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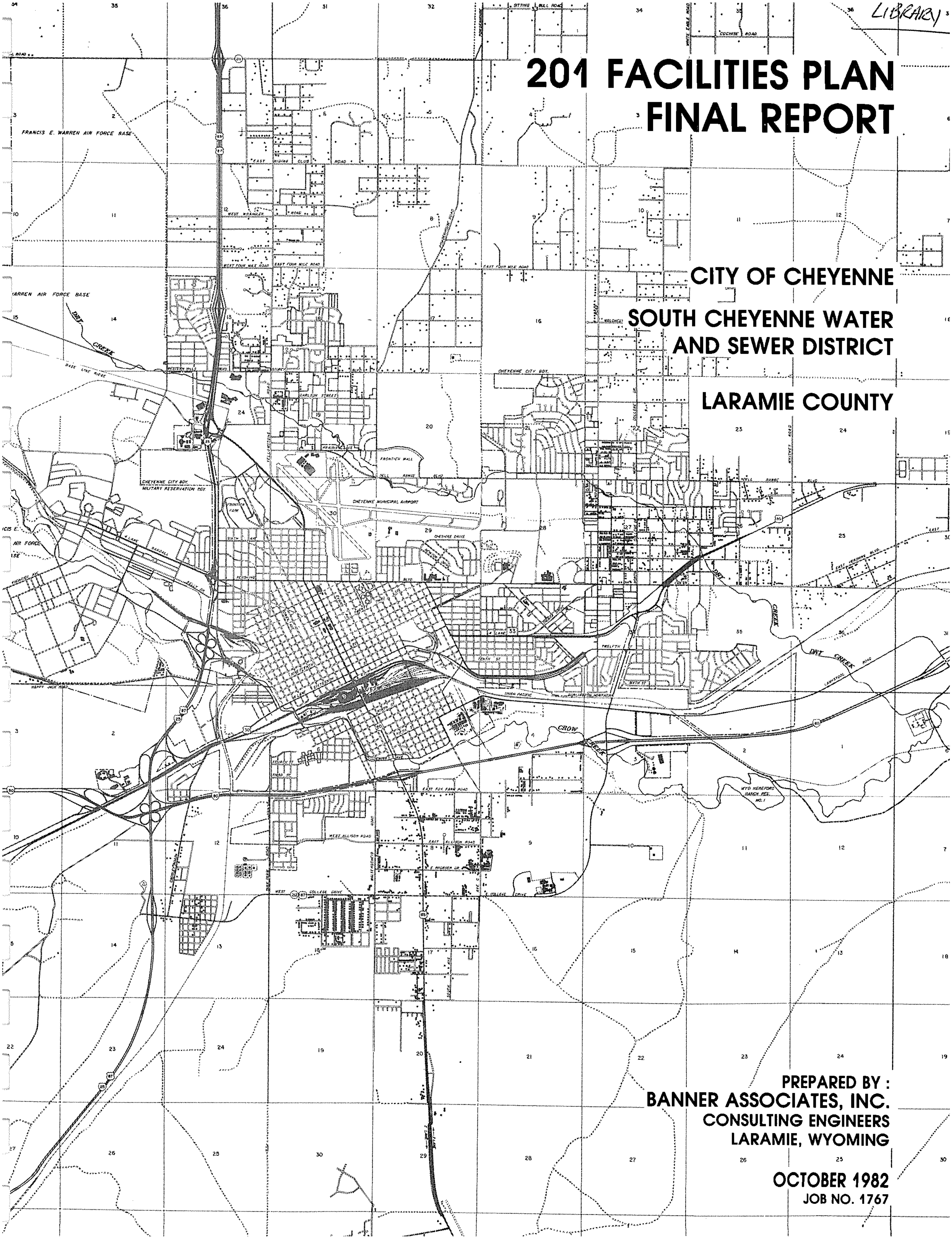
201 FACILITIES PLAN
FINAL REPORT

CITY OF CHEYENNE

SOUTH CHEYENNE WATER AND SEWER DISTRICT

LARAMIE COUNTY



PREPARED BY :
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CONSULTING ENGINEERS
LARAMIE, WYOMING

OCTOBER 1982
JOB NO. 1767

ACKNOWLEDGMENTS

Several city and county agencies have contributed to the development of this Facility Plan Report, without whose contributions this report would not have been possible. Tom Bonds and Jon Arason of the Cheyenne-Laramie County Regional Planning Office have been extremely active with this study throughout the entire process. The Laramie County Environmental Health Unit, through the efforts of Gary Hickman and Don Pack, has also provided valuable information. The engineering evaluations of the areas' wastewater treatment facilities were greatly aided by Art Buffington of the South Cheyenne Water and Sewer District and Jack Young, Superintendent of the Cheyenne sewage treatment facilities. John Price of the Cheyenne Board of Public Utilities also provided valuable information regarding the City's sewer system. Ed Baruth of the Wyoming Department of Environmental Quality, Water Quality Division provided useful guidance throughout the entire process. Floydene Gay of the South Cheyenne Water and Sewer District also greatly aided the development of this report. The Citizens Advisory Committee (Beverly Schwieger, Al Vosler, Elmo Foster, Jay Holland, and Ed Strader) provided extremely important insight regarding the wastewater treatment desires of the people in the study area.

Finally, thanks are in order to all the people of the Cheyenne area who provided comments and suggestions through the Public Participation Program. The common efforts of all involved in the development of this Facility Plan have led to a useful plan for the treatment of wastewater in the Cheyenne Area for the next twenty years.

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I. Summary and Conclusions

A. Summary

This 201 Facility Plan identifies the wastewater treatment requirements for Cheyenne, South Cheyenne, and the surrounding area in Laramie County. During the investigation, several wastewater treatment alternatives for the urban service area were developed, each with the goal of providing facilities that can efficiently treat the area's wastewater for the next 20 years. These alternatives are briefly summarized in Appendix A, and are presented in detail in Appendix B, Working Paper No. 3.

The "Urban Service Area" is defined as the general area within which gravity flow can deliver the wastewater to the treatment plants. One exception to this "gravity flow", concept exists, i.e. there is one existing sewage lift station on Missile Drive. For areas outside this "Urban Service Area", i.e. the ranchette developments, onsite wastewater treatment processes are recommended.

Extensive discussion of the proposed wastewater treatment alternatives between the 201 Committee (South Cheyenne Water and Sewer District, Cheyenne Board of Public Utilities, and Laramie County Commissioners), the Citizens Advisory Committee, and the public (through a public participation program) resulted in the selection of Alternative C (refer to Appendix A, Summary of Regional Wastewater Treatment Alternatives). This alternative entails the abandonment of the South Cheyenne Wastewater Treatment Plant (WWTP), the upgrading of the Crow Creek WWTP, and the upgrading and expanding of the Dry Creek WWTP. Chapter II of this report discusses this alternative in detail, with several references made to Working Paper No. 3.

The total capital cost for this alternative is estimated to be $7,290,910. This includes the Crow Creek upgrading, Dry Creek upgrading and expansion, pipeline from South Cheyenne to the Crow Creek Diversion Stucture, collection lines for the Sunnyside and North Cheyenne areas, and funds for Step 2 and 3 planning and engineering. Assuming 75% federal funding through the Facility Grants Program, and 12½% funding from other federal or state programs, the resulting total local capital cost is $911,360. The development of these costs is presented in the financial worksheets, Tables I-1 through I-4, and is discussed in detail in Chapter III of this report. Operation and maintenance costs are projected by using the EPA publication "Analysis of Operations and Maintenance Costs for Municipal Wastewater Treatment System," (EPA 430/9-77-015). The projected total O&M cost for the proposed wastewater treatment facilities is $821,360 per year.

The financial worksheets include not only the proposed wastewater system costs, but also calculations dealing with the financial capabilities of the local government, burden analysis, and financial risk analysis. The Financial Capabilities worksheet examines the local government's ability to afford the additional capital, operations, and maintenance expenses. The Burden Analysis describes the expected cost of the proposed wastewater treatment system improvements on individual system users for the first year after the system is in place. The Burden Analysis worksheet compares the total costs of the proposed improvements with the existing system costs to the system users. It reduces the complex estimates of one-time capital costs and continuing O&M costs to a single-number estimate of costs per "typical residential user," for both the existing and proposed systems. The Financial Risk Analysis is a technique that estimates the future annual costs per equivalent residential unit (ERU), under different

TABLE I-1

WORKSHEET #1
PROPOSED WASTEWATER SYSTEM COSTS

NO PHASING: DRY CREEK UPGRADING & EXPANSION TREATED AS SEPARATE COSTS

Date: 5 OCTOBER 1982
Agency:
Year of cost calculations: 1982

Wastewater System Components	Estimated Capital Cost: Total Capital	− EPA Grant Eligible Amount	− Other Fed./State Eligible Amount	= Local Capital Cost	Estimated Annual Operations & Maintenance (O & M) Cost: Labor	+ Materials	+ Power	+ General Administration	+ Other	= Annual O & M Cost
A. Wastewater treatment facility										
1. DRY CREEK UPGRADE	1,067,910	800,940	133,480	133,490	220,970	20,710	85,940	26,830	20,830	375,280
2. DRY CREEK EXPANSION TO 7.0 MGD	2,475,730	1,856,800	309,470	309,460	88,630	8,300	34,460	10,760	8,350	150,500
3. CROW CREEK UPGRADE	729,150	546,860	91,140	91,150	174,050	16,310	67,690	21,130	16,400	295,580
B. Interceptor sewers										
4. SOUTH CHEYENNE TO CROW CREEK	433,390	325,040	54,180	54,170						
5. (CAPACITY = 2.5 MGD)										
6.										
7.										
8.										
9.										
10.										
11.										
12.										
C. Pump stations & force mains										
13.										
14.										
15.										
16.										
D. Collection lines										
17. SUNNYSIDE	1,071,700	803,780	133,960	133,960						
18. NORTH CHEYENNE	562,040	421,530	70,260	70,250						
19.										
20.										
E. Sludge handling and disposal facilities										
21.										
F. Land aquisition/lease										
22. Treatment facility										
23. Rights-of-way										
G. Correctable infiltration/inflow										
24.										
H. Step 2-3 planning & engineering										
25. 15% OF TOTAL CAPITAL	950,990	713,240	118,870	118,880						
I. Other identifiable costs										
26.										
27.										
28.										
	$7,290,910	− $5,468,190	− $ 911,360	= $ 911,360 Total Local Capital Cost	$ 483,650	+ $ 45,320	+ $ 188,090	+ $ 58,720	+ $ 45,580	= $ 821,360 Total Annual O&M Cost

Comments/Qualifications: O & M ESTIMATES TAKEN FROM EPA 430/9-77-015; TECHNICAL REPORT: ANALYSIS OF OPERATIONS AND MAINTENANCE COSTS FOR MUNICIPAL WASTEWATER TREATMENT SYSTEMS: FEB, 1978. COSTS UPDATED TO SEPT. 1979. O & M FOR DRY CREEK EXPANSION IS THAT THAT IS ABOVE THE O & M FOR THE UPGRADED PLANT, i.e. TOTAL O & M FOR THE EXPANDED FACILITY IS 375,280 + 150,500 = 525,780.

ASSUMPTIONS: 75% EPA FUNDING, 12½% OTHER FED./STATE FUNDING, 12½% LOCAL CAPITAL COST

Proposed improvements description:

Prepared for the Wyoming Department of Environmental Quality by BMML (6/81)

TABLE I-1 (continued)

NO PHASING: DRY CREEK UPGRADING AND EXPANSION COMBINED AS SINGLE COST

Date: 4 OCTOBER 1982
Agency:
Year of cost calculations: 1982

WORKSHEET #1
PROPOSED WASTEWATER SYSTEM COSTS

Wastewater System Components	Estimated Capital Cost				Estimated Annual Operations & Maintenance (O & M) Cost					
	Total Capital	− EPA Grant Eligible Amount	− Other Fed./State Eligible Amount	= Local Capital Cost	Labor	+ Materials	+ Power	+ General Administration	+ Other	= Annual O & M Cost
A. Wastewater treatment facility										
1. DRY CREEK UPGRADE & EXPAND TO 7.0 MGD	3,543,640	2,657,740	442,950	442,950	309,600	29,010	120,400	37,590	29,180	525,780
2. CROW CREEK UPGRADE	729,150	546,860	91,140	91,150	174,050	16,310	67,690	21,130	16,400	295,580
3.										
B. Interceptor sewers										
4. SOUTH CHEYENNE TO CROW CREEK	433,390	325,040	54,180	54,170						
5. (CAPACITY = 2.5 MGD)										
6.										
7.										
8.										
9.										
10.										
11.										
12.										
C. Pump stations & force mains										
13.										
14.										
15.										
16.										
D. Collection lines										
17. SUNNYSIDE	1,071,700	803,780	133,960	133,960						
18. NORTH CHEYENNE	562,040	421,530	70,260	70,250						
19.										
20.										
E. Sludge handling and disposal facilities										
21.										
F. Land aquisition/lease										
22. Treatment facility										
23. Rights-of-way										
G. Correctable infiltration/inflow										
24.										
H. Step 2-3 planning & engineering										
25. 15 % OF TOTAL CAPITAL	950,990	713,240	118,870	118,880						
I. Other identifiable costs										
26.										
27.										
28.										
	$7,290,910	− $5,468,190	− $ 911,360	= $ 911,360 Total Local Capital Cost	$ 483,650	+ $ 45,320	+ $ 188,090	+ $ 58,720	+ $ 45,580	= $ 821,360 Total Annual O&M Cost

Comments/Qualifications:

O & M ESTIMATIONS TAKEN FROM EPA 430/9-77-015, TECHNICAL REPORT: ANALYSIS OF OPERATIONS AND MAINTENANCE COSTS FOR MUNICIPAL WASTEWATER TREATMENT SYSTEMS. FEB. 1978.

Proposed improvements description:

Prepared for the Wyoming Department of Environmental Quality by BMML (6/81)

TABLE I-1 (continued)

PHASED DEVELOPMENT
PHASE I

Date: 4 OCTOBER 1982
Agency:
Year of cost calculations: 1982

WORKSHEET #1
PROPOSED WASTEWATER SYSTEM COSTS

Wastewater System Components	Estimated Capital Cost: Total Capital	− EPA Grant Eligible Amount	− Other Fed./State Eligible Amount	= Local Capital Cost	Estimated Annual Operations & Maintenance (O & M) Cost: Labor	+ Materials	+ Power	+ General Administration	+ Other	= Annual O & M Cost
A. Wastewater treatment facility										
1. DRY CREEK UPGRADE	1,067,910	800,940	133,480	133,490	220,970	20,710	85,940	26,830	20,830	375,280
2. CROW CREEK UPGRADE	729,150	546,860	91,140	91,150	174,050	16,310	67,690	21,130	16,400	295,580
3.										
B. Interceptor sewers										
4. SOUTH CHEYENNE TO CROW CREEK	433,890	325,640	54,180	54,170						
5. (CAPACITY = 2.5 MGD)										
6.										
7.										
8.										
9.										
10.										
11.										
12.										
C. Pump stations & force mains										
13.										
14.										
15.										
16.										
D. Collection lines										
17. SUNNYSIDE	1,071,700	803,780	133,960	133,960						
18. NORTH CHEYENNE	562,040	421,530	70,260	70,250						
19.										
20.										
E. Sludge handling and disposal facilities										
21.										
F. Land aquisition/lease										
22. Treatment facility										
23. Rights-of-way										
G. Correctable infiltration/inflow										
24.										
H. Step 2-3 planning & engineering										
25. 15% OF TOTAL CAPITAL	579,630	434,720	72,450	72,460						
I. Other identifiable costs										
26.										
27.										
28.										
	$4,443,820	$3,332,870	$555,470	$555,480 (Total Local Capital Cost)	$395,020	$37,020	$153,630	$47,960	$37,230	$670,860 (Total Annual O&M Cost)

Comments/Qualifications:

O&M FROM EPA 430/9-77-015; ASSUME DRY CREEK OPERATING AT 100% CAPACITY (4.5 MGD)

Proposed improvements description:

TABLE I-1 (continued)

WORKSHEET #1

PHASED DEVELOPMENT

PHASE II

PROPOSED WASTEWATER SYSTEM COSTS

Date: 4 OCTOBER 1982
Agency:
Year of cost calculations: 1982

Wastewater System Components	Estimated Capital Cost: Total Capital	− EPA Grant Eligible Amount	− Other Fed./State Eligible Amount	= Local Capital Cost	Estimated Annual Operations & Maintenance (O & M) Cost: Labor	+ Materials	+ Power	+ General Administration	+ Other	= Annual O & M Cost
A. Wastewater treatment facility										
1. DRY CREEK EXPAND TO 7.0 MGD	2,475,730	1,856,800	309,470	309,460	309,600	29,010	120,400	37,590	29,180	525,780
2. CROW CREEK					174,050	16,310	67,690	21,130	16,400	295,580
3.										
B. Interceptor sewers										
4. SOUTH CHEYENNE TO CROW CREEK										
5. (CAPACITY = 2.5 MGD - included in Phase I)										
6.										
7.										
8.										
9.										
10.										
11.										
12.										
C. Pump stations & force mains										
13.										
14.										
15.										
16.										
D. Collection lines										
17.										
18.										
19.										
20.										
E. Sludge handling and disposal facilities										
21.										
F. Land aquisition/lease										
22. Treatment facility										
23. Rights-of-way										
G. Correctable infiltration/inflow										
24.										
H. Step 2-3 planning & engineering										
25. 15% OF TOTAL CAPITAL	371,360	278,520	46,420	46,420						
I. Other identifiable costs										
26.										
27.										
28.										
	$2,847,090	$2,135,320	$355,890	$355,880 (Total Local Capital Cost)	$487,650	$45,320	$188,090	$58,720	$45,580	$821,360 (Total Annual O&M Cost)

Comments/Qualifications:

O&M ASSUMED EQUAL TO THAT FOR "NO PHASING".

Proposed improvements description:

Prepared for the Wyoming Department of Environmental Quality by BMML (6/81)

TABLE I-2

WORKSHEET #2
FINANCIAL CAPABILITIES PART I
GENERAL GOVERNMENT ACTIVITIES

Date: 5 OCTOBER, 1982
Agency:

A. Financial Resources:

	Current year (1982) year	Last year (1981) year	5 years earlier (1977) year
1. POPULATION	49,000	47,200	45,000
2. Population rate of change	3.8 %	4.9 %	
3. TAXABLE ASSESSED VALUATION	a. $ 121,677,236	b. $ 117,552,097	c. $ 80,266,881
4. Assessed valuation rate of change	3.5 %	46.5 %	
5. Assessed valuation per capita	$ 2,483	$ 2,490	$ 1,783
6. SALES REVENUE	$ 98,178,433	$ 99,523,100	$ 70,045,900
7. Sales rate of change	<1> %	42 %	
8. Sales per capita	$ 2004	$ 2109	$ 1,557

B. Revenues & Expenditures:

Revenues:	Current year (1982) year	%	5 years earlier (1977) year	%
9. LOCAL:				
10. Property taxes	$977,185	%	$674,867	%
11. Sales tax	2,945,353		2,101,377	
12. Fees, fines, charges	3,371,734		2,055,505	
Transfers from:				
13. SEVERANCE TAX	1,910,686			
14.				
15.				
16. Other local revenues	3,894,334		1,985,135	
17. NON-LOCAL:	2,112,818		313,391	
18. Total revenues	$15,212,170	100%	$7,130,215	100%
19. Annual rates of change	13 %		113 %	
	Last year to current year 1981 to 1982		5 years earlier to current year 1977 to 1982	

Expenditures:	Current year (____) year	%	5 years earlier (____) year	%
20. Operations & Maintenance:	$13,479,237	%	$5,892,846	%
21. Capital outlays	1,320,253		575,205	
22. Debt service	89,850		91,400	
Transfers to:				
23.				
24.				
25.				
26. Other				
27. Unexpended fund balance				
28. Total expenditures	$14,889,340	100%	$6,559,451	100%
29. Annual rates of change	22 %		127 %	
	Last year to current year 1981 to 1982		5 years earlier to current year 1977 to 1982	

C. Debt History:

GENERAL OBLIGATION DEBT:
(All debt excluding water and wastewater)

	Current year	5 years earlier
30. Outstanding debt	a. $ 0	b. $ 0
31. Annual debt service	$	$

32. Outstanding debt (line 30a) / Assessed valuation (line 3a) = ____ %

33. Total uncommitted indebtedness...... $

Sources of repayment:	% of debt service
34.	%
35.	%
36.	%
Total:	100%

37. Planned General Obligation Bond Issues: NONE

REVENUE BOND DEBT:
(All debt excluding water and wastewater)

	Current year	5 years earlier
38. Outstanding debt	$615,000	$750,000
39. Annual debt service	$89,850	$91,400

Sources of repayment:	% of debt service
40. PARKING FEES	100 %
41.	%
42.	%
Total:	100%

43. Planned Revenue Bond Issues: NONE

D. Tax Rates:

Combined (overlapping) property tax mill levy:

	Current year Actual	Current year Legal limit	5 years earlier Actual
44. Municipality	8.00		8.00
45. County	19.32		19.54
46. School district	44.97		46.45
47. STATE	6.00		6.00
48. WEED & PEST	.94		.94
Total:	79.23 Mills	Mills	80.93 Mills
49. Sales tax rate:	3 %		3 %

Comments/Qualifications:

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TABLE I-2 (continued)

WORKSHEET #2
FINANCIAL CAPABILITIES PART II
ENTERPRISE ACTIVITIES

Date: 4 OCTOBER, 1982
Agency:

I-8

E. Wastewater:

50. Existing system description: DRY CREEK: 4.5 MGD ACTIVATED SLUDGE WWTP; CROW CREEK: 4.0 MGD TRICKLING FILTER WWTD

51. Last audited year: 07/81 mo/year // 06/82 mo/year

52. Sewered population: 53,000 (1) End of audited year

Revenues:

LOCAL:		
53. Plant investment fees	$ 39,625	3 %
54. User charges	1,064,281	76 %
55. Property taxes		%
Transfers from:		
56. INTEREST	275,637	20 %
57. MISCELLANEOUS	14,667	1 %
58. Other local:		%
59. NON-LOCAL:		%
60. Total revenues	$ 1,394,210	100%

Expenditures:

VARIABLE: (Operations and Maintenance)		
61. General administration	$ 320,930	28 %
62. O & M labor	366,221	32 %
63. Materials capital outlay	24,290	2 %
64. Power	112,971	10 %
65. Other variable		%
FIXED:		
66. Debt service payment	140,000	12 %
67. Loan payment		%
Transfers to:		
68. INTEREST EXP.	184,180	16 %
69.		%
70. Other fixed		%
71. Unexpended fund balance		%
72. Total expenditures	$ 1,148,592	100%

Debt History:

GENERAL OBLIGATION DEBT:
73. Outstanding debt: $
74. Annual debt service: $

Sources of repayment	% of debt service
75.	%
76.	%
77.	%
78. Total	100%

79. Outstanding debt (2,950,000) line 73 / Assessed valuation (121,617,236) line 3a = 2.4 %

80. Total uncommitted indebtedness $

REVENUE BOND DEBT:
81. Outstanding debt: $2,950,000
82. Annual debt service: $ 299,180

Sources of repayment	% of debt service
83. USER CHARGE	70 %
84. INTEREST INCOME	30 %
85.	%
86. Total	100%

LONG-TERM LOANS:
87. Outstanding debt: $
88. Annual loan service: $

Sources of repayment	% of debt service
89.	%
90.	%
91.	%
	%
92. Total	100%

93. Lender(s)

User Fees and Charges:

PLANT INVESTMENT FEE:
94. $ 210.00 per single-family tap
INCLUDES PLANT INVESTMENT FEE (150.00) AND TAP IN FEE (60.00 FOR 4" LINE)

COVERAGE:
95. ☐ Share of plant and interceptor
96. ☐ Physical hookup at user's site
97. ☐ Operations and Maintenance

USER CHARGES: 6000 gal/month
98. $ 4.11 avg. per month per single-family user AS OF 6/30/82

F. Water:

99. Existing system description: WELL FIELDS, CROW CREEK DIVERSIONS; TRANS-BASIN WATER IMPORT

100. Last audited year: 7/81 mo/year // 6/82 mo/year

101. Sewered population: 60,000 (2) End of audited year

Revenues:

LOCAL:		
102. Plant investment fees	$ 109,214	3 %
103. User charges	3,361,236	87 %
104. Property taxes		%
Transfers from:		
105. INTEREST	290,046	7 %
106. MISCELLANEOUS	114,180	3 %
107. Other local:		%
108. NON-LOCAL:		%
109. Total revenues	$ 3,814,676	100%

Expenditures:

VARIABLE: (Operations and Maintenance)		
110. General administration	$ 696,314	14 %
111. O & M labor	909,639	18 %
112. Materials capital outlay	1,601,160	33 %
113. Power	133,394	3 %
114. Other variable		%
FIXED:		
115. Debt service payment	1,033,000	21 %
116. Loan payment		%
~~Transfers to:~~		
117. INTEREST	560,230	11 %
118.		%
119. Other fixed		%
120. Unexpended fund balance		%
121. Total expenditures	$ 4,939,737	100%

Debt History:

GENERAL OBLIGATION DEBT:
122. Outstanding debt: $10,310,000
123. Annual debt service: $ 1,358,860

Sources of repayment	% of debt service
124. USER CHARGE	93 %
125. INTEREST INCOME	7 %
126.	%
127. Total	100%

128. Outstanding debt (10,310,000) line 73 / Assessed valuation (121,617,236) line 3a = 8.5 %

129. Total uncommitted indebtedness $

REVENUE BOND DEBT:
130. Outstanding debt: $
131. Annual debt service: $

Sources of repayment	% of debt service
132.	%
133.	%
134.	%
135. Total	100%

LONG-TERM LOANS:
136. Outstanding debt: $
137. Annual loan service: $

Sources of repayment	% of debt service
138.	%
139.	%
140.	%
	%
141. Total	100%

142. Lender(s)

User Fees and Charges:

PLANT INVESTMENT FEE:
143. $ 610.00 per single-family tap AS OF 6/30/82
INCLUDES PLANT INVESTMENT FEE (250.00) AND TAP IN FEE (360.00)

COVERAGE:
144. ☐ Share of plant and interceptor
145. ☐ Physical hookup at user's site
146. ☐ Operations and Maintenance

USER CHARGES: 11,000 gal/month
147. $ 10.88 avg. per month per single-family user AS OF 6/30/82

(For comments and qualifications, please use reverse side.)

Prepared for the Wyoming Department of Environmental Quality by BMML

(1) SEWERED POP.: CITY (48,000) + WARREN AFB (5000) = 52,800 (2) WATER POP.: CITY (48,000) + WARREN AFB (5000) + SO. CHEY. (7,000) = 60,000

TABLE I-3

WORKSHEET #3
BURDEN ANALYSIS

Date: 5 OCTOBER 1982
Agency: ______

EXISTING SYSTEM

A. Existing System Description:

1. DRY CREEK WWTP: 4.5 MGD ACTIVATED SLUDGE FACILITY
   CROW CREEK WWTP: 4.0 MGD TRICKLING FILTER FACILITY
2. Year of cost calculations (Last audited year): 7/81 - 6/82
3. Sewered population (Last audited year): 53,000 (2)

B. Annual Costs:
(Excluding industrial dischargers)

VARIABLE COSTS: (Operations & Maintenance)	
4. General administration	$ 320,930
5. Labor	366,221
6. Materials	24,290
7. Power	112,971
8. Other	
FIXED COSTS:	
9. Annual debt service	140,000
10. Other	
11. Total cost	$ 964,412
12. Less PIF revenue	− 39,625
13. Total annual cost less PIF revenues	$ 924,787

C. Equivalent Residential Units (ERU):

14. a. 6,500,000 (gallons) = Average Daily Base Flow (ADBF) (Excludes industrial dischargers)
    b. 4,240,000 Daily residential flow + c. 2,260,000 Daily non-residential flow (Excludes industrial dischargers)

15. Equivalent Residential Unit (ERU) annual flow:
[Daily residential flow (4,240,000 line 14b) × 365 days] / [Sewered population (53,000 line 3) ÷ Persons per household (2.51)] = 73,292 ERU annual flow

16. Number of ERUs:
[ADBF (6,500,000 line 14a) × 365 days] ÷ ERU annual flow (73,292 line 15) = 32,370 Number of ERUs

D. Annual Costs Per ERU:

17. Total annual costs (Less PIF revenues) (924,787 line 13) ÷ Number of ERUs (32,370 line 16) = $ 28.57 Total annual cost per ERU

PROPOSED IMPROVEMENTS

E. Proposed Improvements Description:

18. DRY CREEK WWTP: UPGRADE AND EXPAND TO 7.0 MGD CAPACITY
    CROW CREEK WWTP: UPGRADE BUT MAINTAIN CAPACITY AT 4.0 MGD
19. Planning period of proposed improvements: 20 YEARS
20. First operational year: 1985
21. First operational year sewered population: 66,500 (3)
22. Year before #20 above sewered population: 65,000

F. Annual Costs:

Capital costs and annual debt	
23. Proposed capital cost	$ 911,360
24. Fiscal, legal, underwriting fees	13,670 (4)
25. Reserve requirement	91,136 (5)
26. Total capital debt	$ 1,016,166
27. Annual debt service	$ 98,771 (6)
Total costs	
VARIABLE COSTS: (Operations and maintenance)	
28. General administration	$ 58,720
29. Labor	483,650
30. Materials	45,320
31. Power	188,090
32. Other	45,580
33. Total annual O&M costs	$ 821,360
FIXED COSTS:	
34. Annual debt service	238,771
35. Other	
36. Fixed cost subtotal	238,771
37. Total annual costs	$ 1,060,131
38. Less PIF revenues first operational year	− 126,000 (7)
39. Total annual costs less PIF revenues	$ 934,131

G. Equivalent Residential Units (ERU):

40. a. 8,000,000 (gallons) = Total Average Daily Base Flow (ADBF) (Excludes industrial dischargers)
    b. 5,320,000 Daily residential flow + c. 2,680,000 Daily non-residential flow (Excludes industrial dischargers)

41. Equivalent Residential Unit (ERU) annual flow:
[Daily residential flow (5,320,000 line 40b) × 365 days] / [Sewered population (66,500 line 21) ÷ Persons per household (2.51)] = 73,292 ERU annual flow

42. Number of ERUs:
[ADBF (8,000,000 line 40a) × 365 days] ÷ ERU annual flow (73,292 line 41) = 39,840 Number of ERUs

H. Annual Costs Per ERU:

43. Total annual O&M cost per ERU:
Total O&M cost (821,360 line 33) ÷ Number of ERUs (39,840 line 42) = $ 20.62 Total annual O&M cost per ERU

44. Total annual costs per ERU:
Total annual costs (Less PIF revenues) (934,131 line 39) ÷ Numbers of ERUs (39,840 line 42) = $ 23.45 Total annual cost per ERU

Comments/Qualifications: (1) ADBF = 3.5 MGD (DRY CREEK) + 3.0 MGD (CROW CREEK) = 6.5 MGD.
DAILY RESIDENTAL FLOW = 53,000 × 80 gpcd = 4,240,000 gpd (80 gpcd IS AVERAGE).
DAILY NON-RESIDENTIAL FLOW = 6.5 - 4.24 = 2,260,000 gpd (INCLUDES I/I).
(2) SOUTH CHEYENNE IS NOT INCLUDED IN "EXISTING SYSTEM" (3) SOUTH CHEYENNE IS INCLUDED IN "PROPOSED IMPROVEMENTS"
(4) UNDERWRITING FEE; USE 1.5% OF CAPITAL COST (5) RESERVE REQUIREMENT; USE 10% OF CAPITAL COST (6) USE 7 1/8 % INTEREST FOR 20 YEARS; CRF FACTOR = .0972 (7) 600 NEW HOUSEHOLDS × $210.00 PIF (LINE 74, WORKSHEET #2 PART II) = 126,000 (8) ADBF = 3.5 MGD (DRY CREEK) + 3.5 MGD (CROW CREEK) + 1.0 MGD (SOUTH CHEYENNE) = 8.0 MGD
DAILY RESIDENTIAL FLOW = 66,500 × 80 = 5,320,000
DAILY NON-RESIDENTIAL = 8,000,000 - 5,320,000 = 2,680,000

Prepared for the Wyoming Department of Environmental Quality by BMML

TABLE I-4

WORKSHEET #4
FINANCIAL RISK ANALYSIS

PLANNED GROWTH RATE

Date: 6 OCTOBER 1982

Agency: ________________

A. Formula:

Conceptual Formula:

$$\text{Annual costs per ERU}_{\text{year } t} = \frac{\text{Operations \& Maintenance costs}_{\text{year } t} + \text{Debt service}_{\text{year } t} - \text{Plant Investment Fee revenues}_{\text{year } t}}{\text{ERU}_{\text{year } t}}$$

Applied Formula:

$$\text{Annual costs per ERU}_{\text{year } t} = \frac{(X)(\text{O\&M Costs}_{\text{year } t} \text{ (current dollar)}) + \text{Debt service}_{\text{year } t} - (Y)(\text{ERU}_{\text{year } 0})(\text{PIF fee})}{(Z)(\text{ERUs}_{\text{year } 0})}$$

Current dollar O&M $\text{costs}_{\text{year } t}$ = Annual operations and maintenance costs for existing and proposed improvements in current (year 0) dollars or in "constant" dollars.

Debt service = Annual principle and interest payments required on old and new bonded indebtedness *and* long term loans.

$\text{ERU}_{\text{year } t}$ = Total number of ERUs the year capital debt begins on the proposed system.

Year 0 = The year the debt on the proposed system begins.

PIF fee = Plant investment fee per equivalent residential unit, assumed constant.

X = Annual rate of inflation for O&M costs.

Y = Incremental growth rate of ERUs over the previous year.

Z = Growth rate of ERUs from year 0.

B. Inputs:

	1. (1985) First operational year	(1986) Year 1	(1990) Year 5	(1995) Year 10
Current dollar O&M costs	2. $821,360	3. $899,390	4. $1,299,020	5. $2,085,527 (1)
Annual debt service	6. $236,415	7. $236,415	8. $236,415	9. $236,415

Number of ERUs:

First operational year 10. 39,840 (Number of ERUs)

Year 0 (1985 year) 11. 34,620 (Number of ERUs) (2)

Plant investment fee 12. $ 210.00

Rate of inflation for O&M 13. 9.5 % (3)

Annual ERU growth rate 14. 2.06 % (4)

C. First Operational Year:

In constant dollars (from Burden Analysis Worksheet):

$$\text{Annual costs per ERU}_{\text{first operational year}} = \frac{\text{O\&M costs (current dollars)} + \text{Debt service} - \text{PIF revenues}}{\text{ERU units}}$$

Annual costs per ERU first operational year = [15. 821,360 (Worksheet #3, line 33) + 16. 238,771 (Worksheet #3, line 27) − 17. 126,000 (Worksheet #3, line 38) / 18. 39,840 (Worksheet #3, line 42)] = $ 23.45 (Worksheet #3, line 44)

With Inflation:

$$\text{Annual costs per ERU}_{\text{first operational year}} = \frac{(X)\,(\text{O\&M costs})_{\text{first operational year}}^{\text{(constant dollars)}} + \text{Debt service} - \text{PIF revenues}_{\text{first operational year}}}{\text{ERUs}}$$

Step	To Determine	Formula	Result
1.	Operations & Maintenance costs	(X) (821,360 entry 2)	= 20. 1,078,390 (5)

To determine X, compound the rate of inflation annually to the first operational year and add 1.0. For example, if rate of inflation is 9% and first operational year is 3, then X = 1.295 (1.09 × 1.09 × 1.09 = 1.295)

Annual costs per ERU first operational year = [1,078,390 (entry 20) + 236,415 (entry 16) − 126,000 (entry 17)] ÷ 39,840 (entry 18) = 21. $ 29.84

OTHER YEAR CALCULATIONS

D. For Year 1:

Step	To Determine	Formula	Result
1.	Operations & Maintenance costs in year 1	(X) (899,390 entry 3) =	22. $ 984,832

Use table below to determine X

Inflation rate	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%
X =	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16

Step	To Determine	Formula	Result
2.	PIF revenues in year 1	(Y) (34,620 entry 11) (210 entry 12) =	23. $ 149,766

Use table below to determine Y

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Y =	.01	.015	.020	.025	.030	.035	.040	.045	.050	.055	.060	.065

Step	To Determine	Formula	Result
3.	Total annual costs in year 1	(984,832 entry 22) + (236,415 entry 7) − (149,766 entry 23) =	24. $ 1,076,481
4.	Number of ERUs in year 1	(Z) (34,620 entry 11) =	25. 35,333

Use table below to determine Z

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Z =	1.010	1.015	1.020	1.025	1.030	1.035	1.040	1.045	1.050	1.055	1.060	1.065

Step	To Determine	Formula	Result
5.	Annual costs per ERU in year 1	(1,071,481 entry 24) ÷ (35,333 entry 25) =	26. $ 30.33

E. For Year 5:

Step	To Determine	Formula	Result
1.	Operations & Maintenance costs in year 5	(X) (1,299,020 entry 4) =	27. $ 2,035,522

Use table below to determine X

Inflation rate	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%
X =	1.402	1.469	1.539	1.610	1.685	1.762	1.843	1.925	2.010	2.101

Step	To Determine	Formula	Result
2.	PIF revenues in year 5	(Y) (34,620 entry 11) (210 entry 12) =	28. $ 170,850

Use table below to determine Y

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Y =	0.010	0.016	0.023	0.027	0.033	0.040	0.047	0.054	0.061	0.068	.076	.084

Step	To Determine	Formula	Result
3.	Total annual costs in year 5	(2,035,522 entry 27) + (236,415 entry 8) − (170,850 entry 28) =	29. $ 2,101,087
4.	Number of ERUs in year 5	(Z) (34,620 entry 11) =	30. 38,324

Use table below to determine Z

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Z =	1.051	1.077	1.104	1.131	1.159	1.188	1.217	1.246	1.276	1.307	1.338	1.370

Step	To Determine	Formula	Result
5.	Annual costs per ERU in year 5	(2,101,087 entry 29) ÷ (38,324 entry 30) =	31. $ 54.82

F. For Year 10:

Step	To Determine	Formula	Result
1.	Operations & Maintenance costs in year 10	(X) (2,035,527 entry 5) =	32 $ 5,044,500

Use table below to determine X

Inflation rate	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%
X =	1.967	2.159	2.367	2.592	2.838	3.105	3.395	3.706	4.042	4.414

Step	To Determine	Formula	Result
2.	PIF revenues in year 10	(Y) (34,620 entry 11) (210 entry 12) =	33 $ 167,796

Use table below to determine Y

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Y =	0.011	0.017	0.022	0.031	0.039	0.049	0.057	0.067	.077	.089	.102	.114

Step	To Determine	Formula	Result
3.	Total annual costs in year 10	(5,044,500 entry 32) + (236,415 entry 9) − (167,796 entry 33) =	34 $ 5,113,119
4.	Number of ERUs in year 10	(Z) (34,620 entry 11) =	35 42,455

Use table below to determine Z

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Z =	1.104	1.160	1.219	1.280	1.344	1.411	1.480	1.551	1.628	1.707	1.791	1.875

Step	To Determine	Formula	Result
5.	Annual costs per ERU in year 10	(5,113,119 entry 34) ÷ (42,455 entry 35) =	36 $ 120.44

(For comments and qualifications, please use reverse side.)

COMMENTS/QUALIFICATIONS

(1) ESTIMATE O&M COSTS INCREASE BY A FACTOR OF 1.09; FROM EPA COMPLETE URBAN SEWER SYSTEM COST INDEX.

(2) ASSUME GROWTH RATE OF 1500 PEOPLE/YEAR AT 2.51 PEOPLE/ERU FOR THREE YEARS (1982 - 1985) = 32,370 + 3(1500/2) = 34,620.

(3) RATE OF INFLATION: 9.5% i.e. O&M YEAR 10 = $(1.095)^{10}(827490)$

(4) DETERMINE ANNUAL ERU GROWTH RATE THUSLY: 39,840 ERU'S FOR POP. OF 66,500; DIRECT RATIO FOR POP. OF 81,500 (1995)

$\frac{39,840}{66,500} = \frac{X}{81,500}$, WHERE X = ERU'S IN 1995 = 48,830; $r = \left(\frac{48,830}{39,840}\right)^{1/10} =$ 1.0206; PERCENT GROWTH RATE = 2.06%

(5) 1985 IS FIRST OPERATIONAL YEAR, i.e. YEAR 3, X = (1.095 x 1.095 x 1.095) = 1.3129

TABLE I-4 (continued)

WORKSHEET #4

FINANCIAL RISK ANALYSIS

ONE HALF OF PLANNED GROWTH RATE

Date: 6 OCTOBER 1982

Agency: ____________

A. Formula:

Conceptual Formula:

$$\text{Annual costs per ERU}_{\text{year t}} = \frac{\text{Operations \& Maintenance costs}_{\text{year t}} + \text{Debt service}_{\text{year t}} - \text{Plant Investment Fee revenues}_{\text{year t}}}{\text{ERU}_{\text{year t}}}$$

Applied Formula:

$$\text{Annual costs per ERU}_{\text{year t}} = \frac{(X)(\text{O\&M Costs}_{\text{year t}} \text{ (current dollar)}) + \text{Debt service}_{\text{year t}} - (Y)(\text{ERU}_{\text{year 0}})(\text{PIF fee})}{(Z)(\text{ERUs}_{\text{year 0}})}$$

Current dollar O&M $costs_{year\ t}$ = Annual operations and maintenance costs for existing and proposed improvements in current (year 0) dollars or in "constant" dollars.

Debt service = Annual principle and interest payments required on old and new bonded indebtedness *and* long term loans.

$ERU_{year\ t}$ = Total number of ERUs the year capital debt begins on the proposed system.

Year 0 = The year the debt on the proposed system begins.

PIF fee = Plant investment fee per equivalent residential unit, assumed constant.

X = Annual rate of inflation for O&M costs.

Y = Incremental growth rate of ERUs over the previous year.

Z = Growth rate of ERUs from year 0.

I-11

B. Inputs:

	1. (1985) First operational year	(1986) Year 1	(1990) Year 5	(1995) Year 10
Current dollar O&M costs	2. $821,360	3. $899,390	4. $1,293,020	5. $2,035,527
Annual debt service	6. $236,415	7. $236,415	8. $236,415	9. $236,415

Number of ERUs:

First operational year 10. 39,840 (Number of ERUs)

Year 0 (1985 year) 11. 34,620 (Number of ERUs)

Plant investment fee 12. $ 210.00

Rate of inflation for O&M 13. 9.5 %

Annual ERU growth rate 14. 1.03 %

C. First Operational Year:

In constant dollars (from Burden Analysis Worksheet):

$$\text{Annual costs per ERU}_{\text{first operational year}} = \frac{\text{O\&M costs (current dollars)} + \text{Debt service} - \text{PIF revenues}}{\text{ERU units}}$$

Annual costs per ERU first operational year = [15. 821,360 (Worksheet #3, line 33) + 16. 238,771 (Worksheet #3, line 27) − 17. 126,000 (Worksheet #3, line 38)] ÷ 18. 39,840 (Worksheet #3, line 42) = $ 23.95 (Worksheet #3, line 44)

With Inflation:

$$\text{Annual costs per ERU}_{\text{first operational year}} = \frac{(X)(\text{O\&M costs (constant dollars)}_{\text{first operational year}}) + \text{Debt service} - \text{PIF revenues}_{\text{first operational year}}}{\text{ERUs}}$$

Step	To Determine	Formula	Result
1.	Operations & Maintenance costs	(X) (821,360) entry 2	= 20 1,078,390

To determine X, compound the rate of inflation annually to the first operational year and add 1.0. For example, if rate of inflation is 9% and first operational year is 3, then X = 1.295 (1.09 × 1.09 × 1.09 = 1.295)

Annual costs per ERU first operational year = [1,078,390 (entry 20) + 236,415 (entry 16) − 126,000 (entry 17)] ÷ 39,840 (entry 18) = 21 $ 29.84

OTHER YEAR CALCULATIONS

D. For Year 1:

Step	To Determine	Formula	Result
1.	Operations & Maintenance costs in year 1	(X) (899,390) entry 3 =	22. $ 984,832

Use table below to determine X

Inflation rate	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%
X =	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16

2. PIF revenues in year 1 (Y) (34,620 entry 11) (210 entry 12) = 23. $ 74,883

Use table below to determine Y

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Y =	.01	.015	.020	.025	.030	.035	.040	.045	.050	.055	.060	.065

3. Total annual costs in year 1 (984,832 entry 22) + (236,415 entry 7) − (74,883 entry 23) = 24. $ 1,146,364

4. Number of ERUs in year 1 (Z) (34,620 entry 11) = 25. 34,977

Use table below to determine Z

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Z =	1.010	1.015	1.020	1.025	1.030	1.035	1.040	1.045	1.050	1.055	1.060	1.065

5. Annual costs per ERU in year 1 (1,146,364 entry 24) ÷ (34,977 entry 25) = 26. $ 32.77

E. For Year 5:

Step	To Determine	Formula	Result
1.	Operations & Maintenance costs in year 5	(X) (1,293,020) entry 4 =	27. $ 2,035,527

Use table below to determine X

Inflation rate	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%
X =	1.402	1.469	1.539	1.610	1.685	1.762	1.843	1.925	2.010	2.101

2. PIF revenues in year 5 (Y) (34,620 entry 11) (210 entry 12) = 28. $ 75,610

Use table below to determine Y

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Y =	0.010	0.016	0.023	0.027	0.033	0.040	0.047	0.054	0.061	0.068	.076	.084

3. Total annual costs in year 5 (2,035,527 entry 27) + (236,415 entry 8) − (75,610 entry 28) = 29. $ 2,196,327

4. Number of ERUs in year 5 (Z) (34,620 entry 11) = 30. 36,440

Use table below to determine Z

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Z =	1.051	1.077	1.104	1.131	1.159	1.188	1.217	1.246	1.276	1.307	1.338	1.370

5. Annual costs per ERU in year 5 (2,196,327 entry 29) ÷ (36,440 entry 30) = 31. $ 60.27

F. For Year 10:

Step	To Determine	Formula	Result
1.	Operations & Maintenance costs in year 10	(X) (2,035,527) entry 5 =	32 $ 5,044,500

Use table below to determine X

Inflation rate	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%
X =	1.967	2.159	2.367	2.592	2.838	3.106	3.395	3.706	4.042	4.414

2. PIF revenues in year 10 (Y) (34,620 entry 11) (210 entry 12) = 33 $ 82,589

Use table below to determine Y

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Y =	0.011	0.017	0.022	0.031	0.039	0.049	0.057	0.067	.077	.089	.102	.114

3. Total annual costs in year 10 (5,044,500 entry 32) + (236,415 entry 9) − (82,589 entry 33) = 34 $ 5,198,326

4. Number of ERUs in year 10 (Z) (34,620 entry 11) = 35 38,337

Use table below to determine Z

Annual ERU growth rate	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%
Z =	1.104	1.160	1.219	1.280	1.344	1.411	1.480	1.553	1.628	1.707	1.791	1.877

5. Annual costs per ERU in year 10 (5,198,326 entry 34) ÷ (38,337 entry 35) = 36 $ 135.60

(For comments and qualifications, please use reverse side.)

assumptions of growth in the sewered population, plant investment fees, operation and maintenance costs, and rates of inflation. The Financial Risk Analysis measures the sensitivity or financial risk in the estimates of costs per ERU. The Burden Analysis uses the "most likely" or "planned for" assumptions about the rate of growth in the sewered population, O&M costs, and plant investment fee, and describes annual costs per ERU for the "first operational year." The Risk Analysis is used to test these "most likely" assumptions for other years, and to test other assumptions for the rate of growth, plant investment fees, and O&M costs.

The results of these financial analysis indicate a range of possible annual costs per ERU from approximately $30.00 in the first year of operation to a maximum of $135.60 for year 10, assuming one-half of the planned growth rate. At the maximum projected annual cost of $135.60 per ERU, this is approximately $11.30 per month per ERU.

C. Conclusion

The implementation of the proposed system improvements would provide the area with efficient, cost-effective wastewater treatment for the next 20 years. This Facility Plan can be used as a planning tool, giving the city and county a consistent, organized idea of how to develop while simultaneously providing efficient wastewater treatment. The continued protection of the area's water resource is secured with the implementation of the recommendation set forth in this 201 Facility Plan Report.

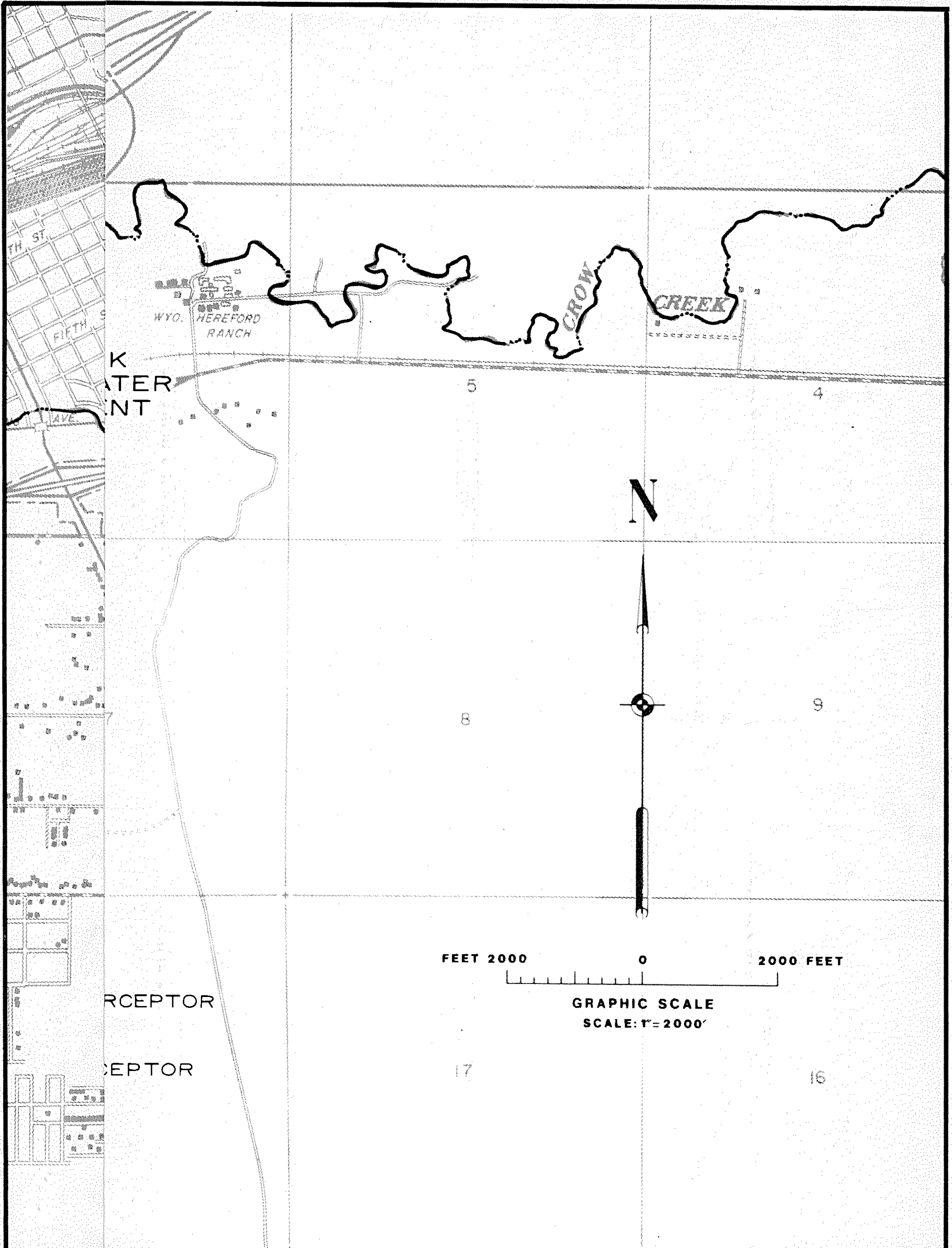
II. Selected Plan

A summary of the regional wastewater treatment alternatives is presented in Appendix A. This briefly discusses the six proposed wastewater treatment alternatives that were developed during the 201 study. After extensive discussion between the South Cheyenne Water and Sewer District and the City of Cheyenne Board of Public Utilities, the choice of alternative C was made. This alternative involves the abandonment of the South Cheyenne WWTF with treatment of wastewater from the entire area's sewered population at the City's facilities (Crow Creek and Dry Creek WWTF's).

Components of this alternative are described in the following paragraphs.

A. Abandonment of the South Cheyenne WWTF; pipeline from South Cheyenne to the City system

Detailed evaluation of the existing South Cheyenne WWTP, coupled with possible future loadings, led to the decision to abandon this facility. Consequently, a pipeline must be constructed to convey wastewater generated in South Cheyenne, and in surrounding areas, to the Cheyenne system. Four alternative pipelines were investigated, as shown in Figure II-1. Alternatives I, II, and III all require pumping, while alternative IV is ccmpletely gravity flow. A great deal of operational flexibility would be afforded by delivering the wastewater from South Cheyenne to the Crow Creek diversion structure, upstream of the Crow Creek WWTF. This flow could then be treated at either of the city treatment facilities, providing extremely beneficial control in which case Alternative I would be recommended. However, the advantage enjoyed by having an interceptor operating by gravity flow is beneficial. The City of Cheyenne expressly wants this interceptor to operate under gravity flow. Therefore, Alternative IV is recommended. Special caution must be exercised in the



DRAWN BY: DAMc

CK'D BY: PCS

PTOR LINE

FIGURE II-1

FR

construction of Alternative IV. This Alternative pipeline reportedly passes through a wetland habitat, as is indicated in the letter from Mr. William E. Jones of the U.S. Fish and Wildlife Service (Chapter VI of this report).

Preliminary cost estimates for pipelines I, II, and III assume the use of Gorman-Rupp lift stations, reinforced concrete pressure pipe where needed, and reinforced concrete pipe for the gravity flow section of alternative III (the last 3700' of alternative III is gravity flow). The respective costs for the pipeline Alternatives I, II, III, and IV are $404,000, $511,300, $453,760, and $433,390. The development of the cost estimates for each of the pipeline alternatives is given in Appendix E. Alternative I has the lowest total capital cost. However, pumping of the wastewater is required for Alternative I, thereby contributing significantly to the annual operation and maintenance costs (pumping cost is estimated to be roughly $5000/yr). Alternative IV, the only alternative pipeline operational with gravity flow, is therefore recommended. The estimated capital cost of Alternative IV is $433,390.

B. Crow Creek WWTP

The discussion of improvements to the Crow Creek facility in Appendix B (Working Paper No. 3) is quite complete and should be referred to for further information. This section of the report serves to reiterate certain points, and to discuss in greater detail certain aspects of the Crow Creek facility. Much of this information was obtained through detailed conversation with Jack Young at the Crow Creek plant.

1. Pretreatment

The discussion of pretreatment at the Crow Creek plant in Working Paper No. 3 is complete, and a more detailed evaluation is not necessary at this time. With the incorporation of the improvements suggested in Working Paper No.

3, the pretreatment process at the Crow Creek plant should perform satisfactorily until the end of the study period.

2. Primary Treatment

The primary clarifiers are sized to handle flows in excess of 4.0 MGD (original plant design capacity was 8.0 MGD). Structurally, these clarifiers are in good shape, but the sludge removal mechanisms have deteriorated extensively. When steel equipment is used in a corrosive atmosphere, as at a wastewater treatment plant, corrosion is almost unavoidable. The retrofitting of new clarifier mechanisms is highly recommended and would insure successful primary clarification for the entire design period.

3. Trickling Filters

Operational difficulties with the trickling filters have been reported regarding the filter dosing. Extremely beneficial operational control would be provided by the addition of slide gates in the influent ports to the dosing tanks. This would allow for the isolation of either trickling filter for maintenance reasons.

Ventilation of the filters should be provided via a ventilation riser connected to the underdrain system. To promote ventilation, the channels within the blocks of the underdrain system should flow at no more than half full. The underdrain system therefore not only carries away effluent, but it also permits circulation of air through the bed. The existing filters allow for ventilation through the effluent manhole. Investigation of these manholes indicates that the effluent trough does indeed flow at about half full, providing ventilation through the underdrain system. The incorporation of blowers on these manholes may improve ventilation, thereby improving the overall filter performance.

4. Final Clarifiers

The operation of the final clarifiers in high rate trickling filter plants is extremely important for the overall treatment efficiency. It is essential that sludge be removed from the final settling tanks before it rises and is carried out with the effluent. In high rate plants, the sludge becomes septic much faster then from standard rate filters; consequently, it should be removed more rapidly. For this reason, the incorporation of new siphon sludge removal systems for both final clarifiers is recommended. These systems could be retrofit into the existing clarifiers, thereby improving the sludge removal efficiency as well as improving the plant's overall treatment efficiency.

While the final clarifiers are dewatered to install new sludge removal systems, the lowering of the effluent weir troughs may facilitate improved hydraulic performance of the clarifiers. Dye tests revealed a degree of short-circuiting in the clarifiers, possibly due to the shallow effluent weir troughs. The elimination of short-circuiting in the final settling tanks should help to improve the overall treatment efficiency.

5. Chemical Treatment

The implementation of chemical treatment at the Crow Creek plant is discussed in Working Paper No. 3. Chemical addition has two major functions: (1) precipitation of phosphorus and (2) removal of the greatest possible amounts of colloids. Physical alterations for the storage, application, and mixing of the chemicals and polymers are quite simple and can be provided for at low capital costs. However, with the relaxing of discharge requirements for trickling filters to 45-45 (45 mg/l BOD_5 and 45 mg/l S.S.) the use of chamical addition to enhance effluent quality may not be required. At this time, the incorporation of the other upgrading techniques discussed in this paper is recommended. If the discharge at the maximum flow rate is not satisfactory after these improvements have been made, chemical treatment may be incorporated to improve the treatment efficiency.

6. Raw Sludge Pumping

The existing raw sludge pump house does not provide for operational control to isolate the primary settling basins. The installation of new sludge valves, as shown in Figure II-2, would provide beneficial control over the sludge handling procedures at the Crow Creek facility.

7. Anaerobic Digestion

The single-stage anaerobic digester occasionally has contributed to operational difficulties at the Crow Creek treatment plant. The discussion of the anaerobic digestion and suggestions to improve the operation were covered quite extensively in Working Paper No. 3. Treatment of the supernatant is extremely important and merits further discussion at this time. Supernatant solid concentrations as high as 45,000 mg/l have been measured. Currently, the supernatant is recycled directly to the head of the plant, contributing to operational headaches as well as to odor problems. The overall treatment efficiency could be greatly improved by piping the supernatant to drying beds, and returning the underflow to the head of the treatment works. New drying beds would be required for this procedure, but the area is available and this should pose no significant problem.

8. Conclusion

The improvements to the Crow Creek WWTF discussed above, in conjunction with those discussed in Working Paper No. 3, should result in a treatment plant that can produce water of the required quality throughout the study period. It is felt that, with these improvements, the Crow Creek plant

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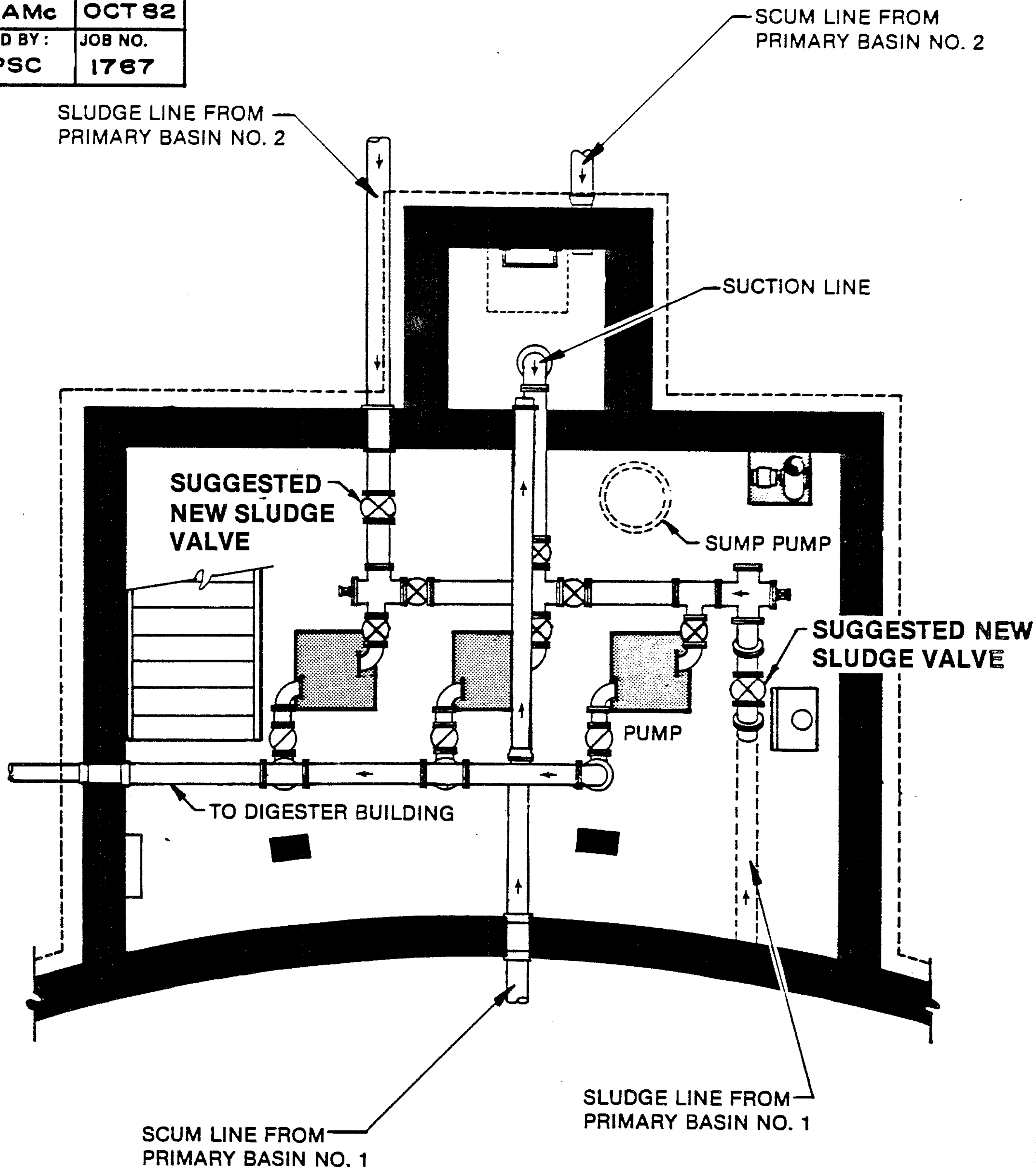

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P.O. BOX 550, LARAMIE, WY 82070 - (307) 745-7366

CROW CREEK
RAW SLUDGE
PUMP HOUSE

FIGURE
II-2

FR

could efficiently treat an average daily flow of 4.0 MGD. With these improvements, this facility may be counted on to operate reliably for the next 20 years.

C. Dry Creek WWTP

Upon extensive discussions between interested parties associated with the 201 Report (Cheyenne Board of Public Utilities, South Cheyenne Water and Sewer District, Laramie County, and the public through an extensive Public Participation Program), the decision to expand the Dry Creek facility to an average day capacity of 7.0 MGD was made. The improvements to the plant presented in Appendix B, Working Paper No. 3 should accompany the proposed expansion, and the reader is referred to that document for detailed discussion. This section of the report serves to reiterate certain key points brought out in Working Paper No. 3 and to expand on procedures necessary to increase the capacity to 7.0 MGD.

1. Water Supply

The availability of a reliable potable water source is of great importance for the successful operation of the Dry Creek WWTF. Two wells have been drilled near the Dry Creek facility to supply potable water to the plant. The first well was abandoned due to a severe sanding problem. This well produced an adequate supply of water, but the sanding probelm made its use unacceptable. The second well, currently in use, has little sanding problem, but an adequate supply of water is not obtainable from this well. Furthermore, the water obtainable from this well is extremely hard. The high hardness causes substantial maintenance problems at the plant. Since the development of a well to meet the potable water requirements at the Dry Creek facility has been unsuccessful in the past, attempts to develop another well are not recommended.

The potable water requirements at the Dry Creek WWTF could be satisfied by supplying city water to the plant. Preliminary design indicates that approximately 9000 feet of 6" steel pipe could deliver the required potable water supply to the plant. The potable water supply currently enters the plant through a 6" line from the well pump, located near the northwest corner of the facility. The new 6" line could tie directly into this existing 6" water line. Preliminary investigation indicates that pressures of approximately 150 psi could be available through this proposed line. This high pressure would be extremely useful, particularly for digester cleaning operations.

2. Pretreatment

Several aspects of the pretreatment operation at the Dry Creek facility will require upgrading and expansion in order to treat an average daily flow of 7.0 MGD. Working Paper No. 3 primarily discusses methods to upgrade the existing facility without an increase in capacity. To expand the pretreatment capacity to an average capacity of 7.0 MGD (corresponding peak flow capacity of 14.0 MGD), the pretreatment building essentially needs to be doubled. Sufficient area is available for this expansion to the east, between the existing pretreatment building and the primary clarifier No. 1. This expansion should include a mechanically cleaned bar rack and an aerated grit chamber. Upon the completion of this expansion, the existing pretreatment processes should be upgraded by incorporating a mechanical bar rack and by converting the existing grit chamber to an aerated grid chamber. Preaeration of the wastewater at this stage in the treatment process would improve subsequent treatment efficiencies.

Solids removal from the pretreatment operation could be more readily facilitated by the construction of (1) a loading dock north of primary clarifier No. 1 or (2) the retrofitting of a conveyer system to automatically load grit into a dump truck for ultimate disposal.

The importance of efficient pretreatment on subsequent operations can not be overemphasized. Part of the existing difficulties in the digester operation is due to inefficient grit removal. The preaeration of the watewater would also greatly reduce the scum problems currently encountered in the primary clarifiers. More detailed design of these suggested improvements must be handled in the Design Step 2 of the Facility Grants Program.

3. Flow Measurement

The existing Parshall flume has a maximum capacity of 9.0 MGD. Flows in excess of 9.0 MGD should be removed from the channel upstream of the Parshall flume and delivered to the equalization basin. Inaccurate readings occasionally result due to freezing, causing the float to stick. The construction of a stilling well in the pretreatment building would increase the reliability of the flow measurement. For flows in excess of 9.0 MGD, equalization is recommended. Without equalization, not only would the Parshall flume be inadequate at flows in excess of 9.0 MGD, but the downstream operation would also be overloaded.

4. Flow Equalization

The existing aerated lagoon could be expanded and used as an equalization basin. This would be beneficial because the activated sludge process is much more efficient when receiving relatively constant loading.

Currently, there exists no method that allows the operators to clean the aerated lagoon. The aeration system consists of a header arrangement; however the headers are too close together to allow a loader to enter the basin for cleaning purposes. By widening the header system to provide eight feet between the headers, a front-end loader with an eight-foot bucket could be used for periodic cleaning of the basin. This method of cleaning can only be accomplished by first replacing the lining in the basin. The lining must be capable of supporting the cleaning equipment without being damaged to prevent seepage to the groundwater.

Typically, treatment plants with equalization show better performance, i.e. 15-25% reduction in the average effluent BOD_5 and SS., than the conventional design without storage. This is probably a combination of the biological and hydraulic effects derived from a uniform and steady load, and from the two-stage activated sludge system (the normal activated sludge units act as the second stage treatment; the equalization tank as the first).

Accompanying this proposed equalization basin enlargement is improvement to the aeration blower system. This can be accomplished in the existing compressor building with the addition of a larger compressor. The installation of a hoist system in this compressor building would serve to simplify regular maintenance of these large compressors.

5. Primary Clarifiers

The discussion of primary clarification in Working Paper No. 3 is quite complete. Scum and grease cause considerable operational difficulties in the digestion process, and should therefore be delivered directly to a new drying bed. This would involve the elimination of the 6" cast iron scum draw-off lines from both clarifiers, and the construction of new piping that delivers the scum directly to the new drying beds. Sufficient area for new drying beds is available to the north of the existing facility (i.e. west of the existing sludge drying beds).

As was indicated in Working Paper No. 3, the existing clarifiers could handle a maximum average day flow of 5.65 MGD. At this flow rate, the clarifiers would be operating at the high end of the design criteria. It is therefore recommended that a third clarifier be constructed when the flows approach about 5.5 MGD to prevent subsequent overloading. Preliminary investigation indicates that area for this third clarifier may be available directly west of Primary Clarifier No. 2. This would necessitate the elimination of approximately half of the existing parking area, but this area could be moved south of the control building.

With the previously discussed improvements to the pretreatment operation, and the improvements to and expansion of the primary treatment facilities, efficient primary treatment for average flows of 7.0 MGD should be possible at the Dry Creek plant. When secondary treatment processes receive wastewater that has undergone successful primary treatment, the potential of the plant to produce a high quality effluent is greatly enhanced. Successful primary treatment is also vital for the efficient operation of the digestion process.

6. Raw Sludge Pumps

The discussion and recommendations regarding the raw sludge pumping in Working Paper No. 3 are complete. Viscosity monitors that can be placed in the sludge discharge lines are available and may aid in the control of the density of sludge pumped to the digesters, or to a sludge thickener. These viscosity monitors are used to register the sludge concentration in the sludge blanket, providing a useful operational tool.

7. Activated Sludge Aeration Basins

The reactor basins at the Dry Creek WWTF currently operate in the conventional activated sludge (CAS) mode. At current flow rates, the activated sludge process is adequately providing secondary treatment; however certain problems with the reactor basins have been identified. The measured dissolved oxygen (D.O.) concentration in the basins has frequently been lower than desirable. However, the existing D.O. probes do not always give accurate readings and should be replaced. The continuous and accurate monitoring for D.O. is essential for adequate operator control. The conversion of the aeration system from the existing mechanical surface aerators to a blower diffuser system is recommended. These fine bubble diffusers have been shown to be an efficient method to transfer oxygen to the wastewater. In conjunction with improved primary treatment, an improved aeration system could greatly improve secondary treatment efficiency.

The existing CAS process provides for a capacity of 4.5 MGD for the activated sludge process. The existing basins are structurally suitable for the conversion to the Complete Mix Activated Sludge (CMAS) process. The CMAS process allows for a higher volumetric loading, higher MLSS concentration, and shorter detention time. Under the CMAS mode, the existing basins would have approximately a 5.25 MGD capacity. When the average daily flows reach approximately 5.0 MGD, an additional reactor basin should be constructed. This new basin, of equal size to each of the existing two basins, could be located directly north of the existing basins.

An associated requirement for the conversion of the aeration system to a fine bubble diffuser arrangement is the installation of compressors and generators in the compressor building. This installation should be arranged to provide control of aeration for both the reactor basins and the aerated equalization basin.

8. Secondary Clarifiers

Secondary clarification at the Dry Creek plant is adequately accomplished in the two existing clarifiers. Recommendations presented in Working Paper No. 3 regarding scum removal should be considered only after improvements to upstream processes have been accomplished. These improvements may eliminate much of the existing scum problems. However, floatable material must be removed in an efficient manner. With the provision of a reliable water supply, a scum washing system could be incorporated on the scum trough. A series of sprayers on the scum trough should move the scum along, to be collected in the scum draw-off pipe. Whether or not the scum should be separated from the return activated sludge or allowed to be returned to the primary clarifiers should be determined after upstream improvements have been implemented and tested.

When average daily flows to the plant reach approximately 6.0 MGD, a third clarifier of equal size to the existing two should be constructed. This would provide for adequate final clarification for average flows of 7.0 MGD.

9. Return Sludge Pumps

The return sludge pumps are essentially in good shape, but operational difficulties do exist. These difficulties arise when one of the three pumps is out of service for repairs. When one pump is out of service, uneven pumping of sludge from the two final clarifiers results. The installation of sludge valves between the sludge pumps, as shown in Figure II-3, would provide the operator with the required control to insure equal sludge removal from both clarifiers.

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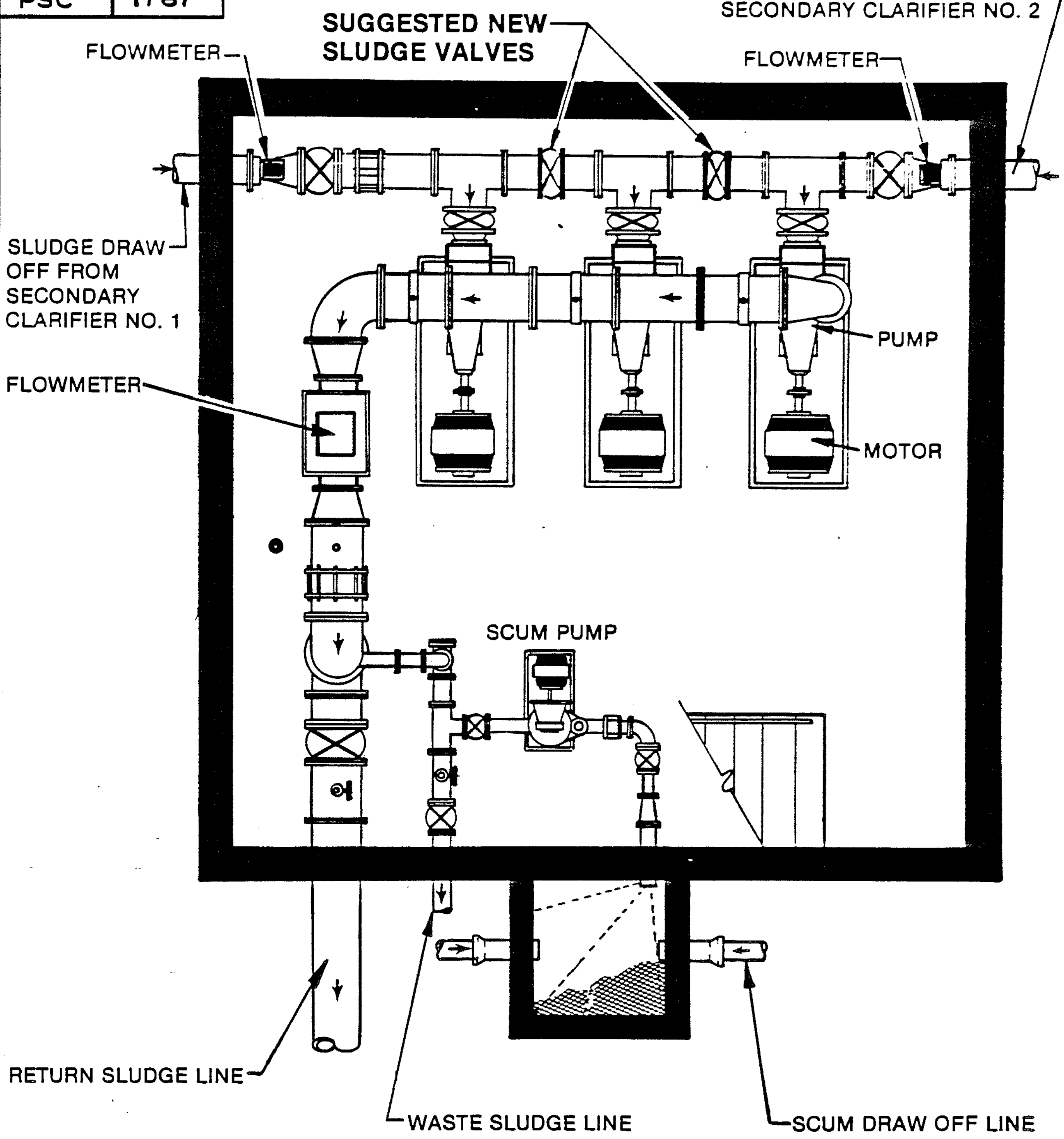

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DRY CREEK
RETURN SLUDGE
PUMP HOUSE

FIGURE
II-3

FR

10. Sludge Thickener

Much of the existing difficulties in the operation of the anaerobic digesters is due to the delivery of sludge with less than 2% solids content. This low solids concentration makes efficient anaerobic digestion almost impossible. The thickening of sludge prior to its delivery to the digesters is recommended, and has several advantages, including:

- lower heat requirement
- less dilution of the buffering alkalinity making digestion system more stable
- less dilution of the biological substrate
- less removal of seed organisms
- maximizing the effect of mixing energy; more power per unit volume
- better control of the process; high alkalinity and more stability
- less supernatant

Preliminary design of a gravity thickener indicates that sufficient area for the 75-foot diameter unit is available south of the digesters. The sludge handling system at the plant (piping and pumping) will require work to facilitate this new sludge thickener. With the delivery of a good sludge with at least 5% solids to the digester, anaerobic digestion at the Dry Creek plant should be substantially improved.

11. Anaerobic Digestion

The discussion in Working Paper No. 3 of the anaerobic digestion system at the Dry Creek plant in quite complete. As is indicated in that report, anaerobic digestion should proceed efficiently when the primary digester receives a sludge of nearly 5% solids, and when scum and grit are eliminated. With the improvements to the plant discussed above, the digestion efficiency should be greatly increased.

12. Chlorination

The chlorination equipment is in good condition, and no expansion of this equipment is required. The contact basin is designed to provide the minimum required contact time of 15 minutes for flows up to 9.0 MGD. When peak flows surpass this rate (9.0 MGD), either flow equalization to dampen out peaks or a new, larger contact basin will be required.

13. Laboratory Requirements

Basically, the laboratory at the Dry Creek plant provides a good environment in which to conduct the required tests. Certain improvements to the general condition of the lab are taken care of by plant personnel. However, more efficient laboratory evaluations could be conducted with the addition of a few pieces of equipment. A spectrophotometer for the analysis of fluoride, color, and ammonia (just to name a few) would be extremely beneficial. The existing pH meter is reported to be unstable, resulting in unreliable pH determinations. A new, reliable pH meter would contribute to the efficient operation of the plant.

14. Conclusion

The Dry Creek WWTF is a relatively new activated sludge treatment plant. With the improvements discussed above, this plant could produce an effluent of required quality for average flows of 7.0 MGD. This facility is capable of protecting the water quality in Crow Creek for many years to come.

D. Sunnyside

Wastewater treatment in the Sunnyside addition is discussed in depth in Working Paper No. 3. Treatment alternatives open to the people included the use of state of the art on-site methods and the connection to the city services. The alternative chosen is for the ultimate connection of the Sunnyside Addition to city services. This implies the construction of a collection system for the entire area, as well as the construction of a water distribution system.

A detailed design of the proposed wastewater collection system in the Sunnyside area would be of tremendous benefit for those people who will eventually receive city services. Upon the completion of such a design, estimates of the work required and of the cost of connection can readily be made for any interested homeowner.

E. North Cheyenne

As is the case for the Sunnyside Addition, the ultimate connection of North Cheyenne to the city services is imminent. A detailed design of the collection system would be useful in forecasting the cost of connection for any interested homeowner.

F. Ranchette Developments

Discussion of the ranchette developments surrounding the city is complete in Working Paper No. 3, and no further detailed discussion is required here. Ranchette Developments are generally located outside of the Urban Service Area, i.e. the area generally defined as sewerable by gravity flow to the publicly owned treatment works. The requirement of 2½ acres per household should allow enough area for the construction of suitable on-site treatment systems.

G. Phasing of Plan

The proposed wastewater treatment facility improvements could be constructed in a "phased-segmented" manner. The order of construction and proposed timetable are given in the Intergovernmental Agreement.

III. Wastewater Treatment System Costs

The costs developed in Working Paper No. 3 for the areawide wastewater treatment alternatives are summarized in Appendix A: Summary of Regional Wastewater Treatment Alternatives. These costs were presented for comparison purposes only, i.e. similar costs for each alternative were not included.

The choice of Alternative C was made. This alternative involves the abandonment of the South Cheyenne wastewater treatment plant, the construction of a 2.5 MGD pipeline to the City of Cheyenne, the upgrading of the Crow Creek facility, and the upgrading and expansion of the Dry Creek facility to an average daily capacity of 7.0 MGD. The total capital cost for alternative C of $4,706,180 is a refinement of the cost developed in Working Paper No. 3. The cost given in Working Paper No. 3 does not include the collection lines in Sunnyside or North Cheyenne and also does not include estimated planning and engineering costs for Steps 2 and 3 of the Facility Grants Program. These costs must be included in determining the total capital cost of the chosen alternative. Upon more detailed investigation of Alternative C, and including all of the proposed system improvement costs, the projected total capital cost is increased to $7,290,910. The components used in developing this projected capital cost are shown in Table III-1. When this capital cost is amortized at the current federal discount rate of 7 3/8% over a period of 20 years, the projected annual cost is $699,050/year.

As is shown in the Financial Worksheet #1, Proposed Wastewater System Costs, and in Table III-2, Delineation of EPA Grant Money Requested, 75% of this $7,290,910 may be EPA Grant eligible, including federal funding for the collection sewers in Sunnyside and North Cheyenne. This grant would total $5,468,190. One-half of the remaining 25%, or 12½% of the total ($911,360), may be eligible for other grant money, i.e. other federal or state programs. This results in a total local capital cost $911,360. Federal funding is not eligible for development in floodplain areas; however federal funds may be eligible for an inceptor sewer that passes through a floodplain area provided that adequate construction precautions are taken to prevent the occurrence of excessive inflow or infiltration.

Projected operation and maintenance costs are developed through the use of "Analysis of Operations and Maintenance Costs for Municipal Wastewater Treatment Systems" (EPA 430/9-77-015). The estimated annual O&M cost is $821,360.

Table III-1 Component Capital Cost of Alternative C (Costs given for each component include contingencies [10%] and Legal, Administrative, and Engineering fees [15%])

Component	Capital Cost
Pipeline from South Cheyenne to Crow Creek Diversion Structure	433,390
Upgrade Crow Creek WWTP	729,150
Upgrade and Expand Dry Creek WWTP to 7.0 MGD	3,543,640
Sunnyside Collection Lines	1,071,700
North Cheyenne Collection Lines	562,040
Subtotal	6,339,920
Step 2 & 3 Planning and Engineering (15%)	950,990
Total Capital Cost	$7,290,910

Table III-2 Delineation of EPA Grant Money Requested for the Chosen Plan

		Estimated Capital Cost	
	Component	EPA Grant Money Requested	Other Fed, State or Local Money
1.	Pipeline from So. Chey. to Crow Creek Interceptor (Alternative IV)	$325,040	$108,350
2.	Collection Lines		
	a. Sunnyside	803,780	267,920
	b. North Cheyenne	421,530	140,510
3.	Dry Creek WWTP		
	a. Upgrade		
	1. Water Line	206,360	68,780
	2. Treatment Plant	594,580	198,190
	b. Expand to 7.0 MGD	1,856,800	618,930
4.	Upgrade Crow Creek WWTP	546,860	182,290
5.	Step 2-3 Planning & Eng (15%)	713,240	237,750
		$5,468,190	$1,822,720

EPA Grant Request = $5,468,190

Funding from other sources (other fed., state or local funding) = $1,822,720

Total Estimated Capital Cost = $7,290,910

These costs are broken down into the categories of labor, materials, power, general administration, and other costs, and each is delineated in the Financial Worksheet #1: Proposed Wastewater System Costs. The calculations used to develop these O & M costs, as well as the revised capital costs, are shown in Appendix E beginning on Page E-44.

IV. Sludge Management

In a meeting on November 22, 1982, representatives from DEQ Water Quality Division, DEQ Solid Waste Division, the Soil Conservation Service, the Board of Public Utilities, the Regional Planning Office, and Banner Associates (the consulting engineer) discussed the sludge management alternatives described in Appendix B, Chapter B-VIII. The complete minutes of this meeting are included in this Chapter.

Currently, the City of Cheyenne applies the dewatered sludge from the Crow Creek and Dry Creek WWTPs to the City's golf courses and cemeteries. This practice is deemed acceptable by DEQ, allowing for the continued use of this method of sludge handling. DEQ does recommend, however, that dewatered sludge be stored for at least one year before application in order to kill all the pathogens potentially present. Additional drying beds at the wastewater treatment facilities will be required.

The Parks and Recreation Department currently uses all the sludge that is produced, and could use more sludge. Therefore, the increase in sludge production resulting from the projected increase in loading to the treatment facilities could be handled adequately by the Parks and Recreation Department.

However, if future sludge handling requirements or sludge production quantities warrant the use of an alternative method, the co-disposal of sludge and refuse should be used. Current questions concerning possible groundwater contamination at the city landfill must be resolved prior to the initiation of a co-disposed program. Once adequate steps have been taken to prevent groundwater contamination at the City landfill, the co-disposal of sludge and refuse would be the most cost-effective sludge handling method.

Cheyenne-Laramie County
Regional
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201 Facilities Plan Study
Sludge Management Meeting
November 22, 1982, 1:30 pm

A meeting was called to discuss the alternatives available to the city for sludge management. Representatives from DEQ Water Quality Division, DEQ Solid Waste Division, the Soil Conservation Service, the Board of Public Utilities, the Regional Planning Office and the consulting engineer attended.

The various sludge management alternatives listed on Table VIII-2 were discussed. Currently, the city drys the sludge and it is used by the Parks and Recreation Department on golf courses and cemetaries. Co-disposal--refuse and sludge--was considered, but since there are questions about possible groundwater contamination at the city landfill this alternative was considered unfeasible. Lon Revall of the DEQ Solid Waste division confirmed this. (Co-disposal--refuse and sludge--was the least expensive alternative in terms of annual cost).

Another alternative discussed was using the sludge for agricultural purposes. After consideration of this alternative, it was deemed too expensive and unworkable due to the quantities of sludge produced and the distance to potential agricultural sites.

The discussion then centered on the city maintaining its current method of sludge disposal. (On Table VIII-2 of the 201 Facilities Plan, this method would fit under the heading Land Application: Land Not Purchased, Dewatered Sludge). Since the Parks and Recreation Department can currently use more dewatered sludge than is produced, this method has been proven effective by past preacices, and the total annual cost of this method is the second least expensive disposal method, it was decided that the current method of sludge disposal could be continued effectively into the future. DEQ recommended that dewatered sludge be stored for at least one year before application in order to kill all the pathogens.

The city will have to monitor the quantities of sludge produced, to ensure that if more sludge is being produced than is being used, a method of disposing the excess can be found. Jack Young stated that the city may need 6 to 8 additional drying beds in the future.

The meeting adjourned at 2:45.

V. Public Participation Program, Public Meeting and Public Hearing Summaries

The Cheyenne-Laramie County Regional Planning Office organized and conducted an extensive public participation program. This program included the active participation of the Citizens Advisory Committee (CAC). Neighborhood meetings were conducted for each of the following areas: Sunnyside, North Cheyenne-Ranchette developments, South Cheyenne, and the City of Cheyenne. During each of the meetings, wastewater treatment alternatives pertaining to the specific area were presented, and comments from the public were solicited. Comments ranged from questions regarding the proposed alternatives to suggestions of other alternatives to be considered. Each comment or suggestion was subsequently studied regarding its viability as a treatment alternative.

A public meeting was then conducted on April 21, 1982, to present Working Paper No. 3: Preliminarly Evaluation of Alternatives. The purpose of this meeting was to present to the public all of the proposed alternatives. The goal of this meeting was to receive further comments and suggestions regarding the alternative of choice and to give the public another opportunity to suggest alternatives previously not considered.

The 201 Committee then became responsible for determining the alternative of choice, i.e. the alternative that coincides with the desires of the public. Complete minutes from 201 Committee Meetings, CAC meetings, and Public Meetings follow.

Cheyenne-Laramie County
Regional
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Office

RECEIVED
DEC 03 1982
BANNER ASSOCIATES, INC.

November 29, 1982

Paul Sorensen
Banner Associates, Inc.
620 Plaza Court
PO Box 550
Laramie, Wyoming 82070.

Dear Paul:

Enclosed is the Responsiveness Summary from the public hearing on the Cheyenne Area 201 Facilities Plan Study. We have waited an additional two weeks and have received no other comments. From the point of view of this office, then, the plan as presented at the hearing meets with the approval of the community.

Since there were no more comments or suggestions from the community, the only comments you will have to address in the final plan are those that come from the reviewing agencies.

I hope you have a happy holiday season.

Sincerely,

Jon Arason
Planner I

2101 O'Neil Avenue Area (307) 637-6281 Cheyenne, Wyo. 82001

Cheyenne-Laramie County
Regional
Planning
Office

RESPONSIVENESS SUMMARY

for

THE CHEYENNE AREA
201 WASTEWATER STUDY

Public Hearing

October 20, 1982; 7:30 p.m.

This responsiveness summary is being prepared as a requirement specified in Section 40 CFR 25.8 of the rules and regulations for "Public Participation in Programs Under The Resource Conservation and Recovery Act, The Safe Drinking Water Act and The Clean Water Act."

A Public Hearing was held on Wednesday, October 20, 1982, at 7:30 p.m. in the Sheridan Room of The Cheyenne Holiday Inn. Legal notice of the hearing was published forty-five days prior to the hearing in the 'Wyoming Eagle' and the 'Wyoming State Tribune'. On August 31, 1982, a front page article in the 'Wyoming Eagle' explained the elements of the final plan to be discussed. Two days prior to the hearing, additional press releases were published about the hearing. Copies of relevant information were available to the public throughout the entire course of the study, and persons were urged to contact the Regional Planning Office if they had any questions. A court reported was present at the hearing to make transcripts and the hearing was tape recorded.

