater Treatment Alternatives

Wastewater generated by residents of Sherwood is currently treated in either of three wastewater treatment plants: Sherwood's North Plant, Sherwood's South Plant, or in North Little Rock's Five-Mile Creek Plant. Sherwood residents whose wastewater is treated in the Five-Mile Creek Plant are further sub-divided into three categories by the Court Order (3), namely, Sherwood customers, District customers, and North Little Rock customers.

For planning purposes, the increases in planning area population and existing unsewered populations are generally assigned to these same three treatment plants for service as follows. The wastewater from those population increases that occur within the Sherwood planning area and are also within the tributary area of one of these existing treatment plants is assumed to receive service from the plant for that respective treatment plant (North, South, or Five-Mile Creek) drainage basin. The population increase occurring within the limits of Gravel Ridge is assumed to receive treatment service from the existing Gravel Ridge Plant. Wastewaters from existing development and from population increases that occur generally along and north of the (proposed) North Belt Freeway (herein called the North Area) is to be provided treatment by Sherwood's North Plant, the Five-Mile Creek Plant, or, possibly, the Gravel Ridge Plant. Three alternatives were considered with each alternative including a plan for each wastewater source. These alternatives are summarized in Table 6-1.

The current physical arrangement whereby the majority of Sherwood wastewater is conveyed south by gravity to be treated in the Five-Mile Creek Plant with the balance being treated in Sherwood's plants has been in place for more than 30 years, and, over these years, the entire gravity sewer system serving Sherwood has been configured to promote this arrangement. Although not impossible, it would be most difficult and expensive to "reconfigure" the Sherwood gravity sewer system to divert Sherwood wastewaters currently treated in the Five-Mile Creek Plant to a different plant; consequently the alternatives considered assume that existing wastewater treatment plants will be used where appropriate and expanded as necessary. Construction of completely new treatment plants or significant reconfiguring of existing sewers is not assumed.

Table 6-1
Alternatives for Treatment and Disposal of Sherwood Planning Area Wastewaters
Sherwood, Arkansas

Wastewater Source		Alternative 1	Alternative 2	Alternative 3	
A	North Plant	Decommission except for EQ basin, connect discharge to North Little Rock sewer system, and treat North Plant wastewater in the North Little Rock Five-Mile Creek Plant	Retain, upgrade, and expand capacity to treat wastewater from existing and new development in current drainage basin and existing and new sources from the North Area	Retain, upgrade, and repair existing facilities as necessary to maintain plant in service; treat wastewater from existing and new development in current drainage basin	
B	South Plant	Decommission except for EQ basin, connect discharge to North Little Rock system, and treat South Plant wastewater in the North Little Rock Five-Mile Creek Plant		Retain and repair existing facilities as necessary to maintain plant in service; treat wastewater from existing and new development in current drainage basin	
C	North Area[1]	Treat wastewater in North Little Rock Five-Mile Creek Plant	Treat wastewater in expanded and upgraded North Plant	Treat wastewater in North Little Rock Five-Mile Creek Plant	Treat wastewater in expanded and upgraded Gravel Ridge Plant

1. Includes existing and new sources north of and along the proposed North Belt Freeway.

Table 6-2

Present Worth Costs of Treatment Alternatives Components
Sherwood, Arkansas

Cost Component	Notes	North Plant Alternatives			South Plant Alternatives			North Area Alternatives			
		1-A	2-A	3-A	1-B	2-B	3-B	1-C	2-C	3-C-1	3-C-2
EQ Basin											
Construction Cost	1	$554,573	$554,573		$416,000	$416,000		$190,658		$758,400	
Operation & Maintenance											
Labor		$12,000	$12,000		$8,800	$8,800		$3,000		$9,400	
Power		$22,500	$22,500		$12,500	$12,500		$11,500		$11,000	
Materials		$11,100	$11,100		$8,700	$8,700		$2,800		$8,300	
Pump Station											
Construction Cost	1	$198,700	$198,700		$272,500	$272,500		$96,500		$261,100	
Operation & Maintenance											
Labor		$1,000	$1,000		$12,000	$12,000		$1,000		$12,000	
Power		$3,250	$3,250		$3,750	$3,750		$2,750		$4,000	
Materials		$1,700	$1,700		$1,900	$1,900		$400		$1,800	
Force Main		$731,814			$221,018	$221,018		$127,246		$604,568	
Aerated Lagoon Expansion											
Construction Cost		$789,600			$1,090,400	$1,090,400		$1,346,700		$1,346,700	
Operation & Maintenance		$74,184			$102,722	$102,722		$120,860		$120,860	
Retain, Upgrade, & Expand Existing											
Construction Cost			$1,683,500	$650,000			$1,274,000				$8,600,000
Operation & Maintenance			$703,345	$267,538			$370,409				$546,400
Sludge Management Equipment											
Construction Cost			$694,840	$115,000			$115,000				
Operation & Maintenance			$310,696	$8,500			$8,500				
Total O&M Costs		$125,734	$1,065,591	$276,038	$150,372	$150,372	$378,909	$142,310	in 2-A	$167,360	$546,400
Present Worth Total O&M Costs	2	$1,635,545	$13,861,135	$3,590,680	$1,956,023	$1,956,023	$4,928,824	$1,851,153		$2,177,002	$7,107,536
Total Construction Cost		$2,274,687	$3,131,613	$765,000	$1,999,918	$1,999,918	$1,389,000	$1,761,104	in 2-A	$2,970,768	$8,600,000
Total Present Worth		$3,910,232	$16,992,748	$4,355,680	$3,955,941	$3,955,941	$6,317,824	$3,612,257		$5,147,770	$15,707,536

1 Incremental cost for 1-A & 1-C

2 20 years, 4.5 percent

The estimated construction cost, annual operation and maintenance cost, and corresponding present worth cost is shown for each cost component according to wastewater source in Table 6-2. The various present worth cost totals are combined for each alternative to develop a total present worth cost for each alternative as given in Table 6-3.

Alternative 1

North Plant

Under Alternative 1, North Plant wastewaters, including that generated from the projected 20-year population increase occurring within the presently sewered North Plant tributary area, will be treated in North Little Rock's Five-mile Creek Plant. An equalization basin, pump station, and force main will be constructed at the current North Plant site, and all other existing North Plant treatment facilities will be de-commissioned. It is assumed that the Five-Mile Creek Plant will be expanded as necessary to accommodate this proposed contribution from the North Plant. The North Plant equalization basin will attenuate significant flow-rate peaks and provide for a smaller expansion of the Five-Mile Creek Plant than might otherwise be required. Implementation of this alternative, of course, depends, in part, upon North Little Rock Waste Water Utility's willingness to accept this wastewater into the Five-Mile Creek Plant, and on terms agreeable to both parties. The estimated present worth cost of the North Plant component of Alternative 1 (1-A) is given in Table 6-2.

South Plant

Under Alternative 1, present and future wastewaters tributary to the South Plant will be treated in North Little Rock's Five-Mile Creek Plant. An equalization basin, pump station, and force main will be constructed at the current South Plant site, and all other existing South Plant facilities will be de-commissioned. It is assumed that the Five-Mile Creek Plant will be expanded as necessary to accommodate the proposed contribution from the South Plant. The estimated present worth cost of this component of Alternative 1 (1-B) is included in Table 6-2.

North Area

Wastewaters generated by existing sources and increasing population in that part of the planning area that is generally north of and along the proposed North Belt Freeway will be gathered by new sewers and pump stations as necessary and discharged into the North Plant

equalization as described above. These wastewaters will then be conveyed to the Five-Mile Creek Plant along with North Plant tributary wastewaters. The estimated present worth cost of this component of Alternative 1 (1-C) is included in Table 6-2.

Alternative 2

North Plant

Under Alternative 2, the North Plant will be expanded and upgraded to accommodate present and future wastewaters tributary to the North Plant drainage basin plus those wastewaters generated by present and future sources in the North Area. The North Plant upgrade will include closure of the existing sludge lagoon and addition of new sludge management facilities to include gravity thickening, chemical conditioning, mechanical dewatering, and temporary storage of dewatered sludge. This proposed sludge management scheme was determined by the present worth analyses of five sludge treatment and disposal options as given in Section 7 of this Report.

The selected option for treatment and disposal of waste sludge generated within the upgraded and expanded North Plant component of wastewater treatment Alternative 2 is Option S5, and these facilities are assumed within North Plant cost within this alternative. However, a close inspection of the disposal options costs of Table 7-1 will show that the recommended facilities through the mechanical dewatering step offer considerable flexibility with respect to ultimate sludge disposal. The assumed ultimate disposal method for the North Plant under Option S5 is by landfill; however, should tipping fees or haul distances become excessive or should landfilling become prohibitive for other reasons, the sludge treatment facilities proposed will yield a conditioned sludge suitable for a variety of disposal and reuse options.

South Plant

Under the South Plant component of Alternative 2, present and future wastewaters tributary to the South Plant will be treated in North Little Rock's Five-Mile Creek Plant. An equalization basin, pump station, and force main will be constructed at the current South Plant site, and all other existing South Plant facilities will be de-commissioned. It is assumed that the Five-Mile Creek Plant will be expanded as necessary to accommodate the proposed contribution from the South Plant. The estimated present worth cost of this part of Alternative 2 (2-B) is included in Table 6-2.

North Area

The North Area component of Alternative 2 proposes to convey wastewaters generated in the North Area to the North Plant for treatment. The estimated cost given for North Plant Alternative 2 (2-A) in Table 6-2 include sufficient additional treatment capacity to accommodate the North Area wastewaters.

Alternative 3

North Plant

Under the North Plant component of Alternative 3, the North Plant will be retained and existing facilities repaired or replaced as necessary to maintain the plant in service to treat wastewaters generated in the North Plant service area including wastewaters from new sources developing within this area.

South Plant

Under the South Plant component of Alternative 3, the South Plant will be retained and existing facilities repaired or replaced as necessary to maintain the plant in service to treat wastewaters generated in the existing South Plant service area including wastewaters from new sources developing within this area.

North Area

Two "sub-components" for treating North Area wastewater were considered within Alternative 3 for treating North Area wastewaters. Under sub-component 1, North Area wastewaters would be flow-rate equalized and treated in the Five-Mile Creek Plant as under Alternative 1. Under sub-component 2, North Area wastewaters would be treated in an upgraded and expanded Gravel Ridge wastewater treatment plant.

Least-Cost Alternative

The corresponding component present worth cost totals are combined for each alternative to develop a total present worth cost for each alternative as given in Table 6-3. As can be seen, total present worth costs vary from slightly less than $12 million for Alternative 1 to almost $30

Table 6-3

Present Worth Cost of Selected Alternatives
Sherwood, Arkansas

Wastewater Source	Notes	Alternative 1	2	3-1	3-2
North Area	1				
Construction Cost		$1,882,746	$312,300	$2,366,200	$8,600,000
Operation & Maintenance		$142,310	$17,300	$167,360	$546,400
North Plant					
Construction Cost		$2,370,814	$2,898,240	$709,600	$709,600
Operation & Maintenance		$108,434	$1,059,641	$304,338	$304,338
South Plant					
Construction Cost		$2,371,918	$2,371,918	$1,641,400	$1,641,400
Operation & Maintenance		$150,372	$150,372	$547,977	$547,977
Total Operation & Maintenance		$401,116	$1,227,312	$1,019,674	$1,398,715
Present Worth Total O&M Costs	2	$5,217,685	$15,964,799	$13,263,856	$18,194,390
Total Construction Cost		$6,625,477	$5,582,458	$4,717,200	$10,951,000
Total Present Worth of Option		$11,843,162	$21,547,256	$17,981,056	$29,145,390

1 Area north of and along proposed North Belt Freeway

2 20 years, 4.5 percent

million for Alternative 3-2, showing Alternative 1 as the least cost alternative on a present worth cost basis.

Under Alternative 1, Sherwood's North and South plants are replaced by flow-rate equalization facilities, and all wastewaters, including that from the North Area, are conveyed to North Little Rock's Five-Mile Creek Plant for treatment. Implementation of this alternative is dependent upon a number of critical factors.

North Little Rock must be willing to accept these additional wastewaters and under terms acceptable to Sherwood. Given that approximately three-fourths of the wastewater generated by Sherwood sewer users is presently treated in the North Little Rock's Five-Mile Creek Plant, it seems reasonable that a suitable accommodation might be crafted between Sherwood and North Little Rock that would permit such an arrangement for the remaining Sherwood wastewater.

North Little Rock must expand its Five-Mile Creek Plant on the order of 40 to 50 percent to accommodate this additional Sherwood wastewater. Inclusion of flow-rate equalization for the Sherwood wastewaters will reduce the volume of expansion required and will minimize the capacities of the pump stations and force mains necessary to connect these wastewaters to the North Little Rock sewer system upstream of the Five-Mile Creek Plant.

Interim Measures

If it is decided that Alternative 1 is the alternative of choice, starting from the present it could take a minimum fo four to five years to fully implement this alternative. If it is decided to implement Alternative 1 in phases, the time required for full implementation could extend beyond five years. If the North or South plants are to remain in service for an extended period, several long-term improvements will be necessary as follows.

North Plant

If the North Plant is to be retained for an extended period, several long-term improvements will be necessary; if wastewater from the North Area is to be treated at the North Plant, the North Plant capacity should be increased by about 50 percent within the long-term improvements project. Proposed long-term plant improvements are included in Table 6-4.

Table 6-4
Proposed Long-Term Improvements
North Plant

Increase the capacity of the existing plant pump station and provide for variable rate pumping.
Revise the equalization basin: increase the water depth, provide aeration and mixing of basin contents, and include a means returning basin contents to the headworks at an adjustable rate.
Provide a flow management system at the headworks to permit flow-rate peaks to discharge to the equalization basin. This flow management system should include the ability to control operation of remote pump stations from the plant control system; install influent flow meter.
Add a second mechanical bar screen.
Provide a means of flow division between existing and future sequencing batch reactor (SBR) basins.
Modify the 2-basin original project (1997) SBR to operate as a single basin; verify that this SBR is in good operable condition; replace equipment and controls as necessary.
Provide standby blower(s); anticipate replacement of SBR recirculation pumps and all blowers.
Reconstruct the sludge storage lagoon to provide adequate capacity, adequate freeboard, and decant facilities; as a alternative, add sludge dewatering facilities replace of on-site lagoon storage of waste sludge.
Construct high-water protection for lower plant facilities.

South Plant

If the South Plant is to be retained in service for an extended period, several long-term improvements will be necessary. Proposed long-term South Plant improvements are included in Table 6-5.

Table 6-5
Proposed Long-Term Improvements
South Plant

Convert existing influent pump station to variable rate pumping;. install influent flow meter.
Revise the equalization basin: increase the water depth, provide aeration and mixing of basin contents, and include a means returning basin contents to the headworks at an adjustable rate.
Provide a flow management system at the headworks to permit the diversion of flow-rate peaks to discharge to the equalization basin.
Install duplicate bar screens (replace existing).
Install grit removal system.
Replace aeration system including blowers.
Rehabilitate existing integral clarifiers; or consider replacing integral clarifiers with external clarifiers.
Improve area lighting and access to various plant facilities.
Revise the sludge storage lagoon to provide adequate freeboard and a means of decanting surface waters to the plant headworks.

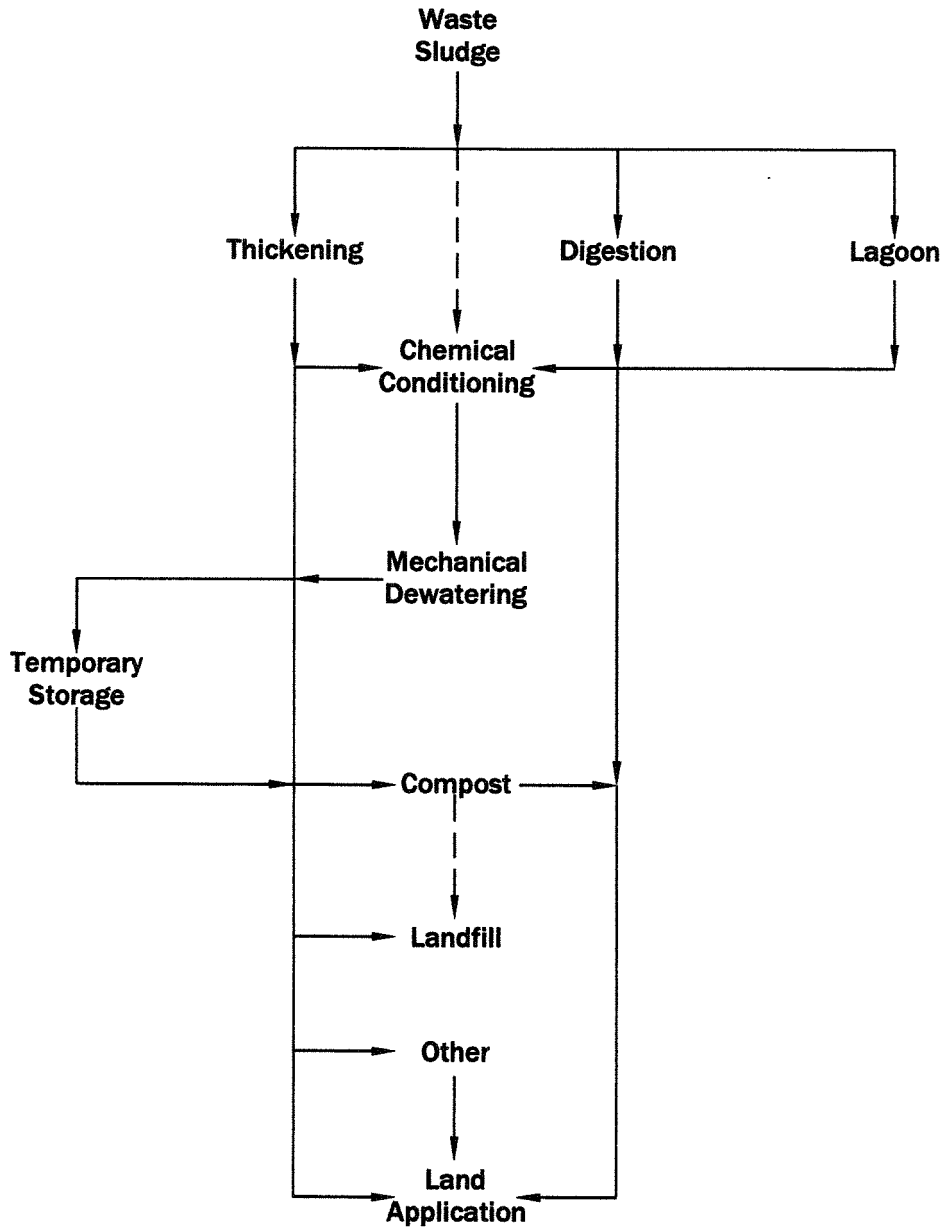
Section 7
Sludge Treatment and Disposal

From a regulatory perspective, the options available for ultimate disposal of municipal sewage sludge are limited. All practical disposal options currently available generally involve either land application (including treatment and reuse options), surface disposal (including landfills), and incineration. Of these three general ultimate disposal categories, land application and landfill are most appropriate for the scale of operation practiced at the Sherwood plants. Treatment and disposal of municipal sewage sludge in Arkansas is governed by federal regulation 40 CFR Part 503 and Arkansas Pollution Control and Ecology Commission solid waste management rules (Regulation 22.704).

A comprehensive sludge treatment and disposal flow sheet showing various processes considered in this Master Plan as being appropriate for an upgraded North plant is shown in Figure 7-1. A complete application of Figure 7-1 would result in a large number of possible options for treatment and disposal of waste plant sludge. Some of these options would be practical, and some would not. Including the current used option, a total of five waste sludge treatment and disposal options were developed from Figure 7-1 for consideration in this Master Plan.

Waste Solids

Waste solids generated during municipal wastewater treatment typically derive from the coarse screening operation, the girt removal operation, and the clarification processes. In the Sherwood plant, coarse screenings and removed grit are drained and disposed by landfill. This Master Plan assumes that these wastewater solids, where present, will continue to be disposed in this manner. The majority of waste solids generated in the two Sherwood plants consist of influent suspended solids and excess sludge accumulating within the secondary process as a consequence of the biological treatment of influent wastewater. Dissolved and particulate organic material present in the wastewater is converted to biological mass in the secondary treatment process (sequencing batch reactor in the North plant or aerated lagoon in the case of the South plant). A portion of this biological mass is retained in the process to provide continuous treatment of influent pollutants, but that portion of the mass that exceeds process requirements must be removed from the system. This excess mass is removed and treated separately as waste sludge.



SLUDGE TREATMENT AND DISPOSAL OPTIONS
SHERWOOD, ARKANSAS

Figure 7-1

Sludge Production

There is little information available concerning sludge production at the existing Sherwood plants from which to estimate design-year production rates. In the late 1970s, after a number of wastewater treatment plants had been constructed under the EPA construction grant program included as part of the 1972 Federal Clean Water Act, it was found that many of the plants did not meet design expectations and NPDES permit requirements. In response to these findings, EPA initiated a comprehensive research project (6) to identify and quantify the causes of this poor performance. According to research findings, the most significant group of performance-limiting factors identified were those associated with sludge production and wasting requirements in activated sludge plants. The study concluded that a sludge production ratio of approximately 0.75 pounds of TSS per pound of BOD5 removed represents a realistic value for providing adequate sludge handling facilities. For the purposes of this Master Plan, the design-year sludge production rate is taken to be 0.75 pounds TSS per pound of BOD5.

Sludge Treatment and Disposal Options

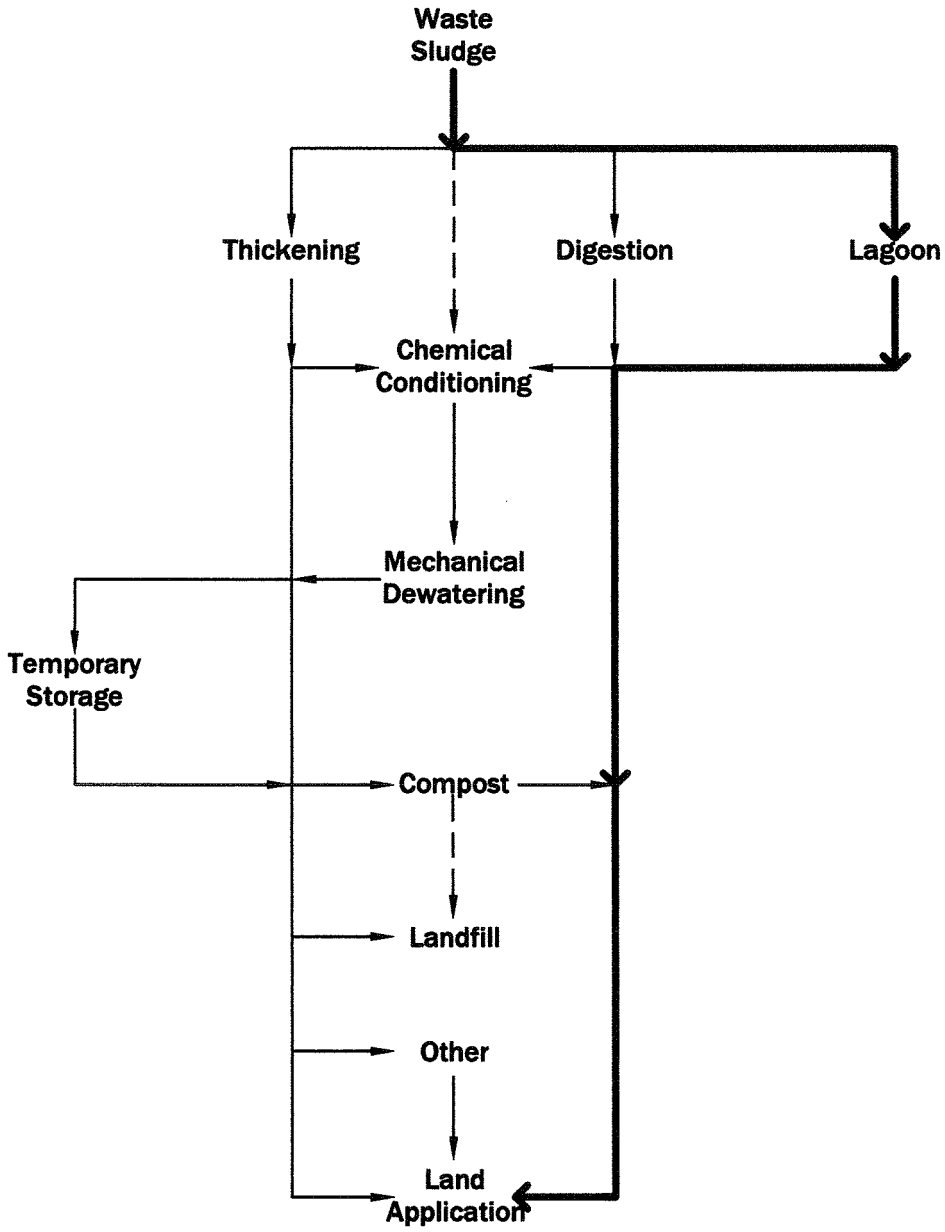
Option S1 (Current Option)

According to their respective discharge permits, sludge generated at Sherwood's two treatment plants is stored on-site by lagooning. This is, of course, a temporary arrangement as these lagoon(s) will eventually fill to the point of having to be cleaned of stored sludge. This treatment and disposal option assumes that the lagoon(s) will be cleaned periodically, as required, and the sludge disposed by land application. It is further assumed that the cleaning and disposal operation will be accomplished through a competitively bid approach. Option S1 is shown in Figure 7-2.

Option S2

Option S2 is shown in Figure 7-3. Under this option waste sludge is aerobically digested, chemically conditioned, and mechanically dewatered to a solids content of 18 to 20 percent before being land-applied at a dedicated disposal site.

The general requirements, pollutant limits, management practices, and operational standards for the land application of sewage sludge in Arkansas are included in federal regulation



SLUDGE TREATMENT AND DISPOSAL OPTION S1
SHERWOOD, ARKANSAS

Figure 7-2

40 CFR Part 503. This regulation establishes operational standards with respect to pathogen and vector attraction reduction and classifies sewage sludge as either Class A or Class B with respect to pathogens.

To be acceptable for application to agricultural and non-agricultural land, sewage sludge must meet at least the pollutant ceiling concentrations, Class B requirements for pathogens, and vector attraction requirements. Sewage sludge disposed on lawns and home gardens or given away or sold must meet Class A requirements and must apply one of a number of available vector attraction reduction processes.

Pollutant and ceiling concentrations included in 40 CFR Part 503 are compared to the pollutant content of Sherwood's North Plant waste sludge, as determined by the most recent analyses, in Table 7-1. As can be seen from this table, Sherwood waste sludge pollutant concentrations are within acceptable federal limits for disposal by land application.

Option S3

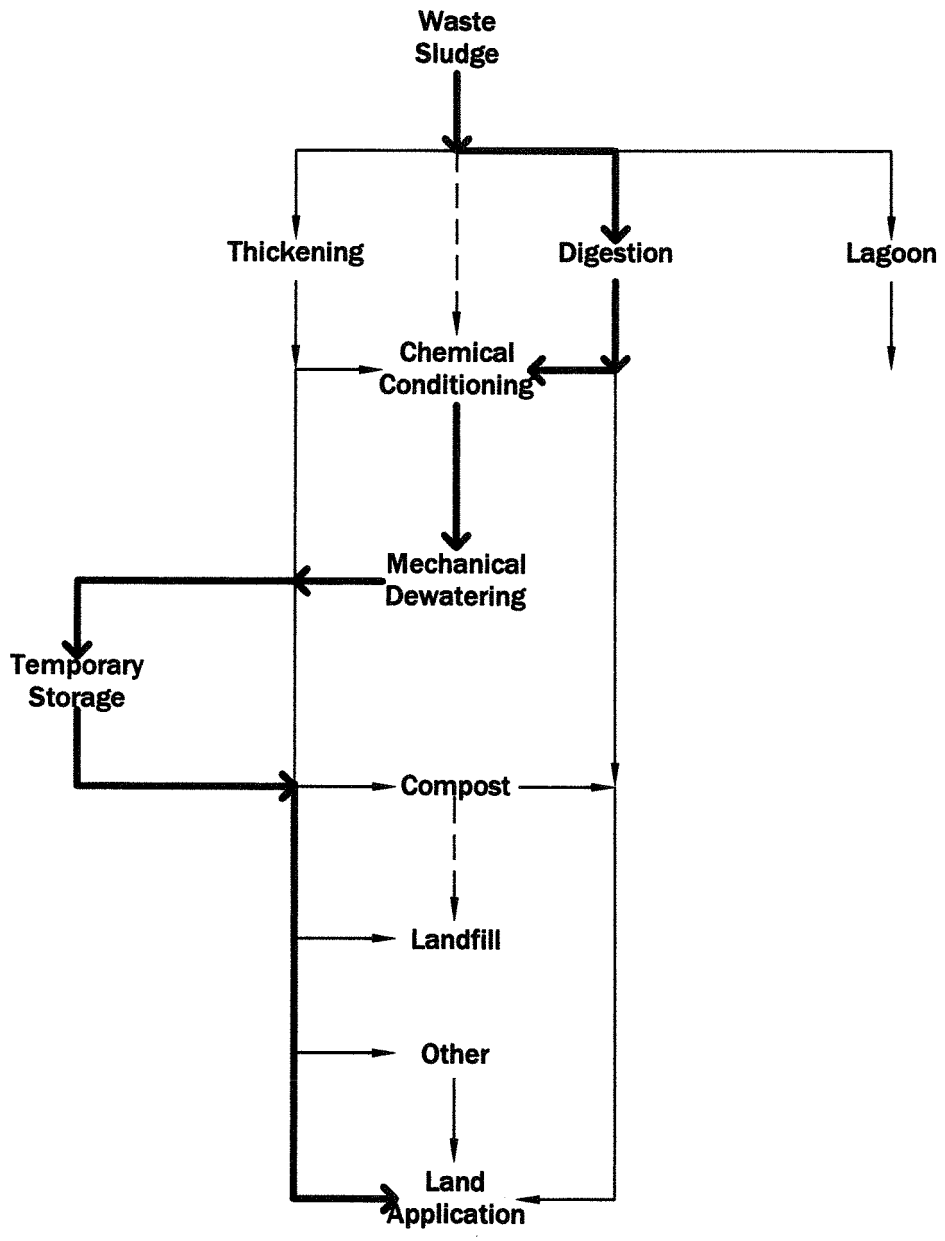
The components of this option are shown in Figure 7-4. Under this option waste sludge is gravity-thickened, chemically-conditioned, mechanically dewatered to a solids content of 18 to 20 percent, and composted before being disposed. Depending upon the character of the process and management of temperature, the composting process can produce a sludge meeting either Class A or Class B requirements. Class B sludge can be land-applied provided that certain site-restrictions are met; while, Class A sludge can be land-applied with no site restriction. Under this option, the term land-applied includes such re-use disposal practices as application to yards or gardens or use in public or private landscaping.

Option S4

Option S4 components are shown in Figure 7-5. Option S4 is similar to Option S3 except that the composting step is replaced by a step that further treats the dewatered sludge with a thermal drying process meeting the requirements of Appendix B to 40 CFR Part 503 (process to further reduce pathogens). Such processes should produce a treated sludge meeting Class A requirements with little or no restrictions for re-use by land application.