The hearing was opened by Jon Arason of the Regional Planning Office. He explained the history of the 201 Study in the area, and the process through which the elements of the final plan had been determined. The floor was then turned over to Paul Sorenson of Banner Associates, Inc., the consulting engineer.

Using a flow chart, Mr. Sorenson began his presentation by explaining the process involved in a 201 Facility Plan Study. The first step is the identification of the need for the study. This is followed by the grant application and consultant selection. The first part of the actual study is the population projections to enable us to predict future wastewater treatment needs. The next step is to do an Infiltration/Inflow (I/I) analysis of the existing system. If I/I into the pipes is excessive, money is available to correct the deficiencies. In our area, I/I was not excessive.

2101 O'Neil Avenue Area (307) 637-6281 Cheyenne, Wyo. 82001

We then divided the region into four study areas. Sunnyside/North Cheyenne, the South Cheyenne Water and Sewer District, Ranchette Development, and the City of Cheyenne. In each of these areas we investigated wastewater treatment, identified problems and developed a number of alternative solutions. A meeting was then held in each area to discuss the various alternative solutions. Eventually one alternative was decided upon that would most effectively handle wastewater treatment in each area. These final alternatives were then discussed at a generap public meeting where more comments were elicited.

This was followed by a discussion of the various alternatives developed and the costs for each. The alternatives are:

1. Recommendation of public sewer for Sunnyside and North Cheyenne.

2. Maintaining the current 2.5 acre minimum for developments using individual wells and septic systems.

3. REcommendation of abandoning the South Cheyenne Water and Sewer District's treatment pland and constructing a pipeline to convey the wastewater to the City's treatment system. This recommendation also includes upgrading both of the City's treatment plants and expanding the Dry Creek plant to 7 mgd.

The total cost for implementing these recommendations would be 7.1 million dollars. Assuming 75% Federal Funding and a 12.5% matching state grant the total local share would be $889,000.

The City would bill the South Cheyenne Water and Sewer District customers the same rate that city users pay. The cost of constructing the pipeline would be borne by the District, costs of plant expansion would be split between the District and the City based on projected wastewater flows. As long as the current funding mechanisms remain in tact, or if we can phase the plan in under current federal funding procedures, the cost per household in the City and the District will not rise above current rates.

The alternatives chosen for the final plan represent the most cost effective manner to treat the region's wastewater and preserve the public health and welfare.

The floor was then turned over for questions after the 201 Committee was introduced.

The first questions concerned clarification of the plan. Residents for the North Cheyenne area were unclear as to the exact area included in North Cheyenne. Another question concerned the regional context of the plan; there was some confusion as to whether all these alternatives constituted the final plan or just the pipeline. The response was that the region has three unique areas of concern and each area had to be addressed separately but within a regional context.

One comment concerned the recently adopted Annexation Policies and how they might help residents of North Cheyenne obtain public water and sewer. The answer was that these policies reinforce the findings of the 201 Study and vice versa, so the possibility of this area obtaining public water and sewer has been enhanced.

A major concer of South Cheyenne Water and Sewer District residents is whether building a wastewater pipeline to the City would mean they would be annexed. It was explained that this plan in no way entailed annexation, and any agreements for the City treating the District's wastewater would be similar to the agreements whereby the City sells water to the District.

One resident suggested that in lieu of all the expensive construction in the recommendations, perhaps we should pipe all the wastewater into the gravel pits southeast of the City. When one gravel pit got full, we could fill another. When the second pit was filled, the first pit would have drained. It would then be a simple matter to clean out the solids on the botton and sell them as milorganite. It was explained that this alternative was not possible as a high level of groundwater contamination would result since nitrates would leach into the water table. This would be in violation of Chapter 8 of The Water Quality Rules and Standards on Groundwater.

Someone asked what we do with the sludge left over from the treatment process. Currently we spread it on parks and cemetaries. One person in attendance said that the sludge used to be put on the Memorial Hospital Grounds until tomato plants started growing all over.

Another person wondered how the residents of the District felt about the Plan. Art Buffington, long time resident of the District and Chairman of the 201 Committee, answered that we chose the least expensive alternative, one that would cost the least for residents of the area. He explained that the plant now in use there was just inadequate.

There was then discussion on the cost per homeowner for this alternative, and the availability of funding to help defray these costs.

After the discussion ended, persons were told that they would have two weeks to give additional comments. An article in the 'Wyoming Eagle' the next day also stated that comments would be accepted for two weeks and all comments would be addressed in the final plan. (No additional comments were received).

The hearing was adjourned. Available to answer questions and respond to comments were representatives from the City, County, South Cheyenne Water and Sewer District, and the State.

Cheyenne-Laramie County
Regional
Planning
Office

August 27, 1982

Jim Cavalli
Banner Associates, Inc.
620 Plaza Court
P. O. Box 550
Laramie, Wyoming 82070

Dear Jim:

At the 201 Committee Meeting on August 17, I was authorized to give Banner Associates, Inc., approval to pursue the final alternatives for the Regional Wastewater Management Plan if the Cheyenne Board of Public Utilities and the Board of the South Cheyenne Water and Sewer District could agree in principal to having the City treat the district's wastewater. Both Boards have agreed in principle to this alternative. You are therefore authorized to proceed with the development of the final plan.

The elements of this plan will include:

1. Alternative C from the Revised Summary of Regional Wastewater Alternatives; this alternative includes the abandonment of the district's wastewater treatment plant, the construction of a 2.5 mgd pipeline, the upgrading of the Crow Creek WWTP, and the expansion of the Dry Creek WWTP to 7.0 mgd.

2. Other alternatives previously agreed upon to include the recommendation that Sunnyside and North Cheyenne obtain public water and sewer, and that developments utilizing on-site wastewater treatment systems maintain the current 2.5-acre minimum.

I have scheduled the public hearing on the final plan for Wednesday, October 20, 1982, at 7:30 P. M., in the Sheridan Room of the Holiday Inn.

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[illegible]

I plan to be in Laramie on Tuesday, August 30, to talk with you and Paul in more detail about the plan.

I look forward to seeing you then.

Sincerely,

Jon Arason
Planner I

INITIALS

Art Buffington (Chairman, 201 Committee) Art Buffington

Shirley Francis S. F.

Herman Noe Herman Noe

JA/cb

cc: Art Buffington
Shirley Francis
Herman Noe
Paul Sorenson
Ed Baruth
Citizens Advisory Committee
201 Files

Cheyenne-Laramie County
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201 COMMITTEE MEETING
August 17, 1982 — 2:00 P.M.

The purpose of the meeting was to present a draft agreement by which the City would treat the District's wastewater to the 201 Committee.

The meeting was opened by Tom Bonds who gave an explanation of the draft agreement and stated that some of the particulars in the agreement were called from the 1970 Water Agreement. This was followed by an item-by-item discussion of the agreement.

Changes made:

Item 3. The wording was changed to read that the City will bill the District at the same rate structure the City changes its own users.

Item 11. It was felt that any particulars concerning the District's agreement with the Read family should be included.

Item 12. The wording was changed to read that any water or sewer line construction has to meet the standards of the Board of Public Utilities.

Item 15. This item was changed to read that all the particulars of the 1970 Water Agreement will still be adhered to.

It was decided to delete the Mayor's signature from the agreement.

Instead of changing Item 11, the particulars concerning the agreement with the Read family were put under Item 6.

Herman Noe thought that there should be an escape clause in the agreement in case the anticipated funding was not available and the parties to the agreement were therefore unable to participate. This was to be added.

There was discussion of the improvements that would be needed at the Dry Creek Plant, including clarifiers and a water line.

There was also some discussion on where the proposed pipeline would tie into the pipeline between the Crow and Dry Creek Plants.

Herman Noe made the motion that if the Water Board agrees in concept to the Draft Agreement with the changes discussed, then Jon Arason is authorized to give Banner Associates the go-ahead to pursue the final regional plan and advertise the public hearing.

Shirley Francis seconded; the motion passed.

There was also a request that Jon Arason look into the billing situation, and find out how much more each entity is obligated.

The meeting adjourned at 3:00 P.M.

Cheyenne-Laramie County
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201 COMMITTEE MEETING

April 29, 1982

County Commissioners' Meeting Room

Art Buffington, Chairman	Jim Cavalli
Shirley Francis	Paul Sorenson
Herman Noe	Ed Baruth
Floydine Gay	Tom Bonds
	Jon Arason

The meeting opened at 2:00 p.m.

Discussion began on alternative D, abandoning the South Cheyenne Water and Sewer District plant and building a pipeline to one of the city's plants. Art Buffington said that he was considering this alternative, but he had to know from Herman Noe how much the city would charge each residence in the District before he could definitely go with it.

Since federal money for step II of the 201 program (the design phase) is not available, it was asked how much the pipeline design would cost. Jim Cavalli said that you could assume that design costs were 2 to 3% of total cost.

Ed Baruth said that phasing the pipeline could be allowed. The first phase could be to build the pipeline to a city plant. The second phase would be to upgrade the Dry Creek plant as it approached capacity. If no federal funds are available in the future, the city will be on its own and may not be forced to expand.

The state has a priority list for funding. The priority is based on how bad the discharge is, stream quality and health problems posed by the discharge.

If in 10 years, predicted flows are not met, then plant expansion does not have to occur.

Ed Baruth asked why alternative D (which including abandonment of Crow Creek) was being looked at over alternative C (which does not include abandonment) when alternative C was more cost effective.

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Herman Noe said that abandoning Crow Creek would save around $100,000 in O & M costs, and this would bring the cost of alternative D close to alternative C.

Ed Baruth said that DEQ probably would not quibble over a slight difference in costs. He said that some compensation for water rights may be necessary. Art Buffington said that he would look into obtaining the water rights.

Herman Noe said that he would look into agreements for the city treating the District's sewage that Art could go along with. Art Buffington said he would look into obtaining the water rights.

Shirley Francis asked what would happen to the District over the next 10 years with alternative D. Paul Sorenson said that the pipeline can be built sooner and that the city has the capacity to treat the additional flows.

Art Buffington said that he felt that it would be best for the region to go with the pipeline option. That if he were to spend 1.3 million to upgrade his plant, this could create a barrier.

In order to give Art and Herman time to work out agreements between the city and the District, it was decided to postpone the hearing date until July 14.

Ed Baruth said that if the phasing plan is submitted and categorized, 75% funding may still be available past 1984. He said that a phasing plan would have to be submitted as soon as possible because it might look suspicious if many phasing plans came in in late 1983.

Herman Noe asked Paul Sorenson for a couple of graphs showing how long his treatment plants would last, and what kind of expansion would be necessary in two years if the District tied in.

The meeting was adjourned at 2:45 p.m.

JA/bl
5-12-82

Cheyenne-Laramie County
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201 COMMITTEE MEETING
April 21, 1982
Minutes

Art Buffington, Chairman
Shirley Francis
Herman Noe
Floydine Gay
Paul Sorenson
Jim Cavalli
Tom Bonds
Jon Arason

The meeting was opened at 3:35 P.M. by Art Buffington.

The first item on the agenda was approval of Billing #3 for engineering costs incurred by Banner Associates and for public participation costs incurred by the Planning Office between December 1981 and March 1982.

Shirley Francis made a motion for approval. Herman Noe seconded, and Billing #3 was approved as submitted.

The next topic of discussion was the phased development plan for the South Cheyenne Water and Sewer District treatment plan. It was pointed out that the major disadvantage of this plan was that there was a higher risk of effluent quality not meeting the standards of the DEQ discharge permit for the plant. The reason for this is that all the parts of the plant will have to operate at the upper level of their capacity.

The first step in the phased development will give about 12 years of extra service. Art Buffington said that they cannot pass another bond issue in the District because the people are against going into debt.

Jim Cavalli said that one problem with that option is that EPA will look at the report on a cost basis and may not go for an option that is not the cheapest. If EPA rejects the report something will have to be done to get the remaining 10% of the costs -- EPA controls the rest of the purse.

Tom Bonds said that the whole purpose of this study is to eliminate effluent problems. Everything we do has to meet the requirements and we have to end up with a plan that will enable us to handle future growth. The final plan has to be something we can feel comfortable with.

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Art Buffington said that spending $1.3 million should put the plant on track. Paul Sorenson said that they could spend $1.3 million now but may have to spend another million dollars in 10-12 years. Art Buffington said that with their new fee structure they may have the money.

There was then a discussion on different types of bonds that could be used to raise money.

The meeting was adjourned at 4:00 P.M.

JA/lkh

Cheyenne-Laramie County
Regional Planning Office

201 STUDY
PUBLIC MEETING
Saratoga Room, Holiday Inn
April 21, 1982

The meeting opened at 7:35 P.M. with an introduction by Jon Arason. The 201 Committee, Citizen Advisory Committee and consulting engineers were introduced. The purpose of the 201 Study was explained, and background information was provided. The floor was then turned over to Paul Sorenson of Banner Associates.

Paul Sorenson said that this meeting combined information gained at the meetings we have held in the past.

Using a flow chart, he then explained the 201 process which is basically a seven step procedure. The steps are:

1. Recognition of need and grant application.
2. Population projections for 20 years into the future to determine treatment plant capacity. This area should have a population of 110,000 by the year 2005.
3. Infiltration/Inflow Study.
4. Complete assessment of current situation.
5. Development of alternatives.
6. Presentation of alternatives.
7. Selection of final alternatives.

We divided the region into five study areas, and a brief synopsis of the alternatives for each area was given.

1. SUNNYSIDE

There have been a number of problems in Sunnyside for quite a while. The major problem is nitrate levels in the drinking water. The major cause of this is the use of septic systems and wells on small lots.

The first group of alternatives dealt with the use of innovative and alternative on site treatment technologies, mound, evapo-transpiration

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and aeration systems, for example. After debate and study it was determined that the health problems were significant enough to warrant other alternatives.

Land application was deemed inappropriate for the area, as was the formation of a water and sewer district.

The final alternative looked at was annexation to Cheyenne which would mean hooking up to the city water and sewer system.

2. NORTH CHEYENNE

These alternatives are the same as those developed for Sunnyside.

3. RANCHETTE DEVELOPMENT

An extensive soil survey was done for the areas surrounding Cheyenne where large lot development occurs using septic systems and wells. Areas were identified which will pose difficulties if the density gets too great. These areas were 'red flagged' for the City-County Health Unit and the Planning Office. If soils are rated as being poor for septic systems, the homeowner may have to go to other on site treatment technologies.

4. SOUTH CHEYENNE WATER AND SEWER DISTRICT

The future capacity of the District's plant was originally based on a service population of 25,000, which would mean the plant would have to treat 2.5 million gallons/day. After subsequent discussions, this population projection was lowered to 15,000 people, or 1.5 million gallons/day (mgd).

The least expensive way to increase the plant's capacity to 1.5 mgd would be to convert it to a contact stabilization form of activated sludge system, alternative A in the summary report. We have also been looking at a phased expansion plan for the plant. In this plan, the extended aeration system presently being used would be maintained and improvements would be made as necessary. This alternative is being considered.

The last alternative is abandonment of the plant with the waste being piped to one of Cheyenne's plants, alternatives C & D in the summary report.

5. THE CITY OF CHEYENNE

The alternatives for Cheyenne hinge somewhat on decisions made in the South Cheyenne Water and Sewer District. The City's two treatment plants are in fairly good shape. The Dry Creek plant could be expanded from its present capacity of 4.5 mgd up to 11 mgd, depending on what is done with the Crow Creek plant. The Crow Creek plant was built in the 1940's, and may not last for 20 more years. A big question, then, is do we want to invest money in this plant?

This concluded Paul Sorenson's presentation on the alternatives, and the floor opened for questions.

Herman Noe had some questions about the operation and maintenance costs in alternatives C & D in the summary report. These questions were answered.

Another question had to do with the availability of government money in the future. Ed Baruth said that federal funding was decreasing, so the importance of the priority list for funding was increasing. He also said that the state funds were stepping into the void of federal funds, although the state could not provide as much money as the federal government has in the past.

There was a question about the costs of the alternatives and how these costs were to be spread out. It was explained that these costs would be broken down when the final alternatives were chosen.

There was concern about the city expanding over the South Cheyenne Water and Sewer District. Art Buffington said there was a good chance that the District will go into the city, that they had been paying off their plant for a number of years and did not want to have to start paying someone else. Ed Baruth said that this was a prime issue, but a decision had to be made.

Bob Whitney asked if the effluent from the South Cheyenne Water and Sewer District can be carried by gravity to either the Crow or Dry Creek plant. Jim Cavalli told him that it could. Paul Schwieger said that there was a water right filed on the District's effluent, and there may have to be compensation if the effluent is treated somewhere else. Ed Baruth said that his office was looking into the water rights issues.

Someone expressed concern that the 201 Committee was going to tell them what to do in regards to abandoning the District's plant. They were told that that was not the case. There are several alternatives and we are looking for citizen input in the decision making.

What we are looking at is a regional plan, and each area is a piece of that plan. We are not saying that any alternative is better than any other, only that some alternatives cost less to achieve the same effect.

There was then a discussion on new development in the District and on the fact that the District cannot expand its boundaries, but can develop higher densities within those boundaries.

The meeting adjourned at 9:00 P.M.

JA/lkh

Cheyenne-Laramie County
Regional Planning Office

RESPONSIVENESS SUMMARY
FOR
201 WASTEWATER STUDY
PUBLIC MEETING ON FINAL ALTERNATIVES

This Responsiveness Summary is being prepared as a requirement in Section 40 CFR 25.8 of the Rules and Regulations for "Public Participation In Programs Under The Resource Conservation And Recovery Act, The Safe Drinking Water Act And The Clean Water Act."

A public meeting was held on Wednesday, April 21, 1982 in the Saratoga Room of the Holiday Inn at 7:30 P.M. The meeting was well advertised in the local media and legal notices appeared in the newspapers about this meeting.

Prior to the meeting, from 4:00 to 7:30, a public information booth was set up in the lobby of the Holiday Inn. There were displays and handouts, and persons were able to talk to the participants in the study to get more information. At the meeting, two summaries of the alternatives were handed out. One was narrative in format, the other broke down the more costly alternatives into capital, operation and maintenance, and annual costs. There was also a handout which described what a 201 Study is.

The presentation included a background of the 201 Study in the area, a synopsis of what a 201 Study is, and a presentation of the alternatives for the areas in the region that were studied separately Sunnyside, North Cheyenne, Ranchette Development, The City of Cheyenne and The South Cheyenne Water and Sewer District.

Questions and comments were directed at Paul Sorenson (the consulting engineer), the 201 Committee, and representatives from the Planning Office, DEQ, the State Engineer's Office and the City-County Health Office.

Most of the questions and comments were about the South Cheyenne Water and Sewer District's alternatives; that is, whether to upgrade the existing plant or abandon the plant and pipe the influent to one of the city's plants. The people in attendance seemed in favor of upgrading the existing plant rather than hooking into the city plant, although they did not want to have to pay for either since they are still paying on the last bond floated for the existing plant.

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One person commented that he hoped that the final plan would prohibit high densities in the county. This comment was received favorably.

The other areas in the region are now cut-and-dried, due to previous meetings and the extent of the health problems that exist or may come up in the future. These areas are those having high densities but no public water and sewer. There is general agreement that these areas need to be annexed, the only problem is the cost and who will pay.

All questions asked were answered by someone with the expertise to answer. All participants in the study were willing to respond to all questions and encouraged those in attendance to comment.

The meeting was informative. Those present were able to learn about the study and how the outcome of the study will affect them in the future.

JA/lkh

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DATE: APR 30 1982

SUBJECT: Cheyenne Area 201 Public Meeting

FROM: CeCe Forget, Public Participation Coordinator
State Programs Management Branch

TO: Addressees

RECEIVED
MAY 03 1982
BANNER ASSOCIATES, INC.

On Wednesday, April 21, 1982, I attended the public meeting of the Cheyenne Area, 201 Facility Planning project. The public meeting was held at the local Holiday Inn. Prior to the 7:30 meeting, an information area was set-up in the lobby. There were charts and diagrams posted, delineating the facility planning process and depicting examples of wastewater treatment processes. Information hand-outs were available, summarizing six alternative technologies and their cost factors. Representatives from the Cheyenne/Laramie County Regional Planning Office, Laramie County Environmental Health Department, and Banner Associates were present to answer questions.

There were 27 local citizens in attendance at the meeting, including 2 representatives from the state office of DEQ. The consulting engineer made a brief presentation of the available alternative technologies indicating an additional one which was also to be considered by the citizens and the 201 Citizen Advisory Committee.

There were a few brief questions, primarily for clarification. These were well responded to by the presenters and representative from DEQ. The audience demonstrated a high level of awareness and understanding of the information which was presented, as well as a sense of positive rapport with the agency representative.

No selection was made of the specific technology to be used, but the citizens were strongly urged to review the alternatives and to contact the appropriate persons with their comments. The meeting appeared to be successful in accomplishing its purpose of providing the necessary information to the local residents and soliciting their responses and continued participation. This public participation effort has been on-going since April of 1980. There have been localized neighborhood meetings, in addition to the general public meetings. All activities and relevant information have been substantially publicized throughout the process. Jon Arason of the Cheyenne/Laramie County Regional Planning Office, Paul Sorenson and Jim Cavalli of Banner Associates, and Gary Hickman of the Laramie County Environmental Health Dept. are to be commended for an outstanding public participation process.

The Public Hearing is scheduled for May 26, 1982.

Addresses

Jack Hoffbuhr
Harv Hormberg
Jim Brooks
Gerry Snyder

Cheyenne-Laramie County
Regional
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Office

201 COMMITTEE MEETING

April 7, 1982

AGENDA

1. Call to order
2. Banner's next billing
3. DEQ Financial Planning Guides--book 4, Intergovernmental Agreements
4. Revised Summary
5. Set new date for public hearing
6. Meeting of April 21
7. Other business
8. Adjourn

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[redacted]

Cheyenne-Laramie County
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201 COMMITTEE MEETING
April 7, 1982
MINUTES

Present:

Art Buffington, Chairman	Ed Baruth (DEQ)
Shirley Francis	Jim Cavalli
Herman Noe	Paul Sorenson
Floydine Gay	Tom Bonds
Larry Robinson (DEQ)	Jon Arason

The meeting was opened at 2:00 by Jon Arason.

The first order of business was to find out about the next billing. Jim Cavalli said it would be ready next week. Floydine Gay said that each participant still owed $8,883.34. It was felt that this money should be released as soon as possible so it would not be carried over into the next budget year. Shirley Francis made a motion to this effect. Art Buffington seconded, and the motion carried.

Larry Robinson of DEQ then explained the Financial Planning Documents which were given to each member.

Worksheet #1 outlines the costs of wastewater treatment plants and sources of funding;
Worksheet #2 outlines the ability of the local government to finance these costs;
Worksheet #3 brings these costs down to the individual residence and makes comparisons to the existing costs; and
Worksheet #4 outlines the process of drafting intergovernmental agreements necessary to implement the final plan.

The next item on the agenda was a discussion of the revised report summary. Art Buffington wanted to know the costs of phased increases in plant capacity for the South Cheyenne Water and Sewer District. Jim Cavalli said that Banner would look into it and give some cost estimates.

Herman Noe said that the Cheyenne Board of Public Utilities would rather pay their share on an as needed basis as opposed to giving their share in a lump sum. A motion was made to this effect. Shirley Francis seconded and the motion carried.

The public hearing date was changed to May 26 at 7:30 p.m.

in the Saratoga Room of the Holiday Inn.

The meeting adjourned at 2:50 p.m.

Cheyenne-Laramie County
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201 COMMITTEE
CITIZEN ADVISORY COMMITTEE MEETING
February 24, 1982, 2:00 P.M.
MINUTES

Present:

Art Buffington	Elmo Foster
Shirley Francis	Jim Cavalli
Herman Noe	Paul Sorenson
Floydine Gay	Tom Bonds
Beverly Schwieger	Jon Arason

The purpose of the meeting was to discuss Working Paper No. 3, "Preliminary Evaluation of Alternatives", as well as tend to some business.

The first order of business was the latest billing. The Committee's bank account had the money to pay Banner Associates latest billing, but not enough to pay the Planning Office for the public participation expenses. Since both these items were on the same invoice, it would take a vote by the Committee to pay Banner Associates immediately and the Planning Office at a later date. This motion was made and carried.

The next item on the agenda was the scheduling of both the Public Meeting and Public Hearing, both of which require a legal notice 45 days prior. After some discussion the dates were set as follows:

> On April 21, 1982 there will be a 201 and Citizen Advisory Committee meeting at 3:30 at the Holiday Inn. This will be followed at 4:00 by the setting up of a Public Information Booth in the lobby. At 7:30 P.M. the actual meeting will begin.
>
> The Public Hearing will be held on May 19, 1982, also at the Holiday Inn.

Discussion then began on Working Paper No. 3.

It was pointed out that the recycle/reuse portion of the paper should be included in the final paper as a policy statement. The same is true of the narrative on flow restricting devices. If, however, flow restricting

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devices are used to the extent that the flow in Crow and Dry Creeks is affected then the City could be held responsible for infringing on downstream water rights. Recycling/reusing would also affect water rights, but the City could obtain the right on future flows that could result from an expansion of the City's water system.

Next discussed were the interest rates used as a basis for cost amortization. In the paper, 7% and 10% rates were used. The Committee requested that Banner Associates rethink the rates, and include a justification of the rate chosen.

There was also concern about what courses of action the City might take in 20 years when the Crow Creek Plant has reached the end of its useful life. Since this study only addresses wastewater management for 20 years, this question is beyond the scope of the present study.

As some of the alternatives require cooperation between the City and the South Cheyenne Water and Sewer District, a question arose about the feasibility of protocols of cooperation between the City and the District. It was found that cooperation may be possible depending on the content of the protocols.

Herman Noe had some questions about cost charts VI-1 and VI-4. Jim Cavalli said he would put together a supplement which summarized the tables and made them easier to read.

Herman Noe also said that his office had been contacted in regards to the possibility of using Terry Lake and Kiwanis Lake as impoundment ponds for the effluent from Warren Air Force Base and Western Hills, and using this effluent to irrigate the golf courses. This could relieve some of the load on the City's treatment plants.

Jim Cavalli said there could be some water rights problems, but that he would look into it as an alternative. Paul Sorenson said there were some screens available which might meet primary treatment standards.

Elmo Foster raised the issue that some residents in the Wyoming Hereford Ranch area discharge directly into the creek. Jim Cavalli said he would look into this.

Herman Noe asked the difference between the South Cheyenne Plant at 1.5 mgd and 2.5 mgd. Jim Cavalli said these flows were determined by growth in and around the district, and whether growth outside the district would be treated in a Cheyenne plant or in the district plant.

The meeting adjourned at 3:05 P.M.

JA/lkh

Cheyenne-Laramie County
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201 COMMITTEE MEETING
FEBRUARY 4, 1982
MINUTES

Attending: Art Buffington
Shirley Francis
Herman Noe
Floydine Gay
Jim Cavalli
Tom Bonds
Jon Arason

Tom Bonds opened the meeting at 2:00 p.m.

The first order of business was to ratify the decision of January 14, 1982, (approval of the 2nd billing). Herman Noe made a motion to approve. The motion was seconded and passed.

The second item was a discussion of the 201 Committee's finances. We have received a total of $73,628 from EPA for the first and second billings. The first billing has been paid, but we are $4,561 short of meeting our obligations for the second billing. Art Buffington said we needed $1500.00 from each jurisdiction represented. Herman Noe said the Board of Public Utilities needed a letter of request for the funds; Shirley Francis said the County needed a voucher. Herman Noe said that each jurisdiction should perhaps give additional money in order to maintain a bank balance. Shirley Francis suggested $2000.00 apiece, and this was the amount decided upon.

The next item was approval of the 201 brochure. A motion was made and carried.

There was discussion on having a Saturday set aside as a public information day on the 201 Plan. Jon Arason said he would ask Scott Doyle if this could substitute for a formal meeting.

February 24 was set as the date for the next meeting. Art Buffington asked Jim Cavalli if as a result of this plan we could get estimates on the cost of Stage II. Jim Cavalli said yes.

A motion was made to adjourn the meeting, and the meeting was adjourned at 2:40 p.m.

JA/gs

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Cheyenne-Laramie County
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201 WASTEWATER MANAGEMENT STUDY
CITY OF CHEYENNE MEETING
JANUARY 14, 1982
MINUTES

The purpose of the meeting was to provide the public with background on the Cheyenne Area 201 Wastewater Management Study in general, and with insights into the City of Cheyenne's wastewater treatment system in particular.

The meeting was opened by Jon Arason at 7:35 p.m. with a brief progress report and a mention that the Cheyenne alternatives' meeting was the last of our meetings for targeted areas. The floor was then turned over to Paul Sorenson of Banner Associates for the presentation.

Mr. Sorenson began his presentation with a synopsis of the 201 process.

Then using a chart which showed the existing wastewater flows to the city treatment plants as well as the "worst case scenario" flows (that is, using the assumption that the population grcwth in the area will be in the range of the projections, but instead of 20,000 + persons being served by the South Cheyenne Water and Sewer District only 15,000 will be) that the existing treatment plants for the City of Cheyenne have the excess capacity to handle a population of 76,000. This is the projected population of the city for 1999. Phased changes may be considered to bring the conbined capacity of the plants to 10 mgd (millon gallons/day) by the year 2005. If something like the MX missle system locates in Cheyenne which causes an influx of people the capacity would be met sooner.

The Crow Creek Plant is already 40 years old. By the end of the study period it will be 60 years old which is about its expected lifetime. Therefore we do not want to make major improvements, but do only enough to bring it to a sustained 4.5 mgd capacity.

Right now the city needs no major expenditures aimed at upgrading the sewage treatment plants. Most of the changes deal with plant operations.

The Dry Creek Plant needs more fresh water to effectively clean it. Tests indicate that influent is only staying in the clarifiers for one hour instead of four.

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The Crow Creek Plant effluent is of good quality. There are problems with snails getting into the influent where they eventually die in the clorination tanks and settle to the bottom. The trickling filter needs to be covered to keep more heat in so the "bugs" can eat the waste better.

If Crow Creek could receive a steady flow of 4 mgd with Dry Creek handling the shock loads, Crow Creek would treat waste effectively.

There is an assumption that 10,000 people would live just outside the South Cheyenne Water and Sewer District but their wastewater would be treated by the City of Cheyenne.

The combined peak capacity of the plants is 14.2 mgd; the combined capacity for average daily flows is 8.5 mgd.

Jack Young (supervisor of the wastewater treatment plants) pointed out that flows of 14.2 mgd cannot be effectively treated, but 8.5 mgd can.

Treatment plants should be designed for peak capacity, or the sewage will begin to back up in the sewer lines away from the plant during peak loadings. Based on engineering data the Cheyenne system is sound, but operational changes are needed to carry the treatment system from 1999 to 2005. The Crow Creek Plant cannot realistically be expected to last more then 20 years without alterations.

Mr. Sorenson ended his presentation by saying that the Cheyenne wastewater treatment system will carry the city into the beginning of the next century, but some operational "fixes" are needed. There should not have to be large expenditures.

End of Mr. Sorenson's presentation.

Some discussion on sludge handling systems.

JA/gs

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RESPONSIVENESS SUMMARY
FOR
201 WASTEWATER STUDY
CITY OF CHEYENNE PUBLIC MEETING

This Responsiveness Summary is being prepared as a requirement specified in Section 40 CFR 25.8 of the Rules and Regulations for "Public Participation in Programs under the Resource Conservation and Recovery Act, the Safe Drinking Water Act and the Clean Water Act."

A public meeting was held on Thursday, January 14, 1982, in the Storey Gym-Board Room at 7:30 p.m. The meeting was well advertised, with press releases appearing in both Cheyenne newspapers, the local TV Station, and radio stations KRAE, KFBC and KUUY.

The presentation included a brief progress report, a synopsis of the 201 process, and a discussion about the City of Cheyenne's wastewater treatment system.

Questions and comments were directed primarily at Paul Sorenson (consulting engineer) and Jack Young (supervisor of the wastewater treatment plants). Since the present system has the capacity to treat sewage effectively until 1999, and needs only phased improvement (mostly to improve operations) to treat the city's sewage until 2005, the meeting was noncontroversial and did not generate a great deal of discussion. There were comments about how the city should handle its sludge.

The Consulting Engineer, the 201 Committee, the Citizen Advisory Committee, and representatives from the City and DEQ responded to all questions.

The meeting was informative. Those present were able to learn that Cheyenne's wastewater treatment system is sound, has the excess capacity to last to 1999 (with normal growth), and needs only minor alterations to take the city into the next century.

JA/gs

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201 Committee Meeting

January 14, 1982

Art Buffington (Chairman) opened the meeting at 7:05. Tom Bonds stated that the only item on the agenda was the approval of the billing submitted by Banner Associates and the Planning Office. He further explained that the other two members of the Committee (Herman Noe and Shirley Francis) were unable to attend, but that he had contacted them earlier that day. Over the phone Shirley Francis made a motion that the billing be approved subsequent to its acceptance by Art Buffington. Herman Noe seconded the motion. At the meeting, Art Buffington stated his approval of the billing, and the billing will therefore be submitted. It was further determined that there will be a meeting of the 201 Committee to reaffirm this action.

The meeting adjourned at 7:10.

JA/gs

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~~1709 Sowder Ave. P.O. Box 369 Area (307) 638-8977 Cheyenne, Wyo. 82001~~

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201 Wastewater Management Study
South Cheyenne Public Meeting
January 7, 1982, 2:00 p.m.
Minutes

PRESENT: Art Buffington (Chairman)
Herman Noe
Shirley Francis
Floydine Gay
Beverly Schwieger
Paul Schwieger
John Barnett
Paul Sorenson
Jim Cavalli
Randy Pahl
Scott Doyle
Ed Baruth
Frank Belede
Jon Arason

The meeting was opened at 2:00 p.m. by Art Buffington.

Paul Sorenson (Banner Associates) expressed his concern about the water rights governing the wastewater treatment plant effluent. Without some kind of agreement between the South Cheyenne Water and Sewer District and the Read family (owners of the water rights) the plant is bound to have the effluent treated to secondary standards of the point of outfall. In order for the district to employ land application the land has to be controlled by the District.

Paul Schwieger (State Engineers Office) said that the District is ultimately responsible for its effluent; it cannot put this responsibility onto a land owner.

The effluent water that the Read's do not use is ultimately used by someone further downstream. If you have an agreement with a landowner he is only responsible for the terms of the agreement, and it is unlikely that anyone would take the responsibility for the effluent. You cannot demand that a landowner use all the effluent. The landowner must only use what he needs.

The Read's claim to the effluent flow is a supplemental agreement. Their entitlement, by the State, is one cubic foot per second for every seventy acres of irrigated land. If this flow is not available from the natural flow, the landowner is entitled to a supplemental flow--in this case the effluent from the treatment plant.

The question was raised about the acre feet of water we were talking about. The flow is 600,000 gallons per day (gpd) but will reach 2 million gpd. by the year 2000.

Art Buffington said he thought this flow projection was very high, and he did not agree with the population projections.

Depending on where future growth is placed south of Cheyenne (in the City or in the South Cheyenne Water and Sewer District) the flows tc the treatment plants will be shifted. As of now there is no expansion policy in the District, due to the availability of water. There are at present alot of undeveloped tracts within the District.

The reason the population projections are based on areas outside the persent boundaries of the District is due to the hydrology of the area.

Art Buffington said that the population is not 6,400 and that it won't grow much more. Herman Noe (BOPU) said that people have asked fcr an expansion of the district but have invariably been denied.

The District is, however, agreeable to growth within the boundaries. The agreement with the city is based on boundaries not population.

The placement of growth makes a difference so far as projected flows. Regardless of flow increases, what about the rights on the effluent? If an agreement cannot be worked out, does that affect some of the alternatives?

There is a priority of beneficial uses of water in the state. What is beneficial to the District may not be beneficial to the state. The desire of the State Engineer's Office is to have the water treated and discharged. There may not be good economics in buying out the water.

Paul Sorenson said that if you use land application you can install a drainage system that will return about 50% of the water back to the creek.

Paul Schwieger said that Crow Creek is not an interstate stream and is a fourth class stream. Therefore they could consider changing the discharge permit to relax the requirements.

Art Buffington asked who made that decision.

Ed Baruth (DEQ) said that DEQ makes that determination based on volume, quality, and population. He said that legally the effluent from the plant is a discharge (even though it does not go directly into a stream), and as such DEQ would have to be approached for any relaxation of standards.

Art Buffington said that avenue should be explored. Jim Cavalli said that his firm would look into it. Ed Baruth said that in order to grant a variance on the discharge permit they will need to know what kind of flow they can expect from the district in the future; they need an overall picture before they can consider repermitting.

Jim Cavalli expressed concern over the time element as far as it related to keeping the study together. Paul Sorenson said that the new information that came to light would cause a reevaluation of the District and the City of Cheyenne. He further stated that a redefinition of the District's effluent limitation will change the alternatives.

Paul Sorenson said that since the Discharge Permit says "Discharge into receiving waters" and since the treatment plant discharges into a ditch, then three ponds, then Crow Creek, where do you monitor the discharge--at the outfall of the plant or the confluence with Crow Creek?

Paul Schwieger said that you monitor at the point of discharge.

Jim Cavalli said that his firm would put together a request for a relaxation of standards and send it in for the 201 Committee's approval. But they would continue with the 201 Plan as if there were no variance in order to keep the plan going. The overall growth predictions have not changed, only where the wastewater will go.

He then asked if EPA will accept one board's policy of no expansion for the District.

Paul Schwieger said they probably would if you had a definite statement.

Art Buffington said that the committee should get a statement from the District and the Board of Public Utilities saying that the boundary will not expand.

John Barnett asked if the District could refuse service if water became short. The answer was yes, so there is a growth control mechanism within the District. Barnett went on to say that what he is worried about is when one home on a five acre tract subdivides into four tracts as this type of growth generally does not raise any alarms, unlike a large subdivision.

Paul Schwieger said that the State Engineer's Office would like to see a 201 Study with consideration given to the downstream area. He appreciated the concern that the committee was giving to this.

Paul Sorenson said he would hold off on some of the report until the placement of growth was more effectively determined; furthermore since the water rights issue seemed not to be resolved as yet, he would base the alternatives on secondary standards.

The meeting adjourned at 3:15 p.m.

JA/gs

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201 WASTEWATER MANAGEMENT STUDY
Ranchette Meeting
December 2, 1981 Minutes

The purpose of the meeting was to provide the public with background data on the Cheyenne Area 201 Wastewater Management Study, and provide insights into some of the problems which may be encountered when deciding to build on a lot not served by public water or sewer.

The meeting was opened at 7:30 P.M. by Jon Arason. The 201 Committee, Citizen Advisory Committee, and consulting engineers were introduced. The purpose of the 201 Study was explained and the floor was given to Paul Sorenson of Banner Associates.

Using a flow chart Mr. Sorenson explained the steps in the 201 process, from the recognition of need for the study to the final public hearing. He said that Working Paper #1 (Population Projections) has yet to be returned from EPA, but Working Paper #2 (Infiltration/Inflow) has been approved by DEQ and returned with slight modifications. The South Cheyenne Water and Sewer District paper should be ready in the next week or two.

In ranchette developments there are several ways to handle wastewater on site. On good soils, a septic tank with an absorption field can be used if proper separation from the house and well can be maintained. On soils with moderate limitations, caution is needed when installing a conventional system. On severe soils, soils which do not perc well or have a low depth to bedrock, extreme caution must be used in deciding how to treat wastewater. Sunnyside, for example, has areas with Kirkham or Bridget soil types which have slow perc rates; this has caused some difficulties.

Using a map of the Cheyenne area showing soil limitations, Mr. Sorenson identified those areas where development may cause problems. In those areas, rated as having soils with severe limitations to onsite treatment, alternative technologies can be used effectively, and should be investigated. In areas having slight soil limitations, conventional systems can be used, although large lots may still be necessary.

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Mr. Sorenson then presented a theoretical design, using all required setbacks and separations to determine the minimum lot size necessary for a house, a well, and a septic system. Under ideal circumstances — if a lot has good soils, is well drained, and is relatively flat, then at least one acre is required. Individual site inspection is desirable, though, to determine soil types and slopes before installing the drainfield, or deciding where to locate the house.

For areas with soils not suited to conventional absorption fields, innovative and alternative onsite systems can be used. There was a discussion of some of these systems, especially mounds. These technologies should be investigated before deciding not to build.

The area adjacent to Sunnyside to the east has similar soils to Sunnyside, so the same problems could arise if similar development occurs. Other areas which may pose problems are those near the Crow Creek Wastewater Treatment Plant, and east of South Cheyenne. If overcrowding occurs in these areas, alternative systems will have to be explored.

In many instances, the location of the house on a site will determine whether or not a conventional absorption field will be feasible. For example, if the lot has steep slopes, placement of the house at the bottom will leave no room for a drainfield.

End of Paul Sorenson's presentation.

Questions and comments.

The meeting adjourned at 8:30 P.M..

JA/lkh

Cheyenne-Laramie County
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RESPONSIVENESS SUMMARY
FOR
201 WASTEWATER STUDY
RANCHETTE MEETING

This Responsiveness Summary is being prepared as a requirement specified in Section 40 CFR 25.8 of The Rules and Regulations for "Public Participation in Programs Under The Resource Conservation and Recovery Act, The Safe Drinking Water Act, and The Clean Water Act."

A public meeting was held on December 2, 1981 in the Davis School Auditorium at 7:30 P.M. to discuss wastewater management problems in "ranchette" type developments. Notice was given of the meeting. The presentation included background information on the 201 Study, an analysis of the soils in the area, and a discussion on how the limitations of soils for individual on site wastewater treatment systems have to be considered before development occurs.

The 201 Committee, Citizen Advisory Committee, and consulting engineers were introduced.

Questions and comments were directed primarily at Paul Sorenson, one of the consulting engineers, who gave the presentation. The map which was used to show soil limitations in the study area had some portions in which soils were not delineated. Questions were asked about these areas. Mr. Sorenson explained that the Soil Conservation Service had yet to map these areas, and it would take another 6-9 years. On extant subdivisions in these areas, Mr. Sorenson said he would get pertinent information from the City-County Health Unit.

Interest was shown in the moratoriums placed on certain developments in the area. Interest was also shown in the perc tests that Banner Associates has performed. Questions were asked about where to obtain information about existing subdivisions. Mr. Sorenson answered that the City-County Health Unit was the best source for this information. He also left his business card so he could help answer questions or obtain additional information.

The consulting engineer, 201 Committee, and Citizen Advisory Committee responded to all questions and entered into discussions with those present.

The meeting was informative for those present. Persons who lived in ranchette developments, owned land there, or who were concerned about the impacts of development there were able to meet those involved in the 201 Study, garner background information, and learn what to watch for in ranchette developments and how to solve problems which may arise.

JA/lkh

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201 Wastewater Management Study
South Cheyenne Public Meeting
October 29, 1981
Minutes

The purpose of the meeting was to provide residents of South Cheyenne a background on the Cheyenne Area 201 Wastewater Management Study, and to present various alternative wastewater management systems available to enable the present wastewater treatment plant to handle increased loads.

The meeting was opened at 7:30 P.M. by Jon Arason. The 201 Committee, the Citizen Advisory Committee, and the consulting engineers were introduced. The purpose of the 201 Study was explained, and the floor was turned over to Paul Sorenson of Banner Associates.

Using a flow chart, Mr. Sorenson explained the seven basic steps in the 201 process: recognition of need for the study, population projections for 20 years into the future (ours are waiting for EPA approval), development of alternatives, submission of alternatives to the 201 Committee, submission of alternatives of choice to DEQ and EPA, and a public hearing about the final plan. Throughout this process there are neighborhood meetings to obtain comments about the various alternatives.

Mr. Sorenson then presented the various alternatives available to South Cheyenne. (The feasibility of each alternative was based on a population projection of approximately 20,000 by the year 2005).

1. No action would result in an eventual overloading of the plant, and DEQ would not approve the effluent.

2. Upgrading the existing plant. The plant presently has a bar rack to remove large solids, but it does get clogged and must be manually cleaned by the operator. Unless automated, the bar rack will only be good until 1990. There is also a need to install a grit chamber to filter the grit from the influent so it will not settle in the aeration tank and cause it to go septic. In an aerated grit chamber you can selectively filter out the grit. The grit is clean and can be landfilled.

   Presently the plant does not maintain 2 mg/liter dissolved oxygen in the aeration tanks. By utilizing "mixed liquer" (varying the influent and returning activated sludge) the plant could control the oxygen in the aeration tank for maximum efficiency.

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By increasing the length of influent stay in the aeration tank, effluent quality can be heightened. In doing this, the plant would be effective until 1990, when more extensive land application would have to be utilized.

The clarifiers at the plant are in good shape. However, they do need hydraulic washers to wash the foam down a trough so the clarified water can pass.

3. Conversion of the plant to a different type of facility based on the type of preapplication treatment necessary for various types of land application, i.e. slow-rate, rapid-infiltration, or over land-flow. Conversion of the plant to a primary treatment facility and piping effluent to the city plants for secondary treatment.

4. Conversion of the plant to a contact stabilization system.

5. Conversion of the plant to a conventional activated sludge system.

6. Land application. The type of pretreatment determines the type of land application. (see table 4 attached).

7. Lagoons. The plant could be abandoned and either leaky or total containment treatment lagoons built. Due to high groundwater levels, total containment may be the better option. Before winter the lagoon has to be drained down from 12' to 1' to store the effluent produced during that season. Lagoons can be used in conjunction with primary treatment.

8. Abandoning the existing plant and building a new mechanical plant. This would only be considered if the various components of the existing plant prove to be incompatible for upgrading.

End of Paul Sorenson's presentation.

Discussion and comments.

The meeting adjourned at 8:30 P.M.

JA/lkh

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RESPONSIVENESS SUMMARY
for
201 Wastewater Study
South Cheyenne Public Meeting

This responsiveness summary is being prepared as a requirement specified in Section 40 CFR 25.8 of The Rules and Regulations for 'Public Participation in Programs under the Resource Conservation and Recovery Act, The Safe Drinking Water Act, and The Clean Water Act."

A public meeting was held on October 29, 1981 in the Arp School Auditorium at 7:30 P.M. to discuss wastewater management alternatives for the South Cheyenne Water and Sewer District. Notice was given of the meeting. The presentation included background information on 201 wastewater management studies and various alternatives for treating waste in the South Cheyenne area.

There was an introduction of the 201 Committee members, the Citizen Advisory Committee, and the consulting engineers.

Questions and comments were directed to Paul Sorenson, the consulting engineer. The questions dealt with water rights issues for land application systems, the current capacity of the wastewater treatment plant, and the feasibility of various plans to upgrade it. Generally negative reaction was shown towards the alternative of using the present plant for primary treatment and piping the effluent to the City of Cheyenne for secondary treatment.

The consulting engineer, the 201 Committee, staff, and Citizen Advisory Committee responded to all questions and entered into discussions with those attending.

The meeting was informative. The residents of South Cheyenne were able to meet the persons involved in the 201 Study, garner background information, and present their views on the various alternative wastewater management techniques presented to them.

JA/lkh 11-2-81

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MINUTES

Citizen Advisory Committee (C.A.C.) Workshop

October 22, 1981

A workshop was held for the Citizen Advisory Committee on Thursday, October 22, 1981, in the first floor conference room of the Municipal Building at 7:30 P. M. In attendance were Beverly Schwieger, Ed Strader and Vern Ostdiek of the C.A.C., Art Buffington (201 Committee, South Cheyenne Water and Sewer District), Paul Sorenson (consulting engineer), Tom Bonds, Floydine Gay, Paul Schwieger, and Jon Arason.

The purpose of the workshop was to give the C.A.C. more background in innovative and alternative technologies, the value and feasibility of land application systems, to discuss the role of the C.A.C., and plan strategies for upcoming neighborhood meetings, the final public meeting, and the public hearing on the alternatives of choice.

The session was opened with a few introductory remarks by Tom Bonds. There followed two slide shows prepared by EPA, "Innovative and Alternative Technologies" and "Land Application".

Following the "Land Application" slide show there was a lively discussion over the issue of water rights in allowing land application. At the present, the South Cheyenne Wastewater Treatment Plant has an agreement with a landowner to provide waste water for land application. It was generally felt, though, that by increasing the water supply due to population growth, we would be adding water into the system that is not covered by water rights agreements. The sewer district could therefore gain control of this water and dispense it for land application in ways the sewer district sees fit.

We then discussed the problems facing Sunnyside. The potential health hazards--backed up individual treatment systems and their effect on potable well water. Many of the lots are too small to accommodate another system, and grant money will probably not be available to provide sewer and water systems. We discussed the feasibility of alternative findings. Paul Schwieger mentioned that the health problems facing Sunnyside were due to nitrates in the drinking

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water, and there is a priority need to get the residents good water.

It was agreed that even though grant funding may not be available to implement the 201 Wastewater Management Plan, the plan will be a good tool for determining where to place growth in the most efficient manner for handling wastewater.

Paul Sorenson then went over the alternatives to be discussed at the South Cheyenne neighborhood meeting. These are:

1. Upgrading the existing plant to increase efficiency. Currently the plant has a capacity of 1.2 mgd and handles anywhere from 400,000 mgd to 800,000 mgd (peak demand).

2. Converting to a more efficient activated sludge system.

3. More extensive use of land application.

4. Using the existing plant as a primary treatment facility and piping the waste to the Cheyenne wastewater treatment plant for secondary treatment.

The Cheyenne wastewater treatment system is in good shape. For this system, the engineer recommended upgrading the Crow Creek plant if necessary.

The final alternatives for the region should be available from the consultant in November.

The role of the C.A.C. was discussed. This role is: remain knowledgeable of the alternatives available to each area in order to help decide which is the most practical, to be aware of the problems, and to encourage neighborhood support and participation in the 201 process.

Strategies for the future involve:

- a meeting for ranchette owners,

- having a brochure to help increase citizen awareness, and

- putting together a supplement for the newspaper dealing with the water quality problems and alternatives.

These are all to prepare for the public meeting.

Vern Ostdiek expressed deep concern over the fact that at the Sunnyside meeting, the consultant mentioned the name of a specific contractor as one who had installed a mound system in Sunnyside. Mr. Ostdiek felt that mentioning one contractor's name, when there are other firms in competition for excavation work, could hurt his business and possibly show favoritism, if not collusion. Paul Sorenson said that the firm was mentioned only as an example in an attempt to give an example of a mound system in the area, and the approximate cost of the system. He apologized for any concern this may have caused Mr. Ostdiek and said that there was no collusion with this firm and that it was meant to be only an example. Mr. Ostdiek did not accept the apology. Feeling that he had not decided the final disposition of the matter and did not want to become involved in a conflict of interest if and when he pursued the matter further, he resigned from the committee. The rest of the committee was in agreement that Mr. Sorenson's mention of the firm in question constituted no collusion, no statement of preference of one firm over another, and was merely used as one example. The committee apologized for any action taken that may have resulted in Mr. Ostdiek's feelings of being slighted, and accepted his resignation.

The session adjourned at 9:15 with a reminder of the South Cheyenne meeting on Thursday, October 29, in the Arp School auditorium at 7:30 P. M.

JA/cb
10/29/81

Cheyenne-Laramie County
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201 Wastewater Management Study

Sunnyside Public Meeting
October 8, 1981
- Minutes -

The purpose of the meeting was to provide residents of Sunnyside a background on the Cheyenne 201 Wastewater Management Study, and to present the various alternative wastewater management systems available to them.

The meeting was opened at 7:30 P. M. by Tom Bonds. Mr. Bonds introduced the 201 Committee, the Citizen Advisory Committee, and Scott Doyle. He then explained the purpose of a 201 Study, and introduced Paul Sorenson of Banner Associates who took the floor.

Mr. Sorenson explained that a 201 Study is Phase I of a three-phase operation. The basic steps in the Phase I Study are: The recognition of need for the study, grant application, population projections (ours are waiting for EPA approval), an Infiltration/Inflow study, a study of alternatives, submission of alternatives to the 201 Committee, submission of the alternative of choice to DEQ and EPA. Throughout this process there are public meetings and hearings on the final alternatives.

Phase II of the process is the design of the chosen system and application for funds.

Phase III is the actual implementation of the plan.

Mr. Sorenson next presented the various alternatives available to Sunnyside:

1. Mound systems are used when there is high ground water or low depth of soil to bedrock, and there are some being used in Sunnyside. Mr. Sorenson's hypothetical design for a family of four would need a 375-foot absorption area, and a total of 1800 sq. ft. at a cost of approximately $5,500. The amount of land required for a mound system is not available to all the residents of Sunnyside.

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2. Evapo-trnaspiration systems require a minimum of 2000 sq. ft. for proper winter use. They are impractical and expensive for this area because of the size requirements and because they would have to be heated in the winter.

3. Aeration systems work by a biologic process. They are expensive but work well, though they require a lot of maintenance.

4. Cluster systems are for two or more houses, and there are some in the county. Problems can arise when the system has to be maintained -- who will pay the cost of upkeep?

5. Land application may be an option in South Cheyenne, but not in Sunnyside. In order for land application to be cost effective, there has to be agricultural land in close proximity.

6. A tie-in to the City sewer entails the cost of the sewer line extension. The wastewater treatment plant has the excess capacity to handle Sunnyside, but would need a little upgrading.

End of Paul Sorenson's presentation.

Discussion and comments.

The meeting ended at 8:35 P. M.

JA/cb
10/16/81

Cheyenne-Laramie County Regional Planning Office

RESPONSIVENESS SUMMARY

for

201 Wastewater Study
Sunnyside Public Meeting

This responsiveness summary is being prepared as a requirement specified in Section 40 CFR 25.8 of the Rules and Regulations for "Public Participation in Programs under the Resource Conservation and Recovery Act, the Safe Drinking Water Act, and the Clean Water Act".

A public meeting was held on October 8, 1981, in the Baggs School auditorium at 7:30 P. M. to discuss wastewater management alternatives for the Sunnyside area. Required notice was given to the residents of the study area. The presentation included background information on 201 wastewater management studies and various alternative plans for Sunnyside.

There was an introduction of the 201 Committee members and the Citizen Advisory Committee.

The alternatives discussed were no action, land application, individual systems, cluster systems, and hooking up to the Cheyenne system.

Questions posed during the meeting were directed at Paul Sorenson, the consulting engineer. Interest was shown in mound systems--specifically the ones in use in the area and their life expectancy. No interest was shown in any other alternative except hooking up to the Cheyenne system and becoming annexed.

Present at the meeting were residents of Sunnyside who had annexed to the City of Cheyenne. This made for lively discussion, as persons attending the meeting were interested in such annexation issues as the cost of running sewer extension lines and the amount of time involved.

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[illegible]

The consulting engineer, the 201 Committee, staff, state personnel, and Sunnyside residents who had annexed their property responded to all the questions and entered into discussions with those attending.

The meeting was informative. The residents of Sunnyside were able to meet the persons involved in the 201 Study, garner background information, and present their views on the various alternative wastewater management techniques presented to them.

JA/cb

VI. Correspondence

Necessary correspondance for the thorough evaluation of the 201 Study Area involve comments from the following agencies:

A. Soil Conservation Service - prime agricultural land.

B. U.S. Fish & Wildlife - wetland, endangered species.

C. Wyoming Game & Fish.

D. All comments from the A-95 review.

E. Wyoming State Archives, Museums & Historical Department - historical impact.

F. The Attorney General's Office - water rights.

G. Corps of Engineers/HUD - floodplain.

H. Wyoming Recreation Commission - archaeology, history, historical architecture, recreation planning.

I. City of Cheyenne/Laramie County Sanitarian.

The Wyoming Game and Fish Department is contacted in order to identify fisheries and wildlife habitat areas in the Study Area that may be affected by the proposed project. This information is necessary to prevent damage to fisheries or wildlife habitats by construction or the discharge of treated wastewater.

The State Historic Preservation Office is contacted in order to identify any unique historical or archaeological features known to exit. This office, if necessary, can recommend that a qualified archaeologist be hired to perform a preconstruction inventory of the areas of potential development to identify potential environmental impacts. A map showing approximate locations of construction associated with the proposed project has been submitted to the State Historical Preservation Office. Response from this submittal is included herein.

The U.S. Department of Agriculture Soil Conservation Service is contacted to identify any prime farm land in the study area. The SCS is also called on to make statements regarding the acceptability of the soil in areas designated as sludge landfill sites. This information is also included herein.

The Wyoming State Engineer's Office is the administrator of water rights issues in the state. Statements from this office or the Attorney General's office regarding the effects the proposed project has on existing water rights are included.

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

SUBJECT: Prime Farmlands in Laramie Co DATE: 1-4-83

TO: Banner Assoc.
P. O. Box 550
Laramie Wy. 82070.

Prime farmlands in Laramie County are all lands which meet all the following criteria:

1. Lands that have been under positive irrigation management for 10 years or more and are currently being irrigated.
2. The soils are on lands that are classified 2 or 3 and
3. the lands are located East of a line which runs along the Torrington Highway from the North boundary of the County to a line 2 miles west of the rangeline between ranges 63 & 64 and which runs directly south from that point to the South boundary of the County.

There are no Prime farmlands located in the Waste Water Study Area as reported in the Cheyenne, Wy. 201 Facility Plan Report.

[signature], D.C.
Soil Conservation Service
P.O. Box 971
Cheyenne Wy. 82003

Ed Herschler
Governor

Wyoming State
Archives, Museums & Historical Department

ROBERT D. BUSH, Ph.D.
Director
307-777-7013

Barrett Building, Cheyenne, WY 82002-0013

Julia A. Yelvington
Division Head
Archives & Records Mgt.
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Mike Mayfield
Division Head
Museums & Historic Sites
307-777-7510

William H. Barton
Division Head
Historical Research & Publications
307-777-7518

RECEIVED
OCT 13 1982

October 12, 1982

Paul Sorenson
Banner and Associates
620 Plaza Court
P. O. Box 550
Laramie, WY 82070

Dear Mr. Sorenson:

To follow up on our telephone conversation of last week, we would be the logical home for artifacts found on state land. Of course, the property owner has the legal right to the artifact unless, of course, it is archaeological in origin or it is covered under numerous other exceptions to the rule of abandoned, lost or mislaid property.

A governor's committee, of which I am a member, has been appointed to analyze the current state of these laws and recommend necessary changes. We anticipate filing a final report by the end of the year. Whether this would change the requirements and ownership of artifacts would depend on the recommendations and on whether the legislature would make them into law.

Under current law, the State Antiquities Act passed in 1935 is administered by the State Land Board. You may wish to contact Oscar Swan, the land commissioner, about that board's requirements.

As to your question about cultural resource evaluations, the Wyoming Recreation Commission's resources division is responsible for those surveys. We recommend contacting them at 777-7697.

Environmental impact statements required by DEQ are sent to us for our approval as to the impact various projects would have on historical sites. We utilize the resources in our collections in order to discern whether or not such a project would impair the historical quality of a location. We make on-site inspection of these sites only when there is some question as to the exact location of the proposed project.

If you have additional questions, please contact us or the State Attorney General's office. They may be able to give you a more definitive answer to several of these questions.

Very truly yours,

Philip J. Roberts
Senior Historian

PJR:km

THE STATE OF WYOMING

RECEIVED OCT 26 1982

ED HERSCHLER
GOVERNOR

Wyoming Recreation Commission

1920 THOMES CHEYENNE, WYOMING 82002

JAN L. WILSON
Director
777-7695

October 22, 1982

Paul Sorensen
Banner Associates, Inc.
P.O. Box 550
Laramie, Wyoming 82070

Dear Mr. Sorensen:

Information concerning the proposed Cheyenne 201 facilities was received in this office. Thank you for giving us the opportunity to comment.

Enclosed is a memorandum from our staff archeologist who reviewed the materials. He indicates that provision must be made for cultural resources. Therefore, the Wyoming State Historic Preservation Officer (SHPO) recommends cultural clearance for the purposes of applicable state and federal laws only if the archeologist's recommendations are followed. In the event that his recommendations are not followed, clearance will be void.

If you have any questions concerning these recommendations please contact the appropriate member of our staff.

Sincerely,

Mark Junge, Deputy
State Historic Preservation Officer

FOR:

Jan L. Wilson, Director and
State Historic Preservation Officer

MGJ:klm
Encls.

WYOMING RECREATION COMMISSION

STATE HISTORIC PRESERVATION OFFICE

REVIEW AND COMPLIANCE

Interdisciplinary Staff Comments

Archeology • History • Historical Architecture • Recreation Planning

TO: Mark Junge, Chief

FROM: Richard Bryant, Compliance Archeologist RB

DATE: October 22, 1982 (district #1)

RE: Proposed Cheyenne 201 Facilities

A file search by our staff indicates that archeological site 48LA325 is located near a portion of the proposed construction area of the Crow Creek-South Cheyenne pipeline. The site is lcoated at the junction of I-80 and College Drive and was excavated as part of the mitigation activity for the highway construction.

The area along Crow Creek may contain additional archeological materials and I recommend that the Crow Creek-South Cheyenne pipeline area be surveyed by an archeologist prior to construction to identify any prehistoric sites or materials which may exist in the area.

No sites are known to occur in the other proposed construction areas and these areas have been previously disturbed by roads and housing. No surface inventory of these areas is warranted. I recommend, however, that the open pipeline trenches be monitored by an archeologist so that any exposed subsurface archeological materials may be identified and recorded.

WYOMING
EXECUTIVE DEPARTMENT
CHEYENNE

ED HERSCHLER
GOVERNOR

November 29, 1982

Please refer to:
A-95 #WY8210291504

Mr. Paul Sorensen
Banner Associates, Inc.
620 Plaza Court
P.O. Box 550
Laramie, WY 82070

Dear Mr. Sorensen:

The City of Cheyenne, South Cheyenne Water and Sewer District 201 Facilities Plan Final Report has been reviewed by the State Clearinghouse and pertinent state agencies. Copies of comments received are attached. Because the Plan is still undergoing a detailed review by the Department of Environmental Quality, Clearinghouse approval is contingent on the review recommendation of that Department.

Sincerely,

STATE CLEARINGHOUSE

Dick Hartman

Dick Hartman,
State Planning Coordinator

DH:a
attachments

cc: Environmental Protection Agency
Department of Environmental Quality

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Department of Environmental Quality

Water Quality Division

1111 EAST LINCOLNWAY CHEYENNE, WYOMING 82002 TELEPHONE 307 777-7781

M E M O R A N D U M

TO: Robert E. Sundin, Director, Department of Environmental Quality
Dick Hartman, State Planning Coordinator

FROM: Ed [illegible]uth, Engineering Evaluator

DATE: November 9, 1982

SUBJECT: A-95 Review, Facility Plan for City of Cheyenne, South Cheyenne Water and Sewer District, Laramie County

This will advise that the Draft 201 Facilities Plan for the referenced area is consistent with the goals and objectives of the Department of Environmental Quality.

The plan is still undergoing a detailed review in accordance with the Environmental Protection Agency guidelines and this Department's final approval is contingent on the results of this review. Appropriate comments and recommendations will be submitted to the grantee for inclusion in the final plan.

cc: EPA
Grant File

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

NOV 08 1982

State Engineer's Office

BARRETT BUILDING CHEYENNE, WYOMING 82002

November 8, 1982

MEMORANDUM

TO: Ann Redman, State Planning Coordinator's Office

FROM: Louis E. Allen, Water Resources Engineer

SUBJECT: A-95 #WY8210291504, Draft Final Report, 201 Facilities Plan, City of Cheyenne, and South Cheyenne Water and Sewer District.

Since the proposed plan is to continue the discharge of treated wastewater to Crow Creek, there are no objections from this office.

Thank you for the opportunity to review this 201 Facilities Plan, which is being returned in accord with your referral memorandum.

LEA/ht

cc: George L. Christopulos
State Engineer

Paul C. Schwieger
Deputy State Engineer

THE STATE OF WYOMING

NOV 10 1982

ED HERSCHLER
GOVERNOR

Department of Environmental Quality

SOLID WASTE MANAGEMENT

401 WEST 19TH STREET
EQUALITY STATE BANK BUILDING

CHEYENNE, WYOMING 82002

TELEPHONE 307-777-7752

M E M O R A N D U M

TO: Robert E. Sundin, Director

FROM: Richard M. Young, Geologist RMY

DATE: November 4, 1982

SUBJECT: Comments Concerning Cheyenne Water & Sewer District EIS

The impact of this facility cannot be assessed until the final sludge management plan has been submitted. Grit disposal has not been addressed and there appears to be no provision to accept wastes from septic tank pumpers.

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Department of Environmental Quality

SOLID WASTE MANAGEMENT

401 WEST 19TH STREET
EQUALITY STATE BANK BUILDING

CHEYENNE, WYOMING 82002

TELEPHONE 307-777-7752

M E M O R A N D U M

RECEIVED APR 1982 WATER QUALITY DIVISION WYOMING

TO: ED BARUTH - DEQ - Water Quality Division

FROM: Lon Revall, Solid Waste Management Program

DATE: April 20, 1982

SUBJECT: Preliminary Alternatives for Sludge Disposal for the City of Cheyenne by Banner Associates, INC.

The Solid Waste Management Program provides the following comments on the working paper submitted for our review.

The Solid Waste Program has no problem with the present practice and the proposed alternative of disposing of screening and grit produced at the Dry Creek and Crow Creek facilities at the Cheyenne landfill.

The narrow and wide trench methods of landfilling sludge would require a permit to construct and operate from the Solid Waste Program. As described in the working paper detailed geological evaluation would have to be provided including lithology of the area, depth to groundwater, cation exchange capacity, etc., as well as, the information required in the Solid Waste Management Rules and Regulations, 1975.

The co-disposal option with refuse will not be considered by the Solid Waste Program until the groundwater question is resolved at the Cheyenne landfill.

The Incineration and landfill option would require the same permit from the Solid Waste Program as the narrow and wide trench method.

Once the alternative is chosen, the Solid Waste Program will be happy to meet with the City of Cheyenne and/or their consultant to discuss the information necessary to obtain a permit to operate.

Walter Cockley, M.D., *Director*

TELEPHONE NUMBERS

Nursing	632-8983
Cancer Screening	632-8988
Family Planning	635-0948
Env. Health	638-8545

City-County Health Unit

1710 SNYDER AVENUE

CHEYENNE, WYOMING 82001

January 12, 1983

Paul Sorenson
Banner & Associates, Inc.
620 Plaza Court
P.O. Box 550
Laramie Wy 82070

RE: 201 Facilities Plan Final Report

Dear Mr. Sorenson:

The staff of Environmental Health has reviewed the above referenced document. The following comments are the composite of said review.

Sunnyside Area: The 201 report addresses the potential and actual problems associated with Sunnyside very accurately. Sunnyside was platted and largely developed prior to adoption of laws and regulations involving onsite sewage management, and prior to the development of many of the state of the art innovative systems utilized at present. Small lot sizes, location of domestic water supplies in close proximity to sources of possible contamination, inadequate construction design of domestic water supplies and onsite sewerage systems, and high artificial and natural ground water levels are contributing factors to the problems found to exist in Sunnyside. Said problems have been documented by surveillance and home loan evaluations conducted by this department and quoted in the 201 report.

Applications for new onsite sewerage disposal system are being disapproved by this department in areas of Sunnyside found not to meet Small Wastewater System Standards. However, this does not rectify the problems on existing lots where lot space is not available to adequately utilize standard or innovative onsite sewerage disposal systems.

Areas of Sunnyside have and are being annexed into the City of Cheyenne. This department agrees that annexation is the ultimate method of abating the water and sewer problems found to exist in Sunnyside. Until such time that annexation is accomplished, it is recommended that a moratorium be placed on Sunnyside prohibiting future development.

North Cheyenne: As was pointed out in the 201 Final Plan Report, North Cheyenne is experiencing some of the same problems found in Sunnyside. However, documented reports appear to indicate that such problems are more scattered and may be less common than those in Sunnyside. This may be due to high water tables not being present in North Cheyenne, and utilization of improved technology in construction of water and sewer facilities. Due to the small lot sizes existing in the North Cheyenne area, this department recommends that the moratorium for future development utilizing wells and septic systems be continued, and that annexation to the city be explored.

Other Fringe Areas of Cheyenne: Fringe areas or county pockets of land located in or near the city not specifically enumerated in Sunnyside or North Cheyenne particularly those along Yellowstone Road on west and between Prairie Avenue on the south and the hydrological gradient north of Storey Blvd., east to Powderhouse Road, and development east and west of Ridge Road from Summit Drive south to Rock Springs and west on Dell Range to Whitney Road, are also areas developed prior to development criteria being established. Small lots, questionable water supplies, and out moded septic systems are among the problems being discovered in these areas. In future planned expansions of services including water and sewer facilities these "pockets" should be considered as important as the present target areas of North Cheyenne and Sunnyside.

Ranchette Areas: Information contained in the 201 Final Report will be of benefit in supplementing information this department requires prior to and during development of Ranchette Subdivisions. At present soil surveys are being required on each subdivision prior to approval. Soil tests including percolation tests are required on each lot along with data involving depth to ground water and impervious material, prior to a permit being issued by this department for an onsite sewerage system. Also inspections prior to construction and at the time of installation are being conducted.

As the 201 report points out, all Ranchettes developed after June, 1979, are required to contain 2½ acres of gross area per lot. Adequate lot sizing is vital in that sufficient area for dilution and filtration of contaminates contained in sewage is needed.

Lot sizes with sufficient area also provides space for replacement of malfunctioning or out moded sewerage systems. The life expectancy for any onsite waste disposal system can not be considered to be indefinite. Lack of maintenance, physical and chemical abuses are among a few of the various factors that may shorten the life of a septic system. Therefore, land area per lot needs to be sufficient for replacement or repair of these systems.

The comments included in the 201 Final Report stating that soils rated severe, due to slopes and rock outcropping, may be modified for use as sites for onsite sewerage systems are valuable and valid statements. This information was not contained in previous preliminary reports.

Ranchette development; with increased lot sizes, subdivision reviews, pre and post construction inspection of onsite sewerage systems, and informational brochures provided to new home owners concerning maintenance of onsite sewerage systems, are a far cry from the problem areas previously mentioned. However, unless a well planned preventive maintenance program is followed, even with the best of planning and inspection, deterioration of onsite wastewater systems will result.

Preventive maintenance programs need to be developed which will properly place responsibility on the owner/user of small wastewater facilities.

Onsite Sewerage Disposal versus Sewerage Treatment Plants: Environmental Health has encountered numerous comments involving onsite sewerage disposal as related to water pollution. However, few comments are directed at Sewerage Treatment Plants. It should be pointed out that onsite disposal systems properly constructed and maintained are very viable and safe means of sewage disposal. Conversely it should also be mentioned that Sewerage Treatment Plants serving numerous people and industrial facilities can create a sense of security that may not be valid. When Sewerage Treatment Plants are overloaded, inadequately designed or not properly maintained/operated correctly, they can create an area of concentrated pollution. Such facilities may result in more damage to the environment than onsite systems.

Thank you for the opportunity to comment on the 201 Final Report.

Sincerely,

Donald E. Pack, R.S., Director
Div. of Environmental Health

DEP:ljw

CC: Walter Cockley, M.D., Director
Laramie County Commissioner, Shirley Francis

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

In reply refer to:

Attorney General

CHEYENNE, WYOMING 82002
PHONE 307 777-7841

STEVEN F. FREUDENTHAL
ATTORNEY GENERAL

M E M O R A N D U M

TO: Ed Baruth
Water Quality Engineering Evaluator

FROM: Steve Jones
Assistant Attorney General

DATE: April 29, 1982

SUBJECT: Water Rights concerns relative to New Sewage Treatment Facilities

This memo is being written in response to your questions concerning certain points raised by the Cheyenne 201 Working Paper, developed by Banner Associates. These points deal primarily with water rights issues raised by the contemplated transfer of effluent as part of the areawide sewage treatment plan now under study. I have attached specific comments to certain pages of the 201 Working Paper. These were areas on which you wanted me to focus. Also attached is a copy of a recent Wyoming Supreme Court case, Thayer vs. City of Rawlins, 594P.2d951. In addition to those specific comments, I wanted to make some general remarks about the current status of water law as it relates to the duties of municipalities to discharge their effluent. That area of the law is in flux. You could anticipate an argument from some lawyer on this subject, no matter what position you took.

In determining the rights of municipalities to use, reuse, and dispose of their water as they may see fit, it will be crucial to learn whether any of the water in question is imported water. Imported water is water which has been "developed" for use which would not have been available had it not been developed. "Trans-basin" water, i.e. water brought in from another drainage system, is the best example of imported water.

The case of Thayer vs. Rawlins indicates fairly definitely that municipalities may do whatever they please with imported water. Herman Noe of the Cheyenne Board of Public Utilities informs me that 60% of Cheyenne's water comes from the "Continental Divide system", 25% from the Crow Creek basin, and 15% from well fields (within the Crow Creek drainage). Thus, it would appear, under the Thayer ruling, that Cheyenne has a right to use, reuse, and dispose of 60% of its water as it may choose, without regard to the claims of downstream users. The water from the well fields is another unresolved legal question. Whether the State Engineer could somehow require where Cheyenne puts this portion of its water is very uncertain. It would certainly be treading on new legal ground. As for the 25% of Cheyenne's water from the Crow Creek basin, much of this may be able to be legitimately claimed by downstream users, as affecting their appropropriations. But even this is up in the air. It's possible that part of this water could be considered "developed" water, since much of it might evaporate before reaching downstream users, if it were not piped to Cheyenne.

You should note, by the way, that the case of Thayer vs. City of Rawlins was decided by a 3-2 vote. Any new cases coming before the Wyoming Supreme Court could have a different outcome since one justice voting with the majority in that case is no longer on the Court. The point is that these issues will be hotly debated no matter what, and it may be in the best interests of everyone concerned to negotiate an amiable agreement between all concerned parties so the time and expense of the lawsuit (s) may be avoided.

PAGE COMMENTS

Page V-73 "Transport Wastewater to City Facility"

It is stated that the Read family has an adjudicated water right, and that the Lummis ranch "uses this water". What was shown to me regarding the Read family is a contract between Winifred Read and the South Cheyenne Water and Sewer District. This is not an adjudicated water right. A check should be made with the Board of Control to see if either the Reads or Lummis's have adjudicated water rights. The verifying documents should be requested.

The Reads obviously will have to be dealt with by the South Cheyenne Water and Sewer District on the basis of their contract, if nothing else. This, by itself however, would not necessitate a hearing of any kind before the Board of Control.

V-109 "General"

The general discussion here is terribly oversimplified. Please see my general comments on this subject for more information.

As I mentioned there, the best legal guess as to what a municipality can do with imported water, is that it can do anything it wants with it.

V-109-110 "Treatment Plant Effluent"

Under the ruling of Thayer vs. Rawlins, it would appear to be very doubtful that the State Engineer could prohibit water reuse by the City of Cheyenne. Compensation of downstream users would therefore not be necessary as a result of reuse unless there exists contractual obligations otherwise binding the City, etc., to discharge so many mgd into Crow Creek.

V-12-13 "Pollutant Reduction"

Some additional questions need to be addressed. I agree that "a full investigation of water rights is recommended." But the first question to answer in this regard is whether any downstream users have any claims upon the volume of Cheyenne's effluent discharge, or upon a change in location for the discharge point of this effluent. The users may certainly make such claims, but that does not mean that such claims are valid (legally or historically).

Depending on certain factors, such as the actual percentage of Cheyenne's water that is imported water, or the resolution in the courts of this area of law, it may be that neither the State Engineer nor the Board of Control will have any authority over what the City of Cheyenne or the South Cheyenne Water and Sewer District do with their water.

The attorneys for these local governments should definitely be consulted for their legal opinions, since they will be the likely defenders of any actions taken by these governments.

Edith M. THAYER, a/k/a Edith Thayer, Individually and as Executrix of the Estate of Sid Thayer, Bruce L. Thayer, Joan L. Thayer, Herbert F. Luthy, Richard D. Howieson and Pearl Irene Howieson, Appellants (Some of defendants below),

v.

CITY OF RAWLINS, a Wyoming Municipal Corporation, Appellee (Plaintiff below).

No. 4991.

Supreme Court of Wyoming.

May 4, 1979.

City sought a judgment declaring that users of effluent water were not entitled to compensation for loss of that water. The District Court, Carbon County, Vernon G. Bentley, J., entered judgment for plaintiff, and defendants appealed. The Supreme Court, Rose, J., held that city had an unrestricted right to change its use and point of diversion of imported waters in creek and, in absence of an abandonment of same when it proposed to establish an aerated lagoon system at a location which would cause water to reach creek at a point below point where landowners were diverting effluent for irrigation, stock water and other purposes, landowners were not entitled to compensation, regardless of whether creek was a natural stream or whether landowners had acquired certificates of appropriations giving them priorities to effluent waters.

Affirmed.

Rooney, J., dissented and filed opinion in which Raper, C. J., joined.

1. Waters and Water Courses ⟹145

Rights in continuation of stream conditions existing at time of appropriations are generally vested in junior appropriators so as to entitle them to resist changes in points of diversion or use which materially affect their rights.

2. Waters and Water Courses ⟹144

An importer of water has right to reuse, successfully use, and make disposition of imported waters.

3. Waters and Water Courses ⟹140

One who by his own effort adds to supply of a stream is entitled to water even though a senior priority might be without water.

4. Waters and Water Courses ⟹143

A priority relates only to natural supply of stream at time of appropriation. W.S.1977, § 41–3–104.

5. Waters and Water Courses ⟹142

Concepts of priority apply to protect right of a senior appropriator to recapture waste and seepage water. W.S.1977, § 41–3–104.

6. Waters and Water Courses ⟹142

Lower landowner using waste and seepage water merely takes his chances as to future supplies no matter how long he uses such water. W.S.1977, § 41–3–104.

7. Waters and Water Courses ⟹151

In the imported water context giving the importer the restricted right to reuse, successfully use, and make disposition of imported waters, importer's right to do those things is not subject to abandonment insofar as lower landowners are concerned. W.S.1977, § 41–3–104.

8. Waters and Water Courses ⟹144

City had an unrestricted right to change its use and point of diversion of imported waters in creek and, in absence of an abandonment of same when it proposed to establish an aerated lagoon system at a location which would cause water to reach creek at a point below point where landowners were diverting effluent for irrigation, stock water and other purposes, landowners were not entitled to compensation, regardless of whether creek was a natural stream or whether defendants had acquired certificates of appropriations giving them priorities to effluent waters. W.S.1977, § 41–3–104.

9. Waters and Water Courses ⇐145

Even if waters below city from which landowners diverted effluent for irrigation, stock water and other purposes constituted a natural stream, where city, insofar as landowners were concerned, had unrestricted right to reuse, successfully use, and make disposition of waters by establishing an aerated lagoon system at a location which would cause waters to reach creek at a point below landowners' point of diversion, neither the State Engineer nor the Board of Control had jurisdiction to resolve the controversy respecting alleged entitlement of landowners to compensation from city for loss of effluent waters. W.S.1977, §§ 41–3–305, 41–3–615.

10. Waters and Water Courses ⇐145

Changes in points of discharge of sewage are not governed by same rules as changes in points of diversion.

11. Waters and Water Courses ⇐145

Statute providing a procedure for those wishing to change a water right and placing limitations on quantity of water that can be transferred was not comparable to require city to submit to a procedure that assumed that restrictions were permissible and, indeed, required where city had unrestricted right to reuse, successfully use, and make disposition of imported waters. W.S.1977, § 41–3–104.

12. Waters and Water Courses ⇐168

Statutory provisions requiring Board of Control approval prior to storage of water by a direct flow appropriator and requiring State Engineer approval prior to construction of a diversion dam to retain water above ten feet in height were inapplicable to temporary holding of effluent waters in five-foot holding ponds for water treatment purposes. W.S.1977, §§ 41–3–305, 41–3–615.

John A. MacPherson, and Catherine L. Dirck, Legal Intern, MacPherson, Golden & Brown, Rawlins, for appellants.

Steve D. Noecker, of Johnson & Noecker, Rawlins, and Frank J. Trelease, Stoughhouse, Cal., for appellee.

Before RAPER, C. J., and McCLINTOCK, THOMAS, ROSE and ROONEY, JJ.

ROSE, Justice.

This appeal concerns the rights of the defendant water users to effluent water discharged by the City of Rawlins. By virtue of water rights dating from 1900, the City of Rawlins has imported all of its municipal water supplies from the North Platte River and from Sage Creek, a tributary of the North Platte River. After using the water for municipal purposes, the City has historically discharged the resulting effluent into a channel, known as Sugar Creek, which connects with the North Platte River. In the past, the point of this discharge was above the points at which the defendants diverted the effluent for irrigation, stock water and other purposes. Defendants diverted the effluent pursuant to certificates of appropriations giving them priorities to the Sugar Creek effluent dating from 1914. To be in compliance with state and federal water-quality laws, the City must now meet certain minimum-quality standards before discharging water into Sugar Creek. To meet these standards, the City of Rawlins proposes to establish an aerated lagoon system at a location which will cause the purified water to reach Sugar Creek at a point below the defendants' point of diversion. In an effort to determine the legal effect of this proposal, the City sought and was granted a judgment declaring that the defendants were not entitled to compensation for the loss of this water. We will affirm the district court's judgment.

Certain aspects of this case justify a full and detailed explanation of the facts. According to an Agreed Statement of Facts, the City acquired water rights, in 1923, to water originating at the headwaters of Sage Creek, a tributary of the North Platte River. Thereafter, water wells—previously providing the City with water—were abandoned, and the City became totally dependent on the Sage Creek-North Platte water.

This water, which is piped some 32 miles to the City, was supplemented by additional water rights obtained in 1966. The remainder of the water supplied to the City is by virtue of a water right obtained by assignment from the Union Pacific Water Company in 1964. This water is transported some 16 miles from the North Platte River to the City through another pipeline.

It is agreed that Sugar Creek consists of a channel which heads some 16 miles west of Rawlins. The channel parallels the south side of the Union Pacific Railroad from a point west of the City to a point about 4 miles east of Rawlins, where it bends north across the railroad and meanders northeasterly, eventually emptying into the Platte River. Originally, the channel of Sugar Creek was used as an open sewer for parts of Rawlins. Subsequently, sanitary sewer mains were installed and the sewage was carried to a point east of Rawlins where it was again disgorged into the Sugar Creek channel. Since the City began disgorging its waste waters into Sugar Creek, the defendants perfected certificates of appropriations, claiming the right to use water out of Sugar Creek at points below where the City disgorges its sewage.

Evidence adduced at trial indicates that whatever flow of water occurred in Sugar Creek below the City was attributable to the City's discharge of sewage. From April to October of each year, this discharge would amount to a daily average of 2.76 cubic-feet-per-second of water. Above the City, a flow occurred in Sugar Creek only after a rainstorm or during snow-melt. The City's expert classified Sugar Creek above the City as an ephemeral stream, or one that runs only in direct response to rainfall and high snow-melt events and not as a result of ground-water flow. In the 1930's, a diversion dam was constructed—apparently without approval of State authorities—which directs this flow into an area known as Hogback Lake. At trial, the City stipulated that it would not object to actions taken to prevent this flow from entering Hogback Lake or to the restoration of the natural channel of Sugar Creek for this purpose.

It is noted that the State of Wyoming was originally a named party to this suit. At trial, the City and the State of Wyoming stipulated that the State would withdraw from the action conditioned on the City's agreement that it would continue to discharge intermittently into Sugar Creek a majority of the sewage effluent it historically discharged into Sugar Creek, and that such waters would be available to water users downstream from the City's point of discharge, as well as to satisfy effluent appropriations in the North Platte River. When asked by the court whether this withdrawal carried the connotation that the State Engineer didn't want to administratively be involved in this matter, the attorney for the State responded that the State had jurisdiction over the use of the natural waters of the State and that this would go to the City's use of the water in question.[1]

It is also noted that the City, in 1922, conveyed by deed all rights to water passing through the sewer pipe and reaching a 20-acre parcel of land, presently owned by Walter Olson and Olson Sisters Corporation, described in a State Engineer Certificate of Appropriation. The City admitted its obligation under this deed.

Subject to the above-mentioned stipulations, the district court found that Sugar Creek was not a natural stream and, therefore, the defendants' appropriations were invalid and did not entitle them to compensation by reason of the City's proposed actions. The court found that the City had the power to recapture all of its future sewage for the purpose of disposing of in it any manner it deemed appropriate. Finally, the court found that the State Engineer had no jurisdiction over the Rawlins facilities or the water in question, and that his

1. We note at this point that due to the unique circumstances of this case—namely, that the defendants' use is dependent solely on the water imported by the City—there is no reason to apply the indispensable-party analysis contained in *State v. Husky Oil Company of Delaware*, Wyo., 575 P.2d 262 (1978).

approval was not required for the planned changes.

Defendants state their position as follows:

"I. The State Engineer and State Board of Control have jurisdiction over the proposed Rawlins facilities and waters of Sugar Creek which must be invoked before judicial determination is proper.

"II. Defendants have vested property rights that are established in Wyoming water law and are entitled to compensation before those water rights are taken away."

ENTITLEMENT TO COMPENSATION[2]

Defendants premise their claim to compensation on the belief that Sugar Creek below the City of Rawlins has, due to the passage of a long period of time, become a natural stream subject to appropriation, thus entitling the defendants to protections afforded to other holders of water rights in the state.

Defendants also assert that Sugar Creek *above* the City is a natural stream. Frankly, we fail to see the importance of classifying the portion of Sugar Creek that lies above Rawlins. The extent to which the defendants have a right or interest in this upper flow of water is not at issue in this case. To the extent that they have a right to such waters—a question we do not here decide—the City has agreed not to interfere with a restoration of the natural channel of this portion of Sugar Creek. The importance of classifying Sugar Creek above the City is further lessened when it is realized that the water, for which defendants seek compensation, is derived solely from discharges that have their source in the North Platte River and tributaries thereof. These waters are entirely distinct from those, if any, originating in the Sugar Creek drainage basin above the City of Rawlins.

While it is true that these defendants have acquired certificates of appropriations, indicating a right to waters contained in Sugar Creek, we find that the validity of these permits—for purposes of protection from the City's proposed actions; and compensation—turns on an analysis of the parties' relative rights to the use of these imported waters. If the City, insofar as these defendants are concerned, has the unrestricted right to change its use and the point of discharge of these imported waters, then it matters little that these defendants hold water permits or have relied on these waters in the past for irrigation and other purposes. The issue of whether Sugar Creek has become a natural stream loses its importance in this context. If the City has the unrestricted right referred to above, then—with the possible exception of its relationship to certain jurisdictional matters—the determination of whether Sugar Creek below the City is a natural stream would be a resolution of a nonissue.

More than fifty years ago, this court stated, in *Wyoming Hereford Ranch v. Hammond Packing Company*, 33 Wyo. 14, 236 P. 764, 772 (1925):

> ". . . Even in this state, where the conservation of water for irrigation is so important, we would not care to hold that in disposing of sewage the city could not adopt some means that would completely consume it. It might, we think, be diverted to waste places, or to any chosen place where it would not become a nuisance, without any consideration of the demands of water users who might be benefited by its disposition in some other manner. . . ."

While we may not rely on the *Wyoming Hereford Ranch* decision for a disposition of the present case—due to significant factual distinctions—it is somewhat prophetic with respect to the clash, between concepts of western water law and the directives of environmental-protection statutes, now before us. We will not, however, attempt to decide all of the potential questions that are bound to arise as the demands for cleaner

2. We will discuss the defendants' issues in reverse order, because our holding on the second issue is largely dispositive of the first issue.

environment begin to impinge on the availability of sufficient supplies of water. For example, we are not asked in this case to theorize with respect to the rights of water users on the North Platte River in the event that the City had gone ahead with its original plan to entirely consume, through treatment, the waters it imports from the North Platte and its tributaries. These questions and others related thereto are bound to arise, but it is important to understand that they are not now before the court. See, gen., Comment, "Water Law—Cessation of Return Flow as a Means of Complying With Pollution Control Laws," 12 Land & Water L.Rev. 431 (1977); and Muys, "Quality v. Quantity: The Federal Water Pollution Control Act's Quiet Resolution in Western Water Rights Administration," 23 Rocky Mt.Min.L.Inst. 1013 (1977). As a result, our discussion and disposition of this case will be narrowly drawn.

[1, 2] The fundamental question becomes: Do the defendants have a right to compensation for a loss occasioned by the City's change in the point of discharge of imported waters? It has been stated that generally junior appropriators have vested rights in a continuation of stream conditions existing at the time of their appropriations, thus entitling them to resist changes in points of diversion or use which materially affect their rights. See, *Farmers Highline Canal & Reservoir Co. v. City of Golden*, 129 Colo. 575, 272 P.2d 629 (1954); and § 41-3-104, W.S.1977. However, an importer of water—at least insofar as these defendants are concerned—has the right to reuse, successively use and make disposition of imported waters. See, *City and County of Denver Board of Water Commissioners v. Fulton Irrigating Ditch Company*, 179 Colo. 47, 506 P.2d 144 (1972). Even though, at the time of the *Fulton Irrigation Ditch* decision, there was a statute authorizing the conclusion reached, the Colorado Supreme Court opined that the rule would be the same without the statute, subject to contrary contractual obligations. 506 P.2d at 147.

[3, 4] The right of the City to use such imported waters finds its roots in the common law of property and the Puritan ethic: One who by his own effort adds to the supply of a stream, is entitled to the water even though a senior priority might be without water. A person should reap the benefit of his own efforts, and a priority relates only to the *natural* supply of the stream at the time of appropriation. Clark, "Background and Trends in Water Salvage Law," 15 Rocky Mt.Min.L.Inst. 421, 434-444 (1969).

[5, 6] These concepts are not new to Wyoming water law, since they have been applied to protect the right of a senior appropriator to recapture waste and seepage water. See, *Binning v. Miller*, 55 Wyo. 451, 102 P.2d 54 (1940); and *Bower v. Big Horn Canal Association*, 77 Wyo. 80, 307 P.2d 593 (1957). See gen., Clark, supra, at 459-460; *Burkart v. Meiberg*, 37 Colo. 187, 86 P. 98 (1906); *Green Valley Ditch Co. v. Schneider*, 50 Colo. 606, 115 P. 705 (1911); and *Tongue Creek Orchard Co. v. Town of Orchard City*, 131 Colo. 177, 280 P.2d 426 (1955). The lower landowner using such water merely takes his chances as to future supplies, no matter how long he uses such water. *Binning v. Miller*, supra, 102 P.2d at 60.

[7, 8] Defendants seem to want this court to declare that the City has abandoned its right to make a change in the point of discharge of these imported waters. We indicated in *Binning v. Miller*, supra, that if the senior appropriator had allowed the lower landowner to use waste water for 35 years, but then legitimately began to use it himself, the lower landowner would have no right to complain—"The water is always different from year to year." 102 P.2d at 62. See, also, *Stevens v. Oakdale Irrigation District*, 13 Cal.2d 343, 90 P.2d 58 (1939). This question, in its broad sense, was raised but not answered in the *Fulton Irrigation Ditch* case, supra. See, gen., Williams, "Optimizing Water Uses: The Return Flow Issue," 44 U.Colo.L.Rev. 301, 318-321 (1973). We hold that in the imported-water context—which gives the importer the unre-

stricted right to reuse, successively use and make disposition—the importer's right to do these things is not subject to abandonment insofar as these defendants are concerned. It must be remembered that any other holding would be inconsistent with the fact that the defendants depend entirely on the City's sufferance—it is always free to terminate the importation. Under such circumstances, we are reluctant to declare an abandonment. This is particularly true in light of the fact that the City, as early as 1922, recognized its right to convey its rights in the effluent by deed. We would suggest that such a transaction places the user in a much more solid position. See, Williams, supra, at 321; and *Wyoming Hereford Ranch v. Hammond Packing Co.*, supra.

JURISDICTION

Defendants assert that the State Engineer and the State Board of Control have authority to resolve their conflict with the City under Article 8, Wyoming Constitution [3], and three sets of statutory provisions: (1) Section 41-3-104, W.S.1977,[4] dealing with changes of use or places of use; (2) section 41-3-305, W.S.1977,[5] deal-

3. Article 8, Wyoming Constitution, provides:

"IRRIGATION AND WATER RIGHTS

"Sec. 1. *Water is state property.*—The water of all natural streams, springs, lakes or other collections of still water, within the boundaries of the state, are hereby declared to be the property of the state.

"Sec. 2. *Board of control.*—There shall be constituted a board of control, to be composed of the state engineer and superintendents of the water divisions; which shall, under such regulations as may be prescribed by law, have the supervision of the waters of the state and of their appropriation, distribution and diversion, and of the various officers connected therewith. Its decisions to be subject to review by the courts of the state.

"Sec. 3. *Priority of appropriation.*—Priority of appropriation for beneficial uses shall give the better right. No appropriation shall be denied except where such denial is demanded by the public interests.

"Sec. 4. *Water divisions.*—The legislature shall by law divide the state into four (4) water divisions, and provide for the appointment of the superintendents thereof.

"Sec. 5. *State Engineer.*—There shall be a state engineer who shall be appointed by the governor of the state and confirmed by the senate; he shall hold his office for the term of six (6) years, or until his successor shall have been appointed and shall have qualified. He shall be president of the board of control, and shall have general supervision of the waters of the state and of the officers connected with its distribution. No person shall be appointed to this position who has not such theoretical knowledge and such practical experience and skill as shall fit him for the position."

4. Section 41-3-104, W.S.1977, provides:

"(a) When an owner of a water right wishes to change a water right from its present use to another use, or from the place of use under the existing right to a new place of use, he shall file a petition requesting permission to make such a change. The petition shall set forth all pertinent facts about the existing use and the proposed change in use, or, where a change in place of use is requested, all pertinent information about the existing place of use and the proposed place of use. The board may require that an advertised public hearing or hearings be held at the petitioner's expense. The petitioner shall provide a transcript of the public hearing to the board. The change in use, or change in place of use, may be allowed, provided that the quantity of water transferred by the granting of the petition shall not exceed the amount of water historically diverted under the existing use, nor exceed the historic rate of diversion under the existing use, nor increase the historic amount consumptively used under the existing use, nor decrease the historic amount of return flow, nor in any manner injure other existing lawful appropriators. The board of control shall consider all facts it believes pertinent to the transfer which may include the following:

"(i) The economic loss to the community and the state if the use from which the right is transferred is discontinued;

"(ii) The extent to which such economic loss will be offset by the new use;

"(iii) Whether other sources of water are available for the new use.

"(b) In all cases where the matter of compensation is in dispute, the question of compensation shall be submitted to the proper district court for determination."

5. Section 41-3-305, W.S.1977, provides:

"The holder or owner of an adjudicated water right to the direct use of the natural unstored flow of any surface stream of the state may store such direct flow so long as no other Wyoming appropriator or user is injured or affected thereby. Prior to the commencement of the storage of water under a direct flow water right, the appropriator shall submit a request for such storage in writing to the state engineer and shall obtain the approval of the state board of control. The state board of control may permit storage at any time so long as there is no intering with the storage of direct-flow water rights; and (3) section 41-3-615, W.S.1977,[6] dealing with the construction of diversion dams.

These propositions are, in part, based on the belief that Sugar Creek is a "natural stream" above and below the City of Rawlins. As noted previously, we view it as irrelevant that Sugar Creek above the City might be considered a "natural stream." To the extent that it is somehow important, the defendants are faced with an adverse factual finding which we are not inclined to overrule.

[9] With regard to Sugar Creek below the City, the defendants may well be correct that it is a natural stream. See, *Binning v. Miller*, supra, 102 P.2d at 60. Assuming, arguendo, that this is true, does this automatically give the State Engineer or the Board of Control jurisdiction over this controversy? We think not. As noted previously, the City—insofar as these defendants are concerned—has the unrestricted right to reuse, successively use, and make disposition of the imported waters in question. Unless there is some statutory provision to the contrary, there is nothing for the State Engineer or the Board to consider—there is only an application of certain legal principles which is within the function of the courts.

We turn, then, to the statutory provisions which purportedly vest the State Engineer or Board of Control with primary jurisdiction over the City's proposed actions. Defendants claim that the City's water-treatment proposal constitutes either a change or expansion in use—because the water will be used as a purifying agent, instead of only as a flushing agent—or a change in the place of use, because the sewage will be transported for treatment to a place outside the city limits. The City, on the other hand, contends that there will be no change in use since the use will still be for municipal purposes, and that the place of use will remain with the City of Rawlins. The only change, according to the City, is a change in the place of discharge.

[10] The difficulty in attempting to classify the changes required by water-pollution-control laws has been noted. Comment, supra, 12 Land & Water L.Rev. 431, 448. The Colorado Supreme Court has indicated that changes in points of discharge of sewage are not governed by the same rules as changes in points of diversion. *Metropolitan Denver Sewage Disposal District No. 1 v. Farmers Reservoir and Irrigation Company*, Colo., 499 P.2d 1190, 1193 (1972). See, *City of Boulder v. Boulder & Left Hand Ditch Co.*, Colo., 557 P.2d 1182, 1185–1186 (1976). This conclusion has, in turn, been severely criticized. Williams, supra, at 304–311. We find no need, however, to put a label on what the City of Rawlins proposes to do, in order to determine whether the City must file a petition under § 41-3-104, supra.

[11] The purpose of § 41-3-104, supra, is to provide a procedure for those wishing to change a water right *and* to place limitations on the quantity of water that can be transferred. *Basin Electric Power Cooperative v. State Board of Control*, Wyo., 578 P.2d 557, 561 (1978). We must ask why the City's proposal should be subjected to these procedures. The manifest result of a § 41-3-104 proceeding is the entry of a Board of Control order limiting the amount of water transferred by a change in use or a change in the place of use. Insofar as these defendants are concerned, we have already held that the City has the *unrestricted* right to reuse, successively use and make disposition of these imported waters. If these rights are not subject to restriction, it

ference with existing water rights or uses. The state engineer is authorized and empowered to prescribe such rules and regulations as may be necessary or desirable to enable him to effectively administer the provisions of this section."

6. Section 41-3-615, W.S.1977, provides:

"Duplicate plans for any diversion dam across the channel of a running stream, above five (5) feet in height, or of any other diversion dam intended to retain water above ten (10) feet in height, shall be submitted to the state engineer for his approval, and it shall be unlawful to construct such a diversion dam until the said plans have been approved."

would be anomalous to require the City to submit to a procedure that assumes that restrictions are permissible and, indeed, required. As a result, we hold that the State Engineer and Board of Control have no jurisdiction, by virtue of § 41-3-101, supra, over the controversy between these parties.

[12] Next, defendants would rely on § 41-3-305, supra. This statute requires Board of Control approval prior to the storage of water by a direct-flow appropriator. Defendants assert this will occur by virtue of the City's impoundment of the sewage in aerating lagoons for treatment. Simply stated, we find no indication of legislative intent that this provision should apply to the temporary holding of effluent waters for water-treatment purposes, especially when all of those waters are imported.

Finally, defendants rely on § 41-3-615, supra. This statute requires State Engineer approval prior to the construction of a diversion dam "to retain water above ten (10) feet in height." The uncontradicted evidence at trial was that, depending on how the holding ponds were constructed, water would be retained at an average height of five feet. Notwithstanding the fact that we fail to see how this provision relates to the question of compensation, the defendants have failed to prove its applicability.

We hold that the State Engineer and Board of Control have no jurisdiction of the controversy between these parties, nor do we see any reason in this case to draw upon the expertise of those agencies.

Affirmed for the reasons stated herein.

ROONEY, Justice, dissenting, with whom RAPER, Chief Justice, joins.

I dissent. I agree with the contention of the defendants that this matter is prematurely in the courts, and that the board of control should first apply its expertise in passing on the issues.

"Beneficial use" of water is paramount. Water is a precious commodity in this state. It has always been so, but with the advent of new uses, the changes in the relative importance of the varied uses, and the increased demands on its use, the necessity to achieve beneficial use of every drop is an overriding concern. As stated by Justice Raper in his dissent in *State By and Through Christopulos v. Husky Oil*, Wyo., 575 P.2d 262, 275 (1978):

> "The concept of beneficial use may thus be characterized as the ultimate foundation and measure of every water right held under the priority appropriation system prevailing in this and other arid states. *Budd v. Bishop*, Wyo.1975, 543 P.2d 368, 373; *Lincoln Land Co. v. Davis*, U.S.D.C.Wyo.1939, 27 F.Supp. 1005, 1008; *McNaughton v. Eaton*, 1952, 121 Utah 394, 242 P.2d 570. * * *"

All issues involving water must be controlled by this concept of beneficial use. The concept is simple in principle, but it is complex in application. This complexity and the continuing and long time future ramifications resulting from implementing it mandate attention and direction by those who have experience and expertise in the area.

The necessary expertise and experience in water matters are with the board of control and the office of the state engineer.[1] They are conversant with the new problems occasioned by increased industrial and municipal needs for water; additional use of water for recreational purposes; transbasin diversions; interstate aspects of water availability and control; intrusion into underground acquifers; diversions of underground streams; development of chemical and physical methods for control of initial flow, for control of return flow and for control of storage of water; pollution; and waste. And they are conversant with the interplay of these new problems on customary and historical use of water.

The overriding importance of beneficial use of water and the primary authority of the board of control and of the state engineer over such use have recognition in our

1. Both the board of control and the office of the state engineer are constitutionally established. The state engineer is a member and president of the board of control. See §§ 2 and 5 of Art. 8, Wyoming Constitution.

constitution. Section 31 of Art. 1, Wyoming Constitution,[2] provides:

> "Water being essential to industrial prosperity, of limited amount, and easy of diversion from its natural channels, its control must be in the state, which, in providing for its use, shall equally guard all the various interests involved."[3]

All of Art. 8, Wyoming Constitution, has to do with irrigation and water rights.[4] Section 3 of Art. 8, Wyoming Constitution, provides that "[p]riority of appropriation for beneficial uses shall give the better right." Portions of § 2 of Art. 8, Wyoming Constitution, are emphasized as follows:

> "There shall be constituted a board of control, to be composed of the state engineer and superintendents of the water divisions; which shall, under such regulations as may be prescribed by law, have the supervision of the waters of the state and of their *appropriation, distribution and diversion*, and of the various officers connected therewith. Its decisions to be *subject to review by the courts* of the state." (Emphasis supplied.)

The emphasized portions of the foregoing reflect two things: The supervision of the board of control in appropriation, distribution and diversion of water is primary, and the decisions resulting from such supervision are subject to *review* by the courts.

Considering these two things in reverse order, this court has held that this section of the constitution directs that "[t]he jurisdiction of the courts is (aside from appeals) confined to determine the rights of the parties in individual cases to the extent that the board has not acted." *Campbell v. Wyoming Development Co.*, 55 Wyo. 347, 100 P.2d 124, 134, reh. den. 102 P.2d 745 (1940). We said in *White v. Wheatland Irrigation District*, Wyo., 413 P.2d 252, 258–259 (1966):

> "* * * The board has broad powers, direct and implied. [Citations.] It has long been recognized that orders of the board establishing such rights are clothed with the dignity of decrees entered by the courts. [Citation.]
>
> * * * * * *
>
> "* * * the board is no doubt better equipped than a court to determine such intricate and involved matters. [Citation.]
>
> "* * * adjudicated water rights of long standing * * * will not be set aside unless the proof of just cause is 'clear, cogent and convincing,' [Citation.]"

See *Farm Investment Co. v. Carpenter*, 9 Wyo. 110, 61 P. 258 (1900); *Kearney Lake, Land & Reservoir Company v. Lake DeSmet Reservoir Company*, Wyo., 475 P.2d 548 (1970), supplemented 487 P.2d 324 (1971); *Hamp v. State*, 19 Wyo. 377, 118 P. 653 (1911). In *Laramie Irrigation & Power Co. v. Grant*, 44 Wyo. 392, 13 P.2d 235, 240 (1932) the court said:

> "* * * The term 'stream' has not been defined by the Legislature. Nor is there any provision that, in order for the board of control to proceed to determine or adjudicate water rights, it must proceed to determine those of a whole watershed or of a whole stream at the same time. Taking all these facts into consideration, we think that the board was given a discretion in deciding the meaning of the term 'stream.'"

This is not to say that the courts are without jurisdiction in water matters. *Anita Ditch Company v. Turner*, Wyo., 389 P.2d 1018 (1964); *Simmons v. Ramsbottom*, 51 Wyo. 419, 68 P.2d 153 (1937); *Farm Investment Co. v. Carpenter*, supra. However, except in those instances where the unusual or emergency nature of the matter dictates otherwise, a party should be compelled to obtain final available administrative action

2. Art. 1, Wyoming Constitution, pertains to the "Declaration of Rights."

3. This section places all "water" under control of the state. Section 2 of Art. 8, Wyoming Constitution, gives supervision of "the waters of the state" to the board of control. Section 5 of Art. 8, Wyoming Constitution, gives "general supervision of the waters of the state" to the state engineer. Section 1 of Art. 8, Wyoming Constitution, makes some of the waters the "property of the state," i. e., the "water of all natural streams, springs, lakes or other collections of still water."

4. Art. 8 is set out in full in footnote 3 of the majority opinion.

before seeking judicial action. *State ex rel. Mitchell Irr. Dist. v. Parshall*, 22 Wyo. 318, 140 P. 830 (1914). The purpose of such was set forth in *United States v. Zweifel*, 10th Cir., 508 F.2d 1150, 1156 (1975), cert. den. sub nom. *Roberts v. United States*, 423 U.S. 829, 96 S.Ct. 47, 46 L.Ed.2d 46, reh. den. 423 U.S. 1008, 96 S.Ct. 438, 46 L.Ed.2d 379:

> "* * * 'When there is a basis for judicial action, independent of agency proceedings, courts may route the threshold decision as to certain issues to the agency charged with primary responsibility for governmental supervision or control of the particular industry or activity involved.' [Citations.] The principal reason behind the practice of so routing certain issues to agency tribunals is the need for orderly and sensible coordination of the work of agencies and of the courts. 'Whether the agency happens to be expert or not, a court should not act upon subject matter that is peculiarly within the agency's specialized field without taking into account what the agency has to offer, for otherwise parties who are subject to the agency's continuous regulation may become the victims of uncoordinated and conflicting requirements.' 3 Davis, Administrative Law Treatise § 19.01 (1958)."

In the past, the water and the water rights here involved were subject to board action in determination of beneficial use. Appropriations were granted on Sugar Creek. The board has, therefore, determined it to be a stream. The city's appropriation was obtained from the board. It cannot be said that the board has not acted on the core of the problem—beneficial use. It should be permitted to augment that action and apply its expertise to the issues here presented. In the words of Justice Raper in *State By and Through Christopulos v. Husky Oil*, supra:

> "* * * This court has encouraged use of the board of control and mentioned, '[t]he ludicrous spectacle of learned judges solemnly decreeing water rights.' *Louth v. Kaser*, Wyo.1961, 364 P.2d 96." 575 P.2d at 282.

The majority opinion has here invalidated certificates of appropriation issued by the board of control—and this is done in a proceeding which is collateral to the proceeding in which the appropriations were granted. The majority opinion has here countermanded the determination by the board of control that Sugar Creek is a stream—again in a collateral proceeding to that determination. These determinations by the board should have been subject to reexamination and reanalysis by the board, whereby its expertise could be applied to gauge the effect of new developments on them and to insure maximum beneficial use of the waters involved. The result could well be the same as that reached by the majority opinion. But the application of the expertise of the board may have identified serious shortcomings in this result. Whatever result reached, it would be subject to court *review*. The court could approve or disapprove, but the court would have the benefit of the expertise of the board. It may not agree with the application of the expertise, but the decision of the courts would be made in the manner circumscribed by statute, court rules and precedent in the normal legal context. Review would be in conformity with principles established for appeal and error.

The other item emphasized in the foregoing quotation from § 2, Art. 8 concerns that which is placed under the supervision of the board of control, i. e, "the waters of the state and of their appropriation, distribution and diversion." This supervision is extensive. It is not limited to appropriation of water—although historically appropriation and that immediately incident thereto was the first task for the board and was a major interest of the board. The constitutional provision directs five areas for such supervision: (1) generally of the waters of the state; (2) appropriation of such; (3) distribution of such; (4) diversion of such; and (5) of the various officers connected therewith.[5] This direction is not one which may be waived by the board or by the state

5. This last area mandates the legislature to centralize control of all water matters in the board, rather than in some other independent agency or officer.

engineer. Nor can they avoid the constitutionally imposed obligations by delay in favor of court disposition before taking action. The duties are not permissive. They are mandatory.

Supervision of "distribution and diversion" includes supervision of water which is not appropriated, and it includes supervision of appropriated water at times and places other than those involved at the initial distribution or diversion. It includes supervision of individual appropriations, of transbasin appropriations, of trans-state deliveries, of underground water—in short, of all water. *Sussex Land & Live Stock Co. v. Midwest Refining Co.*, 8th Cir. 1923, 294 F. 597, 603, on appeal from U.S.D.C., Wyoming, has been said to stand for the proposition that, pursuant to §§ 1 and 3 of Art. 8 of the Wyoming Constitution, a priority of right in water includes the quality as well as the quantity. Quality is a proper concern of the board of control. In the Wyoming Environmental Quality Act, § 35–11–101 et seq., W.S.1977 the legislature was careful to preserve the preeminence of the jurisdiction of the state engineer and the board of control in water matters by providing:

"Nothing in this act:

* * * * * *

"(c) Limits or interferes with the jurisdiction, duties or authority of the state engineer, the state board of control, * * *." Sec. 35–11–1104, W.S.1977.

The majority opinion overlooks this primary jurisdiction and the extensive control of quantity and quality of water in the board of control for the purpose of securing beneficial use of it. The majority opinion lays its cornerstone on the proposition that an importer of water has the unobstructed right to reuse, successively use and make disposition of imported waters. The importer, then, would have supervision over the appropriation, distribution and diversion of such water. Imported water is no less precious than any other kind of water. The mere fact that it is transported from one basin to another does not make it more subject to waste, more subject to the whims of any private citizen, less subject to the requirement of beneficial use, or less subject to the constitutional supervision of the board of control. If there is case law to the contrary, I would reverse it. If there is statutory law to the contrary, I would hold such to be unconstitutional.

Since the supervision by the board of control is subject to court review, it cannot be arbitrary or characterized by an abuse of discretion. It is also subject to regulations prescribed by law. Section 2, Art. 8, Wyoming Constitution.

Constitutional aspects of the issues here presented make proper the conclusions reached in this dissent. But the application of legislative enactments relative to permit requirements, beneficial use, relative rights of appropriators, changing and enlarging use, preferred uses, storage and reservoir requirements, and change in points of diversion and in place of use would result in the same. In support thereof, it is sufficient for the purpose here to refer to the dissents of Justices Raper and Guthrie in *State By and Through Christopulos v. Husky Oil*, supra,[6] wherein the situation is fully analyzed and properly reasoned.

Neither these constitutional aspects nor these statutory aspects are addressed to conclusion in the majority opinion. It stops short of considering the issues of change in use or change in place of use. And it does not direct referral of such issues to the board of control. It backs into its holding. It does not concern itself with the rights of *all* users to the water in question. The loss of use of water by appellants is to it immaterial. It does not address the question of whether or not the city had *relinquished control of the water* discharged over the years into Sugar Creek. If it were a relinquishment, rather than reuse or recapture

6. This dissenting opinion is not only in conformity with the dissents in *State By and Through Christopulos v. Husky Oil*, supra, it is not contrary to the majority opinion therein. The majority opinion did not address the substantive issues involved, but remanded the case for joinder of the Board of Control and the City of Cheyenne as necessary parties.

before losing control, there would be no question but that Sugar Creek is a stream and that appellants' appropriations were independent of the city's use. See *Lasson v. Seely*, 120 Utah 679, 238 P.2d 418 (1951) where the court held that a deposit of sewage back into a stream channel after having been used to full extent intended by the city becomes part of state water and again subject to appropriation on the basis of priority.

The majority opinion was predicated entirely on the proposition that an importer of water has the unrestricted right to change its use and point of discharge without reference to beneficial use. Its reliance on *Bower v. Big Horn Canal Association*, 77 Wyo. 80, 307 P.2d 593 (1957) and on *Binning v. Miller*, 55 Wyo. 451, 102 P.2d 54 (1940) to sustain this proposition is without recognition of the fact that the seepage water recaptured by the appropriators in those cases was water escaping inadvertently from them and was not water which was intentionally abandoned and to which control was relinquished, as in this case. Likewise, reliance on *City and County of Denver Board of Water Commissioners v. Fulton Irrigating Ditch Company*, 179 Colo. 47, 506 P.2d 144 (1972) is misplaced. The Colorado constitutional and statutory provisions relative to procedural water law are so different from those of Wyoming that they cannot logically be used as precedent. Further, the many problems resulting in Colorado from the transbasin diversion involved in that case are to be avoided in Wyoming, if possible.

Once the relinquishment by the city of the control of the discharge into Sugar Creek is recognized, it follows that Sugar Creek is a natural stream and that appellants' appropriations are valid and vested. The city project would then be subject to the statutes relative to change of use and change in place of use. The board of control would make the determination relative thereto on the basis of beneficial use.

The parties to this action spent considerable effort addressing the issue of whether or not Sugar Creek is a natural stream. The desirability and necessity of bringing available expertise to this issue is obvious. As already indicated, the board has recognized it to be such in the past, issuing certificates of appropriation from it. It appears as a stream on maps of the U.S. Geological Survey. Also as already indicated, the board has been given discretion in deciding the meaning of the word "stream." *Laramie Irrigation & Power Company v. Grant*, supra. In making its determination, the board may apply that set out in one case decided by this court as the elements of a natural stream, i. e., consisting of a channel, well-defined bed and banks, and a current of water. *State v. Hiber*, 48 Wyo. 172, 44 P.2d 1005 (1935), but it should note the court cautioned at p. 1009 that:

> "* * * Too much stress ought not, perhaps, be placed upon any one of the elements mentioned, and all should be given due consideration. * * *"

The board could note that the court recognized a "water course" created by man to be a natural stream in *Binning v. Miller*, supra. A composite dictionary definition of the words "natural" and "stream" could be "water, on or under the surface, pertaining to, produced by or conferred by nature (in contrast to that which is artificial) which has a flow or a current." The board might find that Sugar Creek is no longer a natural stream—or, perhaps, never was such. The definition used in the majority opinion of an ephemeral stream, i. e., one that runs only in direct response to rainfall and high snow-melt, is not very helpful. It would apply to the Mississippi River. An ephemeral stream (one running for a very short time) could be a natural stream. In our arid country, there are many of them. The point is that the board of control should exercise its expertise in making this determination. It would then be subject to court review.

There are other aspects of this matter which should be subject to the board's expertise and determination before court review.

The board may pass on the extent to which principles and procedures applicable to water used for irrigation should be also applied, or should not be applied, to water used for municipal purposes under the cicumstances here present. For example, return flow from irrigation is not the same as that resulting from municipal use. Return flow from irrigation is usually subsurface and passes through many channels, generally very small in size. The return flow from a municipality is generally a collection of discard from sanitary and storm sewers discharged in comparatively large volume in one or few channels. The considerations under which the two types of return flow are treated will probably differ substantially.

Beneficial use of appropriations for irrigation can be controlled by setting a limit in relation to the amount of land to be irrigated. This limit is statutorily set at one cubic foot per second for seventy acres. Section 41-4-317, W.S.1977.[7] The use and reuse of the one cubic foot per second on the seventy acres before allowing return flow is proper if it is beneficially used. Even the limit cannot be taken if all of it is not beneficially used. *Quinn v. John Whitaker Ranch Co.*, 54 Wyo. 367, 92 P.2d 568 (1939); *Budd v. Bishop*, Wyo., 543 P.2d 368 (1975); *Farm Investment Co. v. Carpenter*, supra. The appropriation, limitation, and beneficial use is controlled by observation and by measurement at the points of diversion and elsewhere. Here again appropriations for municipal use have different aspects. A municipal appropriation can exceed that for which the water can be put to beneficial use at the time of appropriation. *Holt v. City of Cheyenne*, 22 Wyo. 212, 137 P. 876 (1914). Domestic uses vary from day to day. They continue throughout the year, not only during an irrigation season. They do have seasonal variations. Some municipalities grow in size, some diminish. Municipalities have constitutional authority to acquire water rights of prior appropriators by eminent domain—paying just compensation therefor.[8]

These things are mentioned only to emphasize the necessity and desirability of having the board first consider such matters. Thus, uniformity and coordination in all water uses can better be obtained in addition to the application of expertise and experience to the problems.

Finally, the board and the state engineer should be addressing the varied water problems occasioned by recent changes in population and industry in the state. They cannot do so if they are bypassed by premature court action. One appropriator of an irrigation right cannot transfer it to another appropriator for an industrial right without full analysis by the board and the state engineer of the result on beneficial use. The same is true of a transfer by a municipality to an industrial use.

This case had its origin in a very worthy direction to the City of Rawlins to clean up its discarded water. To do so will cost money. It would be incongruous, in view of the value of water in Wyoming, to not also direct the city to preserve the water as it cleans it—preserve it for additional beneficial use. This may cost more money. Cleaning water is no more worthy than preserving it. The board of control should determine the relation of beneficial use to other aspects of the project. The board may authorize the project as now planned. It may direct pumping to the original place of discharge. It may direct a different method of cleaning. It may require payment of just compensation to the damaged appropriators.[9] It may require change in reservoir construction to provide for a deeper but less extensive body of water so as to reduce evaporation. It may reach the same conclusion as did the district court.

In any event, the board of control should be afforded the opportunity to pass upon the beneficial use of the water involved in the project. The courts would have ample opportunity to *review* the decision, if necessary.

I would reverse and remand with directions that the plaintiff be ordered to

7. The limit is raised in surplus water situations. See §§ 41-4-317 through 41-4-324, W.S.1977.

8. Section 5, Art. 13, Wyoming Constitution. Although the appropriator obtains the right to use water and not the ownership of water, the right obtained is a property right. *Johnston v. Little Horse Creek Irrigating Co.*, 13 Wyo. 208, 79 P. 22 (1904).

9. If just compensation is to be made, the board should refer the matter to the district court for determination of the award.

submit the plans for the project to the state engineer for review and approval.

DIAMOND MANAGEMENT CORPORATION, a Wyoming corporation, Appellant (Third-Party Plaintiff below),

v.

EMPIRE GAS CORPORATION, a Missouri corporation, and Wayne Maxson, Individually and as agent, servant and employee of Empire Gas Corporation, Appellees (Third-Party Defendants below).

No. 5036.

Supreme Court of Wyoming.

May 10, 1979.

Rehearing Denied June 7, 1979.

Ranching corporation appealed from judgment of the District Court of Fremont County, Alan B. Johnson, J., finding that it was not entitled to contribution from propane gas supplier to satisfy judgment paid by ranching corporation in settlement of claims for damages caused by explosion of propane gas bottle. The Supreme Court, Rooney, J., held that: (1) trial court's determination that supplier met standard of duty requiring that every reasonable precaution suggested by experience and known dangers of subject be taken was not clearly erroneous or contrary to great weight of evidence; (2) trial court as trier of fact was not required to accept ranching corporation's interpretation as to what was reasonable precaution as suggested by experience to avoid known dangers, where evidence concerning facts was such that reasonable men could differ as to results, and (3) instructions, warnings and actions of supplier were reasonable precautions suggested by experience to avoid known dangers, and supplier was not negligent.

Affirmed.

1. Appeal and Error ⟹931(1), 1008.1(5), 1012.1(1)

On appeal, findings of fact are presumptively correct and shall not be set aside unless clearly erroneous or contrary to the great weight of the evidence.

2. Appeal and Error ⟹1008.1(5), 1010.1(3), 1012.1(1)

On appeal, the findings and judgment of the trial court are generally affirmed if there is any evidence to support them, and they should be disturbed only when it appears they are clearly erroneous or contrary to the great weight of the evidence.

3. Appeal and Error ⟹1008.1(3)

An appellate court should not substitute its conclusions for those made by the lower court, particularly when a case is tried to a court without a jury and different conclusions can be rationally drawn from the evidence.

4. Gas ⟹18

Standard of duty in dealing with dangerous agency requiring that every reasonable precaution suggested by experience and known dangers of subject ought to be taken was met by supplier of propane gas with respect to gas delivered to ranching corporation whose bottle of gas exploded causing injury to 13 people.

5. Gas ⟹20(2)

Where evidence concerning facts was such that reasonable men could differ as to results, trial court as trier of fact was not required to accept interpretation of ranching corporation, which was alleged to have negligently caused propane gas bottle explosion, as to what was reasonable precaution as suggested by experience to avoid known dangers as applied to gas supplier from whom ranching corporation sought contribution for damages caused by explosion.

6. Gas ⟹20(2)

Evidence in third-party action by ranching corporation against propane gas supplier for contribution for damages caused by explosion of ranching corporation's propane gas bottle supported trial

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Ecological Services
Federal Building, Room 3035
316 North 26th Street
Billings, Montana 59101-1396

IN REPLY REFER TO:

ES

January 14, 1983

Mr. Paul Sorensen
Banner Associates, Inc.
620 Plaza Court
P.O. Box 550
Laramie, WY 82070

Dear Mr. Sorensen:

We have reviewed the information provided us concerning the 201 wastewater facilities plan for the City of Cheyenne. The areas highlighted on Figure II-2 are described as the "North Cheyenne Area" and "Sunnyside Area." We presume that in these two areas it is proposed to construct sewer laterals to service the communities involved. Since these are urban areas with significant development, it would be unlikely that construction of sewer lines would have any significant effect on wildlife resources.

On Figure II-1, the Crow Creek Wastewater Treatment Facility, the Dry Creek Wastewater Treatment Facility, and the Alternative IV interceptor are highlighted. We presume that the plan for the two treatment facilities is some form of expansion to increase capacity. Both of these facilities are adjacent to water courses. Crow Creek and Dry Creek are considered riverine-type wetlands. Encroachment into the Creek and adjacent riparian vegetation should be avoided if at all possible. Accordingly, any expansion of the facilities should be away from the water course and outside the floodplain.

Routes for interceptor lines should be selected to avoid wetlands if at all possible. We reviewed the information you submitted to us, conducted a site inspection, and used USGS quads to assess general impacts. We are concerned about the impacts on wetlands associated with the proposed Interceptor IV route. An intermittent drainage running slightly south of the South Cheyenne wastewater treatment facility (in Section 10) receives inflow from a number of intermittent tributaries draining the hills from the south. The sewage plant also contributes discharge water to the drainage. A number of small wetlands occur along this drainage and would be adversely impacted by the Alternative IV route since it bisects this drainage several times. The photograph provided us shows a good wetland complex. If a pipeline were constructed through this area, there would be significant adverse impacts. Since this particular wetland is fairly well-choked with hydrophytic vegetation such as cattails, its importance to waterfowl is limited. However, the density of vegetation would provide excellent winter cover for small mammals and birds. A large prey base for hawks and other raptors would be expected in the wetland and adjacent areas. Alternative IV also crosses the Wyoming Hereford Ditch No. 1 and the Kingman Ditch. Generally, seepage from ditches creates and maintains narrow strips of wetlands. Accordingly, it would be expected that some wetland habitat also exists in some areas along the ditches.

Although a survey of the entire area could not be made, it is our impression that impacts to wetlands could be virtually avoided if Alternative Routes I or III were used. Alternative II would be less desirable than either I or III. As explained above, Alternative IV would have significant impacts on wetlands. Many of the wetlands could be avoided by some realignment in the route. Even if the South Cheyenne facility is closed, and there is a gradual loss of wetland area, we strongly recommend that either Alternative I or III be used for the interceptor route. If Alternative IV is the only feasible route, our Cheyenne Field Office could aid in defining the route changes necessary to minimize impacts to wetlands.

All of the alternative pipeline routes cross Crow Creek. Some areas along Crow Creek support willows, cottonwoods, and other woody vegetation. SInce this type of vegetation is beneficial to wildlife, routing the pipeline across Crow Creek should be done in a manner which minimizes disturbance of woody vegetation and particularly the larger willows and cottonwoods.

Endangered and threatened species which may occur in the area include the bald eagle, peregrine falcon, and blackfooted ferret. It is likely that the bald eagle and peregrine falcon use the area sparingly. Peregrine falcons do search wetland areas for prey. We are not aware of nest sites for these species in the project area. The blackfooted ferret is associated with prairie dog towns. Accordingly, the interceptor route should be located to avoid prairie dog towns if at all possible. If this cannot be done, the dog towns which would be disturbed should be surveyed for ferret sign. The U.S. Fish and Wildlife Service should be contacted regarding searching and surveying procedures.

We appreciate the opportunity to comment on the proposed 201 facilities plan.

Sincerely,

William E. Jones

William E. Jones
Acting Field Supervisor
Ecological Services

cc: Art Anderson, USFWS, Cheyenne, WY
Regional Director, USFWS, Denver, CO (ENV)

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Game and Fish Department

CHEYENNE, WYOMING 82002

W. DONALD DEXTER
DIRECTOR

October 8, 1982

OCT 11 1982

Mr. Paul Sorensen
c/o Banner and Associates, Inc.
620 Plaza Court
P. O. Box 550
Laramie, Wyoming 82070

RE: Cheyenne Sewage and Waste Water Treatment

Dear Mr. Sorensen:

Information you requested on wildlife distribution and stream classification for the area immediately surrounding the town of Cheyenne, Wyoming, is available in our district office in Laramie or in the Cheyenne office. I am enclosing a copy of "Wyoming Stream Fishery Classification" at no cost. Copies of wildlife distribution maps are available for the cost of reproduction and handling.

Please contact this office or our district office in Laramie for copies of these maps.

Sincerely,

Bruce Marker

H. Bruce Marker
Environmental Specialist

HBM:jo

cc: Game Division
Fish Division

Encl.

DEPARTMENT OF THE ARMY
OMAHA DISTRICT CORPS OF ENGINEERS
6014 U.S. Post Office and Courthouse
Omaha, Nebraska 68102

REPLY TO
ATTENTION OF:

February 9, 1983

Planning Division

Mr. Paul Sorensen
Banner Associates, Inc.
620 Plaza Court
P.O. Box 550
Laramie, Wyoming 82070

Dear Mr. Sorensen:

This responds to your transmittal letter of January 6, 1983 requesting flood plain information in southeast Cheyenne, Wyoming relative to the Cheyenne 201 Wastewater Facilities Plan Report.

Enclosed are copies of portions of the Flood Insurance Rate Map (FIRM) for the city of Cheyenne and Laramie County. This map shows the boundary and elevation of the 100-year flood. We do not currently have copies of the Flood Boundary and Floodway Map (FBFM) for these areas. The FBFM shows the boundary of the floodway. This is an area in which construction which can obstruct floodflows is prohibited. Since both the FIRM and FBFM are portions of flood insurance studies for Cheyenne and Laramie County, they should be available at those locations if you need them.

Federal Flood Plain Management criterion basically states that construction which can be damaged by floodwaters should not be located in the 100-year flood plain. Construction which can obstruct floodflows should not be located in the 100-year floodway. If this is not practicable, residential construction which can be damaged by floodwaters should be above and non-residential construction which can be damaged by floodwaters should be either above or floodproofed to abve the 100-year flood water surface elevation and should be designed to minimize potential harm to or within the flood plain. If the operation of the constructed facilities is considered critical during flood periods, they should be protected from the 500-year flood. Flood plain construction should not increase the water surface elevation of the 100-year flood more than one foot relative to existing conditions. If a floodway has been identified, construction which can obstruct floodflows is prohibited.

If you need additional assistance, feel free to call on us.

Sincerely,

Enclosure

LARRY S. BUSS
Chief, Flood Plain Management Services
Planning Division

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

RECEIVED
DEC 08 1982
BANNER ASSOCIATES, INC.

Department of Environmental Quality

Water Quality Division

1111 EAST LINCOLNWAY CHEYENNE, WYOMING 82002 TELEPHONE 307 777-7781

December 7, 1982

Cheyenne 201 Committee
908 Drew Court
Cheyenne, WY 82001

ATTN: Mr. Art Buffington, Chairman

RE: Draft 201 Facility Plan
EPA Grant No. C560161-01

Dear Art:

This office has completed our review of the Cheyenne area draft facility plan and offer the following comments:

1) We are in receipt of your draft IGA. Our comments are forthcoming.

2) Please include comments from the following agencies to insure degrees of respective impact are minimized:

   a) Soil Conservation Service - prime agricultural land.

   b) U.S. Fish & Wildlife - wetlands, endangered species.

   c) Wyoming Game & Fish

   d) All comments from the A-95 review.

   e) Wyoming State Archives, Museums & Historical Department - historical impact.

   f) The Attorney General's Office, on water rights. (4-29-82 memorandum should be included).

   g) Corps of Engineers/HUD - flood plain.

   h) Wyoming Recreation Commission (Archeology, History, Historical Architecture, Recreation Planning).

   i) City of Cheyenne/Laramie County Sanitarian (Gary Hickman).

3) Please clarify if funding will or will not be requested for Sunnyside and North Cheyenne collector sewers?

4) It would be helpful if a cost estimate sheet was included listing exactly which of the recommended sections will be covered by your request for Federal funds? For example, on Page V-117 a statement is made that several collector lines may need replacing. This is not grant eligible. A summary sheet would clear up this confusion.

5) Funding will not be available to serve areas lying in a designated flood prone area. (The exception would be an interceptor if adequately protected). Please include any pertinent flood plain information.

6) The water allocation (right) issue is still vague, especially when land application is considered. If water rights are only partially an issue, additional information will need to be added before excluding land application alternatives. My notes from several 201 Committee meetings include information which should handle this problem.

7) As discussed at a recent 201 Committee meeting, please clarify which district-to-city pipeline alternative is most reasonable and cost effective.

8) Please incorporate information exchanged at the November 22, 1982 meeting concerning sludge management. At this time the Department of Environmental Quality/Water Quality Division will not impose additional restrictions on your sludge disposal operations. You will need to continue following applicable EPA and Department of Environmental Quality guidance on sludge management.

9) Please include all public hearing information in the Final Facility Plan.

10) As discussed, Federal funding will change on October 1, 1984. After this date, grant assistance will be set at 55% of eligible project costs. Further, eligible project costs will include only present day needs after October, 1984.

The only exclusion to the above is if a project is designated a "phased-segmented" project before this transition date. The old grant regulations would apply in this case.

11) Is the waterline from the city to the plant more cost effective than developing a well? Further, only a waterline sized to meet needs at the plant can be declared eligible.

12) In order to get the above list to you as quickly as possible we have not included comments from our groundwater section. Should something require your response we will forward this information to you.

Please contact this office with any comments or questions.

Very truly yours,

Ed

Ed Baruth
Engineering Evaluator

EB/sk

cc: City of Cheyenne, Water Department - Herman Noe
Laramie County Commissioners, Shirley Francis
City of Cheyenne, Planning Department - Jon Arason
Banner Associates, Paul Sorenson
Grant File
EPA, Gerry Snyder

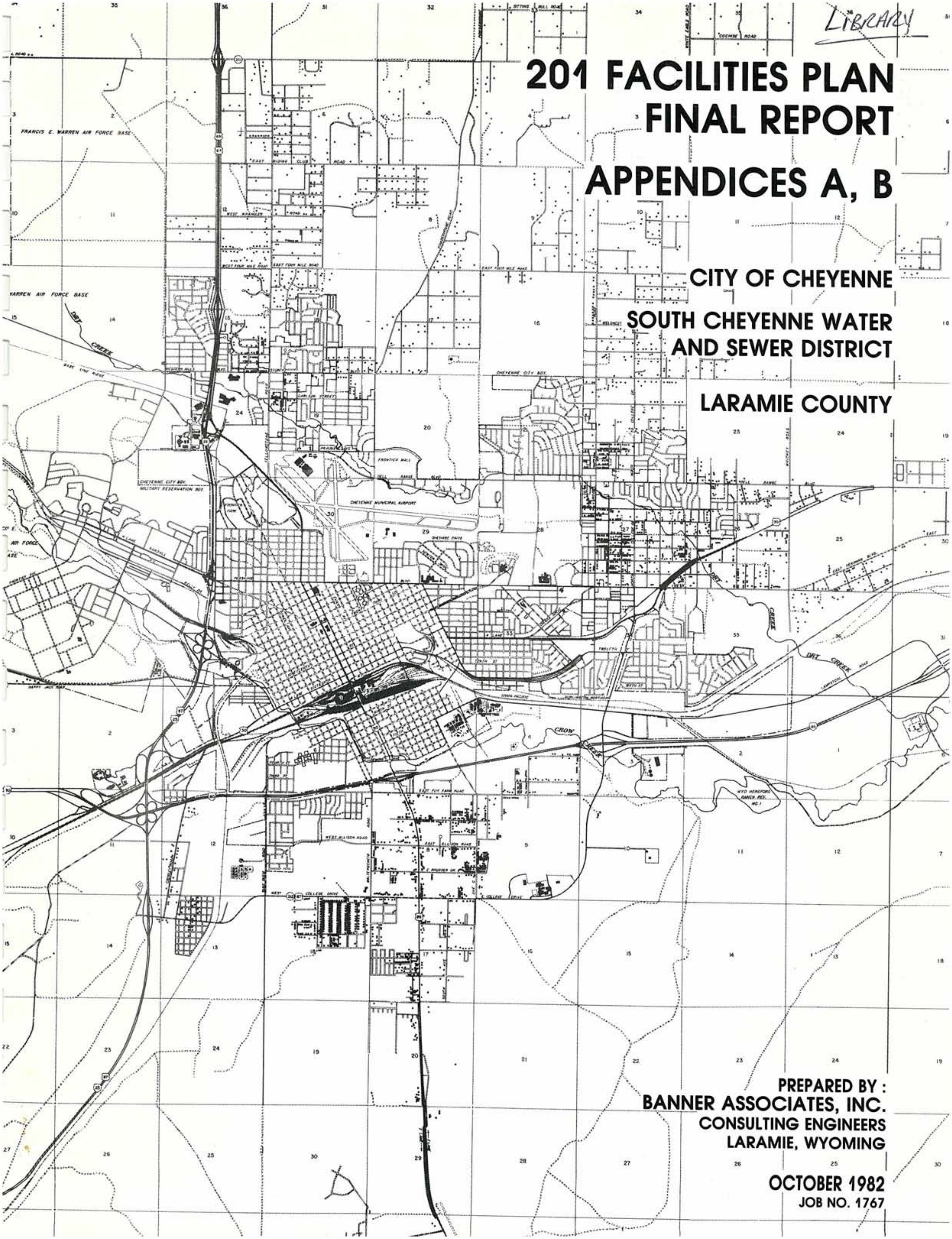
201 FACILITIES PLAN FINAL REPORT

APPENDICES A, B

CITY OF CHEYENNE

SOUTH CHEYENNE WATER AND SEWER DISTRICT

LARAMIE COUNTY



PREPARED BY :
BANNER ASSOCIATES, INC.
CONSULTING ENGINEERS
LARAMIE, WYOMING

OCTOBER 1982
JOB NO. 1767

APPENDIX A

SUMMARY OF REGIONAL WASTEWATER TREATMENT ALTERNATIVES

APPENDIX A

CHEYENNE 201 FACILITY PLAN REPORT

SUMMARY OF REGIONAL WASTEWATER TREATMENT ALTERNATIVES

1. Wastewater Treatment

The 201 Facility Plan Report for Cheyenne and the surrounding area (Study Area) was undertaken to develop viable wastewater treatment alternatives for the region. The goal of all alternatives developed is to produce wastewater treatment plant effluent of the quality demanded by the NPDES (National Pollution Discharge Elimination System) Discharge Permit requirements. Each alternative is technically discussed and economically compared in detail in Appendix B, Working Paper No. 3, Preliminary Evaluation of Alternatives.

The costs of various wastewater treatment alternatives are summarized in Table A-1, Regional Wastewater Treatment Alternatives. The costs given in Table A-1 do not reflect revisions made in the preparation of the Final Report. The costs given in Table A-1 are for comparison purposes only, and those given for the chosen plan in the Final Report are based on a more in-depth evaluation, and are higher. These are regional costs and no attempt has been made to proportion the costs between the City and the South Cheyenne Water and Sewer District. The share of the total annual costs shown in Table A-1 that should be paid by each entity should be determined through negotiations between the Cheyenne Board of Public Utilities and the South Cheyenne Water and Sewer District.

Alternative A assumes that the South Cheyenne Wastewater Treatment Facility would be expanded to an average daily flow capacity of 1.5 MGD (million gallons per day). This expansion is assumed to be the contact stabilizatior alternative, which is discussed in detail in Working Paper No. 3, and is shown to be the most cost effective method to achieve a 1.5 MGD capacity at the South Cheyenne Wastewater Treatment Facility. Accompanying the South Cheyenne Wastewater Treatment Facility expansion for Alternative A are the upgrading of the City facilities (Crow Creek Wastewater Treatment Facility and Dry Creek Wastewater Treatment Facility) and the enlargement of the Dry Creek facility

Table A-1. Regional Wastewater Treatment Alternatives

Alt.	Description	Capital Cost(1) ($)	Amortized Cost= 7 3/8% 20yrs($/yr)	O & M(2) ($/yr)	Total Annual Cost ($)
A.	Expand S. Chey. WWTF to 1.5 MGD	2,675,870		180,920	
	Upgrade Crow Crk & Dry Crk WWTF and Expand Dry Crk to 5.5 MGD	2,441,800		398,950	
	1.0 MGD Pipeline	352,000			
		5,469,670	531,650	579,870	1,111,520
B.	Expand S. Chey WWTF to 2.5 MGD	3,344,840		226,150	
	Upgrade Crow Crk & Dry Crk WWTF	1,029,800		360,530	
		4,374,640	425,220	586,680	1,011,900
C.	2.5 MGD Pipeline-Abandon S. Chey	347,000			
	Upgrade Crow Crk & Dry Crk WWTF and Expand Dry Crk to 7.0 MGD	3,454,800		445,500	
		3,801,800	369,530	445,500	815,030
D.	2.5 MGD Pipeline-Abandon S. Chey	431,700			
	Expand Dry Crk to 11 MGD - Abandon Crow Crk (3)	4,654,690		406,710	
		5,086,390	494,400	406,710	898,110
E.	Expand S. Chey. WWTF to 1.5 MGD	2,675,870		180,920	
	1.0 MGD Pipeline	352,000			
	Expand Dry Crk to 9.5 MGD - Abandon Crow Crk	4,014,610		382,160	
		7,042,480	684,530	563,080	1,247,610
F.	Expand S. Chey. WWTF to 2.5 MGD	3,344,840		226,150	
	Expand Dry Crk to 8.5 MGD - Abandon Crow Crk	3,550,540		348,990	
		6,895,380	670,230	575,140	1,245,370

(1) Capital costs for Dry Creek Expansions developed through use of EPA-430/9-75-002. A Guide to the Selection of Cost Effective Wastewater Treatment Systems, July, 1975.

(2) O & M Costs determined through use of EPA-430/9-78-009, Innovative and Alternative Technology Assessment Manual, in conjunction with current (F.Y. 1982) O & M Costs.

(3) A 2.0 MGD Pipeline paralleling the Crow Creek interceptor line may be required to handle peak flows toward the end of the study period - cost of this line not included.

to an average capacity of 5.5 MGD. Because the South Cheyenne facility would be expanded to treat only 1.5 MGD, and it is projected that nearly 2.5 MGD of wastewater may be generated from this area, a 1.0 MGD pipeline to convey the excess wastewater to the City facilities would also be required. The total annual cost to the region is shown to be approximately $1,111,520 and could be proportioned between the South Cheyenne Water and Sewer District and the City in a manner acceptable to both parties.

The basis of Alternative B is the expansion of the South Cheyenne Wastewater Treatment Facility to an average day capacity of 2.5 MGD and the upgrading of the City facilities to increase the operational efficiency with no expansion in capacity. Since a portion of the projected 2.5 MGD flow to the South Cheyenne facility may be generated from outside the district boundaries, the cost of plant expansion and the annual operation and maintenance costs should be proportioned between the district and the City. The cost of upgrading the City facilities would be borne by the City alone. Therefore, the total projected annual cost of $1,011,900 would be paid partially by the Board of Public Utilities and partially by the South Cheyenne Water and Sewer District. This suggested funding is only one of the possible solutions. Other funding solutions must be investigated jointly by the Cheyenne Board of Public Utilities and the South Cheyenne Water and Sewer District.

Alternative C is based on the abandonment of the South Cheyenne Wastewater Treatment Facility, with the City facilities upgraded and expanded to treat all the wastewater generated in the region. The cost of the 2.5 MGD pipeline from the South Cheyenne District to the City would be shared between the district and the City, as would the cost of upgrading and expanding the City facilities. Alternative C is shown to be the most cost effective choice of all alternatives for the region. The treatment of a given quantity of wastewater is generally accomplished for less money with two facilities than with three facilities. An agreement would be required between the South Cheyenne District and the City that defines the division of payments of the annual costs of $815,030.

The expansion of the Dry Creek facility to treat the entire wastewater flow of the region (approximately 11.0 MGD) would be accomplished in Alternative D. This assumes that both the South Cheyenne Wastewater Treatment Facility and the Crow Creek facility would be abandoned, and a pipeline with an average day capacity of 2.5 MGD from South Cheyenne to the City system would be constructed. The projected annual cost of $898,110 would be divided between the City and the South Cheyenne District.

Alternative E and F both assume the abandonment of the Crow Creek facility. Alternative E calls for the expansion of the South Cheyenne facility to a 1.5 MGD capacity and a 1.0 MGD pipeline to the City. Alternative F calls for the expansion of the South Cheyenne facility to 2.5 MGD. Table 1 shows that the total annual costs of Alternatives E and F are $1,247,610 and $1,245,370 respectively. These represent the highest annual costs of the alternatives presented. Thorough investigation of the Crow Creek facility has resulted in the conclusion that it has a useful life until past the year 2000. Therefore, Alternatives D, E and F all appear to be less desirable than the other choices. However, if any of these alternatives are chosen, the costs should be divided between the City and South Cheyenne in a manner agreeable to both parties.

2. Sludge Handling

The treatment of wastewater produces a residual which must be disposed of into the environment. This residual is generally a semi-solid, odiferous and unmanageable material called sludge. However, sludge often contains substantial nutrients and organics that may be used as a replenishable natural resource.

Sludge represents only a part of the total solid material produced at a wastewater treatment plant. The pretreatment processes generate screenings from the bar rack and grit collected in the grit chamber. These materials generally are of relatively high organic content and may present difficulties in their ultimate disposal.

The sludge generated by the City facilities is stabilized in the anaerobic digesters at the plants. Upon stabilization, this sludge is dewatered on drying beds and then ultimately disposed of via landfill or used as fertilizer on parks and golf courses. Sludge generated at the South Cheyenne Wastewater Treatment Facility is stabilized aerobically, making its disposal as fertilizer or by landfill also acceptable. The pretreatment screenings and grit collected at the area's wastewater treatment facilities may be disposed of in landfills when mixed with digested (stabilized) sludge (Telecom, Tim Link, DEQ Solid Waste Department, 3/19/82).

The costs of alternative sludge disposal techniques that have been examined are summarized in Table A-2. For a more detailed discussion of these alternatives, the reader is referred to Chapter VIII, Sludge Management, in Working Paper No. 3, Preliminary Evaluation of Alternatives. Investigation of this table indicates that co-disposal as a sludge/refuse mixture is the most cost effective method of sludge disposal. The co-disposal of sludge/refuse mixture has hidden costs that are not accounted for in Table 2. These hidden costs relate to the volume of storage occupied by the sludge (approximately 5,012,000 cubic feet by the year 2005) that would otherwise be available for solid refuse. The projected cost may be further increased by the operational difficulties in mixing and handling the sludge/refuse mixture.

Table A-2. Sludge Disposal Alternatives

Alt.	Description	Capital Cost ($)	Amortized Cost = 7 3/8% 20yrs($/yr)	O & M ($/yr)	Total Annual Cost ($)
A.	Dewatering in Drying Beds and Landfilling				
1.	Narrow Trench (solids content = 15 - 28%)	186,800	18,160	114,100	132,260
2.	Wide Trench (solids content > 28%)	212,600	20,670	100,700	121,370
3.	Leachate Control - Required for Narrow or Wide Trench				
B.	Co-Disposal with Refuse				
1.	Sludge/Refuse Mixture	52,300	5,080	81,700	86,780
2.	Sludge/Soil Mixture	115,600	11,240	84,300	95,540
C.	Land Application				
1.	Land Purchased				
a.	Stored Sludge	668,300	64,970	61,200	126,170
b.	Dewatered Sludge	487,400	47,380	61,200	108,580
2.	Land Not Purchased				
a.	Stored Sludge	425,420	41,360	61,200	102,560
b.	Dewatered Sludge	244,520	23,770	61,200	84,970
D.	Incineration	2,998,300	291,470	335,700	627,170

The groundwater quality in the proximity of the existing landfill as affected by the landfill is currently being studied. The addition of sludge to the landfill as a sludge/refuse mixture would probably intensify questions of potential groundwater contamination.

The marketing of dried sludge is not included in Table A-2. Various communities around the country use this technique for sludge disposal, thereby creating income instead of cash outlay. Further tests on the acceptability of domestic sludge for use on home gardens are recommended, as the possible presence of toxic metals may present a hazard. However, the use of digested sludge on land with restricted public access has shown beneficial results. This makes the alternative of land application of sludge without the purchase of land (Alternative C-2 in Table A-2) appear more desirable, assuming an acceptable market for the sludge is obtained.

3. Summary

This summary report of the wastewater and sludge treatment alternatives for the Study Area is intended to provide an overview of the associated costs. The reader who desires more detailed alternative evaluations is, once again, referred to Appendix B, Working Paper No. 3, Preliminary Evaluation of Alternatives. As is stated in Working Paper No. 3, the costs presented for the alternatives are for comparison purposes only. Similar costs, e.g. laboratory and administration buildings, are not included.

The breakdown in annual payments to be made by the Cheyenne Board of Public Utilities and by the South Cheyenne Water and Sewer District varies with different alternatives and must be determined through negotiations between the district and the City.

APPENDIX B

WORKING PAPER NO. 3: PRELIMINARY EVALUATION OF ALTERNATIVES WITH REFINEMENTS

Refinements to Working Paper No. 3. Preliminary Evaluation of Alternatives

The development and evaluation of several wastewater treatment alternatives is presented in Working Paper No. 3: Preliminary Evaluation of Alternatives. The work completed in developing the Final Report, i.e. extensive evaluation of the chosen alternatives, as well as comments received subsequent to the original presentation of Working Paper No. 3, has necessitated certain refinements to Working Paper No. 3. These refinements include:

1. Federal Discount Rate

The total annual costs of the six regional wastewater treatment alternatives presented in Working Paper No. 3 were developed using a Federal discount rate of 10%. The current Federal discount rate is 7 3/8%. Therefore, the annual costs presented require adjustment from 10% to 7 3/8%. This adjustment has been made in Working Paper No. 3; however this adjustment in no way affects the relative annual costs of the alternatives presented.

2. Trails End Mobile Home Park

The Trails End Mobile Home Park operated a small wastewater treatment facility to serve the needs of the mobile home park. Since the publication of Working Paper No. 3, the mobile home park has been annexed, and a pipeline connecting the park with the city sewer system has been installed. This work will eliminate this source of pollution on Crow Creek.

3. City Water Line Extension to the Dry Creek WWTF

The necessity of providing city water to the Dry Creek plant has previously been well documented. However, Working Paper No. 3 indicated that the 1.6 miles of 6" PVC pipe would cost approximately $84,500. More detailed evaluation of this proposed pipeline indicates that boring under the railroad and Interstate 80 would be required. This is an expensive procedure, increasing the estimated cost to $137,500.

4. Costs

The costs developed in Working Paper No. 3 are for the comparison of alternatives only. These estimated costs have been refined in the Final Report, and are detailed in Appendix E, beginning on page E-44.

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Cheyenne 201
Working Paper No. 3
Preliminary Evaluation of
Alternatives

Banner No. 1767

B-I. PURPOSE OF PAPER

Working Paper No. 3 presented herein has been developed to identify applicable wastewater treatment options for the study area. It is intended that the paper will be reviewed by all concerned parties, i.e. the Cheyenne 201 Committee, Citizens Advisory Committee, general public residing within the study area, Department of Environmental Quality (DEQ), and Environmental Protection Agency (EPA).

Based upon comments received and 201 Committee direction, additional alternatives may be considered. If a final alternative is not selected by the 201 Committee, a supplement to this paper will be issued to provide any additional information that is requested. This paper and any supplement will be the basis of the Final Plan paper which will discuss further the final wastewater management plan for the area. The Final Plan will then be presented at a Public Hearing and if accepted will be submitted to DEQ and EPA for acceptance.

B-II. INTRODUCTION

A. BACKGROUND

Congress on October 18, 1972, overrode the President's veto of Senate Bill S2770, and Public Law 92-500 "Federal Water Pollution Control Act Amendments of 1972" became law. The declared objective of the Act was to "restore and maintain chemical, physical, and biological integrity of the Nation's waters". In order to meet this objective the following goals were established:

1. Eliminate by 1985 the discharge of pollutants into navigable waters.
2. Where possible, water quality shall provide for the protection and propagation of fish, shellfish, and wildlife and allow recreation in and on the water by July 1, 1983.

Whether the goal of "zero discharge" by 1985 is achieved remains unresolved as the U. S. Environmental Protection Agency (EPA) has stated that "zero discharge may be neither feasible nor environmentally desirable." However, the goal of improved water quality is being actively pursued through several means:

1. Classifying streams and water quality in relation to their desired use.
2. Establishing discharge permits and effluent standards for wastewater treatment plants as well as other point source discharges.

In 1977, Congress amended the Act again in order to encourage innovation and alternative wastewater treatment solutions. Among the items that must be considered are:

1. Reduction of construction and operating costs of wastewater treatment.

2. Recycling and conservation of water resources.

3. Reclaiming of refuse effluents to increase land productivity.

4. Beneficially utilizing sludge.

Public Law 92-500 defines a three-step planning program: basinwide, areawide, and local or facility planning. The last of these three steps is called a 201 Wastewater Treatment Facilities Plan. Cheyenne and the surrounding zoned area are currently involved in a "201 Plan". The 201 Plan is also divided into three steps:

1. Planning.

2. Design of recommended plan.

3. Construction of the recommended plan.

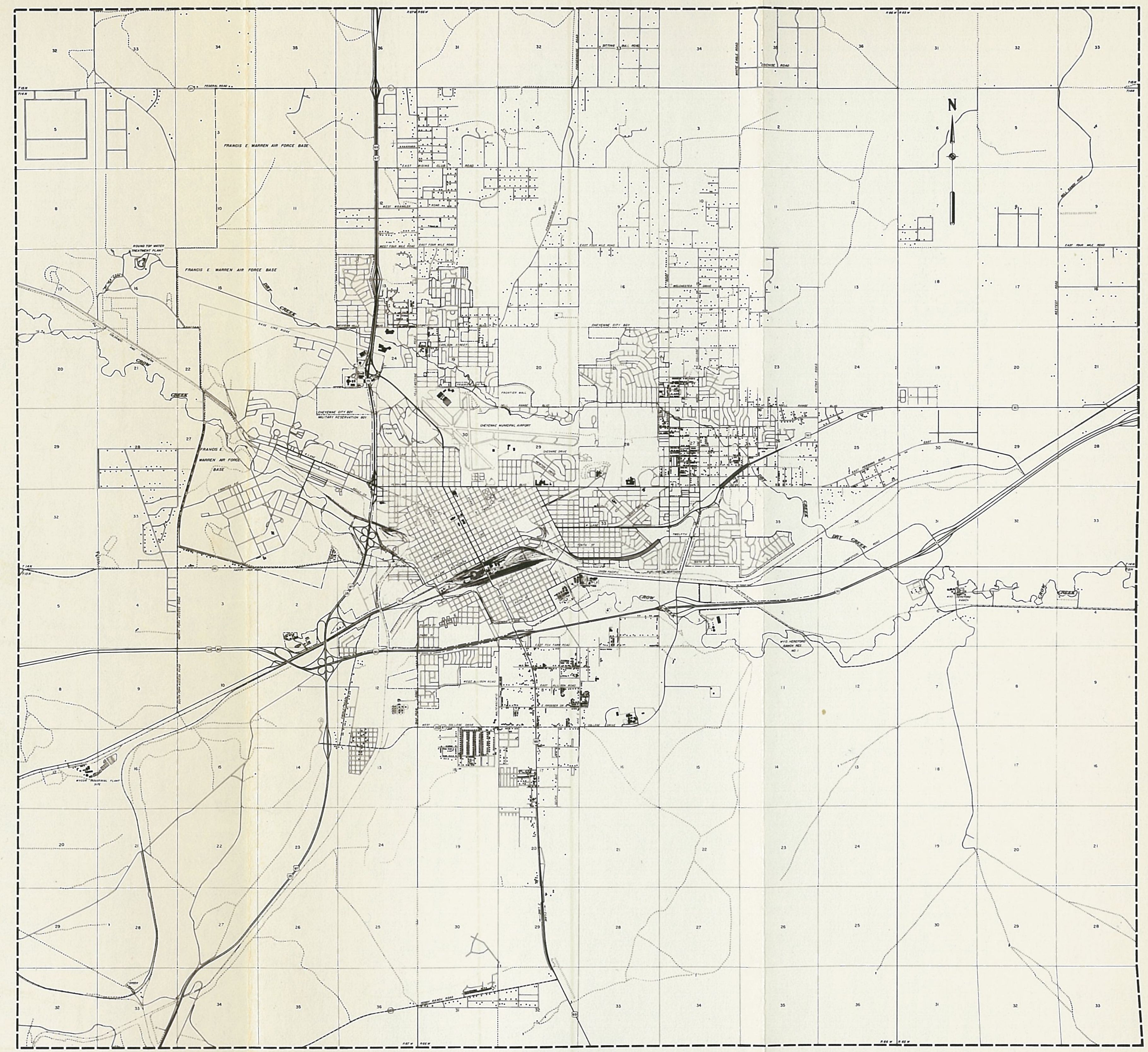
Funding for the 201 Plan is provided by the Environmental Protection Agency (EPA) and is administered through the Wyoming Department of Environmental Quality (DEQ). Specific Federal and State laws must be followed in all three steps of the process.

B. STUDY AREA

Cheyenne and the area surrounding it have experienced significant growth in recent years. With this growth have come increasing demands for wastewater treatment, both individual systems and those that are publicly owned. Recognizing the existing and potential wastewater treatment problems, the City of Cheyenne, the Laramie County Commissioners, and the South Cheyenne Water and Sewer District have combined resources to determine the most desirable wastewater management plan for the area.

The Cheyenne, Wyoming, 201 Wastewater Facility Study Area, shown in Figure B-II-1, includes the City of Cheyenne, surrounding County subdivisions, businesses, mobile homes, etc. One major problem wastewater treatment area has developed (Sunnyside), and other areas are showing signs of similar problems. In addition, the wastewater treatment plant operated by the South Cheyenne Water and Sewer District is unable to consistently meet its effluent limitations.

Figures B-II-2 and B-II-3 further define the study area showing such features as the current Cheyenne city limits, the South Cheyenne Water and Sewer District Boundaries, and current wastewater treatment plant locations.



CHEYENNE, WYOMING

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STUDY AREA BOUNDARY

FIGURE B-II-1

C. STUDY PERIOD

An important facet of any study is the time span over which a forecast must be made. Current EPA guidelines specify a 20-year planning period, but provisions are made for shorter periods for phasing of treatment works. It currently appears that 1984 would be the earliest any construction (if deemed necessary) could begin. Therefore, a planning period ending with the year 2005 has been established for this report.

D. REPORT FORMAT

This report has been organized in an attempt to allow readers to systematically become knowledgeable in the field of wastewater management as it relates to the City of Cheyenne and its surrounding area. Section organization is as follows:

Section III - Existing Water Quality and Effluent Limitations
IV - Existing/Future Settings
V - Development of Alternatives
VI - Evaluation of Alternatives
VII - Areawide Alternatives
VIII - Sludge Management

A large amount of information has been needed to develop this plan, and this technical support information is included in a separate volume entitled "201 Facilities Plan Report - Appendices C-H".

B-III. EXISTING WATER QUALITY AND EFFLUENT LIMITATIONS

A. INTRODUCTION

Any study must establish a framework around which all planning is done. In the case of the 201 Study, water quality, present and future, is the framework used. With the establishment of this framework, the severity of wastewater treatment problems can be evaluated. This section briefly discusses the State water quality stream standards and discharge requirements as they pertain to the study area.

B. DEQ STANDARDS

Two streams in the study area are affected by wastewater discharge: Crow Creek and Clear Creek (See Figures II-2 & II-3). Both streams in the portions where discharge occurs are classified as Class IV streams. According to Chapter I "Quality Standards for Wyoming Surface Waters" promulgated by the Department of Environmental Quality, a Class IV stream is:

> "Those surface waters, other than those classified as Class I, which are determined by the Wyoming Game and Fish Department to not have the hydrologic or natural water quality potential to support fish."

To date no indication has been given that either Crow Creek or Clear Creek will be reclassified to a Class I, II, or III stream, which would significantly increase effluent limitations. Therefore, this study assumes the effluent parameters as currently stated in the appropriate discharge permits will remain in effect throughout the planning period.

C. CURRENT DISCHARGE PERMITS

There are currently six legal and jurisdictional sewage collection and treatment entities subject to the National Pollutant Discharge Elimination System (NPDES) within the study area:

1. City of Cheyenne
2. South Cheyenne Water and Sewer District
3. Wyoming Highway Department
4. Trails End Mobile Home Park
5. Union Pacific Railroad Company
6. Husky Oil Company of Delaware

Of the entities, the South Cheyenne Water and Sewer District and the Trails End Mobile Home Park are unable to consistently meet the NPDES requirements.

The effluent limitations of each permit are listed in Table III-1. As previously stated, no changes are anticipated that would require more stringent treatment before the effluent is discharged.

Table B-III-1

	30 Consecutive Day Period	7 Consecutive Day Period	Instantaneous Maximum
Biochemical Oxygen Demand (mg/1)			
1. South Cheyenne W&S	30	45	90
2. Trails End	30	45	—
3. Union Pacific		** 30 Daily Maximum **	
4. Crow Creek	30	45	90
5. Dry Creek	30	45	90
6. Wyoming Highway Dept.	30	45	—
7. Husky Oil	NA	NA	NA
Total Suspended Solids (mg/1)			
1. South Cheyenne W&S	30	45	90
2. Trails End	30	45	—
3. Union Pacific		** 30 Daily Maximum **	
4. Crow Creek	30	45	90
5. Dry Creek	30	45	90
6. Wyoming Highway Dept.	30	45	—
7. Husky Oil	NA	NA	NA
Fecal Coliform - number/100 ml			
1. South Cheyenne W&S	200	400	1,000
2. Trails End	200	400	—
3. Union Pacific	NA	NA	NA
4. Crow Creek	200	400	1,000
5. Dry Creek	200	400	1,000
6. Wyoming Highway Dept.	200	400	—
7. Husky Oil	NA	NA	NA
Residual Chlorine			
1. South Cheyenne W&S		2.0 mg/1	
2. Trails End		0.05 mg/1	
3. Union Pacific		NA	
4. Crow Creek		1.5 mg/1	
5. Dry Creek		1.0 mg/1	
6. Wyoming Highway Dept.		0.5 mg/1	
7. Husky Oil		NA	

Although there are further effluent requirements dealing with chemical concentrations for Husky Oil and the Union Pacific, neither plant is in violation and neither's effluent would be compatible or desirable at the Cheyenne treatment plants. Therefore, no further study is to be done on these wastewater operations in this report, and the remaining discharge requirements of these two permits are not shown in Table B-III-1.

B-IV. EXISTING/FUTURE SETTINGS

A. INTRODUCTION

Several factors must be included in any wastewater study. Present and future environmental, social, and economic settings have a major impact on projected wastewater flows. Discussion of each of these items can become very complex. This section attempts to summarize these settings while providing enough information for the user to make a decision as to the adequacy of the wastewater flow projections.

B. EXISTING/FUTURE ENVIRONMENT

The study area lies in a semi-arid setting with a climate typified by warm summer days and cool summer nights. Winters are cold and are accompanied by strong winds. The mean annual precipitation is about 15 inches, and the mean annual temperature is 40°F (mean summer 67°F). The frost free season is between 120 and 140 days.

Vegetation is limited, due to the climate, in both abundance and variety. Along the flood plains are found willows and cottonwoods. Rolling prairie grasslands predominate in the undeveloped areas.

Crow Creek, which is formed in the mountains to the west of the study area, flows through Cheyenne and receives all treated wastewater effluent except for the flows from the Wyoming Highway Department Information Center. Flows from the information center go into Clear Creek which in turn enters Crow Creek. Flood Hazard studies of the entire area have been performed by the Department of Housing and Urban Development, and detailed flood plain information can be found in those studies. For the purpose of this report, only those areas where a flood plain contacts a wastewater conveyance or treatment system will be discussed.

When the choice of alternatives is narrowed, a detailed review will be made, and a discussion will be presented not only of the flood hazard potential of the selected alternatives but also of the entire environmental setting.

Geologically the study area is situated within the northern portion of the Denver Basin. The Laramie Mountains flank the Denver Basin, which is a part of the Great Plains physiographic province.

The surface geology is composed of nearly horizontal Tertiary strata of Oligocene and Pliocene Age along with Quaternary alluvium. The Pliocene Ogallala

Formation has the greatest surface exposure in the area and is composed of light-colored limy conglomerate, sandstone and claystone with some volcanic tuff. Alluvium is most abundant along Crow Creek and also occurs in smaller drainages. Appendices 4 and 5 contain a more detailed discussion of the study area geology.

No known endangered species inhabit the study area, nor are there any specific wetlands. However, badgers, muskrats, raccoons, and beaver can be found along Crow Creek in the western portion of the study area.

Migrating birds utilize surface waters (Figures B-IV-1 & B-IV-2) in the area during their annual travel. Areas along Crow Creek are also used by Mallards, Teals, and Gadwalls as a nesting area; they raise one brood before migrating south for the winter.

Antelope and deer can be found in portions of the uninhabitated sections of the study area. The antelope tend to exist closer to human habitation than do the deer.

Crow Creek and Clear Creek, both classified as Class IV streams, in areas where current wastewater discharges occur, cannot support fisheries. However, Crow Creek from the 16th Street Bridge upstream is a Class II stream and is therefore capable of supporting fisheries upstream of all present wastewater discharge points. No new wastewater discharge is anticipated into any portion of Crow Creek that is classified as a Class II stream.

Air quality in the Cheyenne Area is monitored by the Department of Environmental Quality (DEQ) at 20th Street and Central Avenue. Data is collected on the amounts of Total Suspended Particulates (TSP), Sulfur Dioxide (SO_2), and Nitrogen Dioxide (NO_2). As shown in Table B-IV-1, the levels of TSP SO_2, and NO_2 are below the established standards.

Table B-IV-1

Air Quality Data Mean Monthly Values

	TSP	SO_2	NO_2
January 1980	33	2	22
1981	34	6	18
February 1980	48	3	34
1981	29	6	5
March 1980	36	1	16
1981	43	10	11
April 1980	69	0	23
1981	38	25	16
May 1980	130	9	28
1981	32	14	24
June 1980	85	1	28
1981	54	5	19
July 1980	50	1	23
1981	63	DNA	DNA
August 1980	63	2	27
1981	54	DNA	DNA
September 1980	63	0	22
1981	52	DNA	DNA
October 1980	73	1	22
1981	DNA	DNA	DNA
November 1980	71	5	24
1981	DNA	DNA	DNA
December 1980	39	1	10
1981	DNA	DNA	DNA

Notes:

1. 1980 Geometric Mean (TSP) = 51.62
2. Applicable Standards
   Federal TSP
   - Annual Geometric Mean - 75 $\mu g/m^3$
   - 24-Hour Maximum - 260 $\mu g/m^3$ (not to be exceeded more than once a year)

   State TSP
   - Annual Geometric Mean - 60 $\mu g/m^3$
   - 24-Hour Maximum - 150 $\mu g/m^3$ - 1 per year

   Federal SO_2
   - Arithmetic Mean - 80 $\mu g/m^3$
   - Annual Arithmetic Mean - 365 $\mu g/m^3$ - 1 per year

   State SO_2
   - Arithmetic Mean - 60 $\mu g/m^3$
   - Annual Arithmetic Mean - 260 $\mu g/m^3$
     - 24-Hour Max - 1300 $\mu g/m^3$
     - 3-Hour Max - 1 per year
3. DNA = Data Not Available

C. POPULATION

One of the first steps in developing wastewater management alternatives for the study area was to establish a population projection to the year 2005. A complete explanation of the population projections was contained in Working Paper No. 1 "Population Projections/Distribution" (see Appendix D). Below is a summary of that paper.

At the present time, approximately 63,280 people reside within the 201 Study Area. Of this number, approximately 47,200 reside within the city limits of Cheyenne, 4750 reside on the Francis E. Warren Air Force Base, and approximately 6,400 people reside within the South Cheyenne Water and Sewer District. This totals approximately 58,350 people in the study area who currently receive sewer and water service. The balance of the population, approximately 4,930, have private water supply and wastewater disposal systems.

Numerous population projections[1] have been done for the Cheyenne area. Projections have been based on such items as historical utility (electric and gas) and telephone hook-ups, water and sewer taps issued, building permits, as well as the historical population change of the area. Those projections show a range from 56,426 to 150,120 for the year 2000.

The wide range in estimates is due in part to various methods used as well as the area considered for a particular projection. Based upon all of the above studies as well as the 1980 census which shows the Laramie County population

[1]e.g., a) The Cheyenne-Laramie County Regional Planning Office, The Cheyenne Land Use Plan - 1978.
b) Wyoming Department of Administration and Fiscal Control, Research and Statistics Division, Special Report - August 1979.
c) U. S. Census Bureau, Population Projections by State 1980-2000.
d) Wyoming Water Planning Program, State Engineer's Office, Summary and Analysis of the City of Cheyenne's Proposed Stage II Water System Expansion, December 1978.

to be 68,649, a population range of 105,000 to 115,000 in the year 2005 has been established for this study. This projection has been reviewed by and agreed with by the Water Quality Division of the Department of Environmental Quality and the Research and Statistics Division of the Department of Administration and Fiscal Control. Figures B-IV-3 and B-IV-4 show where the growth is expected to occur.

D. LAND USE

Once population projections have been made, it is necessary to estimate where the growth will occur. City and County zoning laws affect where and what type of growth will occur. Figures B-IV-3 and B-IV-4 show the current land use regulations for the study area.

Another factor that influences growth is the elevation of an area in relation to the sewage treatment facility. That is, it is more economical to have a gravity wastewater collection system than a system that requires pumping. If an area gets large enough, this factor has less influence, but when development has the luxury to pick a location where a gravity wastewater system is possible, the development usually occurs in these areas first.

Figures B-IV-3 and B-IV-4 also show an approximate boundary line that development must stay within to maintain a gravity wastewater collection system. These figures also show the estimated amount and areas where development is expected to occur during the planning period.

As can be seen from these figures, most of the open areas adjoining the current city limits are expected to fill in to a normal city density, thus requiring municipal wastewater treatment. In addition, the area served by the South Cheyenne Water and Sewer District is estimated to increase in population by 10,600 people. The entire South Cheyenne area may see a population increase of 19,600.

Because of the fact that the study area has a planning office which reviews and helps with the development of the Cheyenne area, the potential growth areas as shown on Figures B-IV-3 and B-IV-4 can be stated with much more confidence than if the Planning Office did not exist.

E. SEWAGE SYSTEMS

An assessment of the existing sewage treatment systems is given in Section B-V - "Development of Alternatives". A summary of the systems is given below.

1. City of Cheyenne

The Cheyenne Board of Public Utilities operates the Crow Creek and the Dry Creek wastewater treatment plants. Crow Creek utilizes a trickling filter treatment process. Dry Creek is an activated sludge plant, and both plants meet all current discharge requirements. The main feature to be assessed is when their combined treatment capacity will be exceeded. If it is found that the capacity will be exceeded during the study period, alternatives for treating the increased wastewater flow will have to be studied.

Wastewater is conveyed to the Crow Creek and Dry Creek plants via the collection system shown on Figure B-IV-5 (inside back cover). The system consists of approximately 208 miles of sewer lines ranging in size from 4-inch to 36-inch in diameter. An analysis of the sewer system is contained in Section B-V.

2. South Cheyenne Water and Sewer District

South Cheyenne currently operates an extended aeration treatment plant. At times the plant is operating at peak capacity and is unable to consistently meet its discharge permit requirements. An extensive evaluation has been made of this plant. (See Section B-V-D.)

The South Cheyenne Water and Sewer District's collection system is shown on Figure B-IV-6 (inside back cover). Approximately 30.2 miles of pipe ranging in size from 6-inch to 21-inch conveys the wastewater. An analysis of the sewer system is contained in Section B-V.

3. Wyoming Highway Department

The Wyoming Highway Department operates a package sewage treatment plant at the Cheyenne Information Center. All discharge requirements are currently being met and with continued proper maintenance should continue to meet the requirements. This, coupled with the fact that the facility is not near any existing sewage collection system, leads to the recommendation that this system be retained.

4. Trails End Mobile Home Park

The Trails End Mobile Home Park operates a small treatment facility to serve the needs of the mobile home park. According to DEQ discharge monitoring reports the plant is in constant violation of its discharge permit. Therefore, because the park is very close to a city collection line, it is recommended that this facility be abandoned and the park be connected to the city wastewater system.

5. Sunnyside

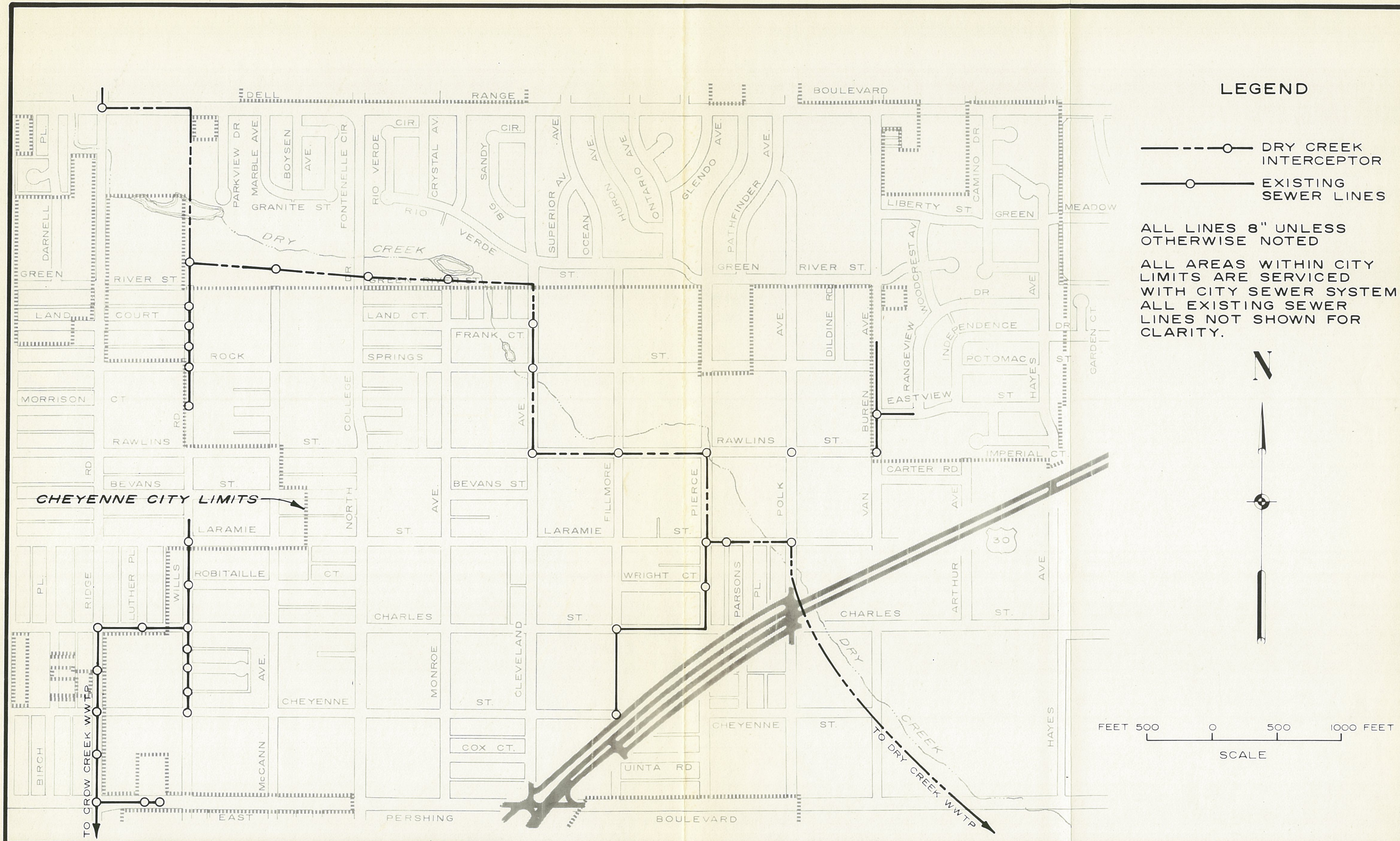
The Sunnyside area shown on Figure B-IV-7 has only a small portion of the area currently being sewered. Projected flows are discussed in section V.I.2.

6. North Cheyenne

The area shown on Figure B-V-19 as North Cheyenne is currently unsewered. The future sewer line needs of the area are discussed in section V.I.3.

7. Other Sources of Wastewater

Both Husky Oil Refinery and the Union Pacific Railroad operate their own wastewater treatment facilities. According to DEQ records, both plants meet their discharge requirements. The industrial raw sewage would not be compatible



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SUNNYSIDE AREA
EXISTING WASTEWATER COLLECTION FACILITIES

FIGURE B-IV-7

with normal municipal sewage without some type of pretreatment. Therefore, as these two plants presently exist and meet standards, it is recommended that these systems be retained.

In addition, there are two non-discharging systems in the area, i.e. Little America and Wycon Chemical. As neither system discharges, no further study of these operations is being made in this report.

F. WASTEWATER FLOWS

The estimation of future wastewater flow is a function of population, wastewater generation per capita, existing infiltration rates, and future infiltration rates. Wastewater flow projection for this study is directly related to the alternatives selected. Decisions on whether to transport South Cheyenne's wastewater and the Sunnyside area's wastewater to the Cheyenne plants or to remain with the current treatment systems will affect the flow projections. For purposes of this paper, the specific flow for each alternatve is given in Section B-V.

B-V. DEVELOPMENT OF ALTERNATIVES

A. INTRODUCTION

The purpose of a 201 Facility Plan Report is to define the need, if any, for improved wastewater treatment and to examine alternative solutions which will provide for the best practicable waste treatment technology (BPWTT) over the life of the treatment works. To acquire a federal grant, the applicant must demonstrate to the EPA that innovative and alternative wastewater treatment processes and techniques aimed at the prevention of the migration of pollutants to the water have been fully studied and evaluated. Also required by the EPA is investigation by the applicant of the reclaiming and reuse of water to prevent the migration of pollutants to the water.

This chapter presents various alternative wastewater treatment techniques that will fulfill the above requirements. The format of this chapter is such that the various wastewater treatment entities within the study area are dealt with separately.

The alternatives developed in this chapter are evaluated for their environmental, engineering, and economic suitability in Chapter B-VI of Appendix B. Chapter B-VII discusses the alternatives on an area wide basis.

B. CRITERIA

In accordance with the Sewage Treatment Construction Grants Manual, applicants for construction grant funds must have evaluated alternative waste treatment management techniques for the application of best practicable waste treatment technology (BPWTT). Alternatives must be considered in three broad categories: treatment and discharge into navigable waters, land application and utilization practices, and reuse of treated wastewater. An alternative is "best practicable" if it is determined to be cost-effective in accordance with the federal guidelines as set forth in 40 CFR Part 35. A "best practicable" alternative must also achieve the degree of treatment attainable by the application of secondary treatment as defined by the federal guidelines set forth in 40 CFR Part 133.

For the attainment of BPWTT, alternatives employing land application techniques must be investigated. The South Cheyenene Water and Sewer District presented the greatest potential for a land application system of the wastewater treatment entities in the Study Area. Upon investigation of land application techniques, it appears that existing Crow Creek water rights issues may preclude the use of this alternative.

Land application techniques for the City of Cheyenne were not investigated because the existing wastewater treatment facilities can effectively treat the projected wastewater flows for at least 15 years without extensive modifications.

For the wastewater treatment facilities in the study area that discharge to surface water (Crow Creek WWTF, Dry Creek WWTF, and South Cheyenne WWTF), alternatives intended to achieve secondary treatment standards were investigated. The South Cheyenne WWTF is in the most critical situation at this time. Several alternatives are developed that should produce an effluent of secondary treatment quality.

The two wastewater treatment plants for the City of Cheyenne (Dry Creek and Crow Creek WWTP's) are investigated from a point of view of improving the operation of the plants. The Dry Creek WWTF is a relatively new activated sludge plant capable of producing an effluent of acceptable quality. The possible upgrading of this facility is aimed at improving the operational control and insuring the consistent production of an effluent that complies with the discharge permit.

The Crow Creek WWTF is a trickling filter plant that will be approaching the end of its useful life by the end of the study period (2005). Upgrading of this facility to insure the consistent production of an acceptable effluent quality at an average flow of 4.0 MGD is discussed. The abandonment of the Crow Creek facility at this time is not considered to be a viable alternative since it is capable of achieving secondary treatment standards.

Alternative wastewater treatment schemes are also developed for areas in the study area currently employing on-site treatment. These areas (e.g. Sunnyside and North Cheyenne) have developed health hazards in relation to inadequately treated septic tank effluent. Alternative treatment methods are presented which would correct onsite treatment problems.

C. EVALUATION OF CITY OF CHEYENNE WASTEWATER TREATMENT FACILITIES

1. Introduction

The wastewater generated by the City of Cheyenne (including the Francis E. Warren Air Force Base) is currently being treated at two wastewater treatment facilities. These are the Crow Creek WWTF and the Dry Creek WWTF.

The Crow Creek WWTF is a trickling filter treatment plant that was constructed in the mid 1940's. This plant was upgraded in 1974, and is capable of producing an effluent of acceptable quality.

The Dry Creek facility is a conventional activated sludge treatment plant constructed in 1974. This plant is also capable of producing an acceptable effluent.