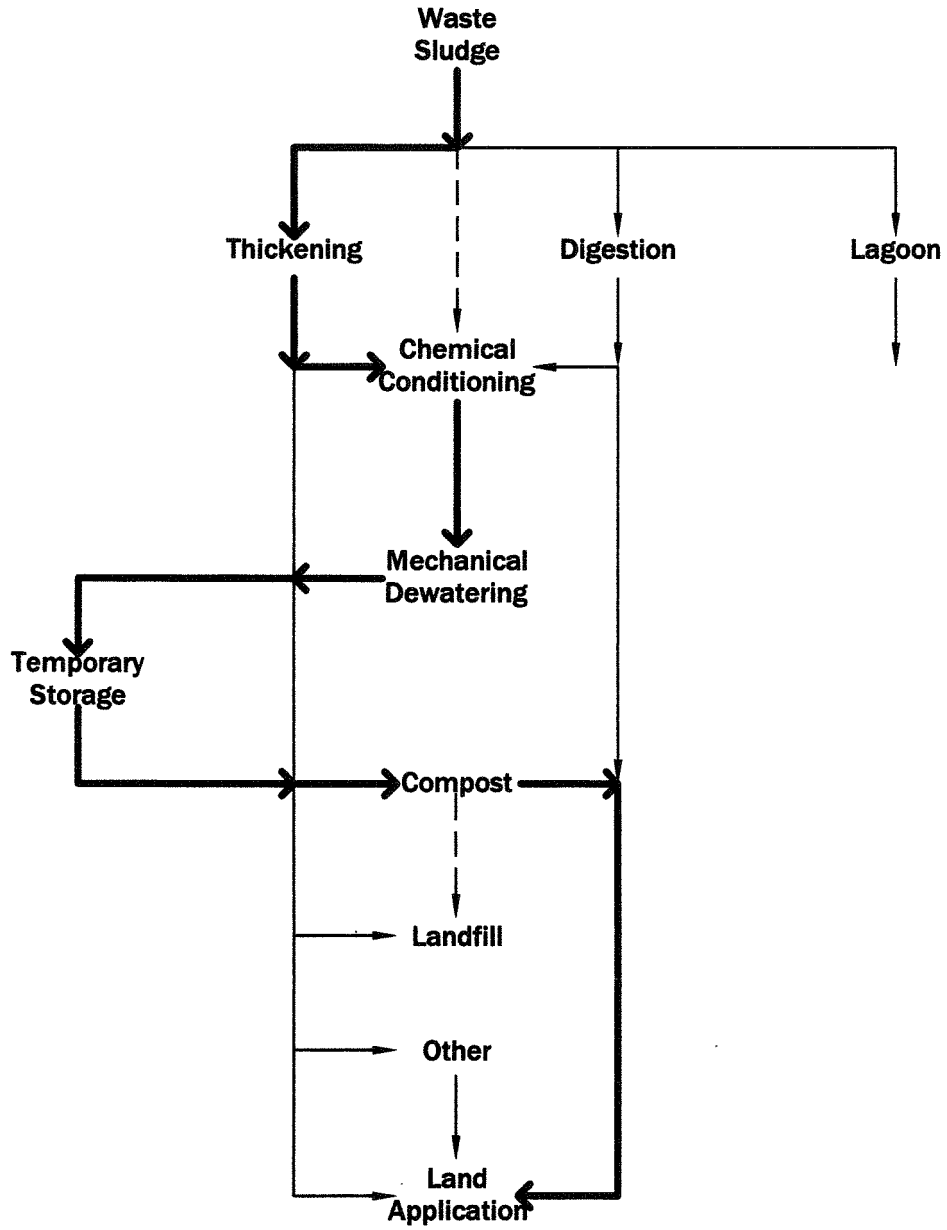
Table 7-1
Lagooned Waste Sludge Sample Results
North Plant -- Sherwood, Arkansas

	40 CFR Part 503 Concentrations			Sample Number (6/19/09 Samples)						
	Ceiling	Pollutant	Sample							
	(Table 1)	(Table 3)	Averages	1	2	3	4	5	6	7
Pollutant	mg/kg dry	mg/kg dry	mg/kg dry	mg/kg dry	mg/kg dry	mg/kg dry	mg/kg dry	mg/kg dry	mg/kg dry	mg/kg dry
Arsenic	75	41	< 23.5	< 18.7	< 18.6	< 17.9	< 46.0	< 20.1	< 20.5	< 22.4
Cadmium	85	39	2.26	2.07	1.94	1.92	3.51	1.84	2.39	2.17
Copper	4300	1500	254	217	244	210	425	216	221	245
Lead	840	300	17.6	17.1	17	13.5	27.7	14.7	17.3	16
Mercury	57	17	< 6.74	< 5	< 5	< 4.77	< 13.9	< 5.56	< 7	< 5.98
Molybdenum	75		< 6.69	< 5.33	< 5.31	< 5.1	< 13.1	< 5.72	< 5.85	< 6.39
Nickel	420	420	13.5	12.4	13.4	11.3	19.7	11.4	13.9	12.7
Selenium	100	100	< 67.4	< 50	< 50	< 47.7	< 139	< 55.6	< 70	< 59.8
Zinc	7500	2800	723	656	681	620	1180	625	650	652



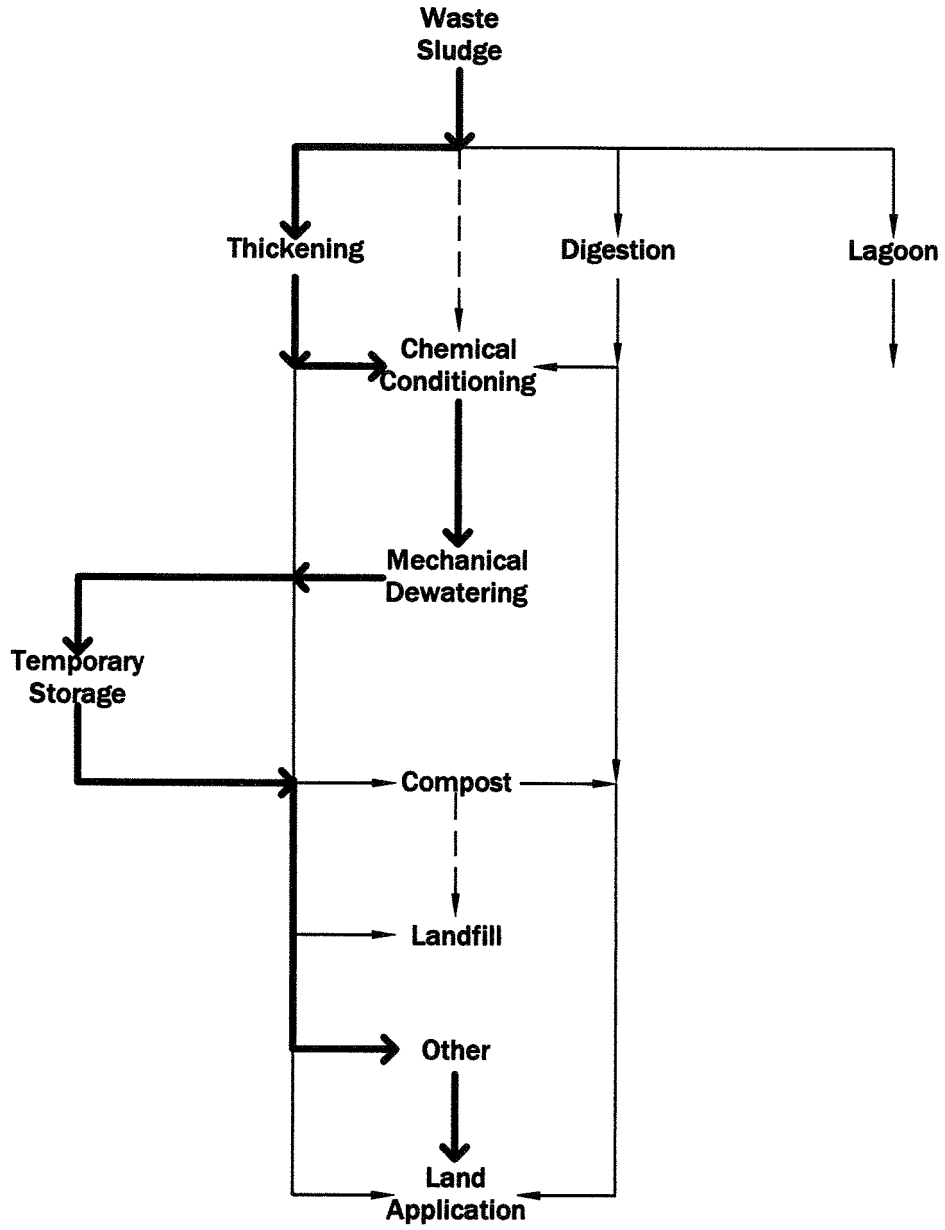
SLUDGE TREATMENT AND DISPOSAL OPTION S2
SHERWOOD, ARKANSAS

Figure 7-3



SLUDGE TREATMENT AND DISPOSAL OPTION S3
SHERWOOD, ARKANSAS

Figure 7-4



SLUDGE TREATMENT AND DISPOSAL OPTION S4
SHERWOOD, ARKANSAS

Figure 7-5

Option S5

Option S5 is shown in Figure 7-6. Option S5 is similar to Option S4 except that the thermal drying step is replaced by landfill disposal.

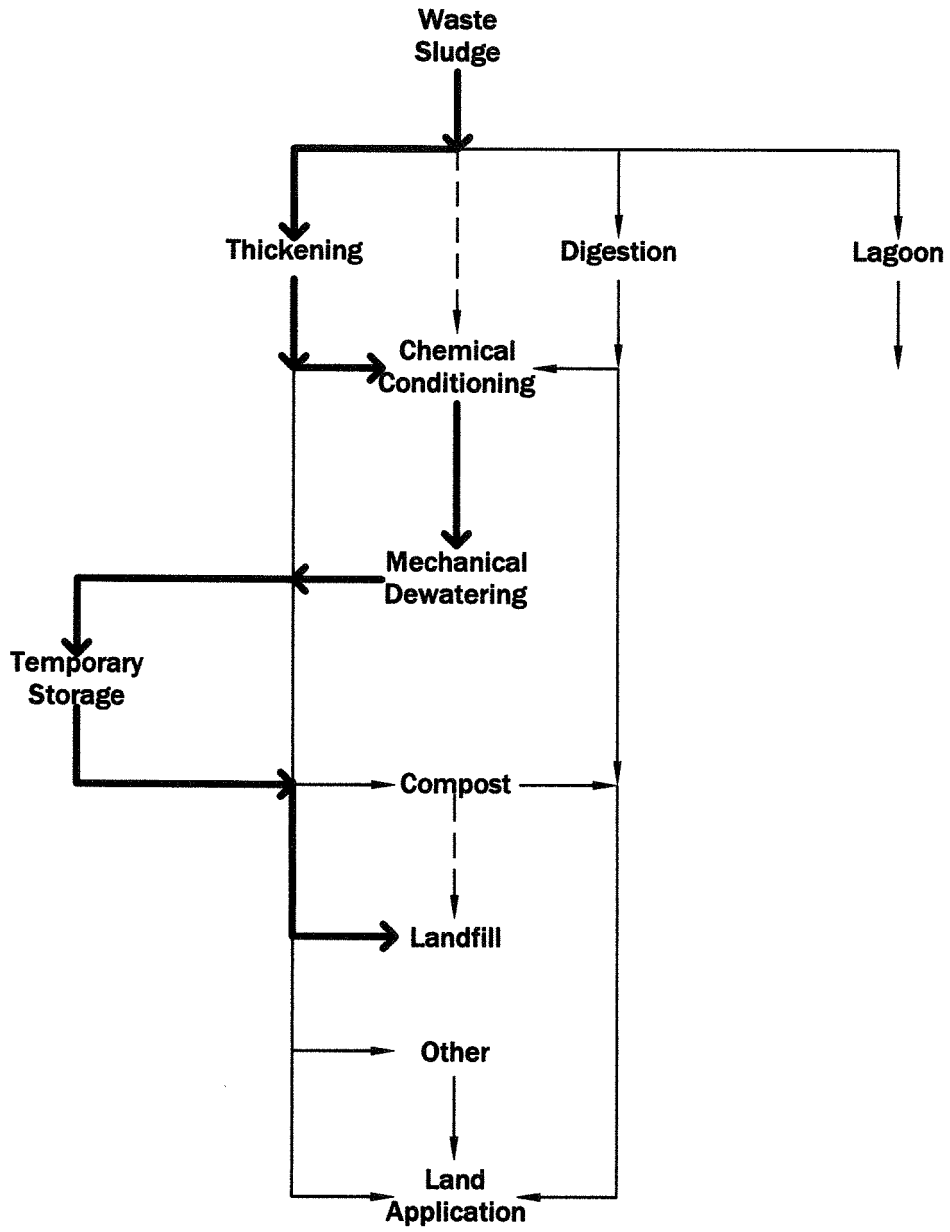
Cost Comparison

The sludge treatment and disposal options presented above are compared on a present worth cost basin in Table 7-2.

The estimated costs given in Table 7-2 were developed to compare relative costs of sludge treatment and disposal options and are order-of-magnitude estimates only. Actual project costs for such facilities will depend upon a number of factors including project scope and schedule, site conditions, market conditions, and the like. Base construction costs and annual operation and maintenance costs are assumed to be constant, and the present worth of such costs is calculated using an equal-payment-series present worth factor at a discount rate of 4.5 percent and a 20-year planning period. Costs were developed from a number of sources including EPA cost curves, engineer records, equipment manufacturer's data, and site-specific information. Cost curve data were adjusted for inflation using Engineering New Record construction cost indices.

As can be seen from this present worth cost analysis, of the options considered, sludge treatment and disposal option S5 gives the lowest total present worth cost by a rather slim margin over Option S1, with Option S2 running a reasonably close third. Options S3 and S4 were costed without an ultimate disposal method. It is thought that the Class A sludge to be produced by either of these options could readily be given away or used by the City for landscaping or other uses at costs much less that required for ultimate disposal by landfill or other land application.

It should be noted that an annual cost is included under Option S1 for contract disposal of lagooned solids. The value of this cost determines which option–Option S1 or Option S5–shows to be most cost-effective by the present worth cost analysis. Should the actual cost to clean the lagoon and land-apply the lagoon contents be much less that the contract disposal cost shown, Option S1 would be the least cost option. It should also be noted that selection of Option S1 leaves no flexibility to utilize other ultimate disposal methods as does Option S5.



SLUDGE TREATMENT AND DISPOSAL OPTION S5
SHERWOOD, ARKANSAS

Figure 7-6

Table 7-2
Present Worth Cost Analysis
Sludge Treatment and Disposal Options

Process or Operation	Cost	Option S1	Option S2	Option S3	Option S4	Option S5
Gravity Thickening						
Base Capital Cost	$152,440			$152,440	$152,440	$152,440
Labor	$4,500			$4,500	$4,500	$4,500
Energy & Fuel	$500			$500	$500	$500
Materials & Maint	$1,442			$1,442	$1,442	$1,442
Aerobic Digestion						
Base Capital Cost	$412,000		$412,000			
Labor	$18,000		$18,000			
Energy & Fuel	$1,400		$1,400			
Materials & Maint	$2,472		$2,472			
Chemical Conditioning						
Base Capital Cost	$61,800		$61,800	$61,800	$61,800	$61,800
Labor	$12,000		$12,000	$12,000	$12,000	$12,000
Polymer	$4,974		$4,974	$4,974	$4,974	$4,974
Materials & Maint	$1,339		$1,339	$1,339	$1,339	$1,339
Mechanical Dewatering						
Base Capital Cost	$432,600		$432,600	$432,600	$432,600	$432,600
Labor	$14,250		$14,250	$14,250	$14,250	$14,250
Energy & Fuel	$1,000		$1,000	$1,000	$1,000	$1,000
Materials & Maint	$37,080		$37,080	$37,080	$37,080	$37,080
Temporary Storage						
Base Capital Cost	$48,000		$48,000	$48,000	$48,000	$48,000
Labor	$3,900		$3,900	$3,900	$3,900	$3,900
Energy & Fuel	$2,500		$2,500	$2,500	$2,500	$2,500
Materials & Maint	$1,500		$1,500	$1,500	$1,500	$1,500
Composting						
Base Capital Cost	$1,030,000			$1,030,000		
Labor	$34,500			$34,500		
Energy & Fuel	$45,000			$45,000		
Materials & Maint	$185,400			$185,400		
Lagoon Storage						
Base Capital Cost	$556,200	$556,200				
Labor	$7,800	$7,800				
Energy & Fuel	$9,000	$9,000				
Materials & Maint	$5,768	$5,768				
Contract Disposal	$250,000	$250,000				
Land Application						
Base Capital Cost	$1,091,800		$1,091,800			
Labor	$51,000		$51,000			
Energy & Fuel	$21,000		$21,000			
Materials & Maint	$35,200		$35,200			
Land Fill						
Hauling Base Cap Cost	$164,800					$164,800
Unit Tipping Fee, $/ton	$28.00					$38,696
Hauling Labor	$40,500					$40,500
Hauling Fuel	$25,500					$25,500
Hauling Maintenance	$41,200					$41,200
Other (Thermal Drying)						
Base Capital Cost					$1,350,000	
Operation & Maintenance					$250,000	
Total Annual O&M		$272,568	$207,615	$349,885	$334,985	$230,881
Present Worth Total O&M, 7.5%, 20 years		$3,545,547	$2,700,643	$4,551,282	$4,357,464	$3,003,285
Total Base Capital Costs		$556,200	$2,046,200	$1,724,840	$2,044,840	$859,640
Total Present Worth		$4,101,747	$4,746,843	$6,276,122	$6,402,304	$3,862,925

Section 8
Collection and Pumping

The Sherwood wastewater collection system, like most municipal wastewater systems, can be subject to excessive inflow and infiltration during wet-weather events. Such extraneous water frequently leads to wastewater flow rates that exceed system capacities, and sanitary sewer overflows (SSOs) typically result. The November, 2008 Consent Administrative Order (DEQ Order) called for Sherwood to complete a comprehensive evaluation of the Sherwood municipal wastewater collection system with the objective of identifying "...all wastewater mains and pumping stations that cannot carry peak hydraulic loads caused by inflow and infiltration."

In response to these requirements, Sherwood is conducting a comprehensive evaluation of its wastewater system (referred to as a sewer system evaluation study, or SSES) with the ultimate objective of discovering those parts of the collection system subject to hydraulic overloads and selecting appropriate corrective measures. The initial phase of the SSES involved manhole inspections and updating of system maps. A parallel effort involved dry-weather and wet-weather flow rate measurements at selected manholes.

By Court Order (3), sewer customers within the City of Sherwood are divided into three categories: Sherwood customers, District customers, and North Little Rock customers. By default, this Order divided the Sherwood sewer system into two categories: sewers that are owned, operated, and maintained by the City of Sherwood and sewers that are owned, operated, and maintained by North Little Rock. Based on population, it is estimated that the pre-2008 annexation Sherwood city limit included approximately 575,000 linear feet of municipally-owned gravity sewers. The SSES identified about 346,913 linear feet (60 percent) of municipal gravity sewer within the pre-annexation area that is owned, operated, and maintained by the City of Sherwood, leaving about 228,087 linear feet (40 percent) as being the responsibility of North Little Rock.

The measurement of dry and wet weather wastewater flow rates involved the installation of eleven wastewater flow-rate meters at selected locations defining eight basins within the Sherwood collection system. Wet and dry weather flow-rate data was recorded at each meter site and was used to estimate the severity of wet-weather induced inflow and infiltration within each of the designated collection system basins. The results of this wastewater flow-rate study (5) concluded that over half of the wet-weather induced inflow and infiltration (also called rainfall dependent inflow and infiltration, or RDII) occurs from about one-third of the collection system,

and about 90 percent of the measured RDII occurs from five of the metered basins. Table 8-1 gives the size of the eight flow-metered basins by linear feet of gravity sewer and also gives the priority assigned to each basin according to severity of defects indicated. Priority 1 indicates the basin with the greatest number of structural defects leading, in turn, to the largest flow rates arising from RDII. The flow-rate study concluded that these five basins (2, 1, 7, 8, and 12) should be subjected to further investigation with the goal of identifying the structural defects serving as sources of extraneous water entering the collection system and selecting appropriate repair and rehabilitation methods. The results of these further studies will be used to define basin-specific rehabilitation projects.

Table 8-1
Estimated Sewer System Inventory by Basin and Priority
Sherwood, Arkansas

Basin		Linear Feet of Gravity Sewer[3]
Number	Priority[1]	
1	2	39,531
2	1	15,913
5	8	24,949
7	3	19,028
8	4	57,358
9[2]	-	47,687
10	6	24,957
11	7	46,299
12	5	71,191
Total		346,913

1. From SSES Report (5)
2. Designation for all sewers not in other basins.
3. Owned, operated, and maintained by Sherwood.

This Master Plan assumes the completion of these studies and eventual completion of the respective rehabilitation projects. It should be noted that basin-specific collection system repair and rehabilitation costs cannot be determined until the basin studies are completed; however,

projections of possible project costs can be made on the basis of previous similar projects, and the repair and rehabilitation costs included in this Plan are based on data from similar projects completed elsewhere. These estimated costs must be adjusted and updated as the results of Sherwood-specific studies become available. Potential Sherwood collection system rehabilitation costs, based on similar projects, are given in Table 8-2.

Successful sewer system rehabilitation accomplishes several cost-effective objectives. Sewer system rehabilitation increases the effective capacity of existing sewers by eliminating storm water that is consuming existing capacity and thereby postponing the need for new or supplemental sewer capacity by extending the capacity life of existing sewers. Effective rehabilitation also lowers treatment costs by reducing the wet-weather load on the wastewater treatment plant. A successful rehabilitation program also tends to increase effective capacity of a treatment plant by eliminating the extraneous water that otherwise consumes plant capacity; the availability of this "additional" treatment capacity may allow postponement of an otherwise needed plant expansion.

The Corrective Action Plan, submitted to DEQ in response to the DEQ Order, (Appendix 1) anticipated that the Sherwood collection system would be divided into eight basins for rehabilitation purposes and that the sewers in two of the eight basins would be rehabilitated each year. In keeping with this assumption and using information presented in the SSES flow-rate measurement report, the Sherwood sewer system rehabilitation program might be similar to the four-year program presented in Table 8-2.

Table 8-2
Potential Four-Year Sewer System Rehabilitation Program
Sherwood, Arkansas

Start	Priority[1]	Basin	Estimated Cost[2]
2010	1, 2	1 & 2	$707,100
2011	3, 4	7 & 8	$1,003,400
2012	5, 6	10 & 12	$1,300,900
2013	7, 8	11 & 5	$992,200

1. Per flow-rate measurement report (5)
2. Inflation adjusted at 3%/yr; includes proration of Basin 9

Once a pair of basins has been rehabilitated, a second (post-rehabilitation) flow-rate measurement program should be conducted for the rehabilitated basins. A comparison of pre-rehabilitation with post-rehabilitation flow-rate measurements can then be made to estimate the effectiveness of the rehabilitation effort. The capacity of the existing collection system and pump stations to accept additional wastewater from population growth cannot be determined until the effectiveness of the rehabilitation work is known. Once the post-rehabilitation flow-rate data is available, an assessment can be made of the need for supplemental capacity in a particular basin.

The largest area of developable (but typically unsewered) property within the Sherwood planning area lies generally north of the proposed North Belt Freeway route, west of Highway 107, and east of Camp Robinson. Drainage is provided by Bayou Meto and its tributaries, Kellogg Creek and its tributaries from the north. For planning purposes, this area is collectively called the North Area.

It seems logical to gather wastewaters generated in that part of the Bayou Meto watershed that is within the North Area by a series of 8-inch, 10-inch, and 12-inch gravity sewers to a wastewater pump station located just north of the Highway 107 Bayou Meto crossing. This pump station, herein called the Bayou Meto Pump Station, should have a firm capacity of about 700 gpm and should discharge through a 10-inch force main running generally west and south along Highway 107 approximately 4,900 feet and then turning west to connect to a proposed 18-inch gravity sewer tributary to a proposed Kellogg Creek Pump Station. A small pump station will likely be required to serve a portion of the Bayou Meto drainage area that lies to the north and west of Highway 107 and east of the Bayou Meto flood plain. The location and anticipated size of these proposed sewers are shown on Plate I.

It seems reasonable to provide sewer service for that part of the North Area tributary to Kellogg Creek by a series of 8-inch, 10-inch, 12-inch, and 18-inch sewers tributary to a wastewater pump station located on the north side of Kellogg Creek just west of the Highway 107 Kellogg Creek crossing. This pump station, herein referred to as the Kellogg Creek Pump Station, should have a firm capacity of about 1,400 gpm and should discharge through a 14-inch force main running generally south, west of and parallel to Highway 107, to connect to an existing manhole on a 21-inch gravity sewer tributary to the existing Brockington Pump Station. The Brockington Pump Station discharges directly to the North Plant through an 18-inch force main. The location and anticipated size of the proposed Kellogg Creek drainage area sewers are shown on Plant I.

Section 9
Revenue, Expenses, and User Charges

Customer Base

The Sherwood wastewater customer base is somewhat complicated. Wastewater generated by residents of Sherwood is currently treated in either of three wastewater treatment plants: Sherwood's North Plant, Sherwood's South Plant, or in North Little Rock's Five-Mile Creek Plant. Sherwood residents whose wastewater is treated in the Five-Mile Creek Plant are further sub-divided into three categories by the Court Order (3), namely, Sherwood customers, District customers, and North Little Rock customers. There are also Sherwood residents whose service line is connected to a sewer main operated and maintained by North Little Rock Waste Water Utility who are considered to be North Little Rock customers for billing purposes.

It is typical with most municipal water and sewer systems for sewer user charges to be based on water consumption as measured through a water meter. In the case of Sherwood and North Little Rock, water service is provided by Central Arkansas Water (CAW), and, generally speaking, all Sherwood and North Little Rock sewer customers are also CAW customers with respect to water service. When CAW bills Sherwood or North Little Rock sewer users for water service, it also bills those customers for sewer service on behalf of Sherwood or North Little Rock as appropriate.

Central Arkansas Water bills Sherwood's North Plant and South Plant customers directly at Sherwood rates for sewer service (according to water consumption) and renders the resulting revenue directly to Sherwood on a monthly basis. Central Arkansas Water also bills the Sherwood category of Sherwood sewer customers tributary to the Five-Mile Creek Plant directly for sewer service and renders the resulting revenue directly to Sherwood on a monthly basis. North Little Rock Waste Water Utility, in turn, renders a lump sum monthly bill to Sherwood for sewer service provided the Sherwood sewer customers. This monthly bill that North Little Rock Waste Water Utility renders to Sherwood for wastewater treatment service provided by Five-Mile Creek Plant for residents of Sherwood in the Sherwood category is determined according to a method set forth in the Court Order. This method allocates total Five-Mile Creek Plant costs to each category of Five-Mile Creek Plant customers (Sherwood customers, District customers, or North Little Rock customers) on the basis of water consumption as determined by CAW water meter readings.

Central Arkansas Water bills the residents of Sherwood who are also sewer customers tributary to the Five-Mile Creek Plant and are in the District category or are otherwise North Little Rock sewer customers directly at North Little Rock rates for sewer service and renders the resulting revenue directly to North Little Rock Waste Water Utility.

Cost of Treatment

Sherwood operates and maintains a wastewater system including collection network, pump stations, and two treatment plants. Wastewater system expenses for the years 2007 and 2008 are allocated to these three components of the wastewater system in Table 9-1. As can be seen from the calculations presented in this table, the estimated 2008 cost for Sherwood to provide wastewater treatment in its North and South Plants was about $178 per customer in 2007 and about $205 per customer in 2008, or about a 16 percent increase of 2008 over 2007.

Those Sherwood customers in the "Sherwood" category (as defined by the Court Order) have their wastewater treated in North Little Rock's Five-Mile Creek Plant, and the North Little Rock Waste Water Utility bills Sherwood a lump sum each month for the cost of that treatment service. Table 9-2 gives those billings on an annual basis for the years of 2007 and 2008. As can be seen from Table 9-2, the cost to Sherwood for treatment by North Little Rock's Five-Mile Creek Plant was about $138 per customer in 2007 and about $146 per customer in 2008, or about a six percent increase of 2008 over 2007.

A comparison of the per customer cost data given in Table 9-1 and 9-2 will show that it cost about 30 percent more in 2007 and about 40 percent more in 2008 for Sherwood to operate and maintain wastewater treatment at its North and South Plants than to purchase wastewater treatment from North Little Rock in its Five-Mile Creek Plant. This cost difference likely derives from several factors including economy of scale and degree of treatment. At a design flow rate of 6.6 mgd, the Five-Mile Creek Plant is significantly larger than either of Sherwood's plants. In general, the effluent limits included in a wastewater treatment plant's permit relate directly to the capacity of the receiving stream to accept the treated discharge. The greater the capacity of the receiving stream, the less strict are the discharge limits, and the less strict the limits, the less expense to treat to compliance. The effluent from the Five-Mile Creek Plant is pumped directly to the Arkansas River, while the receiving streams for Sherwood's plants are much smaller and have much less capacity to accept a treated wastewater discharge.

Table 9-1

Estimated Cost of Wastewater Treatment
North and South Plant Customers
Sherwood, Arkansas

	Component Cost Allocation			2007		2008	
Expense Category	Admin	Collection	Treatment	Total O&M	Treatment Only	Total O&M	Treatment Only
Labor	25%	38%	38%	$212,558	$79,709	$328,233	$123,087
Professional Fees	10%	45%	45%	$21,653	$9,744	$36,903	$16,606
Insurance	25%	38%	38%	$6,474	$2,428	$7,055	$2,646
Utilities	5%	25%	70%	$104,780	$73,346	$128,576	$90,003
Supplies & Chemicals	1%	30%	69%	$18,292	$12,621	$24,368	$16,814
Vehicles & Equipment	10%	65%	25%	$22,455	$5,614	$18,608	$4,652
Laboratory	0%	0%	100%	$16,640	$16,640	$30,939	$30,939
Miscellaneous	10%	45%	45%	$15,040	$6,768	$6,172	$2,777
Pump Stations	0%	100%	0%	$8,283	$0	$54,448	$0
Collection System	0%	100%	0%	$28,570	$0	$78,484	$0
Debt Service	0%	0%	100%	$102,756	$102,756	$102,756	$102,756
Depreciation	20%	40%	40%	$315,000	$126,000	$315,000	$126,000
Cost Totals				$872,501	$435,626	$1,131,542	$516,281
Estimated Number of Customers Tributary to North and South Plants					2,441		2,514
Annual Treatment Cost per Customer					$178.47		$205.36

Table 9-2
Cost to Sherwood of Wastewater Treatment
in North Little Rock's
Five-Mile Creek Wastewater Treatment Plant

	2007	2008
Cost of Operations to Sherwood	$320,638	$349,037
Customers per Year	27,966	28,627
Unit Cost to Sherwood, $/cust/year	$137.58	$146.31

Revenues and Expenses

The Sherwood wastewater system derives its operating revenues from user charges, other operating income such as connection fees and penalties, and interest. Operation and maintenance expenses relate to administration of the wastewater system; operation and maintenance of the collection system, pump stations, and the North and South plants; and charges rendered by North Little Rock Waste Water Utility for treatment of Sherwood wastewater in the Five-Mile Creek Plant. Of the available revenue sources, typically 85 to 95 percent of system revenue comes from user charges, and user charge revenue is not indexed for inflation. Wastewater utility expenses, however, are much effected by inflation and other cost pressures.

Historical Sherwood wastewater system revenue and expense information for 2007-2008 is given in Table 9-3. As can be seen, revenues declined about 5.4 percent from 2007 to 2008, while system operation and maintenance expenses (excluding depreciation) increased over 22 percent over the same period. This resulted in a revenue shortfall of over $260,000 for 2008. If depreciation is included, the 2008 shortfall would be almost $600,000. Table 9-3 also gives a four-year projection (three years beyond current year) of wastewater system revenues and expenses assuming a constant level of revenue (no increase in user charges) and an annual increase in operation and maintenance expenses of ten percent, which is not unreasonable for a wastewater utility. As can be seen, at these expense levels and with no increase in user charge revenue, the shortfall in a few brief years, even without funding depreciation, will likely exceed two million dollars. Certainly, the fiscal health of the Sherwood wastewater system is at risk.