Existing flow records indicate a current combined average day hydraulic loading of approximately 6.5 MGD, with the Dry Creek facility handling 3.5 MGD. This places the operation at 75% of the combined capacity. With a total capacity of 8.5 MGD (4.0 MGD at Crow Creek and 4.5 MGD at Dry Creek), the existing facilities are adequately sized to treat wastewater generated by a total population of approximately 76,000 people, at 112 gallons per capita per day (gpcd) (see Appendix 3). The time at which a population of 76,000 people will contribute wastewater to the city facilities is, in part, dependent on the development of South Cheyenne. If South Cheyenne's development is restricted to a population of 15,000 due to the District's boundary and operating policy, the total projected sewered population of 76,000 in the city will be reached near the end of the century. If all of the projected growth in the South Cheyenne area is allowed to join the District's treatment systems, the sewered population of South Cheyenne could be 25,000 in the year 2005. The South Cheyenne WWTF would have a capacity of 2.5 MGD. Therefore, the capacity of the city facilities would not be reached until the year 2004. If the South Cheyenne WWTF is abandoned, with the entire flow from the District being delivered to the City, plant expansion may be required as early as 1990.

Basically, the city facilities are sound. The following discussion centers on possible general upgrading procedures, the goal of which is to improve the operation of the facilities to insure the continued production of an effluent of required quality.

2. Dry Creek Wastewater Treatment Facility

The Dry Creek WWTF is located in the NW¼ Section 6, T13N, R65W and is a conventional activated sludge plant with a design average day flow capacity of 4.5 MGD (Figures B-V-1 and B-V-2). The facility is structurally sound and has a projected lifetime well beyond the study period. The unit processes and operations are generally discussed below.

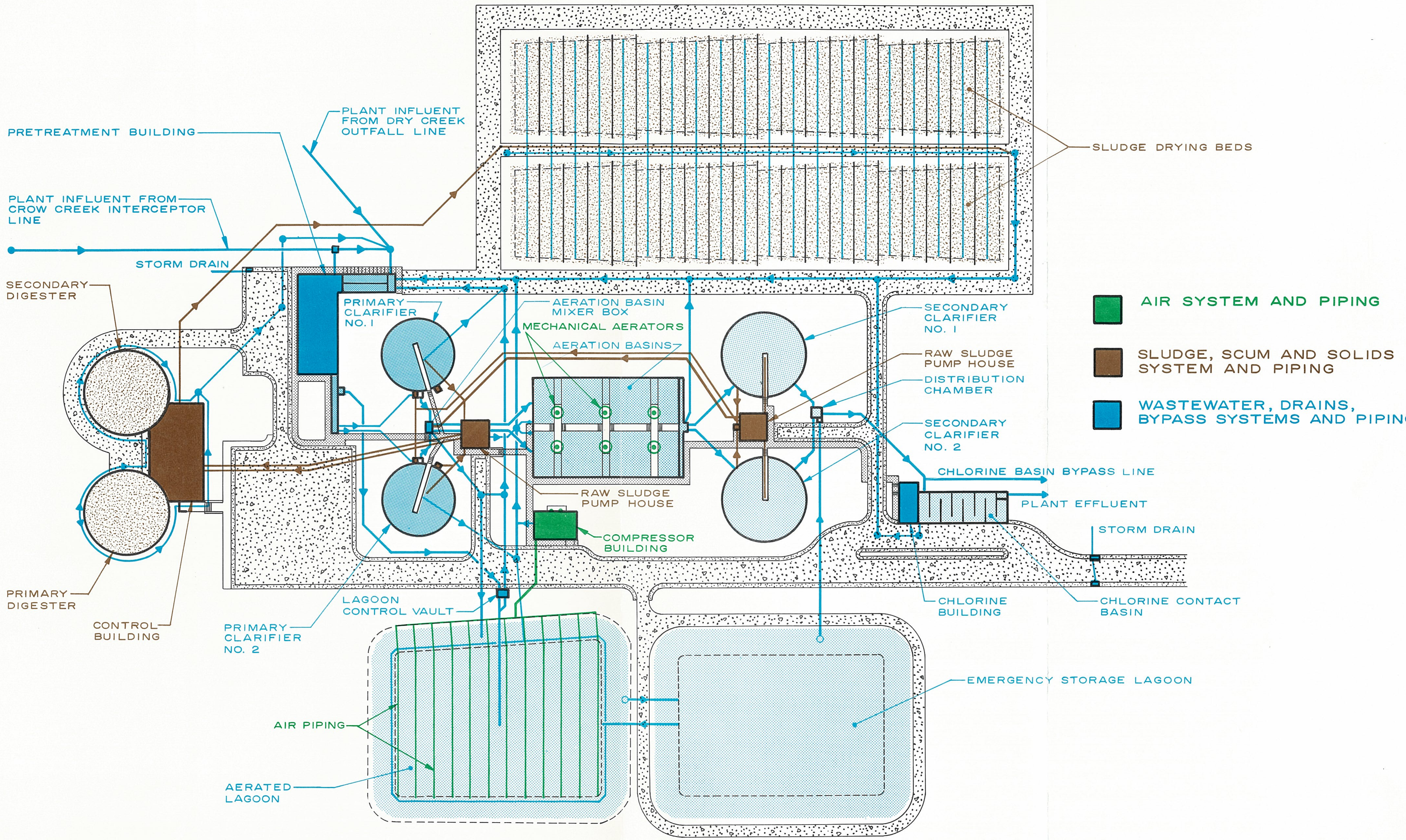
a. Water Supply

The normal operation of a wastewater treatment plant calls for a reliable water supply for cleaning and other operational procedures. The well at the Dry Creek Plant is not always able to meet the needs of the plant. Operational difficulties have been encountered when the well does not meet the needs, i.e. digester cleaning.

It is recommended that the city consider extending its water supply to the Dry Creek facility. The nearest water line is reported to be 1.6 miles away from the plant. Jack Young, the head operator of the city wastewater treatment facilities, reports that a reliable water supply "could reduce maintenance costs by one-third at the Dry Creek Plant."

b. Pretreatment

The existing pretreatment facility includes a manually cleaned bar rack and a square grit chamber (detritus tank). A barminutor, originally



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EXISTING DRY CREEK WASTEWATER TREATMENT FACILITY

FIGURE B-V-1

placed downstream of the grit chamber, has been removed. From an operational point of view, the pretreatment operation is the most undesirable aspect of a wastewater treatment plant. The operators currently must manually clean the bar rack twice a day to prevent excessive head loss and blockage. Screenings and grit must be manually loaded into a truck for subsequent disposal.

In order to accomplish the removal of undesirable large solids with considerable less operator time, it is recommended that the existing bar rack be converted to a trash rack by removing every other bar. The barminutor location could then be modified to facilitate a mechanically cleaned bar rack.

It is reported by Jack Young that the grit removal facility is successfully removing grit from the waste flow, and therefore no major renovation of this operation is required. Problems are frequently encountered, however, with the grit removal and washing screw conveyor. The existing auger has a midship bearing that has required frequent servicing. The replacement of this auger with a single piece auger or a reciprocating rake mechanism (grit washing mechanism), including an organic return mechanism, would eliminate the problems with the midship bearings.

The screenings and grit collected in the pretreatment operations are currently deposited in a wheelbarrow and then hand loaded overhead into a dump truck for subsequent disposal. This practice is not only inefficient, but also poses a considerable health hazard. The incorporation of a vertical elevator and/or a conveyor system, or the construction of a loading dock for the automatic deposition of screenings and grit is recommended. This recommendation will be more thoroughly discussed in the final report.

Current flow measurement problems exist during winter months when the float on the Parshall flume tends to collect ice and stick resulting in inaccurate flow measurement. The construction of a stilling well adjacent to the parshall flume and tapped into the flume at the appropriate location with the float situated in the stilling well may result in the acquisition of reliable flow measurement.

c. Primary Clarification

Primary clarification at the Dry Creek plant is accomplished with two 60' diameter circular clarifiers. These clarifiers are the peripheral feed-center draw-off type designed to handle average flows of 2.25 MGD each and peak flows of 4.5 MGD each.

The incorporation of some minor changes may improve not only the clarification process but also the efficiency of subsequent operations and processes. Scum and grease accumulation has proven to be an operational headache, particularly in the primary digester. The existing scum draw-off lines connect directly to the sludge draw-off lines. The scum then accompanies the primary sludge to the primary digester via the raw sludge pump house. Scum and grease are hydrophobic and as such do not mix with the sludge. This gives rise to the reported scum and grease difficulties in the primary digester (Jack Young).

Scum and grease generally have a high COD due to fats and oil, but are not considered dangerous for landfill disposal. It is recommended that the scum draw-off lines be disconnected from the sludge draw-off lines. The scum and grease should then be transported to a side hill dewatering screen or a drying bed (separate from the existing sludge drying beds) to be dewatered with subsequent landfill disposal. A more detailed discussion of a sidehill dewatering screen will be presented in the final report.

To prevent short-circuiting of the flow in center draw-off clarifiers, extreme care must be exercised in setting the level of the influent and effluent weir. If one side is lower than the other, currents could be established in the clarifier, causing a portion of the waste stream to be passed out of the clarifier before the required hydraulic retention time is reached. It is recommended that the level of the weir troughs be checked. If the weirs are found to be out of level, the situation should be rectified.

The existing primary clarifiers provide a detention time of 135 minutes at an average flow of 4.5 MGD. At this flow rate, the weir overflow rate is nearly 12,000 gpd/foot, and the surface loading is 795 gpd/square foot. These quantities are within the acceptable range according to the "Ten States Standards", which are the guidelines that are used by DEQ. The existing primary clarifiers could handle an average flow of 5.65 MGD and would be operating at the high end of the design criteria, i.e. 105 min D.T.; 15,000 gpd/foot weir overflow rate; and 1,000 gpd/square foot surface loading (Ten States Standards). An average day flow of 5.65 MGD should not be reached until after the year 2005, if 2.5 MGD is treated at the South Cheyenne WWTF.

d. Sludge Pumps

The existing raw sludge pumps are variable speed units, each with a maximum capacity of 250 gpm at 65 feet TDH. These pumps are reported to operate satisfactorily, and no renovation of the sludge pumps is recommended at this time. Operational difficulties do arise, however, with the control of these pumps. The sludge pumps were intended to operate as long as the sludge density is sufficient (2% or more) as measured by a density meter. Jack Young reports that the density meter was inaccurate and difficult to calibrate, resulting in the pumping of a sludge with too low a density for the proper operation of the digesters. Therefore, the density meters are not being used to control pump operation. The difficulties with the density meters should be further explored to determine if they can be placed in service and will operate satisfactorily in order to insure a sludge density of at least 3%. To insure that a sludge with high enough density is being delivered to the digesters, sludge thickening should be incorporated. This is discussed in greater detail in the final report.

e. Activated Sludge Aeration Basins

The existing activated sludge aeration basins operate in the conventional activated sludge (CAS) mode. It is reported by Jack Young that the existing aeration facilities are operating adequately (i.e. providing adequate detention time, and subsequent BOD and SS reduction). Difficulties have arisen with motor bearings on the aerators, but with the quality of operator maintenance that exists, these problems appear manageable.

It is reported that the dissolved oxygen (D.O.) in the aeration basins is 1.7 mg/l, which is somewhat lower than desired (2.0 mg/l). A microbiological examination of the mixed liquor may provide information regarding the populations of the various microorganisms present in the mixed liquor. If a high population of filamentous organisms is present, steps should be taken to eliminate the filamentous population. Filamentous organisms survive well at relatively anaerobic conditions and may also contribute to a brown foam buildup. This and other possible explanations of the low D.O. and methods to increase the D.O. to the desired level of 2.0 mg/l will be discussed in the final report.

It is also reported that the D.O. sensors at the effluent end of the reactor basins consistently fail to give accurate readings. The reason for these inaccurate readings should be further investigated. Some thought should be given to the value of situating six D.O. probes throughout the basin in order to get an indication of the D.O. throughout.

Based on Ten States Standards and MOP-8 design criteria, as shown in Table B-V-1, the existing reactor basins can handle an average flow of 4.5 MGD. This flow is expected to be reached at the Dry Creek plant in approximately the year 2000. At that time, upgrading of the plant may be required.

Table B-V-1

Activated Sludge Aeration Basin Design Criteria

	Volumetric Loading	MLSS	D.T.	Qr/Q
Conventional	20-40 lb BOD/ 1000 cubic feet	1500-3000 mg/l	4-8 hr	.25-.50
Complete Mix	50-120 lb BOD/ 1000 cubic feet	3000-6000 mg/l	3-5 hr	.25-1.00

When the required conventional activated sludge reactor basin capacity is reached, it is suggested that piping rearrangements be undertaken to convert to a Complete Mix Activated Sludge (CMAS) scheme. Assuming 30% BOD removal in the primary clarifiers, D.T. of 3 hours, and a Qr/Q ratio of 0.50, the existing reactor basins have an average flow capacity of 5.25 MGD when in the CMAS mode of operation. With average flow capacities of 5.25 MGD at the Dry Creek facility and 4.0 MGD at the Crow Creek facility, the city wastewater treatment capability should be adequate until a population equivalent of approximately 80,000 is reached.

The biological activity occurring in the reactor basins is highly temperature dependent. When the temperature is reduced during the winter months, the biological activity is slowed down. The installation of covers, e.g. fiberglass reinforced plastic (FRP), on the aeration basins could greatly improve the treatment efficiency. This recommendation will be more thoroughly discussed in the final report.

f. Aerated Lagoon, Compressor, and Generator

The 1.35 million gallon aerated lagoon is complete with a liner, aeration system, influent and effluent lines, and drain lines. The lagoon is used for storage and aeration of excess or bypassed sewage flows at the plant.

Maintenance difficulties have developed with the compressors. The two compressors are positive displacement compressors, each with a maximum capacity of 3000 cfm at a discharge pressure of 4.0 psig. Both compressors leak oil around the seals causing maintenance costs. The variable speed motor on compressor number 1 is reported to need work to correct its tendency to gallop. No difficulties with the emergency generator have been reported.

g. Secondary Clarifiers

Preliminary evaluation of the two 70 feet diameter peripheral feed, center draw-off clarifiers at the Dry Creek WWTF indicates that they are adequately sized to handle a peak flow of 9.24 MGD. This flow is not expected to occur during the design period based on the required overflow rate, solids loading, and weir loading. The clarifiers are structurally sound and should provide for adequate final clarification throughout the study period.

The scum removal system could be improved. The installation of a scum spraying system would greatly improve the movement of the scum to the scum draw-off pipe. Once the scum is drawn off, it is stored in a scum pit and then mixed with the waste sludge and returned to the primary clarifiers. This increases the scum problem in the primary clarifier as well as in subsequent processes and operations. It is recommended that the scum not be mixed with the waste sludge, but instead be piped to a scum drying bed for dewatering and disposal.

Secondary sludge is successfully removed with a rotating collector arm where suction is applied through the sludge collection nozzles. The suction is generated by the return sludge pumps. This is typical of secondary sludge removal system and should fulfill this need adequately throughout the study period. A drain that connects with the sludge draw-off line is located in the bottom of each clarifier, roughly 4 feet from the torque tube. Jack Young reported that the drain plug in both clarifiers has been damaged, allowing for continuous draining. This does not have a serious effect on the clarification performance, but it could reduce the sludge removal capability by decreasing the suction being applied through the sludge collector nozzles. Another effect could be a reduction in sludge density that is removed, but this is most likely only a minor effect, if even that.

The effluent weir trough is situated in a similar manner as in the primary clarifiers. It is vital that the level of this effluent trough be set accurately to insure the proper hydraulic operation of the clarifier.

h. Return Sludge Pump

The return sludge pumping is accomplished with three horizontal sludge pumps, each with a maximum capacity of 1500 gpm at 1200 rpm. Normal operation calls for the use of two pumps with the third on standby. Difficulties in operation reportedly arise when any one of the pumps is put out of operation. The exact cause of the problem and possible solutions will be thoroughly explored and presented in the final report.

The return sludge density meter has a capacity of 0 to 1% solids. It is reported by Jack Young that this meter is unreliable, as is the raw sludge density meter. It is recommended that this situation be rectified, as the continuous accurate recording of sludge density provides a valuable operational tool.

i. Chlorination

The existing chlorination equipment consists of two solution feed vacuum operated chlorinators, each with a capacity of 500 lbs/day. There is also a remote solution feed vacuum operated chlorinator with a capacity of 500 lbs/day. With the chlorine water booster pump, chlorine scale, two chlorine ejectors, and a chlorine diffuser in the contact basin, this system is capable of chlorinating up to 9.0 MGD. At a flow of 9.0 MGD, the contact basin provides a 15-minute detention time, which is within the recommended range (MOP8). The basin is reported to be operating properly, and no changes appear to be necessary.

j. Sludge Digestion

Sludge digestion at the Dry Creek facility is accomplished with two circular anaerobic digesters, each having a volume capacity of approximately 800,000 gallons. The anaerobic digesters treat the raw sludge taken from the primary clarifiers for subsequent application to the sludge drying beds for dewatering.

The normal operation of the anaerobic digesters is in a series flow pattern. Raw sludge is pumped by the raw sludge pumps to the heat exchanger where the temperature should be increased to 90-95°F (desirable temperature range for anaerobic digestion). Recirculated sludge is also pumped to the heat exchanger. The mixture of raw and recirculated sludge is then discharged to the primary digester.

In a two-stage digestion system, the function of the first stage (primary digester) is to anaerobically decompose the organic solids (digestion). Mixing should also be accomplished in the primary digester to break up scum formations and generally aid in the digestion process. The mixing should be accomplished by the gas recirculation and gas mixing systems. The first-stage digester also holds the sludge during the most active gas production stage.

The secondary digester is used for storage and concentration of digested sludge for the formation of a relatively clean supernatant and for residual gas extraction. The sludge is transferred from the primary to the secondary digester by gravity flow. Once in the secondary digester, the sludge is allowed to settle to the tank bottom, with the clearer supernatant portion collecting above. The supernatant is then withdrawn and directed back to the plant influent. After a digestion period of about 30 days, the sludge is directed to the sludge drying beds to be dewatered with subsequent disposal.

Serious operational difficulties have developed in the anaerobic digestion process at the Dry Creek facility. The accumulation of scum and grease in the primary digester has resulted in the formation of a heavy layer that has prevented gas production and the related mixing. Plant operators report that a grit accumulation in the primary digester has added to the poor digestion performance. A thorough cleaning of the primary digester is recommended. It may be that a commercial cleaning firm will have to be hired to clean the digester due to the thickness of the blanket. In the future, with a water system having adequate pressure, the buildup of a scum blanket could be avoided.

The changes in the scum handling at the plant discussed previously (primary and secondary clarifiers) would improve the digestion operation by eliminating the presence of the scum. Scum consists primarily of grease and oil and hinders the required mixing in the primary digester. The provision of greater control over the raw sludge density being delivered to the digester should also improve the digester performance. The raw sludge delivered to the digester should have a minimum density of 2% solids. A sludge density of 4 to 5% should improve performance even more.

The heat exchanger must be capable of raising the temperature of the raw sludge to 95°F prior to its entrance to the digester. If this can be accomplished, the digester performance should be improved. The pumping of large volumes of this sludge (density less than 2% solids) at a high rate tends to cool the sludge rapidly. With the above mentioned control over sludge density, and pumping at a slower rate, a reduction in the total volume and heat required should be accomplished.

The digesters, as designed, should effectively produce a stabilized sludge suitable for dewatering on the sand drying beds. Several sludge samples were taken of the digester influent sludge (raw sludge and waste sludge) and effluent sludge. These tests indicated that the sludge is suitable for application to sand drying beds.

k. Conclusion

The Dry Creek WWTF is a modern and effective wastewater treatment plant. With the above improvements, this plant should have no difficulty in producing an effluent of required quality for an average flow of 4.5 MGD. These improvements should aid in the operation and reduce maintenance costs. The final report will discuss in detail the effects that the chosen alternative will have on the Dry Creek facility.

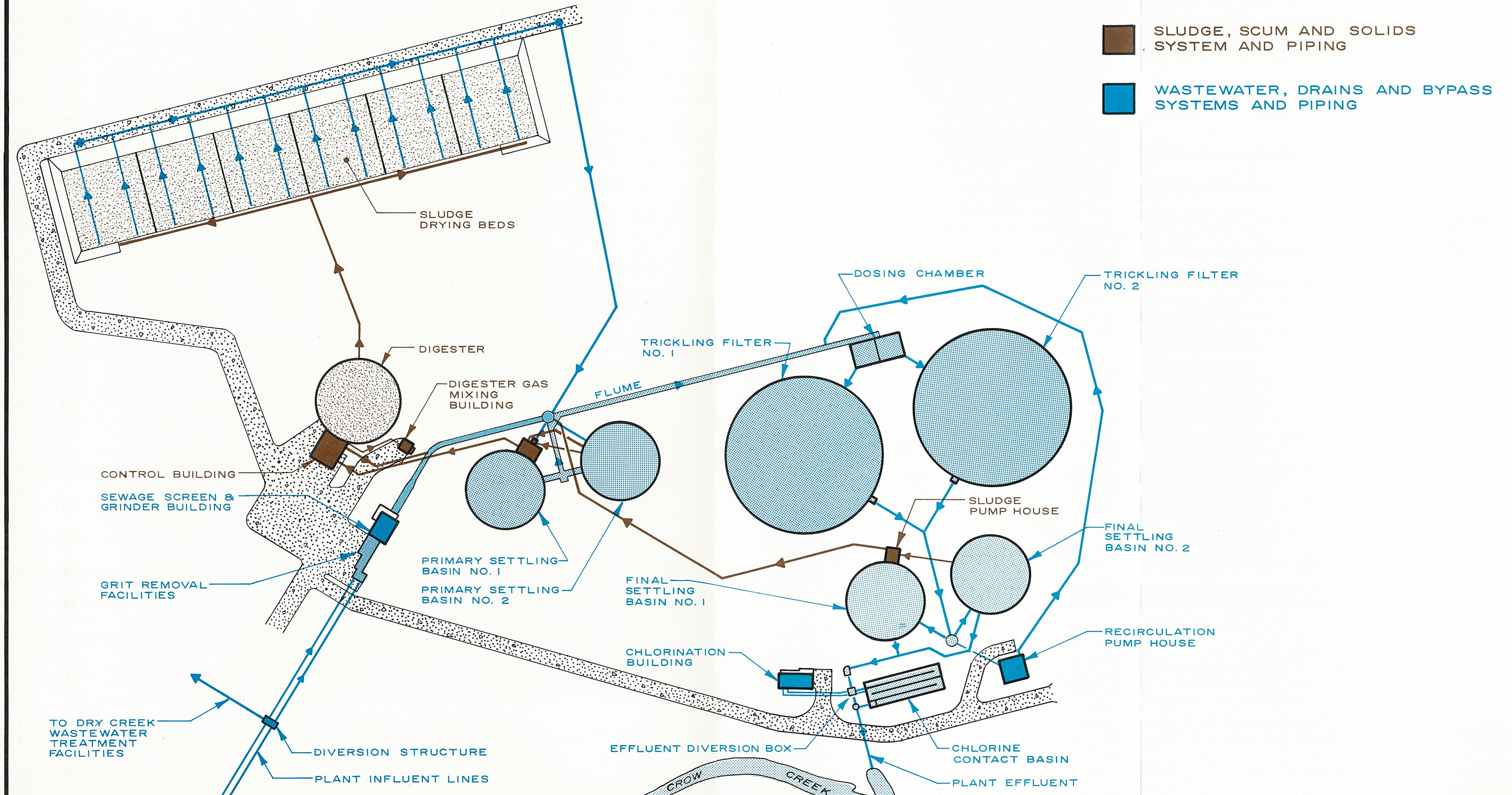
3. Crow Creek Wastewater Treatment Facility

a. General

The Crow Creek WWTF is located in the SE¼ of Section 3, T13N, R66W and is a trickling filter wastewater treatment plant.

This facility was constructed in the early 1940's, and was originally a low-rate trickling filter plant with an 8.0 MGD average daily flow capacity. The original design of the plant was a single-stage low-rate (no recirculation) facility. In 1974, upgrading of the facility was undertaken. This renovation resulted in a high-rate trickling filter plant (recirculation rate of 4.0 MGD) with a design flow capacity of 4.0 MGD (average day flow). The flow diagram of the Crow Creek WWTF is presented in Figures B-V-3 and B-V-4.

By the end of the study period (2005), the Crow Creek facility will be 60 years old. It is felt that at that time, this facility will be approaching its expected design life. For this reason, no major renovations are considered wise at this time. Techniques aimed at improving the



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EXISTING CROW CREEK WASTEWATER TREATMENT FACILITY

FIGURE B-V-3

operation of this plant to insure the production of an acceptable effluent until the year 2005 are therefore the goal of this section. It is assumed that an average flow goal of 4.0 MGD will be maintained at this plant. Each unit process and operation are generally discussed below.

b. Pretreatment

The existing pretreatment facilities at the Crow Creek plant consist of a rake and channel grit chamber with an auger and wheelbarrow for grit removal, followed by a mechanically cleaned bar rack and a Parshall flume.

The grit removal chamber is a horizontal flow, velocity controlled type. Chambers of this type are designed to maintain a flow velocity as close to 1 fps as practical. At a velocity of 1 fps, most organic particles will be carried through the chamber, but the heavier grit will be allowed to settle out. For the efficient operation of this type of grit chamber, a control section on the downstream end of the channel should be employed to vary the depth of flow in the channel as the volume changes, thus providing relatively uniform velocities over a wide range of flow. Without this flow control, excessive organics are deposited with the grit during low flow conditions, and grit passes through the chamber during high flow conditions. This essential flow control is not provided at the Crow Creek facility. A proportional weir, such as a Sutro weir, is frequently used as a control device. These weirs are adaptable to rectangular channels and could be retrofitted to the Crow Creek facility. The installation of a control device, such as a proportional weir, is recommended and would probably improve the overall grit removal operation.

To prevent excessive accumulations of grit, the grit collector should be continuously operated. New chains and flights were recently installed on the grit collector (1980). No problems with the grit collector, grit elevator, and grit washer have been reported. It is believed that, with regular maintenance, the existing grit removal system with the added flow device will be adequate for the study period.

The mechanically cleaned bar screen is manufactured by Link-Belt. This screen is approaching its anticipated lifetime, but Jack Young reports that he is planning to rebuild the unit since it basically functions properly. With the proper rebuilding of the bar rack, adequate screening should be accomplished throughout the study period.

Flow measurement is accomplished by a Parshall flume located in the channel downstream of the pretreatment building. A 2" line goes from the appropriate location in the Parshall flume to a stilling well in the control building, where the flow is continuously recorded on a 12" circular chart. This system has a range of 0.2 to 10.0 MGD and should accurately record the flow rate to the Crow Creek facility until the end of the study period.

In general the pretreatment facility is sound, and with the incorporation of a flow control device for the grit chamber, pretreatment should be adequately accomplished until the year 2005. An improved system of disposal of the grit and screenings would aid in the successful pretreatment operation. Currently, the grit and screenings are placed in a dump truck outside of the pretreatment building. By covering this loading area, or providing a means of moving this operation inside, the overall pretreatment operation would be acceptable.

c. Primary Clarification

Primary clarification at the Crow Creek facility is accomplished in two 80-foot diameter circular clarifiers. Using a conservative value of 800 gpd per square foot for the surface settling rate, the capacity of the primary clarifiers is 8 MGD. For a weir loading rate of no greater than 15,000 gpd/lineal foot at average flow conditions, the capacity of the primary clarifiers is 7.4 MGD. These calculations indicate that the primary sedimentation basins are more than adequately sized to handle an average flow of 4.0 MGD.

It is reported by Jack Young that some structural steel has aged and needs to be replaced. The extent of and benefits derived from replacing any structural steel will have to be evaluated within the maintenance program established for the Crow Creek facility.

The motor and electrical units on the primary clarification mechanisms are generally in good shape, but the drive units (large pinion gears and idler shafts) are reported to need repair. The clarifiers have a 10.5 feet side water depth (S.W.D.), so retrofitting the basins with completely new mechanisms could be accomplished relatively easily. This will be examined in greater detail in the final report.

It is reported by Jack Young that a fairly good solids concentration of approximately 3-3½% is removed from the primary clarifiers. With regular maintenance and with the replacement of equipment as necessary, the existing clarifiers should function quite well throughout the duration of the study period.

d. Trickling Filters

High-rate trickling filter wastewater treatment is accomplished at the Crow Creek facility with two 165-foot diameter trickling filters with a media depth of 5½ feet. Each filter has a 4-arm rotary distributor with a capacity of 5500 gpm (7.92 MGD). Each arm has a series of flow nozzles to allow water to discharge. These nozzles occasionally become plugged, but regular maintenance rectifies this situation.

Both filters are reported to be structurally sound (Jack Young). The piping and other components (i.e. weirs) are all in good condition and with regular maintenance should remain in satisfactory condition for the duration of the study period.

Poor ventilation of the filters could result in odor problems. The ventilation could be improved by forcing air into the filter drain system. This would result in a more pleasant atmosphere and perhaps an increase in filter efficiency by providing the aerobic microorganisms on the rock media with a more desirable environment. The filter ventilation system will be more thoroughly investigated and discussed in the final report.

It is reported that a snail population has caused considerable operational difficulties. The snails appear on check valves and in the secondary sludge pumps, and are killed and settle in the chlorine contact basin, where their presence is a nuisance. The presence of snails is generally caused by climatic conditions, and can be eliminated by chlorinating the influent to the trickling filters in order to produce a residual of 0.5-1.0 mg/l. Another method of removing the snail population is to flush the filter with the maximum recirculation rate.

Alternative methods of improving the trickling filter performance have been investigated. One such alternative considered was conversion of the media to a plastic media, e.g. Surpac media. The conversion to plastic media is not recommended because of the extremely high recirculation rate (approximately 18 MGD) required to keep the media surface wet.

Another alternative investigated was covering the filters to control the temperature loss through the filters. Temperature plays an important role in the efficiency of trickling filters, but the temperature drop during the winter is mainly in the influent to the plant. The covering of the filters would prevent approximately 2°C drop in temperature and would result in roughly a 5% improvement in filter efficiency. For the estimated cost of $600,000 to cover the filters, this alternative is not recommended at this time.

The third alternative considered was the construction of a roughing filter 30 feet in diameter and 20 feet deep with plastic media. The roughing filter is estimated to cost approximately $200,000, with an annual O&M cost of $14,500/year and would result in only about a 4% increase in overall plant efficiency. This improvement in overall efficiency is not great enough to justify the expense of a roughing filter. Since the anticipated lifetime of the Crow Creek WWTF is not expected to be much beyond the end of the study period, the construction of a new unit process is hardly justifiable.

A fourth alternative investigated was the addition of chemicals during the winter months only. Chemical addition counteracts the adverse effects of cold sewage and air temperature and increases the efficiency of BOD and SS removal. This effectively reduces the loadings on the filters and final clarifiers. The increase in sludge volume of 50 to 100% could result from chemical addition.

Chemical additions prior to the primary clarifiers could increase the BOD removal in the primaries to 50% and could improve the trickling filter efficiency to 80%. The overall plant efficiency could be increased to 90%. The effect of chemical addition (alum, ferric chloride, polymers, or lime) will be more thoroughly discussed in the final report.

Evaluations of the existing trickling filters were undertaken. Using a primary clarifier efficiency of 35% and a temperature correction factor of 6%, an influent flow of 4 MGD with a recirculated flow of 4.0 MGD can be sufficiently treated. It is felt that the existing filters, with regular maintenance, will provide adequate wastewater treatment until the end of the study period. Regular maintenance of the trickling filters would be more easily facilitated if valving on the gates of the dosing tank were improved.

e. Final Clarifiers

The two 80-foot diameter final clarifiers at the Crow Creek facility are reported to be generally sound. Cracks in the bottoms allow for some groundwater intrusion, but this is considered to be a minor problem. If the basins are ever dewatered, the cracks in the bottom should be sealed. The drive units are in need of work, but regular maintenance should take care of this, if maintenance funds are available. The clarifiers are constructed in such a manner that possible retrofitting of new mechanisms would not be an extremely difficult undertaking.

Dye tests run on the secondary clarifiers indicated that the hydraulic efficiency of the clarifiers is reduced due to short-circuiting of flow. When short-circuiting occurs, it is accompanied by a corresponding dead space within the clarifier where stagnation of flow is occurring. Causes of and solutions for this situation, if possible, will be evaluated in the final report.

Sludge removal is accomplished by sludge flights that direct the sludge to a pocket near the center of each basin. From the sludge pocket, the solids are removed through a 6" pipe by the return sludge pumps. Secondary sludge is typically very light, and has the tendency to float over mechanical devices like sludge flights. A better arrangement for secondary sludge removal would be a siphon sludge removal system. The incorporation of such a system will be discussed in detail in the final report.

The secondary sludge pumps are reported to be in good condition. Problems have arisen where snails have gotten into the check valve, causing excessive wear. With the removal of the snail population, this problem should be eliminated.

f. Recirculation System

The purpose of the recirculation system is to recirculate the trickling filter effluent back to the dosing chambers of the trickling filters. Two vertical sewage pumps with a capacity of 2000 gpm (2.88 MGD) are used to recirculate the flow. This system is generally sound, but difficulties with the motor bearings have been reported. A new check valve for the sump is needed. With these minor improvements, the recirculation system should operate adequately for recirculated flow of up to 5.7 MGD.

The recirculation flow meter has a capacity of 6000 gpm (8.64 MGD). Recirculated flow is reported to range from 75% to 100% of the influent flow (Jack Young), but this is currently not closely monitored.

g. Disinfection

Disinfection is provided by the chlorination facility, consisting of two vacuum operated, solution feed chlorinators, each with 500 pounds/day capacity, with all the required appurtenances (chlorine water booster pump, scale, chlorine injectors, and diffusers). The contact basin is sized to provide a 30-minute detention time at a flow of 4.0 MGD. All the above mentioned equipment is in good condition. Regular maintenance will insure that the disinfection process successfully accomplishes coliform destruction throughout the study period.

The main operational problem encountered in the disinfection basin has been the settling out of snails. This problem should be taken care of by the successful elimination of the snail population in upstream processes.

h. Anaerobic Digestion

A combination of primary sludge and a small amount of secondary, waste sludge is stabilized in the single-stage anaerobic digester at the Crow Creek facility. In the single-stage process, the functions of digestion, sludge thickening, and supernatant formation are carried out simultaneously.

Raw sludge is added to the zone where sludge is actively digesting and the gas is being released. As gas rises to the surface, it lifts sludge particles and other materials (grease, oils, and fats), ultimately giving rise to the formation of a scum layer. As a result of digestion, the sludge becomes more mineralized, e.g. percent of fixed solids increases, and it thickens due to gravity. This in turn leads to the formation of a supernatant layer above the digested sludge.

The biological activity occurring in the anaerobic digestion process involves two different groups of bacteria. In the first group, facultative and anaerobic bacteria (called acid-forming bacteria) convert the organic material in the sludge to organic acids. Some carbon dioxide is formed in this group, and some stabilization occurs. In the second group, the organic acids are converted to carbon dioxide and methane gas by anaerobic bacteria called methane-forming bacteria. Most of the stabilization occurs in this group as the organics are converted into gas, water, and a small amount of biological mass.

The anaerobic process is mostly controlled by the methane-forming bacteria. These bacteria grow slowly and are very sensitive to pH, sludge composition, and temperature. If the pH drops below 6.0, methane does not form, and the organic concentration in the sludge does not decrease.

Sludge samples from the Crow Creek digester influent and effluent were analyzed by James H. Stewart and Associates, Inc. environmental laboratory in Fort Collins, Colorado. The results of these tests indicate a high volatile acid concentration and low pH. This indicates that the acid-forming reaction is proceeding too rapidly for the methane-forming activity to keep up. The acid-forming bacteria are not hindered by the low pH, and so their activity proceeds. The methane-forming bacteria, on the other hand, cannot function when the pH is below about 6.5. These bacteria are not destroyed, but are rendered inert.

The condition of high volatile acid concentration and low pH probably developed by allowing the temperature to drop while maintaining a constant sludge dosing. This results in a reduced ability to destroy volatile acids. A temperature drop of only 2 or 3 degrees is enough to disturb the balance between the acid and methane formers. The digester should be operated in the 90-95°F temperature range.

This condition indicates that the volatile acid:alkalinity ratio has risen and must be reduced. One method of accomplishing this is to add alkalinity in the form of sodium bicarbonate ($NaHCO_3$). This would effectively increase the pH, allowing for the production of methane. Extreme care must be exercised if this method is used to avoid the formation of a $NaHCO_3$ sludge that could harden in the bottom of the digester.

Another method of rectifying this situation is to discontinue the feeding of raw sludge to the digester and give the methane formers a chance to catch up. This means that the raw sludge collected in the primary clarifiers will have to be handled elsewhere in the meantime. The discontinuation of sludge dosing must be accompanied by heating to nearly 100°F and by mixing. Much foaming will initially develop, but this must not cause the operation to stop. The digester contents should be closely monitored for pH and alkalinity, and for CO_2 content in the produced gas. When these parameters are brought into the appropriate range, raw sludge feeding may continue. The digester must then be monitored for pH, alkalinity, and CO_2 to prevent overloading.

The third possible solution would be to empty the tank and start the process over again. The tank should be half filled with sludge from a good digester and then filled with primary sludge. The contents should then be heated to approximately 100°F and the digestion process allowed to proceed. Close monitoring of the above mentioned parameters is critical to insure the continued successful operation of the digester.

It has been reported that extremely high supernatant solids concentration has presented considerable operational difficulties. With the efficient operation of the digester, and by supernatant withdrawal from the appropriate location in the digester, the supernatant solids concentration should be reduced to the desired level of approximately 5000 mg/1.

The supernatant is currently recycled to the plant influent. The solids in the supernatant have characteristics that make them difficult to treat. It is suggested that the drying beds be expanded in order to accept the supernatant rather than returning this flow to the plant influent. The underdrain flow from this drying bed should then be returned to the plant influent. The solids, collected on the drying bed, can be disposed of with the sludge from the drying beds.

The raw sludge pumping system is reported by Jack Young to be in need of extensive repair. It is suggested that the existing sludge pumps, which are approaching their expected lifetime, be replaced with new sludge pumps capable of delivering a sludge of 5% solids to the digester. It is essential for efficient digester operation that the quantity of sludge delivered to the digester not be so great as to upset the digestion operation. The installation of a new sludge flow meter is therefore recommended. Improvements in the piping arrangement ahead of the heat exchanger would also aid in the digester operation.

The gas system is in need of a complete renovation. The piping on the digester interior is reported to be in poor condition and in need of replacement, as well as the exterior gas piping. The gas mixer is reportedly in good condition and requires no renovation at this time.

The heat exchanger is generally in good condition, but does require minor renovation. The exchanger unit should be soundproofed, as it currently is very noisy and may be above OSHA limits (Jack Young). The exchanger exhaust system needs renovation.

Structurally, the digester is basically sound. A very small hairline crack has developed in the wall, and slight oil penetration into the control room from the digester has developed. This could be patched from the inside and should be accomplished when the digester is emptied to replace the piping. The floating cover has tipped severely. This is because the rollers on the cover are not stout enough to provide steady support. This situation should be rectified when the digester is emptied.

This discussion of the anaerobic digestion system at the Crow Creek facility has centered on means of improving the digester performance. Upon the reestablishment of efficient digester operation, with the above mentioned piping and structural improvements, anaerobic digestion at the Crow Creek facility should be successfully accomplished throughout the study period.

i. <u>Site Improvements</u>

Generally, the structures are in sound condition, considering their age. Normal maintenance procedures should be sufficient to maintain the structural integrity throughout the study period.

The flumes, sidewalks, and exterior stairs are in basically good condition, and very little corrosion has occurred. Some cracks in the concrete are noticeable and need to be taken care of.

The grounds are well maintained and should remain so with regular maintenance.

j. <u>Conclusion</u>

The Crow Creek Wastewater Treatment Facility is capable of producing an effluent of acceptable quality. With the structural upgrading and operational improvements discussed, this plant should continue to produce a high quality effluent throughout the study period.

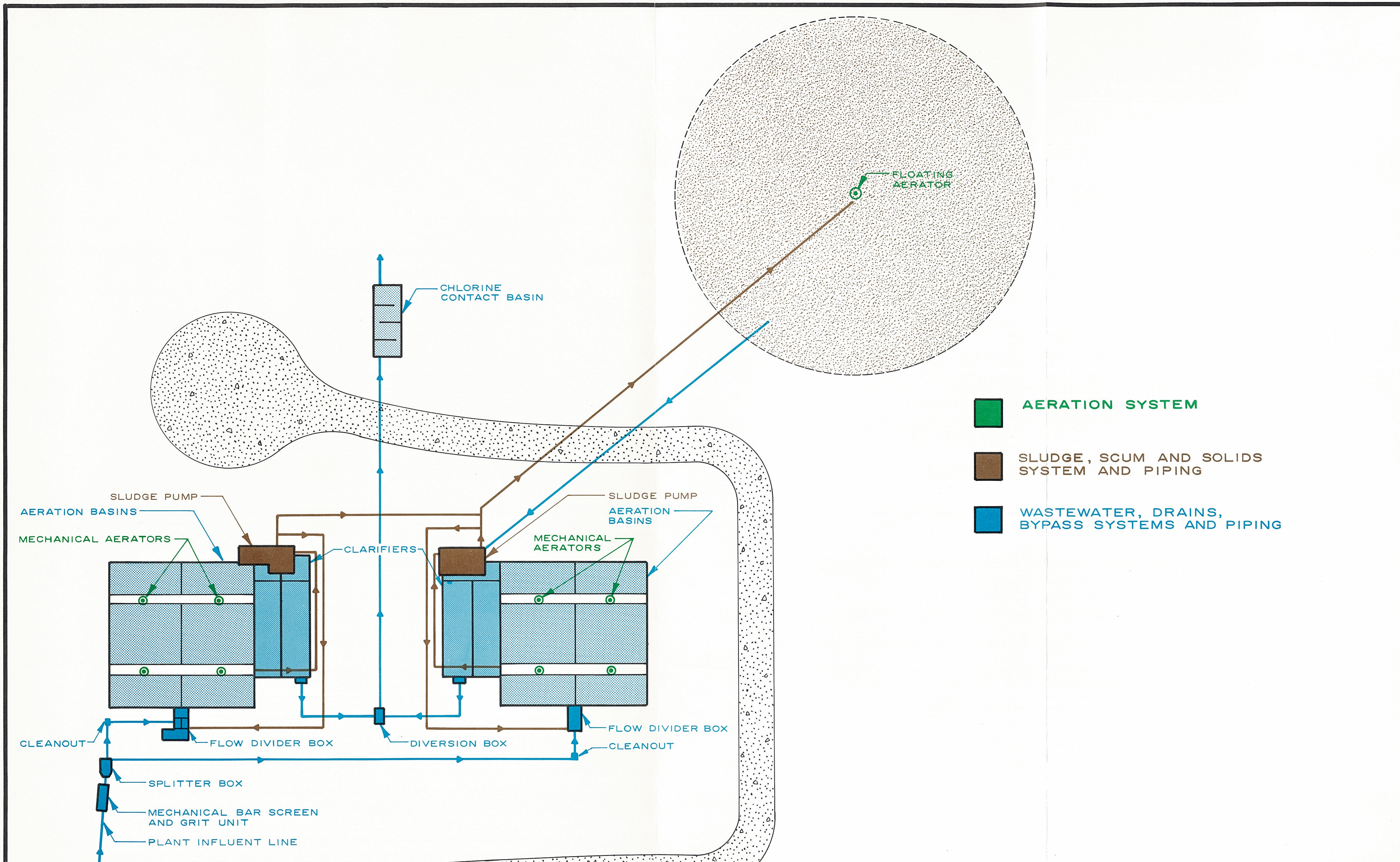
D. SOUTH CHEYENNE WATER AND SEWER DISTRICT

1. Background

The current population for the South Cheyenne Water and Sewer District is estimated to be 6400 people. This population contributes an average flow of .58 MGD and an average influent BOD_5 of 238 mg/l (.18 lb BOD_5 pcpd) to the extended aeration activated sludge wastewater treatment facility in the district. These figures are based on the DEQ Discharge Monitoring Reports, Nov. 1979 through May, 1981.

The South Cheyenne Wastewater Treatment Plant (WWTP) (Figures B-V-5 and B-V-6) has a design hydraulic capacity of .8 MGD (design population of 8000 at 100 gpcd) and a design organic loading of .17 lb BOD_5 pcpd, or 1360 lb BOD_5 per day. With a total aeration basin reactor volume of 107,670 ft^3, a volumetric loading of 12.63 lb $BOD_5/1000\ ft^3$ reactor volume results. Typical volumetric loading for extended aeration processes ranges from 10 to 15 lb $BOD_5/100\ ft^3$ reactor volume. The organic loading on the South Cheyenne WWTP is within the desired range, and this facility was designed to accomplish 90% reduction in BOD_5 and SS at the above specifications.

The plant was not hydraulically nor organically overloaded on the average during the time period of the DEQ Discharge Monitoring Reports investigated. More recent flows (Summer, 1981) have contributed peak and average daily loadings in excess of the design capacity resulting in degradation of the effluent quality. Data are incomplete, but the increasing trend is noticeable. By extrapolation of the average daily flow line to the year 2005, an average daily flow of nearly 2.5 MGD is obtained if all flows from this area are treated at this plant. This coincides with the projected hydraulic loading of 2.5 MGD based on a population of 25,000 persons, each contributing 100 gallons per day.



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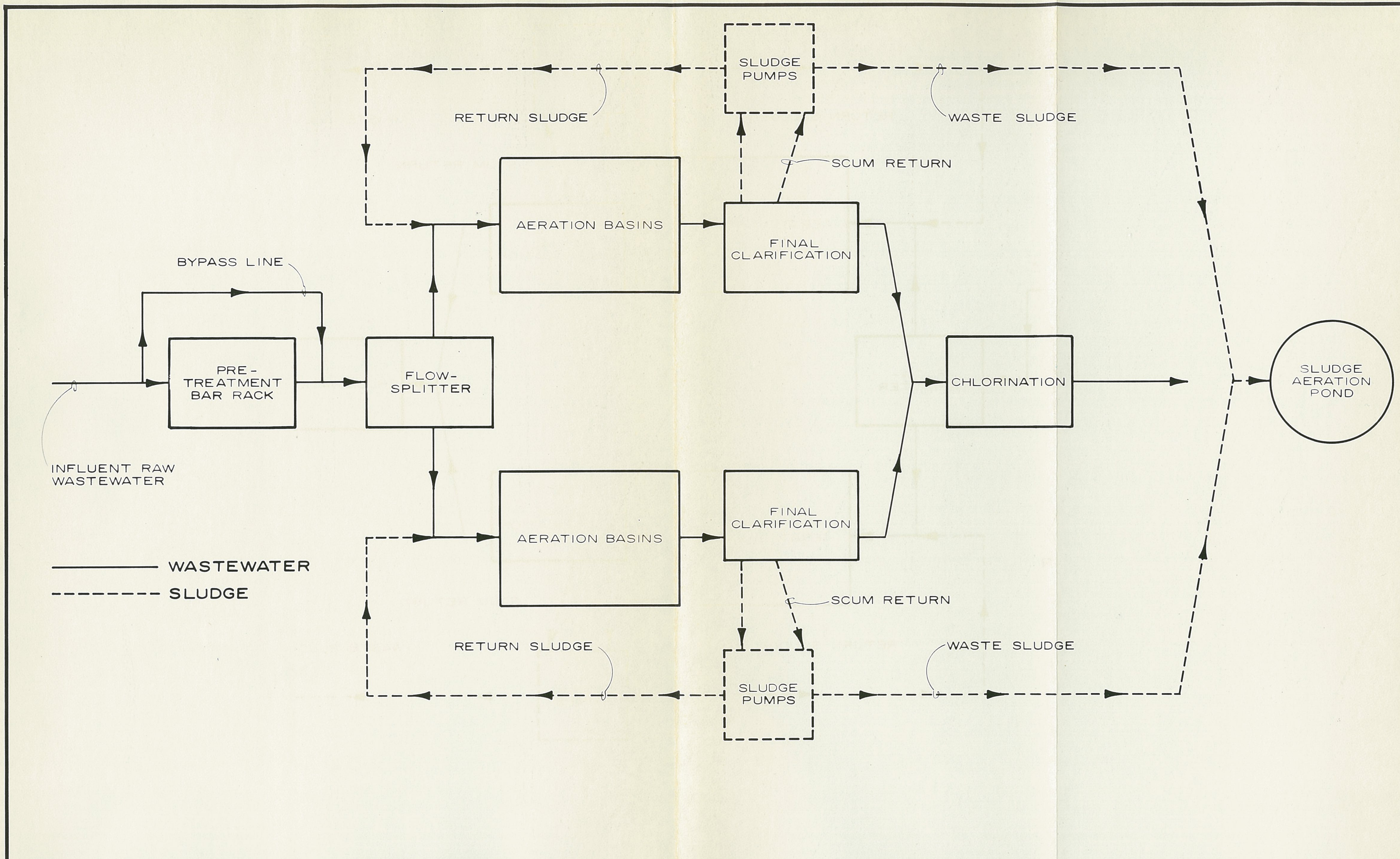
EXISTING SOUTH CHEYENNE
WASTEWATER TREATMENT FACILITY

FIGURE
B-V-5



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SOUTH CHEYENNE WASTEWATER TREATMENT FACILITY
PROCESS DIAGRAM

FIGURE
B-V-6

There are two factors that will affect the flow by the year 2005. According to Art Buffington, Chairman of South Cheyenne Water and Sewer Board, and Herman Noe, Director of the Cheyenne Board of Public Utilities, the boundary of the South Cheyenne Water and Sewer District cannot be changed without permission from the City, which is unlikely. This means that some of the projected 25,000 people could be living outside the present boundaries and therefore could be sewered by the City. Also, the current South Cheyenne Water and Sewer District Board's feelings are to not expand their plant for future growth.

If both of the factors continue, approximately 1.5 MGD will need to be treated by South Cheyenne, and the remaining 1 MGD will be treated by the City. One of the possibilities is to still treat 2.5 MGD at South Cheyenne but with an operational agreement with the City in order to share the costs.

Therefore the alternatives for South Cheyenne will be examined for both 1.5 MGD and 2.5 MGD. For some of the treatment alternatives discussed in this section, only the 2.5 MGD flow is used. However, Chapter B-VI "Evaluation of Alternatives" will consider both flows.

Assuming a loading of .17 lb BOD_5 per person per day and a 2005 population of 25,000 persons, an organic loading of 4250 lb BOD_5 per day is anticipated. With the existing reactor volume of 107,670 ft^3, this would result in a volumetric loading of 39.5 lb $BOD_5/1000\ ft^3$ reactor volume. This loading is greatly in excess of the allowed amount, making upgrading or abandonment of this plant mandatory.

The DEQ reports indicate that the South Cheyenne WWTP is frequently in violation of NPDES discharge requirements. What follows in this report is a thorough evaluation of the existing facility and presentation of alternative methods which will enable the South Cheyenne Water and Sewer District to become and remain in compliance with discharge requirements.

2. Existing Wastewater Treatment Plant Evaluation

a. General

The South Cheyenne WWTP was constructed in two distinct phases: the north "half" and the south "half". Both halves are of identical size, but some differences do exist, such as aeration basin overflow weirs and return activated sludge pumps. There are no support systems such as sludge treatment, nor are there means to measure and control the amount of return sludge. The wastewater treatment plant, as it currently exists, has several operational and design shortcomings that contribute to the district's discharge of an unacceptable effluent.

The existing South Cheyenne wastewater treatment facility is depicted in the process diagram in Figure B-V-6. This facility was designed to treat an average daily flow of 800,000 gallons per day or a population equivalent of 8,000 persons at 100 gallons per day. The present treatment plant facilities consist of the following unit operations and processes.

1) Pretreatment: Bar screen
2) Aeration Basins
3) Final Clarifiers
4) Disinfection
5) Sludge aeration

What follows in this section is first a discussion of the current wastewater treatment situation and suggested improvements to the existing plant followed by alternative methods enabling South Cheyenne to treat its expected future waste load and comply with discharge requirements. Each process in the treatment scheme will be dealt with separately, but it must be remembered that proper wastewater treatment may be accomplished only when the various unit operations and processes are compatibly constructed, operated, and maintained.

b. Pretreatment

Wastewater enters the treatment plant in a 21" influent line. A bypass structure is situated such that the bar rack may be bypassed for maintenance. No bar screen is situated in this bypass channel, allowing for the bypass of solids that could potentially damage downstream equipment and decrease the treatability of the wastewater. The bypassed flow reenters the process scheme at the flow-splitter.

The bar rack is manufactured by AIR-O_2-GEST, and has 1" clear openings. The steel bars are 3" wide and ½" thick. This bar screen is mechanically cleaned, but it is reported that the mechanical rake is capable of removing only the larger solids. The accumulation of solid material on the racks requires manual cleaning, which must be done on the average of once every two days.

The existing bar rack (tritor screen) is situated over a depression in the channel and was theoretically intended to accomplish grit removal as well as solids screening. In theory, the grit deposited in this depression would be carried out by the mechanical rake. This is not accomplished, and frequent plugging of the screen occurs. The result is that grit removal is not accomplished, and the grit is carried through the pretreatment facility and deposited in the aeration basins. Failure to remove grit prior to the aeration basins reduces the treatability of the wastewater and causes damage to pumps and other hydraulic structures.

To accomplish adequate pretreatment, the existing bar rack and pretreatment building should be abandoned, and a new building housing a mechanically cleaned bar rack, an aerated grit chamber, and a Parshall flume for flow measurement should be constructed. This will be addressed in greater detail in the section discussing wastewater treatment alternatives.

c. Activated Sludge Aeration Basins

The extended aeration activated sludge treatment process is characterized by the introduction of raw wastewater directly to the reacter basin (no primary clarification), long-term aeration, high MLSS (mixed liquor suspended solids), high sludge return rate, and low sludge wasting. Extended aeration wastewater treatment processes operate in the endogenous respiration (self-consuming) phase of the microbe's life and thus require lower BOD loading per reactor volume and higher MLSS concentration than conventional activated sludge processes. The extended aeration process also requires a long detention time (D.T.) of approximately 24 hours, and therefore the aeration basin must be sized accordingly. With a total volume of 805,400 gallons in the two halves of the plant, and a design capacity of .8 MGD, the hydraulic residence time, θ, (detention time) is 1.01 days or 24 hours ($\theta = \frac{\text{volume}}{\text{design flow}} = \frac{805,400}{800,000} = 1.01$ day).

The activated sludge for the extended aeration process undergoes aerobic digestion in the reactor basin (endogenous respiration), thereby requiring more oxygen in the basin than is required in other single stage systems. The activated solids theoretically remain in the system so long that they are disintegrated and dispersed throughout the liquid and pass off in the effluent of the final tanks. This is not entirely true, but the solids are stabilized quite well.

Samples of the mixed liquor (activated sludge) were analyzed by James H. Stewart and Associates Environmental Laboratory in Ft. Collins, Colorado, for microbiological species determinations. These tests revealed that 65-70% of the microbes present were filamentous in nature. Five to 15% were coccoid growth, and 15-30% protozoa were observed. A high percentage of filamentous growth is not desirable and is often associated with low dissolved oxygen concentration in the aeration basin. This is in fact the case. Dissolved oxygen concentration tests were taken from various locations and depths in the aeration basins of both halves of the treatment plant. The results indicate a D.O. concentration of 1.13 mg/l in the north or "old" half and a D.O. concentration of 1.19 mg/l in the south half. These low dissolved oxygen values support a filamentous population. Filamentous growth inhibits settling characteristics of the sludge and may contribute to the foam difficulties at the treatment plant. Due to their structure, filamentous populations are very susceptible to the addition of hypochlorous acid (a chlorine solution) and do not survive well at a D.O. concentration greater than 2 mg/l. Methods to reduce the filamentous population and increase the more desirable protozoa population will be discussed later.

The aeration equipment differs between the two halves of the plant. The south, or new, half has 4 Air-O_2-Cone Model 70_2 aerators, each capable of transferring 35 lb. O_2/hr. to the aeration basin, or 140 lb. O_2/hr. for that half of the plant. The north, or old, half has four aerators, each capable of transferring approximately 25 lb. O_2/hr. At an organic loading of 680 lb. BOD_5/day/half, this equates to an oxygenation rate of 3.53 lb. O_2/lb. BOD_5 and 4.94 lb. O_2/lb BOD_5 for the old and new halves, respectively.

The Ten States Standards require that the mechanical aeration system be able to maintain a minimum of 2.0 mg/l of dissolved oxygen in the mixed liquor at all times throughout the aeration basin. Also stated in these standards is that "the design oxygen requirements for all activated sludge processes shall be 1.1 lbs. O_2/lb peak BOD_5 applied to the aeration tanks, with the exception of the extended aeration process, for which the value shall be 1.8 lb O_2/lb peak BOD_5 applied".

Calculations comparing the aeration requirements with the existing equipment at the South Cheyenne WWTP are presented in Appendix E. These figures indicate that the existing aeration equipment is adequately sized for this WWTP, assuming a design flow of 0.8 MGD and a peak flow of 1.2 MGD. The existing aerators should suffice until the BOD_5 loading reaches 2100 lb BOD_5/day, or at .17 lb BOD_5 pcpd, a population equivalent of 12,350 people, at which time the aerators in the old half of the plant will be inadequate. The population should be reached in 1990, the time at which the plant will also reach its hydraulic capacity of 1.2 MGD.

The aerators in service should theoretically provide an adequate D.O. in the reactor basin if continuously operated. The current operation of "6 minutes on 6 minutes off" not only provides inadequate D.O. concentration, but also puts additional strain and wear on the pump motors unless special motors designed for intermittent duty are provided. It is possible that without these special motors, insulation breakdown can occur as a result of intermittent use and shorten motor life. As previously stated, the low D.O. level aids in the development of filamentous microorganisms which thrive in these relatively anoxic conditions. Protozoa, which are desirable for the biological oxidation of the organic matter, require a D.O. of at least 2.0 mg/l.

Filamentous growth, due to their structure, are very susceptible to the addition of hypochlorus acid (a chlorine solution). The introduction of a "slug dose of hypochlorus acid (approximately 2 ppm) in the return sludge line would serve to eliminate the filamentous growth while not affecting the more desirable protozoa population. Extreme care should be taken in this operation, as too high a chlorine dose would also eliminate the protozoa and severely disrupt the biological processes in the reaction basin.

With continuous aeration to maintain the dissolved oxygen concentration (D.O.) in the aeration basins at or above 2.0 mg/l, the redevelopment of the filamentous growth should not occur since they do not survive when the D.O. is greater than 2.0 mg/l. If a D.O. concentration of 2.0 mg/l in the aeration basins cannot be maintained, even with continuous operation, the MLSS may be too high, i.e. the microorganism population is too high with a correspondingly high oxygen consumption, and sludge wasting may be necessary to increase the D.O. back up to the desired level. With an increase in sludge wasting, the F/M (food to microorganism) ratio is increased. This is acceptable when nitrification is not required as is the case here. Currently, the operator has no control over the wasting of sludge. A program for the controlling of sludge wasting is necessary.

d. Final Clarifiers

The final clarifiers are rectangular in shape and, with a total volume of 136,435 gal, provide for a 4.09 hr. detention time at a design flow of .8 MGD. The clarifiers have a number of shortcomings limiting effectiveness. One aspect of the design that limits effectiveness is clarifier depth. The clarifiers have a 7'-8" side water depth (SWD) compared to a desirable depth of 10 to 12 feet. A deeper clarifier provides more efficient liquid-solids separation resulting in improved effluent quality. A second limiting factor is the current skimming system. The third and more serious limiting factor is the lack of an effective sludge withdrawal system. The sludge withdrawal system should be controlled to permit rapid sludge withdrawal to reduce clarifier sludge detention time. A siphon withdrawal sludge pickup system has been effective in similar processes.

The final concern regarding the final clarification system is that the existing clarifiers will be overloaded on the basis of solids loading rate at average day plant flows exceeding 0.8 MGD assuming a MLSS concentration of 3500 mg/l and a return flow percentage of 50% of flow. It is recommended that new final clarifiers be installed and the existing finals be converted to primary clarifiers or abandoned, depending on which treatment process is selected.

e. Sludge Pumps

According to the original construction specifications for each half of the plant, the sludge return pumps are not equally sized. The 1961 specifications for the old plant indicate a pumping capacity of 150 gpm/pump, with 2 pumps set up to operate in an alternating fashion. This results in a capacity of only .22 MGD. The 1973 specifications for the new half of the plant indicate a sludge return pumping capacity of 400 gpm/pump, operating alternately, or a daily capacity of .58 MGD. Both pump systems can return 100% of the sludge produced, but operational difficulties are numerous. The pump houses are cramped which makes maintenance difficult. Very few parts are kept on hand to facilitate rapid repair. Essential control devices, e.g. valves and flow measurement devices, are lacking. To successfully operate an activated sludge treatment plant the operator must be able to measure and control the sludge return rate. This gives him necessary flexibility for efficient operation, i.e. control of MLSS and thereby D.O. in the aeration reactor basins.

f. Chlorination

The chlorine equipment is deteriorated and in poor condition. A cylinder mounted chlorine feed meter (Fisher & Porter Series 3600) with a capacity of 100 lb Cl/day is used to inject chlorine into the contact chamber. Possible chlorine leaks were detected during onsite investigations of the treatment plant. Solids accumulate in the chamber, and scum accumulates on the surface behind a screen, presumably due to solids carry-over from the final clarifiers.

It is recommended that the present chlorine injection system be abandoned, and a new chlorine facility be constructed that will provide safe and efficient chlorination of the treatment plant effluent.

g. Operator Control

The operation of any activated sludge wastewater treatment facility requires the performance by the operator of certain tasks above regular maintenance.

First, influent and effluent parameters should be determined to give the operator an idea of the strength and volume of wastewater entering the plant and treatment efficiency. This requires flow measurement and composite samples for the determination of influent and effluent BOD_5 and SS on a daily basis.

Second, tests of the mixed liquor in the aeration basin should include the following (WPCF, Manual of Practice No. 8, Wastewater Treatment Plant Design, 1977):

1) Dissolved oxygen: D.O. determinations in the reactor basin should be made on a continuous basis from various locations throughout the basin until an operating history is established and documented. A minimum D.O. of 2.0 mg/l must be maintained in the reactor basin.

2) Mixed liquor suspended solids: MLSS should be evaluated and control of the return sludge must be provided in order to maintain the desired MLSS. This involves the use of settleometer and spin tests 2-3 times/day, and gravimetric analysis 3 times/week. Devices are available for continuous measurement of the MLSS concentration in the reactor basin.

3) Mixed liquor volatile suspended solids: MLVSS should also be determined 3 times a week. (Metcalf & Eddy, Wastewater Engineering).

Operators cite lack of time to perform these required tasks. Currently, three personnel share responsibilities of operating the wastewater treatment plant and maintaining the water and sewer systems throughout the district. This appears to be a large volume of work for 3 people to handle. It is suggested that the South Cheyenne Water and Sewer District consider assigning an operator whose sole responsibility is to operate the wastewater treatment plant and to make the required treatment evaluations.

h. Conclusion

The wastewater treatment plant in the South Cheyenne Water And Sewer District is frequently unable to meet effluent discharge requirements. Refinements in the operation of this plant or general upgrading of the facility are in order. This and other alternative solutions to the wastewater treatment problem in the South Cheyenne Water And Sewer District are discussed below.

3. Common Elements - All Alternatives

a. General

If growth is allowed to continue in this area, the South Cheyenne Water and Sewer District must increase its wastewater treatment capability. Several alternatives that will possibly enable the district to meet its future wastewater treatment needs have been studied. These alternatives include:

1) Upgrade the existing extended aeration process.
2) Convert to contact stabilization activated sludge process.
3) Convert to conventional activated sludge process.
4) Construct an oxidation ditch system.
5) Construct a lagoon system.
6) Utilize land treatment:
    a) Irrigation.

b) Overland flow.

c) Rapid infiltration.

7) Abandon treatment process and connect to an alternate treatment facility (e.g. new mechanical plant or a city facility).

8) No action.

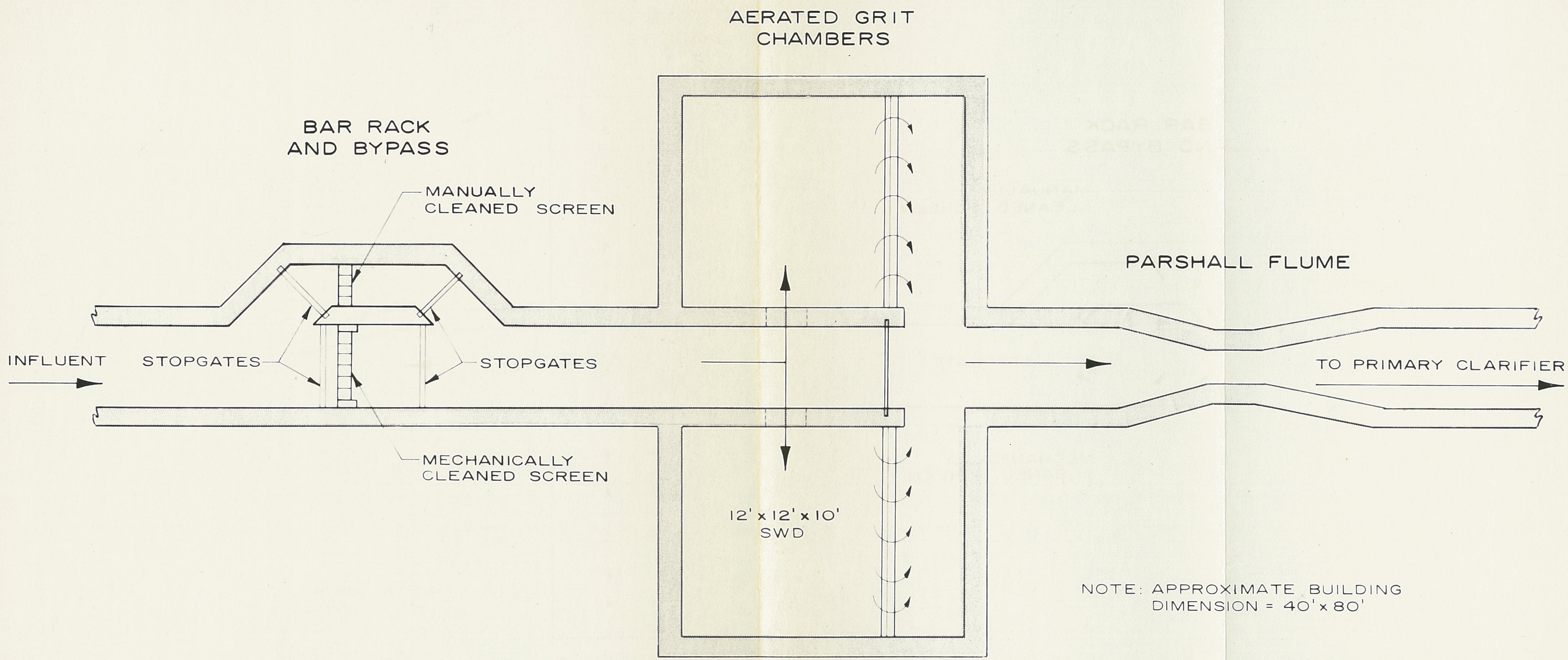
These alternatives are evaluated on the basis of their engineering and economic feasibility beginning on page B-V-43.

b. Pretreatment

Common to all wastewater treatment alternatives listed above, with the exception of lagoon systems and no action, is the need for efficient pretreatment and flow measurement. Pretreatment is recommended to include a mechanically cleaned bar screen, aerated grit chamber, and a Parshall flume for flow measurement.

As was discussed in the section "Existing Wastewater Treatment Plant Evaluation," the existing bar rack is designed such that a solids buildup frequently occurs. The depression of approximately 3½ ft in the channel at the bar screen allows for the accumulation of solids resulting in the clogging problem. Not only are the operators required to manually clean the screen every two days, but grit also passes through the pretreatment process and is carried into the aeration basin. To overcome these difficulties, a new mechanically cleaned bar rack should be installed (see Figure B-V-7) with a bypass channel containing a manually cleaned screen to be used when maintenance of the mechanical unit is required.

The existing wastewater treatment plant provides no facility for the removal of grit. For each of the various methods presented to upgrade this plant, grit removal is a vital part of the process. The removal of grit protects moving mechanical equipment from abrasion and abnormal wear; reduces conduit clogging caused by deposition of grit particles in pipes or channels,



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SOUTH CHEYENNE-ALTERNATIVE # 1
PRETREATMENT BUILDING LAYOUT

FIGURE
B-V-7

particularly at changes in direction; and prevents loading of the treatment works with basically inert matter that might interfere with operation of treatment units.

During the summer of 1981, an aerator failure in the "old" half of the plant required the dewatering of the aeration basin. At that time, accumulation of grit as deep as three feet was observed in the basin bottom. This significantly reduces the basin volume resulting in an increase in BOD loading per 1000 ft^3 of reactor volume and a corresponding decrease in treatment efficiency. Another effect of the presence of grit in the aeration basin is the trapping of organic material with the grit as it settles in the basin. This could result in septic conditions, increasing odor problems and further decreasing treatment efficiency.

An aerated grit chamber is recommended and has many advantages over conventional methods, including:

1) Preaeration freshens the wastewater, resulting in some additional removal of SS and BOD.
2) Aerated grit chambers result in a minimum of head loss through the chamber.
3) By controlling the rate of aeration, a grit of relatively low putrescible (biodegradable) organic content can be removed.
4) Preferential removal of grit larger than a desired size is possible if a constant specific gravity is assumed. Removal limitations do exist because of variations in particle size, shape, and specific gravity.
5) The same efficiency of grit removal is possible over a wide flow range.

The addition of a grit chamber in the pretreatment process following the bar rack generally improves the overall treatment plant operation. When efficient grit removal and washing are practiced, grit normally contains little organic material and frequently can be disposed of as fill in the vicinity of the plant.

Also not included in the existing WWTP is an influent flow measuring device. A Parshall flume should be incorporated in the treatment process, and should be located downstream of the grit chamber. For conventional grit chambers, a Parshall flume may be used as a flow control device, thereby insuring successful grit removal. Aerated grit chambers are designed on a peak flow basis and operate properly over the entire flow range of a treatment plant. The Parshall flume following an aerated grit chamber is therefore incorporated strictly as a flow measuring device. The entire pretreatment process, including the bar rack, grit chamber, and Parshall flume, should be contained in a pretreatment building. This would require the removal of the existing pretreatment building and the construction of a new 40 ft. by 80 ft. building. A potential layout for such a building is shown in Figure B-V-7.

c. Laboratory and Control Facility

The successful operation of an activated sludge wastewater treatment facility depends on the maintenance of a favorable environment for the desired microbial population. The operator should be aware of the strength of waste being treated (i.e. influent parameters) and of the efficiency of each unit process. This requires the collection of wastewater samples from various locations throughout the plant for the purpose of laboratory evaluation. Table B-V-2 shows a list of typical tests that are run at an activiated sludge plant that aid the operator in insuring the proper operation of the system.

Table B-V-2
Typical Tests for an Activated Sludge
Wastewater Treatment Plant

Test	Type of Sample	Frequency
Mixed Liquor Suspended Solids (MLSS) (Spin Test)	Grab	3/day Recommended
Mixed Liquor Volatile Suspended Solids (MLVSS)	Grab	3/wk Recommended
BOD (influent)	24 hr. Composite	3/wk
BOD (effluent)	24 hr. Composite	3/wk
D.O. in Reactor	Grab	Every 2 Hours
Suspended Solids (inf.)	24 hr. Composite	3/wk
SS (eff.)	24 hr. Composite	3/wk
Sludge Settleability	Grab	3/day Recommended

The tests indicated in Table B-V-2 do not include all tests that can be made in the evaluation of treatment plant efficiency, but they are sufficent to give the operator a fair idea of how the plant is operating. The laboratory equipment necessary to perform such tests is not extensive, and includes the following:

1) Drying oven and dessicator
2) BOD incubator
3) Analytical balance
4) Settleometer for rapid determination of MLSS
5) D.O. probe for instantaneous determination of dissolved oxygen in the aeration basins
6) Centrifuge
7) Microscope for determination of the microbial population
8) Two automatic samplers for BOD and SS composite sampling

The laboratory should be set up at the treatment plant site, and the above tests should be made regularly without failure. The tests should be run to ensure that the plant is operating within the design parameters. When the operator is given control over such things as the waste activated sludge and return activated sludge rates, and when such things as the MLSS in the reactor basin can be determined, the desired MLSS can be maintained by varying the rate of sludge return. The knowledge gained by daily monitoring of the treatment plant is essential for the production of an effluent of required quality.

The operator needs to also be aware of:

1) Influent flow rate
2) Return sludge flow rate
3) Waste sludge flow rate
4) In situ D.O. monitoring
5) Status on major equipment:
    a) Aerators
    b) Return sludge pumps
    c) Waste sludge pump
    d) Bar screen
    e) Grit chambers
    f) Sludge thickener

4. Alternatives

a. Upgrading the Extended Aeration Wastewater Treatment Plant

Activated sludge extended aeration wastewater treatment plants are suited for small flows, cited in the literature (Metcalf & Eddy) as typically less than 1 MGD due to the required long detention time. For this reason, South Cheyenne may continue to employ this extended aeration process only until 1990, or when the flow rate dictates the conversion to a process requiring shorter D.T. The upgrading of the existing plant may facilitate a phased conversion and thereby be the most cost-effective way to proceed. A possible process diagram for the upgraded extended aeration process is shown in Figure B-V-8. A preliminary cost comparison of all alternatives considered is presented in Chapter B-VI.

SOUTH CHEYENNE - ALTERNATIVE #1
EXTENDED AERATION - PROCESS DIAGRAM

Process Description

*	**Screening**	Mechanically cleaned barscreen
*	**Grit Removal**	Aerated grit chambers and grit handling system
*	**Flow Measurement**	Parshall flume
*	**Control Structure**	Aeration basin flow splitter
	Aeration Basins	Existing reactor basins with existing aerators
	Final Clarifiers	Existing clarifiers with improved sludge and scum removal capability
*	**Disinfection**	New chlorinator using the existing contact chamber
*	**Sludge Drying Beds**	Underdrained sand drying beds

* New Construction

(1) Pretreatment

The necessary pretreatment facilities are the same as discussed in 3b of this section.

(2) Aeration

Extended aeration process calls for a hydraulic retention time that ranges from 16 to 24 hours in the reactor basin. The existing plant has a total reactor basin volume of 107,380 ft^3, or 803,200 gallons. Allowing for the minimum required hydraulic retention time of 16 hr, a maximum flow of 1.20 MGD may be treated at this plant. This flow rate has a population equivalent of 10,200 people (at 118 gpcd) (See Appendix E). This population should be reached by the year 1986. The assumption that a 16-hr. retention time is adequate for extended aeration is optimistic and places this process at its extreme maximum capability. Some design criteria, i.e. Wastewater Engineering, Metcalf & Eddy, gives a recommendation of a retention time of 18-36 hours. The capacity of 1.20 MGD is arrived at through the following calculation:

$$\left(\frac{803{,}200 \text{ gal.}}{16 \text{ hr.}}\right)\left(\frac{24 \text{ hr.}}{\text{day}}\right)\left(\frac{1}{10^6}\right) = 1.20 \text{ MGD}$$

The initial recommended action for the upgrading of this plant is the dewatering of the aeration basins for the purpose of removing the accumulated grit, thereby providing the design capacity.

Banner Associates conducted a computer modeling of the extended aeration wastewater treatment plant employing the CH_2M-Hill program entitled "BIOTREAT" assuming various operating conditions. A flow rate of 1.2 MGD and a hydraulic retention time of 16 hours were assumed. The characteristics of the influent wastewater were assumed to be those of an average strength wastewater, i.e. BOD5 = 203 mg/l, total volatile suspended solids = 150 mg/l (80 mg/l biodegradables and 70 mg/l refractory, or non-biodegradable), total inorganic suspended solids = 50.0 mg/l, ultimate BOD (BOD_L) = 1.5 X BOD_5 = 304 mg/l. With a mean cell residence time of 21.84 days (typical values for extended aeration range from 20-30 days) the amount of O_2 required is 0.7785 lbs O_2/lb BOD_L removed. At a removal rate of 2964.3 lbs BOD_L/day, this equates to an O_2 requirement of 2308 lb O_2/day. This is comparable to the O_2 requirements as calculated in Appendix E.

The aerators in the "new" half of this plant are capable of providing 140 lb O_2/hr combined, or 3360 lb O_2/day with continuous operation. The aerators in the "old" half of the plant are capable of providing approximately 105 lb O_2/hr combined, or 2520 lb O_2/day with continuous operation. It can be seen that, according to the previously mentioned calculation, the aeration equipment currently being used at the South Cheyenne WWTP can provide adequate oxygen for the biological processes required. The stockpiling of spare aeration equipment (if economically feasible) would facilitate rapid repair of any malfunctioning aerators.

The addition of spray nozzles on the effluent weir may help to reduce the foam problem. It should be noted, however, that this attacks a symptom, and not the cause. With proper aeration techniques and plant operation, the DO in the aeration basin should be greater than 2.0 mg/l, and protozoa should dominate the microbial population. With the elimination of the filamentous microorganism, the foam problem may be greatly reduced.

(3) Final Clarifiers

In extended aeration processes, the activated solids theoretically remain in the system so long that they are disintegrated and dispersed throughout the liquid and pass off in the effluent of the final clarifier. There are currently no adequate means of solids removal in the clarifiers. Chain and flight scrapers move the solids to the inlet end of the basin. The sludge is deposited in the collection trough where it is theoretically removed by the sludge pumps. A siphon sludge withdrawal system would be more effective in removing these solids than the existing sludge pumps.

Secondary sludge characteristically does not move with the scrappers of a chain and flight system. The sludge is relatively light and simply floats over the scrapper and resettles on the clarifier bottom. A siphon sludge removal system operates in a manner similar to a vacuum cleaner. The system is set on rails bolted to the clarifier floor and "vacuums" the sludge off the bottom as it moves back and forth in the clarifier.

The surface loading rate (overflow rate) for final clarifiers is recommended (WPCF, MOP #8) to be 800 gpd/ft^2 at average flows, and 1600 gpd/ft^2 at a peak 2-hour sustained flow. The surface area of the existing final clarifiers totals 2304 ft^2. At the average daily flow of 2.5 MGD, this is a loading of 1085 gpd/ft^2. At a peak hourly flow of 5.5 MGD, the surface loading on the existing clarifiers would be 2387 gpd/ft^2. These numbers indicate that the existing final clarifiers are not adequately sized to handle the expected design period flow rates (e.g. flow in the year 2005) if the flow at the plant is 2.5 MGD. At 1.5 MGD, however, the final clarifiers are adequately sized.

Typical of the extended aeration process is the development of a rising sludge in the sedimentation tank due to denitrification. This can be controlled by an increase in return sludge rate with the corresponding decrease in clarifier sludge detention time. The existing skimming apparatus is ineffective and requires constant operator surveillance to prevent the carry-over of floatables (primarily foam) from entering the effluent flow. The surface skimming device currently used is a chain and flight mechanism and is accomplished by the same flight conveyors that are intended to move the solids along the bottom. As the flights move along the surface, they skim the solids and move them toward the skimming trough arrangement. At this point, the skimming device is ineffective. Frequently, the floatable solids are carried over the trough arrangement and end up in the effluent line. A hydraulic washing device should be incorporated that would automatically move the skimmings along the trough. The floating solids should then be returned to the activated sludge process for decomposition or removed and placed on a scum drying bed until ultimate disposal.

The existing clarifiers are constructed with less side water depth than is normally accepted. Typical depths for rectangular basins when used as primary settling tanks are 8 to 10 ft, and when used as secondary tanks are 10 to 12 feet. The existing settling tanks have a side water depth (SWD) of 7'8". When the SWD is reduced, the effect is a decrease in the effective solids removal. Inadequate depth may result in too little space for storage of settled solids, scour along the basin bottom caused by high forward velocity of flow, and picking up of solids at the effluent takeoff point by updrafts in current. On the other hand, excessive depths may result in a long retention time of settled solids causing anaerobic conditions.

The successful operation of any activated sludge process requires that the operator be able to monitor and control the amount of return sludge. This is necessary to maintain the desired environment in the aeration reactor basins.

(4) Sludge Treatment

The extended aeration process typically produces a sludge that has been stabilized quite well. The sludge that is wasted should be suitable for direct application to sludge drying beds. The underflow from these drying beds should be returned to the plant influent. The dried sludge may then be disposed of by one of the alternatives discussed in Section B-VIII - Sludge Management.

(5) Climate Control

The extended aeration system is especially subject to the adverse impact of low temperature in severe climates. When heat loss is controlled, the process has a much better chance of producing an effluent of high quality. The construction of covers that include not only the final clarifiers (existing) but also the reactor basins may result in an improvement in treatment efficiency. The incorporation of covers may result in the maintenance of a more constant temperature (i.e. 20^{o}C) making it easier to monitor and control the biological processes.

Fiberglass Reinforced Plastic (FRP) covers could be installed to cover the aeration basins. These covers would aid treatment efficiency by containing heat produced by the aeration motors and by preventing heat loss due to wind and other environmental factors. Due to the high humidity produced, special precautions in the electrical apparatus would be required. FRP covers have successfully been employed at other wastewater treatment facilities, e.g. Brookings and Milbank, South Dakota.

(6) Chlorination

The existing chlorination unit has deteriorated to the point where it should be abandoned and a new unit installed. The contact basin has a detention of time of 35 minutes for a design flow of .8 MGD. At a design average daily flow of 1.2 MGD, a D.T. of 20 min. is achieved. Typical chlorination of wastewater treatment plant effluent requires a contact time of 15 to 30 minutes, so the existing contact basin is adequate for flows up to 1.2 MGD.

(7) Conclusion

Typically, the extended aeration process requires a 24-hr. hydraulic retention time. Some literature (Metcalf & Eddy) suggests a minimum of 18-hour retention time. A retention time of 16 hours was used for the above discussion, and is based on the allowable BOD loading of 15 lb BOD_5/day-1000 ft^3 reactor volume and places the extended aeration process on the extreme high end of operation. Any increase in loading beyond this point would render the extended aeration process ineffective. Therefore, it is felt that the existing facility is not of adequate capacity to be upgraded for continued operation for flows greater than 1.2 MGD without the addition of another complete treatment unit. The construction of an oxidation ditch, which is another form of extended aeration, is considered in a subsequent section of this report.

b. <u>Convert to Contact Stabilization Activated Sludge Wastewater Treatment Plant</u>

(1) <u>General</u>

The conversion of activated sludge wastewater treatment plants to a contact stabilization type of process has proven to be a successful way to increase a plant's capacity. A potential process diagram for the Contact Stabilization alternative is shown in Figure B-V-9. The contact stabilization process takes advantage of the absorptive properties of activated sludge. Most of the colloidal, finely suspended, and dissolved organics are absorbed in the activated sludge during the contact, or absorptive phase of the process. The second phase, oxidation, metabolically assimilates the absorbed organics. In conventional activated sludge processes, these two phases occur in a single tank. Contact stabilization separates these phases into different tanks. This alternative would incorporate the use of existing facilities, with modifications. New construction would include the pretreatment process (mechanically cleaned bar rack, aerated grit chamber, and Parshall flume), control structure, pump station, divider wall in one aeration basin, final clarifier flow splitter, final clarifiers, disinfection basin and sludge treatment system, i.e. sludge pump, sludge thickener, and sludge drying beds.

The preliminary design of the contact stabilization process alternative is based on the projected population of 25,000 in the year 2005. The corresponding average daily flow (ADF) is 2.5 MGD. The peak daily flow

SOUTH CHEYENNE - ALTERNATIVE #2
CONTACT STABILIZATION - PROCESS DIAGRAM

Process Description

*	**Screening**	Mechanically cleaned barscreen
*	**Grit Removal**	Aerated grit chambers and grit handling system
*	**Flow Measurement**	Parshall flume
*	**Control Structure**	Primary clarifier flow splitter
	Primary Clarifiers	Four units, each 12′ x 48′ (existing final clarifiers)
*	**Pump Station (three 36″ screwpumps)**	Lift station to lift effluent to aeration basins, total capacity required = 3820 GPM, 15′ total dynamic head
	Contact Unit	Contact unit for contact stabilization, ½ of existing cell with new 25 HP aerator
	Solids Reaeration Cell	Solids reaeration unit, 1½ cells of existing aeration basin with existing 10 HP aerators
*	**Control Structure**	Final clarifier flow splitter
*	**Final Clarifiers**	Two clarifiers, each 60′ diam., 12′ side water depth (S.W.D.) with siphon sludge withdrawal system
*	**Disinfection Basin**	15 min. detention time at peak hourly flow, 24′ x 40′ x 8′ S.W.D.
*	**Sludge Pump Station**	Return activated sludge pump capacity = 2780 GPM, waste activated sludge (W.A.S.) pump capacity = 150 GPM
*	**Sludge Thickener**	Thickener for W.A.S., dissolved air flotation unit
	Sludge Digesters	Aerobic digestion using existing basins with 4-50 HP aerators
*	**Sludge Drying Beds**	Underdrained sand drying beds

* New Construction

(PDF) and peak hourly flow (PHF) are 4.0 MGD and 5.5 MGD, respectively. These flows are used for all wastewater treatment alternatives that are intended to handle the needs of South Cheyenne until the year 2005.

(2) Pretreatment

The pretreatment requirements were previously discussed.

(3) Primary Clarification

Evaluations performed in the preliminary design of the contact stabilization process indicate that the existing clarifiers could be converted to primaries with adequate capacity for projected design flows. They could be severely overloaded at peak hourly flow; consequently, provisions for bypassing a portion of the flow around them is suggested.

The sludge transport mechanism within the basins is an acceptable type of mechanism for primary clarifiers. It may be necessary to replace the chains and flights due to wear on existing equipment. When replacement is planned, consideration should be given to the use of the new lighter, corrosion-resistant plastic chains and fiberglass flights.

The sludge pumping system should be converted to a system more suitable for handling heavy primary sludge. Positive displacement pumps, piston pumps, or diaphragm pumps with suction lines directly into the clarifier sludge pits suggested.

(4) Contact-Stabilization Tanks

The existing wastewater treatment facility could be converted to a contact-stabilization facility by constructing a divider wall in one of the reactor basins. This wall would allow for the contact tank to be one-half of an original reactor basin, and the reaeration chamber to be the remaining one and one-half of the original reactor basins. The aeration equipment of the existing plant should be upgraded for this conversion to supply the required 60 lb O_2/hr-aerator (at Standard Temperature and Pressure, STP) for the reaeration process. Two 25 Hp aerators, capable of supplying 220 lb O_2/hr (at STP) to the contact tank, would also be required.

The changes discussed above for the conversion of half of the existing facility would allow for the operation of a contact stabilization process for flows up to 2.5 MGD. For peak flows above 2.5 MGD, a modified complete mix activated sludge (CMAS) scheme could be used. Figure B-V-10 is a schematic indicating how this modification could be accomplished. A more detailed discussion of the conversion to a complete mix activated sludge (CMAS) system is discussed in the next section.

(5) Final Clarification

The construction of new final clarifiers is necessary. Two clarifiers, each with 60 ft. diameter, will be required for the 20-year design period. At present-day flows, one final clarifier is adequate. The second clarifier can be added at a later date when it is required.

(6) Disinfection

The simplest and least capital intensive system for disinfection is chlorination; it is a system familiar to the operators, and a chlorination system is currently on site. The existing system is in a bad state of repair and should be replaced. A contact time of 15 to 30 minutes is required for chlorination. Assuming a 15-minute detention time in the contact basin at peak hourly flow (PHF) of 5.5 MGD, a volume of 57,300 gallons is required. This requirement can be met by a contact tank with dimensions of 40' X 24' X 8' SWD. The existing contact tank is too small, thereby requiring the construction of a new basin.

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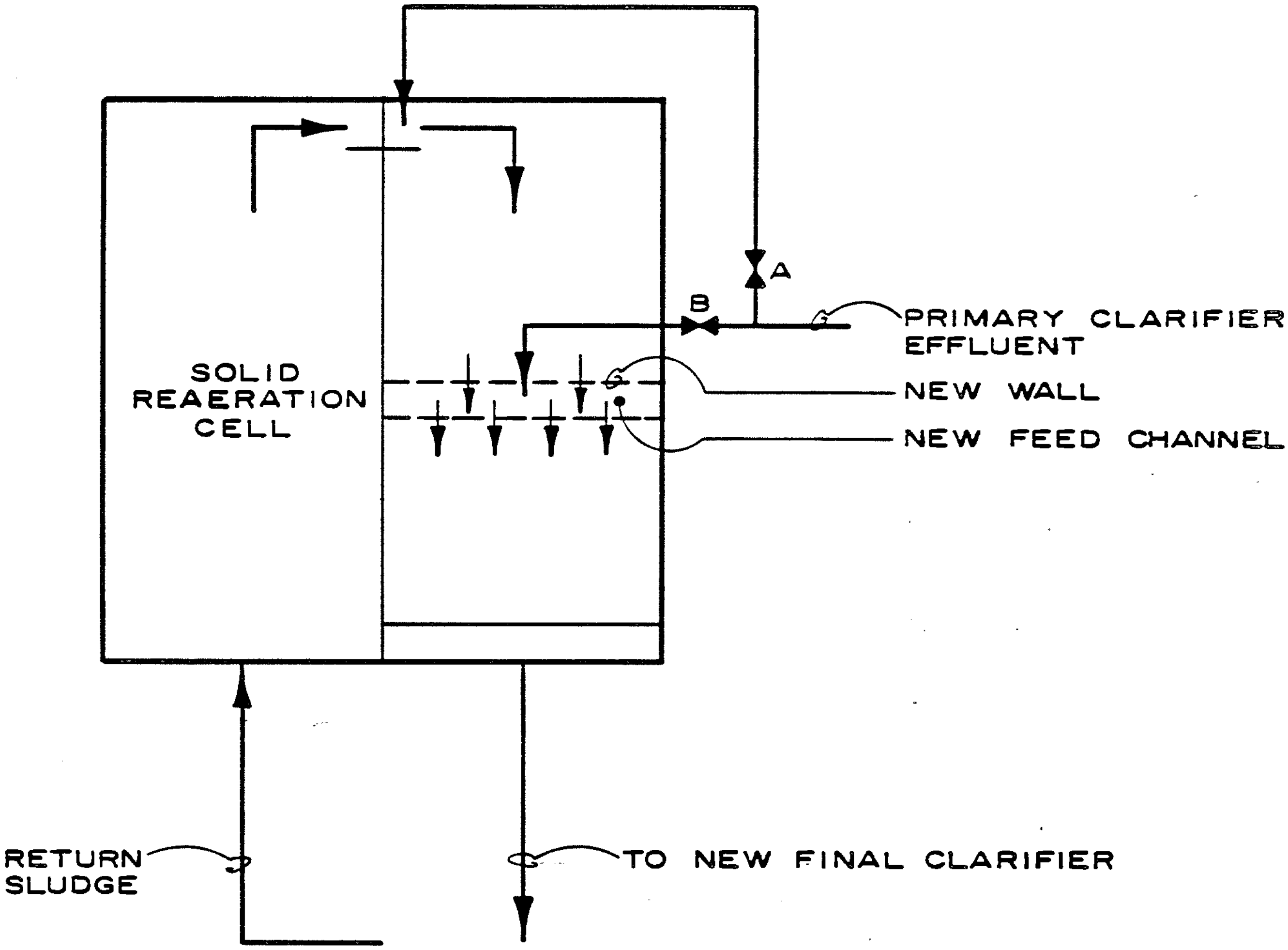

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S. CHEYENNE-ALT. #2
AERATION BASIN
MODIFICATIONS

FIGURE
B-V-10

(7) Return Activated Sludge

The importance of control over return sludge flow rate has been discussed previously. The return sludge system must be able to measure and control the return rate. This is not present in the existing facility; therefore, a new sludge return system is recommended.

It is suggested that sludge be removed from the new final clarifiers with a siphon withdrawal system. The return rate can be controlled by controlling the differential head for the siphon. The sludge must be pumped to the aeration basin. Available pumps for this service include screw pumps, air lift pumps, centrifugal pumps, and positive displacement pumps. Screw pumps can be constant speed pumps because they are variable capacity depending on the wet well level. Air lift pump capacity can be controlled by wet well level and air flow rate control. Centrifugal pumps and positive displacement pumps can be used; however, variable flow capacity is more difficult to achieve. Usually, variable speed drives are required.

(8) Waste Activated Sludge

In a contact stabilization process, excess sludge solids are produced by microorganism reproduction. The excess sludge must be removed from the system regularly to maintain the desired microorganism population. The excess solids are waste activated sludge and should be pumped to a sludge treatment process. This waste activated sludge (WAS) could be withdrawn from the return sludge line.

(9) Sludge Treatment

Prior to disposal, the sludges must be stabilized by reducing the organic content (volatile solids). This can be accomplished in several ways including aerobic digestion, anaerobic digestion, and incineration.

The contact stabilization process would utilize only half of the aeration capacity of the facility, leaving the other two aeration basins available for alternative uses, e.g. aerobic sludge digestion.

Assuming an average daily flow of 2.5 MGD, an average influent SS of 200 mg/l, and 65% SS removal in the primary clarifiers, it is estimated that 9286 gpd of primary sludge will be produced.

With an overall BOD_5 removal of 65% and a waste activated sludge (WAS) production of .55 lb WAS/lb BOD_5 removed, a total of 1215 lb WAS/day is produced. Wasting at a concentration of 6000 mg/l from the return activated sludge line, a total volume of 24,280 gpd of WAS is produced. Coupled with the primary sludge, this results in a total sludge volume of 33,570 gpd.

The existing aeration basins not incorporated in the contact stabilization processes could be used as an aerobic digester. For the total volume of 401,630 gallons, a 12-day hydraulic detention time is provided for the 33,570 gpd of sludge. This detention time is lower than the desired 18-22 days for primary plus activated sludge at 20°C. At lower temperatures, the required detention time increases.

If only primary sludge were to be handled, assuming a 35% volitile solids reduction at 15°C, a detention time of 43 days would result. This 43-day detention time is adequate for relatively low temperatures.

By incorporating sludge thickening, the total waste sludge volumes can be substantially reduced. The incorporation of thickening to concentrate the WAS to 2% solids would reduce the WAS volume at average daily flow to about 7,285 gpd. Added to the primary sludge volume of 9286 gpd, a total sludge volume of 16,570 gpd is produced. With this amount of sludge and the 401,630-gallon capacity, a detention time of 24 days is provided. This is within the desired detention time period and would provide for fairly complete volatile solids reduction.

At present day flows, a total sludge volume of 9,600 gpd is estimated (7000 gpd WAS plus 2600 gpd of primary sludge). The approximate hydraulic detention time in the aerobic digestion would be 59 days, adequate for roughly 42% volatile solids reduction at an average temperature of 15°C. At lower temperatures, the percent of volatile solids reduction would be somewhat decreased. Although the anticipated volatile solids reductions are less than can be achieved by alternate methods, the sludge should be stabilized enough to permit dewatering on sand drying beds.

The suggested mixing requirement for aerobic digestion is .5 to 1 HP/1000 ft^3. For this volume available, the mixing HP required would be 200 to 400 horsepower. The existing mixers provide 4 X 7.5 = 30 Hp, so new aeration/ mixing equipment is necessary.

Another method of sludge treatment to be considered is anaerobic digestion. The geometric requirements for anaerobic digesters are such that the existing tanks cannot be used. Anaerobic digester facilities may be square or rectangular, but are usually circular tanks with 20 to 25 ft SWD. The required volume for 10-day D.T. at average daily flow is 335,660 gal. This is accomplished with a primary digester with dimensions of 50 ft diameter by 25 ft SWD.

If sludge thickening were used to concentrate WAS to 2% solids, the raw sludge volume would be reduced to 7285 gpd for WAS and a total sludge volume of 16,570 gpd at design flow. The corresponding design volume for the digester would be 22,150 ft^3 for a 10-day D.T. The primary digester required dimension is 40 ft diameter by 20 ft. SWD.

Normally, two digesters should be used -- a primary and a secondary of equal volume. In a two-stage process the first tank is used for digestion.

It is heated and equipped with mixing facilities (e.g. gas mixer). In the first tank, raw sludge enters the digester and is heated and agitated to insure complete interaction of the microorganism (facultative anaerobic acid producers and methane fermenters) and the organic sludge. The most active gas production occurs in this stage.

The digested sludge is pumped to the unheated secondary digester for supernatant separation and residual gas extrations.

Other sludge treatment alternatives that can be considered are: transporting sludge to another facility for treatment, incineration or physical-chemical processes such as belt presses. Ordinarily, incineration, compaction, and similar means of sludge treatment are not cost-effective for small treatment facilities; however, they can be viable options if a central sludge treatment facility handling sludge from more than one treatment plant is part of the ultimate sludge handling plan for the planning area.

c. Convert to Conventional Activated Sludge Process

(1) General

Conventional activated sludge processes consist of pretreatment, primary clarification, aeration, secondary clarification, disinfection, and sludge treatment. The construction required for the conversion of the South Cheyenne WWTP to a conventional activated sludge plant is similar to that for the conversion to contact stabilization, as discussed previously.

A process diagram for the conventional activiated sludge process alternative is shown in Figure B-V-11. When comparing Figure B-V-11 with Figure B-V-9, Process Diagram-Contact Stabilization Process Alternative, the only differences seen are in the piping arrangement of the primary clarifier effluent into the aeration reactor basins, the existence of a control structure (final clarifier flow splitter) on the reactor basin effluent for the contact stablization process, and the route of the return activated sludge.

SOUTH CHEYENNE - ALTERNATIVE #3
CONVENTIONAL ACTIVATED SLUDGE - PROCESS DIAGRAM

Process Description

* **Screening**	Mechanically cleaned barscreen
* **Grit Removal**	Aerated grit chambers and grit handling system
* **Flow Measurement**	Parshall flume
* **Control Structure**	Primary clarifier flow splitter
Primary Clarifiers	Four units, each 12′ x 48′ (existing final clarifiers)
Pump Station (three 36″ screwpumps)	Lift station for primary clarifier effluent, capacity = 3820 GPM, 15′ total dynamic head
Aeration Basin	Existing aeration basin with existing aerators, one cell divided in half for operational flexibility
* **Final Clarifiers**	Two clarifiers, each 60′ diam., 12′ side water depth (S.W.D.), with siphon sludge withdrawal system
* **Disinfection Basin**	Contact tank with 15 min. detention time at peak hourly flow; 24′ x 40′ x 8′ S.W.D.
* **Sludge Pump Station**	Return activated sludge pump capacity = 1854 GPM, waste activated sludge (W.A.S.) pump capacity = 150 GPM
* **Sludge Thickener**	Thickener for W.A.S., dissolved air flotation unit
Sludge Digesters	Aerobic digesters using existing basins with 4-50 HP aerators
* **Drying Beds**	Underdrained sand drying beds

* New Construction

(2) Activated Sludge

If only secondary treatment is required, mean cell residence times of 10-15 days are normally not necessary. Thus the maximum anticipated MLVSS concentration can be kept under 3000 mg/l. Under these conditions, the existing facility, with the previously mentioned upgrading, will be able to handle peak daily flows within the operating range for an activated sludge process, while using no more than half of the existing aeration basin capacity. The replacement of the existing aerators with new aerators with a transfer capacity of 100 lb O_2/hr each will be required (the total oxygen required is 400 lb O_2/hr, at STP) when operating at peak flow conditions.

Half of the existing plant could be modified and converted to a conventional activated sludge plant with operational flexibility by installing a wall to divide one of the cells in half and modifying the flow control structures to permit operation of one-fourth, one-half, three-fourths, or all of the aeration basin volume. The existing aerators would need to be replaced with aerators of greater oxygen transfer capacity.

(3) Clarification

The required final clarifier size is the same as for the contact stabilization alternative, i.e. 2 clarifiers, each 60 ft. in diameter. This size assumes a return sludge rate (QRS) to influent flow (Q) ratio of 0.25 to 1.0. As with the contact stabilization process, the existing sludge handling system is inadequate and should be replaced.

The existing final clarifiers could be converted to primary clarifiers with adequate capacity for projected design flows. They would be severely overloaded at peak hourly flow; consequently, provisions for bypassing a portion of the flow around these clarifiers are suggested.

(4) Sludge Handling

The sludge transport mechanism within the existing clarifiers is an acceptable type of mechanism for primary clarifiers. It may be necessary to replace the chains and flights due to wear on existing equipment. When replacement is planned, consideration should be given to the use of the new lighter, corrosion-resistant plastic chains and fiberglass flights.

The sludge pumping system should be converted to a system more suitable for handling heavy primary sludges. A positive displacement pump with suction line directly into the clarifier sludge pit is suggested.

The sludge handling system requirements have been described in some detail in the preliminary design of the contact stabilization process. The requirements are essentially the same for either process. Existing aeration basins could be used for aerobic digesters if new and larger aerators were installed. If anaerobic digestion were selected, new digesters would be required. For either digestion alternative, thickening of Waste Activated Sludge is suggested to reduce the volume of sludge to be handled in the digester system. Other alternatives such as incineration should be considered if centralized sludge treatment and disposal facilities are anticipated for the planning area. (See Section B-VIII - Sludge Management.)

d. Construct Oxidation Ditch WWTF

(1) General

The oxidation ditch is an extended aeration process that has been used for a variety of applications in the United States and Europe. The ditch has some benefits over the rectangular aeration basin (as exists currently, 1981) in reduced energy requirements for mixing and aeration. The major disadvantage of the oxidation ditch alternative is that it would require 100% new construction.

A process diagram of the oxidation ditch alternative is shown in Figure B-V-12. It consists of a ring-shaped channel about 15 ft. deep. This depth is acceptable only when jet, or turbine, aerators are employed. The oxidation ditch must be preceded by pretreatment, including bar screen, grit removal, and flow measurement, as discussed previously. This process does not require primary clarification but does require final clarifiers capable of high return sludge flow rates. The existing clarifiers are not suitable for this service; therefore, new final clarifiers are required. None of the existing wastewater treatment processes will be salvaged, if this alternative is selected.

Volumes of 3 million gallons (MG) and 2.5 MG were evaluated and provide an 18-hr detention time (D.T.) at peak daily flow and a 24-hr D.T. at average daily flow, respectively. The BOD loadings for the 3 MG size are relatively low, but the 2.5 MG capacity results in acceptable loadings. The 2.5 MG capacity is therefore used as the basis for the preliminary design.

The configuration of an oxidation ditch may be set to satisfy site requirements. For this stage of the study, a channel 20 ft wide with a 15 ft SWD is used. A "racetrack" geometry is typical of oxidation ditches, as shown in Figure B-V-12, and is used here, with 20 ft between the channels. With this geometry, a total length of 600 ft for the ditch and site requirements is needed.

(2) Aeration Requirements

The oxygen requirement for BOD removal and for nitrification is 610 lb O_2/hr at STP. This equates to a requirement of 175 HP, assuming a transfer of 3.5 lb O_2 per HP-hr. Four jet, or turbine, aerators should be used, each with 152.5 lb O_2/hr capacity (45 HP aerators).

(3) Final Clarifiers

The final clarifiers are sized with the assumption that the return sludge rate to influent flow ratio (QRS/Q) ranges from 0.75 to 1.50. The

SOUTH CHEYENNE - ALTERNATIVE #4
OXIDATION DITCH - PROCESS DIAGRAM

Process Description

Screening	Mechanically cleaned barscreen
Grit Removal	Aerated grit chambers and grit handling system
Flow Measurement	Parshall flume
Control Structure	Controls for flow to ditch
Oxidation Ditch	Hydraulic detention time (D.T.) at average daily flow = 24 HR, volume = 2.5 MG. Approximate dimensions: length = 600′, channel width = 20′, depth = 15′
Control Structure	Flow splitter for final clarifiers
Final Clarifiers	Two clarifiers, each 70′ diam., 12′ side water depth (S.W.D.), with siphon sludge withdrawal system; staged construction
Disinfection Basin	Contact tank with 15 min. D.T. at peak hourly flow, 24′ x 40′ x 8′ S.W.D.
Sludge Pump Station	Return activated sludge pump capacity = 2776 GPM, waste activated sludge pump capacity = 75 GPM
Sludge Drying Beds	Underdrained sand drying beds

Note: This alternative assumes 100 percent new construction return rate (QRS) is limited to the influent flow (QRS/Q = 1.0) when peak daily flow conditions are encountered. The surface area requirement for design flow is 11,583 ft^2. This area could be reduced to 7413 ft^2 based on the maximum allowable loading, but experience indicates that extended operation at high loading rates contributes to operating difficulties with rising sludge and poor settleability. Staged construction of a total of three final clarifiers is therefore recommended. A surface area of 3861 ft^2 is required per clarifier, or 70 ft diameter for a circular clarifier.

For present flows, one clarifier will be sufficient. The second clarifier should be added when an average daily flow of 1.6 MGD is reached. When the average daily flow reaches 2.5 MGD, the third clarifier will be needed. This third clarifier may be needed to prevent effluent quality deterioration only a few years before the end of the design period. Since two clarifiers will suffice until nearly 2005, this preliminary comparison of alternatives assumes the use of two clarifiers, as shown in Figure B-V-12, and cost comparisons assume the use of two clarifiers.

(4) Disinfection

The disinfection requirements are the same as those described for the other mechanical plant alternatives discussed above.

(5) Sludge Handling

Pumps for the return sludge and the waste sludge should have capacities of 2776 gpm and 75 gpm, respectively. The extended aeration process produces a sludge that is relatively stable. The sludge wasted from the oxidation ditch should therefore require no further digestion and could be pumped directly to sand drying beds. The underflow collected from these drying beds would be recycled in the influent to the oxidation ditch.

e. Construct Lagoon System

(1) General

The preliminary design presented here is a lagoon system composed of 4 cells: 2 cell aerated facultative lagoon followed by 2-cell stablization pond system. Other lagoon arrangements are possible, and may merit further consideration. A possible arrangment of this 4-cell system is shown in Figure B-V-13.

This alternative involves the complete abandonment of the existing facility and 100% new construction of the lagoons. The system processes are discussed below.

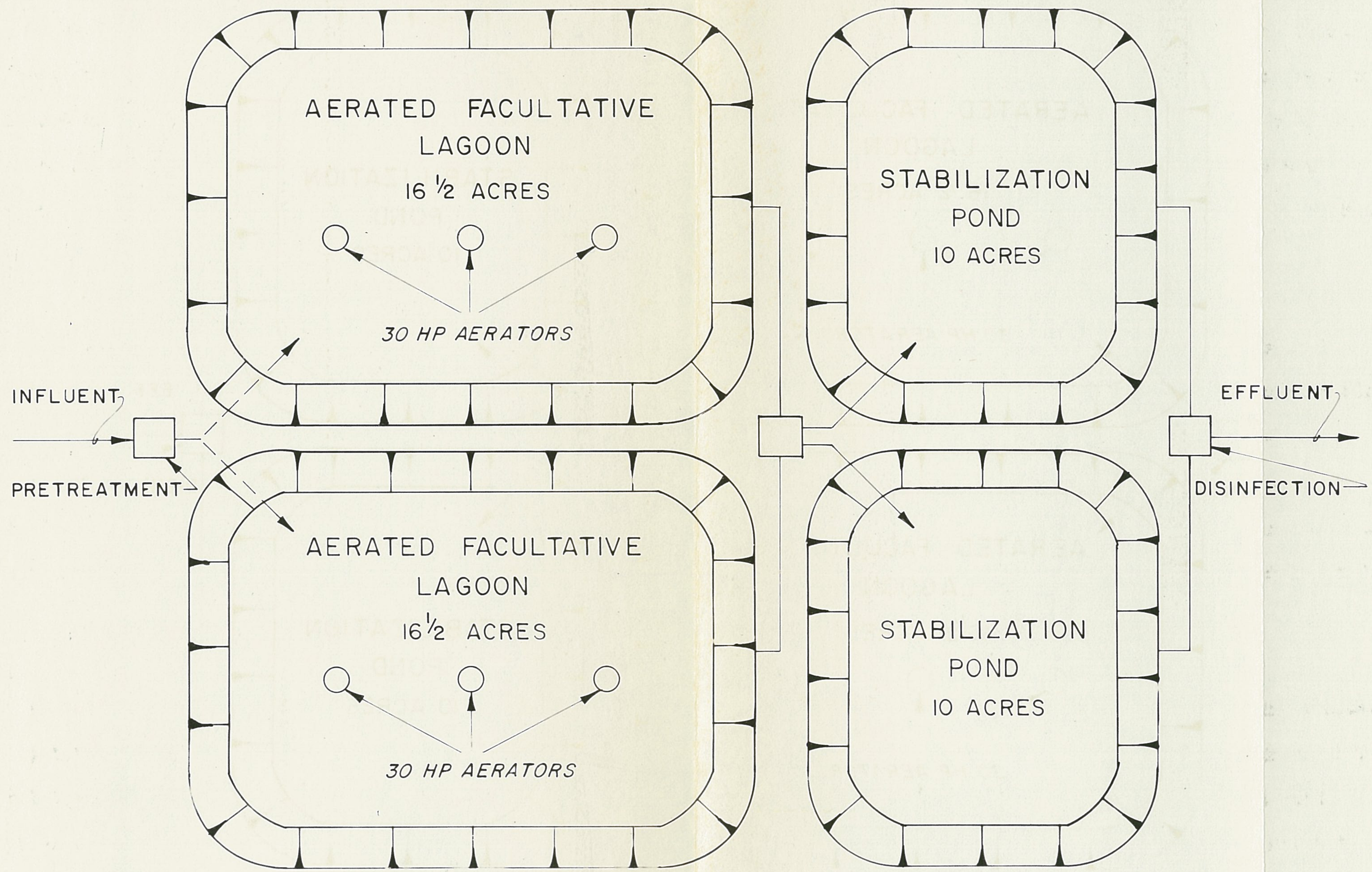
(2) Pretreatment

Pretreatment facilities are not required for lagoon systems to the degree as for the other alternatives discussed in this report. A manually cleaned bar rack with approximately 2-inch openings should adequately remove solids that could present treatment difficulties.

A flow measuring device, i.e. Parshall flume, is desirable for continued knowledge of the volume of wastewater entering the facility during any time period.

(3) Aeration

Preliminary design of the aerated facultative lagoon is based on a 34-day hydraulic retention time at the average design flow of 2.5 MGD. Providing a 9-foot depth, with 1 foot allowed for sludge settlement (effective depth of 8 feet), the required surface area is approximately 33 acres. Fill material should be used to build the lagoons up to provide 3 ft. of freeboard. Two cells, each with surface area of 16½ acres, are recommended. The aeration equipment in these lagoons must be able to provide 14,850 lb O_2/day, or 620 lb O_2/hr. Using six aerators, 3 in each cell, and assuming an oxygen transfer efficency of 3.5 lb O_2/Hp-hr, 30 Hp aerators are required.



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SOUTH CHEYENNE–ALTERNATIVE # 5
LAGOON SYSTEM / PROCESS DIAGRAM

FIGURE
B-V-13

The aerated facultative lagoons should successfully remove 80-95% of the BOD_5 and produce an effluent quality ranging from 20-70 mg/l BOD_5. The effluent from these ponds next goes into a 2-cell series of stabilization ponds.

(4) Stabilization

Two unaerated aerobic stabilization ponds with a total hydraulic retention time of 10 days are included in the preliminary design. With a depth of 4 feet, the required surface area is 20 acres. Two 10-acre lagoons should be used. No aeration equipment is required in these lagoons as algae is the primary oxygen source.

(5) Disinfection

Chlorination requirements are essentially the same as previously discussed.

(6) Conclusion

A total area of 53 acres is required for this 4-cell aerated facultative lagoon-stabilization pond system. To provide service area and area for the pretreatment facilities, 60 acres should be provided. Due to the high groundwater in the area near the South Cheyenne WWTP, proper steps to prevent the contamination of this groundwater must be taken.

Lagoons are simple and flexible means of wastewater treatment by biological decomposition of organic material. They can be designed for complete evaporation of inflow, for sludge concentration or storage for emergency overflow, for groundwater recharge by percolation, or for supplying water and nutrients to crops through irrigation.

In severe climates, such as in Cheyenne, consideration should be given to complete retainment of wintertime flow. To do this, the liquid level in the stabilization ponds could be dropped to approximately 1.5-2 feet at the beginning of the winter, and the flow accumulated during the winter with no discharge. The aerated cells must be maintained at essentially full depth.

This aerated facultative lagoon system is capable of 80-95% BOD_5 removal efficiency and would be suitable for effluent discharge or as a pre-application technique prior to land treatment. The constant operator supervision required for activated sludge processes is not necessary for lagoons to maintain an effluent of high quality.

f. Convert to Primary Treatment

(1) General

The goal of primary treatment is (1) to remove settleable solids capable of forming sludge banks in the receiving waters and (2) to remove much of the floating material. Effectively designed and operated primary sedimentation tanks should remove from 50 to 65% of the suspended solids, and from 25 to 40% of the BOD_5. A process diagram for the conversion of the existing treatment plant to a primary plant is shown in Figure B-V-14.

A primary wastewater treatment plant should include the following unit processes and operations:

1) Bar rack or screen to remove coarse sewage solids.

2) Grit chamber for the removal of grit, sand, and gravel, Aerated grit chambers provide preaeration and increase the efficiency of primary sedimentation.

3) Skimming and grease traps for the removal of the lighter floating solids.

4) Sedimentation to remove settleable solids.

5) Sludge pumping for the removal of sludge from the bottom of the sedimentation tanks, and for the pumping of sludge between various operations and processes.

SOUTH CHEYENNE - ALTERNATIVE #6
PRIMARY TREATMENT - PROCESS DIAGRAM

Process Description

*	**Screening**	Mechanically cleaned barscreen
*	**Grit Removal**	Aerated grit chamber and grit handling system
*	**Flow Measurement**	Parshall flume
*	**Control Structure**	Primary clarifier flow splitter
	Primary Clarifier	Four units, each 12′ x 48′ (existing)
	Equalization Tank	Existing aeration basin
*	**Pump Station**	Lift station to return equalized flow to clarifiers
*	**Control Structure**	Disinfection basin flow structure
*	**Disinfection**	Chlorination for odor control, oxidation and disinfection
	Sludge Digester	Aerobic digestion using two existing basins with 4-50 HP aerators
*	**Sludge Drying Beds**	Underdrained sand drying beds

* New Construction

6) Chlorination for odor control, oxidation, and disinfection.

(2) Pretreatment

The pretreatment requirements (bar rack, aerated grit chamber, and flow measurement) were discussed previously and remain unchanged for this alternative. Total new construction of the pretreatment facility is required.

(3) Skimming and Sedimentation

The existing final clarifiers could be used as primary sedimentation tanks for this alternative. The Ten States Standards call for surface loading rates no greater than 1000 gpd/ft^2 at design average daily flow and no greater than 1500 gpd/ft^2 at peak hourly flows. The existing clarifiers have a total surface area of 2304 ft^2, resulting in surface loadings of 1085 and 2387 gpd/ft^2 at ADF and PHF, respectively. For design flows, this would be a 9% overload at average daily flow and 59% overload at peak hourly flow. The existing clarifiers could, however, be used as primary clarifiers under average flow conditions throughout the design life. Provisions for bypass of flow or for flow equalization in an existing aeration basin should be made for peak flow conditions. The equalization tank should be aerated to maintain a complete mix situation.

Skimming could be accomplished in the clarifiers with the existing chain and flight mechanisms. When replacement of the chains and flights is needed, corrosion-resistant fiberglass flights and plastic chains are recommended.

As was previously discussed, the existing solids removal system is inefficient. Siphon sludge withdrawal is not suited for primary clarifiers, but with new pumping systems, the existing mechanisms would perform adequately.

(4) Sludge Treatment

Primary sludge treatment may be accomplished with aerobic digestion followed by sludge drying beds and landfill or landspreading. For an anticipated volume of 9300 gpd of primary sludge at the average daily design flow of 2.5 MGD, the remaining existing aeration basin could be used as an aerobic digester. Under average flow conditions, a hydraulic detention time of 43 days would be provided.

At present-day flows of 1.0 MGD, only one of the existing aeration cells would be required for the aerobic digester. When future flows require it, the second basin could be added.

The aeration and mixing requirements for the aerobic digester call for .5 - 1.0 Hp/1000 ft^3 of digester volume. For the available volume, 200-400 Hp is required. This requirement could be met by replacing the existing aerators (7.5 Hp/aerator and 10 Hp/aerator for the "old" and "new" halves of the plant, respectively) with four 50 Hp units.

(5) Disinfection

As was discussed previously, a new chlorination facility is required.

(6) Conclusion

Primary treatment would render the effluent acceptable for various land application techniques, which will be discussed more thoroughly in the next section. Also to be considered is the transporting of the primary effluent to another facility for further treatment and disposal. Water rights to the South Cheyenne effluent must be investigated prior to the transporting of the effluent to another facility.

g. Land Application

(1) General

According to Art Buffington, President of the South Cheyenne Water and Sewer District, a type of land application is currently being used by

South Cheyenne. However, the District does not have total control over how the effluent is used, and in the winter months some of the effluent reaches Crow Creek. Therefore, DEQ has not recognized the current operation as a viable land application system. This may be a viable treatment component, and should be examined further.

The degree of preapplication treatment required depends on the type of system employed and the accessibility of the public to the land used. The EPA has established guidelines for determining the level of preapplication treatment. These treatment levels will be considered as grant eligible for Federal EPA support without special justification on a case by case basis. These criteria recognize the treatment capacity of the site and become increasingly stringent as public exposure and access increase. These guidelines are shown in Table B-V-3.

Table B-V-3

Guidance for Assessing Level of Preapplication Treatment*

I. Slow-rate Systems (reference sources include Water Quality Criteria 1972, EPA-R3-73-003, Water Quality Criteria EPA 1976, and various state guidelines).

A. Primary treatment - acceptable for isolated locations with restricted public access and when limited to crops not for direct human consumption.

B. Biological treatment by lagoons or inplant processes plus control of fecal coliform count to less than 1,000 MPN/100 ml-acceptable for controlled agricultural irrigation except for human food crops to be eaten raw.

C. Biological treatment by lagoons or inplant processes with additional BOD or SS control as needed for aesthetics plus disinfection to log mean of 200/100 ml (EPA fecal coliform criteria for bathing waters) - acceptable for application in public access areas such as parks and golf courses.

II. Rapid-infiltration Systems

A. Primary treatment - acceptable for isolated locations with restricted public access.

B. Biological treatment by lagoons or inplant processes-acceptable for urban locations with controlled public access.

III. Overland-flow Systems

A. Screening or comminution - acceptable for isolated sites with no public access.

B. Screening or comminution plus aeration to control odors during storage or application - acceptable for urban locations with no public access.

* From EPA Construction Grants Program Requirements Memorandum PRM 79-3, issued Nov. 15, 1978

Each of the land application processes is summarized regarding its design features, site characteristics, and expected quality of treated water in Tables B-V-4, B-V-5, B-V-6, respectively (taken from Cost of Land Treatment System, EPA-430/9-75-003, Sept. 1979). These criteria recognize the capability of the land treatment site to serve as an active component in the treatment process. Unnecessarily stringent preapplication treatment requirements usually result when the renovative capabilities of the land treatment site are minimized or ignored.

Table B-V-4

Comparison of Design Features for Land Treatment Processes

Feature	Principal processes			Other processes	
	Slow rate	Rapid infiltration	Overland flow	Wetlands	Subsurface
Application techniques	Sprinkler or surface[a]	Usually surface	Sprinkler or surface	Sprinkler or surface	Subsurface piping
Annual application rate, ft	2 to 20	20 to 560	10 to 70	4 to 100	8 to 87
Field area required, acres[b]	56 to 560	2 to 56	16 to 110	11 to 280	13 to 140
Typical weekly application rate, in.	0.5 to 4	4 to 120	2.5 to 6[c] 6 to 16[d]	1 to 25	2 to 20
Minimum preapplication treatment provided in United States	Primary sedimentation[e]	Primary sedimentation	Screening and grit removal	Primary sedimentation	Primary sedimentation
Disposition of applied wastewater	Evapotranspiration and percolation	Mainly percolation	Surface runoff and evapotranspiration with some percolation	Evapotranspiration, percolation, and runoff	Percolation with some evapotranspiration
Need for vegetation	Required	Optional	Required	Required	Optional

a. Includes ridge-and-furrow and border strip.
b. Field area in acres not including buffer area, roads, or ditches for 1 Mgal/d (43.8 L/s) flow.
c. Range for application of screened wastewater.
d. Range for application of lagoon and secondary effluent.
e. Depends on the use of the effluent and the type of crop.

1 in. = 2.54 cm
1 ft. = 0.305 m
1 acre = 0.405 ha

Table B-V-5

Comparison of Site Characteristics for Land Treatment Processes

	Principal processes			Other processes	
Characteristics	Slow rate	Rapid infiltration	Overland flow	Wetland	Subsurface
Slope	Less than 20% on cultivated land; less than 40% on noncultivated land	Not critical; excessive slopes require much earthwork	Finish slopes 2 to 8%	Usually less than 5%	Not critical
Soil permeability	Moderately slow to moderately rapid	Rapid (sands, loamy sands)	Slow (clays, silts, and soils with impermeable barriers)	Slow to moderate	Slow to rapid
Depth to groundwater	2 to 3 ft (minimum)	10 ft (lesser depths are acceptable where underdrainage is provided)	Not critical	Not critical	Not critical
Climatic restrictions	Storage often needed for cold weather and precipitation	None (possibly modify operation in cold weather)	Storage often needed for cold weather	Storage may be needed for cold weather	None

1 ft = 0.305 m

Source: EPA Land Treatment Design Manual

Table B-V-6

Expected Quality of Treated Water from Land Treatment Processes

mg/L

Constituent	Slow rate[a]		Rapid Infiltration[b]		Overland flow[c]	
	Average	Maximum	Average	Maximum	Average	Maximum
BOD	<2	<5	2	<5	10	<15
Suspended solids	<1	<5	2	<5	10	<20
Ammonia nitrogen as N	<0.5	<2	0.5	<2	0.8	<2
Total nitrogen as N	3	<8	10	<20	3	<5
Total phosphorus as P	<0.1	<0.3	1	<5	4	<6

a. Percolation of primary or secondary effluent through 5 ft. (1.5 m) of soil.
b. Percolation of primary or secondary effluent through 15 ft. (4.5 m) of soil.
c. Runoff of comminuted municipal wastewater over about 150 ft. (45 m) of slope.

Source: EPA *Land Treatment Design Manual*

(2) Slow Rate Process

In the slow rate process, the applied wastewater is treated as it flows through the soil matrix, and a portion of the flow percolates to the groundwater. On sites where subsoil or shallow geologic conditions restrict downward movement of water, a condition that exists on much of the land east of the South Cheyenne WWTF, consideration of the need to provide underdrainage is critical. A schematic view of the typical hydraulic pathway for slow rate process is shown in Figure B-V-15 (EPA, Cost of Land Treatment System, Sept, 1979).

Generally, operation as a wastewater treatment system is the principal objective. The typical final effluent quality from a land treatment system, as indicated in Table B-V-6, could not be achieved by a secondary activated sludge plant by itself but only with the incorporation of tertiary treatment. However, the effluent from a land treatment system would be of much higher quality than is required by the current NPDES for South Cheyenne. A slow rate system can achieve this quality at a cost less than that required for activated sludge. Detailed cost comparisons are presented in Chapter B-VI of this report.

(3) Rapid Infiltration

In the rapid infiltration land treatment process, most of the applied wastewater percolates through the soil, and the treated effluent, if not recovered by underdrain systems, eventually reaches the groundwater. The wastewater is applied to rapidly permeable soils, such as sands and loamy sands, by spreading in basins or by sprinkling, and is treated as it travels through the soil matrix. Typical hydraulic pathways are shown in Figure B-V-16 (EPA, Cost of Land Treatment Systems, Sept. 1979). A much greater portion of the applied wastewater percolates to the groundwater than with slow rate land treatment. Frequently, the recovery of renovated water via underdrains or wells is an integral part of this system.

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SAH	JAN 82
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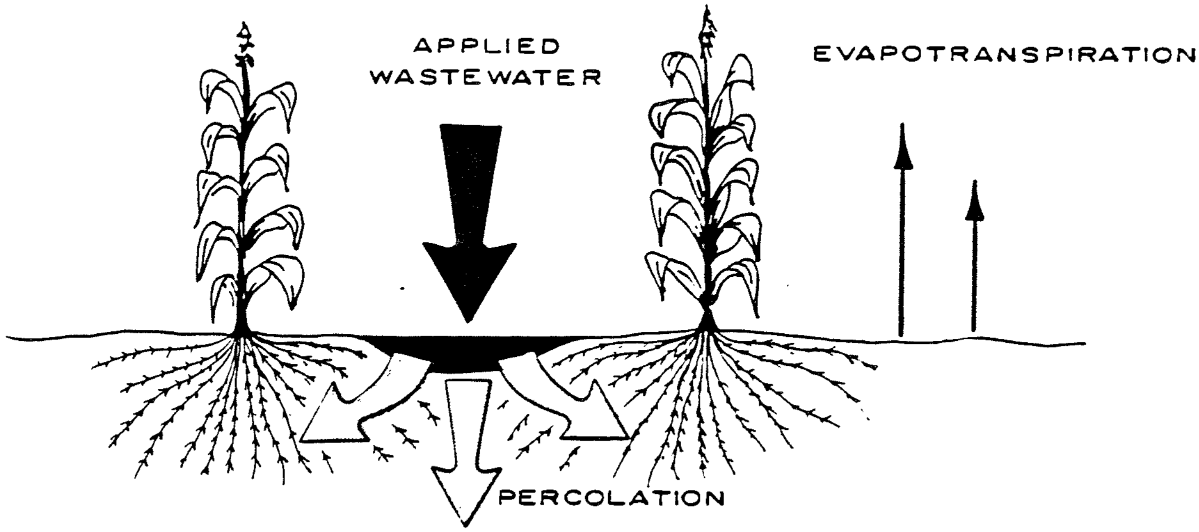
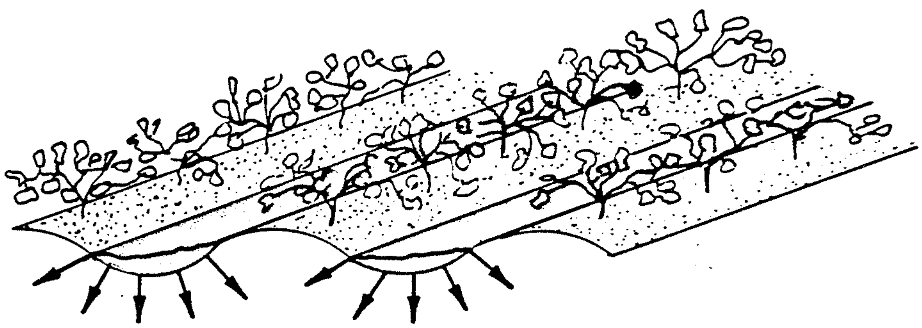
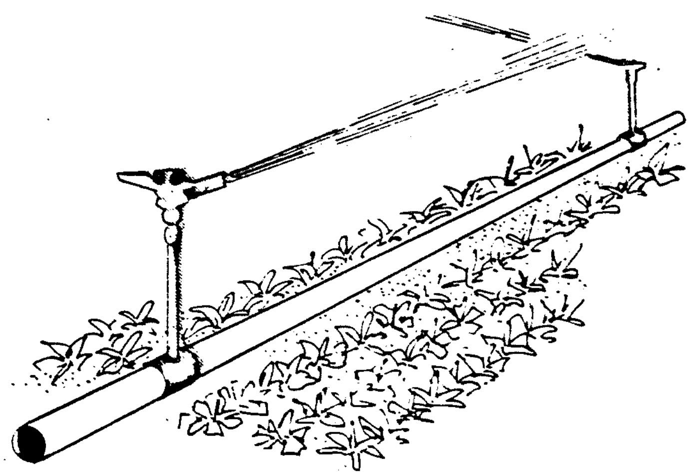
JIC	1767



HYDRAULIC PATHWAY



SURFACE DISTRIBUTION



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S. CHEYENNE ALT. #7
LAND APPLICATION
SLOW RATE

FIGURE
B-V-15

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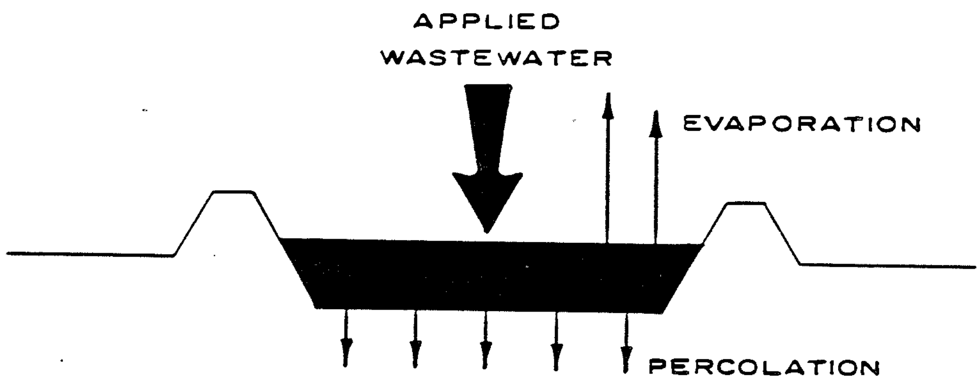
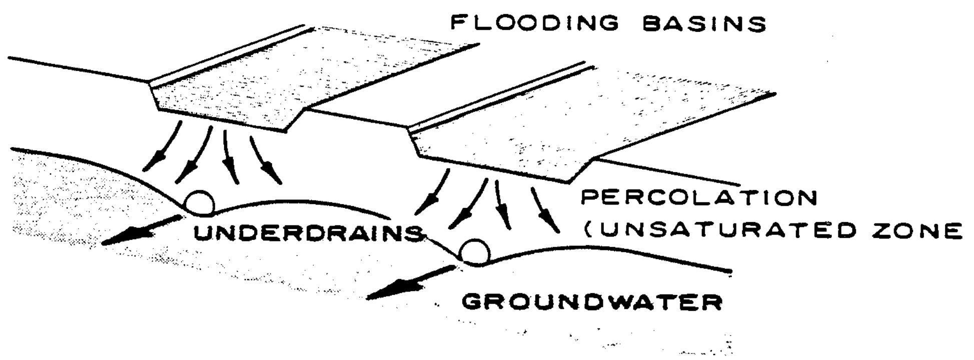
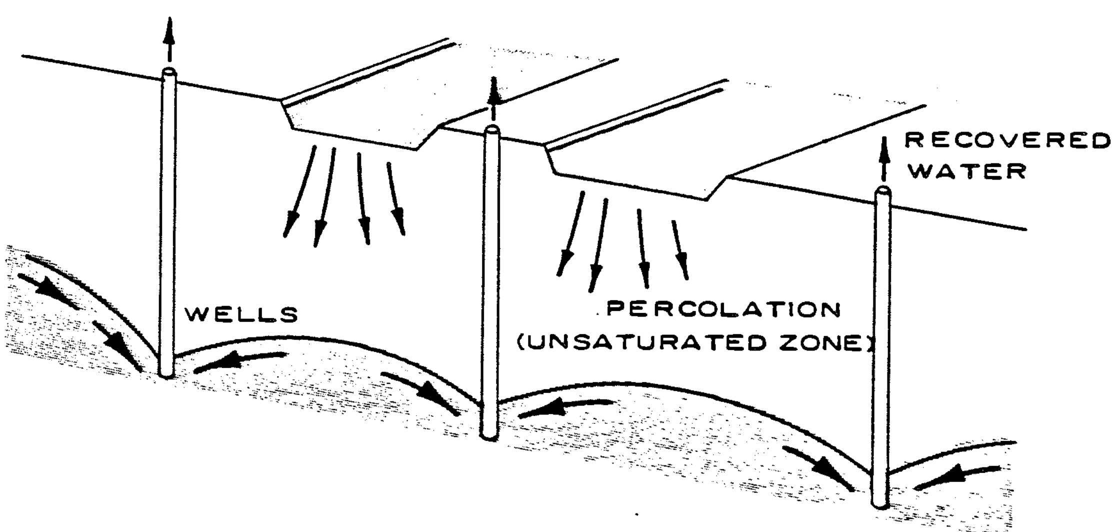


HYDRAULIC PATHWAY



RECOVERY OF RENOVATED WATER BY UNDERDRAINS



RECOVERY OF RENOVATED WATER BY WELLS

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S. CHEYENNE ALT. #8
LAND APPLICATION
RAPID INFILTRATION

FIGURE B-V-16

The expected effluent quality is shown in Table B-5. In a situation when the nitrogen content in the percolate is above the 10 mg/l (as N) drinking water standard, the percolate should be recovered for surface reuse or discharge. Alternatively, the system could be located over an aquifer not used for drinking purposes.

Rapid infiltration is generally the most cost-effective land treatment concept (EPA, Land Treatment Design Manual). Even under unfavorable site conditions, a rapid infiltration system could produce the quality cited in Table B-V-6 at a lesser cost than a conventional activiated sludge plant.

(4) Overland Flow

In overland flow land treatment, wastewater is applied over the upper reaches of sloped terraces and allowed to flow across the vegetated surface to runoff collection ditches. The renovation of the wastewater occurs by physical, chemical, and biological means as it flows in a thin film down the relatively impermeable slope. A schematic view of overland flow is shown in Figure B-V-17.

As shown in Figure B-V-17, there is relatively little percolation involved either because of an impermeable surface soil or a subsurface barrier to percolation. Generally less than 20 percent of the applied liquid percolates, 20 percent or more is lost to evapotranspiration, and approximately 60 percent or more appears as final effluent in the collection ditches. Slopes range from 2 to 8% and from 100 to 200 feet wide in practice. Hydraulic detention times under these conditions range from 20 to 45 minutes.

Overland flow is a relatively new treatment process for municipal wastewater in the United States. There have been several research efforts and pilot scale projects as well as a number of industrial wastewater systems in various parts of the country. As a result, consideration of overland flow was

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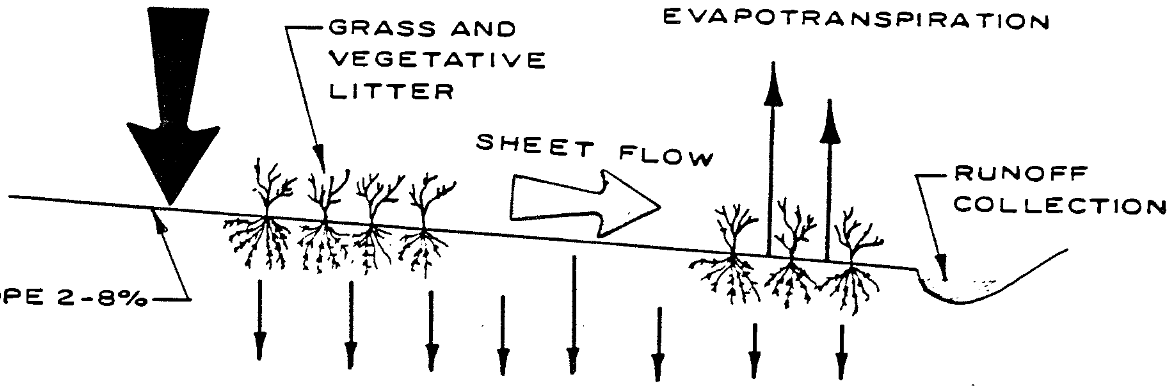
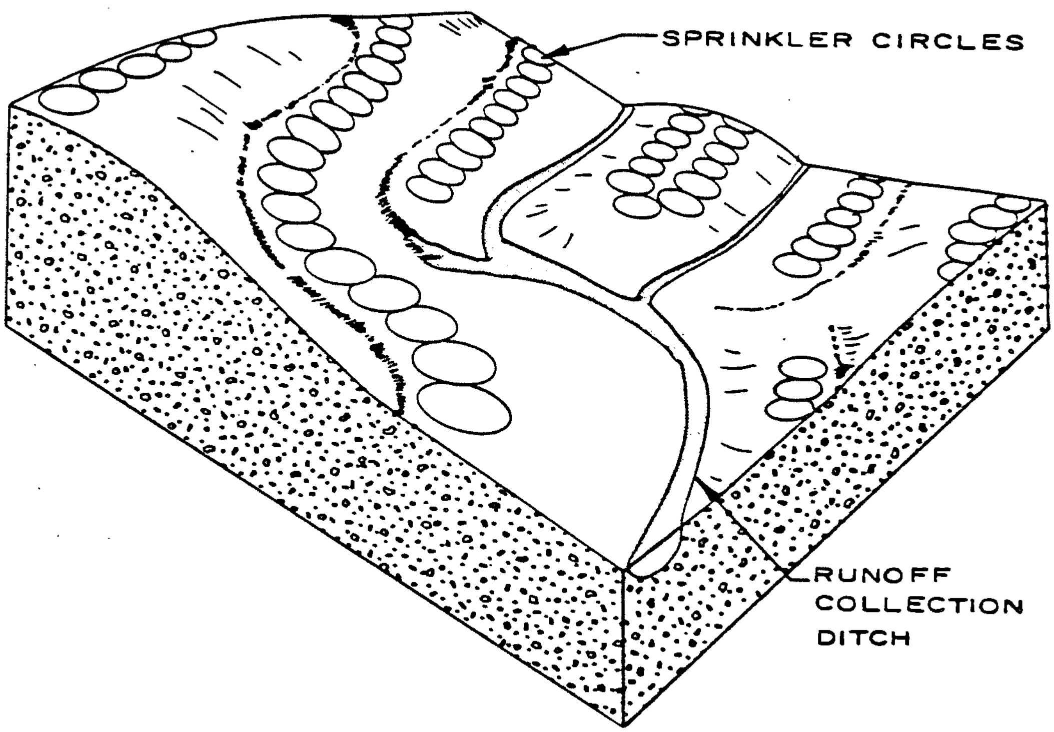


HYDRAULIC PATHWAY



PICTORIAL VIEW OF SPRINKLER APPLICATION

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S. CHEYENNE ALT. #9
LAND APPLICATION
OVERLAND FLOW

FIGURE
B-V-17

made optional except for regionally designated areas, rather than mandatory in EPA requirements for facility planning.

The objectives of overland flow are wastewater treatment and, to a minor extent, crop production. Treatment objectives may be either (1) to achieve secondary or better effluent quality from screened and comminuted raw wastewater, or primary treated, or lagoon treated wastewater, or (2) to achieve high levels of nitrogen and BOD removals comparable to conventional advanced wastewater treatment from secondary treated wastewater. Treated water is collected at the toe of the overland flow slopes and can be either reused or discharged to surface water. Overland flow can also be used for production of forage grasses and the preservation of greenbelts and open space.

Final effluent quality from a typical overland flow system is given in Table B-V-6. If additional BOD, suspended solids, or phosphorus removal is required, the overland flow slope can be followed by rapid infiltration in a combined system. Chemical addition to precipitate additional phosphorus on the slope has also been demonstrated in pilot scale facilities. A mechanical system to achieve the same effluent quality as defined in Table B-V-6 might include rotating biological contractor, nitrogen removal, partial phosphorus removal, clarification, and disinfection. Under favorable site conditions an overland flow system could produce the specified effluent quality at a lesser cost than just the biological component in the competing system. It is also more energy-efficient. As shown in Table B-V-4 screening or comminution is the only pre-application treatment required in many situations.

(5) Conclusion

Significant difficulties may develop with the use of a land application program. The use of wastewaster treatment plant effluent for land application would require a twenty year commitment from the landowners to continue use of this water. This commitment is looked upon with reluctance from the landowners because they cannot project their water use for the next twenty years. Furthermore, the landowners currently entitled to the discharge from the South Cheyenne WWTP cannot use all of this water, allowing a significant volume to reenter Crow Creek each year.

The City of Cheyenne and the South Cheyenne Water and Sewer District are both growing, and expansion to the east (toward the existing wastewater treatment facilities) may encompass potential land application sites. If indeed the City does expand to these areas, significant environmental problems could develop. Therefore, since no guarantee regarding the use of the treatment plant effluent can be made, and since environmental problems could develop with the use of land application, the alternative of land application is not recommended.

h. Abandon Existing Facility and Connect to Alternative Treatment Facility

(1) General

This alternative assumes 100% abandonment of the existing facility. The wastewater would then be treated by an entirely new South Cheyenne wastewater treatment facility (mechanical plant) or it would be transported to the City of Cheyenne's treatment facilities (Crow Creek or Dry Creek WWTF) for treatment and disposal.

(2) New Mechanical WWTF

This alternative assumes the construction of an entirely new WWTP, other than the previously discussed oxidation ditch or lagoon systems. This plant could be an activated sludge, trickling filter, or other treatment process. The cost-effectiveness of this proposal will be presented in Chapter VI of this report, at which time all alternatives will be compared.

(3) Transport Wastewater to City Facility

In considering the alternative of transporting the South Cheyenne wastewater to the City facilities for treatment, several items must be investigated. Of primary importance is historic use of the South Cheyenne WWTP discharge. The Read family has adjudicated water rights for the Read Sprinkler System and Read Reservoir in Section 10, T13N, R66W (same section as the South Cheyenne WWTP). These rights do not include the effluent from the treatment plant, however a contract between the South Cheyenne Water and Sewer District and the Read family gives the Reads the right to use the WWTP discharge. This contract is not an adjudicated water right, but must be dealt with by the South Cheyenne Water and Sewer District if the WWTP effluent is discontinued.

i. No Action

The final alternative to be considered is the "no action" alternative. This implies the continued use of the extended aeration wastewater treatment plant currently in operation without modifications. The effects of "no action" are discussed below.

(1) Pretreatment

The existing pretreatment facilities are currently unable to remove grit from the waste flow, and this situation could only be intensified by no action. Grit accumulations would be a constant and nagging operational headache.

The screening process would continue to create operational difficulties (freezing in winter and manual cleaning requirements) and would only be intensified in the future. Flow records would remain uncertain without the addition of a measurement device (Parshall flume).

In general, pretreatment efficiency would continue to degrade, and the resulting overall treatment efficiency would be correspondingly degraded.

(2) Aeration

With increasing hydraulic and organic loading the existing reactor basins would become increasingly overloaded. The hydraulic detention time would be shortened to the point where operation in the extended aeration mode would no longer be acceptable. With no action, the filamentous population would continue to predominate, the D.O. would remain below the required level of 2.0 mg/l for biological treatment, and operational headaches (foam) would be intensified. Grit accumulations in the reactor basins would continue to build up, and the associated difficulties are not difficult to envision.

(3) Clarification

The existing sludge removal methods are not acceptable for secondary sludge. Solids buildup in the clarifier's would increase, resulting in an increasing amount of solids carry-over into the effluent, further hindering the disinfection process and reducing effluent quality.

(4) Disinfection

The existing deteriorating chlorination equipment could only get worse with no action. The equipment inadequately disinfects the effluent. The leaking chlorination equipment also poses a serious health hazard for personnel working in the proximity of the chlorination facility.

(5) Conclusion

The "no action" alternative would result in the continued discharge of an effluent of unacceptable quality from the South Cheyenne WWTP. Such a discharge would be a violation of the NPDES permit and could result in the state forcing South Cheyenne Water and Sewer District to stop discharging. Also, the ultimate cost of developing adequate wastewater treatment facilities can only increase with time. A "no action" decision at this point in time would serve to multiply the district's difficulties in the future.

E. SUNNYSIDE ADDITION: PRELIMINARY WASTEWATER TREATMENT ALTERNATIVES

1. General

In the past two decades, development has occurred on the eastern outskirts of the City of Cheyenne. Some of this development (Sunnyside) utilizes onsite wastewater treatment, i.e. septic tanks and leach fields, which affects the density of development and in the case of Sunnyside can pose health hazards.

The presence of high nitrate (NO_3) concentration in the well water supply (as reported by Gary Hickman of the Environmental Health Office) in much of the Sunnyside area is apparently the result of pollution of the water supply by domestic wastewater discharges and/or by livestock feeding operations. This pollution represents an increasingly hazardous situation. Currently, the high NO_3 concentration in certain areas effectively prohibits further developments employing onsite wastewater treatment. Some of the areas identified by the Environmental Health Office that have developed high NO_3 concentrations (as NO_3^-) in the water supply are indicated in Appendix 4.

The nitrate concentrations expressed in this chapter are in terms of NO_3^-. For example, 45 mg/l NO_3^- is expressed as the form in which it appears in solution. This may also be expressed in terms of the amount of nitrogen present by the following calculation:

$$(45 \text{ mg/l } NO_3^-)\ \frac{14 \text{ mg N}}{62 \text{ mg } NO_3^-} = 10.16 \text{ mg/l } NO_3^-\text{-N}$$

where: 14 = atomic weight of nitrogen
62 = molecular weight of nitrate

The EPA Drinking Water Standards recommended upper limit on nitrate for public water supplies is 10 mg/l NO_3^--N. This is approximately equivalent to

45 mg/l NO_3^-.

According to Tom Bonds of the City Planning Office, it is the policy of the City of Cheyenne not to provide sewer service to any area outside the city limits. In the past few years, the city has annexed parts of the Sunnyside Addition in a "piecemeal" fashion as the water supply became polluted, i.e. NO_3 concentration greater than 45 mg/l. Upon annexation, water and sewer lines were extended to the areas annexed. Currently, there is a plan being undertaken by 15 property owners of the Sunnyside Area which is to construct a sewer line extension into the Sunnyside Addition. This extension will provide sewer services to the area between Charles and Rawlins Streets and between Cleveland and Polk Avenues. If current policy is followed, this area must be annexed in order to discharge to the city sewer system. This line will contribute flow to the Dry Creek WWTP via the Dry Creek Interceptor Line.

It is estimated that 1200 people currently reside outside the City Limits in the Sunnyside Addition and the nearby areas of Green Meadow Estates, Darnell Homesites, and Downey Addition (based on 2.51 people per household and 490 households). These people utilize onsite wastewater treatment. By the year 2005, as many as 8000 people may reside in this area. This number is based on a planimetered area for the Sunnyside Addition of 470 acres and a population density of 17 people per acre. Assuming a medium strength wastewater of 40 mg/l total nitrogen (15 mg/l as organic N and 25 mg/l as ammonia, NH_3-N), and an average wastewater production of 100 gpcd (gallons per capita per day), the total annual pounds of nitrogen discharged to the onsite system in Sunnyside may be calculated. Based on a 1980 population of 1200, 40 lb N/day (14,610 lb N/year) were discharged, principally to the aquifer. This is the amount that contributed to the nitrate problem as identified in Appendix F. Assuming a 2005 population of 8,000 people in the

Sunnyside Addition, 270 lb N/day or 97,410 lb N/year will be discharged.

What follows in this report is a discussion of preliminary wastewater treatment alternatives, as we presently see them, open to the residents of the Sunnyside Addition and other similarly situated, as yet unannexed areas.

2. No Action

To consider the "no action" alternative, the planned extension of the sewer lines, as mentioned above, must be disregarded. This alternative implies that the Sunnyside Addition will remain in the jurisdiction of Laramie County, and onsite wastewater treatment will continue to be used. Although there is currently no moratorium, per se, restricting development in this area, the Environmental Health Office will not issue permits for septic tanks in areas unsuitable for onsite wastewater treatment according to the following criteria:

1) If lots were platted after January 1979, they must be situated on at least 2½ acres.

2) If lots were platted prior to January 1979, adequate separation (100 ft.) must be available between septic tank and any adjacent well (minimum lot size of 1/8 acre).

3) Lots on flood plains will not be issued septic tank permits.

Working Paper No. 1: Population Projection/Distribution (Appendix D) indicates that as many as 10,000-20,000 people may move to the eastern portion of Cheyenne in the next 20 years. As many as 8000 of these people may reside in the Sunnyside Addition. If 8000 people will indeed reside in the Sunnyside Addition, this equates to a density of 17.02 people/acre, or, at 2.51 people/household, .15 acre/house. This would be approximately equal to 1/8 acre/house which would be in violation of the standard of 2½ acres/house as put forth by the Environmental Health Office. With a possible nitrogen load of 97,410 lb N/year contributed to the aquifer, the potential pollution caused by this nitrogen must be addressed.

To comply with the 2½ acre/house restriction, assuming that the current population of 1200 reside at a density of 17 people/acre (70 acres) the remaining 400 acres could support only 400 people, based on 2.51 people/house and 2½ acres/house.

(400 acres)(1 house/2.5 acres)(2.61 people/house) = 401.6 people.

The total population for the year 2005 for the Sunnyside Addition would therefore be only 1600. The projected influx of population to the east of Cheyenne would develop to the east of Sunnyside, eventually enveloping the Sunnyside Addition. The long-term result would be the existence of a county controlled area completely surrounded by the city. If no action is pursued, it is expected that the nitrogen level would continue to increase and could create a health hazard to all homes in the area.

Due to the impending health hazards that exist currently which would get worse if no action was undertaken, the "no action" alternative is deemed unacceptable and should be dropped from consideration.

3. <u>State of the Art On-site Methods</u>

a. <u>Treatment Components</u>

This alternative also implies that the Sunnyside Addition will remain in the jurisdiction of Laramie County and onsite wastewater treatment will continue to be used. Also implied by this alternative is that well water will continue to be the primary source. For this situation to be acceptable, the well water currently displaying high nitrate concentration must be treated.

Homes in this area that currently employ onsite wastewater treatment must be evaluated in terms of volume reduction and increased treatment efficiency. Upgraded onsite systems must be employed to prevent the future buildup of nitrogen (primarily as NO_3) in the well water. Various onsite wastewater treatment methods are available which may adequately treat the wastewater and maintain the groundwater quality. Onsite treatment methods include a treatment component and a disposal component. The discussion that follows will first deal with treatment components and then with disposal components. The complete system is a combination of components suitable for the given situation, and can be determined for a specific site only by thorough site investigation. The treatment component must be capable of transforming the raw household wastewater into an effluent suited to the disposal component.

(1) Septic Tank

Septic tanks are designed and constructed to receive wastewater from a home; to separate solids, grease, oil, and scum from the liquid by sedimentation and flotation; to provide limited digestion of organic matter; to store solids; and to allow the clarified liquid to discharge for further treatment and disposal. When an onsite wastewater treatment system fails, it is commonly caused by a gradual plugging of the soil with suspended materials and biological slimes. A properly operated septic tank will effectively remove a substantial portion of the suspended solids.

Nutrient removal may also be accomplished in a septic tank through chemical precipitation, and will be discussed below under "Nutrient Removal".

An improved effluent quality may be accomplished without an increase in septic tank volume by the segregation of blackwater (toilet wastewater) from the household graywater. By discharging the graywater to a separate treatment disposal system, the efficiency of blackwater treatment is improved. New homes to be built in this area could consider this, and the appropriate plumbing would have to be installed. Homes already in existence in areas that have displayed deteriorating water quality could consider the option of going to a segregated wastewater treatment scheme. The cost and derivable benefits for an undertaking like this must be considered on a case-by-case basis, e.g. plumbing costs.

Multi-compartment tanks generally perform better than single-compartment tanks of the same total capacity. These tanks provide better protection against solids carry-over into discharge pipes during periods of surges or upset due to rapid digestion.

Septic tank performance can be affected by several factors, including geometry, hydraulic loading, inlet and outlet arrangements, number of compartments, temperature, and operation and maintenance practices. For any situation where there is reason to suspect poor septic tank performance, these factors must be investigated, and the proper steps taken to rectify the situation, whether it be simply to improve O&M practices, or to install completely new septic tanks.

With proper design and proper operation and maintenance practices, septic tanks are capable of producing an effluent that can be applied to a suitable disposal system. When the density of development becomes great as in Sunnyside Addition, the importance of a properly operating septic tank cannot be overemphasized. For septic tank use in the Sunnyside Area to continue in the future, this operational control must be maintained to insure an effluent of acceptable quality.

(2) Intermittent Sand Filters

In this scheme, wastewater is applied intermittently to a bed of granular material which is underdrained to collect and discharge the final effluent. If properly operated and constructed, this technique will produce effluents of very high quality. This process is normally used to polish effluents from septic tank or aerobic treatment processes and would be followed by disinfection prior to reuse or disposal.

The beds of granular material (sand, anthracite, garnet, ilmenite, activated carbon, or mineral tailings) are 24 to 36 inches deep, underlain by graded gravel and collecting tile. Distribution pipes or troughs apply intermittent doses, uniformly distributed by flooding the entire surface of the bed. The filters provide physical straining and sedimentation of solid materials within the media grains. Biological growth within the filters is vital for the assimilation of filtered and sorbed materials and hence the successful operation of the intermittent sand filter.

Physical, chemical, and biological factors may lead to the clogging and eventual failure of the system. Physical clogging is normally caused by the accumulation of stable solid materials within or on the surface of the sand. The grain size, porosity, and characteristics of the wastewater primarily determine physical clogging. Chemical clogging of the filter may be caused by the precipitation, coagulation, and adsorption of the materials in the wastewater onto the filter media.

When the intricate biological population within the filter becomes imbalanced, biological clogging may develop. Microbial imbalances are most likely caused by toxic components in the wastewater, high organic loading, absence of dissolved oxygen, and decrease in filter temperature. Pore clogging of all forms generally occurs simultaneously throughout the filter bed. The clogging mechanism is dependent upon wastewater characteristics, method and rate of wastewater application, characteristics of the filter media, and filter environmental conditions.

Wastewater applied to intermittent sand filters should be pretreated at least by sedimentation to reduce the suspended solids concentration. A minimum requirement for pretreatment should be septic tanks. Higher rates of wastewater application and longer filter runs may be accomplished under conditions favorable for aerobic biological processes to proceed. In areas with extended periods of subfreezing weather, covered filters are required.

Performance of intermittent sand filters is affected by: (1) type and biodegradability of the wastewater, (2) environmental conditions within the filter, and (3) design characteristics of the filter. On-site investigation must be thoroughly undertaken to insure proper design and installation of the intermittent sand filter. High-quality effluents with respect to BOD_5 and suspended solids may be expected from properly operated intermittent sand filters. If the filter remains aerobic, nitrogen is almost completely transformed to nitrate. Little or no denitrification should occur in a properly operated intermittent sand filter. Denitrification processes will be discussed later.

Types of filters to be considered include buried filters, free access filters, and recirculating filters. Intermittent sand filters should also be considered for multi-home installation, followed by a large denitrification and disposal system.

(3) <u>Aerobic Treatment Units</u>

The goal of biological wastewater treatment is to transform dissolved and colloidal pollutants into gases, cell material, and metabolic end products. In the presence of oxygen (aerobic processes), high-quality effluents containing a variety of oxidized end products, carbon dioxide, and metabolized biomass will be produced. The synthesis and subsequent separation of microbial cells from the treated liquid is an essential feature of biological processes. Some of this microbial cell mass (sludge) must be wasted, but it is important to maintain within the system an active population of microbes to carry out the desired biochemical reactions.

Aerobic processes remove BOD and suspended solids that are not removed by sedimentation (septic tanks). Secondarily, nitrification of ammonia to nitrates and a significant reduction of pathogenic organisms are also accomplished. Whichever aerobic process scheme is chosen (suspended growth or fixed growth), three things must occur: (1) provide oxygen transfer to the wastewater, (2) provide intimate contact between the microbes and the waste, and (3) promote solids separation and removal. The use of a septic tank preceding the aeration process reduces problems with floating debris in the final clarifier, clogging of flow lines, and plugging of pumps.

Onsite extended aeration package plants are labor-intensive and require semi-skilled personnel to insure reasonable performance. Extended aeration systems should also be considered for multi-home applications. It must be understood, however, that multi-home applications may be more complex and require a greater degree of operator attention.

(4) Disinfection

The destruction of pathogenic organisms in the wastewater stream is the goal of disinfection. This step in the treatment process is important when discharging to surface water. If discharge of treated wastewater to surface water is determined acceptable for this area by the Environmental Health office, the eventuality of including disinfection in the treatment scheme must be considered. At that time, alternative disinfection techniques must be studied.

When incorporated with a subsurface disposal system, disinfection generally follows a sand filter, followed by an adsorption field and then soil disposal.

(5) Nutrient Removal

Nitrogen and phosphorus are plant nutrients and may cause undesirable plant growth in lakes and impoundments. Ammonia-nitrogen may be a toxicant to fish, and nitrate-nitrogen may be a toxicant to man and animals. The treatment objective for nitrogen and phosphorus in wastewater is dependent upon the ultimate means of disposal. Subsurface water quality standards are not well defined by EPA and DEQ, but nitrate-nitrogen and/or total phosphate is limited.

Onsite nutrient removal may be accomplished by a number of processes, but long-term data on field applications are sparse. In-house segregation of blackwater and graywater appears to be the most cost-effective method for onsite nitrogen and phosphorus control. Although certain chemical, physical, or biological processes may effectively accomplish adequate nutrient removal, these processes are complex and energy and labor intensive. Possible onsite nutrient removal systems are discussed below.

(a) Nitrogen Removal

(1) In-house Segregation

Blackwater (toilet wastewater) contributes approximately 78-90% of the nitrogen in wastewater discharged from the home. There are a variety of low water carriage and waterless toilet systems available. The resultant residuals from toilet segregation (ash, compost, chemical sludge, or blackwater) must be considered in this treatment strategy. Management of the segregation fixtures determines the effectiveness of this method for onsite nitrogen removal.

(2) Biological Processes

Nitrogen in wastewater undergoes decomposition to ammonia and nitrification to nitrate-nitrogen (NO_3-N). Nitrates may be reduced anaerobically to nitrogen gas (N_2) by the action of a variety of organisms. Let us assume that the nitrogen is in the nitrate form as is effluent from an intermittent sand filter or from an aerobic treatment process. This represents the current situation in many areas of the Sunnyside Addition, i.e. high nitrate level in the receiving groundwater.

Biological denitrification occurs anaerobically by the action of facultative, heterotrophic microorganisms. By this process, nitrates are reduced to nitrogen gas. An outside organic carbon source must be supplied for denitrification to be accomplished. Metering of the organic carbon source to the nitrified wastewater requires control to ensure a proper carbon:nitrogen (C:N) ratio. If the C:N ratio is too low, decreased denitrification rates result. If C:N is too high, the effect will be an increase the effluent BOD.

Soil leach fields, operated properly, are another method of onsite denitrification. Total nitrogen concentrations of less than 1 mg/l-N are achievable in effluents during summer months. Colder weather causes the effluent nitrogen concentration to increase somewhat, e.g. 5-10 mg/l-N.

(3) Ion Exchange

This scheme of nitrogen removal has been successfully used in full-scale water and wastewater treatment plants, but no long-term experience for onsite systems exists. Nitrogen removal by ion exchange is effective and simple to operate, and site conditions and climatological factors should not limit its application. Periodic replacement of the exchange media is necessary and expensive, and regeneration of the media onsite does not appear to be practical at this time.

(b) Phosphorus Removal

(1) In-house Segregation

The use of detergents low in phosphate would drastically reduce the amount of phosphorus in home wastewater. Segregation of blackwater and graywater, as discussed above, could also effectively reduce the phosphate-phosphorus concentration for the treatment process.

(2) Chemical Precipitation

Chemical precipitation results when the phosphorus is rendered insoluble by the addition of a number of coagulant chemicals. This phosphorus precipitation results in a sludge generation of as much as 200-300% by weight of the normal amount of precipitate produced in a septic tank.

b. Disposal Components

Methods of disposal of effluent from onsite wastewater treatment systems may be divided into three groups: (1) subsurface soil adsorption systems, (2) evaporation systems, and (3) treatment systems that discharge to surface waters. A number of alternatives exist for each group, and choosing the most appropriate system can be difficult. A system design matrix is presented in the EPA Design Manual "Onsite Wastewater Treatment and Disposal Systems" (EPA 625/1-80-012) and can be used as an aid in selecting an onsite system.

(1) Subsurface Soil Adsorption Systems

When suitable conditions prevail, subsurface soil adsorption is generally the method of choice. In order to achieve adequate removal of pathogenic organisms and other pollutants from the wastewater, it must travel through two to four feet of unsaturated soil. In determining the type of subsurface soil adsorption system to use, several critical factors, including soil profile characteristics and permeability, soil depth over water tables or bedrock, slope, and size of the acceptable area must be investigated.

(a) Trench and Bed Systems

These systems may be employed when the soil is moderately permeable and remain unsaturated several feet below the system throughout the year. In many locations in the Sunnyside Addition, particularly near Dry Creek, the groundwater level is very high, occasionally saturating the soil from the surface down. Trenches and beds rely on the upper horizons to absorb the wastewater. A very high groundwater level would eliminate these systems from consideration.

(b) Seepage Pits

Seepage pits are deep excavations used for subsurface disposal of pretreated wastewater. Covered porous-walled chambers are placed in the excavation and surrounded by gravel or crushed rock. Septic tank effluent enters the chamber and is stored until it seeps out through the chamber wall and infiltrates the sidewall of the excavation. Seepage pits may be used if the groundwater level is deep at all times or if the upper 3 to 4 feet of the soil profile is underlain by a more permeable unsaturated soil to a great depth. Soils with percolation rates slower than 30 min./in. are generally excluded. To insure protection of groundwater quality, a sufficient separation between the bottom of the seepage pit and the high water table must be maintained. It appears that many areas in the Sunnyside Addition have soil characteristics and a water table level that would restrict the use of seepage pits.

(c) Mound Systems

Mound systems are designed to overcome problems associated with slowly permeable soils, shallow permeable soils over porous bedrock, and permeable soils with high water tables. A mound system is a soil adsorption system that is elevated above the natural soil surface with a suitable fill material. In slowly permeable soils, the mound serves to improve adsorption of the effluent by utilizing the more permeable topsoil. In permeable soil with insufficient depth to water table or porous bedrock, the fill material of the mound provides the necessary treatment of the wastewater.

The slope of the land imposes limitations on the use of mound systems, particularly on sites with slowly permeable soils. Mounds should not be used on areas with greater than 6% slope for soils with percolation rates slower than 60 min./in. For soils with percolation rates faster than 60 min./in., slopes of as great as 12% are acceptable.

Textural qualities of the fill material and the natural soil must not create a soil interface that represents an abrupt textural change. If this occurs, downward percolation could be restricted, increasing the chance for surface seepage from the base of the mound.

The necessary depth to an impermeable layer is determined by soil permeability, climate, slope, and mound layout. Slow permeability, cold climates, and level sites are three factors requiring greater mound system depths.

Mound systems must be preceded by a suitable pretreatment scheme. Septic tanks are commonly used for pretreatment and have proven to be satisfactory.

(d) Fill Systems

Sites where slowly permeable soils overlie sands and sandy loams rule out the construction of a conventional system below the tight soil horizons. The slowly permeable soil may be stripped away and replaced with a sandy fill material to provide 2 to 4 feet of unsaturated soil above the seasonally high water table or bedrock. A trench or bed system may then be constructed within the fill.

The use of fills is restricted to sites where unsuitable surface soils may be stripped away without damaging the underlying soils. This restriction limits the use of fills to sites where the underlying soils are sands or sandy loams and the seasonally high water table or bedrock is not within 1 foot of the sand or sandy loam surface.

(e) Artificially Drained Systems

These systems employ methods to artificially drain high groundwater levels thereby facilitating the use of trenches, beds, or seepage pits. Vertical drains, curtain drains, and underdrains are commonly used techniques. Soil and site conditions determine which technique should be used.

(f) Electro-osmosis

Electro-osmosis has been defined as "The movement of liquid with respect to a fixed solid (e.g. a porous diaphragm or a capillary tube) as a result of an applied electrical charge" (International Dictionary of Physics and Electronics). These systems were developed to enhance wastewater absorption in slowly permeable soils (percolation rates slower than 60 min./in.). Natural materials (i.e. no external power source) are used to construct a galvanic cell capable of generating a 0.7- to 1.3-volt potential. Conventional absorption trenches are constructed, and a mineral rock-filled anode is installed immediately adjacent to the trench. Coke-filled cathodes with graphite cores are installed some distance from the trench. The water moves to the cathode and is removed by evapotranspiration. This process has been successfully applied in many locations in the Midwest and Wyoming.

(2) Evaporation Systems

Two basic systems, evapotranspiration beds and lagoons, are employed by this technique. These systems utilize the natural energy of the sun and, optionally, the natural purification capabilities of the soil to dispose of the wastewater. They are restricted to use in favorable climates, effectively eliminating them as an option for use in Cheyenne, Wyoming. Also, they may be restricted in water-short areas where consumptive water use is forbidden.

(3) Discharge to Surface Water

For this type of treatment scheme to be viable, an appropriate receiving water must be available. Dry Creek is an intermittent stream, and as such is an inappropriate receiving water. This scheme is therefore unacceptable for the Sunnyside Area, unless piping to Crow Creek is accomplished and the approval of the Environmental Health Office is secured.

4. Cluster Systems

Cluster systems imply that two or more users contribute treatment effluents for combined disposal.

This alternative also assumes that Sunnyside Addition will not be annexed to the City of Cheyenne, and, as such, the people in this area are responsible for their own wastewater treatment and disposal.

Cluster systems are popular among small communities and can be effective in achieving an effluent of acceptable water quality. Onsite pretreatment of household wastewater (septic tanks, aerobic systems, etc.) is incorporated, the effluents from which are collected for combined disposal. Disposal may be to subsurface or surface water, or by evaporation/evapotranspiration.

Where suitable soil, groundwater, and bedrock conditions exist, a number of the disposal methods discussed above may be sized and applied for cluster systems. The area required must be carefully determined, and adequate land must be obtained. Also to be considered is the cost of the pipe system required to deliver pretreated wastewater from each site to the disposal area.

5. Formation of an Independent Sunnyside Water and Sewer District

This alternative implies that the Sunnyside Area will remain outside the Cheyenne city limits, and the responsibility of providing water and sewer services to the residents of this area is their own. As was stated earlier, the policy of the City of Cheyenne is not to provide water and sewer services to areas outside the city limits and also not to sell water to a separate jurisdictional entity. Sunnyside, under this alternative, would have the responsibility of developing their own water supply and distribution network. This new water and sewer district would also be responsible for collection, treatment, and disposal of the wastewater generated by this area. The cost of construction of sewerage and a sewage treatment plant would be borne by the residents of the Sunnyside Area.

An important aspect to consider under this alternative is the bureaucratic responsibilities associated with a separate water and sewer district that would have to be dealt with. The residents of the Sunnyside Area would have to cooperate in the formation of this bureaucracy and be willing to support it. In considering the 201 study area in general, the formation of another water and sewer distrct appears to be an extremely inefficient and cumbersome way for the area to enter into the 21st century.

6. Connection to the City of Cheyenne System

Under this alternative, water and sewer services would be extended to the Sunnyside Area.

Fifteen property owners in the area have obtained private loans to construct water and sewer services through a main portion of Sunnyside. The sanitary sewer lines include the following: 1) 8" sanitary sewer line on Charles Street running between Cleveland and Fillmore Avenues, connecting to an existing 8" sanitary sewer on the corner of Charles Street and Fillmore Avenue; 2) an 8" sanitary sewer on Laramie Street from M.H.-4 (between Cleveland and Fillmore Avenues) to Pierce Street, where it will hook into the Dry Creek Interceptor line; and 3) an 8" sanitary sewer on Polk Avenue going from M.H.-1 (between Rawlins and Rock Springs St.) tying into an existing 8" sanitary sewer line that connects with the Dry Creek Interceptor line. Figure B-V-18 is a map of the Sunnyside Area, indicating existing and proposed sewer lines.

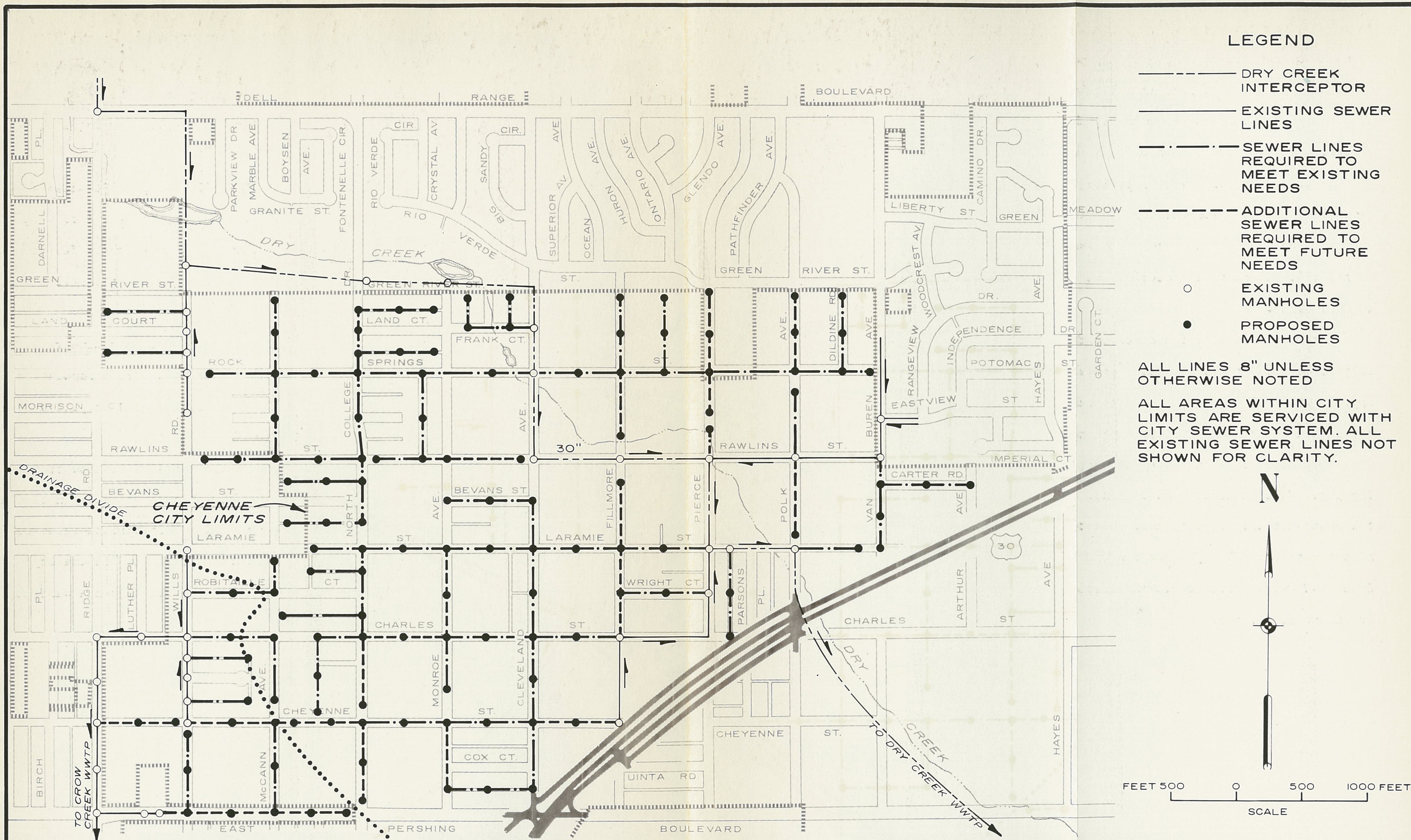
The cost to the residents of Sunnyside that would result from annexation has effectively prevented annexation in the past. Included in the costs are not only water and sewer services, but also other municipal benefits, e.g. street pavement, curb and gutters, etc. The city is willing to lessen the burden of annexation by giving the residents of Sunnyside certain options. According to Tom Bonds of the City Planning Office, owners of buildings in Sunnyside not meeting city codes will have two years to bring the property up to code. People with large lots will be allowed to subdivide and sell smaller lots, thereby lessening some of their financial burden. The city will establish a special ordinance that guarantees a tap-in fee paid to the fifteen property owners from anybody tapping into their proposed sewer lines in the future. This will help them pay off the planned water and sewer line extensions.

The Sunnyside Community Corporation (the 15 property owners) has developed annexation maps, preliminary planning, construction plans, and, according to the Wyoming State Tribune (July 11, 1981) "...has or is nearing award of a contract to a Greeley firm." With this alternative, the sewer lines discussed above represent only part of the total required sewerage extension. The northern part of Sunnyside, i.e. along Rock Springs St., would also need sewer and water services. These services would have to be developed by the residents who would be using them.

In accordance with stated policy, the city will not provide water and sewer services to areas outside the city limits. Since the stage of work on the sewer and water extensions discussed above has advanced quite far at this point, this alternative appears to be the most reasonable of these discussed in this paper.

A review of the design notes of the Dry Creek Interceptor Line reveals that it is sized to handle the wastewater flow generated from a population of approximately 60,000 people. This number greatly exceeds the projected population of the area contributing wastewater to this line.

This alternative would result in a noticeable increase in flow to the Dry Creek Wastewater Treatment Plant. The effect of this increase in flow at the sewage treatment plant must be determined, and an appropriate recourse must be chosen. Flow projections and the effect of this flow on the Dry Creek WWTP were discussed in the section dealing with the Cheyenne wastewater treatment facilities.



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SUNNYSIDE-ALTERNATE #17
PROPOSED WASTEWATER COLLECTION FACILITIES

FIGURE B-V-18

F. NORTH CHEYENNE

1. No Action

The "no action" alternative would mean this area would remain under County jurisdiction and continue to utilize existing treatment methods. Due to the limited size of the area and the housing density, groundwater contamination is possible in the future.

Therefore, due to the impending health hazards, the "no action" alternative is deemed unacceptable and should be dropped from consideration.

2. On-Site Methods

The types of on-site methods that could be utilized are similar to those discussed in the Sunnyside alternatives. Refer to section V.E for a complete discussion.

3. Cluster System

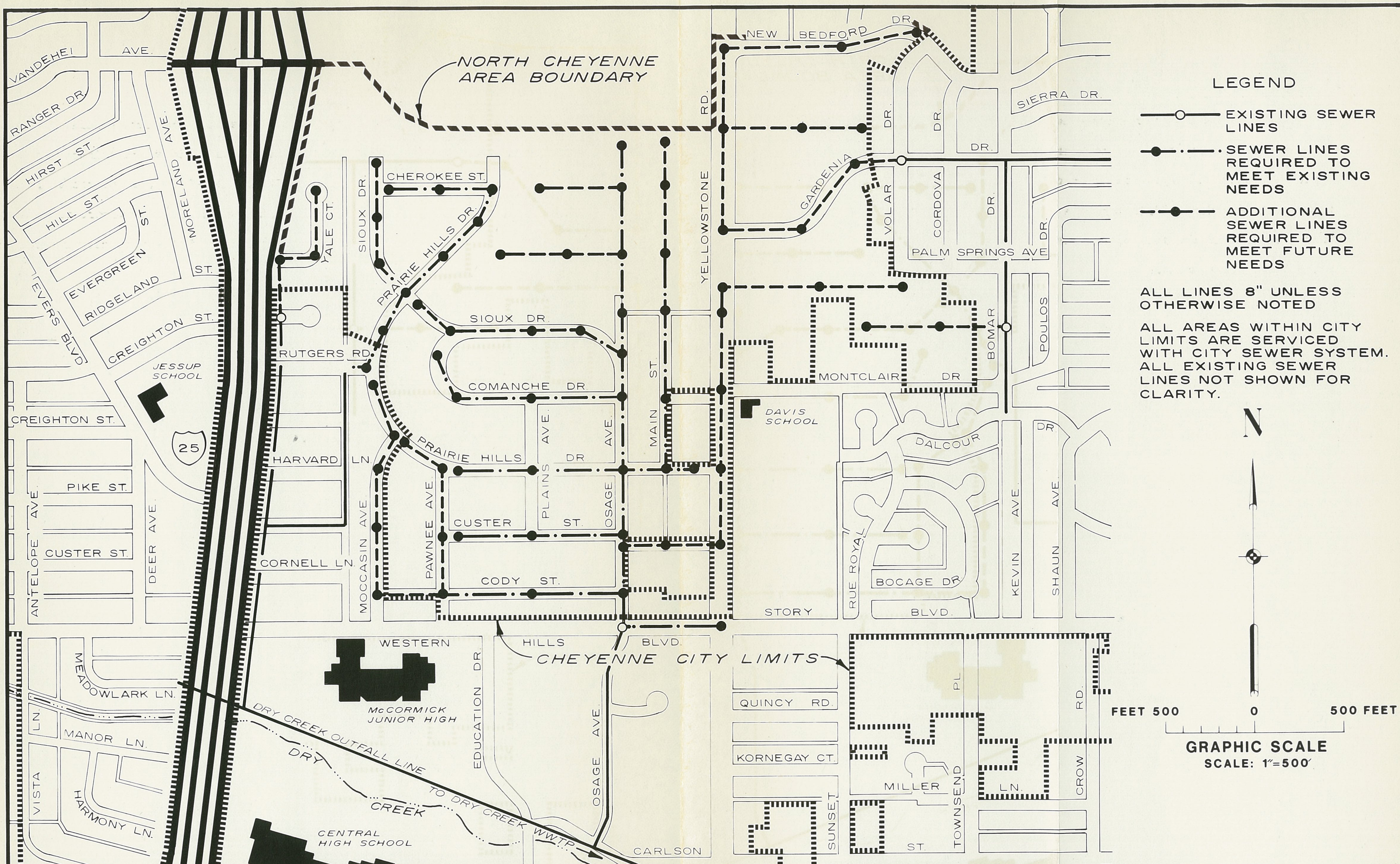
Again the discussion of the Sunnyside Alternatives contains information concerning a cluster system that is applicable to this area also. The area classified in this report as "North Cheyenne" is much smaller than Sunnyside which makes the location of a cluster system treatment area much more difficult than it was for Sunnyside.

4. Formation of Sewer District

The formation of an independent sewer district does not appear feasible for two reasons: (1) the area is small which would make the cost per household of a treatment facility large and (2) a total containment treatment system would be required as there are no acceptable discharge streams, ditches, etc. in the area.

5. Connection to City

If the area wants to avoid wastewater treatment problems similar to Sunnyside, it appears that connection to City services is the only viable alternative. A suggested sewer line layout is shown on Figure B-V-19. The annexation problems discussed in section B-V.E.5 are the same for this area. However, if safe wastewater treatment is the goal of the area, it appears hook-up to city sewer services is the only viable option.



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NORTH CHEYENNE-ALTERNATIVE #22 PROPOSED WASTEWATER COLLECTION FACILITIES

FIGURE B-V-19

G. RANCHETTES

1. General

There has been significant growth in the area surrounding Cheyenne in recent years. The vast majority of growth outside the city limits utilizes onsite wastewater treatment systems that utilize septic tanks followed by absorption fields. In the past, conventional soil absorption fields have at times been installed on lands that are not suitable for this type of application, resulting in potentially serious health hazards. Contaminated wells may result when septic tank effluent enters the groundwater following soil absorption field installations in areas with unsuitable geologic or soil conditions.