Table 9-3
Historical and Projected Wastewater System Revenue and Expenses
Sherwood, Arkansas

	Historical		Percent		Projection			
	2007	2008	Change	Notes	2009	2010	2011	2012
Revenue								
User Charges	$768,669	$784,551	2.1%					
Other	$13,115	$9,048	-31.0%					
Interest	$112,609	$52,628	-53.3%					
Total Revenue	$894,393	$846,227	-5.4%	1	$870,310	$870,310	$870,310	$870,310
Expenses								
System Operation & Maintenance	$618,363	$757,677	22.5%					
Five-Mile Creek Treatment	$320,638	$349,037	8.9%	4				
Total Operation & Maintenance Expenses	$939,001	$1,106,714	17.9%	2	$1,217,385	$1,339,123.94	$1,473,036	$1,620,340
Estimated Depreciation	$315,000	$315,000		3	$315,000	$315,000	$315,000	$315,000
Total O&M Expenses plus Depreciation	$1,254,001	$1,421,714			$1,532,385	$1,654,124	$1,788,036	$1,935,340
Revenue less Total O&M Expenses	-$44,608	-$260,487			-$347,075	-$468,814	-$602,726	-$750,030
Cumulative Shortfall					-$347,075	-$815,889	-$1,418,616	-$2,168,646
Rev less Total O&M Exp less Depreciation	-$359,608	-$575,487			-$662,075	-$783,814	-$917,726	-$1,065,030
Cumulative Shortfall					-$662,075	-$1,445,889	-$2,363,616	-$3,428,646

1 Revenue projected at constant amount equal to average of 2007 & 2008
2 Total expenses projected forward at annual increase of 10%
3 Estimated depreciation requirement for population served
4 Cost of operations per NLRWWU; Sherwood allocation

Not only is the current Sherwood rate structure not meeting routine operation and maintenance requirements, no system depreciation is provided for. Depreciation is a legitimate component of the cost of operating and maintaining a municipal wastewater utility. Depreciation can be defined as the loss in value of utility assets that takes place from the wear and tear of use, decay or corrosion, obsolescence, or exceeding capacity, that is not replaced by maintenance. The funding of depreciation as a revenue requirement permits the recovery of a capital investment over its anticipated service life. On the other hand, failure to adequately fund depreciation leaves the utility with no readily available revenue source from which to replace facilities as they wear out or become obsolete. Failure to fund depreciation through user charges frequently results in excessive borrowing which can, in turn, place a utility under a significant debt burden.

Table 9-4 presents a comparison of sewer user charges for the City of Sherwood and the nearby cities of Jacksonville, Little Rock, and North Little Rock. The monthly bills shown are for a consumption of five thousand gallons as measured through a water meter. A state rank at the 15th percentile means that 85 percent of Arkansas municipal sewer users incur a higher monthly sewer bill for five thousand gallons of water consumption than does the sewer customer whose monthly bill is a the 15th percentile. From this table, it appears that there is room for some adjustment in Sherwood sewer user charges.

Table 9-4
Monthly Residential Sewer Bills
for Five Thousand Gallons Consumption
Selected Cities

Wastewater Utility	Unit Charge, $ per thou gals	Monthly Bill for 5 thou gal Consumption[1]	Rank Among Arkansas Public Sewer Systems[2]
Jacksonville	$3.98	$23.30	79th Percentile
Little Rock[3]	$3.93	$34.28	96th Percentile
North Little Rock	$3.41	$17.05	49th Percentile
Sherwood	$2.26	$11.30	15th Percentile

1. Excludes other charges such as franchise fees, taxes, and such
2. Based on March, 2008 municipal rate survey by ANRC
3. Includes a $14.63 service availability charge

The data of Table 9-3 suggest that an average system revenue increase of about 70 to 100 percent over 2008 levels will be necessary to adequately fund routine Sherwood wastewater system operations for the 3-year period 2010-2012. It should be noted that such revenue increases do not provide for any new debt service that might be required to support wastewater system improvements such as sewer system rehabilitation, new collection system or pump station work, or wastewater treatment plant construction. It seems appropriate for Sherwood to commission a detailed study for the purposes of establishing a sewer user charge schedule adequate to properly support routine operation and maintenance, to provide for necessary improvements, and to fund depreciation.

Section 10
Consent Administrative Order Response

Consent Administrative Order

The City of Sherwood was placed under a Consent Administrative Order (DEQ Order) by ADEQ effective January 9, 2009. The DEQ Order addresses the reduction of sewer system wet-weather induced inflows and correction of hydraulic and treatment deficiencies.

The DEQ Order also calls for an evaluation of wastewater treatment capacities and capabilities leading to a comprehensive plan for improvements required to ensure permit compliance. The text of the comprehensive plan for DEQ Order compliance is included as Appendix 1.

Rather than select a short-term approach to the issues of concern included in the DEQ Order, it was elected to include compliance with the requirements of the DEQ Order in the preparation of a wastewater system master plan. Such an approach should address immediate problems and avoid repeated offences. This Master Plan addresses outstanding issues raised in the DEQ Order as follows. Reference is made to the test of the DEQ Order as included in Appendix 1.

Sherwood increased staffing within the wastewater system, conducted additional training, completed equipment maintenance and repairs to wastewater treatment facilities, which brought the North and South Plants into compliance with their respective permits. Compliance is demonstrated through the effluent data shown in Figures 5-4 through 5-7 and Figures 5-11 through 5-14.

The facilities of the North and South Plants were evaluated with respect to condition, serviceability, and continued use. A flow sheet was prepared for each plant showing active plant facilities. These flow sheets are included with this Report as Figures 5-2 and 5-9.

The evaluations determined that the flow equalization basin and the waste sludge lagoon at each plant is a necessary component of the treatment process and should remain in service. Suggested plant improvements with a corresponding implementation schedule for each plant are given below. If all existing plant facilities are to be retained as suggested, closure plans are not required.

North Plant

Short term improvements necessary for the North Plant to meet the immediate requirements of the Consent Order are given in the following table.

Table 10-1
Proposed Short-Term Improvements
North Plant

Revise the equalization basin such that a minimum required freeboard is provided; this may require that the levees be raised, or, in conjunction with other work, may be accomplished by including new water level control.
Provide a flow management system at the headworks to permit diversion of flow-rate peaks to discharge to the equalization basin at a controlled rate.
Construct facilities at the equalization basin to permit stored wastewater to be returned to the plant headworks.
Revise the sludge storage lagoon to provide adequate freeboard and a means of decanting surface waters to the plant headworks.

A suggested schedule for implementing the short-term North Plant improvements is given in Table 10-2.

Table 10-2
Schedule for Implementing Short-Term Improvements
North Plant

Task	Schedule	
	Duration	Possible Dates
Planning & Design	6 months	Nov, 2009 - Apr, 2010
Approvals & Pre-Construction	3 months	May-Jul, 2010
Construction	8 months	Aug, 2010 - Apr, 2011

March 2011

June 2011

July 2011 - March 2012

South Plant

Short term improvements necessary for the South Plant to meet the immediate requirements of the Consent Order are given in the following table.

Table 10-3
Proposed Short-Term Improvements
South Plant

Revise the equalization basin such that a minimum required freeboard is provided; this may require that the levees be raised, or, in conjunction with other work, may be accomplished by including new water level control.
Provide a flow management system at the headworks to permit diversion of flow-rate peaks to discharge to the equalization basin at a controlled rate.
Construct facilities at the equalization basin to permit stored wastewater to be returned to the plant headworks.
Revise the sludge storage lagoon to provide adequate freeboard and a means of decanting surface waters to the plant headworks.

A suggested schedule for implementing the short-term South Plant improvements is given in Table 10-4.

Table 10-4
Schedule for Implementing Short-Term Improvements
South Plant

Task	Schedule	
	Duration	Possible Dates
Planning & Design	6 months	Nov, 2009 - Apr, 2010
Approvals & Pre-Construction	3 months	May - Jul, 2010
Construction	8 months	Aug ,2010 - Apr, 2011

March 2011
June 2011
July 2011 - March 2012

Sewer System

The DEQ Order requires that Sherwood should "...eliminate peak flows caused by inflow and infiltration for the treatment works..." To this end, Sherwood has initiated a comprehensive sewer system evaluation study (SSES) comprised of rainfall and flow-rate measurements at selected locations within the municipal sewer system; smoke testing of the entire Sherwood gravity sewer system; internal inspection of selected sewers by closed-circuit television; identification and prioritization of system defects and pump station capacity deficiencies; and

Consent Administrative Order LIS NO. 8-135

NPDES Permit AR0037176

NPDES Permit AR0045608

Sherwood, Arkansas

Submittal:

Comprehensive Report/Plan Schedule

Corrective Action Plan & Schedule

(Due February 9, 2009)

Crist Engineers, Inc.

Consulting Engineers

Consent Administrative Order LIS NO. 8-135

NPDES Permit AR0037176

NPDES Permit AR0045608

Sherwood, Arkansas

Submittal

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COMPREHENSIVE PLAN for Reducing Sewer System Wet-weather Induced Inflows, and Correction of Hydraulic and Treatment Deficiencies Sherwood, Arkansas			
Consent Administrative Order		Sherwood Proposal	
Task	Description	Description	Submittal (from January 9, 2009)
1.	Within thirty (30) days of the effective date of this Order, the Permittee shall submit to ADEQ a comprehensive Corrective Action Report which shall detail the steps the Permittee took to achieve full compliance with the effluent characteristic limits of NPDES Permits AR0037176 and AR0045608.	The CAO calls for permit compliance within 30 days or submission of a comprehensive plan both to "...achieve compliance with the terms of the permits and to eliminate effluent characteristics violations..." While obtaining full compliance with the terms of the two NPDES permits held by Sherwood may be possible within the time allowed in the CAO, achieving such compliance would only be a temporary expedient. Given recent growth within the City, Sherwood recognizes the need for planning beyond the immediate and proposes to incorporate the requirement of CAO Task 2. within a long-term (20-year) master planning effort for the Sherwood municipal wastewater system. The resulting master planning document will position the Sherwood wastewater system to meet projected future requirements as well as meet the demands of the CAO by including the repairs, rehabilitations, and improvements necessary for Sherwood's two wastewater treatment plants to achieve long-term compliance with their respective discharge permits.	Within 8 months
2.	If the Permittee determines that full compliance with the terms of the permits cannot be achieved within thirty (30) days of the effective date of this Order, the Permittee shall submit to ADEQ a comprehensive plan with milestone schedule in lieu of the corrective action report required by Paragraph 1 above. The plan shall detail the steps the Permittee shall take to achieve compliance with the terms of the permits and to eliminate the effluent characteristics violations cited in Paragraphs 2 and 3 of the Findings of Fact and to prevent future violations. Upon approval by ADEQ, the submitted milestone schedule shall be incorporated into this Order by reference and shall be followed by the Permittee. Failure to comply with the schedule, as approved by ADEQ, shall be subject to the stipulated penalties contained in Paragraph 12 below.		

COMPREHENSIVE PLAN for Reducing Sewer System Wet-weather Induced Inflows, and Correction of Hydraulic and Treatment Deficiencies Sherwood, Arkansas			
Consent Administrative Order		Sherwood Proposal	
Task	Description	Description	Submittal (from January 9, 2009)
3.	Within thirty (30) days of the effective date of the Order, the Permittee shall submit the Discharge Monitoring Reports, tabular SSO reports, and any applicable noncompliance reports for NPDES Permit AR0045608 for the months of January 2007 and April 2007.	Submitted	Complete
4.a.	Within ninety (90) days of the effective date of the Order, the Permittee through the services of an engineer licensed in the State of Arkansas shall submit to ADEQ a revised process flow schematic for the north facility, NPDES Permit AR0037176. The revised process flow schematic will include any of the old wastewater treatment system that is currently being used as part of the treatment process.	Sherwood has retained the services of a professional engineer to assist in Sherwood's response to the CAO. It is proposed that the north facility flow sheet be revised as part of the master planning effort. The planning effort will determine which existing treatment facility components should be retained, which should be decommissioned, and which should be added. A copy of the master plan report will be provided to DEQ.	Within 8 months

COMPREHENSIVE PLAN for Reducing Sewer System Wet-weather Induced Inflows, and Correction of Hydraulic and Treatment Deficiencies Sherwood, Arkansas			
Consent Administrative Order		Sherwood Proposal	
Task	Description	Description	Submittal (from January 9, 2009)
4.b.	The engineer also shall evaluate the parts of the old lagoon system that will be utilized by the permittee to ensure the lagoons have been maintained in compliance with the Ten-States Standards. If the engineer determines parts of the old lagoon system require maintenance and/or rehabilitation to meet the Ten-States Standards, then the Permittee must also submit a milestone schedule for the improvements required to bring the facility up to standards. Upon approval by ADEQ, the submitted milestone schedule shall be incorporated into this Order by reference and shall be followed by the Permittee. Failure to comply with the schedule, as approved by ADEQ, shall be subject to the stipulated penalties contained in Paragraph 12 below.	Wastewater treatment plant components to be retained and improved will be determined as part of the master planning effort. The construction project developed from master planning recommendations will likely involve facilities in addition to the sludge storage lagoon. Once the project is defined, a design and construction schedule will be developed.	To be determined after completion of the master plan
		In the interim, Sherwood proposes to clean the existing sludge storage lagoon located at the north wastewater treatment plant (AR0037176) and dispose the lagoon contents by land application.	Within 12 months
4.c.	In addition, the engineer will submit to ADEQ a closure plan for any parts of the old lagoon system that will not be part of the existing system. The closure plan is subject to approval by ADEQ.	Closure plan will be prepared and submitted once the need for closure is known.	To be determined
4.d.	In considering the information submitted as required by this paragraph, ADEQ may require the Permittee to submit an application for permit modification and either modify the permit, revoke and reissue the permit, or allow the Permittee to continue to operate under the existing permit	It is proposed that Sherwood wastewater treatment plant(s) be re-permitted; either for permit renewal (at 6 months prior to existing expiration dates) or before newly constructed facilities are placed into operation.	To be determined

COMPREHENSIVE PLAN for Reducing Sewer System Wet-weather Induced Inflows, and Correction of Hydraulic and Treatment Deficiencies Sherwood, Arkansas			
Consent Administrative Order		Sherwood Proposal	
Task	Description	Description	Submittal (from January 9, 2009)
5.	Within thirty (30) days of the effective date of this Order, the Permittee shall submit to ADEQ a comprehensive Corrective Action Plan which shall detail the steps the Permittee shall take to eliminate peak flows caused by inflow and infiltration for the treatment works permitted under NPDES Permits AR0037176 and AR0045608. This plan shall at a minimum include the following items:	See Attachment 1	Within 30 days
5.a.	The Permittee shall complete a comprehensive collection system evaluation within one (1) year of the effective date of this order. 1. This comprehensive collection system evaluation shall identify all wastewater mains and pumping stations that cannot carry peak hydraulic loads caused by inflow and infiltration.	See Attachment 1	Within 72 months Letter dtd 7-10-09
	2. The evaluation shall also identify all pumping stations that do not have auxiliary power or sufficient storage as required by Part II, Section B, Paragraph 7 of NPDES Permits AR0037176 and AR0045608	Sherwood proposes to install auxiliary power at the remote pumping stations as appropriate.	Within 12 months
	3. and shall identify all pumping stations that do not have direct notification alarms.	Sherwood proposes to install a centralized supervisory, control, and data acquisition (SCADA) system for the remote pumping stations as appropriate.	Within 12 months

COMPREHENSIVE PLAN for Reducing Sewer System Wet-weather Induced Inflows, and Correction of Hydraulic and Treatment Deficiencies Sherwood, Arkansas				
Consent Administrative Order			Sherwood Proposal	
Task		Description	Description	Submittal (from January 9, 2009)
5.b.	1.	The Permittee shall submit to ADEQ within fifteen (15) months of the effective date of this order a milestone schedule for the replacement and/or repair of all wastewater mains and pumping stations that cannot convey peak hydraulic loads as identified by the comprehensive collection system evaluation required in Paragraph 5a of this section.	See 5. (Attachment 1)	See 5.a.
	2.	This milestone schedule shall include dates for the installation of direct notification alarms and auxiliary power or storage capacity at pumping stations identified during the collection system evaluation. Upon approval by ADEQ, the submitted milestone schedule shall be incorporated into this Order by reference and shall be followed by the Permittee. Failure to comply with the schedule, as approved by ADEQ, shall be subject to the stipulated penalties contained in Paragraph 12 below.	See 5.a.2. and 5.a.3.	See 5.a.2. and 5.a.3.