This section of the study explores the general suitability of soils in developing areas surrounding Cheyenne to adequately treat septic tank effluent as well as other wastewater treatment options. Data was obtained from the Soil Conservation Service, City-County Health Unit, Environmental Health Unit, Environmental Protection Agency, and field investigations by Banner Associates. These data were coordinated to achieve the results and conclusions of this evaluation.

Current ranchette development within the 201 Study Area is occurring in a number of locations (see Figures B-IV-1 and B-IV-2). The soils in areas where development is presently occurring in the study area, and where development is likely to occur, are discussed in detail in Appendix G.

This section attempts to identify such lands that pose potential problems regarding the use of conventional onsite wastewater treatment systems. By the identification of such lands, if development is to still occur, everyone concerned will have the knowledge that a wastewater treatment system utilizing something other than conventional onsite treatment will need to be installed.

The soil classifications presented are taken from the U. S. Soil Conservation Service Cheyenne City Report, Cheyenne, Wyoming, as developed by Abe Stevenson, Soil Scientist, in 1976. Each soil type is given a limitation rating of slight, moderate, or severe regarding its use as a septic tank effluent absorption field. A rating of slight indicates soil having properties favorable for the operation of an absorption field, including permeability, slope, and depth to bedrock. A rating of moderate is given to those soils having properties limiting to some extent the operation of conventional absorption fields. For these soils, extensive onsite testing and careful planning are required to compensate for the limitations imposed by the soil. Soils that are rated severe have properties that are not satisfactory for operation of conventional absorption fields. Soils with moderate or severe ratings do not necessarily preclude the use of onsite wastewater treatment. Onsite treatment on these soils requires the investigation of alternative and innovative treatment technologies. Table B-V-7 summarizes the soil types that are typically found in outlying developments.

Table B-V-7

Housing Developments, Soil Types, and Absorption Field Limitations

Development	Location ¼	S	T	R	Soil Types	Absorption Field Ratings-Limitations
Murray Hill Estates	NE	1	14N	67W	242C: Archerson-Dix complex; 6-10% slope	Slight-moderate: slope
					242E: Archerson-Dix complex; 10-30% slope	Moderate-severe: slope[1]
Project "N"	NE	1	14N	67W	46A: Archerson loam 0-3% slope	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
Sunset Tracts/ Longview Home-sites	SE	1	14N	67W	46A	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope[1]
					46B: Archerson loam 3-6% slope	Moderate: slope
Gray Fox Estates	NW	6	14N	66W	46A	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope[1]
Francis Homesites	NW	6	14N	66W	46A	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope[1]
Suburban Heights	NW	6	14N	66W	46A	Slight
Romsa Addition	SW	6	14N	66W	242C	Slight-moderate: slope
All America Subdivision	SW	6	14N	66W	242E	Moderate-severe: slope[1]
					46B	Moderate: slope
All America Subdivision	SE	6	14N	66W	46A	Slight
Riding Club Estates					242C	Slight-moderate: slope
					242E	Moderate-severe: slope[1]
					36A: Albinas loam, 1-3% slope	Moderate: percs slowly
Wyoming Ranchettes		33	15N	66W	46A	Slight
					46B	Moderate: slope
					242C	Slight-moderate: slope
Wyoming Ranchettes II		35	15N	66W	46A	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
					162: Trelona-Rock Outcrop complex	Severe: depth to bed-rock & slope[2]

Table B-V-7

Housing Developments, Soil Types, and Absorption Field Limitations (Continued)

Development	¼	Location S	T	R	Soil Types	Absorption Field Ratings-Limitations
Briarwood Ranchettes/ Arabian Hills		4	14N	67W	42B: Ascalon loam 3-6% slope	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope[1]
Pioneer Estates		34	15N	67W	42B	Slight
					36A	Moderate: percs slowly
					46A	Slight
					46B	Moderate: slope
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope[1]
Quarter Circle Five		5	14N	67W	42B	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope[1]
Read Tracts	SW	12	14N	67W	46A	Slight
					46B	Moderate: slope
					242C	Slight-moderate: slope
					162	Severe: depth to bedrock & slope[2]
Sunset Tracts (Filing #1), Ponderosa Hills, and Meadowview Estates	SE	12	14N	67W	46A	Slight
					36A	Moderate: percs slowly
Sunset Tracts (Filing #3)	NE	12	14N	67W	46A	Slight
					46B	Moderate: slope
					36A	Moderate: percs slowly
					242C	Slight-moderate: slope
Roundup Heights	NW	7	14N	66W	46A	Slight
					46B	Moderate: slope
					36A	Moderate: percs slowly
					162	Severe: depth to bedrock & slope[2]
					42A: Ascalon loam Slope 0-3%	Slight

Table B-V-7
Housing Developments, Soil Types, and Absorption Field Limitations
(Continued)

Development	Location ¼	S	T	R	Soil Types	Absorption Field Ratings-Limitations
Westview Addition, Laughlin Tracts	SW	7	14N	66W	162	Severe: depth to bed-rock and slope
					42A	Slight
					36A	Moderate: percs slowly
Bluegrass Subdivision		7	14N	66W	242C	Slight-moderate: slope
					36A	Moderate: percs slowly
					162	Severe: depth to bed-rock & slope
					42A	Slight
					36A	Moderate: percs slowly
North Hills & Volk Estate		8	14N	66W	162	Severe
					36A	Moderate: percs slowly
					242E	Moderate-severe: slope[1]
					46A	Slight
Commuter Estates		9	14N	66W	36A	Moderate: percs slowly
					242E	Moderate-severe: slope[1]
					162	Severe: depth to bed-rock & slope[2]
Paradise Valley, Woolsey Tracts, Buckles Subdivision		10	14N	66W	162	Severe: depth to bed-rock & slope[2]
					36A	Moderate: percs slowly
Lomalinda Subdivision	SW	7	14N	65W	42A	Slight
Vandehei Estates	NE	13	14N	67W	42B	Slight
North Cheyenne Monterey Ranchettes	SE	13	14N	67W	162	Severe: depth to bed-rock & slope[2]
Skyline Tracts	SE	18	14N	66W	163: Trelona-Wages complex	Slight-severe: depth to bedrock & slope[2]
Airport Valley Tracts	NE	19	14N	662	162	Severe: depth to bed-rock & slope[2]

Table B-V-7
Housing Developments, Soil Types, and Absorption Field Limitations
(Continued)

Development	¼	Location S	T	R	Soil Types	Absorption Field Ratings-Limitations
Lunar View Estates Montclair Tracts		17	14N	66W	36A	Moderate: percs slowly
					163	Slight-severe: depth to bedrock & slope[2]
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope[1]
					162	Severe: depth to bedrock & slope[2]
Cynthia Acres	NW	15	14N	66W	162	Severe: depth to bedrock & slope[2]
Crestmoor West	SW	15	14N	66W	36A	Moderate: percs slowly
Crestmoor Addition		15	14N	66W	162	Severe: depth to bedrock & slope[2]
					36A	Moderate: percs slowly
					42A	Slight
Del Range Addition		22	14N	66W	162	Severe: depth to bedrock & slope[2]
					36A	Moderate: percs slowly
					42A	Slight
					242C	Slight-moderate: slope
Wenandy Acres	SE	26	14N	66W	22B: Bridget very fine sand	Severe: percs slowly, slope
					36A	Moderate: percs slowly
					46A	Slight
Foster Tracts		25	14N	77W	36A	Moderate: percs slowly
					162	Severe: depth to bedrock & slope[1] [2]
					42B	Slight
					46A	Slight
					242E	Moderate-severe: slope[1]
Mesa Tracts		30	14N	65W	42A	Slight
					36A	Moderate: percs slowly

Table B-V-7
Housing Developments, Soil Types, and Absorption Field Limitations
(Continued)

Development	¼	Location S	T	R	Soil Types	Absorption Field Ratings-Limitations
Cox Country Estates		28	14N	67W	223: Kirkham, silty clay loam	Severe: flooding-wet
Rolling Hills Estates		30	14N	67W	46A 46B	Slight Moderate: slope
Southcrest Heights	NW	13	13N	67W	X63 242C	Slight Slight-moderate: slope

[1] Absorption fields can be placed on sites with slopes of 15% or greater by proper site preparation.

[2] Absorption fields can be installed if special site preparation is performed.

Most soils, with proper planning, are capable of effective wastewater treatment, provided ambient groundwater and geological conditions are suitable. The depth to bedrock or other impermeable layers must be great enough to transmit and treat wastewater in the soil strata above. The depth to groundwater must also be great enough to treat septic tank effluent before discharging it into the groundwater. Soil must have the capacity to treat organic and inorganic materials and pathogens by acting as a filter, cation exchanger, and adsorber.

The main strength of soil in wastewater treatment is its ability to retain organic matter found in wastewater in the pores of the soil as the septic tank effluent is passed through. This ability is optimal when the soil is unsaturated because as the soil becomes saturated the small pores fill with water first and it is in these pores that the most effective retention of organics (suspended solids) occurs. If the soil is saturated, the wastewater will pass only through the large pores and the adsorption of the organics in the effluent is minimal.

Regardless of soil type available for onsite treatment, several factors limiting treatment effectiveness must be taken into consideration. These limitations include: groundwater level, soil depth, slope of terrain, proximity to streams and lakes and flood plains, and population density. These limitations are discussed in Appendix G.

2. State-of-the-Art Onsite Methods

Effective onsite treatment is essential to health and safety, especially in moderately populated areas. The growth in the study area and the increased cost of land and housing have eliminated the luxury of large acreages for many people. Consequently, absorption fields have been placed on lots that are not properly designed or large enough to handle the volumes of wastewater applied to them. As a result, some wells have been located dangerously close to absorption fields.

Several hazards exist in association with poor wastewater treatment. The first and most obvious occurs when unfiltered sewage reaches the surface. Flooding, high groundwater, poor soil conditions, other means of saturating the absorption field, or improperly maintained septic tanks could cause wastewater to reach the surface causing an unhealthy miasma. This not only looks bad and causes unpleasant odors, but also attracts flies and other disease-bearing insects.

Another threat to health and environment occurs when improperly treated wastewater is discharged into surface waters from nearby developments. The waters become nutrient-enriched causing excessive growth of undesirable vegetation, impeding growth of marine life and limiting industrial and domestic use of the water.

A third problem and probably the most applicable to the study area is groundwater contamination attributed to inadequately treated septic tank effluent. Mr. Gary Hickman of the City-County Health Unit provided extensive information on this problem in the Cheyenne area.

When the soil in an area is improperly suited for an absorption field or an absorption field and a well are in too close proximity, high nitrate concentrations in well water may develop. High nitrate concentration in well water may also result from livestock manure, petroleum products, nitrogen rich fertilizer, runoff water from subdivisions containing lawn fertilizer and waste, and from naturally occurring deposits. The EPA allowable limit for nitrate concentrations in drinking water is 45 mg/l (10 mg/l NO_3-N; in terms of the amount of nitrogen present). High concentrations of nitrates are credited for the disease methemoglobinemia, a blood disease found in children less than four months of age. The disease renders an infant's red blood cells incapable of combining with molecular oxygen and leads to asphixia.

Raw wastewater contains nitrogen combined in proteinaceous matter and urea. Bacteria consume this matter converting the nitrogen to ammonia (NH_3-N). Ammonia is oxidized first to nitrite (NO_2-N) and then to nitrate (NO_3-N).

Available data indicates approximately 2-10% of the total nitrogen from household waste will be removed in the septic tank. Biological denitrification is carried out if a sufficient organic carbon source is present. Septic tank effluent can serve as an organic carbon source. Also, an outside carbon source, such as methanol, may be required to provide the appropriate carbon to nitrogen ratio of approximately three-to-one. Operation and maintenance requirements for denitrification systems are normally complex and call for semi-skilled labor for proper performance. When a system is improperly maintained, high nitrate concentrations result in the ambient soil environment, a condition that has been recorded in part of Laramie County -- more specifically, heavily developed areas adjacent to the Cheyenne city limits.

The depth of soil needed for effective onsite treatment is determined by the soil permeability. Fine-textured or clayey soils have small, discontinuous pores and act as an excellent solids filter. Clayey soils, however, retain water for a long period of time and do not drain well, which could result in untreated sewage reaching the surface in the event of heavy precipitation. As a result, a very large land area is required to handle average volumes of household wastewater.

On the other end of the soil spectrum are the coarse-textured or sandy soils. Sandy soils have large, continuous pores and drain very well. Sandy soils, due to their rapid draining characteristics, do not filter very well which could result in partially treated sewage being discharged into the groundwater. As a result a very deep absorption field is required to treat average volumes of household wastewater.

Loamy soils, on the other hand, fall somewhere between clayey soils and sandy soils. Loamy soils contain large pores which accept and transmit wastewater at a moderate rate and small pores which provide better filtering characteristics. Loamy soils are best suited for septic tank absorption fields. Typical onsite methods were discussed in section B-V.E. Those methods are applicable for Ranchette areas where the soil has been determined to be satisfactory.

3. Cluster Systems

The theory of a cluster system was previously discussed in the section on Sunnyside. If one portion of a development is suitable for an onsite system but another portion of the development is not, a cluster system gives the developer a treatment option. The major disadvantages would be the installation of a sewer line collection system and insuring that the treatment site and sewer lines are properly maintained. At this time it appears questionable that a developer would utilize a cluster system due to these disadvantages.

4. Connection to City

Current City policies regarding annexation before connecting to City services make this alternative unworkable. Even if the policy is altered, the density of population in the Ranchette areas makes this alternative prohibitively expensive.

5. Formation of Sewer District

If onsite treatment systems are not practical, the formation of a sewer district is a possibility. As in item 4 above, this option would prove to be quite expensive due to the density of development. Many miles of sewer lines would have to be installed to collect the wastes of a development.

Once the wastes are collected, they would then have to be treated, either at the City plant (this would require a special agreement), or at an independent sewer district plant. In either case it appears this option would not be cost-effective at this point.

6. No Action

The no action alternative would continue the status quo. It would mean that the City-County Health Unit would continue reviewing septic tank/absorption field locations. The moratorium on new septic tanks would probably continue. Continued degradation of the groundwater in this area would be likely. Therefore, the monitoring system should remain at least as strong as it currently is. If deterioration of the groundwater occurs, more stringent requirements may have to be instigated.

H. RECYCLE/REUSE - FLOW REDUCTION

1. General

As an alternative to expanding a wastewater treatment plant, sewer lines, etc., the possibility of reducing the volume of wastewater flow should be considered. The money saved in reduced treatment plant costs may justify the implementation of a wastewater reduction program. A wastewater reduction program can occur at two levels: (1) at the wastewater treatment plant or (2) in the individual home. Any program that reduces the quantity of existing wastewater flow must be scrutinized for compliance with Wyoming Water Law. In a telephone conversation on February 26, 1982, Paul Schwieger, Deputy State Engineer, stated that the City of Cheyenne does not have the authority to do anything it wants with all of its water. The City can use the water for its specified purpose, treat it, and discharge it for downstream user benefit. According to the Attorney General's office, however, this appears to be an unresolved legal issue. In an April 29, 1982, memorandum from Steve Jones, Assistant Attorney General, he states,

> "In determining the rights of municipalities to use, reuse, and dispose of their water as they may see fit, it will be crucial to learn whether any of the water in question is imported water. Imported water is water which has been "developed" for use which would not have been available had it not been developed. "Trans-basin" water, i.e. water brought in from another drainage system, is the best example of imported water.
>
> "The case of Thayer vs. Rawlins (see Chapter VI, Final Report) indicates fairly definitely that municipalities may do whatever they please with imported water. Herman Noe of the Cheyenne Board of Public Utilities informs me that 60% of Cheyenne's water comes from the "Continental Divide system", 25% from the Crow Creek basin, and 15% from well fields (within the Crow Creek drainage). Thus, it would appear, under the <u>Thayer</u> ruling, that Cheyenne has a right to use, reuse, and dispose of 60% of its water as it may choose, without regard to the claims of downstream users. The water from the well fields is another unresolved legal question.

Whether the State Engineer could somehow require where Cheyenne puts this portion of its water is very uncertain. It would certainly be treading on new legal ground. As for the 25% of Cheyenne's water from the Crow Creek basin, much of this may be able to be legitimately claimed by downstream users, as affecting their appropriations. But even this is up in the air. It's possible that part of this water could be considered "developed" water, since much of it might evaporate before reaching downstream users, if it were not piped to Cheyenne.

"You should note, by the way, that the case of Thayer vs. City of Rawlins was decided by a 3-2 vote. Any new cases coming before the Wyoming Supreme Court could have a different outcome since one justice voting with the majority in that case is no longer on the Court. The point is that these issues will be hotly debated no matter what, and it may be in the best interests of everyone concerned to negotiate an amiable agreement between all concerned parties so the time and expense of the lawsuit(s) may be avoided."

The April 29, 1982 memorandum from Steve Jones and a copy of the Wyoming Supreme Court case, Thayer vs. City of Rawlins, are included in Chapter VI of the Final Report.

Reduction in the rate of increase of wastewater flow should cause no problems with Wyoming Water Law as this increased flow does not have a historical use in the Crow Creek drainage basin.

2. Treatment Plant Effluent

The effluent from the existing study area wastewater treatments plant is used for irrigation by downstream users. According to the State Engineer's Office, compensation to downstream users with water rights on Crow Creek must be made if a flow reduction program limits the available supply in Crow Creek, even if this supply is imported water. However, according to the Attorney General's office, unless contractual obligations exist binding the City to discharge a specified flow from the two WWTP's, it would "appear to be very doubtful that the State Engineer could prohibit water reuse by the City of Cheyenne. Compensation of downstream users would therefore not be necessary as a result of reuse." (Steve Jones, Assistant Attorney General, memorandum April 29, 1982).

a. Reuse-Irrigation

Approximately 750 million gallons per year of water are used to irrigate golf courses, parks, and cemeteries. Assuming that the majority of the watering occurs in four months, a municipal use of 6.25 MGD results. Wastewater plant effluent could meet this demand by the year 2005. The effluent from Dry Creek Plant is of acceptable quality, and no further treatment would be required. The cost of this alternative is discussed in Section B-VI.

b. Recycle-Drinking Water

The second option for using the 4 MGD of wastewater in the year 2005 is to further treat the wastewater and place the water into the City water system. This would require a tertiary treatment plant. The costs associated with this option are also discussed in Section B-VI.

3. Individual Home

In lieu of handling the wastewater reuse at the treatment plant, it may be worthwhile to consider reducing the volume of wastewater and pollutant loading that enters the sewer system.

a. Flow Reduction

A variety of techniques and devices are available which reduce the volume of wastewater that enters the sewer system. The first technique, and possibly the most difficult to be successful, involves public education to reduce wastewater flows. Even such seemingly simple items as eliminating leaking faucets will reduce the amount of wastewater that flows into the sewer system.

Water saving devices such as toilet tank inerts, dual-flush toilets, composting toilets, and reduced flow shower-heads all serve to reduce wastewater flow. According to EPA figures, savings of up to 23% can be experienced when such devices are properly installed and used. Mandatory use of any of these items would require not only the passage of special ordinances but also some type of enforcement procedures which could prove difficult if not impossible. One possible method would be to allow only the sale of water devices that meet certain water saving standards. Also, none of these devices are free. There is a cost associated with any option chosen.

A third flow reduction technique involves the collecting and processing of the wastewater flow produced from specific areas within the home and subsequent reuse. For example wastewater from bathing, laundry, and the bathroom sink can, with minor treatment, be applied to lawns. Of course in the Cheyenne area this would be viable as a rule from only May through September. Also, there may or may not be a need to use all of the water that could be generated. Therefore, it is extremely difficult to state how much of a wastewater flow reduction is really possible.

b. Pollutant Reduction

A decrease in the amount of pollutants that enter a sewer system should result in a lower BOD, suspended solids, nutrients, and pathogenic organism loading that will be treated at a treatment plant. As in the case of flow reduction, several alternatives exist.

The first alternative again involves public education. Teaching people about the problems created at a wastewater treatment plant because of disposable diapers, sanitary napkins, grease from pots and pans, and high phosphate detergents may result in the elimination of some of these items.

Method two involves the elimination of garbage disposal waste. The use of a garbage disposal, according to EPA figures, can contribute approximately 30% of the BOD and suspended solids found in residential wastewater. Of course elimination of this waste from the wastewater system would then increase the waste volume at the sanitary landfill. The volume of waste does not totally disappear; it becomes a problem for another aspect of waste treatment.

Another possibility would be to separate human excreta by means of a composting or incinerating toilet. Removal of human excreta eliminates significant quantities of suspended solids, nitrogen, and pathogenic organisms from the wastewater.

The use of any of these wastewater reduction methods, or combinations thereof, could help decrease the loads on the wastewater treatment plants within the Study Area, therefore reducing treatment costs. The limiting factors that determine the possible extent of wastewater reduction are public awareness and the water rights issue. A full investigation of the water rights of downstream users should be carried out, and all adjudicated water rights should be protected. However, since 60% of the water used in Cheyenne is imported water (Herman Noe, Cheyenne Board of Public Utilities), the City of Cheyenne apparently can do whatever it wants with this water according to the Attorney General's office. Any pollutant reduction program that reduces the discharge from the WWTP's to less than 40% of the current level would require a thorough investigation to protect downstream users.

If the State Engineer determines that adjudicated water rights would be damaged, a wastewater reduction program could be initiated only upon compensatory agreements or for the reduction of flows from future users of the municipal treatment systems without some type of compensation being agreed to by the downstream users.

A flow reduction program for future customers could include the retrofitting of toilet dams and low-flow shower-heads for existing homes to be annexed into the city, and specific changes in local ordinances, building codes, or plumbing codes requiring the installation of water saving devices such as water conserving toilets, shower-heads, lavatory faucets, and appliances in new homes, hotels, institutions, and other establishments. In general, passive wastewater reduction methods or devices not significantly affected by user habits tend to be more reliable than those which are subject to user habits and require a preconceived active role by the users. For example, a low-flush toilet is a passive device, while a flow reducing shower-head is an active one. The use of an "active" device, such as a flow reducing shower-head, is likely to be bypassed or removed if the results of the device are not acceptable to the user. The success of a reduction program would depend upon the selection of methods or devices whose characteristics and merits indicate a potential for long-term user acceptance, but at the same time would concentrate on those areas of use, i.e. bathing, clothes-washing, toilet flushing, etc., that would lend themselves more readily to a reduction program. It is logical to assume that more could be achieved by concentrating on those areas of use that contribute a majority of the wastewater flows or those areas of use where the most waste occurs. An assessment of the users' habits needs to be performed in order to define these problem areas and to provide sufficient information so that a magnitude of reduction could be estimated.

I. SEWER LINE EVALUATION

All major existing sewer lines were investigated to determine what portion of their capacity is currently being utilized. Also, an estimation of future sewer line capacities has been made and is included in the review that follows:

1. City of Cheyenne

Section B-IV, Figure B-IV-5 shows the existing Cheyenne sewer system which consists of approximately 208 miles of sewer line ranging in size from 4-inch to 36-inch. The Infiltration/Inflow analysis (Appendix F) concluded that the level of infiltration and inflow was within allowable standards. Therefore, the only question remaining is whether new sewer collector or trunk lines are needed now or in the future.

a. Dry Creek Outfall Line

This line goes from the Dry Creek Plant towards Town and connects with the Dry Creek trunk line. By the year 2005, the average flows at Dry Creek are estimated to be 5.71 MGD. Approximately 2 MGD of this flow reaches Dry Creek via the Crow Creek Interceptor, discussed below, with 3.71 MGD entering the plant from the Dry Creek Outfall Line. Even if the line experiences a 3.0 peak hourly factor, which existing records show is not the case, the line will be able to adequately handle the flows. Therefore, no changes are recommended to this line through the end of the study period.

b. Crow Creek Interceptor

This line begins at the Crow Creek Plant and terminates at the Dry Creek Plant. Currently, approximately 2 MGD (average daily flow) is carried in this line. Estimating the future flows in this line involves the examination of three cases:

1. Crow Creek Plant is abandoned.

2. South Cheyenne Plant is abandoned.

3. Both Crow Creek and South Cheyenne Plants are abandoned.

Case 1 - If the Crow Creek plant is abandoned, approximately 6 MGD (average daily flow) would have to be carried by the Crow Creek Line. If the current ratio of average daily to peak hourly flows continues, the line would have to carry a peak hourly flow of approximately 12 MGD. The line has adequate capacity making no changes necessary for this case.

Case 2 - If the South Cheyenne Plant is abandoned, all of its wastewater flow would be diverted to the Crow Creek interceptor thence to the Dry Creek Plant. A new 30-inch line would need to be constructed from the existing South Cheyenne Plant to the Crow Creek Interceptor. A total peak hourly flow of 7.9 MGD would then be added to the existing 4 MGD peak hourly flow making a total of 11.9 MGD by the year 2005. Since the line has a capacity of approximately 15 MGD, no change would be required to the existing line if this case became a reality. As previously stated, a new 30-inch line approximately 6300 feet long would have to be built to connect South Cheyenne to the Crow Creek Line.

Case 3 - If both the South Cheyenne and the Crow Creek plants are abandoned, the Crow Creek line would need to have a peak hourly capacity of approximately 17 MGD by the year 2005, which is 2 MGD greater than the existing line capacity. Therefore, if this case occurs, a new line will need to parallel the Crow Creek Interceptor in order to meet to peak hourly flows.

c. Main Sewer Lines

The main collector lines in Cheyenne can be placed in two groups: (1) those connecting to the Dry Creek Outfall line and (2) those connecting with the Crow Creek interceptor (Figure B-IV-5).

The Dry Creek line ranges in size from 18-inch to 42-inch with a flow capacity of approximately 4.8 MGD to 18.0 MGD. Based upon existing flows and population projections to the year 2005, no portions of the line will be at capacity, even for peak hourly flows, by the end of the study period. If the population growth occurs at a faster rate than assumed in this study, the lines should be checked as the Cheyenne sewer population approaches 80,000.

Basically, no significant increase in flows should occur in those lines that connect to the Crow Creek facility since the area is already developed. The one exception to this statement is the growth that may occur in the south-west corner of Sunnyside. However, the amount of flow from this area will not have a significant impact in view of the total overall flow.

Eighteen manholes on collector lines for this area were inspected. No evidence of surcharge nor any 100% capacity flows were observed except as discussed in Appendix F. Because no significant increase in flows to these lines is expected, no improvements appear necessary. Again, if a substantial flow increase is experienced in this area, these lines should be reexamined.

2. South Cheyenne

The sewer line needs of the South Cheyenne Water and Sewer District will depend upon the amount of growth that occurs within the District. Population projections for the area range from 15,000 to 25,000 people. Although the growth of the area is expected to be 25,000, at least 10,000 of that growth may be connected to City services rather than those of the District. Table B-V-8 below summarizes the expected sewer flows in various collector lines (shown in Figure B-IV-6) at both a 15,000 and 25,000 population.

Table B-V-8

Capacities and Expected Flows in
Sewers of South Cheyenne

Line Location	Capacity	Current Flow ADF	Current Flow PHF	15,000 Population ADF	15,000 Population PHF	25,000 Population ADF	25,000 Population PHF
21" Outfall	3.7 MGD	0.64 MGD	1.6 MGD	1.5 MGD	3.8 MGD	2.5 MGD	6.3
18" Interceptor	3.3	0.52	1.3	1.3	3.3	2.2	5.6
College Dr./ E. Prosser 12"	1.4	0.43	1.1	1.0	2.5	0.8	2.1
Avenue "C" 15%	2.1	0.15	0.4	0.3	0.8	1.1	2.8
South 12" Line	1.2	0.10	0.3	0.25	0.6	1.0	2.5
Avenue "D" 8"	0.5	0.12	0.3	0.15	0.4	0.2	0.6

ADF = Average Daily Flow
PHF = Peak Hourly Flow

As can be seen in Table B-V-8 only the 12-inch, College Drive/East Prosser Drive, Sewer line would need to be enlarged for a 15,000 population. However, if the area is allowed to grow to 25,000, all of the lines would be incapable of conveying the estimated peak hourly flow. The replacement of these lines is not included in the 201 Facility Plan recommendations and probably would not be considered eligible for federal funds.

3. Sunnyside

If the Sunnyside alternative (Section B-V.E.) of connecting to City services is chosen, a major sewer line project will be required. A system consisting of approximately 36,000 L.F. of 8-inch PVC sewer pipe with approximately 102 manholes (Figure B-V-18) would be necessary to serve the existing houses. An additional 10,800 L.F. of 8-inch PVC with 26 manholes would be needed if the presently undeveloped sections of Sunnyside are to be included.

4. North Cheyenne

If the North Cheyenne alternative (Section B-V.F.) of connecting to City services is chosen, approximately 12,000 L.F. of 8-inch PVC will need to be installed as shown in Figure B-V-19. In order to place sewers in the entire area, approximately 23,700 L.F. of 8-inch PVC would be required.

B-VI. EVALUATION OF ALTERNATIVES

A. INTRODUCTION

Each of the wastewater treatment alternatives developed in Chapter B-V must be evaluated for its respective cost-effectiveness to aid the 201 Committee and the people of the study area in their selection of a final alternative. The economic evaluations presented in this chapter should not be construed as being the ultimate cost of each alternative because similar aspects of each alternative were not included, e.g. laboratory, sludge disposal, conveyance pipelines, administration buildings, etc. The costs presented are for comparison purposes only, and final cost estimates will be prepared after the list of alternatives is shortened.

The discussion of the city wastewater treatment facilities (Crow Creek WWTF and Dry Creek WWTF) is presented first, followed by the discussion of the alternative wastewater treatment options for the South Cheyenne Water and Sewer District. Sunnyside, North Cheyenne, and the Ranchette development options follow the South Cheyenne discussion.

The costs of the various alternatives presented are in 1981 dollars. Total capital costs are presented as well as annual costs. Total annual costs were developed by summing the yearly operation and maintenance (O&M) costs and the construction costs (amortized over 20 years at 7-3/8% interest).

B. CITY OF CHEYENNE

The alternatives for the City of Cheyenne include: (1) no action, (2) upgrade to improve operation without an increase in capacity, and (3) increase total wastewater treatment capacity as required, depending on the degree of expansion, if any, accomplished by the South Cheyenne Water and Sewer District.

1. No Action

The "no action" alternative implies that the total wastewater treatment capacity of the City of Cheyenne will remain at 8.5 MGD (4.5 MGD at Dry Creek and 4.0 MGD at Crow Creek). Population projections for the sewered population in the study area for the year 2005 indicate a total required treatment capacity of roughly 11.0 MGD by the end of the study period (Appendix 3). The effect that this growth will have on Cheyenne's wastewater treatment system is, in part, dependent on the South Cheyenne Water and Sewer District. If the South Cheyenne WWTF is expanded to handle an average flow of 2.5 MGD, the facilities of the City of Cheyenne would have sufficient capacity to treat the projected flows. On the other hand, if the South Cheyenne WWTF is abandoned, or expanded to only 1.5 MGD, the city facilities will require expansion, as discussed below.

The "no action" alternative for the City of Cheyenne is, therefore, not necessarily an undesirable alternative, but other factors must be considered before this choice is made. If South Cheyenne development is limited, as is highly possible, this alternative could render the city's treatment facilities overloaded in the later part of the study period, resulting in the discharge of an effluent that most likely will not meet DEQ discharge requirements.

Table B-VI-1 shows the total and annual costs of all the alternatives developed for the City of Cheyenne. The total annual costs for the no action alternative, as shown in Table B-VI-1, may result in higher costs in the future; the discharge of an unacceptable effluent is likely to occur as the treatment plants approach their capacity if the upgrading that was previously discussed is not undertaken.

The O&M costs presented in Table B-VI-1 are based on the reported budget for Fiscal Year 1982 (July 1, 1982-June 30, 1982). The O&M costs presented in Table B-VI-1, for flows other than the current 8.5 MGD, have been prorated in relation to this current flow.

Table B-VI-1

City of Cheyenne: Costs of Wastewater Treatment Alternatives

Treatment Alternatives	Capital Costs Total $	Capital Costs Amortized 7-3/8%,20Yrs $/Yr	O&M Costs $/Yr	Total Annual Cost
No Action	0	0	360,530	360,530
Upgrading to improve operation (South Chey = 2.5 MGD)	1,029,800[1]	100,100	360,530[2]	460,630
Expand Dry Creek to 5.5 MGD (South Chey = 1.5 MGD)	2,541,930[3]	247,080	397,450	644,530
Expand Dry Creek to 7.0 MGD (South Chey abandoned)	2,784,340[4]	270,640	466,570	737,210
Expand Dry Creek to 8.5 MGD (Crow Creek abandoned, South Chey = 2.5 MGD)	2,555,310	248,380	360,530	608,910
Expand Cry Creek to 9.5 MGD (Crow Creek abandoned, South Chey = 1.5 MGD)	3,241,300[3]	315,050	402,950	718,000
Expand Dry Creek to 11.0 MGD (Crow Creek & South Chey abandoned)	3,522,640[4]	342,400	466,570	808,970

[1] This total cost is broken down between the Dry Creek and Crow Creek facilities thusly:

Dry Creek upgrading: $487,700
Crow Creek upgrading: $542,100

[2] Jack Young, Superintendent of the Cheyenne Wastewater Treatment Facilities, indicates that with upgrading, the O&M costs could be considerably reduced, i.e. "City water supply could reduce Dry Creek O&M by 1/3." However, no reduction has been included at this time.

[3] Cost of pipeline with Q_{ADF} = 1.0 MGD from South Cheyenne to Crow Creek diversion structure paid totally by City.

[4] South Cheyenne WWTF abandoned. Cost of pipeline with Q_{ADF} = 2.5 MGD from South Cheyenne to Crow Creek diversion structure is prorated between City and South Cheyenne (40% City, 60% South Cheyenne).

2. Upgrading Dry Creek and Crow Creek

The major premise of this alternative is that the total wastewater treatment capacity of the City facilities will not be increased beyond the existing 8.5 MGD. This alternative should lessen O&M costs while facilitating improved wastewater treatment and solids handling.

An extensive examination of both treatment plants and detailed discussions of the operation of the plants with Jack Young, Superintendent of the Cheyenne Wastewater Treatment Facilities, precipitated the recommendations that were discussed in Chapter V.

a. Dry Creek WWTF

Improvements to the Dry Creek facility would result in a total cost of $487,700. The breakdown of this cost is shown in Table B-VI-2. When amortized over 20 years at 7-3/8% interest, this results in an annual cost of $47,400.

Table B-VI-2

Upgrading Costs: Dry Creek WWTF

Improvement	Total Cost
City Water Supply	$ 84,480
Pretreatment	72,520
Primary Clarification	100,200
Aeration Covers	103,500
Secondary Clarification	11,800
Sludge Digester	13,000
Subtotal	$385,500
Contingencies	38,600
Subtotal	$424,100
Legal, Admin., Engr.	63,600
Total	$487,700

A detailed breakdown of the development of these costs, as well as costs for all other alternatives, is included in Appendix E.

If funds are limited, there does exist a certain degree of priority for some of these improvements. High on this list of priorities is the delivery of city water supply to the Dry Creek Plant. Jack Young reports that a reliable city water supply would "reduce O&M costs by 1/3" at the Dry Creek facility. The cleaning of the digesters is also considered imperative, along with the installation of scum handling equipment in the clarifiers.

The other recommendations should follow, as determined by the operation of the facility.

b. Crow Creek WWTF

The improvements to the Crow Creek facility discussed in Chapter B-V have an estimated price of $542,100. A summary of this cost is shown in Table B-VI-3. When this total cost is amortized over 20 years at 7-3/8% interest, the annual cost is $52,700.

Table B-VI-3

Upgrading Costs: Crow Creek WWTF

Improvement	Total Cost
Pretreatment	$ 43,400
Primary Clarification	55,000
Trickling Filters	56,000
Final Clarifiers	140,000
Anaerobic Digestion	125,000
Site Improvements	10,000
Subtotal	$429,400
Contingencies	42,900
Subtotal	$472,300
Legal, Admin., Engr.	70,800
Total	$542,100

These costs were developed in a similar manner as those presented for the Dry Creek facility, and can be examined in Appendix E.

3. Expand Cheyenne Sewage Treatment Capacity

The expansion of the sewage treatment capability for the City of Cheyenne will be necessary if South Cheyenne limits its development or if the Crow Creek WWTF is abandoned. This expansion could be facilitated by enlarging the Dry Creek plant or by the construction of a new facility. The degree of the expansion required is based on various combinations of alternatives, as shown in Table B-VI-1. The total costs of the expanded Dry Creek facility were developed with the aid of EPA cost estimate curves presented in EPA-430/9-75-002, "Technical Report, A Guide to the Selection of Cost-Effective Wastewater Treatment Systems" July 1975. These costs are based on the National Average WWTP cost index of 177.5 for February 1973, and were updated to September 1981 cost by multiplying by the appropriate cost index. The September 1981 cost index was 386.8. Therefore the costs were multiplied by 386.8/177.5 = 2.18. The costs presented were developed with the assumption that new facilities would be constructed to treat the increased flow. For example, let us consider the expansion of Dry Creek to a 5.5 MGD facility. This equates to a required expansion of 1.0 MGD. The construction of a 1.0 MGD activated sludge facility would be approximately $1,016,210. This amount is based on the above mentioned EPA technical report, and was computed at an interest rate of 5-7/8%. When this value is brought to 7-3/8%, the capital costs total $1,160,130. The improvements to the two facilities (Dry Creek and Crow Creek) as discussed are assumed to accompany this alternative. Also included would be a pipeline from South Cheyenne to the Crow Creek diversion structure. Therefore, the costs of upgrading presented above are included in the total cost for this expansion. The total cost therefore equals $1,160,130 + $1,029,800 + $352,000 = $2,541,930. For the alternatives that assume the abandonment of the Crow Creek facility, only the upgrading costs of Dry Creek are added.

As can be seen in Table B-VI-1, it appears that the most cost-effective alternative for the City of Cheyenne would be to upgrade their facilities to improve operation without increasing the capacity, i.e. annual cost of $481,530.00 assuming the "no action" alternative is ruled out. This would indeed be the case if the South Cheyenne Water and Sewer District were to be responsible for the treatment of 2.5 MGD. It appears unlikely at this time that the South Cheyenne Water and Sewer District should be totally responsible for the treatment of 2.5 MGD, as some of this projected flow would come from outside of the District's boundaries.

Considering the possibility that the South Cheyenne Water and Sewer District's flow would be 1.5 MGD, Cheyenne will either have to expand its treatment capacity to a total of 9.5 MGD or arrange a working agreement with South Cheyenne whereby the South Cheyenne WWTF is expanded to 2.5 MGD, but the costs of expansion and O&M are shared between the City and the district. This sharing of costs should be proportioned thusly:

South Cheyenne payment = 1.5/2.5 = 60%

Cheyenne payment = 1.0 - .6 = 40%

An arrangement like this (i.e. City capacity = 8.5 MGD and South Cheyenne capacity = 2.5 MGD, with the City paying 40% of the South Cheyenne expenses) would result in a total annual cost to the City of $729,200, assuming the contact stabilization alternative with a 2.5 MGD capacity is used at the South Cheyenne WWTF, and the City facilities upgraded but not expanded.

Table B-VI-4 indicates that the above scheme would be less cost-effective for the City than the expansion of the City facilities to 9.5 MGD and the South Cheyenne facility to 1.5 MGD. Also indicated in Table B-VI-4 is that the most cost-effective alternative for the area in general would be to abandon the South Cheyenne WWTF and upgrade the City facilities to a capacity of 11.0 MGD.

Regardless of the particular combination of alternatives chosen, it is recommended that the existing facilities in the City of Cheyenne be upgraded to improve operation. The Crow Creek plant should be a useful facility until the year 2005, and should not be abandoned until then. The Dry Creek facility is relatively new and should be capable of producing an effluent of desirable quality well past the year 2005, if its capacity is not exceeded.

Table B-VI-4

Annual Cost Comparisons

Alternative	City Annual Cost $/Yr	S. Cheyenne Annual Cost $/Yr	Total Annual Cost $/Yr
S. Chey. 1.5 MGD, Contact Stabilization + City 9.5 MGD	684,720[1]	495,330	1,180,050
S. Chey. 2.5 MGD, Contact Stabilization (40% of Costs to City) + City 8.5 MGD	729,200[2]	371,500	1,100,700
S. Chey. 1.5 MGD Ext. Aer. City 9.5 MGD	684,720[1]	493,270	1,177,990
Abandon S. Chey. City 11.0 MGD	793,730[1]	25,180[3]	824,160

[1]See Table B-VI-1
[2]Includes $481,530 for upgrading City facilities
[3]Cost of pipeline with Q_{ADF} = 2.5 MGD; South Cheyenne's portion = 60% of cost

C. SOUTH CHEYENNE WATER AND SEWER DISTRICT

The costs of the wastewater treatment alternatives investigated for the South Cheyenne Water and Sewer District are summarized in Table B-VI-5. The development of these costs may be examined in Appendix 3. The costs of the extended aeration expansion to 1.5 MGD and of the contact stabilization, activated sludge, oxidation ditch, and lagoon system, each with a design flow of 2.5 MGD, are all based on the expected materials requirement and manufacturers' prices, anticipated labor requirements, etc. The 1.5 MGD costs for the contact stabilization, activated sludge, oxidation ditch, and lagoon system are assumed to be 80% of the respective 2.5 MGD costs. The new activated sludge and trickling filter plants' costs are based on EPA-430/9-78-009, "Innovative and Alternative Technology Assessment Manual", February 1980. The costs presented in this EPA manual are based on September 1976 prices and are adjusted to September 1981 prices by multiplying by 1.47 (386.8/262.8).

Table B-VI-5

South Cheyenne Wastewater Treatment Alternatives

Economic Comparison

Alternative	Capital Costs Total	Capital Costs Amortized	O&M $/Yr	Total Annual Cost ($/Yr)
Extended Aeration Q_{ADF} = 1.5 MGD	2,708,570	318,260	175,010	493,270
Contact Stabilization Q_{ADF} = 1.5 MGD	2,675,870	314,410	180,920	495,330
Contact Stabilization Q_{ADF} = 2.5 MGD	3,344,840	393,020	226,150	619,170
Activated Sludge Q_{ADF} = 1.5 MGD	2,724,570	320,140	186,830	506,970
Activated Sludge Q_{ADF} = 2.5 MGD	3,405,710	400,170	233,540	633,710
Oxidation Ditch Q_{ADF} = 1.5 MGD	3,058,400	359,360	151,730	511,090
Oxidation Ditch Q_{ADF} = 2.5 MGD	3,823,000	449,200	189,660	638,860
Lagoon System Q_{ADF} = 1.5 MGD	3,946,560	463,720	76,770	540,490
Lagoon System Q_{ADF} = 2.5 MGD	4,933,200	579,650	95,960	675,610
New Activated Sludge Q_{ADF} = 1.5 MGD	3,452,670	405,690	171,460	577,150
New Activated Sludge Q_{ADF} = 2.5 MGD	4,315,840	507,110	214,320	721,430
New Trickling Filter Q_{ADF} = 1.5 MGD	3,836,990	454,020	155,460	609,480
New Trickling Filter Q_{ADF} = 2.5 MGD	4,829,990	567,520	194,320	761,840

The extended aeration enlargement alternative appears to be the most cost-effective alternative for South Cheyenne, as shown in Table B-VI-5. The enlargement of the extended aeration process would require, in effect, the duplication (or doubling) of the existing facility. Although this alternative appears to be the most cost-effective, it is felt, that based on current plant operational procedures, operational difficulties would result in higher costs than presented in Table B-VI-5.

The contact stabilization alternative, therefore, appears to be the most cost-effective alternative, regardless of the degree of expansion, i.e. 2.5 MGD or 1.5 MGD. As was discussed in Chapter B-V, the existing facility could be upgraded to operate in a contact stabilization mode. Past applications of this type of conversion from extended aeration processes have proven successful.

If funds are limited and the decision to continue operating the South Cheyenne WWTF is made, certain improvements to the existing facility have priority status. Discussions of these recommended improvements and their estimated costs follow in descending priority.

Pretreatment is an extremely important aspect of wastewater treatment. Not only does it remove larger and difficult to handle solids, but it also acclimates the wastewater, making it easier to treat in subsequent processes. Adequate pretreatment, essentially lacking in the existing facility, is the number one priority. A new pretreatment facility has an estimated cost of $440,900.

The second most necessary improvement is related to final clarification and sludge handling. The existing final clarifiers lack an adequate solids removal system, and there is currently no control over (or measurement of) the amount of return and waste sludge. The conversion to a siphon sludge removal system and the incorporation of control devices for sludge handling are highly recommended. Since the existing facility is currently overloaded, the price presented here is determined based on facility enlargement to handle an average flow of 1.5 MGD. The estimated cost for these improvements is $352,000. If no expansion to the facility is planned, but only an improvement to the current facility, this figure could be reduced by approximately one-half (i.e. $176,000).

Improvements to the chlorination facility have the next priority, and are estimated to cost approximately $24,000.

Also considered important for the efficient operation of this facility is a thorough cleaning of the aeration basins. Upon the incorporation of adequate pretreatment, the aeration basins should be dewatered, and the accumulated grit should be removed.

Carrying out the recommendations presented for the South Cheyenne WWTF, the District should be much more efficient in their endeavors to treat wastewater, and should be able to consistently produce an effluent of desired quality.

D. SUNNYSIDE ADDITION

The alternative wastewater treatment options available for the Sunnyside Addition include the continuation of onsite methods, the utilization of cluster systems, the formation of a separate sewer district, the connection to the City sewer system, or no action. Of these alternatives, all but the connection to the City sewer system have been effectively eliminated in previous discussions. For this reason, cost-effectiveness comparisons of these alternatives are not considered necessary at this time. The estimated capital cost for existing or future sewer lines needed in the Sunnyside area is $1,071,708.

E. NORTH CHEYENNE

The alternative wastewater treatment options for the North Cheyenne area are similar to those of the Sunnyside Addition. For the same reasons, only connection to the City sewer system is deemed appropriate for this area. The capital cost of the sewer lines for existing and future needs is estimated to be $562,040.

F. RANCHETTE DEVELOPMENTS

For the majority of Ranchette developments in the study area, onsite wastewater treatment will continue to be the primary method throughout the study period. Costs of particular systems are dependent on the system types, as determined by site requirements. When the City limits encroach upon an area or when development density becomes great, the costs of subsequent sewer system connection would be similar to those for the Sunnyside and North Cheyenne areas.

G. WASTEWATER FLOW REDUCTIONS

1. General

The reduction of wastewater flows at the point of origin can decrease the need for expanding a wastewater treatment plant, sewer lines, etc. making flow reduction a viable alternative to those treatment alternatives previously discussed. Wastewater flows can be decreased by reducing the amount of water that is wasted in a household, business, etc. or by reducing the amount of solids that enter the wastewater. Reduction can be achieved with a variety of techniques and devices as discussed in Chapter B-V, Section H.

A flow reduction program can be implemented to reduce present and future flows. Present flows can be reduced with the retrofitting of water saving devices, i.e. toilet dams, reduced flow shower-heads, etc., to existing plumbing, and with education of the public as to the benefits of conserving. Future flows can be reduced with the retrofitting of water saving devices in existing houses that are to be hooked into the sewer system in the future, with specific changes in local ordinances, building codes, or plumbing codes requiring the installation of certain water saving devices in new construction, and with education of the public.

2. Cheyenne

The current sewered population in Cheyenne is approximately 52,600 with a wastewater flow of 6.2 MGD. A reduction in wastewater flows of approximately 13.5 gpcpd could be expected with the retrofitting of faucet aerators, toilet dams, and reduced flow shower-heads into the existing sewered houses. See Table B-VI-6. This would amount to a 0.7 MGD reduction in the current flow. Assuming a cost of $26/household, a reduction program for the existing developments would cost approximately $544,900. It must be remembered that any reduction in current wastewater discharge could affect existing water rights and compensation for these rights would be in addition to the cost shown.

Table B-VI-6

Common Water Saving Devices - Their Effectiveness and Cost*

Device	Water Savings gpcpd	Materials and Installation Cost
Faucet Aerators	0.5	$ 2
Reduced Flow Shower-Head	7.5	$10
Toilet Dam	5	$12
Shallow Trap Toilet	7.5	$26
Insulation of Hot Water Pipes	2.0	$ 1/ft

*Taken from "Cheyenne Stage II Water Diversion Proposal - Final Environmental Impact Statement"

The sewered population in Cheyenne is expected to increase by 34,900 by the year 2005, assuming that South Cheyenne's population is limited to 15,000. With the proper building codes in effect requiring the installation of faucet aerators, reduced flow shower-heads, shallow trap toilets, and insulation on hot water pipes, a reduction in the future wastewater flows of 18.0 gpcpd could be expected. This would amount to a 0.63 MGD reduction in future flows, the burden of the cost of the reduction being on homeowners.

The projected wastewater flow for the City of Cheyenne is 9.7 MGD by the year 2005. A flow reduction program could possibly decrease that flow to 8.37 MGD or a 14% decrease in the projected flow. With this amount of reduction, the existing WWTPs have sufficient treatment capacity for the study period.

The cost of reducing the wastewater flow by 1.33 MGD is $409/1000 gallons whereas the cost of treating and constructing additional treatment plant capacity for the 1.33 MGD is $370/1000 gallons.

3. South Cheyenne

The 1980 sewered population in South Cheyenne was approximately 6400 with a wastewater flow of 0.64 MGD. By the year 2005, the population is expected to be 15,000 with a wastewater flow of 1.5 MGD. With the flow reduction program described for the City of Cheyenne, South Cheyenne could expect to reduce its year 2005 flow to 1.26 MGD, a savings of 16%. The cost of reducing the wastewater flows by 0.24 MGD is $66,000 or $275/1000 gallons whereas the cost of treating and constructing additional treatment plant capacity for the 0.24 MGD is $1189/1000 gallons.[1]

The population of South Cheyenne may be allowed to expand to 25,000 by the year 2005, resulting in a wastewater flow of 2.5 MGD. With the installation of the proper flow reduction devices, flow could be reduced to 2.08 MGD, a savings of 17%. The cost of reducing the wastewater flows by 0.42 MGD is $66,000 or $157/1000 gallons[2] whereas the cost of treating and constructing additional treatment plant capacity for the 0.42 MGD is $1180/1000 gallons.[1]

4. Summary

The actual amount of flow reduction achieved depends on public acceptance of the program. If users are dissatisfied with the performance of the particular flow reducing devices installed in their homes, it is likely that they would remove these devices. An enforcement program may have to be organized with periodic inspections of homes, businesses, etc. in order to

[1] The South Cheyenne Plant capacity, 0.8 MGD, will have to be expanded regardless of any flow reduction techniques that might be instigated. Therefore, this cost per 1000 gallons may be somewhat deceiving.

[2] This cost figure assumes all future growth pays for its own water saving devices.

locate any plumbing alterations. If removal of any devices is discovered, corrective orders could then be issued. This would add an additional cost to the flow reduction program.

The actual amount of flow reduction achieved could also be affected by educating the public so that they are aware of the benefits of wastewater flow reduction. The reduction amount would be difficult to predict.

There are many factors involved in the success of a flow reduction program. The reduction percentages given for Cheyenne and South Cheyenne are only estimates of the success possible.

H. RECYCLE/REUSE - TREATMENT PLANT EFFLUENT

1. General

The recycle/reuse of wastewater treatment plant effluent is not only a means of disposing of the effluent but also a means of productively using the effluent. Treatment plant effluent can be used in applications where the domestic water supply is generally used. This may be cost-effective depending on the availability and cost of the domestic water supply.

As discussed in Chapter B-V, Section H, the water rights issue excludes the use of the current effluent quantity for recycling. Only the additional effluent quantity produced in the future that is over and above the existing effluent quantity may be recycled. This quantity available for recycling will increase every year and by the year 2005 is expected to reach 4 MGD. The recycle/reuse options of this 4 MGD include the irrigation of municipal parks, etc. and the supplementing of the domestic water supply. These options would be the most cost-effective for the study area with the use of one central treatment plant, such as the Dry Creek WWTF. All costs for the two alternatives were developed assuming the Dry Creek WWTF treats the area's wastewater with 4 MGD of its effluent used for recycle/reuse purposes by the year 2005.

2. Irrigation of Municipal Parks

This alternative involves the use of treatment plant effluent for the irrigation of the golf courses, parks, and cemeteries. The City of Cheyenne currently uses approximately 6.25 MGD of the domestic water supply four months out of the year for the purpose of irrigation of the parks, etc. Treatment plant effluent could be used for irrigation in place of a portion of the City water supply. By the year 2005, 4 MGD of effluent will be available for irrigation. The savings would increase from 0 MG/year at the commencement of this recycling program to an estimated 480 MG/year in the year 2005.

The Dry Creek WWTP effluent is of acceptable quality for irrigation.

The estimated capital cost of reusing treatment effluent is $6,366,800 with an annual operation and maintenance cost of $70,000. These costs include the construction and operation of a pump station at Dry Creek WWTP, a 500,000 gallon standpipe, and the necessary supply and distribution lines.

3. Supplement Domestic Water Supply

The second option for using the 4 MGD of the WWTF effluent that will be available by the year 2005 involves the addition of a tertiary treatment plant with the effluent providing an additional drinking water supply to the City.

The estimated construction cost of supplementing the City's domestic water supply with WWTF effluent is $16,308,400 with an annual operation and maintenance cost of $535,000. These costs include the construction and operation of a tertiary treatment plant, a pump station at the Dry Creek WWTF, and the necessary supply line to connect into the City's water distribution system.

I. CONCLUSION

The costs presented in this chapter are for comparison purposes only. The actual costs will be evaluated in greater detail after the preliminary design of the alternative chosen. This more detailed cost evaluation will be presented in the final report.

Also not considered in this chapter are area-wide alternatives. It can be seen that the most cost-effective alternative for the City may not correspond with the most cost-effective alternative for the South Cheyenne Water and Sewer District, and vice versa. Cooperation between these entities is imperative for the selection of the best area-wide alternative.

B- VII. AREA-WIDE ALTERNATIVES

A. INTRODUCTION

One important goal of the 201 study is to examine and select the best wastewater management plan for the area. Therefore, the purpose of this section is to discuss various combinations of technical wastewater treatment alternatives coupled with the management possibilities for the area.

B. TREATMENT ALTERNATIVES

1. No Action

The title "no action" is somewhat of a misnomer. This alternative does not mean that a particular plant will not be improved but rather that the improvement would be done disregarding what might be best for the entire study area. Each entity (Cheyenne, South Cheyenne, etc.) would be concerned only with what is best for it and not what might be best for the entire area.

Selection of this alternative could cause numerous problems in terms of timing and location of future wastewater treatment facilities as well as a sludge management system. Cheyenne, Laramie County, and the South Cheyenne Water and Sewer District showed, when they formed the 201 Committee, that there needed to be an area-wide management plan. Therefore, this alternative should be eliminated from further consideration.

2. Expansion of South Cheyenne Plant

a. 15,000 Population

The first alternative involving the expansion of the South Cheyenne Plant would enlarge the plant so it would be capable of supporting a population of 15,000. Population projections (Appendix D) show that this portion of the study area could reach a population of 25,000. However, Art Buffington, chairman of the South Cheyenne Sewer and Water Board, has stated that no more than 15,000 people could reside within the current District boundaries due not only to District policy concerning growth, but also to available water supply. Therefore, this alternative includes the placement of a 21-inch trunk line from the South Cheyenne Plant to the Crow Creek Interceptor. This line would not have to be built until the growth outside of the current District Boundary begins.

This alternative would allow the South Cheyenne Plant to treat only flows from within the District thereby eliminating the need for a working agreement as discussed in the section that follows.

b. 25,000 Population

This alternative involves expanding the South Cheyenne Plant so that it can treat all of the projected flow from this portion of the study area. According to information from Herman Noe, Director, Cheyenne Board of Public Utilities, it is unlikely that the Board would allow South Cheyenne to expand its District's boundaries. Therefore, this alternative would require an agreement between the two entities concerning not only construction costs, but also the sharing of operation and maintenance costs. The agreement would also have to include a statement as to control of the plant and the decision making process for determining the timing of any maintenance work.

The economics of both of these expansion options were discussed in Chapter B-VI.

3. Eliminate the South Cheyenne WWTF

This alternative involves the abandonment of the South Cheyenne treatment plant and diversion of the area's sewage flow to the Crow Creek and Dry Creek treatment plants. With this alternative, the South Cheyenne Water and Sewer District would continue to exist, but the District would pay the City of Cheyenne for the treatment of District wastewater based on recorded flows. Current policy prohibits the City from handling wastewater from unannexed areas. If the District is to stay intact, a working agreement would be needed between the City of Cheyenne and South Cheyenne for treating the South Cheyenne wastewater. The elimination of the South Cheyenne Water and Sewer District is discussed under Area-Wide Management Options.

The elimination of the South Cheyenne WWTF would put an increased load on the Crow Creek and Dry Creek plants. Their combined treatment capacity would be reached by 1991. Additional treatment capacity would need to be provided by 1991. The Dry Creek WWTP is the most likely plant to be expanded. The construction of an interceptor line from South Cheyenne to the Crow Creek Interceptor line at the Crow Creek WWTF would also be needed in addition to the expansion of the Dry Creek WWTF. The economics of this alternative were discussed in Chapter B-VI.

4. Eliminate the Crow Creek WWTF

This alternative involves the abandonment of the Crow Creek WWTF and the diversion of plant influent to the Dry Creek WWTF. The Crow Creek WWTF is presently meeting discharge requirements, and, with some minor repairs to existing equipment, the Crow Creek WWTP could be expected to operate successfully until the end of the study period.

The elimination of the Crow Creek WWTF would put an additional load on the Dry Creek WWTF with its treatment capacity of 4.5 MGD ADF then being exceeded. At that time additional treatment capacity would need to be provided either by expanding the Dry Creek WWTF or constructing an additional plant. Since Crow Creek WWTF is expected to operate another 20 years, it is not economically advisable to eliminate the Crow Creek WWTF at this time.

5. Eliminate the Crow Creek and South Cheyenne Treatment Plants

This alternative involves the abandonment of the Crow Creek and South Cheyenne treatment plants and the diversion of both plants' effluents to the Dry Creek WWTF by means of the Crow Creek Interceptor.

The elimination of both the Crow Creek and the South Cheyenne WWTFs would put an additional load on the Dry Creek WWTF with its treatment capacity of 4.5 MGD ADF then being exceeded. At that time additional treatment capacity would need to be provided either by expanding the Dry Creek WWTF or by constructing another treatment plant. The capacity of the existing Crow Creek Interceptor is not sufficient to handle the peak flows expected from the Crow Creek and South Cheyenne WWTFs and would need to be increased before the two plants were abandoned. Therefore, it appears that this alternative is also not desirable at this time.

6. Sludge Treatment

This alternative involves the implementation of an area-wide sludge management program. This program would provide a centrally located site for the ultimate disposal of the sludge produced by the South Cheyenne, Crow Creek, and Dry Creek WWTFs. A working agreement would be needed between the City of Cheyenne and South Cheyenne for the operation and management of the program. The working agreement would assign responsibilities for the management and coordination of the program, the sludge hauling, and the operation of the disposal site.

A discussion of the various disposal methods available for an area-wide sludge management program is in Chapter B-VIII.

C. MANAGEMENT ALTERNATIVES

1. No Action

This alternative implies the continued existence of the governmental entities and agencies that regulate activities within the study area, i.e. Cheyenne Board of Public Utilities, South Cheyenne Water and Sewer District, Cheyenne-Laramie County Regional Planning Commission, etc., and that these entities and agencies will continue to operate in their current capacities. Currently, there is cooperation between the various groups on matters of new development in the study area. For example, the "Subdivision Regulations - City of Cheyenne and Laramie County, State of Wyoming, June 1979" define the extent of this cooperation between the agencies involved in subdivision development in the study area. The purpose of these regulations is to provide the technical requirements relating to the platting of land and to establish minimum standards for subdivisions in order to encourage compatible development and to promote the public health, safety, morale, and general welfare of the residents of the City of Cheyenne and the County of Laramie.

By selection of this "No Action" alternative, the South Cheyenne Water and Sewer District would continue to exist. It is conceivable that the City of Cheyenne could grow up around South Cheyenne leaving a separate district within the city. This may not be a desirable situation. Generally, the fewer entities involved in wastewater treatment in an area, the more efficiently and cost-effectively the entities can operate. As discussed above, the existing cooperation between the City of Cheyenne and the County of Laramie provides for a safe and healthy future growth for the study area.

2. Eliminate the South Cheyenne Water and Sewer District

This alternative involves the elimination of the South Cheyenne Water and Sewer District with South Cheyenne being annexed into the City of Cheyenne.

The elimination of the South Cheyenne Water and Sewer District and the annexation of South Cheyenne would give control of the area to the City of Cheyenne. Fewer entities would be involved, and the entire study area could benefit from more consistent control over development in the study area. However, forced annexation is often very undesirable.

3. City Control Over Formation of Further Sewer Districts

This alternative involves the City of Cheyenne having control over the formation of further sewer districts within the area. The City of Cheyenne currently reviews proposed developments if they are located within one mile of the city limits. Under this alternative, additional sewer districts would not be allowed to form anywhere in the study area without the approval of the City of Cheyenne. The City could possibly have control over the district, if so desired. This would involve some changes in the current City policy.

This alternative would give the City of Cheyenne even further power in directing the development of the area in an intelligent manner. Formation of new districts could be limited, and a newly formed district could be located so as not to interfere with the future growth of the City of Cheyenne. If the possibility existed for the new district to interfere with future expansion, the City of Cheyenne could be delegated control over the operation of the district, or, with a change of policy, the district's sewer system could be allowed to tie into the City's sewer system.

D. SUMMARY

The possible alternatives for an area-wide management plan are complex. Several key decisions must be made before an alternative can be chosen. Among these decisions are:

1. Will unannexed areas be allowed to tie in to City sewers on a case-by-case basis?
2. Is the South Cheyenne Water and Sewer District willing to sign a working agreement with the City concerning wastewater treatment?
3. Is the County Government willing to establish a working agreement with the City whereby the City can control the formation of Sewer Districts within the entire study area?
4. Do all entities favor the status quo in terms of the management of wastewater treatment for the study area?

B-VIII. SLUDGE MANAGEMENT

A. INTRODUCTION

With the increasing knowledge of items which may affect our environment, the sludge handling methods of wastewater treatment plants are receiving increasing attention. In many cases the result has been implementation of a cost-effective alternative that not only safeguards the environment but actually helps a wastewater plant operate more efficiently.

Whatever alternative is selected for this particular study area, its goal must be to adequately protect groundwater, surface water, air quality, and land quality.

Presently, according to Jack Young, Superintendent of Wastewater Treatment (Crow Creek and Dry Creek Plants), all of the sludge produced by these two plants is utilized by the City of Cheyenne on the parks and cemeteries. However, due to increasing monitoring requirements by DEQ, this method of disposal may have to cease. If this disposal method is to continue, several new requirements will have to be met in its handling and treatment. The discussion that follows on the various alternatives will further explain the treatment requirements.

B. SLUDGE CHARACTERISTICS - PRESENT/FUTURE

Before alternative methods of sludge treatment can be developed, the quantitative and qualitative characteristics of the sludge must be determined. Table B-VIII-1 summarizes the qualitative nature of the sludge at Crow Creek, Dry Creek, and South Cheyenne. Appendix 6 contains the test results of all of the sludge samples that were analyzed.

According to Mr. Jack Young, Superintendent of Wastewater Treatment, Crow Creek and Dry Creek produced the following sludge volumes.

	Crow Creek	Dry Creek
1979	15,000 ft^3	11,700 ft^3
1980	28,576 ft^3	22,167 ft^3

Note:
1. Sludge volumes are based upon 70% solids concentration.
2. The increase in sludge in 1980 was the result of operational difficulty with the anaerobic digesters.

The 1980 sludge volume equates to a dry solids weight of approximately 1,400 tons. It is estimated that the South Cheyenne plant could have yielded 171 tons of dried sludge if sludge was wasted properly from the treatment process. The combined total for all treatment plants is approximately 1,571 tons of dried sludge or 0.027 tons/person for the current sewered area.

Based upon a year 2005 population of 102,500 being serviced by a publicly owned treatment plant, the projected yearly sludge quantity would be 2,729 tons of dry solids. The actual volume of material that must be handled will be directly related to the percent solids of the sludge. Because of this variable an average

Table B-VIII-1

Summary of Sludge Tests

Location	Arsenic mg/l	Barium mg/l	Cadmium mg/l	Copper mg/l	Chromium mg/l	Lead mg/l	Mercury mg/l	Nickel mg/l	Potassium mg/l	Selenium mg/l	Silver mg/l	Zinc mg/l
Dry Creek - Secondary Digester Effluent	0.0254	7.93	2.20	143.7	22.6	1.70	0.0022	0.554	155.0	0.0036	0.119	133.0
Crow Creek Digester Effluent	0.0056	4.68	0.305	16.5	10.4	6.01	0.0037	1.43	55.7	0.0005	0.755	35.8
South Cheyenne Sludge Pond	0.0402	2.22	0.0889	1.09	0.274	0.690	ND	0.313	67.9	0.0014	0.0189	3.10
South Cheyenne Secondary-Old	0.0104	1.13	0.021	0.96	0.067	1.60	ND	0.0114	35.8	ND	0.0051	1.75
South Cheyenne Secondary-New	0.194	2.08	0.095	1.52	0.435	0.714	ND	0.597	66.3	0.0015	0.0156	2.72

B-VIII-1 (Continued)

	Conductivity micromhos/cm	Ammonia mg/l as N	Organic Nitrogen mg/l as N	Total Kjeldahl Nitrogen	pH	Total Phosphorus mg/l as P	Total Solids %	Volatile Solids % of TS	Specific Gravity	Organic Acids mg/l	Volatile Acids mg/l	PCB (1016) mg/l	PCB (All Others) mg/l	Phenol mg/l
1	2030	501	1279	2680	7.37	30.4	9.34	49.2	1.04	1547	322	0.0639	ND	ND
2	2200	89	871	960	5.59	36.8	2.15	64.4	1.01	3560	674	0.0315	ND	0.0112
3	1120	270	280	550	7.53	34.7	0.56	28.3	1.01	414	117	0.130	ND	ND
[illegible]	730	7	1013	1020	7.14	26.1	0.32	73.2	1.00	304	48	0.0166	ND	ND
[illegible]	590	3	1057	1060	6.91	41.1	0.46	73.1	1.00	69	19	ND	ND	ND

ND = None Detected

sludge volume and weight for the study period will be used for the evaluation of alternatives.

Volume @ 5% Solids	=	1,378,200 ft^3
Dry Weight	=	2,150 Tons

In addition to the disposal of the sludge, an acceptable method of disposing of screenings and grit must be found. This is a relatively minor cost in relation to sludge disposal and is not discussed separately as an alternative.

Presently, approximately 14,700 cubic feet of screenings and grit are produced from Crow Creek and Dry Creek. Screenings are generally organic in composition. Therefore, due to the volume and organic content, landfill disposal at a sanitary landfill will normally result in the least cost. The small volume of material plus the monitoring requirements that can be imposed make it non-cost-effective to dispose of the material in some other manner.

C. CRITERIA

Most sludge disposal alternatives deal with stabilized sludge such as the anaerobically treated sludge from the Crow Creek and Dry Creek plants. The sludge from the South Cheyenne plant is currently treated aerobically. Selection of a final wastewater treatment alternative for South Cheyenne may produce a sludge other than one treated aerobically.

Stabilized sludge is important becuase stablization (1) reduces the quantity of volatile solids, thereby reducing the quantity of solids that must be disposed, (2) destroys pathogenic organisms, and (3) destroys the colloidal waterbinding structure of the sludge which makes dewatering more efficient.

Site selection for sludge disposal, regardless of the disposal method, can have a major effect on a sludge management program. Therefore, some of the items that should be examined when considering a site are:

Topography

Sites are normally limited to areas that have slopes greater than 1% and less than 20%. Flat slopes, less than 1%, can be poor draining and tend to pond while steep slopes, greater than 20%, tend to erode excessively causing operational difficulties.

Surface Water

A sludge disposal system must not contaminate surface water sources.

Geology

The geology of an area, i.e. soil texture, structure, depth, permeability, pH, and cation exchange capacity, must be examined to insure that the proper treatment can be attained.

Groundwater

Sludge should not be placed in areas where there is the potential for direct contact with the groundwater. The soil matrix aids in further treatment of the sludge. Therefore, as much separation as possible should be maintained between the sludge disposal and the groundwater table.

Vegetation

A disposal site should have a substantial vegetation cover in order to reduce dust, control odor, and reduce application visibility.

Site Access

Haul routes to a site should utilize major roads to the maximum extent possible and avoid the use of city streets.

Land Use

Both current and projected land use with respect to a regional treatment site must be considered.

Environmentally Sensitive Areas

Areas that are environmentally sensitive, such as wetlands and floodplains, should be avoided.

Site Life

A site should be sized to adequately treat the projected sludge quantities for the entire study period.

D. ALTERNATIVES

With the criteria established for site selection, specific alternatives can now be examined.

1. Dewatering in Drying Beds and Landfilling

There are two alternatives that fall under this heading: a narrow trench landfill and a wide trench fill.

a. Narrow Trench

A narrow trench method of landfill utilizes a trench less than 10 feet wide. Sludge is normally placed in a single lift by equipment operating on the ground surface beside the trench, and is then covered with soil. The main advantage of a narrow trench is that equipment does not enter the trench. Hence, a low solids content, 15% to 28%, can be used which minimizes initial drying time in drying beds. This in turn reduces the total drying bed volume required.

Two disadvantages of a narrow trench operation are that more land is required than in a wide trench, and it is generally impractical to install liners if it is necessary to protect the groundwater from the leachate.

If we assume:

1) trenches 10 feet wide
2) trenches 10 feet deep including 4 feet of final soil cover
3) 15 feet between trenches
4) 100 feet buffer zone around perimeter

approximately 62 acres will be required for a treatment site.

Three possible sites have been identified using the criteria discussed above. There are undoubtedly other suitable sites, but those shown currently satisfy all of the nine requirements of Section B-VIII-C previously listed and will continue to meet the requirements throughout the planning period. (See Figure B-VIII-1.

Capital cost of a narrow trench landfill including sludge handling equipment and land aquisition is estimated to be $186,800. Estimated annual operation and maintenance cost would be $114,100.

b. Wide Trench

A wide trench is defined as one that is over 10 feet wide. It is usually excavated by equipment that operates in the trench rather than to the side as in the narrow trench method. In order for the filled trench to support equipment with 3 to 4 feet of soil cover, the solids content should be greater than 28%.

The major advantages of the wide trench method are that less land area is required and a liner can be installed, if necessary, in the trench. The higher solids content required by this method is the major disadvantage, i.e. longer drying bed time is required to obtain the higher solids content, hence more drying bed space is required.

If we assume:

1) trenches 40 feet wide and 10 feet deep
2) final soil cover is 4 feet
3) 15 feet spacing between trenches with a 100 feet buffer zone around the site

it can be shown that approximately thirty (30) acres would be needed for a disposal site.

The three prospective sites previously identified as narrow trench sites (Figure B-VIII-1) could also serve as wide trench sites.

Capital cost of a wide trench alternative is estimated to be $212,600. Annual operation costs are estimated to be $100,700.

c. Leachate Control - Narrow and Wide Trench

The costs shown above do not include a leachate control system, which may be required if there is concern over possible groundwater contamination.

Soil at a given site may not be able to attenuate contaminants in the sludge by means of physical-chemical processess. Properties such as grain size, organic content, cation exchange capacity, pH, hydrous oxides, and fill lime content will determine whether or not a leachate control system is necessary at a particular site. If a leachate system is necessary, it could add as much as $33,600 per year to the cost of the system.

2. Co-disposal with Refuse

Disposal of sludge with solid refuse can occur utilizing either a sludge/refuse mixture or a sludge/soil mixture. Each option has specific advantages and disadvantages.

a. Sludge/Refuse Mixture

Sludge is placed atop a layer of refuse, and is then well mixed, compacted, and covered with a layer of soil. The ratio of sludge to refuse is dependent upon the solids concentration of the sludge. For example, at a 3% solids content, one (1) ton of wet sludge should be mixed with seven (7) tons of refuse. At a 20% solids concentration, one (1) ton of wet sludge can be mixed with four (4) tons of refuse.

Currently the Cheyenne Sanitary Landfill receives approximately 175 tons/day for 5½ days/week of refuse. This equates to 138 tons/day for 365 days per year. At a 25% solids content for the sludge generated from the wastewater treatment facilities, there would be the need to mix approximately 17 tons/day of sludge. This would give a sludge to refuse mix ratio of 1:8, which is well within acceptable limits.

Currently some questions have been raised as to whether the existing landfill is affecting the groundwater in the area. The addition of sludge to the landfill would probably raise further questions as to the possibility of contamination.

By the end of the 20-year planning period, it is estimated that the sludge will occupy 5,012,000 cubic feet of storage that would have otherwise been available for refuse. Based upon the current landfill refuse placement operations this equates to approximately 2.8 surface acres.

The capital costs, consisting of replacing the 2.8 acres of land and a sludge hauling truck, would be approximately $52,300. Yearly operation and maintenance costs are estimated to be $81,700/year. The major disadvantage to this alternative is the operational difficulties in mixing and handling the sludge/refuse mixture.

b. Sludge/Soil Mixture

This method involves mixing sludge and soil at a 1:1 ratio and using this mix for intermediate or final cover for the refuse. The advantage of this system is that it is not necessary to handle the sludge directly with the refuse, which saves operational difficulties. On the other hand, more equipment and manpower may be necessary to mix the soil and sludge.

Capital cost of this system is estimated to be $115,600, and the yearly operation and maintenance cost is estimated to be $84,300. The costs of both of the refuse options do not include any type of groundwater monitoring system that could be required.

3. Land Application

Land application includes those projects where sludge is applied for disposal, crop utilization, or reclamation of spoiled areas. The most common land application alternative is crop utilization. This alternative attempts to keep the land usable, i.e. crop production, while the other alternatives severely limit the land's use.

Crop selection is limited in the Cheyenne area without supplemental irrigation. Dryland native grasses are the most common "crops" and are used for livestock grazing. If sludge is applied to native grasses, an increase in grazing capacity should result due to the addition of nitrogen, potassium, and phosphate that will be present in the sludge. However, only 0.9 inch of additional moisture would come from the sludge application which means the increase in grass production would not be large.

A land application system involves the injection of sludge into the soil normally with a specialized truck using high flotation tires. Sludge is injected during the growing season with the recommended dates being April 15 to August 31. Ending the application August 31 allows for some growth to occur before heavy frost begins. Storage must be supplied for sludge during non-application periods.

Determining the amount of land and its location is the principal design problem with a land application, sludge disposal system. Based upon the sludge characteristics of the existing wastewater treatment plants, a 384-acre site would be needed. For purposes of cost comparison, it has been assumed that the land would be purchased. However, land purchase is not required if a lease could be arranged that insures the operation will comply with all Department of Environmental Quality rules and regulations. Among DEQ's requirements are the restriction of public access for 12 months and the restriction of access by grazing animals for 1 month. This would require the site to be fenced into sections so that one portion could be grazed while the other portion receives its sludge application. It is estimated that a 192-acre site could support 8 to 12 cattle per year if grazing was continuous.

Figure B-VIII-2 shows a proposed site that could be used for a sludge land application area. Site selection was based upon the criteria previously discussed. There are undoubtedly other areas that could be used, but the one shown best fits all of the criteria.

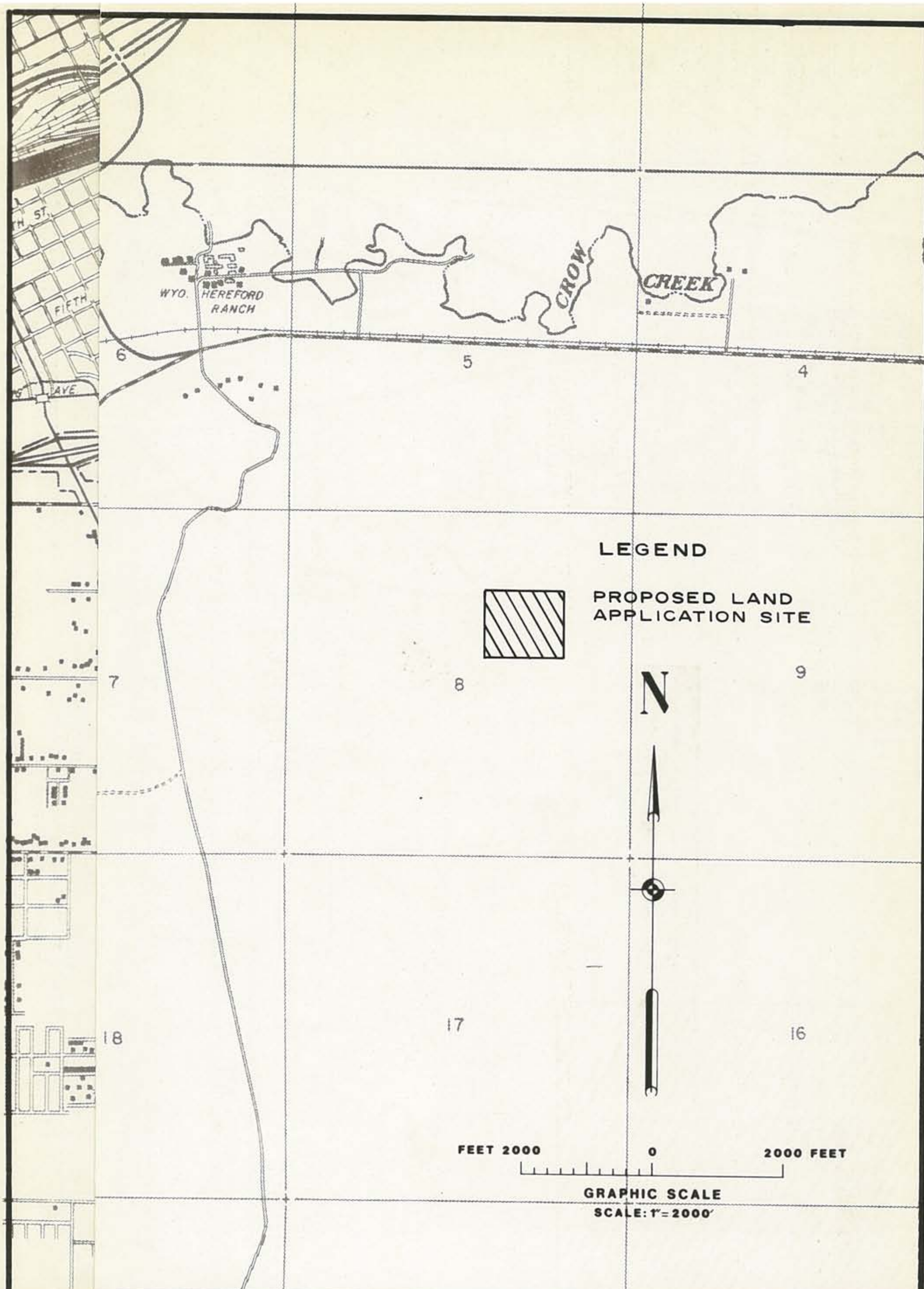
The amount of storage required is directly related to the solids content. At 5% solids 868,250 cubic feet of storage area are required while at 50% solids only 66,800 cubic feet of storage are needed. However, at 50% solids the sludge could not be injected but would have to be applied as a cake which would mean a different type of sludge application equipment than would be used for injection.

A land application system with storage lagoons is estimated to cost $668,300 (See Appendix E). Without storage lagoons the cost is estimated to be $487,400. Yearly operation and maintenance of either system would be approximately $61,200 per year.

4. Incineration and Landfill

A dewatered sludge can be incinerated in a multiple hearth or a fluidized bed with the resultant ash placed in a landfill. Basically the less moisture a sludge contains the more economical the incineration, up to a solids content of 30%. At this solids concentration a self-supporting combustion will occur. Generally it is more economical to incinerate undigested sludge as it contains more volatiles than does digested sludge. Currently the Dry Creek and Crow Creek wastewater plants produce anaerobically digested sludge which would be more expensive to incinerate than if the sludge is not digested. Therefore, to use this alternative the digesters would be taken out of service, and a sludge thickener would have to be added to both plants.

As shown in Appendix H, approximately 6 acres of land would be required for an ash disposal site. The three sites previously identified as potential landfill sites could be used for this alternative.



DRAWN BY
SH/DM
CK'D BY:
JIC

TION SITE

FIGURE
B-VIII-2

Incineration is a fairly expensive operation. Capital cost is estimated to be $2,998,300, and yearly operation and maintenance is estimated to be $335,700. These costs make this a very undesirable alternative.

5. Marketing Dried Sludge

Various communities around the country have decided to market their dried sludge as a fertilizer as a means of sludge disposal. Sludge that has gone through a composting process has proven popular with home gardeners. However, some research studies have shown that growing plants have a tendency to absorb toxic metals that are present in sludge. Therefore, the use of composted sludge for home gardens needs more research before it is deemed to be an acceptable alternative.

Likewise the current use of dewatered sludge as a fertilizer on the city parks may require close monitoring if the practice is to continue. Digested sludge may still contain bacteria, viruses, and worms that make it undesirable to place the sludge on a publicly accessible site.

The remaining market appears to be for application to farm and ranch land. Who is responsible for monitoring the effects of the sludge fertilizer will bear on the decision concerning the validity of this alternative. The first step in the viability of this alternative is defining the intended market. Specific criteria must be given by DEQ for this particular sludge before it can be determined if this alternative is feasible. A more detailed analysis of the effects, if any, of sludge components on plant uptake should be done if this alternative is selected.

6. Summary

If a use for the existing dried sludge as a fertilizer can be found that is acceptable to DEQ, this would be the most desirable alternative as no additional costs would be involved. In fact, it might be possible to develop a market of several potential users so that an annual bidding procedure could be used to determine who receives the product. If an acceptable market cannot be found, a land application system using dewatered sludge has the lowest operation and maintenance cost. (See Table B-VIII-2)

Table B-VIII-2

Comparison of Sludge Alternatives

	Capital Cost	Amortized 7% @ 20 yrs	O & M	Total Annual
Landfill				
Narrow Trench	$186,800	$22,000	$114,100	$136,100
Wide Trench	212,600	25,000	100,700	125,700
Co-disposal				
Refuse/Sludge	52,300	6,200	81,700	87,900
Soil/Sludge	115,600	13,600	84,300	97,900
Land Application				
Land Purchased				
Stored Sludge	668,300	78,500	61,200	139,700
Dewatered Sludge	487,400	57,300	61,200	118,500
Land Not Purchased				
Stored Sludge	425,420	50,000	61,200	111,200
Dewatered Sludge	244,520	28,700	61,200	89,900
Incineration	2,998,300	352,300	335,700	668,000

THE STATE OF WYOMING

RECEIVED
MAY 14 1982
BANNER ASSOCIATES, INC.

ED HERSCHLER
GOVERNOR

Department of Environmental Quality

Water Quality Division

1111 EAST LINCOLNWAY CHEYENNE, WYOMING 82002 TELEPHONE 307 777-7781

May 12, 1982

Mr. Art Buffington, Chairman
Cheyenne 201 Committee
908 Drew Court
Cheyenne, WY 82001

RE: Working Paper No. 3
EPA Grant No. C560161-01

Dear Art:

This Office has reviewed the Cheyenne 201, Working Paper No. 3, Preliminary Evaluation of Alternatives and offers the following comments:

1. The water rights issue appears to be paramount in this study. Find attached a copy of the April 29, 1982 memorandum from Steve Jones, Assistant Attorney General, and the packet of material from the State Engineers' office dated May 7, 1982, for your use in determining how best to resolve this issue.

   This Department concurs with the discussion held during the committee's April 29 meeting at which time interest was expressed to discuss the alternatives with the affected effluent users. On a related note, it is suggested that the committee have fully documented in the facility plan, probable costs and/or other restrictions applicable to acquiring these existing water rights. This will be necessary to compare fairly, cost effectiveness of the various alternates. Also the study will be better received if the State Engineer is contacted, perhaps by your consultant, to work with you on any other particulars.

   Please feel free to contact this office for additional input when necessary.

2. As discussed during the April 29 committee meeting, the cost effective solution will be viewed as the fundable solution unless nonenvironmental factors are documented and included in the plan to EPA's satisfaction.

3. Concerning the actual cost estimate of the chosen alternate, in order to be considered for a grant, a best estimate of all costs will need to be reported including costs common to all alternates. Additionally, the approved federal discount rate is 7 3/8%, not 10%.

4. Please consider the attached April 20 memo from the Department of Environmental Quality, Solid Waste Management as our division's response to your examination of sludge disposal alternatives. If an additional landfill site is needed for the proposed alternate, this too should be included in your final cost estimates.

5. The attached January 20, 1982 letter from EPA was forwarded to your consultant on January 25 and should be considered in your final facility plan.

6. If funding for collector sewers in Sunnyside and North Cheyenne is to be requested, eligibility must be evaluated (see EPA publication Facility Planning 1981, 430/9-81-002). Also, information necessary to evaluate affordability criteria will need to be provided (see enclosed checklist, "Attachment, Environmental Assessment Checklist for Facility Plans" Item 5, Economics and Social Profile).

7. The "Evaluation of the Use of Wastewater for the Irrigation of Golf Courses in Cheyenne" as submitted by your consultant, adequately describes both the environmental and economic costs associated with the concept. This office concurs with the negative recommendation.

8. As previously discussed, an Intergovernmental Agreement (IGA) will need to be drafted and finalized between all parties affected by the Facility Plan. This IGA should detail how service will be provided to areas so designated and describe those areas to be served by on-site systems; all of this within a reasonable extent of the planning area. On this note, the final report should specifically define both a service area and a proposed schedule for servicing the designated areas. This will aid the county in phasing any new construction permits for onsite systems in soon to be serviced areas.

9. Find attached a copy of the "Facilities Plan Review Checklist" that will be used by our office to review the facility plan when complete. This is provided for you to consider as you work to finish this report.

Please feel free to contact this office when we can be of further assistance.

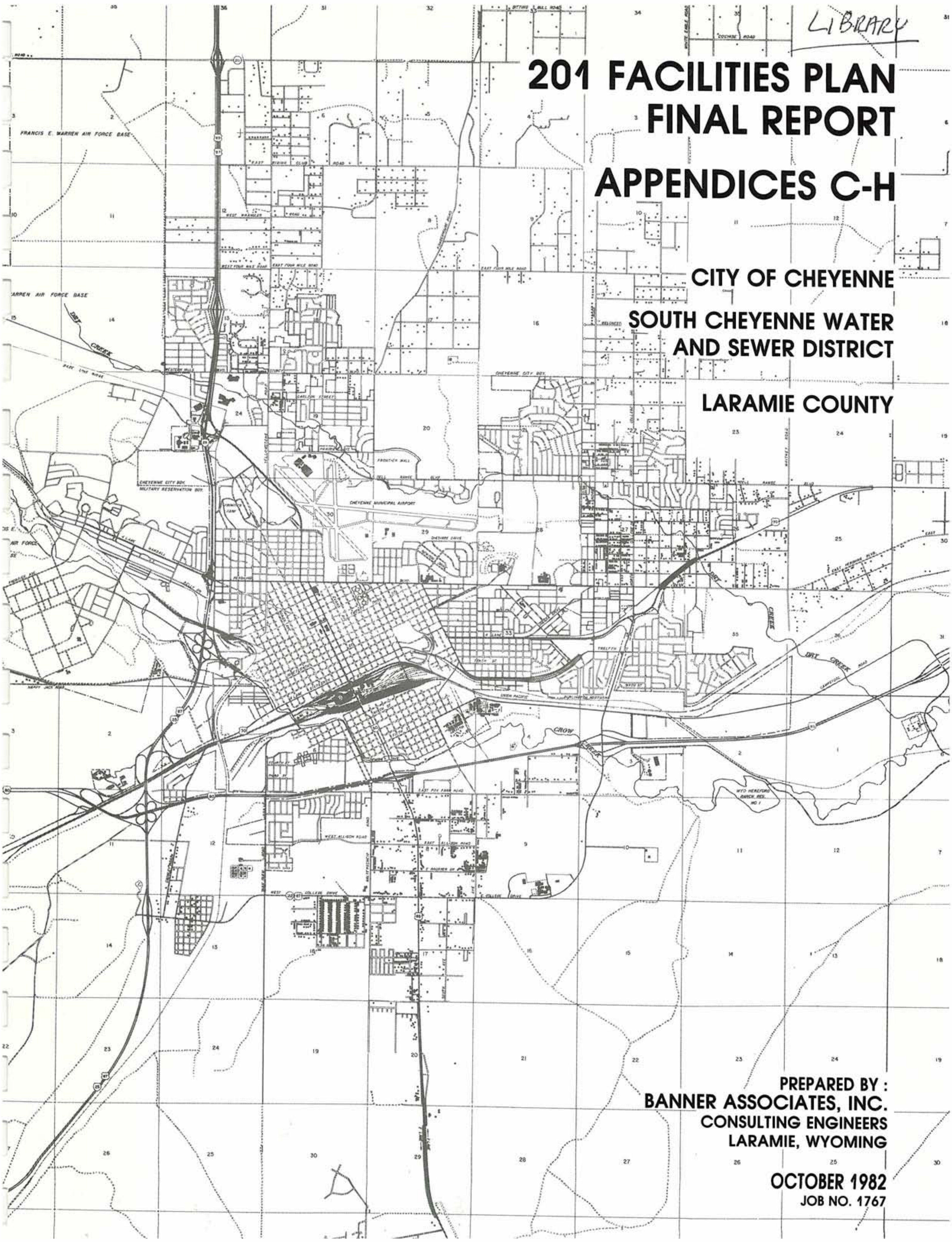
Very truly yours,

Ed

Ed Baruth
Engineering Evaluator

EB/sk
Enclosures

cc: City of Cheyenne, Planning Dept., Jon Aarson (w/encl.)
City of Cheyenne, Water Dept., Herman Noe (w/encl.)
Laramie County Commissioners, Shirley Francis (w/encl.)
Banner Associates, Paul Sorenson (w/encl.)
Grant File (w/encl.)
EPA, Gerry Snyder



201 FACILITIES PLAN
FINAL REPORT
APPENDICES C-H

CITY OF CHEYENNE
SOUTH CHEYENNE WATER AND SEWER DISTRICT
LARAMIE COUNTY

PREPARED BY :
BANNER ASSOCIATES, INC.
CONSULTING ENGINEERS
LARAMIE, WYOMING

OCTOBER 1982
JOB NO. 1767

APPENDIX C

ABBREVIATIONS/DEFINITIONS

APPENDIX C

ABBREVIATIONS/DEFINITIONS

ADF - Average Daily Flow

aerobic - in the presence of oxygen

anaerobic - in the absence of oxygen

anoxic - lacking oxygen

Biochemical oxygen demand or BOD - the amount of dissolved oxygen, in milligrams/liter, used by microorganisms in the biochemical oxidation of organic matter

BOD5 - 5-day biochemical oxygen demand; the quantity of oxygen in mg/l, used by microorganisms in the biochemical oxidation of organic matter during a 5-day period at 20°C

BOD_L - ultimate biochemical oxygen demand; the total amount of BOD present at the start of the BOD_5 test

BPWTT - best practicable waste treatment technology

CAS - conventional activated sludge

cfm - cubic feet per minute

CMAS - complete mix activated sludge

COD - chemical oxygen demand, the amount of oxygen required for the chemical oxidation of organic compounds in a liquid

denitrification - reduction of nitrates to nitrogen gas

°C = Degree Centigrade

°F = Degree Fahrenheit

DEQ - Wyoming Department of Environmental Quality

DO - dissolved oxygen

DT - detention time

eff - effluent

endogenous respiration - stage of microorganisms' life cycle when they are forced to metabolize their own protoplasm without replacement; when the concentration of available food (organic material) is at a minimum in the wastewater

EPA - United States Environmental Protection Agency fecal coliform bacteria - a group of organisms found in the intestinal tracts of people and animals. Their presence in water indicates pollution and possible dangerous bacterial contamination.

F/M ratio - food to microorganism ratio; relates the amount of food available for consumption, i.e. organic material, to the microbial population available to oxidize the organics

fps - feet per seond

FRP - fiberglass reinforced plastic

ft - feet

ft^2 - square feet

ft^3 - cubic feet

gpcd or gpcpd - gallons per capita per day

gpd - gallons per day

gpm - gallons per minute

HP - horsepower

hr - hour

inf. - influent

lbs. - pounds

MG - million gallons

MGD - million gallons per day

mg/l - milligrams per liter

min. - minute

ml. - milliter

MLSS - mixed liquor suspended solids; the combination of raw or settled sewage and recycled sludge in the aeration reactor basin

MLVSS - mixed liquor volatile suspended solids; that portion of the MLSS that is volatile

MOP-8 - "Manual of Practice, Volume 8, Wastewater Treatment Plant Design" by the Water Pollution Control Federation and the American Society of Civil Engineers

MPN - most probable number

N - nitrogen

nitrification - the conversion of ammonia nitrogen to nitrates

NO_2 - nitrogen dioxide

NO_3 - nitrate

NPDES - National Pollution Discharge Elimination System

O_2 - oxygen

OSHA - Occupational Safety and Health Administration

pcpd - per capita per day

PDF - peak daily flow

percolation - the downward flow or filtering of water thorugh pores or spaces in rock or soil

pH - a measurement of acidity or alkalinity. pH values range from 0 to 14, 7 indicating neutrality, at 25^{o}C number less than 7 increasing acidity, and numbers greater than 7 increasing alkalinity.

PHF - peak hourly flow

POTW - publicly owned treatment works

ppm - parts per million

psig - pounds per square inch gauge

putrescible - a substance that is susceptible to decomposition

QRS - return sludge rate

Q - amount of flow

QRS/Q - ratio of return sludge flow to total flow

RAS - return activiated sludge

rpm - revolutions per minute

SO_2 - sulfur dioxide

SS - suspended solids, matter in sewage that cloud the water

STP - standard temperature and pressure, standard conditions of temperature and pressure used for the measurement of gases, i.e. temperature = 0^{o} Centigrade, pressure = 760 millimeters of mercury

Supernatant - a liquid forming a layer on top of the digested sludge in an anaerobic digester

SWD - side water depth

TDH - total dynamic head

TSS - total suspended solids; includes volatile and fixed suspended solids

WAS - waste activated sludge

wk - week

WPCF - Water Pollution Control Federation

WQD - Water Quality Division

WWTF - wastewater treatment facility

WWTP - wastewater treatment plant

APPENDIX D

CHEYENNE STEP I 201 REPORT

WORKING PAPER NO. 1:

POPULATION PROJECTIONS/DISTRIBUTION

2a

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
1860 LINCOLN STREET
DENVER, COLORADO 80295

RECEIVED JAN WATER QUALITY DIVISION

Ref: 8W-EO

JAN 20 1982

Mr. William L. Garland, Administrator
Water Quality Division
Department of Environmental Quality
1111 East Lincolnway
Imperial Plaza
Cheyenne, Wyoming 82002

Re: Federal Sewage Works Grant
C560161-01 (Step 1)
South Cheyenne, Wyoming

Dear Mr. Garland:

This office has reviewed the population projections for the referenced project as presented in Working Paper No. 1 and the letter from Banner Associates, Inc. to your office dated 1 May 1981. The population projection of 115,000 for 2005 for the Cheyenne Metropolitan area is consistent with the EPA approved variance to the BEA projection of 111,690 for 2000. Additional information should be provided indicating why the South Cheyenne area will receive approximately 50% of the population increase. This information would include descriptions of proposed developments in South Cheyenne and evidence of growth limitations in other areas.

If you have any questions, please contact Gerry Snyder of this office at FTS 327-3961.

Sincerely yours,

William H. Hormberg

William H. Hormberg, P.E.
Chief
Municipal Facilities Branch

Introduction

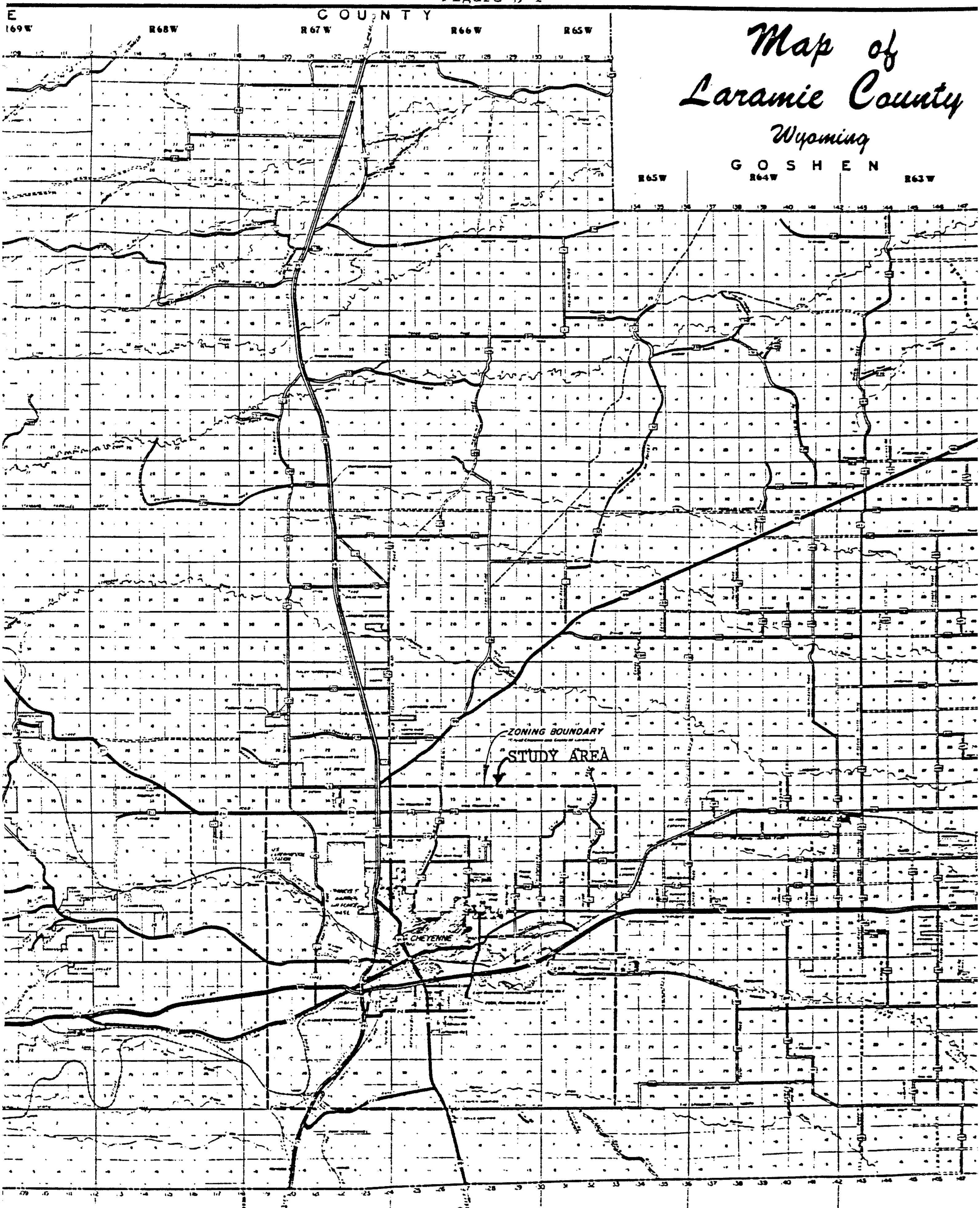
This working paper was written to combine population projections and other available data in order to establish a population figure and growth rate for the Step I 201 Report. General statements in regard to present and expected population distribution are also included. The figures presented in this working paper were subject to approval by the 201 Committee, DEQ, and EPA.

Summary

The 1980 census shows that approximately 63,280 people reside within the 201 Report Study Area (Figure D-1). Of this number, approximately 47,200 reside within the city limits of Cheyenne, 4750 reside on the Francis E. Warren Air Force Base, and approximately 6400 people reside within the South Cheyenne Water and Sewer District. This gives a total of nearly 58,350 people in the study area who are currently receiving city water and sewer service. It must be noted that this is an approximate figure, as the City of Cheyenne is continuously annexing areas when the density of the development dictates. When the city annexes an area, it then becomes the responsibility of the annexed neighborhood to construct water and sewer facilities, thereby increasing the total number of people receiving city services. The balance of the population (approximately 4930 people) have private water supply and sewage disposal systems, i.e. septic tanks.

Various population projections have been made for the study area to the year 2000. These projections range from a minimum of 56,426 to a maximum of 150,120 for the year 2000. It is believed that a reasonable and workable range of projected population for the Study Area in the year 2000 is from 95,000 to 105,000, and for the year 2005, the range is from 105,000 to 115,000.

South Cheyenne appears to be faced with a significant portion of the above mentioned growth, and their present waste treatment capacity will not be adequate


COUNTY
R69W
R68W
R67W
R66W
R65W
Map of Laramie County
Wyoming
GOSHEN
R65W
R64W
R63W
ZONING BOUNDARY
STUDY AREA
HILLSDALE
CHEYENNE

to treat the waste generated from this growth. It will be necessary for the District either to provide increased wastewater treatment capacity in the near future or to restrict growth.

Present Population

The historical trends in population are useful in determining future population. One way the growth of an area may be depicted is by the number of residential utility and telephone hook-ups made annually. Table D-1 gives the number of total end-of-year residential telephone hook-ups and water taps for the city of Cheyenne from 1970 to 1980. The numbers in Table D-1 for both services indicate continuous growth for the 10-year period. The higher percentage increase in telephone hook-ups for the 10-year period (41.26%) indicates that residences are being established outside the city limits where people receive telephone service but do not receive city water service.

Similarly, a fairly high growth rate of nearly 40% for the 10-year period, 1970-1980, is indicated by the natural gas and electric services hook-ups, as shown in Table D-2. This data, along with the data presented in Table 2-1, provides sound evidence of continuous growth in the Cheyenne area.

The historical population data for Wyoming, Laramie County, and the City of Cheyenne are presented in Table D-3. The U. S. Census figures for the population of Cheyenne in 1970 and 1980 are 40,914 and 47,188, respectively. These figures show only the population residing within the city limits of Cheyenne, and represent a growth of 15.33% over the 10-year period. The 201 Report is concerned with the zoned area, and as such it is necessary to include the entire study area population to give an accurate account of actual growth occurring in the area. The figures given in Table D-3 for the years 1970 and 1980 were developed to represent the 201 Report Study Area. It is assumed that census figures prior to 1970 are accurate representations of the study area population, as migration of people to rural housing developments began after the 1960 census

Table D-1. Residential Telephone Hook-ups and Total Water Taps for City of Cheyenne

Year	Residential Phone Hook-ups	% Change	Total Number of Water Taps (Includes 3/4" and Smaller, 1-2", and 3" and Larger)	% Change
1971	16,819	-	12,425	-
1972	18,046	7.30	12,765	2.74
1973	19,125	5.98	13,051	2.24
1974	19,571	2.33	13,397	2.65
1975	20,251	3.47	13,677	2.09
1976	20,691	2.17	14,014	2.46
1977	21,312	3.00	14,691	4.83
1978	22,204	4.19	15,162	3.21
1979	23,078	3.94	15,530	2.43
1980	23,758	2.95	15,936	2.61
10-year Change:		41.26		28.26

Table D-2. Electric and Natural Gas Hook-ups as Reported by the Cheyenne Light, Fuel & Power Company

Year	Residential Electric	% Change	Residential Natural Gas	% Change
1971	17,437	-	15,478	-
1972	18,528	6.26	16,296	5.28
1973	19,454	5.00	17,053	4.65
1974	20,327	4.49	17,834	4.58
1975	20,814	2.40	18,274	2.47
1976	21,453	3.07	18,835	3.07
1977	22,350	4.18	19,402	3.01
1978	22,919	2.55	19,934	2.74
1979	23,709	3.45	20,340	2.04
1980	24,431	3.05	20,905	2.78
10-year Change:		40.11		35.06

Table IX-3. Historical Population of Wyoming, Laramie County and Cheyenne

Year	Cheyenne-Study Area Population[1]	% Change	Cheyenne, % of Wyo. Pop.	Laramie County Population	% Change	Laramie Co., % of Wyo. Pop.	Wyoming Population	% Change
1870	1,450	-	15.90	2,957	-	32.43	9,118	-
1880	3,456	+138.3	16.62	6,409	+116.7	30.83	20,789	+128.0
1890	11,690	+238.3	18.69	16,777	+161.8	26.82	62,555	+200.1
1900	14,087	+ 20.5	15.52	20,181	+ 20.3	21.81	92,531	+ 47.9
1910	11,320	- 19.6	7.76	26,127	+ 29.5	17.90	145,965	+ 57.7
1920	13,829	+ 22.2	7.11	20,699	- 20.8	10.65	194,402	+ 33.2
1930	17,361	+ 25.5	7.70	26,845	+ 29.7	11.90	225,565	+ 16.0
1940	22,474	+ 29.5	8.96	33,651	+ 25.4	13.42	250,742	+ 11.2
1950	31,935	+ 42.1	10.99	47,662	+ 41.6	16.41	290,529	+ 15.9
1960	43,505	+ 36.2	13.18	60,149	+ 26.2	18.22	330,066	+ 13.6
1970	47,785[2]	+ 9.8	13.56	56,360	- 6.3	16.95	332,416	+ .71
1980	63,276[2]	+ 32.4	13.44	69,649	+ 21.8	14.58	470,816	+ 41.6

[1]Assumed: Prior to 1960, there was little or no development outside city limits. City population figures also represent study area population.

[2]Estimated figures.

The number in Table D-3 for the 1980 study area population was determined by subtracting from the 1980 U. S. Census Laramie County population (68,649) the population of the county outside the study area. "Laramie County Maps and Addresses" as approved by the Laramie County Board of Commissioners, February 1, 1980, was used to determine the number of households existing in the county outside the study area. The 1970 U. S. Census figures indicate that in 1970, the average family size was 2.90 people. By 1980, the average family size in Laramie County had decreased to 2.51, and it is assumed for this study that the average number of people per household is 2.51. According to the "Laramie County Maps and Addresses" there are 1547 households in Laramie County outside the study area (excluding Burns, Albin, and Pine Bluffs) with a population of approximately 3900 people. The combined population of Albin, Burns, and Pine Bluffs is 1473. This gives a total population of Laramie County outside the study area of roughly 5373 people. The resulting 1980 study area population is 63,276.

The study area population of 63,276 represents approximately 92% of the Laramie County population. The 1960 population figures indicate that Cheyenne represented 72% of Laramie County population at that time. The U. S. Census Bureau figures indicate a 1970 Cheyenne population of 40,914. The Cheyenne division of Laramie County includes not only the city, but also the residential nuclei of Fox Farm and Orchard Valley. These entities totaled 2344 in 1970. The West Division of Laramie County includes the Francis E. Warren Air Force Base and totaled 4527 in 1970. These divisions totaled up to a 1970 study area population of 47,785, or 85% of the Laramie County population. The steady increase in the study area population percentage of Laramie County population from 1960 to 1980 indicates a more rapid growth of the city compared with that of rural parts of the county. It is reasonable to assume that by the year 2000, at least 92% of the Laramie County population will still reside within the study area.

The change in study area population from 1970 to 1980, of 47,785 to 63,276, represents an increase of 32.4%. This is slightly lower than the percentage increases in telephone and utility hook-ups as shown in Tables 2-1 and 2-2. This not only indicates that some residences have more than one connection, but also indicates a slight decrease in the number of people per household, from 2.90 to 2.51 from 1970 to 1980.

The people currently receiving sewer services include those residing within the city limits of Cheyenne, those residing on the Francis E. Warren Air Force Base, and those residing within the South Cheyenne Water and Sewer District. These areas have a combined population of approximately 58,350 people. The remaining 4930 people in the study area use private septic systems to handle their waste.

Population Projections

In order to present an acceptable wastewater management plan to the 201 Committee, it was first necessary to establish population projections and associated future wastewater treatment needs. Population projections are traditionally controversial since they determine the scope and thus the cost of any proposed program.

To develop a range in the projected population figures, linear and geometric progressions were undertaken. Linear population progressions involve the following computations:

1) $$K_a = \frac{dP}{dt} = \frac{P_2 - P_1}{t_2 - t_1}$$

where: K_a = growth rate constant

t = time

$P_1 \& P_2$ = population at $time_1$ and $time_2$ respectively

(K_a was established by using 1970, t_1, and 1980, t_2, population figures;

$t_2 - t_1 = 10$

2) $P_{2000} = P_{1980} + K_a t$

where: P_{2000} = population in year 2000

P_{1980} = population in 1980

$t = 20$

When an area is experiencing more rapid growth than historical records would indicate, as is currently occurring in the state of Wyoming, geometric progressions may be more representative of the actual situation than are linear progressions. Geometric progressions involve the use of natural logarithms in the following manner:

1) $$K_g = \frac{d(\ln P)}{dt} = \frac{\ln P_2 - \ln P_1}{t_2 - t_1}$$

where: K_g = geometric growth rate constant

dt = change in time

(As for the linear progression, K_g was determined based on 1970 and 1980 populations, as the growth during the 1970's more accurately represents the current population growth than does growth prior to 1970.)

2) $\ln P_{2000} = \ln P_{1980} + K_g t$

Population projections were performed based on 1970 and 1980 study area populations of 47,785 and 63,276, respectively. Using the above linear and geometric progression methods results in the following population projections, shown in 5-year increments from 1985 to 2005:

		Projected Population	
Year	Population	Linear	Geometric
1970	47,785		
1980	63,276		
1985		71,022	72,814
1990		78,767	83,789
1995		86,513	96,418
2000		94,258	110,952
2005		102,004	127,676

These figures are graphically displayed in Figure D-2. A reasonable estimation of the 2005 study area population ranges from 105,000 to 115,000.

Projecting the population of the South Cheyenne Water and Sewer District separately, based on 1970 and 1980 populations of 2344 and 6173, respectively, results in the following populations:

Year	Population	Projected Population Linear	Projected Population Geometric
1970	2,344		
1980	6,173		
1985		8,008	10,018
1990		10,002	16,257
1995		11,917	26,382
2000		13,831	42,813
2005		15,846	69,477

It is felt that a workable population estimation for South Cheyenne for the year 2005 is 15,000 - 25,000. This figure includes the population within the South Cheyenne Water and Sewer District Boundaries as well as other developments outside of the District's boundaries but within the South Cheyenne area.

Comparison with Past Population Projections

Numerous population projections were formulated for the City of Cheyenne prior to the 1980 Census. The following is a list of the projections investigated:

1) The Cheyenne-Laramie County Regional Planning Office, The Cheyenne Land Use Plan - 1978.

2) Wyoming Department of Administration and Fiscal Control, Research and Statistics Division, Special Report - August 1979. Adapted to Towns by the Institute for Policy Research, College of Commerce and Industry, University of Wyoming.

3) U. S. Census Bureau, Population Projections by State - 1980-2000, 1979. Adapted to County and Towns by DAFC-IPR allocation methodology.

4) Wyoming Water Planning Program, State Engineer's Office, Summary and Analysis of the City of Cheyenne's Proposed Stage II Water System Expansion, December 1978.

Table D-4 gives a comparison of population projections for the City of Cheyenne. The projections referenced above were all completed prior to the 1980 census. The 1980 population of the study area of 63,276 developed by Banner Associates is in close agreement with that reported by the Cheyenne Mayor's office, as distributed from Mick Snapp to all department/division heads on March 5, 1981. These figures are as follows:

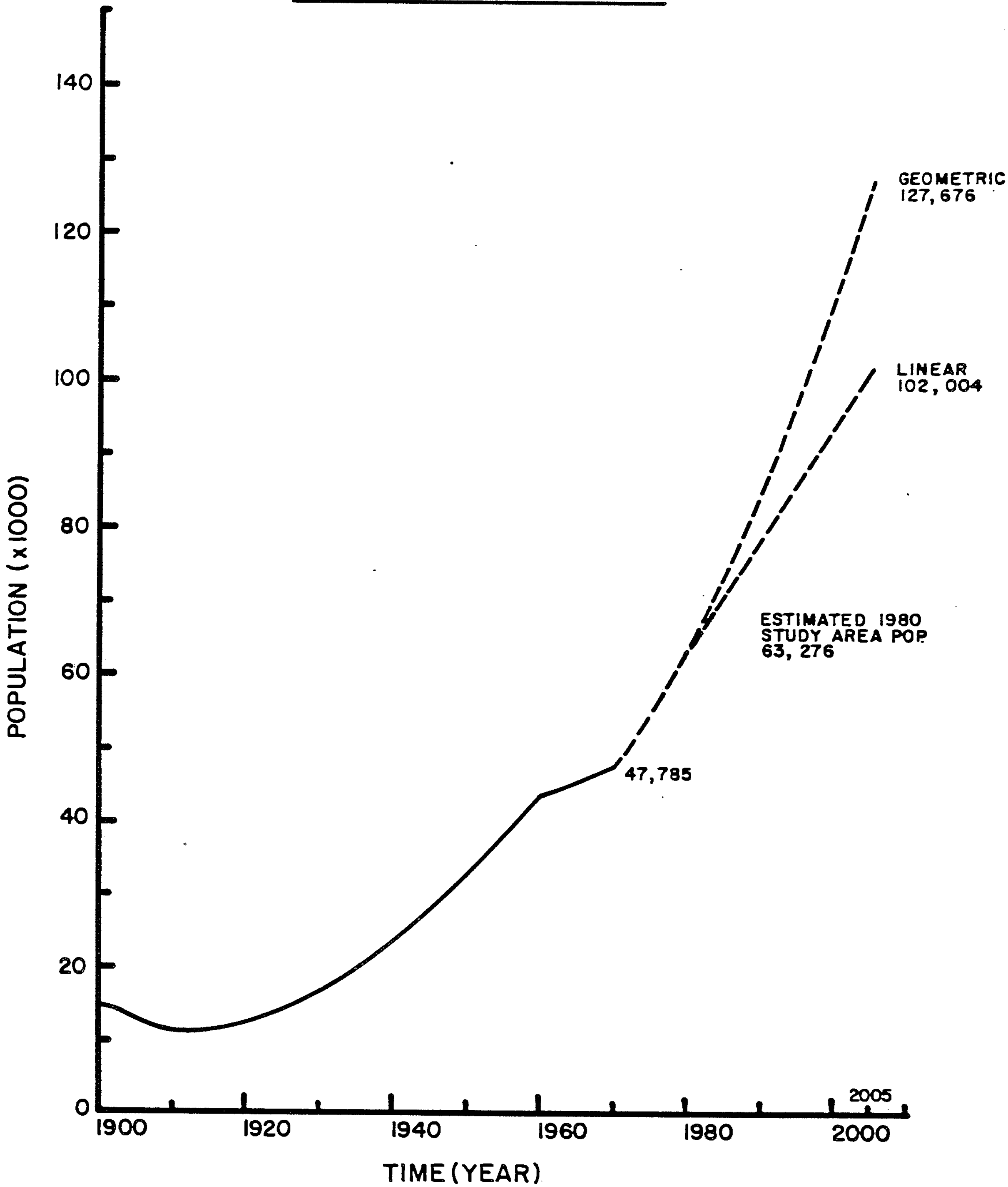
The City of Cheyenne within city limits =	47,250
The City of Cheyenne and its immediate environs (zoned area) =	65,800
Laramie County =	68,500

Although the 1980 stable growth population projection made by the Planning Office was the most accurate 1980 figure (64,860), it is felt that the Planning Office's projected population of 118,490 for the year 2000 is somewhat high. The rapid growth rate that is currently occurring will probably level off, resulting in a slightly lower population in 2000 than 118,490. The population projection completed by the Wyoming Water Planning Program of 113,490 for the year 2000 is also considered to be slightly high for that year, although 113,490 is a reasonable prediction for the study area population in the year 2005. It is the considered opinion of Banner Associates that a reasonable study area population for the year 2005 will range from 105,000 to 115,000. This estimation is slightly higher than the linear projection made, but is lower than the geometric progression of 127,676.

Table D-4. Comparison of Population Projections for the City of Cheyenne and Zoned Areas

Method	1980	Population 2000	2005
1. Banner	63,276		
a. linear		94,258	102,004
b. geometric		110,952	127,676
2. Planning Office: Land Use Plan			
a. Minimal growth	62,100	74,640	
b. Stable growth	64,860	118,490	
c. Phenomenal growth	84,980	150,120	
3. Wyoming Water Planning Program	59,860	113,490	
4. DAFC-1PR	52,919	99,529	
5. Census (DAFC-1PR)	50,680	56,426	

CHEYENNE 201 REPORT



STUDY AREA

POPULATION PROJECTIONS

FIGURE D-2

Population Distribution

The expansion of the Cheyenne area has occurred to the south, to the east, and to a lesser degree to the north and west of the current city limits. There is an area roughly defined by a "ridge" at approximately 6200' MSL extending from the northwest corner of the study area to the Dry Creek Wastewater Treatment Plant, and then southwest to the South Greeley Highway within which sewage flow to the treatment plants is accomplished by gravity (see Figure D-3). If extensive development were to occur outside of this area, i.e. to the north, sewage lift stations would be required, thereby dramatically increasing development costs.

The area to the north is zoned R-2 or A-1 (medium density residential or agricultural) thereby restricting development in this area to ranchette-type homes, each situated on 2½ acres of land. Do Palma, of the Cheyenne City Planning Office, indicated in a telephone conversation that there is currently no evidence of serious water contamination in the ranchette developments to the north. For this situation to be maintained, it appears at this time that future developments must be restricted to one house per 2½ acres or to the use of a common water source with each house having private septic tanks. This density of development would result in a population of approximately 7500 people in the ranchette developments to the north of the city. A complete investigation of these private systems is contained in Appendix G. In general, the area to the north of the "ridge" will most likely not receive heavy development due to the prohibitively high cost. North Cheyenne and Section 20, T14N, R66W are currently not developed to their potential. North Cheyenne has developed onsite wastewater treatment difficulties, and annexation appears likely for this area. Future development of said Section 20 is also considered likely. These areas total approximately 640 acres and could support a population range of 7000 to

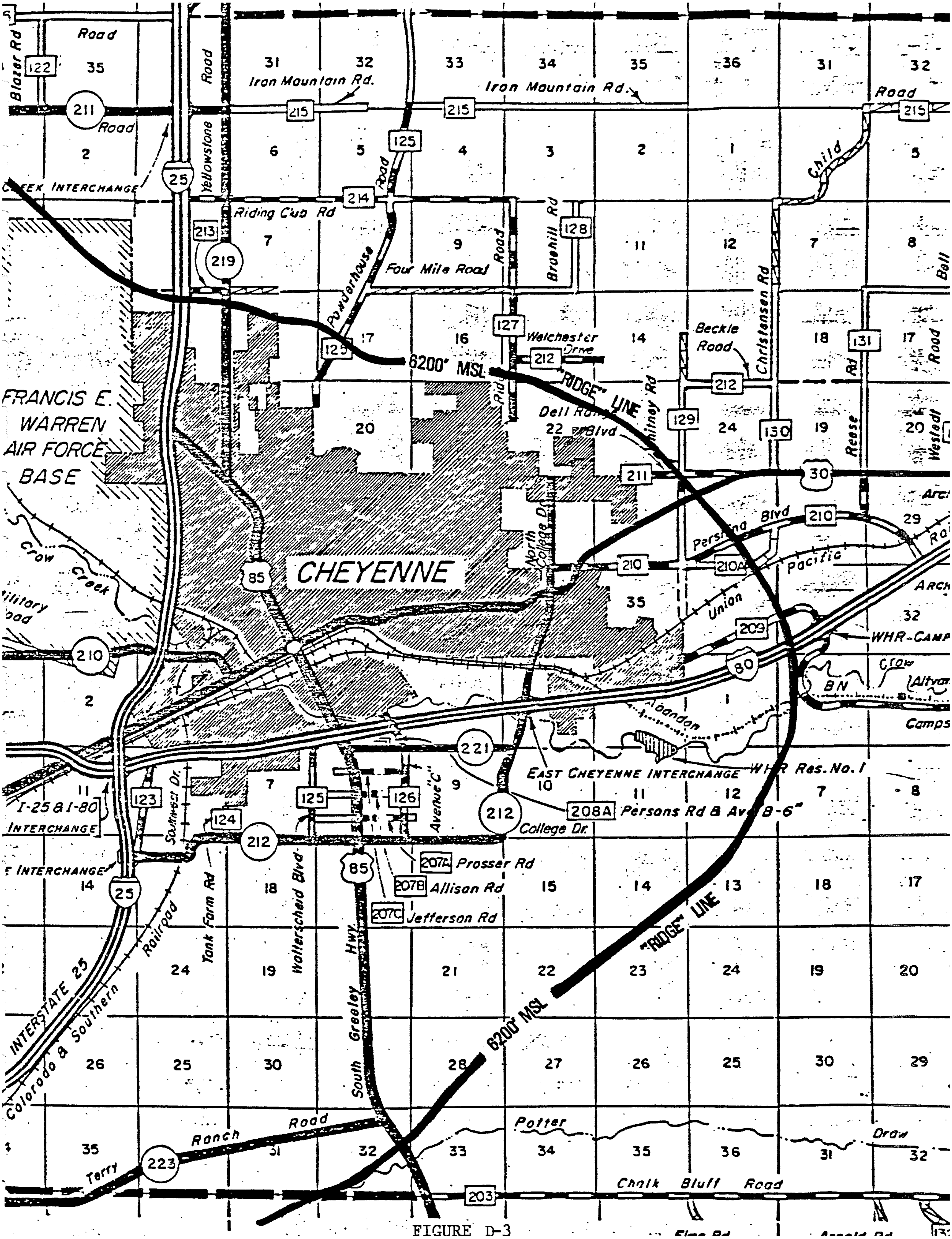

CHEYENNE
FRANCIS E. WARREN AIR FORCE BASE
6200' MSL "RIDGE" LINE
Iron Mountain Rd.
Riding Club Rd
Four Mile Road
Powderhouse Road
Yellowstone Road
Brashill Rd
Christensen Rd
Beckle Road
Welchester Drive
Dell Range Blvd
Whitney Rd
Pershing Blvd
Union Pacific
North College Dr
Crow Creek
EAST CHEYENNE INTERCHANGE
WHR Res. No. 1
Persons Rd & Ave B-6"
College Dr.
Prosser Rd
Allison Rd
Jefferson Rd
I-25 & I-80 INTERCHANGE
Southwest Dr.
Tank Farm Rd
Walterscheid Blvd
South Greeley Hwy
Avenue "C"
INTERSTATE 25
Colorado & Southern Railroad
Terry Ranch Road
Potter Draw
Chalk Bluff Road
WHR-CAMP
BN
Camps
Child Road
Reese Rd
Westedt Road
Blazer Rd
Crow Creek Interchange
Military Road

FIGURE D-3

9500 persons (10.94 to 14.84 persons/acre). This represents approximately 9 to 16% of the expected area-wide population increase.

The area to the east of the city limits is subjected to much heavier development than the area to the north, with much of the area to the east zoned R-3: High Density Residential. The Sunnyside Addition, for example, is very heavily developed. At present, in the Sunnyside Addition, new wells and septic tanks are not permissible for lots less than one acre in size. Certain sections of the Sunnyside Addition that developed extremely poor water quality due to extensive nearby development have been annexed by the city and have subsequently received water and sewer services. As is the case for northern growth, development to the east is most economical when it is kept within the 6200' MSL "ridge" as shown in Figure D-3. Any sewer system designed for developments to the east of this "ridge" would require the use of lift stations, which can be quite expensive. It is probable that the area between the present city limits and this "ridge" will be extensively developed before the area to the east of the "ridge". Based on a 2005 study area population of 115,000 with 92% of this population, or 105,800 receiving water and sewer services, approximately 46,000 people will be moving to the study area. It is estimated that as many as 11,000 to 21,000 (24%-45%) of the 46,000 people that are expected to move to the area will reside in the eastern portion of the city, i.e. Sunnyside Area and other developments. Extensive development is currently proceeding in this direction. This increase in population will contribute wastewater flow entirely to the Dry Creek Wastewater Treatment Plant.

The area to the south of Cheyenne, in the South Cheyenne Water and Sewer District, is extensively zoned R-3 and is expected to be faced with a high growth rate. Among the reasons for this prediction are: 1) less strict zoning laws, 2) lower development costs, and 3) the zoning for trailer parks (not legal in Cheyenne). This area provides more affordable living than the other areas of the city for many people and as such could be subject to a relatively high influx of people in the area; consequently, extensive improvement in the wastewater treatment capacity will be required. The South Cheyenne Water and Sewer District is currently experiencing rapid growth. Existing information (1981) indicates that the population has risen to approximately 7200. Using this number and the 1970 population of 2344 for a linear projection (as discussed above), a 2005 population of 17,800 results. This calculation, along with the fact that area for development is available within and surrounding the district boundaries, results in the conclusion that the South Cheyenne area could see an increase in population of 9,000 to 18,000 people (19%-38% of the total area population increase) between the present time and the year 2005. This will result in a total population of 16,000-25,000 people in this area. According to Art Buffington, Chairman of the South Cheyenne Water and Sewer District the possibility exists that development within the district could be limited to 15,000. This does not preclude the development of areas South of Cheyenne, but indicates that this extra development would occur outside the existing South Cheyenne Water and Sewer District. Another imminent problem for the South Cheyenne Water and Sewer District is the new Holiday Inn, located in this district, that was opened June 1, 1981. This facility has 300 rooms with a convention center to handle 1300 people. The Holiday Inn, in union with the rapid growth of the area, makes improvements in the South Cheyenne Water and Sewer District's wastewater treatment facility of paramount importance.

To the west of the city is the Francis E. Warren Air Force Base. The Base discharges its waste to the city sewer system. Lt. Sohotra of the Engineering Branch on the Base, indicated in a telephone conversation of March 27, 1981, that the Base population is 4,750 on Base with 525 civilians. This population is expected to remain fairly constant from year to year. In 1979, 200 million gallons of wastewater were discharged to the city. The 1980 discharge was 248 million gallons. Assuming a Base population of 4,750 in 1980, this equates to a wastewater generation of approximately 143 gpcd (gallons per capita per day). This figure appears to be fairly high and will, therefore, be investigated further. There are developments proposed for the area to the west of Francis E. Warren Air Force Base. High energy costs have prevented these developments from gaining popularity. As yet, this area has not been extensively developed, and it is not expected that extensive development will occur in the foreseeable future.

Conclusion

In 1980, the 201 Report Study Area had a population of approximately 63,280 people, 58,350 (92%) of whom were recieving city sewer services. By the year 2005, it is expected that the study area population could range from 105,000 to 115,000 people. Most of this growth will occur within a 6200' MSL "ridge" running from the northwest of the study area to the Dry Creek Wastewater Treatment Plant and then southwest to the South Greeley Highway. The development that occurs within this ridge is expected to eventually be annexed to the city and will receive city water and sewer services. Table D-5 summarizes the projected population increases for various areas within the 201 Study Area. It is estimated that at least 92% of the 2005 population, or 96,600 to 105,800 people, will be receiving city water and sewer services.

Increased wastewater treatment capabilities will be required to meet the needs of this projected population. Several alternatives have been developed and are discussed in the main body of the 201 report.

TABLE D-5. PROJECTED DISTRIBUTION OF POPULATION GROWTH TO STUDY AREA

Area	Current Population (1980)	2005 Population Range Low	2005 Population Range High	Δ Pop Low	Δ Pop High	% of total Δ Pop (6) (47,000) Low	% of total Δ Pop (6) (47,000) High
South Cheyenne	6,400	15,000	25,000(1)	9,000	18,000	19	38
East (2)	3,750	15,000	25,000	11,250	21,250	24	45
North (3)	150(4)	7,000	9,500	6,850	9,350	15	20
Ranchette (5)	1,000(4)	5,000	7,500	4,000	6,500	9	16
City	47,200	47,200		—		—	
Warren AFB	4,750	4,750		—		—	
Σ	63,250	115,000		42,000 min to 52,000 max		100	

(1) Includes South Cheyenne Water and Sewer District and Southern Areas outside of District Boundaries.

(2) Includes Sunnyside Addition and other eastern, unsewered developments in general proximity of city limits.

(3) Includes North Cheyenne and Sec. 20, T14N, R66W, as yet undeveloped.

(4) Estimated values based on number of homes and 2.51 persons/home.

(5) Includes ranchette developments to north and west.

(6) Percent of average increase in population: (42,000 + 5,200)/2 = 47,000

APPENDIX E

FLOW PROJECTIONS AND MISCELLANEOUS CALCULATIONS

E.1. South Cheyenne Data

Table E-1
South Cheyenne WWTF Flow and Loading Projections
(South Cheyenne Population = 15,000 in 2005)

Year	Average Day Flow (MGD)	Average Day BOD (lb/day)	Average Day SS (lb/day)	Peak Day Flow (MGD)	Peak Day BOD (lb/day)	Peak Day SS (lb/day)
1980	0.64	1,088	1,280	1.02	1,344	1,920
1985	0.90	1,530	1,800	1.44	1,890	2,700
1990	1.30	2,210	2,600	2.08	2,730	3,900
1995	1.50	2,550	3,000	2.40	3,150	4,500
2000	1.50	2,550	3,000	2.40	3,150	4,500
2005	1.50	2,550	3,000	2.40	3,150	4,500

Table E-2
South Cheyenne WWTF Flow and Loading Projections
(South Cheyenne Population = 25,000 in 2005)

Year	Average Day Flow (MGD)	Average Day BOD (lb/day)	Average Day SS (lb/day)	Peak Day Flow (MGD)	Peak Day BOD (lb/day)	Peak Day SS (lb/day)
1980	0.64	1,088	1,280	1.02	1,344	1,920
1985	0.90	1,530	1,800	1.44	1,890	2,700
1990	1.30	2,210	2,600	2.08	2,730	3,900
1995	1.70	2,890	3,400	2.72	3,570	5,100
2000	2.10	3,570	4,200	3.36	4,410	6,300
2005	2.50	4,250	5,000	4.00	5,250	7,500

South Cheyenne Water and Sewer District

I. Existing and Design Loadings

A. Existing BOD_5 loading $= \frac{0.58 \text{ MGD} \times 238 \text{ mg/l} \times 8.34}{6400 \text{ persons}}$

$= 0.18$ lb BOD_5 pcpd

B. Design BOD_5 loading = 0.17 lb BOD pcpd x 8000

= 1360 lb BOD_5/day

II. Aeration Requirements for Existing Extended Aeration WWTP (South Cheyenne, as built)

A. Ten-States Requirements for Extended Aeration

1. 2000 ft^3 air/lb BOD_5 applied (diffused air system)

2. 1.8 lb O_2/lb BOD_5 applied (general aeration)

B. Treatment Plant Loading

1. (8000 people)(.17 lb BOD pcpd) = 1360 lb BOD/day

2. Loading for each half of the plant: 680 lb BOD/day

C. Aeration Requirement (Mechanical Aeration Equipment)

(1.8 lb O_2/lb BOD_5)(680 lb BOD/day)

= 1224 lb O_2/day - half of plant

O_2 requirements for entire plant = 2448 lb O_2/day

D. Existing Aerator Capacity

1. "New" half of plant

4-10 Hp aerators with transfer capability of 3.5 lb O_2/Hp-hr

capacity = (3.5 #O_2/Hp-hr)(10 Hp)(4)

= 140 #O_2/hr

= 3360 #O_2/day

3360 #O_2/day > 1224 #O_2/day OK

2. "Old" half of plant

4-7.5 Hp aerators with transfer capability of 3.5 lb O_2/Hp-hr

capacity = (3.5)(7.5)(4)

= 105 #O_2/hr

= 2520 #O_2/day

2520 #O_2/day > 1224 #O_2/day OK

E. Evaluate Aerators at peak BOD_5 loading conditions.

Assume BOD_5 peak = 225 mg/l @ 1.2 MGD = 2251 lb BOD/day

For each half of plant: 1125 lb BOD/day

Requirement: $(1.8\ \#O_2/\#BOD)(1125\ \#BOD/day) = \underline{2026\ \#O_2/day}$

1. New Half

$3360\ \#O_2/day > 2026\ \#O_2/day$ <u>OK</u>

2. Old Half

$2520\ \#O_2/day > 2026\ \#O_2/day$ <u>OK</u>

With all aerators operating, the existing aeration system is adequate to handle peak organic loading (225 mg/l @ 1.2 MGD).

Maximum BOD_5 loading for each half of the plant, assuming one aerator is down:

1. New half capacity = $(3.5\ \#O_2/Hp\text{-}hr)(10\ Hp)$ (3 aerators)(24 hr) = $2520\ \#O_2/day$

$$\frac{(2520\ \#O_2/day)}{(1.8\ \#O_2/\#BOD_5)} = 1400\ lb\ BOD_5/day$$

2. Old half capacity = $(3.5\ \#O_2/Hp\text{-}hr)(7.5\ Hp)$ (3)(24) = $1890\ \#O_2/day$

$$\frac{(1890\ \#O_2/day)}{(1.8\ \#O_2/\#BOD_5)} = 1050\ lb\ BOD_5/day$$

Assuming even hydraulic and organic loading, use criteria for old half to determine population equivalent:

$(1050\ lb\ BOD/day\text{-}half)2 = \underline{2100\ \#BOD_5/day}$ MAXIMUM LOADING

Population Equivalent

$$\frac{2100\ \#BOD_5/day}{.17\ \#BOD_5\ pcpd} = \underline{12{,}350\ people}$$

According to population projection, this population should be reached by the year 1990.

$Q_{1990} = 1.2$ MGD

III. Sludge Volume Calculations

A. Primary Sludge

Q_{ADF} = 2.5 MGD

SS_{inf} - 200 mg/1

65% S.S. removal in primaries

Vol = (2.5 MGD)(200 mg/1)(.65)(1/.035*)(8.34/8.34)) = <u>9286 gpd</u>

*.035 is concentration

B. Waste Sludge Volume

MOP8, pg 268, 0.4-0.6 lb WAS/lb BOD_5 removed

Use .55 lb WAS/lb BOD removed

Assume 65% BOD_5 overall removal

BOD_5 loading = 3400 lb/day

WAS = (3400)(.65)(.55) = 1215 lb/day

Wasting @ 6000 mg/1

(6000 mg/1)(8.34) = 50,040 lb/MB

$$\frac{1251 \text{ lb/day}}{50.040 \text{ lb/MG}} = .02 \text{ MGD} = \underline{24,280 \text{ gpd}}$$

Total Sludge Produced

9,286 gpd primary + 24,280 gpd WAS = <u>33,570 gpd</u>

WAS Volume @ 2% Solids = 0.6/2 x 24,280 = <u>7,285 gpd</u>

IV. Final Clarifiers Evaluation

A. Surface area = 2304 square feet

B. Plant influent, Q = 0.8 MGD

C. MLSS = 3500 mg/1

D. QRS/Q = 0.50

E. Allowable solids loading rate = 0.6 lb/ft^2-hr

F. Loading rate $= \dfrac{(1.5 \times 0.8)\ \text{MGD})(8.34)(3500\ \text{mg/1})}{24\ \text{hr/day} \times 2304\ \text{square feet}}$

$= 0.63\ lb/ft^2\text{-hr} > 0.6$

Therefore, solids loading rate is exceeded at approximately 0.8 MGD ADF.

James H. Stewart and Associates, Inc.
Consulting Engineers and Surveyors

214 North Howes Street
P.O. Box 429
Fort Collins, Colorado 80522
(303) 482-9331

Laboratory:
301 Lincoln Court
P.O. Box 429
Fort Collins, Colorado 80522
(303) 484-6309

September 30, 1981

Mr. Paul C. Sorrenson
Banner Associates, Inc.
620 Plaza Court
Post Office Box 550
Laramie, Wyoming 82070

Dear Mr. Sorrenson:

Subject: Environmental Testing Report

INTRODUCTION:

This letter report presents the results of our microbiology analysis of activated sludge in the Cheyenne, Wyoming area.

PURPOSE AND SCOPE:

The scope of our work includes the determination of various organisms in activated sludge that is being utilized in the City of Cheyenne, Wyoming.

INVESTIGATION AND PROCEDURES:

Grab samples by Banner Associates, Inc. of activated sludge were taken to our laboratory in Fort Collins, Colorado. All samples were received at our laboratory and tested and analyzed in accordance with the latest edition of the following standards:

1. Standard Methods for Examination of Water and Wastewater, 15th Edition, 1980, APHA, AWWA, WPCF
2. ASTM Standards, Part 31, Water, American Society for Testing and Materials
3. Methods for Chemical Analysis of Water and Waste, USEPA, 1980

All samples were run in multiple tests to varify our results. Our work and procedures were closely supervised by key personnel and control diagrams were utilized to maintain a check of consistency.

RESULTS:

For all of the samples we found the popoulation to be broken down as follows:

1.	Filamentaous growth	65-70%
2.	Coccoid growth	5-15%
3.	Protozoa	15-30%

Mr. Paul C. Sorrenson
September 30, 1981
Page 2

Some examples of the specific organisms are Pleuronema ciliates, Astasia flagellates, Dichotomosiphon and Westella.

DISCUSSION:

From the above results, it has been shown that a large amount of filamentous growth is present. This is usually due to low dissolved oxygen values in the aeration basin. Filamentous growth also inhibit settling characteristics. Filamentous growth, due to their structure, are very susceptible to the addition of hypochlorus acid (a chlorine solution). They also do not survive very well at a dissolved oxygen level above 2 ppm.

LIMITATIONS:

This report has been prepared to aid in the identification of micro-organisms in activated sludge in the City of Cheyenne. These findings are based upon Banner Associates, Inc. grab samples. Environmental conditions and other factors might influence the characteristics of these sludges. If variations from the conditions presented in this report are encountered during subsequent handling, this report should be reviewed.

We appreciated the opportunity of working with you on this proejct. If you have any questions regarding this report, please call.

Sincerely,

JAMES H. STEWART AND ASSOCIATES, INC.

David R. Stewart, P.E.
Director, Environmental Laboratory

DRS/vr

VAX/VMS PCS1767XB EVALAERO 26-OCT-1981 13:37 LPA0: 26-OCT-1981 13:37 _DRA1:[PCS]EVALAERO3.OUT;1 VAX/VMS
VAX/VMS PCS1767XB EVALAERO 26-OCT-1981 13:37 LPA0: 26-OCT-1981 13:37 _DRA1:[PCS]EVALAERO3.OUT;1 VAX/VMS