COMPREHENSIVE PLAN for Reducing Sewer System Wet-weather Induced Inflows, and Correction of Hydraulic and Treatment Deficiencies Sherwood, Arkansas			
Consent Administrative Order		Sherwood Proposal	
Task	Description	Description	Submittal (from January 9, 2009)
6.	Within ninety (90) days of the effective date of this Order, the Permittee shall establish and implement an overflow response plan for the treatment works permitted under NPDES Permits AR0037176 and AR0045608 which shall: 1. Identify the individual(s) responsible for making the appropriate reports (24-hour notification and monthly tabular reports) to ADEQ, 2. Ensure that collection system overflows are identified and responded to in a timely manner, 3. Establish written procedures for cleaning up after sanitary sewer overflows, 4. Have provisions to notify the affected public of overflows in parks and other public areas where access is not restricted and a reasonable potential exists for exposure to bacteria and other disease causing agents, and 5. Have provisions to notify any affected permit holders including municipal separate stormwater sewer permit (MS4) holders.	Sherwood proposes to prepare and submit an Overflow Response Plan including, as a minimum the elements listed under this task of the CAO.	Within 90 days

COMPREHENSIVE PLAN for Reducing Sewer System Wet-weather Induced Inflows, and Correction of Hydraulic and Treatment Deficiencies Sherwood, Arkansas			
Consent Administrative Order		Sherwood Proposal	
Task	Description	Description	Submittal (from January 9, 2009)
7.	Within one (1) year the Permittee shall establish and maintain a minimum inventory of spare parts necessary to make immediate repairs to the pump stations, wastewater lines, and manholes for the treatment works permitted under NPDES Permits AR0037176 and AR0045608. The Permittee will submit this inventory list to ADEQ upon completion of the inventory.	Sherwood proposes to establish and maintain a minimum inventory of spare parts as required by task 7 of the CAO.	Within 12 months
8.	The Permittee shall at least every two (2) years reevaluate the wastewater collection systems for the treatment works permitted under NPDES Permits AR0037176 and AR0045608 and make whatever changes are necessary to the corrective action plan and construction projects to ensure the Permittee meets the goal of elimination of collection system overflows and problems related to peak hydraulic loads.	Plan for revaluation of completed rehabilitation projects is under development. One method under consideration is the installation of permanent flow meters at key locations. Analysis of this flow data should permit an determination of system condition with respect to changing system capacities.	To be deter-mined
9.	The Permittee shall, within thirty (30) days of the effective date of this Order, either submit an application for an Industrial Stormwater Permit and develop and implement a stormwater pollution prevention plan (SWPPP), or it shall resubmit the "no exposure certification" for the facility.	Sherwood proposes to prepare and submit a "no exposure certification" as required by the CAO.	Within 30 days

ATTACHMENT 1

Outline of Corrective Action Plan
for Reducing Excessive Sewer System Wet-weather Induced Inflow
and Correcting Hydraulic Deficiencies
Sherwood, Arkansas

1. System Mapping and Manhole Inspections
   a. Locate each system manhole and construction system map
   b. Conduct internal inspection of manholes; include results in report of findings

2. Flow and Rainfall Measurement
   a. Divide sewer system into logical basins
   b. Install flow meter at downstream of each sub-basin
   c. Install rain gages at representative locations
   d. Maintain through period of wet weather
   e. Report of findings
   e. Prioritize sub-basins as to severity of I/I

3. For Selected Basin(s)
   a. Smoke testing
   b. Clean and CCTV selected sewers
   c. Report of findings and recommendations

4. Develop Rehabilitation Program
   a. Review SSES report and select system section(s) for rehabilitation
   b. Field surveys
   c. Select rehabilitation methods
   d. Prepare contract documents
   e. Secure regulatory approvals
   f. Address private services

5. Construction
   a. Advertise for receipt of bids
   b. Select contractor
   c. Proceed with construction

6. Post-rehabilitation Flow and Rainfall Measurement
   a. Identify hydraulically deficient sewers
   b. Identify hydraulically deficient pump stations

7. Develop Plan for Correcting Hydraulic Deficiencies
   a. Supplemental sewer capacity
   b. Pump station upgrades or replacement

APPENDIX 2

Metroplan Population Information

lgaddis@cristengineers.com

From: "Jonathan Lupton" <jlupton@metroplan.org>
To: <lgaddis@cristengineers.com>
Sent: Friday, January 16, 2009 4:07 PM
Attach: SherwoodAreaTrend2000-2030.xls; SHERWOODTAZ2030.DBF; SherwoodTAZ2030.shp; SherwoodTAZ2030.shx
Subject: Sherwood projections

Larry:

Enclosed is an Excel file giving a projection I did for the Sherwood area. I based it on traffic zone (TAZ) geography, which is the base-level geography in our Metro 2030 projections. The base geography is bigger than Sherwood city limits, even after the Gravel Ridge annexation. I allowed a little room for Sherwood to grow toward the north after the Gravel Ridge annexation, whereas in other directions the city is now hemmed in and outward growth is difficult or impossible. The boundaries are also somewhat generalized, so there are tiny corners of NLR and Jacksonville in them, and other spots where the boundaries do not quite include all of Sherwood city limits. This is a necessary form of generalization to develop projections using TAZ geography, and past experience has demonstrated it is fairly accurate.

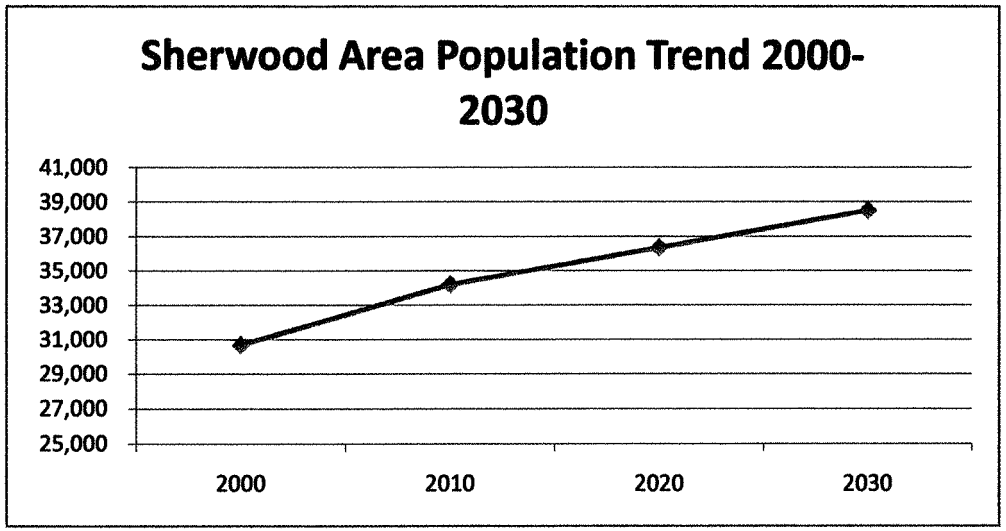
Let me also give you the best official Sherwood population figures, pre-Gravel Ridge:
1. Census 2000 - 21,511
2. Metroplan estimate 1/1/2008 - 25,340
As I told you, I am working on estimating the population of the area taken in. I will get back with you when I have developed an estimate - probably Tuesday or Wednesday of next week. If you do not get it by Thursday, please remind me.

I have also enclosed the components of a .shp file so you can look at the geography yourself.I use a different GIS program from ArcGIS so my .shp files are in WGS lat/long format - if you have any trouble importing them let me know and Metroplan's GIS wizards can take care of it.

Jonathan Lupton AICP
Research Planner
Metroplan
372-3300

SherwoodAreaTrend2000-2030.xls

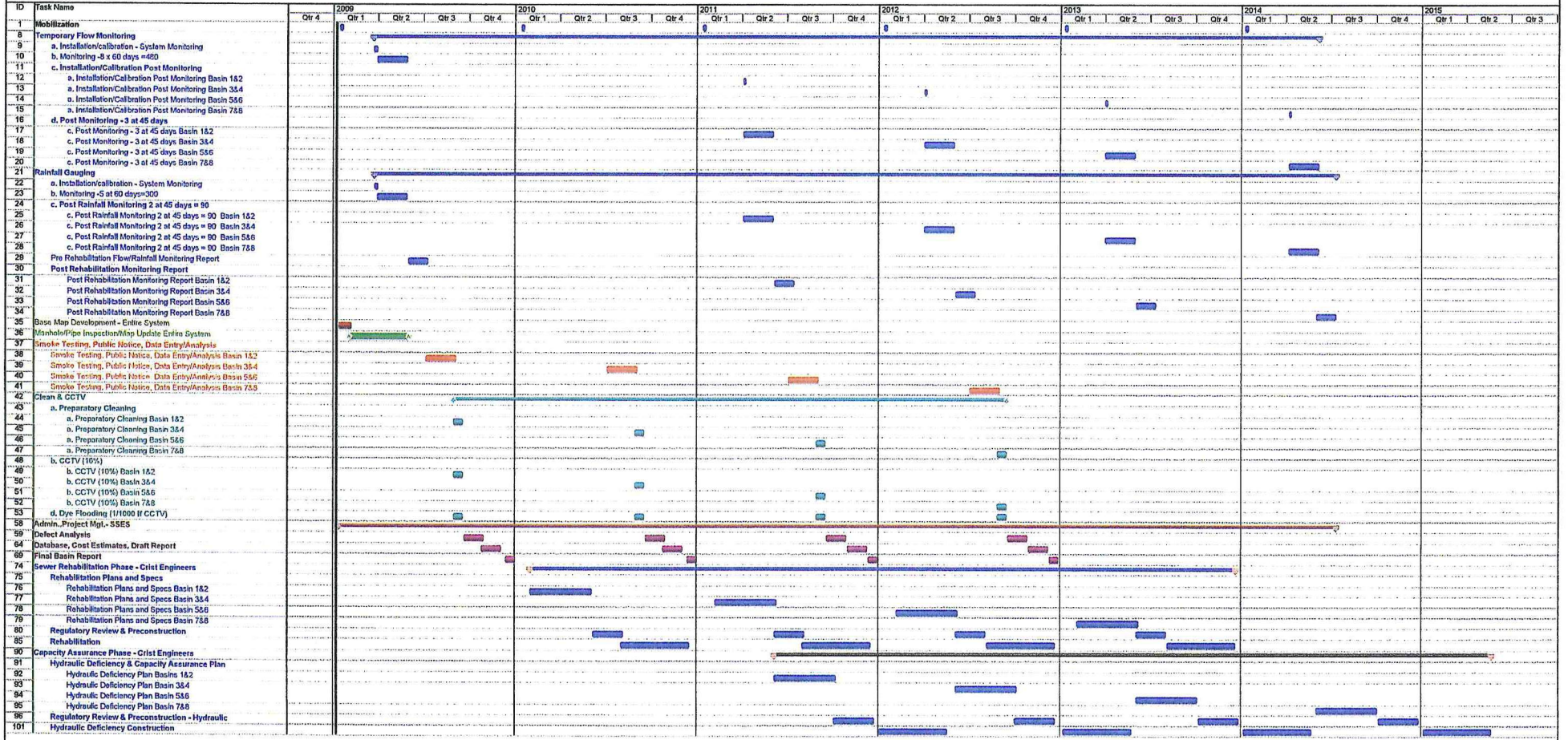
	2000	2010	2020	2030
Population	30,677	34,205	36,353	38,501



Sources: 1. Census 2000 TAZ-level population data.
2. Metro 2030 Plan, Metroplan 2004.

Compiled by
Metroplan
1/16/2009

Sanitary Sewer Corrective Action Plan Schedule
City of Sherwood, Arkansas



PIPELINE ANALYSIS, LLC

lgaddis@cristengineers.com

From: "Jonathan Lupton" <jlupton@metroplan.org>
To: <lgaddis@cristengineers.com>
Sent: Friday, January 23, 2009 2:54 PM
Attach: Shw-Est09.xls
Subject: Gravel Ridge Annexation

Larry:

I have done an annexation analysis for the Gravel Ridge area. The attached spreadsheet gives a short summary of the results. The "Gravel Ridge CDP" is the Census Designated Place for Gravel Ridge, for which we have Census 2000 data as one unit. GIS analysis of aerial photos suggested little population/housing change since that time. The total area annexed was larger than the CDP, however, so I conducted an analysis using GIS aerials and Census 2000 block data for the additional area. The estimate for "old Sherwood" is the city pre-annexation, and includes the latest construction activity through 1/1/2009.

The abbreviations are as follows:

HP = household population
HH = households
HU = housing units
GQ = population in group quarters
Occ = occupancy rate
PPH = persons per household

This is a draft of the estimate that will be published in Metroplan's forthcoming Demographic Review and Outlook. Although I worked diligently to attain accuracy, we are now nine years after the most recent census, and any estimates must be treated with care.

Jonathan Lupton

Sherwood Population Estimate 2009

Combination of Annexation With Permit-Based Estimate

	Pop	HP	HH	HU	GQ	Occ	PPH
"Old" Sherwood	25,701	25,319	10,638	11,439	382	93.0%	2.38
Gravel Ridge CDP	3,232	3,232	1,275	1,331	-	95.8%	2.53
Additional Area	1,042	1,042	390	415	-	94.0%	2.67
Sherwood Total	29,975	29,593	12,303	13,185	382	93.3%	2.41

Notes:

1. Data on Gravel Ridge CDP taken from Census 2000. GIS Analysis indicated no significant change in housing units since 2000; most blocks showed fewer HU than indicated by census figures.

2. Data on additional area based on careful GIS analysis, using Census 2000 block data as a base with modifications in most blocks based on analysis of aerial images; many blocks had gained HU since Censu 2000.

Compiled by
Metroplan
1/21/2009

APPENDIX 3
Excerpts from Court Order

IN THE CHANCERY COURT OF PULASKI COUNTY, ARKANSAS
FIRST DIVISION

THE SEWER COMMITTEE OF THE CITY OF SHERWOOD, ARKANSAS, and THE CITY OF SHERWOOD, ARKANSAS

PLAINTIFFS/ COUNTERDEFENDANTS

vs. NO. 88-4160

GARY MILLS, Manager of the Waste Water Utility of the City of North Little Rock, Arkansas, and K. W. MATTHEWS, CLARK McGLOTHIN, LARRY DYER, JIM GLOVER, and J. LARRY TAYLOR, Commissioners of the Sewer Committee of the City of North Little Rock, Arkansas, and the CITY OF NORTH LITTLE ROCK, ARKANSAS

DEFENDANTS/ COUNTERCLAIMANTS

INTERIM STIPULATIONS

These Interim Stipulations are entered into this day between the Sewer Committee of the City of Sherwood, the City of Sherwood, Arkansas, the North Little Rock Waste Water Utility, and the City of North Little Rock, Arkansas.

WHEREAS, there is currently a lawsuit pending between the parties hereto over the extent and boundaries of the sewer lines and customers covered by the sewer systems of each City and the rates to be charged; and

WHEREAS, the parties wish to stipulate to facts not in dispute to allow a temporary order to be entered in a manner beneficial to both parties;

BE IT HEREBY STIPULATED BY THE PARTIES AS FOLLOWS:

1. For purposes of these stipulations there shall be three (3) defined categories of customers: (a) "Sherwood customers", (b) "District customers", and (c) "North Little Rock Waste Water Utility customers".

2. Sherwood customers consist of any and all sewer customers within a certain land area, the legal description of which is more particularly described as follows: All land area within the city limits of Sherwood which is south of a line described as follows. Said line shall begin at the intersection of Highway 107 and the city limits of Sherwood and shall extend along the southeastern side of Highway 107 going in a northerly direction until it reaches Club Road, then said line shall continue along Club Road in an easterly direction until it reaches Claremont Street, then it shall proceed in a northerly direction until it reaches the south side of Lee Avenue, and then it shall continue in an easterly direction until it reaches the east side of Bronco Lane and from the southeast corner of said intersection, said line shall then extend in a due southerly direction until it shall intersect with a line exactly even with Club Road were Club Road extended in said easterly direction and then from that point due east along a line exactly even with Club Road until said line reaches the eastern boundary of the city limits of Sherwood, said line to be south of Hollywood Drive and north of Carnagie Drive extending through the middle of Rest Hills Cemetery (Rest Hills Cemetery shall be considered a Sherwood customer) and all customers within the city

limits of Sherwood which are south of this line shall be considered Sherwood customers, with the exception of the Overbrook Subdivision which shall be that part of Sherwood southwest of the Creek traveling through the southwest corner of Sherwood, the location of said creek being known to the parties.

3. District customers are sewer customers of sewer lines leading to Five Mile Creek Treatment Plant and related facilities (hereinafter Five Mile Creek), if said customers are within Improvement Districts 212, 233, 234 or 236, and if said customers do not constitute Sherwood customers. Specifically, customers within District 212 who are also within the geographic boundary described in paragraph 2 above shall be considered "Sherwood customers". The respective legal boundaries of Improvement Districts 212, 233, 234 and 236 have been established and drawn on a map in the possession of the parties.

4. North Little Rock customers are defined as any and all sewer customers within the City of Sherwood who tie on to any lines leading to the Five Mile Creek or any other North Little Rock Sewer Station except those customers which are either Sherwood customers or District customers.

5. Temporarily until entry of a final order, the City of Sherwood and the Sherwood Sewer Committee shall have the right to bill direct (under any method which they see fit to use) any and all "Sherwood customers" for sewer service. The City of Sherwood shall in turn pay to the North Little Rock Waste Water Utility an

amount each month for the privilege of using the North Little Rock sewer lines and the Five Mile Creek to treat the sewage of said customers, said amount to be determined according to an established formula percentage. The amount that Sherwood bills its customers for said service shall have no bearing on the amount Sherwood shall pay to North Little Rock. Sherwood shall set its billing rates, but North Little Rock shall be paid according to the formula regardless of Sherwood's collection efforts or the success thereof. Said formula percentage shall be fixed by a formula designed to most accurately determine the percentage of usage attributable to Sherwood customers. Currently, the method used shall be the ratio of usage of water by Sherwood customers as shown by water meter readings, divided by the total of all water meter readings for all customers of Five Mile Creek. The ratio or percentage so derived shall be known as "p", which shall then be multiplied by the total cost of the operation of the plant "t", elements of which shall be determined according to the cost schedule attached hereto as Exhibit "A". Where cost elements or allocation thereof are absent, whether such cost is included, or the manner in which it shall be allocated shall be determined by general accepted accounting principals as established by the American Institute of Certified Public Accountants. The cost formula set out algebraically is p x t = amount to be paid by Sherwood.

6. The amount to be paid under such formula shall be collected on a monthly basis based upon a number derived at the

close of the preceding fiscal year for said Five Mile Creek. The amount to be collected in the current year shall be an amount equal to One Hundred Ten Percent (110%) of the amount derived by applying the above formula to the cost of operation of the Plaint for the previous year (i.e., p x t previous year). As soon as possible after the close of the fiscal year, the actual amount which should have been paid for that year will be figured, and any over-payment by the City of Sherwood will be credited and amortized over the next twelve (12) payments due, and any under-payment by the City of Sherwood shall be added to its payments for the following year and amortized over the following twelve (12) months until said deficiency is retired.

7. With regard to District customers, the City of North Little Rock shall continue to operate the sewer systems for all District customers in the manner currently being practiced.

8. With regard to North Little Rock customers within the City of Sherwood, which includes all legally authorized customers tied to Five Mile Creek who are not District or Sherwood customers, the City of North Little Rock will operate the said sewer lines and maintain them and bill said customers in a manner and amount which is the same as customers of the North Little Rock Waste Water Utility within the City of North Little Rock are serviced and billed pursuant to the same rules, regulations, and laws as is currently being done.

9. It is understood by the parties that the new rate structure developed by this Agreement shall be made retroactive to September 16, 1988, and the amount owed from that date to the current time shall be computed and assessed against Sherwood as an arrearage, said arrearage to be paid by December 1, 1989, and to be determined by actual historical data and not projections.

10. It is understood by the parties that these are interim stipulations and that the parties hereto are currently renegotiating their prior existing agreements and that these issues remain to be renegotiated in final form. It is hereby agreed that final agreement with regard to the dispute between the parties are to be resolved if possible no later than August 31, 1989.

11. The effective date of the new rates shall be August 1, 1989, and the effective date of the establishment of customer identify shall also take effect on August 1, 1989. The amount owed as an arrearage from September 16, 1988 to August 1, 1989 shall be determined and paid by December 1, 1989.

12. Since the amount of the arrearage will be ascertainable from historical data, the amount of the arrearage shall not be based on future projections, as are the other rates collected, but shall be based on the actual usage of the customers who were actually billed by Sherwood. Appropriate credit will be made for any customers who paid double bills or who paid the wrong party.

13. These stipulations shall become effective upon approval by the Court and shall remain in effect until subsequent Court

order.

Stipulated to this 26 day of July, 1989.

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APPENDIX 4

North and South Plant Effluent Data Sets

Sherwood North WWTP Facility Performance Data Base

	Eff Q, mgd		BOD5, mg/L				TSS, mg/L				NH3-N, mg/L								FCB, #/100 ml GM			
Month	Day Avg	Day Max	30-day		7-day		30-day		7-day		30-day				7-day				30-day		7-day	
			Actual	Limit	Actual	Limit	Actual	Limit	Actual	Limit	Actual	Actual	Actual	Limit	Actual	Actual	Actual	Limit	Actual	Limit	Actual	Limit
Jan-07	0.21	0.51	5.8	15	6.2	22.5	9.1	20	10.0	30	7.1	7.1		5	7.9	7.9		7.5	18	1000	83	2000
Feb-07	0.35	0.61	6.0	15	7.4	22.5	10.3	20	12.0	30	10.6	10.6		5	12.0	12.0		7.5	155	1000	335	2000
Mar-07	0.29	0.31	4.5	15	7.7	22.5	8.0	20	12.0	30	11.6	11.6		5	18.7	18.7		7.5	30	1000	71	2000
Apr-07	0.35	0.71	2.5	15	2.8	22.5	4.0	20	5.0	30	6.3		6.3	2	14.5		14.5	5.6	339	1000	2228	2000
May-07	0.26	0.36	3.3	15	4.1	22.5	4.0	20	5.0	30	2.0		2.0	2	2.1		2.1	5.6	447	1000	1041	2000
Jun-07	0.28	0.46	3.0	15	3.4	22.5	3.5	20	4.3	30	4.8		4.8	2	5.5		5.5	5.6	468	1000	973	2000
Jul-07	0.29	0.68	2.9	15	3.2	22.5	3.0	20	3.3	30	5.0		5.0	2	5.9		5.9	5.6	427	1000	777	2000
Aug-07	0.26	0.35	3.9	15	5.1	22.5	3.6	20	5.5	30	5.6		5.6	2	8.5		8.5	5.6	632	1000	1124	2000
Sep-07	0.30	0.64	2.9	15	6.9	22.5	4.8	20	9.2	30	2.6		2.6	2	8.5		8.5	5.6	693	1000	1113	2000
Oct-07	0.37	0.75	3.6	15	4.7	22.5	5.3	20	6.9	30	0.2		0.2	2	5.3		5.3	5.6	377	1000	938	2000
Nov-07	0.33	0.94	5.8	15	11.8	22.5	13.8	20	25.8	30	2.7	2.7		5	6.6	6.6		7.5	790	1000	5546	2000
Dec-07	0.49	0.96	2.9	15	5.3	22.5	5.5	20	7.8	30	1.1	1.1		5	2.3	2.3		7.5	52	1000	469	2000
Jan-08	0.36	0.54	3.8	15	6.8	22.5	6.9	20	13.5	30	2.8	2.8		5	6.0	6.0		7.5	38	1000	83	2000
Feb-08	0.52	0.98	3.6	15	6.1	22.5	3.4	20	6.7	30	0.7	0.7		5	1.1	1.1		7.5	21	1000	40	2000
Mar-08	0.63	1.73	2.4	15	6.1	22.5	5.7	20	9.3	30	1.2	1.2		5	2.2	2.2		7.5	64	1000	86	2000
Apr-08	0.50	0.92	2.0	15	2.0	22.5	4.8	20	6.9	30	2.9		2.9	2	4.6		4.6	5.6	145	1000	208	2000
May-08	0.37	0.63	6.6	15	13.5	22.5	7.5	20	10.3	30	4.3		4.3	2	4.8		4.8	5.6	685	1000	943	2000
Jun-08	0.30	0.40	6.0	15	12.2	22.5	4.6	20	8.1	30	1.9		1.9	2	2.5		2.5	5.6	1656	1000	2194	2000
Jul-08	0.27	0.39	3.0	15	4.7	22.5	7.3	20	14.0	30	1.0		1.0	2	2.1		2.1	5.6	1878	1000	2611	2000
Aug-08	0.32	0.91	1.7	15	3.5	22.5	2.6	20	6.4	30	0.9		0.9	2	1.3		1.3	5.6	425	1000	1210	2000
Sep-08	0.50	2.60	2.8	15	3.7	22.5	2.9	20	3.2	30	1.8		1.8	2	4.7		4.7	5.6	468	1000	2115	2000
Oct-08	0.32	0.63	2.4	15	9.2	22.5	2.2	20	9.2	30	0.5		0.5	2	2.3		2.3	5.6	143	1000	369	2000
Nov-08	0.29	0.42	1.3	15	1.7	22.5	0.7	20	0.9	30	0.5	0.5	0.5	5	1.7	1.7		7.5	136	1000	451	2000
Dec-08				15		22.5		20		30				5				7.5		1000		2000
			MD PF																			
2007	0.32	0.96	3.05																			
2008	0.40	2.60	6.53																			
2008	0.40	1.73	4.30																			
	Max Mo		MM PF																			
2007	0.49		1.56																			
2008	0.63		1.58																			
average			3.6		6.0		5.4		8.5		3.4	4.3	2.7		5.7	6.5	5.2					
stdev			1.5		3.2		3.0		5.1		3.1	4.4	2.0		4.5	5.8	3.5					
t-dist 95%			1.645		1.645		1.645		1.645		1.645	1.645	1.645		1.645	1.645	1.645					
Attainable Performance:			6.1		11.3		10.2		16.8		8.6	11.4	6.0		13.0	16.0	10.9					

Sherwood South WWTP Facility Performance Data Base

			NLR	BOD5, mg/L				TSS, mg/L				NH3-N, mg/L								FCB, #/100 ml			
	Eff Q, mgd		Precip	30-day		7-day		30-day		7-day		30-day				7-day				30-day		7-day	
Month	Day Avg	Day Max	inches	Actual	Limit	Actual	Limit	Actual	Limit	Actual	Limit	Actual	Actual	Actual	Limit	Actual	Actual	Actual	Limit	Actual	Limit	Actual	Limit
Jan-07	0.37	0.88	7.48	2.8	10.0	3.8	15.0	2.5	15.0	6.0	23.0	3.0	3.0		8.0	7.1	7.1		12.0	199	1000	1000	2000
Feb-07	0.24	0.41	2.42	3.1	10.0	3.8	15.0	1.5	15.0	3.0	23.0	6.0	6.0		8.0	8.1	8.1		12.0	1195	1000	2000	2000
Mar-07	0.22	0.85	1.61	2.8	10.0	5.6	15.0	4.5	15.0	11.0	23.0	2.8	2.8		8.0	4.4	4.4		12.0	193	1000	210	2000
Apr-07	0.25	1.07	4.56	2.5	10.0	2.7	15.0	3.1	15.0	4.0	23.0	2.5	2.5		8.0	4.1	4.1		12.0	794	1000	>4000	2000
May-07	0.22	0.44	1.7	2.6	10.0	3.1	15.0	3.1	15.0	8.0	23.0	2.6		2.6	7.0	8.3		8.3	11.0	663	1000	1397	2000
Jun-07	0.16	0.63	1.4	2.4	10.0	2.4	15.0	1.0	15.0	2.0	23.0	0.4		0.4	7.0	0.4		0.4	11.0	190	1000	450	2000
Jul-07	0.20	0.61	7.74	2.4	10.0	2.4	15.0	1.3	15.0	2.0	23.0	0.2		0.2	7.0	0.3		0.3	11.0	351	1000	>4000	2000
Aug-07	0.14	1.12	0.01	3.5	10.0	5.3	15.0	4.7	15.0	11.2	23.0	0.4		0.4	7.0	0.9		0.9	11.0	1645	1000	2820	2000
Sep-07	0.23	0.66	5.48	1.9	10.0	2.9	15.0	2.4	15.0	3.6	23.0	1.1		1.1	7.0	2.4		2.4	11.0	1616	1000	1750	2000
Oct-07	0.40	0.91	6.55	2.4	10.0	3.5	15.0	4.9	15.0	9.0	23.0	0.2		0.2	7.0	0.3		0.3	11.0	898	1000	4350	2000
Nov-07	0.35	0.93	3.65	4.1	10.0	5.9	15.0	1.0	15.0	2.0	23.0	0.6	0.6		8.0	1.2	1.2		12.0	1905	1000	2625	2000
Dec-07	0.41	0.93	6.45	1.1	10.0	1.3	15.0	0.6	15.0	1.2	23.0	3.8	3.8		8.0	7.3	7.3		12.0	13	1000	20	2000
Jan-08	0.31	0.71	1.33	3.0	10.0	6.4	15.0	1.4	15.0	5.2	23.0	7.1	7.1		8.0	8.2	8.2		12.0	102	1000	1640	2000
Feb-08	0.39	0.75	3.82	1.0	10.0	1.8	15.0	0.8	15.0	2.4	23.0	0.1	0.1		8.0	4.6	4.6		12.0	18	1000	30	2000
Mar-08	0.60	1.00	8.46	1.8	10.0	3.4	15.0	1.4	15.0	4.8	23.0	1.8	1.8		8.0	5.6	5.6		12.0	40	1000	660	2000
Apr-08	0.39	0.92	6.31	1.9	10.0	3.8	15.0	1.4	15.0	7.7	23.0	0.2	0.2		8.0	1.1	1.1		12.0	10	1000	10	2000
May-08	0.44	0.90	4.26	1.9	10.0	2.1	15.0	13.6	15.0	26.0	23.0	2.2		2.2	7.0	2.2		2.2	11.0	185	1000	1380	2000
Jun-08	0.31	0.53	2.08	4.4	10.0	6.3	15.0	4.2	15.0	5.6	23.0	4.4		4.4	7.0	6.2		6.2	11.0	541	1000	1200	2000
Jul-08	0.22	0.38	1.56	1.3	10.0	2.0	15.0	1.0	15.0	1.6	23.0	0.1		0.1	7.0	0.3		0.3	11.0	124	1000	340	2000
Aug-08	0.21	0.56	6.18	2.6	10.0	2.7	15.0	1.6	15.0	2.8	23.0	0.3		0.3	7.0	0.6		0.6	11.0	44	1000	220	2000
Sep-08	0.27	0.92	8.57	2.5	10.0	3.0	15.0	1.2	15.0	2.0	23.0	0.1		0.1	7.0	0.2		0.2	11.0	753	1000	1840	2000
Oct-08	0.35	1.20	4.08	1.8	10.0	3.2	15.0	1.4	15.0	2.0	23.0	0.1		0.1	7.0	0.1		0.1	11.0	126	1000	220	2000
Nov-08	0.25	0.46	1.78	1.9	10.0	2.4	15.0	0.8	15.0	1.0	23.0	0.1	0.1		8.0	0.2	0.2		12.0	263	1000	750	2000
Dec-08			3.48		10.0		15.0		15.0		23.0				8.0				12.0		1000		2000
				MD PF																			
2007	0.26	1.12		4.22																			
2008	0.34	1.20		3.51																			
	Max Mo			MM PF																			
2007	0.41			1.56																			
2008	0.60			1.76																			
average				2.4		3.5		2.6		5.4		1.7	2.5	1.0		3.2	4.7	1.8					
stdev				0.9		1.5		2.8		5.4		2.0	2.4	1.4		3.1	2.9	2.7					
t-dist 95%				1.645		1.645		1.645		1.645		1.645	1.645	1.645		1.645	1.645	1.645					
Attainable Performance:				3.8		5.9		7.1		14.3		5.1	6.4	3.2		8.3	9.5	6.2					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
2														
3								Influent Rate, mgd						
4		Mo Avg Effluent, mg/L					Mo Avg	NLRWWU FMC WWTP				5MC-NLR	5MC-OLD	5MC-SH
5	Month	BOD5	BOD5 Limit	TSS	TSS Limit	Precip, in	Eff, mgd	Mo Avg	Permitted		Max Day	Mo Avg	Mo Avg	Mo Avg
6														
7	Jan-06	23.6	30.0	30.0	90.0	3.83	4.5	3.86	6.60		9.28	1.78	0.69	1.39
8	Feb	17.2	30.0	18.6	90.0	2.08	4.96	4.30	6.60		5.90	1.91	0.76	1.63
9	Mar	19.7	30.0	24.5	90.0	4.04	5.88	5.11	6.60		12.29	2.35	0.91	1.85
10	Apr	30.7	30.0	43.9	90.0	7.98	5.12	4.60	6.60		15.36	2.10	0.82	1.68
11	May	21.2	30.0	35.0	90.0	4.36	6.34	5.22	6.60		12.76	2.39	0.93	1.90
12	Jun	13.7	30.0	24.4	90.0	1.78	3.37	2.90	6.60		4.38	1.30	0.55	1.05
13	Jul	13.2	30.0	28.7	90.0	2.89	2.95	2.75	6.60		4.18	1.22	0.52	1.01
14	Aug	14.9	30.0	44.8	90.0	3.57	3.34	2.89	6.60		5.00	1.27	0.58	1.03
15	Sep	13.2	30.0	35.2	90.0	3.13	3.4	2.90	6.60		4.77	1.30	0.54	1.06
16	Oct	15.9	30.0	27.4	90.0	4.14	3.3	3.01	6.60		6.11	1.36	0.55	1.10
17	Nov	28.9	30.0	33.4	90.0	6.09	4.94	3.95	6.60		11.45	1.80	0.69	1.46
18	Dec-06	21.0	30.0	29.2	90.0	5.89	7.31	5.84	6.60		14.13	2.67	1.02	2.16
19	Jan-07	16.6	30.0	18.4	90.0	7.48	9.8	7.31	6.60		13.97	3.35	1.29	2.67
20	Feb	17.7	30.0	16.9	90.0	2.42	5.4	4.25	6.60		8.26	1.83	0.75	1.67
21	Mar	18.5	30.0	20.4	90.0	1.61	4.64	3.84	6.60		4.80	1.65	0.68	1.50
22	Apr	29.7	30.0	47.0	90.0	4.56	5.18	4.38	6.60		9.09	1.94	0.81	1.63
23	May	29.4	30.0	41.0	90.0	1.7	3.93	3.40	6.60		5.00	1.47	0.63	1.30
24	Jun	16.1	30.0	42.0	90.0	1.4	3.23	2.81	6.60		3.77	1.22	0.53	1.06
25	Jul	13.1	30.0	31.0	90.0	7.74	4.3	3.78	6.60		9.34	1.62	0.72	1.44
26	Aug	10.0	30.0	43.7	90.0	0.01	2.77	2.77	6.60		3.41	1.20	0.53	1.04
27	Sep	9.9	30.0	29.3	90.0	5.48	3.93	3.57	6.60		8.34	1.51	0.67	1.39
28	Oct	11.4	30.0	33.7	90.0	6.55	4.72	4.11	6.60		7.94	1.73	0.77	1.62
29	Nov	19.1	30.0	35.9	90.0	3.65	4.22	3.69	6.60		11.36	1.53	0.69	1.48
30	Dec-07	19.0	30.0	21.7	90.0	6.45	7.38	6.28	6.60		13.50	2.67	1.08	2.53
31	Jan-08	12.2	30.0	20.9	90.0	1.33	4.3	3.74	6.60		5.34	1.56	0.71	1.47
32	Feb	16.4	30.0	18.7	90.0	3.82	6.76	5.63	6.60		10.82	2.31	1.07	2.25
33	Mar	11.1	30.0	11.2	90.0	8.46	7.99	6.83	6.60		12.60	2.79	1.29	2.76
34	Apr	10.1	30.0	18.5	90.0	6.31	7.47	5.45	6.60		9.18	2.31	1.04	2.10
35	May	25.9	30.0	39.0	90.0	4.28	5.05	4.07	6.60		6.84	1.68	0.77	1.62
36	Jun	20.4	30.0	33.6	90.0	2.08	3.42	2.91	6.60		4.02	1.25	0.58	1.08
37	Jul	15.9	30.0	18.9	90.0	1.56	3.24	2.57	6.60		3.77	1.09	0.50	0.98
38	Aug	18.6	30.0	22.2	90.0	6.18	3.89	3.23	6.60		9.92	1.35	0.63	1.25
39	Sep	16.0	30.0	26.3	90.0	8.57	5.25	4.20	6.60		10.11	1.76	0.82	1.62
40	Oct	9.5	30.0	31.0	90.0	4.08	4.06	3.44	6.60		7.76	1.38	0.66	1.40
41	Nov	23.2	30.0	16.9	90.0	1.78	3.57	3.09	6.60		4.88	1.30	0.61	1.18
42	Dec-08	24.9	30.0	24.4	90.0	3.48	5.21	4.24	6.60		6.47	1.74	0.82	1.68
43														
44	Maximum						9.80	7.31			15.36	3.35	1.29	2.76
45	Average	18.0		28.9			4.86	4.08			8.23	1.77	0.76	1.56
46	Stdev	6.0		9.4										
47	t-dist 95%	1.645		1.645										
48	Attainable	27.8		44.3										
49														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	Data from NLR for 5MC WWTP																									
2																										
3		Influent Rate, mgd					5MC-NLR					5MC-OLD					5MC-SH (SIDs ?)					Totals for Five Mile Creek WWTP				
4		NLRWWU FMC WWTP		5MC-NLR	5MC-OLD	5MC-SH	# of	Water Consumption		gals/cust/	% of FMC	# of	Water Billed by CAW		gals/cust/	% of FMC	# of	Water Billed by CAW		gals/cust/	% of FMC	# of	Water Consumption		gals/cust/	% of FMC
5		Mo Avg	Max Day	Mo Avg	Mo Avg	Mo Avg	Customers	CCF	Gallons	month	Total Flow	Customers	CCF	Gallons	month	Total Flow	Customers	CCF	Gallons	month	Total Flow	Customers	CCF	Gallons	month	Total Flow
6																										
7	Jan-06	3.86	9.28	1.78	0.69	1.39	4275	50783	37985684	8,886	46.13%	2232	19716	14747568	6,607	17.91%	5073	39586	29610328	5,837	35.96%	11580	110085	82343580	7,111	100.00%
8	Feb	4.30	5.90	1.91	0.76	1.63	4278	47402	35456696	8,288	44.42%	2244	18963	14184324	6,321	17.77%	5577	40344	30177312	5,411	37.81%	12099	106709	79818332	6,597	100.00%
9	Mar	5.11	12.29	2.35	0.91	1.85	4298	48315	36139620	8,408	46.01%	2246	18683	13974884	6,222	17.79%	5577	38023	28441204	5,100	36.21%	12121	105021	78555708	6,481	100.00%
10	Apr	4.60	15.36	2.10	0.82	1.68	4295	49774	37230952	8,668	45.62%	2249	19493	14580764	6,483	17.87%	5572	39841	29801068	5,348	36.52%	12116	109108	81612784	6,736	100.00%
11	May	5.22	12.76	2.39	0.93	1.90	4310	51703	38673844	8,973	45.77%	2259	20200	15109600	6,689	17.88%	5597	41068	30718864	5,488	36.35%	12166	112971	84502308	6,946	100.00%
12	Jun	2.90	4.38	1.30	0.55	1.05	4331	52733	39444284	9,107	44.87%	2264	22254	16645992	7,352	18.93%	5607	42548	31825904	5,676	36.20%	12202	117535	87916180	7,205	100.00%
13	Jul	2.75	4.18	1.22	0.52	1.01	4329	53981	40377788	9,327	44.52%	2271	22863	17101524	7,530	18.86%	5594	44403	33213444	5,937	36.62%	12194	121247	90692756	7,437	100.00%
14	Aug	2.89	5.00	1.27	0.58	1.03	4302	50670	37901160	8,810	44.11%	2270	23170	17331160	7,635	20.17%	5587	41038	30696424	5,494	35.72%	12159	114878	85928744	7,067	100.00%
15	Sep	2.90	4.77	1.30	0.54	1.06	4302	50670	37901160	8,810	44.98%	2279	20948	15669104	6,875	18.59%	5587	41038	30696424	5,494	36.43%	12168	112656	84266888	6,925	100.00%
16	Oct	3.01	6.11	1.36	0.55	1.10	4302	50670	37901160	8,810	45.23%	2283	20325	15203100	6,659	18.14%	5587	41038	30696424	5,494	36.63%	12172	112033	83800684	6,885	100.00%
17	Nov	3.95	11.45	1.80	0.69	1.46	4302	50670	37901160	8,810	45.55%	2283	19543	14618164	6,403	17.57%	5587	41038	30696424	5,494	36.89%	12172	111251	83215748	6,837	100.00%
18	Dec-06	5.84	14.13	2.67	1.02	2.16	4302	50670	37901160	8,810	45.64%	2287	19322	14452856	6,320	17.40%	5587	41038	30696424	5,494	36.96%	12176	111030	83050440	6,821	100.00%
19	Jan-07	7.31	13.97	3.35	1.29	2.67	4324	50552	37812896	8,745	45.82%	2284	19497	14583756	6,385	17.67%	5593	40278	30127944	5,387	36.51%	12201	110327	82524596	6,764	100.00%
20	Feb	4.25	8.26	1.83	0.75	1.67	3921	46472	34761056	8,865	43.00%	2290	19136	14313728	6,251	17.71%	6018	42455	31756340	5,277	39.29%	12229	108063	80831124	6,610	100.00%
21	Mar	3.84	4.80	1.65	0.68	1.50	3958	46264	34605472	8,743	42.99%	2307	19184	14349632	6,220	17.83%	6095	42176	31547648	5,176	39.19%	12360	107624	80502752	6,513	100.00%
22	Apr	4.38	9.09	1.94	0.81	1.83	3961	46557	34824636	8,792	44.26%	2312	19562	14632376	6,329	18.60%	6077	39065	29220620	4,808	37.14%	12350	105184	78677632	6,371	100.00%
23	May	3.40	5.00	1.47	0.63	1.30	3962	48632	36376736	9,181	43.38%	2320	20769	15535212	6,696	18.52%	6079	42718	31953064	5,256	38.10%	12361	112119	83865012	6,785	100.00%
24	Jun	2.81	3.77	1.22	0.53	1.06	3935	51037	38175676	9,702	43.38%	2341	22134	16556232	7,072	18.82%	6122	44469	33262812	5,433	37.80%	12398	117640	87994720	7,097	100.00%
25	Jul	3.78	9.34	1.62	0.72	1.44	3931	49153	36766444	9,353	42.88%	2341	21918	16394664	7,003	19.12%	6132	43557	32580636	5,313	38.00%	12404	114628	85741744	6,912	100.00%
26	Aug	2.77	3.41	1.20	0.53	1.04	3946	53448	39979104	10,132	43.23%	2346	23764	17775472	7,577	19.22%	6181	46432	34731136	5,619	37.55%	12473	123644	92485712	7,415	100.00%
27	Sep	3.57	9.34	1.51	0.67	1.39	3954	50199	37548852	9,496	42.34%	2354	22187	16595876	7,050	18.71%	6202	46175	34538900	5,569	38.95%	12510	118561	88683628	7,089	100.00%
28	Oct	4.11	7.94	1.73	0.77	1.62	3904	49261	36847228	9,438	42.05%	2358	21847	16341556	6,930	18.65%	6300	46035	34434180	5,466	38.30%	12562	117143	87622964	6,975	100.00%
29	Nov	3.69	11.36	1.53	0.69	1.48	3905	45987	34398276	8,809	41.33%	2352	20704	15486592	6,584	18.61%	6329	44567	33336116	5,267	40.06%	12586	111258	83220984	6,612	100.00%
30	Dec-07	6.28	13.50	2.67	1.08	2.53	3903	45986	34397528	8,813	42.59%	2361	18504	13840992	5,862	17.14%	6317	43493	32532764	5,150	40.28%	12581	107983	80771284	6,420	100.00%
31	Jan-08	3.74	5.34	1.56	0.71	1.47	3889	47112	35239776	9,061	41.64%	2361	21470	16059560	6,802	18.97%	6321	44568	33336864	5,274	39.39%	12571	113150	84636200	6,733	100.00%
32	Feb	5.63	10.82	2.31	1.07	2.25	3887	44634	33386232	8,589	41.08%	2362	20582	15395336	6,518	18.94%	6321	43428	32484144	5,139	39.97%	12570	108644	81265712	6,465	100.00%
33	Mar	6.83	12.60	2.79	1.29	2.76	3878	43465	32511820	8,384	40.78%	2374	20078	15018344	6,326	18.84%	6358	43051	32202148	5,065	40.39%	12610	106594	79732312	6,323	100.00%
34	Apr	5.45	9.18	2.31	1.04	2.10	3879	47271	35358708	9,115	42.41%	2375	21284	15905472	6,697	19.08%	6347	42938	32117624	5,060	38.52%	12601	111473	83361804	6,617	100.00%
35	May	4.07	6.84	1.68	0.77	1.62	3886	46568	34832864	8,964	41.32%	2386	21295	15928660	6,676	18.90%	6356	44826	33529848	5,275	39.78%	12628	112689	84291372	6,675	100.00%
36	Jun	2.91	4.02	1.25	0.58	1.08	3894	51363	38419524	9,866	42.94%	2396	23877	17859996	7,454	19.96%	6410	44384	33199232	5,179	37.10%	12700	119624	89478752	7,046	100.00%
37	Jul	2.57	3.77	1.09	0.50	0.98	3893	50833	38023084	9,767	42.39%	2392	23544	17610912	7,362	19.63%	6396	45536	34060928	5,325	37.97%	12681	119913	89694924	7,073	100.00%
38	Aug	3.23	9.92	1.35	0.63	1.25	3887	46936	37352128	9,610	41.87%	2394	23226	17373048	7,257	19.47%	6420	46115	34494020	5,373	38.66%	12701	119277	89219196	7,025	100.00%
39	Sep	4.20	10.11	1.76	0.82	1.62	3883	48261	36099228	9,297	41.85%	2399	22471	16808308	7,006	19.48%	6405	44593	33355564	5,208	38.67%	12687	115325	86263100	6,799	100.00%
40	Oct	3.44	7.76	1.38	0.66	1.40	3879	46997	35153756	9,063	40.11%	2389	22363	16727524	7,002	19.09%	6400	47814	35764872	5,588	40.81%	12668	117174	87646152	6,919	100.00%
41	Nov	3.09	4.88	1.30	0.61	1.18	3883	45010	33667480	8,670	42.22%	2395	21005	15711740	6,560	19.70%	6391	40599	30368052	4,752	38.08%	12669	106614	79747272	6,295	100.00%
42	Dec-08	4.24	6.47	1.74	0.82	1.66	3878	44866	33559768	8,654	40.94%	2404	21224	15875552	6,604	19.36%	6373	43513	32547724	5,107	39.70%	12655	109603	81983044	6,478	100.00%
43																										
44																										
45	Average	4.06	8.23	1.71	0.79	1.62	3885			9087	41.627%	2386	21867		6855	19.286%	6375			5195	39.087%	12645			6704	
46	Maxium	7.31	15.36			density =	2.42		gal/cust/day	303				gal/cust/day	229				gal/cust/day	173				gal/cust/day	223	

APPENDIX 5
References

References

1. Munksgaard, Donald G., and Young, James C., "Flow and load variations at wastewater treatment plants," Journal WPCF, Vol 52, No. 8, August 1980.

2. Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, "Recommend Standards for Wastewater Facilities," 2004 Edition, Health Education Services Division, Albany, N.Y.

3. Sherwood vs. Mills, et. al., 1989 (See Appendix 3 to this Report)

4. Metcalf & Eddy, "Wastewater Engineering, Treatment Disposal Reuse," Third Edition, 1991, McGraw-Hill, Inc., New York.

5. Pipeline Analysis, LLC, "Sanitary sewer Evaluation Study Wastewater Flow Monitoring Final Report, Sherwood Wastewater Utility," July 2009, Dallas, Texas.

6. USEPA Municipal Environmental Research Library, "Evaluation of Operation and Maintenance Factors Limiting Municipal Wastewater Treatment Plant Performance," EPA-6002-80-129, August 1980.

MAP(S) / PLAN(S) SCANNED IN

SEPARATE FILE