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PPPP     CCCC   SSSS      1     7777    666    7777   X     X  BBBB
P   P   C      S         11        7   6          7   X     X  B    B
P   P   C      S          1        7   6          7    X   X   B    B
PPPP    C       SSS       1       7    6666      7       X     BBBB
P       C          S      1      7     6    6   7      X   X   B    B
P       C          S      1     7      6    6  7      X     X  B    B
P        CCCC  SSSS      111   7        666   7       X     X  BBBB
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EEEEEEEEEE  VV        VV    AAAAAA    LL              AAAAAA    EEEEEEEEEE  RRRRRRRR       000000      333333
EEEEEEEEEE  VV        VV    AAAAAA    LL              AAAAAA    EEEEEEEEEE  RRRRRRRR       000000      333333
EE          VV        VV  AA      AA  LL            AA      AA  EE          RR      RR   00      00  33      33
EE          VV        VV  AA      AA  LL            AA      AA  EE          RR      RR   00      00  33      33
EE          VV        VV  AA      AA  LL            AA      AA  EE          RR      RR   00    0000          33
EE          VV        VV  AA      AA  LL            AA      AA  EE          RR      RR   00    0000          33
EEEEEEEE    VV        VV  AA      AA  LL            AA      AA  EEEEEEEE    RRRRRRRR     00  00  00        33
EEEEEEEE    VV        VV  AA      AA  LL            AA      AA  EEEEEEEE    RRRRRRRR     00  00  00        33
EE          VV        VV  AAAAAAAAAA  LL            AAAAAAAAAA  EE          RR  RR       0000    00          33
EE          VV        VV  AAAAAAAAAA  LL            AAAAAAAAAA  EE          RR  RR       0000    00          33
EE            VV    VV    AA      AA  LL            AA      AA  EE          RR    RR     00      00  33      33
EE            VV    VV    AA      AA  LL            AA      AA  EE          RR    RR     00      00  33      33   ....
EEEEEEEEEE      VV        AA      AA  LLLLLLLLLL    AA      AA  EEEEEEEEEE  RR      RR     000000      333333     ....
EEEEEEEEEE      VV        AA      AA  LLLLLLLLLL    AA      AA  EEEEEEEEEE  RR      RR     000000      333333     ....
                                                                                                                ....
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  OOOOOO    UU      UU  TTTTTTTTTT    ;;;;      11
  OOOOOO    UU      UU  TTTTTTTTTT    ;;;;      11
OO      OO  UU      UU      TT        ;;;;    1111
OO      OO  UU      UU      TT        ;;;;    1111
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PPPP     CCCC   SSSS      1     7777    666    7777   X     X  BBBB
P   P   C      S         11        7   6          7   X     X  B    B
P   P   C      S          1        7   6          7    X   X   B    B
PPPP    C       SSS       1       7    6666      7       X     BBBB
P       C          S      1      7     6    6   7      X   X   B    B
P       C          S      1     7      6    6  7      X     X  B    B
P        CCCC  SSSS      111   7        666   7       X     X  BBBB
```


VAX/VMS PCS1767XB EVALAERO 26-OCT-1981 13:37 LPA0: 26-OCT-1981 13:37 _DRA1:[PCS]EVALAERO3.OUT;1 VAX/VMS
VAX/VMS PCS1767XB EVALAERO 26-OCT-1981 13:37 LPA0: 26-OCT-1981 13:37 _DRA1:[PCS]EVALAERO3.OUT;1 VAX/VMS

BIOTREAT
A WASTEWATER TREATMENT MODEL

INPUT PARAMETERS :

REACTION FOR BACTERIA CELL SYNTHESIS

1	0.050 C5H702N	0.450 H20	-0.200 CO2	-0.050 HCO3-	-0.050 NH4+	-1.000 H+	-1.000 E-	0.000	0.000 G

REACTION FOR ELECTRON ACCEPTOR

3	0.500 H2O	-0.250 O2	-1.000 H+	-1.000 E-	0.000	0.000	0.000	0.000	18.675 G

REACTION FOR ELECTRON DONOR

7	0.020 C10H1903N	0.360 H20	-0.180 CO2	-0.020 NH4+	-0.020 HCO3-	-1.000 H+	-1.000 E-	0.000	-7.600 G

MINIMUM STABILITY FACTOR = 200.00 ✓

MAXIMUN STABILITY FACTOR = 210.00 ✓

STABILITY FACTOR INCREMENT = 5.00

SECOND STEP REACTION DONOR EQUATION IS 7

TEMPERATURE = 20.0 DEGREES CENTIGRADE

KS = 304.0 MG/L (AS BODL)

B = 0.20 PER DAY

K = 0.0 GM BODL/GM BACT-DAY

MAX CELL YIELD, Y = 0.00 GM BACT/GM BODL

K2 = 0.0 GM BODL/GM BACT-DAY

MAX CELL YIELD, Y2 = 0.00 GM BACT/GM BODL

INFLUENT FLOW = 1.2 MGD

THE INFLUENT ULT. BOD = 304.0 MG/L

INF. BIODEGRADABLE VOLATILE SUSP. SOLIDS = 80.0 MG/L

INF. REFRACTORY VOLATILE SUSP. SOLIDS = 70.0MG/L

INF. INORGANIC SUSPENDED SOLIDS = 50.0 MG/L

THE INPUT MLSS = 0. MG/L

INPUT HYDRAULIC DETENTION TIME = 16.0 HOURS.

OUTPUT CONSTANTS:

A = 0.576

AE = 0.635

K = 21.9 GM BODL/GM BACT-DAY

MAX CELL YIELD, Y = 0.45 GM BACT/GM BODL CONSUMED

MIN. THETAC = 0.10 DAYS

SOLIDS RETENTION TIME = 20.80 DAYS SYSTEM STABILITY FACTOR = 200.00

FRACTION TO SYNTHESIS , FS = 0.225 FRACTION TO ENERGY, FE = 0.775

THE OVERALL REACTION IS

0.02000 C10H19O3N	-0.12873 H2O	-0.13494 CO2	-0.00873 NH4+	-0.00873 HCO3-	0.19367 O2
-0.01127 C5H7O2N					

THE OVERALL REACTION NORMALIZED TO ONE MOLE IS .

1.00 C10H19O3N	-6.44 H2O	-6.75 CO2	-0.44 NH4+	-0.44 HCO3-	9.68 O2
-0.56 C5H7O2N					

THE AMOUNT OF O2 REQUIRED IS 0.7747 LBS PER LB BODL REMOVED OR 309.87 GRAMS PER MOLE C10H19O3N

THE AMOUNT OF BIOLOGICAL SOLIDS PRODUCED IS 0.1591 LBS PER LB BODL REMOVED OR 63.65 GRAMS PER MOLE C10H19O3N

REACTOR TANK MLSS = 5279.9 MG/L

REACTOR TANK MLVSS = 3719.6 MG/L

REACTOR TANK HYDRAULIC DETENTION TIME = 16.0 HOURS

REACTOR TANK VOLUME = 0.1070E+06 CUBIC FEET

EFFLUENT SUBSTRATE CONCENTRATION = 7.9 MG/L

TOTAL LBS OF ULT. BOD REMOVED = 2963.5 LBS/DAY

AVERAGE REQUIREMENTS 'FOR ELECTRON ACCEPTOR = 95.7 LBS/HOUR

TOTAL WASTE SOLIDS FROM SYSTEM = 1693. LBS PER DAY

VOLATILE PORTION OF TOTAL WASTE SOLIDS = 70.4 PERCENT

BIODEGRADABEL PORTION OF TOTAL WASTE SOLIDS = 13.4 PERCENT

SOLIDS RETENTION TIME = 21.32 DAYS SYSTEM STABILITY FACTOR = 205.00

FRACTION TO SYNTHESIS , FS = 0.223 FRACTION TO ENERGY, FE = 0.777

THE OVERALL REACTION IS

0.02000 C10H19O3N	-0.12883 H2O	-0.13533 CO2	-0.00883 NH4+	-0.00883 HCO3-	0.00000 H+
0.00000 E-	0.19416 O2	-0.01117 C5H7O2N			

THE OVERALL REACTION NORMALIZED TO ONE MOLE IS

1.00 C10H19O3N	-6.44 H2O	-6.77 CO2	-0.44 NH4+	-0.44 HCO3-	0.00 H+
0.00 E-	9.71 O2	-0.56 C5H7O2N			

THE AMOUNT OF O2 REQUIRED IS 0.7766 LBS PER LB BODL REMOVED OR 310.65 GRAMS PER MOLE C10H19O3N

THE AMOUNT OF BIOLOGICAL SOLIDS PRODUCED IS 0.1578 LBS PER LB BODL REMOVED OR 63.10 GRAMS PER MOLE C10H19O3N

REACTOR TANK MLSS = 5398.8 MG/L

REACTOR TANK MLVSS = 3799.5 MG/L

REACTOR TANK HYDRAULIC DETENTION TIME = 16.0 HOURS

REACTOR TANK VOLUME = 0.1070E+06 CUBIC FEET

EFFLUENT SUBSTRATE CONCENTRATION = 7.8 MG/L

TOTAL LBS OF ULT. BOD REMOVED = 2963.9 LBS/DAY

AVERAGE REQUIREMENTS 'FOR ELECTRON ACCEPTOR = 95.9 LBS/HOUR

TOTAL WASTE SOLIDS FROM SYSTEM = 1689. LBS PER DAY

VOLATILE PORTION OF TOTAL WASTE SOLIDS = 70.4 PERCENT

BIODEGRADABEL PORTION OF TOTAL WASTE SOLIDS = 13.2 PERCENT

SOLIDS RETENTION TIME = 21.84 DAYS SYSTEM STABILITY FACTOR = 210.00

FRACTION TO SYNTHESIS , FS = 0.222 FRACTION TO ENERGY, FE = 0.778

THE OVERALL REACTION IS

0.02000 C10H19O3N	-0.12892 H2O	-0.13570 CO2	-0.00892 NH4+	-0.00892 HCO3-	0.00000 H+
0.00000 E-	0.19462 O2	-0.01108 C5H7O2N			

THE OVERALL REACTION NORMALIZED TO ONE MOLE IS

1.00 C10H19O3N	-6.45 H2O	-6.78 CO2	-0.45 NH4+	-0.45 HCO3-	0.00 H+
0.00 E-	9.73 O2	-0.55 C5H7O2N			

THE AMOUNT OF O2 REQUIRED IS 0.7785 LBS PER LB BODL REMOVED OR 311.40 GRAMS PER MOLE C10H19O3N

THE AMOUNT OF BIOLOGICAL SOLIDS PRODUCED IS 0.1564 LBS PER LB BODL REMOVED OR 62.57 GRAMS PER MOLE C10H19O3N

REACTOR TANK MLSS = 5517.6 MG/L

REACTOR TANK MLVSS = 3879.2 MG/L

REACTOR TANK HYDRAULIC DETENTION TIME = 16.0 HOURS

REACTOR TANK VOLUME = 0.1070E+06 CUBIC FEET

EFFLUENT SUBSTRATE CONCENTRATION = 7.8 MG/L

TOTAL LBS OF ULT. BOD REMOVED = 2964.3 LBS/DAY

AVERAGE REQUIREMENTS 'FOR ELECTRON ACCEPTOR = 96.2 LBS/HOUR

TOTAL WASTE SOLIDS FROM SYSTEM = 1685. LBS PER DAY

VOLATILE PORTION OF TOTAL WASTE SOLIDS = 70.3 PERCENT

BIODEGRADABEL PORTION OF TOTAL WASTE SOLIDS = 13.0 PERCENT

E.2. City Data

Table E-3
City of Cheyenne WWTF Flow and Loading Projections
(South Cheyenne Population = 25,000 in 2005)

Year	Sewered Population	ADF* gpcpd	Average Day Flow (MGD)	Average Day BOD (lb/day)	Average Day SS (lb/day)	Peak Day Flow (MGD)	Peak Day BOD (lb/day)	Peak Day SS (lb/day)
1980	52,600	117	6.18	8,940	10,520	7.73	11,050	15,780
1985	57,500	117	6.73	9,775	11,500	8.75	12,075	17,250
1990	61,000	116	7.08	10,370	12,200	9.20	12,810	18,300
1995	64,500	115	7.42	10,965	12,900	9.64	13,545	19,350
2000	71,000	114	8.09	12,070	14,200	10.52	14,910	21,300
2005	77,500	112	8.68	13,175	15,500	11.28	16,275	23,250

*Calculated using 100 gpcpd for new developments

Table E-4
City of Cheyenne WWTF Flow and Loading Projections
(South Cheyenne Population = 15,000 in 2005)

Year	Sewered Population	ADF* gpcpd	Average Day Flow (MGD)	Average Day BOD (lb/day)	Average Day SS (lb/day)	Peak Day Flow (MGD)	Peak Day BOD (lb/day)	Peak Day SS (lb/day)
1980	52,600	117	6.18	8,940	10,520	7.73	11,050	15,780
1985	57,500	117	6.73	9,775	11,500	8.75	12,075	17,250
1990	61,000	116	7.08	10,370	12,200	9.20	12,810	18,300
1995	66,500	114	7.58	11,300	13,300	9.86	13,465	19,950
2000	77,000	112	8.62	13,090	15,400	11.21	16,170	23,100
2005	87,500	111	9.71	14,880	17,500	12.63	18,375	26,250

*Calculated using 100 gpcpd for new developments

Table E-5
Crow Creek WWTF Flow and Loading Projections
(Independent of South Cheyenne Flow)

Year	Average Day Flow (MGD)	Average Day BOD (lb/day)	Average Day SS (lb/day)	Peak Day Flow (MGD)	Peak Day BOD (lb/day)	Peak Day SS (lb/day)
1980	3.08	4,455	5,245	3.78	5,405	7,715
1985	3.15	4,575	5,385	4.10	5,660	8.085
1990	3.25	4,760	5,600	4.23	5,890	8,415
1995	3.50	5,220	6,140	4.55	6,445	9,205
2000	4.00	6,075	7,145	5.20	7,500	10,715
2005	4.00	6,130	7,210	5.20	7,565	10,810

I. Crow Creek WWTF

A. Primary Clarifiers

1. Surface loading = $\frac{8 \text{ MGD}}{10{,}050 \text{ square feet}}$ = 800 gpd/square foot

2. Weir loading = $\frac{7.4 \text{ MGD}}{496 \text{ ft of weir}}$ = 15,000 gpd/ft

B. Trickling filters

1. Existing plant

a. Filter efficiency = $\frac{100}{1 + 0.0085\left(\frac{W_1}{VF}\right)}$

where W_1 = BOD_5 loading to filter (not including recirculation)
V = Volume of filter media (acre-feet)

$$F = \frac{(1 + R/I)}{(1 + [1-P]\frac{R}{I})^2}$$

where R/I = Recirculation ratio

P = 0.9 .

b. Design flow = 4 MGD

c. Recirculation = 4 MGD, R/I = 1

d. Influent BOD_5 = 200 mg/1

e. Primary efficiency = 35%

f. W_1 = 8.34 x 4 MGD x 200 mg/1 x 0.65
= 4337 lb/day

g. V = 5.4 acre-feet

h. $F = \frac{(1 + 1)}{(1+[1-0.9]1)^2} = 1.65$

i. Efficiency = $\frac{100}{1+0.0085\left(\frac{4337}{5.4\text{x}1.65}\right)^{\frac{1}{2}}}$ = 84%

j. Temperature correction = 6%

k. Plant effluent = (200x0.65) x [1 - (0.84-0.06)] =
28.6 mg/1 < 30 mg/1
<u>OK</u>

2. Filter Covers

a. Plant influent temperature of 12°C in winter

b. $\frac{\text{Filter efficiency at } 12°C}{\text{Filter efficiency at } 20°C} = 1.035^{(12-20)}$

$= 0.76$

$= 76\%$

c. Plant effluent temperature of 9°C in winter

d. 2°C lost through trickling filters

e. $\frac{\text{filter efficiency at } 10°C}{\text{Filter efficiency at } 20°C} = 1.035^{(10-20)}$

$= 0.71$

$= 71\%$

f. Approximate increase in efficiency with covers = 76%-71%
= 5%

3. Addition of Roughing Filter

a. Assume primary efficiency = 25%

b. Assume trickling filter efficiency = 80%

c. Existing plant efficiency = 25% + 75%(0.80)
= 85%

d. Assume roughing filter efficiency = 25%

e. Primary and roughing efficiency = 25% + 75%(0.25) = 43.75%

f. Plant with roughing efficiency = 43.75% + (100%-43.75%)(0.80) = 89%

g. Plant efficiency increase with roughing filter = 89% -85% = 4%

4. Chemical Addition

a. Primary efficiency = 50%

b. Trickling filter efficiency = 80%

c. Overall plant efficiency = 50% + 50%(0.80) = 90%

Table E-6
Dry Creek WWTF Flow and Loading Projections
(South Cheyenne Population = 15,000 in 2005)

Year	Average Day Flow (MGD)	Average Day BOD (lb/day)	Average Day SS (lb/day)	Peak Day Flow (MGD)	Peak Day BOD (lb/day)	Peak Day SS (lb/day)
1980	3.10	4,485	5,275	3.95	5,645	8,065
1985	3.58	5,200	6,115	4.65	6,415	9,165
1990	3.83	5,610	6,600	4.97	6,920	9,885
1995	4.08	6,080	7,160	5.31	7,520	10,745
2000	4.62	7,015	8,255	6.01	8,670	12,385
2005	5.71	8,750	10,290	7.43	10,810	15,440

Table E-7
Dry Creek WWTF Flow and Loading Projections
(South Cheyenne Population = 25,000 in 2005)

Year	Average Day Flow (MGD)	Average Day BOD (lb/day)	Average Day SS (lb/day)	Peak Day Flow (MGD)	Peak Day BOD (lb/day)	Peak Day SS (lb/day)
1980	3.10	4,485	5,275	3.95	5,645	8,065
1985	3.58	5,200	6,115	4.65	6,415	9,165
1990	3.83	5,610	6,600	4.97	6,920	9,885
1995	3.92	5,810	6,830	5.10	7,165	10,235
2000	4.09	6,100	7,180	5.32	7,540	10,770
2005	4.68	7,105	8,355	6.08	8,770	12,530

II. Dry Creek WWTF

A. Primary Clarifiers

1. Detention time = $\frac{422{,}000 \text{ gal}}{4.5 \text{ MGD}}$ x 1440 min/day = 135 minutes

2. Weir overflow rate = $\frac{4.5 \text{ MGD}}{380 \text{ ft of weir}}$

= 12,000 gpd/ft < 15,000 gpd/ft

OK

3. Surface loading = $\frac{4.5 \text{ MGD}}{5660 \text{ sq ft}}$

= 795 gpd/sq ft < 1000 gpd/sq ft

OK

B. Aeration Basins

1. Conventional Activated Sludge Mode

a. Basin volume = 983,770 gallons

b. Minimum D.T. = 4 hrs

c. Minimum QRS/Q = 0.25

d. Total Q_T = Q + QRS = $\frac{983{,}770}{4}$ x 24 = 5.90 MGD

e. 0.25Q = QRS
Q + QRS = 5.90 MGD
therefore, Q + 0.25Q = 5.90 MGD
Q = 4.7 MGD ≃ 4.5 MGD

f. Maximum BOD loading = 40 lb BOD/1000 cubic feet

Total loading = $\frac{983{,}770 \text{ gallon} \times 1337 \frac{\text{cft}}{\text{gal}} \times 40 \text{ lb BOD}/100 \text{ cft}}{1000}$

= 5260 lb BOD/day

g. Check BOD_5 loading on basins at 4.5 MGD

BOD_5 influent = 200 mg/l

30% removal by primaries
Basin BOD_5 influent = 0.7 x 200 = 140 mg/l

Daily loading = 140 mg/l x 8.34 x 4.5 MGD = 5254 lb BOD/day

<5260 lb. OK

2. Complete Mix Activated Sludge Mode

a. Basin volume = 983,770 gallons

b. Minimum D.T. = 3 hours

c. QRS/Q = 0.5

d. Total $Q_T = Q + QRS = \frac{983{,}770 \text{ gallons} \times 24 \text{ hr/day}}{3 \text{ hrs}}$

$= 7.87$ MGD

e. $0.50Q = QRS$
$Q + QRS = 7.87$ MGD
therefore, $Q + 0.5Q = 7.87$ MGD
$Q = 5.25$ MGD

f. Allowable BOD_5 loading = 50-120 lb BOD/1000 cubic ft

g. Check BOD loading on basins at 5.25 MGD

BOD influent = 200 mg/1

30% removal by primaries

Basin BOD_5 influent = 0.7 x 200 mg/1 = 140 mg/1

Daily loading = 140 mg/1 x 8.34 x 5.25 MGD =
6130 lb BOD/day

Loading per 100 cubic feet =

$$\frac{6130 \text{ lb BOD/day} \times 1000}{983{,}770 \text{ gallons} \times 0.1337 \text{ cft/gal}}$$

= 47 lb BOD/1000 cubic feet

< 120 OK

E.3. Cost Analysis

I. City of Cheyenne Wastewater Treatment Alternatives

A. Upgrading to Improve Operation

1. Crow Creek WWTF

Capital Cost Items	Costs
Pretreatment	$ 43,400
Primary Clarifiers	55,000
Trickling Filters	56,000
Final Clarifiers	140,000
Anaerobic Digester	125,000
Site Improvements	10,000
Subtotal	$429,400
Contingencies	42,900
Subtotal	$472,300
Legal, Eng., and Admin.	70,800
Total Capital Cost	$542,100

Operation and Maintenance Costs
Fiscal Year 1982 O&M Budget = $180,260/year

2. Dry Creek WWTF

Capital Cost Items	Costs
Water Supply Pipeline	$ 84,480
Pretreatment	72,520
Primary Clarifiers	100,200
FRP Covers	103,500
Secondary Clarifiers	11,800
Sludge Digesters	13,000
Subtotal	$385,500
Contingencies	38,600
Subtotal	$424,100
Legal, Eng., and Admin.	63,600
Total Capital Cost	$487,700

Operation and Maintenance Costs
Fiscal Year 1982 O&M Budget = $180,270/year

B. Expand Dry Creek to 5.5 MGD

Capital Cost Items	Costs
Pretreatment	$ 48,230
Primary Clarification	208,800
Activated Sludge	482,000
Disinfection	64,300
Subtotal	$ 803,330
Contingencies	80,330
Subtotal	$ 883,660
Legal, Eng., and Admin.	132,550
Subtotal	$1,016,210
Upgrading Existing Crow Creek and Dry Creek WWTF	1,029,800
Subtotal	$2,046,010
1 MGD Pipeline from S. Cheyenne	352,000
Total	$2,398,010

Operation and Maintenance Costs

$$\text{Total O\&M Cost} = 360{,}530 \times \frac{9.5 \text{ MGD}}{8.5 \text{ MGD}} = \$402{,}950/\text{yr}$$

C. Expand Dry Creek to 7.0 MGD

Capital Cost Items	Costs
Pretreatment	$ 100,400
Primary Clarification	240,900
Activated Sludge	803,300
Disinfection	105,790
Subtotal	$1,250,480
Contingencies	125,050
Subtotal	$1,375,530
Legal, Eng., and Admin.	206,330
Subtotal	$1,581,860
Upgrading Existing Crow Creek and Dry Creek WWTF	1,029,800
Subtotal	$2,611,660
2.5 MGD Pipeline (40%)	172,680
Total	$2,784,340

Operation and Maintenance Costs

$$\text{Total O\&M Cost} = 360{,}530 \times \frac{11.0 \text{ MGD}}{8.5 \text{ MGD}} = \$466{,}570/\text{yr}$$

D. Expand Dry Creek to 8.5 MGD, Crow Creek Abandoned

Capital Cost Items	Costs
Pretreatment	$ 139,240
Primary Clarification	278,480
Activated Sludge	1,092,490
Disinfection	124,260
Subtotal	$1,634,470
Contingencies	163,450
Subtotal	$1,797,920
Legal, Eng., and Admin.	269,690
Subtotal	$2,067,610
Upgrading Existing Dry Creek WWTF	487,700
Total Capital Cost	$2,555,310

Operation and Maintenance Costs

Fiscal Year 1982 O&M Budget = $360,530/year

E. Expand Dry Creek to 9.5 MGD, Crow Creek Abandoned

Capital Cost Items	Costs
Pretreatment	$ 160,700
Primary Clarification	321,300
Activated Sludge	1,285,300
Disinfection	131,200
Subtotal	$1,898,500
Contingencies	189,850
Subtotal	$2,088,350
Legal, Eng., and Admin.	313,250
Subtotal	$2,401,600
Upgrading Existing and Dry Creek WWTF	487,700
Subtotal	$2,889,300
1.0 MGD Pipeline from S. Cheyenne	352,000
Total	$3,241,300

Operation and Maintenance Costs

$$\text{Total O\&M Cost} = 360{,}530 \times \frac{9.5\ \text{MGD}}{8.5\ \text{MGD}} = \$402{,}950/\text{yr}$$

F. Expand Dry Creek to 11.0 MGD, Crow Creek Abandoned

Capital Cost Items	Costs
Pretreatment	$ 181,060
Primary Clarification	382,900
Activated Sludge	1,566,430
Disinfection	132,270
Subtotal	$2,262,660
Contingencies	226,260
Subtotal	$2,488,420
Legal, Eng., and Admin.	373,340
Subtotal	$2,862,260
Upgrading Existing Dry Creek WWTF	487,700
Subtotal	$3,349,960
2.5 MGD Pipeline (40%)	172,680
Total	$3,522,640

Operation and Maintenance Costs

$$\text{Total O\&M Cost} = 360{,}530 \times \frac{11.0 \text{ MGD}}{8.5 \text{ MGD}} = \$466{,}570/\text{year}$$

II. South Cheyenne Wastewater Treatment Alternatives

A. Expand Extended Aeration to 1.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 440,900
Control Structure	26,600
Final Clarifiers	352,000
Chlorination	24,000
Expanded Capacity	940,800
Subtotal	$1,784,300
Site Work, 20%	356,860
Subtotal	$2,141,160
Contingencies	214,116
Subtotal	$2,355,276
Legal, Eng., and Admin.	353,291
Total Capital Cost	$2,708,570

O&M Cost Items	Costs
Pretreatment	$ 25,470
Aeration	57,660
Clarification	25,520
Disinfection	6,560
Staffing Requirements	59,800
Total O&M Cost	$ 175,010/year

B. Contact Stabilization WWTF, 1.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 352,720
Primary Clarifiers	86,560
Primary Pump Station	201,920
Aeration Basins	67,000
Final Clarifiers with Control Structure	320,720
Disinfection	80,720
Sludge Pumping Station	133,120
Sludge Thickener	120,000
Aerobic Digesters	212,800
Sludge Drying Beds	187,200
Subtotal	$1,762,760
Site Work, 20%	352,550
Subtotal	$2,115,310
Contingencies	211,530
Subtotal	$2,326,840
Legal, Eng., and Admin.	349,030
Total Capital Cost	$2,675,870

O&M Cost Items	Costs
Pretreatment	$ 20,380
Primary Clarification	13,780
Aeration	19,020
Final Clarification	6,500
Sludge Pumps	6,890
Disinfection	8,890
Aerobic Digestion	47,860
Staffing Requirements	57,600
Total O&M Cost	$ 180,920/year

C. Contact Stabilization WWTF, 2.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 440,900
Primary Clarifiers	108,200
Primary Pump Station	252,400
Aeration Basins	83,750
Final Clarifiers with Control Structure	400,900
Disinfection	100,900
Sludge Pumping Station	166,400
Sludge Thickener	150,000
Aerobic Digesters	266,000
Sludge Drying Beds	234,000
Subtotal	$2,203,450
Site Work, 20%	440,690
Subtotal	$2,644,140
Contingencies	264,414
Subtotal	$2,908,554
Legal, Eng., and Admin.	436,283
Total Capital Cost	$3,344,840

O&M Cost Items	Costs
Pretreatment	$ 25,470
Primary Clarification	17,220
Aeration	23,770
Final Clarification	8,130
Sludge Pumps	8,620
Disinfection	11,120
Aerobic Digestion	59,820
Staffing Requirements	72,000
Total O&M Cost	$ 226,150/Year

D. Activated Sludge WWTF, 1.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 352,720
Primary Clarifiers	85,560
Primary Pump Station	201,920
Aeration Basins	107,000
Final Clarifiers	312,800
Disinfection	80,720
Sludge Pumping Station	133,120
Sludge Thickener	120,000
Aerobic Digesters	212,800
Sludge Drying Beds	187,200
Subtotal	$1,794,840
Site Work, 20%	358,970
Subtotal	$2,153,810
Contingencies	215,380
Subtotal	$2,369,190
Legal, Eng., and Admin.	355,380
Total Capital Cost	$2,724,570

O&M Cost Items	Costs
Pretreatment	$ 20,370
Primary Clarification	13,770
Aeration	24,930
Final Clarification	6,500
Sludge Pumps	6,900
Disinfection	8,900
Aerobic Digestion	47,860
Staffing Requirements	57,600
Total O&M Cost	$ 186,830/year

E. Activated Sludge WWTF, 2.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 440,900
Primary Clarifiers	108,200
Primary Pump Station	252,400
Aeration Basins	133,750
Final Clarifiers	391,000
Disinfection	100,900
Sludge Pumping Station	166,400
Sludge Thickener	150,000
Aerobic Digesters	266,000
Sludge Drying Beds	234,000
Subtotal	$2,243,550
Site Work, 20%	448,710
Subtotal	$2,692,260
Contingencies	269,226
Subtotal	$2,961,486
Legal, Eng., and Admin.	444,223
Total Capital Cost	$3,405,710

O&M Cost Items	Costs
Pretreatment	$ 25,470
Primary Clarification	17,220
Aeration	31,160
Final Clarification	8,130
Sludge Pumps	8,620
Disinfection	11,120
Aerobic Digestion	59,820
Staffing Requirements	72,000
Total O&M Cost	$ 233,540/year

F. Oxidation Ditch WWTF, 1.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 352,720
Control Structure with Piping	20,400
Oxidation Ditch	797,000
Control Structure with Piping	10,800
Final Clarifiers	376,800
Disinfection	80,720
Sludge Pumping Station	133,120
Sludge Drying Beds	187,200
Site Demolition	56,000
Subtotal	$2,014,760
Site Work, 20%	402,950
Subtotal	$2,417,710
Contingencies	241,770
Subtotal	$2,659,480
Legal, Eng., and Admin.	398,920
Total Capital Cost	$3,058,400

O&M Cost Items	Costs
Pretreatment	$ 20,370
Oxidation Ditch	51,060
Final Clarification	6,900
Disinfection	8,900
Sludge Pumping	6,900
Staffing Requirements	57,600
Total O&M Cost	$ 151,730/year

G. Oxidation Ditch WWTF, 2.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 440,900
Control Structure with Piping	25,500
Oxidation Ditch	996,250
Control Structure with Piping	13,500
Final Clarifiers	471,000
Disinfection	100,900
Sludge Pumping Station	166,400
Sludge Drying Beds	234,000
Site Demolition	70,000

Subtotal	$2,518,450
Site Work, 20%	503,690
Subtotal	$3,022,140
Contingencies	302,214
Subtotal	$3,324,354
Legal, Eng., and Admin.	498,653
Total Capital Cost	$3,823,000

O&M Cost Items	Costs
Pretreatment	$ 25,470
Oxidation Ditch	63,820
Final Clarification	8,630
Disinfection	11,120
Sludge Pumping	8,620
Staffing Requirements	72,000
Total O&M Cost	$ 189,660/year

H. Lagoon System WWTF, 1.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 28,000
Aerated Facultative Lagoons	1,886,720
Stabilization Lagoons	548,400
Disinfection	80,720
Site Demolition	56,000
Subtotal	$2,599,840
Site Work, 20%	519,970
Subtotal	$3,119,810
Contingencies	311,980
Subtotal	$3,431,790
Legal, Eng., and Admin.	514,770
Total Capital Cost	$3,946,560

O&M Cost Items	Costs
Lagoon Aeration	$ 43,070
Disinfection	8,900
Staffing Requirements	24,800
Total O&M Cost	$ 76,770/year

I. Lagoon System WWTF, 2.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 35,000
Aerated Facultative Lagoons	2,358,400
Stabilization Lagoons	685,500
Disinfection	100,900
Site Demolition	70,000
Subtotal	$3,249,800
Site Work, 20%	649,960
Subtotal	$3,899,760
Contingencies	389,980

Subtotal	$4,289,740
Legal, Eng., and Admin.	643,460
Total Capital Cost	$4,933,200

O&M Cost Items	Costs
Lagoon Aeration	$ 53,840
Disinfection	11,120
Staffing Requirements	31,000
Total O&M Cost	$ 95,960/year

J. New Activated Sludge WWTF, 1.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 352,720
Primary Clarifiers	270,950
Activated Sludge	572,000
Final Clarifiers and Sludge Pumping	453,840
Disinfection	80,720
Aerobic Digester	301,060
Sludge Drying Beds	187,200
Site Demolition	56,000
Subtotal	$2,724,490
Site Work, 20%	454,900
Subtotal	$2,729,390
Contingencies	272,940
Subtotal	$3,002,330
Legal, Eng., and Admin.	450,340
Total Capital Cost	$3,452,670

O&M Cost Items	Costs
Pretreatment	$ 20,380
Primary Clarification	14,110
Activated Sludge	24,700
Final Clarification and Sludge Pumping	15,280
Disinfection	8,900
Aerobic Digestion	30,880
Staffing Requirements	57,600
Total O&M Cost	$ 171,840/year

K. New Activated Sludge WWTF, 2.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 440,900
Primary Clarifiers	338,690
Activated Sludge	715,000
Final Clarifiers and Sludge Pumping	567,300
Disinfection	100,900
Aerobic Digester	376,320
Sludge Drying Beds	234,000

Site Demolition	70,000
Subtotal	$2,843,110
Site Work, 20%	568,622
Subtotal	$3,411,732
Contingencies	341,173
Subtotal	$3,752,905
Legal, Eng., and Admin.	562,936
Total Capital Cost	$4,315,840

O&M Cost Items	Costs
Pretreatment	$ 25,470
Primary Clarification	17,640
Activated Sludge	30,870
Final Clarification and Sludge Pumping	19,100
Disinfection	11,120
Aerobic Digestion	38,600
Staffing Requirements	72,000
Total O&M Cost	$ 214,800/year

L. New Trickling Filter WWTF, 1.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 352,720
Primary Clarifiers	270,950
Trickling Filter	842,960
Final Clarifiers and Sludge Pumping	453,840
Disinfection	80,720
Aerobic Digester	301,060
Sludge Drying Beds	187,200
Site Demolition	56,000
Subtotal	$2,545,450
Site Work, 20%	509,090
Subtotal	$3,054,540
Contingencies	305,450
Subtotal	$3,359,990
Legal, Eng., and Admin.	504,000
Total Capital Cost	$3,863,990

O&M Cost Items	Costs
Pretreatment	$ 20,210
Primary Clarification	14,110
Trickling Filter	8,480
Final Clarification and Sludge Pumping	15,280
Disinfection	8,900
Aerobic Digestion	30,880
Staffing Requirements	57,600
Total O&M Cost	$ 155,460/year

M. New Trickling Filter WWTF, 2.5 MGD Capacity

Capital Cost Items	Costs
Pretreatment	$ 440,900
Primary Clarifiers	338,690
Trickling Filter	1,053,700
Final Clarifiers and Sludge Pumping	567,300
Disinfection	100,900
Aerobic Digester	376,320
Sludge Drying Beds	234,000
Site Demolition	70,000
Subtotal	$3,181,810
Site Work, 20%	636,362
Subtotal	$3,818,172
Contingencies	381,817
Subtotal	$4,199,989
Legal, Eng., and Admin.	629,998
Total Capital Cost	$4,829,990

O&M Cost Items	Costs
Pretreatment	$ 25,260
Primary Clarification	17,640
Trickling Filter	10,600
Final Clarification and Sludge Pumping	19,100
Disinfection	11,120
Aerobic Digestion	38,600
Staffing Requirements	72,000
Total O&M Cost	$ 194,320/year

III. Area Sludge Management Alternatives

A. Narrow Trench

Capital Cost Items	Costs
Land, 62 Ac @ $500	$ 31,000
Site Access Improvements	10,000
Fencing	27,600
6 Monitoring Wells	9,000
Surface Water Control Ditches	5,000
Equipment	65,000
Subtotal	$ 147,600
Contingencies	14,800
Subtotal	$ 162,400
Legal, Eng., and Admin.	24,400
Total Capital Cost	$ 186,800

O&M Cost Items	Costs
Sludge Transporting	$ 44,000
Landfill Operation	70,100
Total O&M Cost	$ 114,100/year
Leachate Collection System	$ 40,000/year

B. Wide Trench

Capital Cost Items	Costs
Land, 30 Ac @ $500	$ 15,000
Site Access Improvements	10,000
Fencing	19,100
6 Monitoring Wells	9,000
Surface Water Control Ditches	5,000
Equipment	110,000
Subtotal	$ 168,100
Contingencies	16,800
Subtotal	$ 184,900
Legal, Eng., and Admin.	27,700
Total Capital Cost	$ 212,600

O&M Cost Items	Costs
Sludge Transporting	$ 51,000
Landfill Operation	49,700
Total O&M Cost	$ 100,700/year
Leachate Collection System	$ 33,600/year

C. Co-disposal with Refuse; Sludge/Refuse Mixture

Capital Cost Items	Costs
Land, 2.8 Ac @ $500	$ 1,400
Equipment	40,000
Subtotal	$ 41,400
Contingencies	4,100
Subtotal	$ 45,500
Legal, Eng., and Admin.	6,800
Total Capital Cost	$ 52,300

O&M Cost Items	Costs
Sludge Transporting	$ 44,000
Landfill Operation	37,700
Total O&M Cost	$ 81,700/year

D. Co-disposal with Refuse; Sludge/Soil Mixture

Capital Cost Items	Costs
Land, 2.8 Ac @ $500	$ 1,400
Equipment	90,000
Subtotal	$ 91,400
Contingencies	9,100
Subtotal	$ 100,500
Legal, Eng., and Admin.	15,100
Total Capital Cost	$ 115,600

O&M Cost Items	Costs
Sludge Transporting	$ 44,000
Landfill Operation	40,300
Total O&M Cost	$ 84,300/year

E. Land Application - Sludge not Dewatered

Capital Cost Items	Costs
Land, 384 Ac @ $500	$ 192,000
Fencing	63,300
Sludge Lagoons	163,000
8 Monitoring Wells	12,000
Site Access Improvements	10,000
Liquid Sludge Truck	88,000
Subtotal	$ 528,300
Contingencies	52,800
Subtotal	$ 581,100
Legal, Eng., and Admin.	87,200
Total Capital Cost	$ 668,300

F. Land Application - Sludge Dewatered

Capital Cost Items	Costs
Land, 384 Ac @ $500	$ 192,000
Fencing	63,300
8 Monitoring Wells	12,000
Site Access Improvements	10,000
Liquid Sludge Truck	88,000
Lake Applicator Attachment	20,000
Subtotal	$ 385,300
Contingencies	38,500
Subtotal	$ 423,800
Legal, Eng., and Admin.	63,600
Total Capital Cost	$ 487,400

O&M Cost Items	Costs
Sludge Transporting	$ 24,700
Sludge Application	36,500
Total O&M Cost	$ 61,200/year

G. Incineration

Capital Cost Items	Costs
Gravity Thickener	$ 160,700
Vacuum Filter	652,500
Multiple Hearth	1,450,000
Sludge Loading and Unloading Facilities	87,000
Land, 6 Ac @ $500	3,000
Site Access Improvements	10,000
Fencing	6,000
Surface Water Control Ditches	1,000
Subtotal	$2,370,200
Contingencies	237,000
Subtotal	$2,607,200
Legal, Eng., and Admin.	391,100
Total Capital Cost	$2,998,300

O&M Cost Items	Costs
Gravity Thickening	$ 9,200
Vacuum Filtering	101,500
Incinerating	160,000
Sludge Handling	50,500
Ash Disposal	14,500
Total O&M Cost	$ 335,700/year

H. Comparison of Sludge Alternatives

	Capital Cost	Amortized 7% @ 20 Yrs	O & M	Total Annual
Landfill				
Narrow Trench	$ 186,800	$ 22,000	$114,100	$136,100
Wide Trench	212,600	25,000	100,700	125,700
Co-disposal				
Refuse/Sludge	52,300	6,200	81,700	87,900
Soil/Sludge	115,600	13,600	84,300	97,900
Land Application				
Land Purchased				
Stored Sludge	668,300	78,500	61,200	139,700
Dewatered Sludge	487,400	57,300	61,200	118,500
Land Not Purchased				
Stored Sludge	425,420	50,000	61,200	111,200
Dewatered Sludge	244,520	28,700	61,200	89,900
	2,998,300	352,300	335,700	668,000

Banner Assoc., Inc.
Wyoming and South Dakota

Summary
Revised Cost ESTIMATE
FOR
Alternative C

Cheyenne 201 Study Area

PREPARED BY Sorensen

DATE 10/1/82

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	Costs given include contingencies (10%) and				
	Legal, Admin., & Eng. (15%)				
I	Pipeline: 2.5 MGD from South				
	Cheyenne to Crow Cr. Diversion				
	Structure:				
	Alternative V				433,390
II	Crow Creek WWTP				
	Upgrade				729,150
III	Dry Creek WWTP				
	Upgrade & Expand to				
	Q_{ADF} = 7.0 MGD				3,543,640
IV	Sunnyside Collection lines				1,071,700
V	North Cheyenne Collection lines				562,040
		subtotal			6,339,920
VI	Step 2 & 3 Planning & Engineering (15%)				950,990
		Total Capital Cost			$7,290,910

Banner Assoc., Inc.
Wyoming and South Dakota

Preliminary ESTIMATE
FOR
Dry Creek WWTF
Upgrade & Expand to 7.0 MGD

PREPARED BY Sorensen
DATE 10/1/82

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1.	City Water Supply				217,500
2.	Pretreatment				272,900
3.	Equalization				200,000
4.	Primary Clarification				341,100
5.	Aeration Basins				1,000,000
6.	Secondary Clarification				362,000
7.	Sludge Pumping				12,000
8.	Digester Cleaning				30,000
9.	Sludge Thickener				200,000
10.	Disinfection -- Contact Basin				105,800
11.	Miscellaneous Piping & Pumping				60,000
		Subtotal			2,801,300
12.	Contingencies (10%)				280,130
		Subtotal			3,081,430
13.	Legal, Admin., & Eng. (15%)				462,210
		Total Capital Cost			3,543,640
	Annual Cost Amortized @ 7 3/8% for 20 yr. =				$ 344,490/yr

Banner Assoc., Inc.
Wyoming and South Dakota

Preliminary ESTIMATE
FOR
Dry Creek WWTP

PREPARED BY PCS

DATE 10/4/82

UPGRADE ONLY
SUMMARY

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1.	City Water Supply				217,500
2.	Pretreatment				72,500
3.	Primary Clarification				100,200
4.	Activated Sludge				200,000
5.	Secondary Clarification				12,000
6.	Sludge Pumping				12,000
7.	Digester Cleaning				30,000
8.	Sludge Thickener				200,000
		Subtotal			844,200
9.	Contingencies (10%)				84,420
		Subtotal			928,620
10.	Legal, Admin., & Eng. (15%)				139,290
		Total Capital Cost			$1,067,910

Banner Assoc., Inc.
Wyoming and South Dakota

Preliminary ESTIMATE
FOR
Dry Creek WWTP

PREPARED BY PCS
DATE 10/4/82

EXPAND TO 7.0 MGD
SUMMARY

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1.	Pretreatment				200,400
2.	Equalization				200,000
3.	Primary Clarification				240,900
4.	Activated Sludge				800,000
5.	Seçondary Clarification				350,000
6.	Chlorination				105,800
7.	Miscellaneous Piping				60,000
		Subtotal			1,957,100
8.	Contingencies (10%)				195,710
					2,152,810
9.	Legal, Admin., & Eng. (15%)				322,920
		Total Capital Cost			2,475,730

Banner Assoc., Inc.
Wyoming and South Dakota

Engineer's Cost ESTIMATE
FOR
Dry Creek WWTF Improvements &
Expansion to 7.0 MGD

PREPARED BY Sorensen

DATE 9/22/82

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
I.	City Water Supply				
A.	6" Steel Pipe	9,000	L.F.	$15.00	135,000
B.	Boring Under R.R.	100	L.F.	275.00	27,500
C.	Boring Under Interstate	200	L.F.	275.00	55,000
					$217,500
II.	Pretreatment				
A.	Upgrade Existing Processes	1	L.S.	72,500	72,500
B.	Expand to 7.0 MGD	1	L.S.	200,400	200,400
					$ 272,900
III.	Equalization	1	L.S.	200,000	200,000
IV.	Primary Clarification				
A.	Upgrade Existing Clarifiers		L.S.	100,200	100,200
B.	Expand to 7.0 MGD		L.S.	240,900	240,900
					$ 341,100
V.	Aeration Reactor Basins				
A.	Conversion to CMAS &				
	Construction of New Basin	Upgrade --			200,000
	to get Capacity (ADF) = 7.0 MGD	Expand --			800,000
	(includes diffusion blower system,				
	piping, D.O. meters & new basin &				$1,000,000
	covering of basins)	E-48			

Banner Assoc., Inc.
Wyoming and South Dakota

Cost ESTIMATE
FOR
Dry Creek WWTP Improvements
& Expansion to Q_{ADF} = 7.0 MGD

PREPARED BY Sorensen
DATE 9/22/82

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
V.	Secondary Clarifiers				
A.	Upgrade (scum removal)		L.S.	12,000	12,000
B.	Expand to Q_{Ave} = 7.0 MGD				
	~ construct one clarifier of				
	equal size as existing clarifiers		L.S.	350,000	350,000
	(includes req'd pumping				
	& piping, concrete &				
	sludge removal mechanism)				$362,000
VI.	Sludge Pumping				
A.	Raw Sludge Density Meter		L.S.	10,000	10,000
B.	Return Sludge				
	12" Gate Valves	2	L.S.	1,000	2,000
					$ 12,000
VII.	Digester Cleaning	1	L.S.	30,000	30,000
VIII.	Sludge Thickening				
A.	75' diameter X 12' SWD				
	tank -- (concrete, steel,	375	C.Y.	350	131,250
	formed & poured)				
B.	Mechanism	75	L.F.	900	67,500
					$198,750
				USE	$200,000

Banner Assoc., Inc.
Wyoming and South Dakota

Preliminary ESTIMATE
FOR
Crow Creek WWTF
Upgrade

PREPARED BY Sorensen

DATE 10/1/82

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1.	Pretreatment	1	L.S.		$ 43,400
2.	Primary Clarifiers	1	L.S.		122,000
3.	Trickling Filters	1	L.S.		56,000
4.	Final Clarifiers	1	L.S.		140,000
5.	Anaerobic Digester	1	L.S.		125,000
6.	Supernatant Drying Beds		L.S.		80,000
7.	Site Improvements		L.S.		10,000
		Subtotal			576,400
8.	Contingencies (10%)				57,640
		Subtotal			634,040
9.	Legal, Admin., & Eng. (15%)				95,100
		Total Capital Cost			729,150

Banner Assoc., Inc.
Wyoming and South Dakota

Preliminary ESTIMATE FOR

Annual O & M Costs

Alt C. (Crow Creek & Dry Creek)

PREPARED BY Sorensen

DATE 10/1/82

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
I.	Pumping for Pipeline from				
	So. Cheyenne to Crow Creek				
	Diversion Structure	147,000	KWH	.035	$ 5,150
			5150	X 1.19 =	6,130
II.	Crow Creek WWTF (1)				
	- high rate trickling filter				
	w/ Q_{ADF} = 4.0 MGD -				
	Average Operating Cost				
	for T.F. Plants @ 90-100%				
	of Operational Cost	1460	MG	170.00	$248,200
	4MGD X 365 =		248,200	X 1.19 =	295,580
III.	Dry Creek -- Assume				
	Operating @ 90% of the				
	Capacity of 7.0 MGD or 6.3				
	MGD = 6.3 X 365 = 2300 MG	2300	MG	192.00	441,500
			441,500	X 1.19 =	525,780
		Total Projected O & M			$694,850
	Update to Sept. 79, 827,500 / 694,850 = 1.19; 5150 X 1.19 = 6130	O & M =		$827,500/yr	
(1)	From EPA 430/9-77-015, Technical Report; Analysis of Operations and Maintenance Costs for Municipal Wastewater Treatment Systems Feb. 1978				

Banner Assoc., Inc.
Wyoming and South Dakota

Preliminary ESTIMATE
FOR
Annual O & M Costs

PREPARED BY Sorensen
DATE 10/4/82

Dry Creek WWTF w/ Upgrade Only (Phase I)

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	From EPA 430/9-77-015				
	Assume operating @ 100% Capacity --	4.5	MGD		
	4.5 MGD X 365 = 1642.5 MG/yr				
	O & M	1642.5	MG	192.00	$315,360
	Bring up-to-date:	315,360	X 1.19	=	$375,280

Banner Assoc., Inc.
Wyoming and South Dakota

Engineer's Cost ESTIMATE
FOR
Pipeline Alternative I

PREPARED BY Sorensen

DATE 9/24/82

South Cheyenne WWTP to Crow Creek Diversion

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Alternative I					
1.	Gorman-Rupp Lift Station				
	(complete assembly:				
	3 T-10 Pumps to Handle				
	Wide Range of Flows; w/				
	electronic control)	1	L.S.	92,200	$ 92,200
2.	Reinforced Concrete				
	Pressure Pipe; 18" dia.	4500	L.F.	50.00	225,000
	(Price/ft from 1982 Dodge Guide)				
3.	Easement		L.S.		2,000
		Subtotal			319,200
4.	Contingencies (10%)				31,920
		Subtotal			351,120
5.	Legal, Admin., and Eng. (15%)				52,670
		Total Capital Cost			$ 403,790
			Say		$ 404,000

Banner Assoc., Inc.
Wyoming and South Dakota

Engineer's Cost ESTIMATE
FOR
Pipeline Alternative II

PREPARED BY Sorensen

DATE 9/27/82

South Cheyenne WWTP to Crow Creek Interceptor

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1.	Gorman-Rupp Lift Station	1	L.S.	92,200	$ 92,200
2.	R.C. Pressure Pipe	6200	L.F.	50	310,000
3.	Easement	1	L.S.	2,000	2,000
		Subtotal			404,200
4.	Contingencies (10%)				40,420
		Subtotal			444,620
5.	Legal, Admin. & Eng. (15%)				66,690
		Total Capital Cost			$ 511,313
		Say			$ 511,300

Banner Assoc., Inc.
Wyoming and South Dakota

Engineer's Cost ESTIMATE
FOR
Pipeline Alternative III

PREPARED BY Sorenson
DATE 9/24/82

South Cheyenne to Crow Creek Diversion

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	Alternative III				
1.	Gorman-Rupp Lift				
	Station	1	L.S.	92,200	$ 92,200
2.	R.C. Pressure Pipe (18")	2700	L.F.	50	135,000
3.	R.C. Pipe (24")	3700	L.F.	35	129,500
4.	Easement		L.S.		2,000
		Subtotal			358,700
5.	Contingencies (10%)				35,870
		Subtotal			394,570
6.	Legal, Admin., and Eng. (15%)				59,190
		Total Capital Cost			$ 453,760

Banner Assoc., Inc.
Wyoming and South Dakota

Engineer's Cost ESTIMATE
FOR

PREPARED BY Sorenson

Pipeline Alternative IV

DATE 9/27/82

South Cheyenne to Crow Creek Interceptor

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1.	R.C. Pipe	9700	L.F.	35	339,500
2.	Easement		L.S.	3100	3,100
		Subtotal			342,600
3.	Contingencies (10%)				34,260
		Subtotal			376,860
4.	Legal, Admin., & Eng. (15%)				56,530
		Total Capital Cost			$ 433,390

APPENDIX F

WORKING PAPER NO. 2:

INFILTRATION/INFLOW

ANALYSIS AND SOIL SURVEY

WORKING PAPER NO. 2: INFILTRATION/INFLOW ANALYSIS AND SOIL SURVEY

I. Summary, Conclusions, and Recommendations

Within the 201 Study Area exist eight wastewater treatment facilities, three of which are Publicly Owned Treatment Works (POTW) and five of which are private dischargers. Of the five private entities (Little America, Trails End Mobile Home Park, Wyoming Highway Department Information Center, Union Pacific Railroad, and Husky Oil Refinery) only the Trails End Mobile Home Park is not in compliance with NPDES discharge regulations. Plans are in effect to rectify this situation by connecting this mobile home park with the city sewer system.

The three POTWs are the Dry Creek and Crow Creek Wastewater Treatment Plants, both in the City of Cheyenne, and the South Cheyenne WWTP, in the South Cheyenne Water and Sewer District.

A study of the South Cheyenne Water and Sewer District sewer system indicates non-excessive infiltration/inflow (I/I) for the system as a whole. Orchard Valley, a neighborhood in South Cheyenne, appears to be contributing excessive I/I of 2240 gpd/in/mi, as shown in Table F-4. A more detailed investigation of this area may be in order, as funds allow. Having non-excessive I/I for the overall system eliminates the possibility of receiving EPA funds to further evaluate the sewer system in South Cheyenne.

The evaluation of the sewerage of the City of Cheyenne indicated locations where I/I is excessive, but that overall I/I is non-excessive. Table F-10 shows the results of the field investigations of the Cheyenne sewerage.

The sewer system connected to the 15" line above the Belaire, Henderson, and Grier manhole appeared to contribute excessive I/I during the initial investigation. It was felt that the measured BOD_5 of 20 mg/l at that location was possibly misrepresentative of the actual situation and resulted in an unrealistically high I/I value (2960 gpd/in/mi). A second sampling for flow and BOD_5 at this location was completed to substantiate or reject this value and corresponding infiltration/inflow rate. The second round of tests showed a similarly low BOD value, but this set of tests indicated a substantially lower flow rate corresponding with this low BOD. The calculated I/I is shown to be non-excessive. An investigation of 5 manholes upstream of this location did reveal, however, deteriorated conditions of these manholes and signs of considerable infiltration/inflow.

The results of the monitoring for flow and BOD_5 at the manhole on Maxwell Ave., between 2nd and 3rd Streets, also show excessive I/I above this location. A second set of tests for flow and BOD was also completed at this location. The results of this test, shown in Table F-10, continued to indicate excessive I/I. Further tests were then run to determine COD:BOD ratio (chemical oxygen demand:biochemical oxygen demand) to determine if the low BOD value was a result of an inhibitory agent present in the wastewater. The high COD:BOD ratio (Table F-11) indicated the possible existence of an inhibitory agent. The determined I/I rate may be concluded to be somewhat high, and the actual situation is probably one of lower I/I than indicated. Deteriorated manholes and one manhole where the storm sewer empties into the sanitary sewer were observed upon further investigations.

If funds are available, a more detailed investigation of the above mentioned two sewer lines would be of benefit to the city. Since I/I was determined to be non-excessive as a whole, EPA funding for further sewer system evaluation is not available.

The soil survey completed for areas currently employing onsite wastewater treatment indicates that much of the land near the Cheyenne city limits to the east and north (i.e. Sunnyside and North Cheyenne) is not suitable for onsite wastewater treatment. All locations tested were found to be "somewhat limited to severely limited in ability to adequately treat septic tank effluent." The conclusion to be drawn from the soil survey is that the continued employment of onsite wastewater treatment for the expected growth in the Sunnyside and North Cheyenne areas would result in deterioration of the well water quality to the point where it would no longer be acceptable for human consumption. Another effect would be the increased occurrence of unsightly and hazardous raw wastewater surfacing during wet weather.

The connection of these areas with city water and sewer services in the interest of public health is highly recommended at this time. Detailed analyses of all alternatives open, not only to the Sunnyside and North Cheyenne areas but also to the entire Study Area, are presented in Working Paper No. 3: Identification of Wastewater Treatment and Land Application/Reuse Alternatives.

II. Introduction

A. Authority and Scope

The Working Paper No. 2: Infiltration/Inflow Analysis is prepared under the authority of the U. S. Environmental Protection Agency (EPA) under the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) as amended by the Clean Water Act of 1977 (P.L. 95-217) with the EPA acting as administrator of the Act. The Wastewater Facility Plan for the Cheyenne Study Area is prepared under joint sponsorship of the South Cheyenne Water and Sewer District, Laramie County, and the City of Cheyenne, by contract dated January 21, 1981; the U. S. EPA by Federal Sewage Works Grant #C560161-01; and the Wyoming Department of Environmental Quality (DEQ).

The U. S. EPA requires that every applicant for a treatment works grant demonstrate that each sewer system discharging into the treatment works is not or will not be subject to excessive infiltration/inflow as defined in the following section. The Infiltration/Inflow Analysis of the wastewater systems serving the City of Cheyenne and the South Cheyenne Water and Sewer District is presented as Working Paper No. 2: Infiltration/Inflow Analysis and Soil Survey and is an engineering analysis of the sewer system. The goal of this analysis is to determine if there is excessive infiltration/inflow into the system.

If this analysis indicates that excessive I/I does exist, a detailed sewer system evaluation survey shall be recommended as another phase of the Facility Plan.

Included in this report are (1) a survey of the wastewater collection systems serving the City of Cheyenne and the South Cheyenne Water and Sewer District, (2) findings and conclusions of the monitoring program conducted by the Wyoming DEQ (Water Quality Division) of five private entities in the Study Area with discharge permits, (3) a review of existing wastewater plant flow records and sewer system maintenance programs, (4) an engineering survey and analysis of infiltration/inflow to the sewerage, (5) a determination of infiltration/inflow as being excessive or nonexcessive, and (6) conclusions and recommendations.

Also included in this report is a soil survey of areas surrounding Cheyenne which are experiencing problems with onsite wastewater treatment associated with poor soil conditions and the impact of growth. The suitability of soils in these areas for onsite treatment, i.e., septic tanks followed by absorption fields, was determined by field testing. This soil information was coordinated with Soil Conservation Service (SCS) information to make projections of potential problems with onsite treatment in other areas not yet experiencing growth. A map of the soil types in the Cheyenne area as determined by the SCS and a table listing the specific soil abilities to treat wastewater are included in this report.

B. Problem

Infiltration and inflow are defined as follows:

1. Infiltration: The volume of water entering sewers and building sewer connections from the soil through defective joints, broken or cracked pipe, improper connection, manhole walls, etc.

2. Inflow: The volume of surface water discharged into sewer lines from such sources as roof drains, basement and yard area drains, foundation drains, broken manhole covers or manhole covers with holes in them, commercial and industrial "clean water" discharges, drains from springs or swampy areas, etc. It does not include, and is distinguished from, "infiltration".

3. Infiltration/Inflow: The combined volume of both infiltration and inflow water found in existing sewer systems.

4. Excessive Infiltration/Inflow: Defined by the U. S. Environmental Protection Agency as any infiltration and/or inflow in excess of 1500 gallons per day (gpd) per inch pipe diameter per mile of pipe. It has been deemed by the EPA as being non-cost-effective to rehabilitate the sewerage for infiltration/inflow less than this amount.

Excessive infiltration/inflow can result in serious problems because it:

- Uses up capacity in sewers
- Causes flooding in basements
- Increases pumping costs
- Overloads treatment plants

- Decreases efficiency of treatment plants

III. Sanitary Sewer: Infiltration/Inflow Evaluation

A. General Description of Collection System

The City of Cheyenne provides the bulk of the area's wastewater treatment needs through the operation of two wastewater treatment plants (WWTP). These are the Dry Creek WWTP and the Crow Creek WWTP. There are also five (5) private entities in the City of Cheyenne with permits to discharge treated wastewater to Crow Creek, when discharge is required. The South Cheyenne Water and Sewer District is an independent jurisdictional entity and operates a wastewater treatment plant that discharges into an irrigation ditch feeding Crow Creek.

The five private dischargers will be discussed first, followed by discussion of the South Cheyenne Water and Sewer District and the City of Cheyenne's sewer systems.

1. Trails End Mobile Home Park

In October 1979, LeRoy Feusner and Kathy Rittmueller of the Wyoming DEQ, Water Quality Division (WQD), inspected the wastewater treatment facility at Trails End Mobile Home Park. At that time, wastewater treatment consisted of a septic tank(s) followed by a polishing pond of approximately 75'x75' in dimension. Effluent from the polishing pond flowed into a smaller excavated depression. Any discharge occurring from the depression would flow into Crow Creek. The entire treatment system was found to be in need of maintenance. The integrity of the polishing pond had been lost, and wastewater could be seen flowing toward Crow Creek. Solids washout from the septic tank(s) was indicated by visual observations of the polishing pond. It was felt that the septic tank(s) was in need of maintenance. The water quality of Crow Creek was felt to be endangered, particularly during periods of high water table.

This inspection resulted in a recommendation that the entire system be either completely rehabilitated or the mobile home park connect to a city sewer main near the area. The latter solution was felt to be the best alternative, with consequent abandonment of the septic tank/polishing pond system.

Currently (August 1981) the wastewater treatment facilities have not been improved. The latest communication between DEQ, WQD and the owner of the Trails End Mobile Home Park indicated that plans are in effect to connect this trailer park with the City sewer system. This is the best solution to the problem and has been the recommended course of action since the October 1979 inspection. DEQ advised the Trails End Mobile Home Park in January of 1982, if the treatment facility is not improved or hooked into the City system by July 1982, the treatment system will be in violation of its permit.

2. Little America

Wastewater treatment for Little America, located at the junction of I-80 and I-25, is accomplished by an extended aeration package plant and a large polishing pond. Originally, effluent was discharged to an unnamed ditch which flowed approximately one mile before its confluence with Crow Creek. In December 1978, John Wagner of Wyoming DEQ, WQD conducted onsite inspection, at which time it was noted that the outfall pipe from the holding pond had been permanently closed. Consequently, the Little America discharge permit (Wy-0021326) was placed in "inactivate" status, and therefore, the monitoring program became unnecessary. Currently, Little America practices total water reuse. In the summer, the treated wastewater is used to irrigate the golf course, and in the winter it is stored in the holding pond.

If it becomes necessary to reactivate the discharge permit in the future, no difficulty is foreseen. In June 1979, Little America requested to lower the holding pond level by discharging to Crow Creek. Analysis indicated a very high bacteriological quality of water and discharge presented no health hazard and thus were deemed acceptable.

No action is recommended at this point, as wastewater treatment at Little America is being accomplished to an acceptable degree.

3. Wyoming Highway Department Information Center

The Wyoming Highway Department Information Center is located southwest of the City of Cheyenne, next to I-25. Wastewater treatment facilities serving the center consist of an extended aeration package plant followed by chlorination and a polishing pond. A trailer dump station is served by a non-discharging septic tank and leach field system. The polishing pond discharges to Clear Creek drainage (discharge permit no. Wy-0024694). This discharge requires compliance with national secondary treatment standards and Wyoming in-stream water quality standards.

A review of the monitoring reports from January 1, 1978 through April 1, 1981 indicates that the wastewater treatment facilities at the Wyoming Highway Department Information Center produce an effluent of extremely high quality. BOD_5 and SS removal efficiency as high as 99% was noted. Since this treatment facility is functioning extremely well, no action is recommended.

4. Union Pacific Railroad

Industrial wastewater generated by the UPRR is collected by their sewer system and delivered to their wastewater treatment plant. Treatment of the industrial wastewater is accomplished through a series of processes. The wastewater first enters an API gravity separator. This employs centrifugation to separate liquids of different densities and to remove sand

and grit. Air flotation is next in line to remove grease and to neutralize the pH. Coagulation and floculation are accomplished next with chemical treatment. A microfloc biocell is next in line, where biological treatment occurs for the reduction of BOD_5. The clarifier is next from which activated sludge is recycled back to the biocell. Sludge digestion is accomplished in the digester prior to discharge to Crow Creek.

The UPRR discharges to Crow Creek by authority of NPDES permit number Wy0000C47. A review of the discharge monitoring report from January 1975 to April 1981 indicated that discharge from the UPRR meets EPA requirements. Since the wastewater treatment facility at the UPRR appears to be effective in treating their industrial waste, no action is recommended at this time.

5. Husky Oil

Treatment of the industrial wastewater generated at the Husky Oil Company is accomplished with a series of ponds. Five oil/water separator ponds incorporating oil skimmers are first in line. These are the upper ponds. Effluent from these ponds then passes through 5 lower level ponds (called cell 1 through cell 5). Cell 2 of the lower level ponds has floating aerators, and cell 3 has fixed aerators. Prior to October 1981, the effluent from this series of ponds was pumped to a full containment reservoir. However, at that time Husky began discharging 0.115 MGD in order to satisfy water rights of downstream users. Because this discharge has only recently been established, a long-term record of effluent quality has not been established. However, DEQ indicates that the discharge complies with the discharge permit. Even if the discharge does not meet its permit requirements, the City feels that the effluent is not compatible with normal city wastewater and therefore would be undesirable at the City's treatment plants.

6. South Cheyenne Water and Sewer District

a. General Information

Much of the information in this portion of Working Paper No. 2 was obtained through field investigation by Banner Associates and through an interview with Tracy Long, operator of the South Cheyenne WWTP. Floydene Gay of the South Cheyenne Water and Sewer District also provided Banner Associates with pertinent information.

The South Cheyenne sanitary sewer system consists of approximately 30 miles of sewer line ranging in size from 6" to 21" in diameter, as listed in Table F-1. The system flows entirely by gravity, with no forced mains and no lift stations. The layout of the sanitary sewer system is shown in Figure IV-6, Working Paper No. 3.

Table F-1
Summary of Sanitary Sewers
South Cheyenne Water and Sewer District

Pipe Diameter Inches		Pipe Length Feet	Percent of Total
6		3,330	2.09
8		116,740	73.16
12		26,510	16.61
15		2,640	1.65
18		7,340	4.60
21		3,010	1.89
	Total	159,570	100.00

This table does not include service lines from buildings to the collection system.

No storm sewer system exists in South Cheyenne; consequently, all storm water runs off in ditches or soaks into the ground. This results in a situation of saturated soil surrounding the sewerage, thereby increasing the potential for infiltration during periods of wet weather.

b. Maintenance Program

The maintenance program for the South Cheyenne Water and Sewer District involves periodic checking of problem spots (i.e. Orchard Valley, Turk Street, West Allison Road, and Terry Road). Tree roots present a considerable problem in the Orchard Valley area, requiring the cleaning out of the sewers in this area. Three maintenance personnel split the duties of responding to all complaints in the area. A homemade sewer jet and a rodder are used to clean the sewers out, and they function extremely well. The efficiency of the maintenance operations in South Cheyenne is very difficult to quantify since no maintenance records are available, but grease and tree roots are apparently the major problems.

c. Known Sewer Condition

Nearly 10 miles of the sanitary sewer system consist of tile pipe, the rest being PVC (plastic). Most of this tile pipe is located in the Orchard Valley area or near Turk Avenue and was constructed in the 1940's. These are the oldest sections in the South Cheyenne Water and Sewer District. The pipe depths average 8 feet deep ranging from 3 feet on Turk Avenue to 18-20 feet on Artesian Road and on Jefferson Road near the South Greeley Highway, according to Tracy Long.

The manholes in the South Cheyenne District are coned, with bricked or precast concrete tops. Nineteen manholes in this district were opened and entered to determine their general condition. Of these manholes, six had bricked tops, and thirteen had tops in which the bricks had been replaced with rings. Signs of infiltration through the bricked tops were obvious in six of these manholes. For example, the manhole that collects all the flow from Orchard Valley, on the corner of Citrus Street and Division Avenue, not only has a bricked top, but the top is also offset by approximately 4 inches. This manhole shows signs of much I/I and is in need of repair. The manhole covers are solid cast iron, with one aluminum cover. All manhole covers are reported to be in good condition with none reported broken. The distance between manholes averages 300 feet and is as great as 400 feet in some locations.

d. Sewer Infiltration/Inflow Allowance

The maximum allowable non-excessive I/I rate for the South Cheyenne sewer system as a whole is based on 1500 gpd/in/mi and is shown in Table F-2.

Table F-2
Maximum Allowable Non-excessive I/I
South Cheyenne Water and Sewer District Sewer System

Pipe Diameter Inches	Pipe Length Miles	Allowable I/I gpd
6	0.63	5,671
8	22.11	265,325
12	5.02	90,392
15	0.50	11,280
18	1.39	37,468
21	0.57	17,898
	Total	428,034

This table shows that, as a whole, 428,034 gpd I/I may occur in the South Cheyenne sewerage before it is deemed excessive.

e. Flow at Wastewater Treatment Plant

Infiltration/inflow is indicated when there is an increase in flow to a wastewater treatment plant associated with a precipitation event. It must be realized that, in the Cheyenne area, storms may be highly localized, and the precipitation recorded at the weather bureau may or may not give an accurate account of precipitation in South Cheyenne. Appreciating this restriction, a general relationship between wastewater flow at the South Cheyenne WWTP and precipitation is given on a monthly basis for the years 1977-1980 in Figure F-1. In May 1978, a noticeable relationship between precipitation and wastewater flow is seen. This relationship may indicate the existence of I/I into the sewer system. The detailed I/I investigation discussed next examines the I/I question in greater detail. Observable in Figure F-1 is the general trend of increasing wastewater flow with time. This is indicative of the increasing population in South Cheyenne.

f. Infiltration/Inflow Analysis

The amount of infiltration/inflow occurring in South Cheyenne was calculated in two different manners, the results of which were used to determine if the I/I is excessive. First, a theoretical I/I rate was determined by comparing the amount of water delivered to the South Cheyenne Water and Sewer District to the volume of wastewater showing up at the wastewater treatment plant for the same period of time. Secondly, the I/I occurring in the district was determined through the monitoring for flow, BOD_5, and SS at selected manholes. Under low flow conditions, the reduction in BOD value from theoretically accepted values is the basis for determining I/I.

The South Cheyenne Water and Sewer District purchases water from the City of Cheyenne, and then sells it to their customers in South Cheyenne. The total amount of water delivered to South Cheyenne on a monthly basis, as well as the volume of wastewater showing up at the wastewater treatment plant, is shown in Table F-3.

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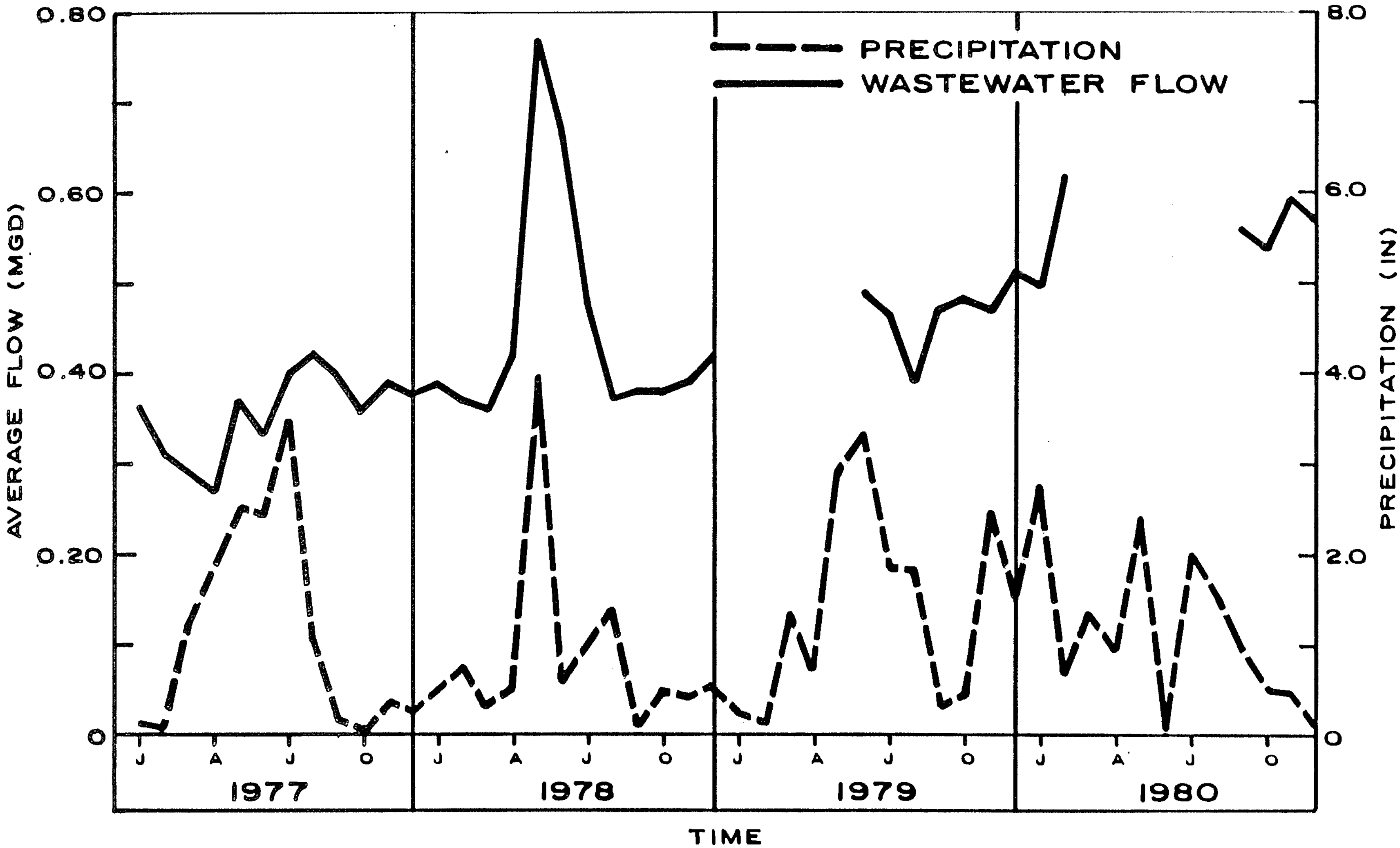
1767



SOUTH CHEYENNE WWTP

WASTEWATER FLOW & PRECIPITATION

FIGURE F-1

Table F-3
Water and Wastewater Volumes for South Cheyenne
1979 and 1980

Year and Month	Total Water Delivered (1000 Gal)	Total Waste-Water Inf. (1000 Gal)	% Q Waste of Q Water
1979			
January	14,414	N/A	
February	11,506	N/A	
March	11,424	N/A	
April	13,195	N/A	
May	12,713	N/A	
June	15,289	14,700	96.15
July	22,385	14,570	65.09
August	17,171	12,090	70.41
September	17,430	14,100	80.90
October	15,077	N/A	
November	13,392	N/A	
December	11,012	N/A	
	175,008		
1980			
January	12,827	15,500	120.84
February	12,472	17,360	139.19
March	12,551	N/A	
April	13,211	N/A	
May	13,291	N/A	
June	24,941	N/A	
July	22,903	N/A	
August	26,400	N/A	
September	23,423	16,800	71.72
October	14,767	16,740	113.36
November	11,478	17,700	154.21
December	13,018	17,670	135.74
	201,282		

N/A = data not available

It is reported by Floydene Gay of the South Cheyenne Water and Sewer District that Orchard Valley is entirely on private water supply but does contribute wastewater to the district. A total of approximately 160 homes use sewer services but not water services. The numbers in Table F-3 representing the total volume of water supplied should therefore be increased by the proportionate amount, as determined below. Assumptions made in this determination are: (1) average water demand is 120 gpcd; (2) 2.51 residents per household.

(160 households)(2.51 people/household)(120 gpcd) =
48,192 gpd

Considering only the "worst cast" scenario from the data presented in Table F-3, the I/I rate may be theoretically determined. Table F-3 indicates that in November of 1980, the wastewater stream represented 154.21% of the water delivered. With the 48,192 gpd correction made to the water supply, this percentage changes thusly:

Water supplied = 11,478,000 + (48,192)(30)
= 12,923,760 gallons

Wastewater flow = 17,700,000 gallons (ave = .59 MGD)

Wastewater flow = 136.96% of Q water delivered

It is generally accepted that between 60 and 80% of water delivered for domestic use becomes sewage. The assumption of 60% results in greater theoretical I/I than does assuming the 80% value. With the assumption that 60% of the per capita water use becomes sewage, the theoretical wastewater total influent for November 1980 is 7,754,250 gallons. The difference in the measured and theoretical wastewater influent is considered to be caused by infiltration/inflow. This difference is 9,945,744 gallons, or an average rate of 331,525 gpd.

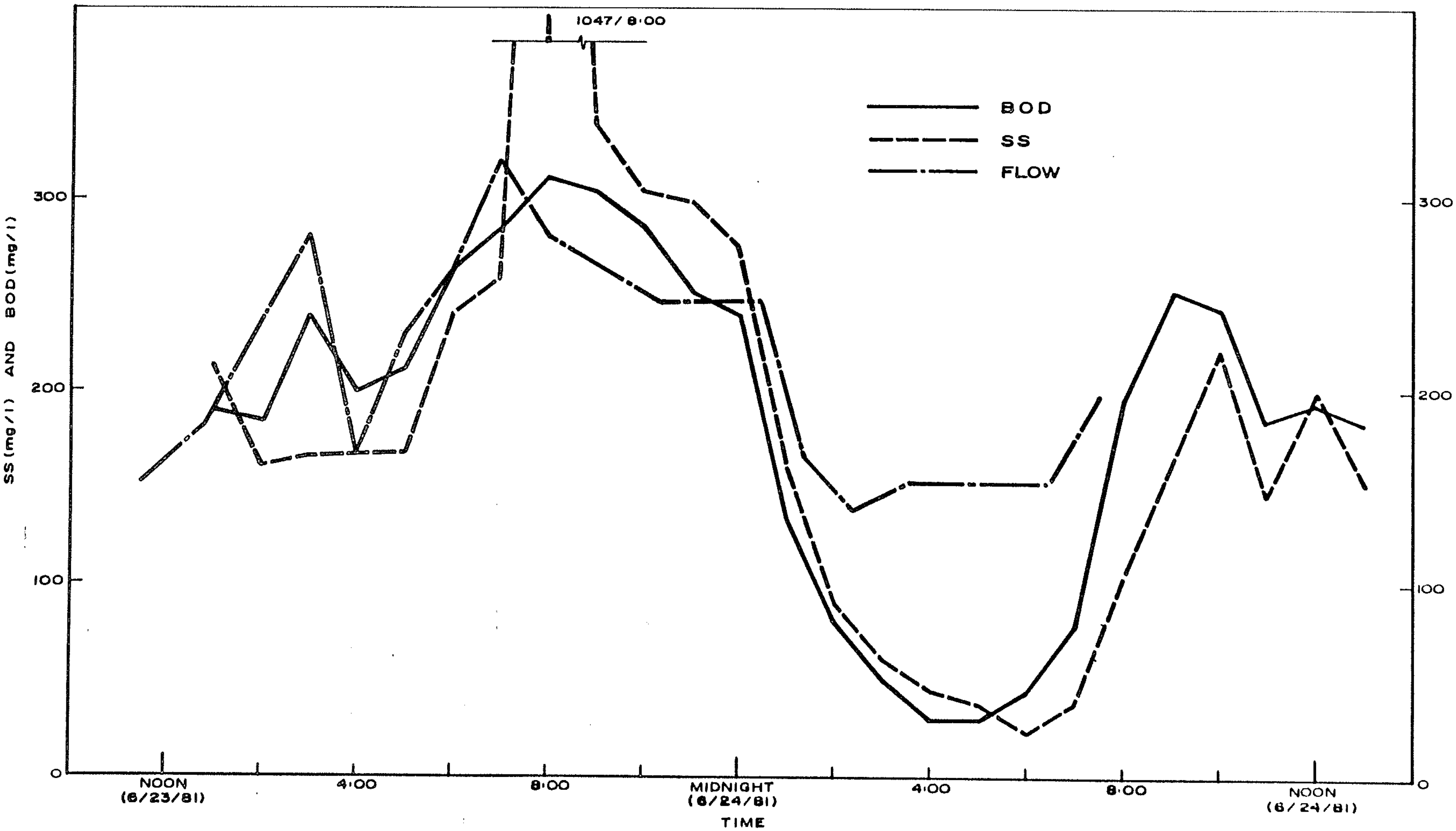
A review of the daily flow records for the South Cheyenne WWTP for November 1980 indicates that on November 16 the average flow was .71 MGD. This was the peak daily flow at the plant for that month. On a direct ratio basis, the infiltration/inflow occurring that day was determined to be .40 MGD ($.33/.59 = Q_{I/I}/.71$; $Q_{I/I} = .40$ MGD).

Both of the above calculations indicate that the I/I in the South Cheyenne sewerage is non-excessive as a whole since both values are less than the determined maximum non-excessive I/I of 428,034 gpd.

The second method of determining I/I involved the actual measurement of flow, BOD_5, and SS in selected manholes throughout the district. Tracy Long, operator of the South Cheyenne WWTP, identified certain sections of the district as problem spots, i.e. locations within the sewer system that may be contributing excessive I/I to the wastewater flow. These sections are (1) Orchard Valley, (2) Allison Tracts, on West Allison Road east of Walterscheid Avenue, (3) Cheyenne Irrigated Gardens, and (4) Terry Road.

During the months of May, June, and July 1981, six manholes in South Cheyenne were opened and entered to determine the condition of the collection system. The manholes chosen for this monitoring program are situated so as to isolate the identified problem areas. The locations of the manholes used are indicated in Figure B-IV-6, Working Paper No. 3. To determine infiltration flow, early morning (2 A.M. to 6 A.M.) flow and BOD concentrations were measured. Wastewater samples were taken to James H. Stewart and Assoc. in Fort Collins, Colorado, for analysis for BOD and SS concentrations.

The dirunal variations in flow, BOD , and SS values obtained from these manholes are depicted in Figures F-2 through F-8.



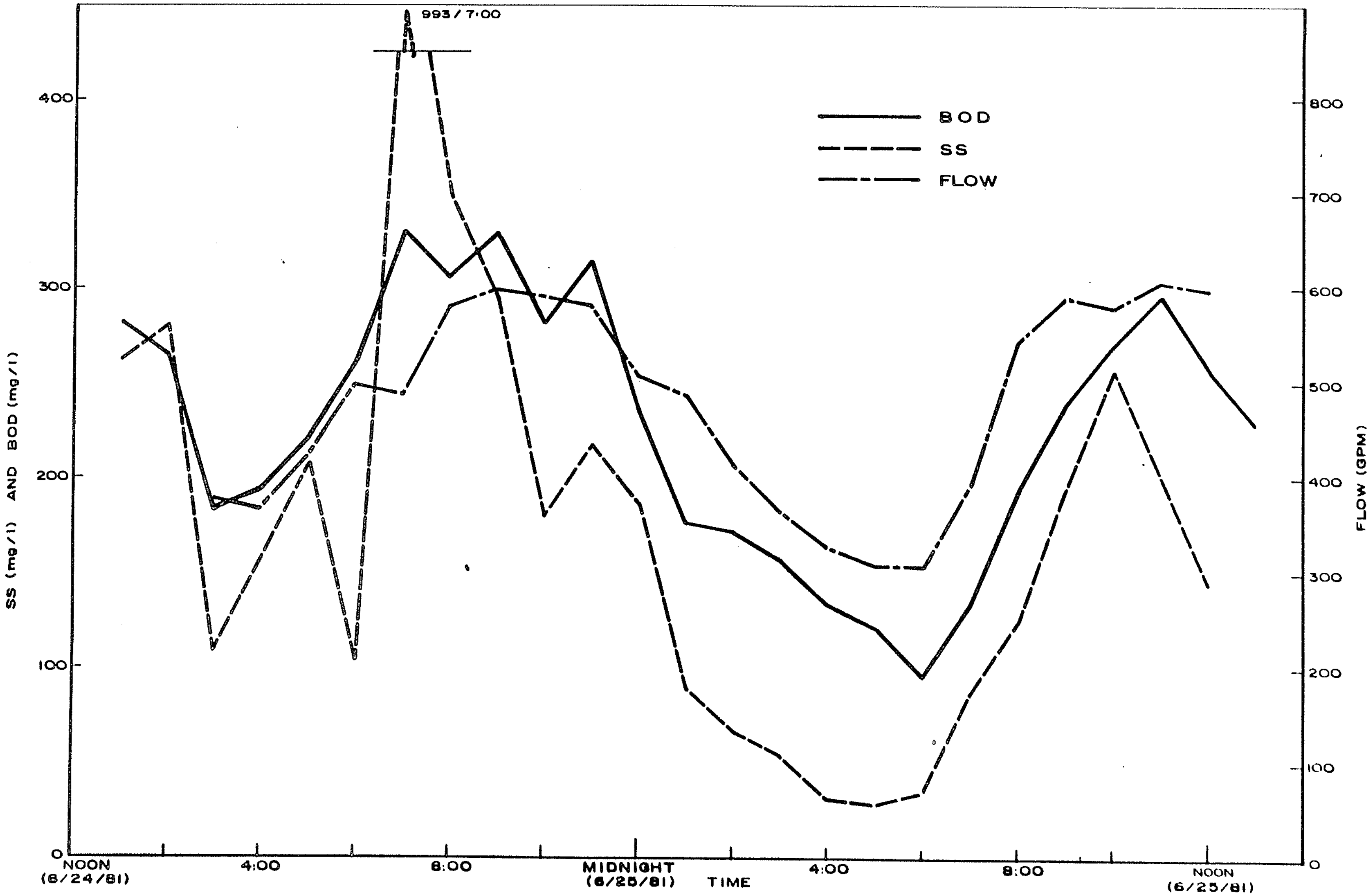
SOUTH CHEYENNE

SAMPLE SITE S-1

FLOW, BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-2

WP 82 8/81
1767



SOUTH CHEYENNE

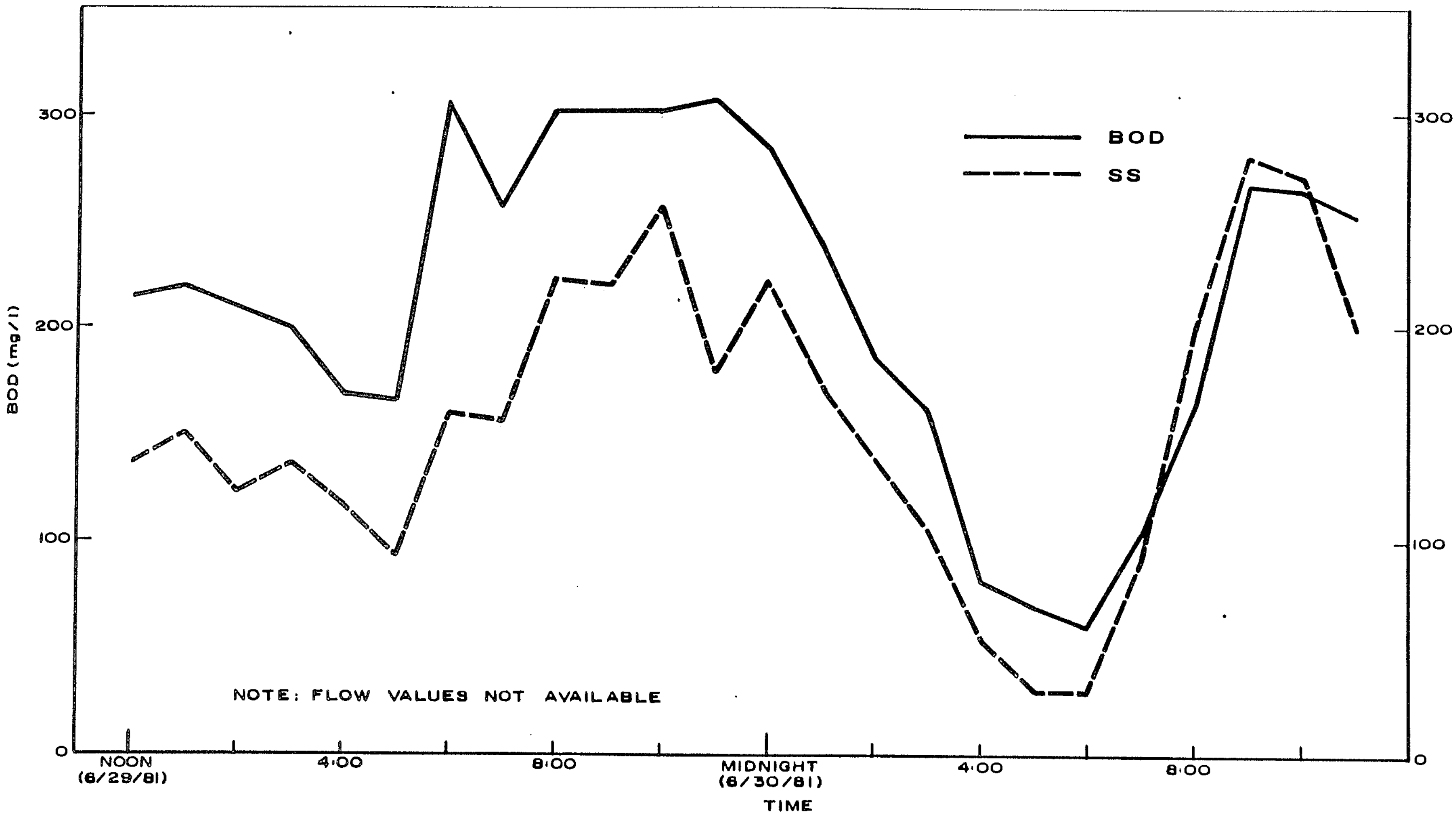
SAMPLE SITE S-2

FLOW, BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-3

WP #2 8/81 1767

WP #2 8/81
1767

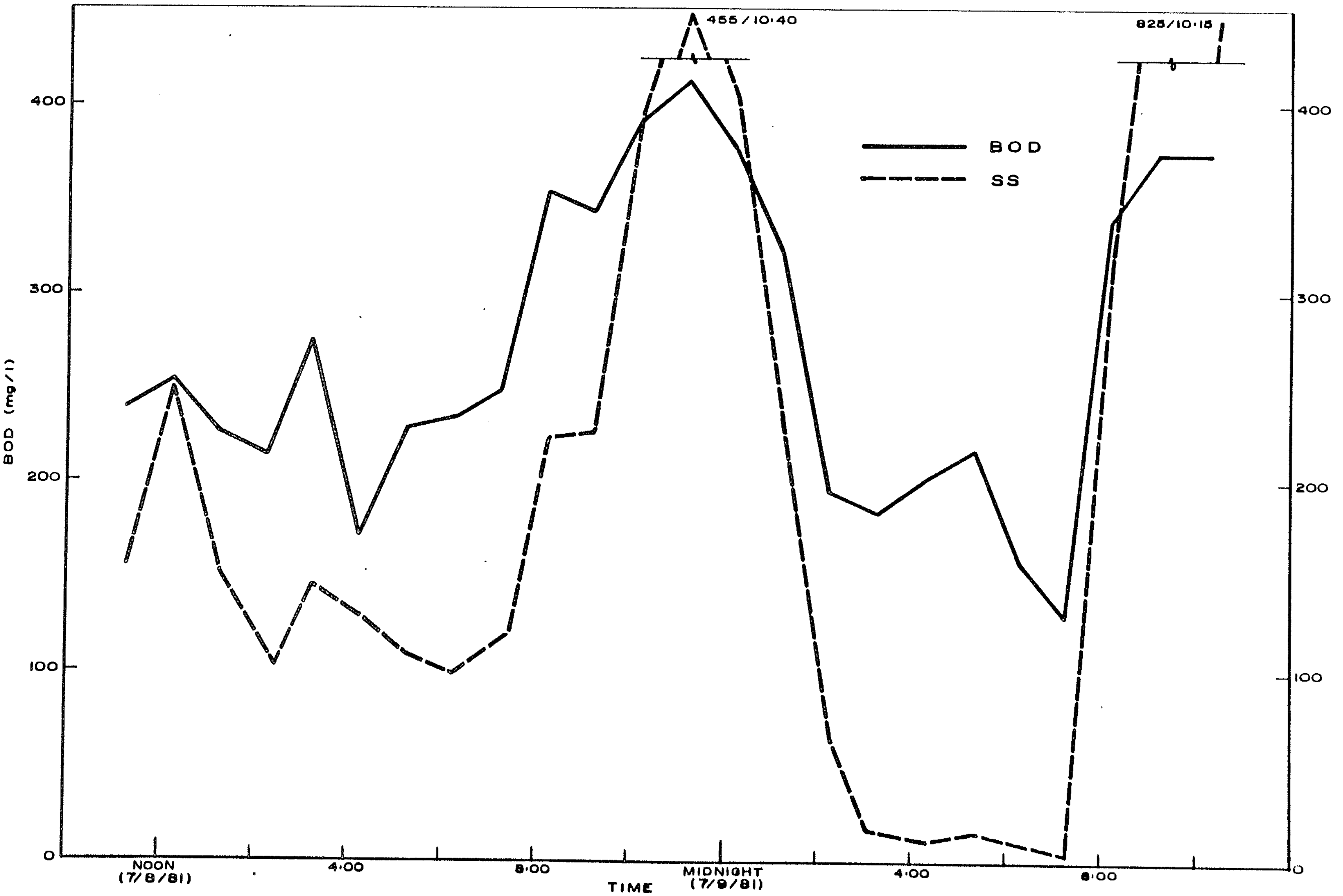


SOUTH CHEYENNE

SAMPLE SITE S-3

BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-4



SOUTH CHEYENNE

SAMPLE SITE S-4

BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-5

WP 82 8/81 1767

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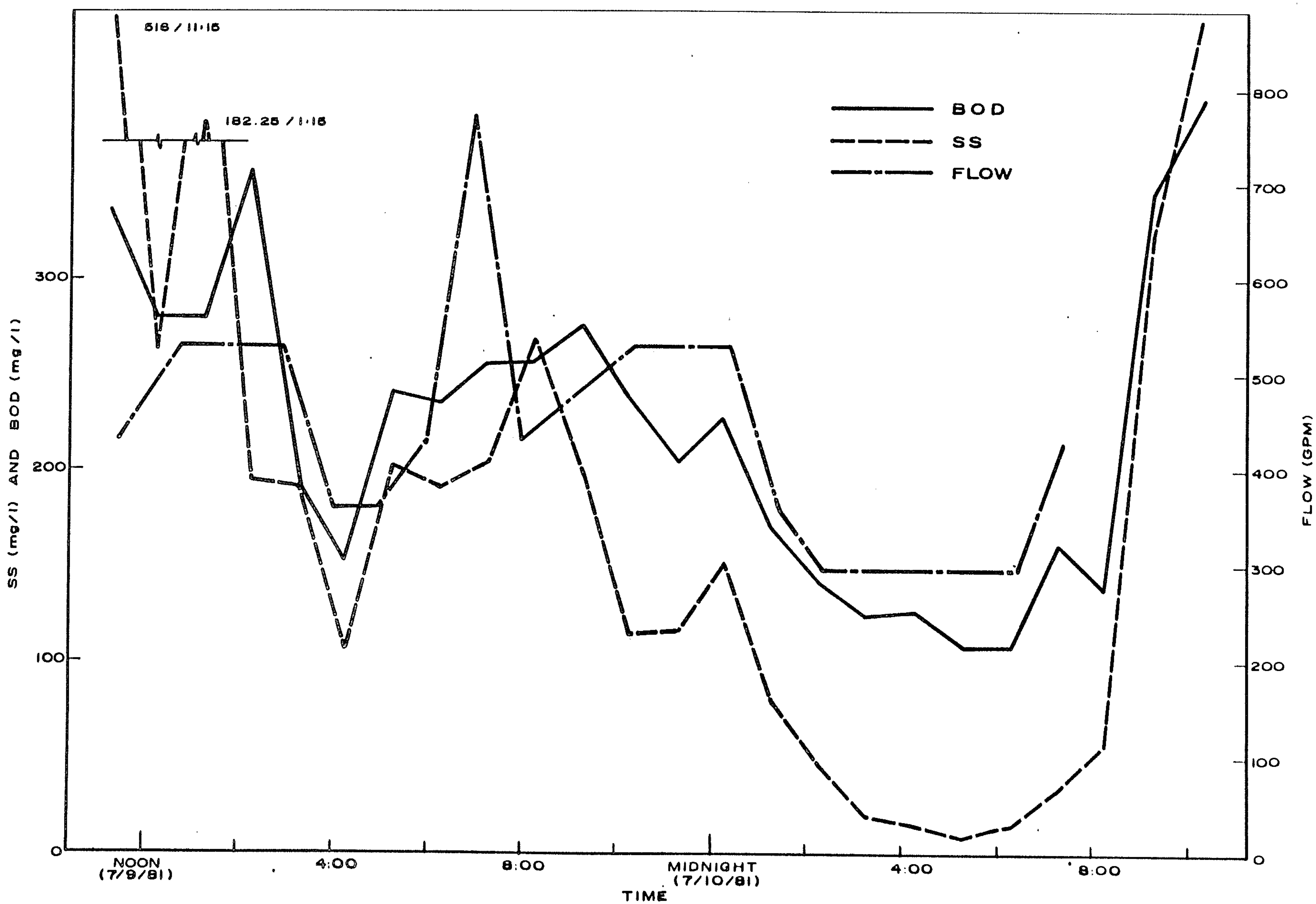
1767

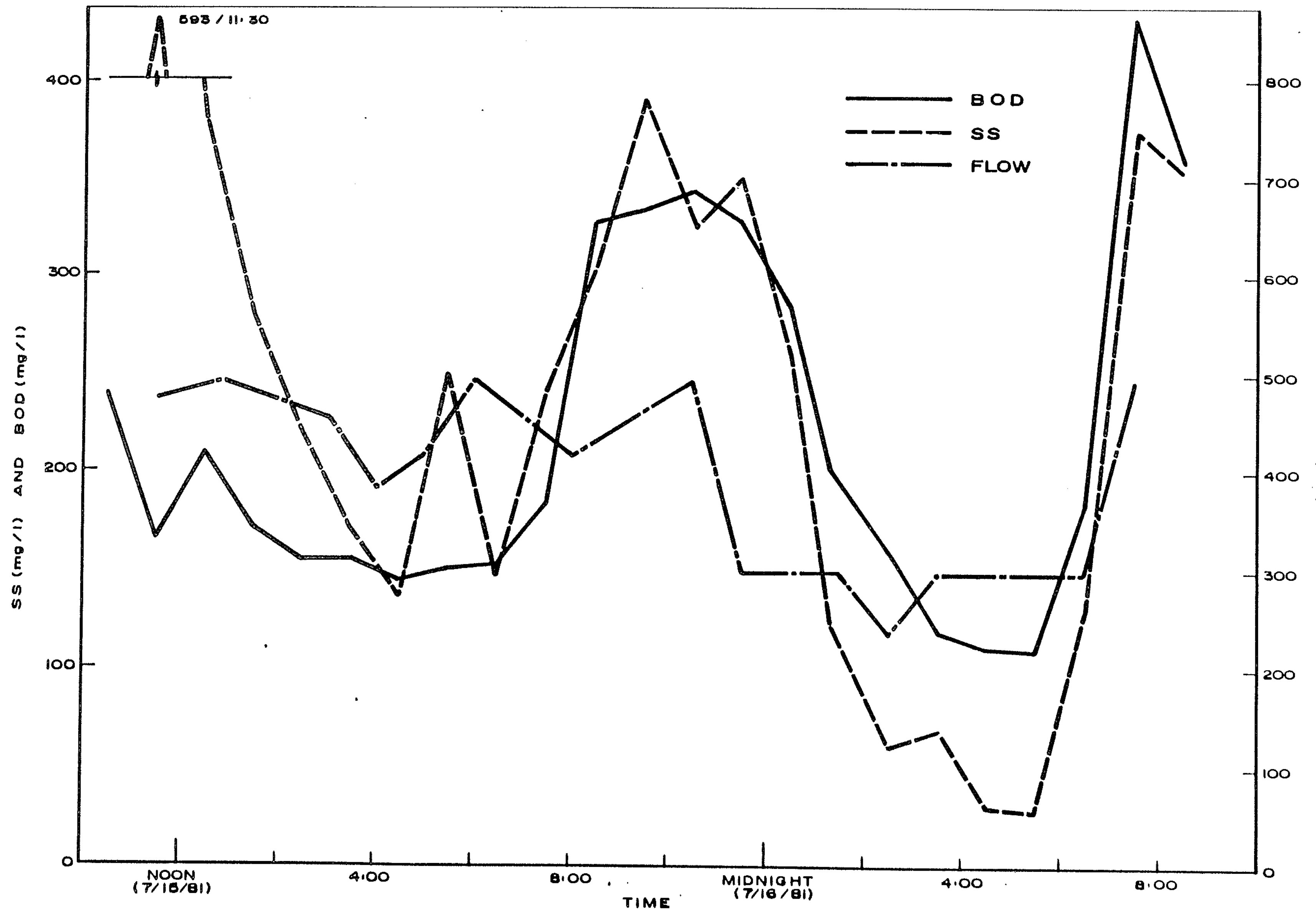


SOUTH CHEYENNE

SAMPLE SITE S-4

FLOW, BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-6



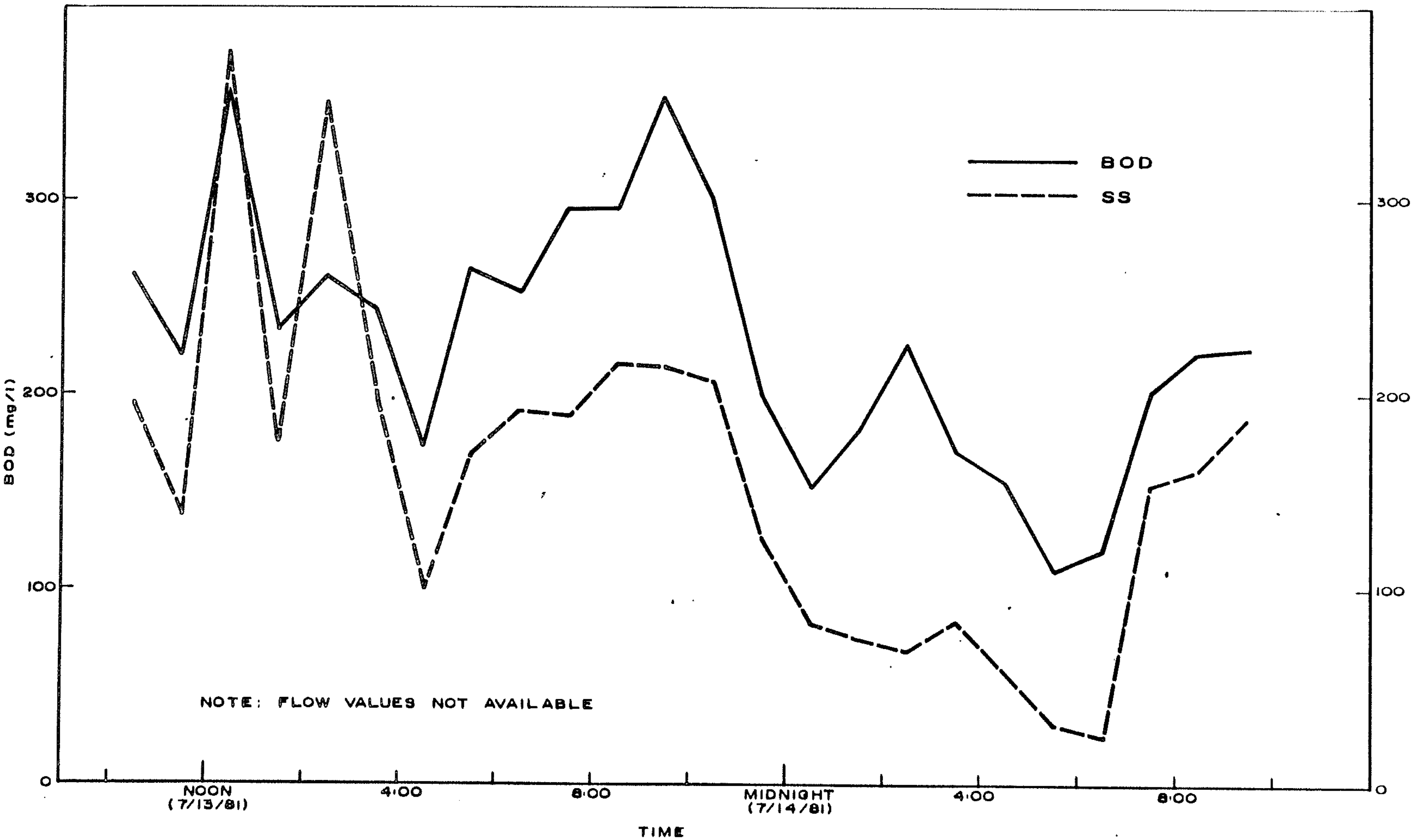
SOUTH CHEYENNE

SAMPLE SITE S-5

FLOW, BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-7

WP 02 8/81 1767



SOUTH CHEYENNE

SAMPLE SITE S-6

BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-8

Flow determinations were made during the early morning hours when water consumption is low. The base flow during this time consists mainly of infiltration with only small quantities of sewage. It was assumed that I/I water has a BOD_5 value of 0.0 mg/l. This 0.0 mg/l assumption was based upon the fact that infiltration/inflow water should be free of organics or other material that cause an oxygen demand. Therefore, the low BOD_5 of the I/I water will dilute any sewage flow present. It was further assumed that the domestic sewage had a BOD_5 of 130 mg/l based upon a literature review of typical diurnal wastewater strength. If the I/I was determined to be excessive based upon these assumptions, further investigation into the wastewater strength would have been conducted. However, as shown later in this section, the I/I was shown to be non-excessive even with these worst case assumptions. Samples taken during the early morning hours generally have BOD_5 values less than 130 mg/l, presumably due to dilution by infiltration/inflow water. The volume of water in the sewage flow that is I/I in origin may be calculated based on the reduction of BOD_5 value below the theoretically accepted value of 130 mg/l for domestic sewage.

The flow rates were determined by measuring the depth of flow and assuming this to be normal depth. At normal depth, knowing the pipe diameter and slope, flow rate may be determined by using the Manning formula and assuming a roughness coefficient of 0.013.

Calculation of the contribution to flow from I/I is accomplished by the steps shown in the following example (data taken from manhole number 1, Avenue C south of College Drive):

Flow = Q = .20 MGD

Measured BOD_5 = 65 mg/l

1) $65 \text{ mg/l} \times 8.34 \frac{\text{lb/MG}}{\text{mg/l}} = 542.10 \text{ lb/MG}$

8.34 is a conversion factor to change units from mg/l to pounds per million gallons.

2) 542.10 lb/MG x .20 MGD = 108.42 lb/day

This step yields the pounds of BOD_5 contributed per day to the sewage, at the measured concentration.

3) The theoretical concentration of 130 mg/l equates to 1,084.20 lb/MG.

4)
$$Q_{theo.} = \frac{\text{actual lb } BOD_5\text{/day}}{\text{theoretical lb/MG}}$$

$$= \frac{108.42 \text{ lb } BOD_5\text{/day}}{1{,}084.20 \text{ lb/MG}} = 0.10 \text{ MGD}$$

This step determines the flow rate that would result in a BOD concentration of 130 mg/l based on the actual pounds per day, as determined in step 2).

5) $Q_{I/I} = .20 - .10 = .10 \text{ MGD} = 100{,}000 \text{ gpd}$

The difference in the measured flow rate and the flow rate arrived at in step 4) is considered to be I/I in origin.

6) $\frac{100{,}000 \text{ gpd}}{69 \text{ in-dia-miles}} = 1450 \text{ gpd.in/mi}$

The I/I flow (gpd) determined in step 5) is divided by the inch diameter-miles of sewerage upstream of the manhole to arrive at the I/I in gpd/in/mile.

The results of these flow and BOD_5 measurements and corresponding calculations are shown in Table F-4. The numbers presented in Table E-4 indicate that although I/I for South Cheyenne is non-excessive as a whole, there are areas of the district that may contribute excessive I/I. All the wastewater and I/I flow produced in Orchard Valley passes through

Table F-4
Infiltration/Inflow Analysis for South Cheyenne Water and Sewer District

Sewer Location	Line Size (Inches)	Recorded Flow (MGD) Flow	Time Recorded	Recorded BOD_5 (mg/l)	Corrected I/I (MGD)	Inch-Diameter Miles of Sewer	I/I (gpd/in/mi)
Ave. C between Murray Rd. and College Dr.	15	.20	2:25 AM	65	.10	69	1450
312 W. College Dr. on K-9 Corral Prop.	12	.45	6:00 AM	95	.12	54	2240
South of Arp School	18	N/A				222	
South of Ideal-Aerosmith	8	.09		108	.02	24	630
Prosser Rd. and Colorado Dr.	12	.43	5:30	109	.07	86	810
Ave. C between Murray Rd. and Artesian Rd.*	12	N/A		-	-	-	-

*This manhole is very close to manhole #1 (Ave. C between Murray and College), and therefore no separate Q data obtained here. Assume same I/I value here as for Ave. C between Murray and College.

N/A = Data Not Available

manhole number 2, located near 312 W. College Drive. The figures in Table F-4 indicate excessive I/I in this area. The data collection from this manhole occurred during wet weather, when I/I is assumed to be at its highest value. Orchard Valley is in an older part of the district, with tile pipe and many bricked manholes.

The area in the southern part of the district, including the area near Terry Road, contributes flow to manholes number 1 and 6, on Avenue C south of E. College Drive. The determined I/I rate of 1450 gpd/in/mile is non-excessive, but is so close to being excessive that a more in-depth investigation of this area may be in order.

The manhole on the 8" line south of Ideal Aerosmith Inc. passes flow originating in the Cheyenne Irrigation Garden area, i.e. the area near Turk Avenue. The results of this investigation indicate a fairly tight sewer system in this section of the district.

Manhole number 5, located on Prosser Road, just east of the South Greeley Highway, is over the 12" pipe that carries wastewater generated in the Allison Tracts as well as from Orchard Valley. The data collected from this manhole occurred during a period of dry weather, which explains the lower flow than that recorded from manhole number 2, located upstream of this point. These data indicate non-excessive I/I during the time of sampling. Since excessive I/I has already been displayed from Orchard Valley, these data may imply a relatively tight sewer system in the Allison Tract area.

g. Conclusions and Recommendations

The calculated I/I values shown in Table F-4 indicate that only Orchard Valley has excessive infiltration/inflow. The low values for the area of Cheyenne Irrigated Gardens (manhole south of Ideal Aerosmith) and the area upstream of Prosser Road and Colorado Drive are probably due to the dry weather conditions that prevailed during the sampling at those locations. It is believed through discussion with personnel at the South Cheyenne Water and Sewer District that I/I from these areas is somewhat higher than indicated.

The I/I determined upstream of the manhole on Avenue C is very close to being excessive. These data were collected during relatively wet weather (over .2" rain occurred at the weather bureau) and therefore represent an accurate account of the actual I/I situation.

Since the Orchard Valley Area has excessive infiltration/inflow and since the southern part of the district is approaching excessive I/I, a more extensive investigation of these areas may be desirable, as funds allow. The total I/I for the south Cheyenne Water and Sewer District is not excessive, and therefore, a more detailed investigation of the sewerage may not be accomplished with funds available through the EPA.

7. City of Cheyenne

a. General Information

The information in this and following sections was obtained through an interview and subsequent discussions with John Price of the Cheyenne Water and Sewer Department; Tom Bonds of the City Planning Office; Herman Noe, Director, Board of Public Utilities; and Jack Young, head operator of the Dry Creek and Crow Creek WWTPs. Information was also obtained through field investigations at selected manholes within the Cheyenne sewer system.

The City of Cheyenne sewer system consists of approximately 210 miles of gravity sewer line ranging in size from 4" to 36" in diameter, as shown in Table F-5. The sanitary sewers are constructed of cast iron, clay, tile, and concrete pipe, but consist primarily of concrete and clay. Tile pipe exists extensively in the older, residential areas of the city. Some of the newer lines, i.e. near Johnson Jr. High, are PVC (plastic). The interceptor lines and main lines' layout is depicted in Figure B-IV-5 in Working Paper No. 3.

Table E-5
Summary of Sanitary Sewers
City of Cheyenne, Wyoming

Pipe Diameter (inches)	Pipe Length (Feet)	Percent of Total
Unspecified†	335,353	30.54
4	3,140	0.29
6	66,915	6.09
8	431,139	39.27
9	13,430	1.22
10	42,742	3.89
12	54,680	4.98
15 (& 14)	36,217	3.30
16 (& 17)	4,555	0.41
18	13,117	1.19
21	3,340	0.30
24	12,905	1.18
27	18,425	1.68
30	40,903	3.73
33	6,094	0.58
36	15,000	1.37
	Σ 1,097,955	100.00
	≈ 208 miles	

†Most unspecified pipe appears to be 6", 8", or 10", mostly 8". Assume all unspecified pipe is 8" diameter for further analysis.

The one lift station in the City of Cheyenne is the Missile Drive Lift Station and is located at 24th Street and Missile Drive. This is a Gorman-Rupp sewage lift station and is a complete, factory-built, internally wired, automatic pumping station. The Gorman-Rupp T-series pump that is used is an "unclog pump" capable of operating under a wide range of capacity and head conditions. This lift station serves only a small area, and is reported to operate virtually trouble-free. No operational difficulties have developed with this lift station since its installation in

1977. This condition will probably continue in the future as there is little room for development in the area that would require increased use of this lift station.

The sewer system crosses Crow Creek in nine locations. The pipe at each of these river crossings is cast iron. Syphons exist at these crossings, and regular maintenance is performed to insure safe and effective operation. No problems have been reported at any of these river crossings. The pipe sizes and locations of the crossings are shown in Table F-6.

Table F-6
Sewer Crossings on Crow Creek

Pipe Diameter (inches)	Location
12	W. 17th St.
8	Dey Ave. between 16th and 17th St.
24	Snyder Ave. and Deming Dr.
24	10th St. and Pioneer Ave.
15	7th St. and Pioneer Ave.
8	6th St. and Pioneer Ave.
12	5th St. and Pioneer Ave.
8	Capital Ave.
10	E. 2nd St. between House and Evans Ave.

b. Storm Sewers

Storm sewers exist separately and deliver runoff water directly to Crow Creek. In the downtown area, the sanitary and storm sewers exist in close proximity, i.e. either parallel or at right angles to each other. No problems are reported to exist due to this proximity.

Roof drains that were identified as being connected to the sanitary sewer in the downtown area have been eliminated. It is suspected that other roof drains in the downtown area are connected to the sanitary sewer, but to identify these connections would be extremely difficult. It is believed, however, that these roof drains do not cause severe difficulties.

It was reported in the Phase 1B & "Cheyenne Downtown Storm Sewer Report" by BRW/Noblitt and Wright-McLaughlin Engineers that locations exist where the sanitary sewer empties into the storm sewer, thereby polluting Crow Creek. These locations were identified in that report, and steps are being taken to correct the situation.

c. Maintenance Program

The information in this and the following sections was obtained in an interview with John Price. The Water and Sewer Department maintains a list of areas that are potential problem spots in the sewer system. They undergo maintenance of these areas on the 1st and 15th of each month. This schedule prevents "95% of stoppage" in the sewer system. These problems develop primarily due to cottonwood tree roots. Therefore, "Sewer Aid" is used for root control and to dissolve rags and paper. Also, much of the sewer in the heavily treed areas is treated with Sanfax 222, a caustic like Drain-O but more powerful, to further prevent blockage.

The Water and Sewer Department has a very organized system to handle regular maintenance procedures and to deal with customer complaints. A crew is on standby 24 hours a day, 7 days a week to respond to any and all problems. The following information is noted and procedures carried out for all complaints and regular maintenance operations:

1) The condition of the manhole is detailed. Any problems here are corrected. If the manhole needs to be rebuilt, arrangements are made to do so. The department is very strict in regard to manholes.
2) Address of complainer and date of complaint.
3) Phone number of complainer.
4) Lapse time from complaint to problem solution.

5) Manhole on surface or under pavement?

6) Manhole depth.

7) Sewer size (inches).

8) When manhole cover was lifted off, was sewage flowing or not flowing?

9) Purpose of service; i.e. preventive maintenance or other.

10) Equipment used to unplug sewer:

    a) Water hydraulic sewer jet.

    b) Mechanical rods.

    c) Auger.

11) Size of auger used or nozzle used on jet machine.

12) Feet rodded or flushed (total feet).

13) Distance in sewer until meet obstruction (feet).

14) Type of obstruction. (Generally, obstructions are grease, rags, roots, or sand.)

15) Was a city line or owner's line plugged?

16) Was solution accomplished to satisfaction of the complainer (owner relief)?

17) Sketch of situation and brief description.

All the above information is stored in the Water and Sewer Department's computer for rapid referral. One question always considered is, "Why is the sewer plugging?" Grease is the single most significant problem and is usually contributed to the sewer system by restaurants.

d. Known Sewer Condition

In 1971, Guildner Sewer and Water Inc. performed television camera inspection of certain sections of the sewer system in gathering information for the Dry Creek Wastewater Treatment Plant. Severe infiltration was noticed in the interceptor line to the Crow Creek WWTP. This line was subsequently abandoned, and a new line was constructed, thus eliminating the infiltration problem. All other lines that were determined to contribute excessively to infiltration have been repaired or replaced.

One area in the city that may contribute to infiltration is in the vicinity of Sloan Lake. There is an old tile line that parallels Sloan lake into which infiltration has been noticed. The infiltration into this line is slight, and occurs only when the water level of Sloan Lake is very high. Other possible problem areas are the Sunnyside and East Lake View Additions. Prior to development, these areas were swampy, and natural ponding was observable. These are relatively low-lying areas, and should be monitored carefully to insure that infiltration or inflow does not become a problem. All other areas discussed with John Price were said to have no infiltration problems.

In general, John Price maintains that the Cheyenne sewer system is extremely "tight" and the maintenance program is designed to keep the sewer system "tight". Any area that develops a problem is rapidly corrected by either repairing or replacing damaged lines. When a new sewer line is being constructed, the Water and Sewer Department undertakes very careful inspection to insure a "tight" and reliable sewer line.

Manholes exist at all locations where sewer lines change in direction or grade. The distance between manholes is less than or equal to 400'. House service connections are all Wise or Saddle-type hookups. Mr. Price reports that basement backups occur only as a result of sewer blockage and that such blockage is immediately cleaned out.

During July and August of 1981, Banner Associates entered approximately 20 manholes in the City of Cheyenne and noted their general condition. Of these manholes inspected, 16 had metal ringed tops and were in excellent condition. A good number of these 16 manholes were elevated, thereby further reducing the chance of inflow. The manholes entered on

Maxwell Avenue, between 2nd and 3rd Streets, were bricked and generally in poor condition. Of the manholes investigated, two had floors of dirt or clay, except along the flow line. This may result in silt being picked up and carried in the sewers. One manhole inspected, above the 12" line on Henderson Drive, Bellaire Avenue, and Grier Blvd., is purely cosmetic. The line running through it has never been cut open. Evidence of surcharge was noticeable in many locations, but any continual surcharge problems are usually dealt with effectively by the City Water and Sewer Department crews.

e. Sewer Infiltration/Inflow Allowance

The maximum allowable non-excessive I/I rate for the City of Cheyenne sewer system as a whole is based on the standard of 1500 gpd/in/mile and is shown in Table E-7. This standard amounts to 3,252,330 gpd of infiltration/inflow for the entire system. Information contained later in this report will identify separate areas in the city as being below or above this amount.

Table F-7
Maximum Allowable Non-excessive I/I
City of Cheyenne Sewer System

Pipe Diameter (inches)	Pipe Length (miles)	Allowable I/I (gpd)
Unspecified (8")†	63.51	762,170
4	0.59	3,570
6	12.67	114,060
8	81.66	979,860
9	2.54	34,340
10	8.10	121,426
12	10.36	186,410
15 (& 14)	6.86	154,330
16 (& 17)	0.86	20,700
18	2.48	67,080
21	0.63	19,930
24	2.44	87,990
27	3.49	141,330
30	7.75	348,610
33	1.15	57,130
36	2.84	153,410
		3,252,330

†Assume unspecified is 8" pipe.

f. Flow at Wastewater Treatment Plants

When I/I contributes flow to a sewer system, the influent to the WWTP would increase during wet weather. Figures F-9 and F-10 compare the monthly influent to Dry Creek and Crow Creek WWTPs from 1977 through 1980, with the total precipitation recorded by the weather bureau at the airport. In certain instances, i.e. May and June 1979 for the Crow Creek WWTP, an increase in precipitation corresponds with an increase in WWTP influent. It should be noted, however, that precipitation can be highly localized in this region and recorded precipitation at the weather bureau may not be indicative of actual precipitation for the Study Area in general. This information may, however, shed some light on the overall I/I question.

Despite the fact that precipitation may be highly localized in this area, a more detailed comparison of precipitation and influent records for the months of May through July 1981 was made. These comparisons are presented in Figures F-11 through F-22. The correlation between large amounts of precipitation and an increase in flow rate are indicative of the occurrence of I/I.

An excellent example of an increase in flow at the wastewater treatment plants in response to a precipitation event is seen in Figures F-15 and F-20 for July 12, 1981. On this day between the hours of 7:00 P.M. and 12:00 midnight, 1.69" of rain was recorded at the weather bureau. As shown in these figures, flow at both wastewater treatment plants jumped dramatically in response to this rain. It is concluded that a fairly high amount of I/I must have occurred to show this jump in wastewater influent flow.

g. Infiltration/Inflow Analysis

The I/I determination for the City of Cheyenne was computed in the same manner as was done for South Cheyenne. First, an I/I figure was determined for the system as a whole by comparing the volume of water supplied with the volume of influent wastewater to the two WWTPs. Second, specific manholes, identified in Plate II, were investigated for flow, BOD_5, and SS values. The I/I occurring upstream of each of the manholes was then determined.

To determine I/I for the system as a whole, the amount of water sold to private dischargers (Little America, Husky Oil, Union Pacific Railroad, and the South Cheyenne Water and Sewer District) was first subtracted from the total amount of water delivered to the city. This resulted in a "corrected" volume delivered. (See Table F-8.) The data for the volume of water delivered to each of the private dischargers was obtained from the

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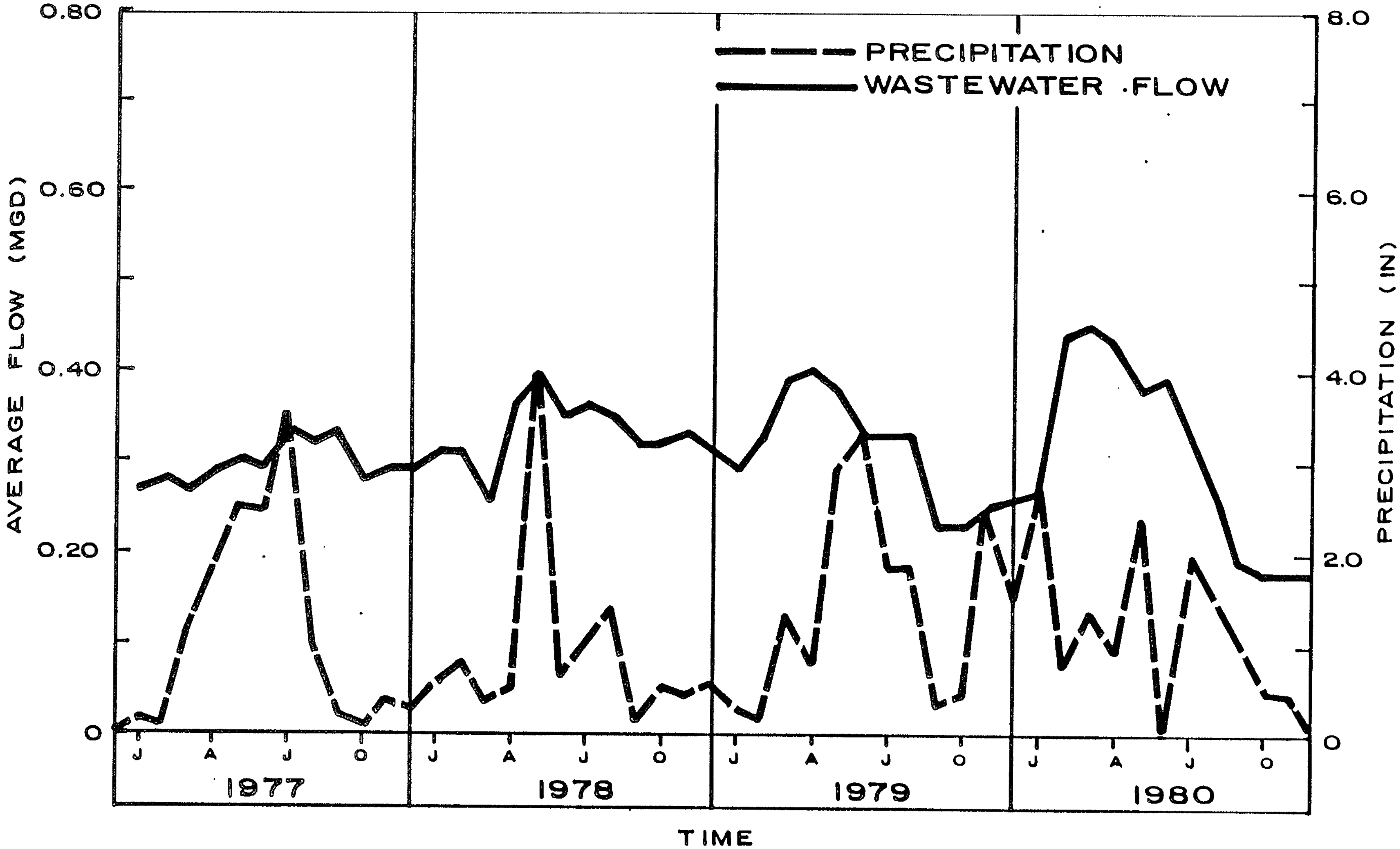

DRY CREEK WWTP
WASTEWATER FLOW & PRECIPITATION

FIGURE F-9

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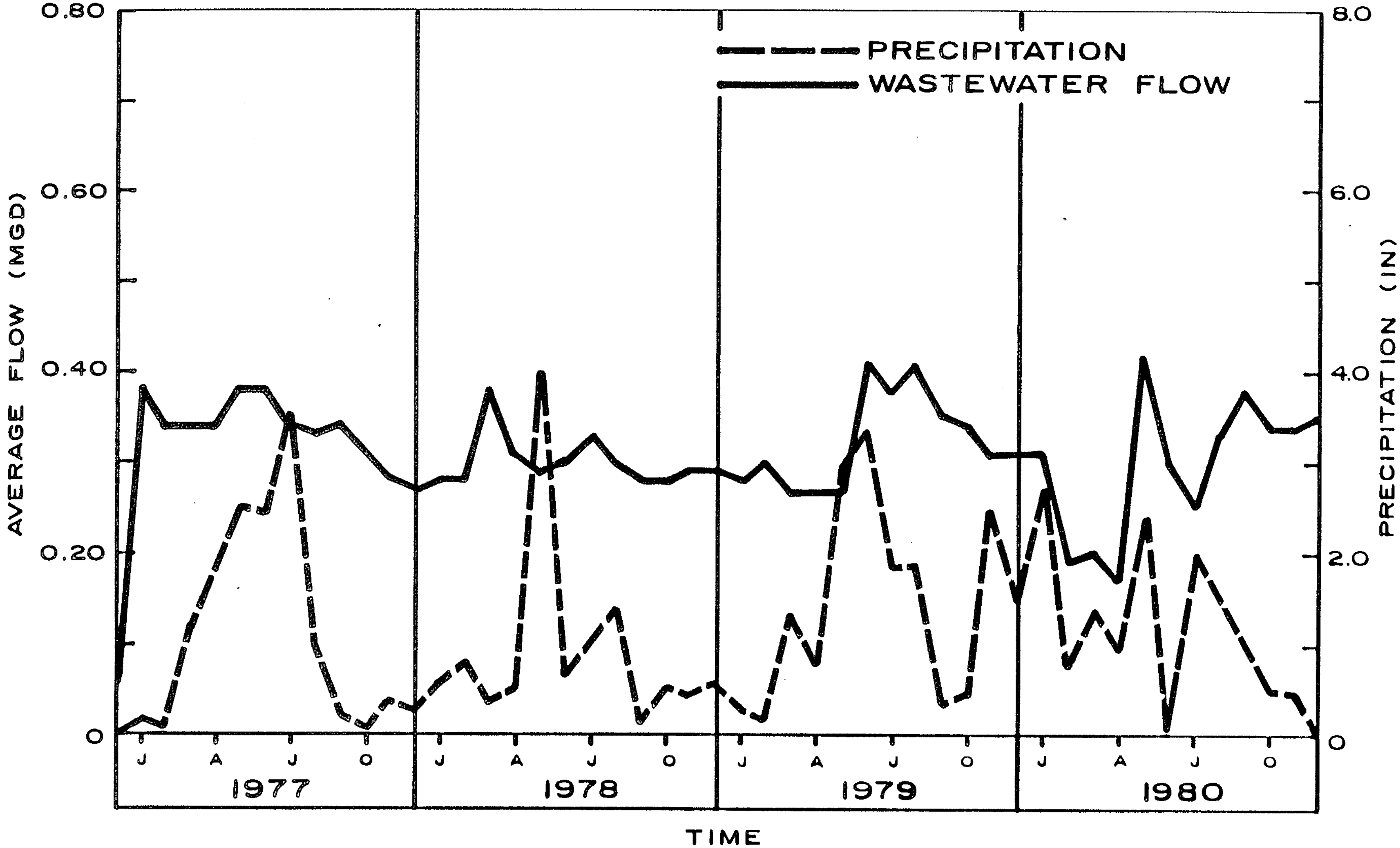
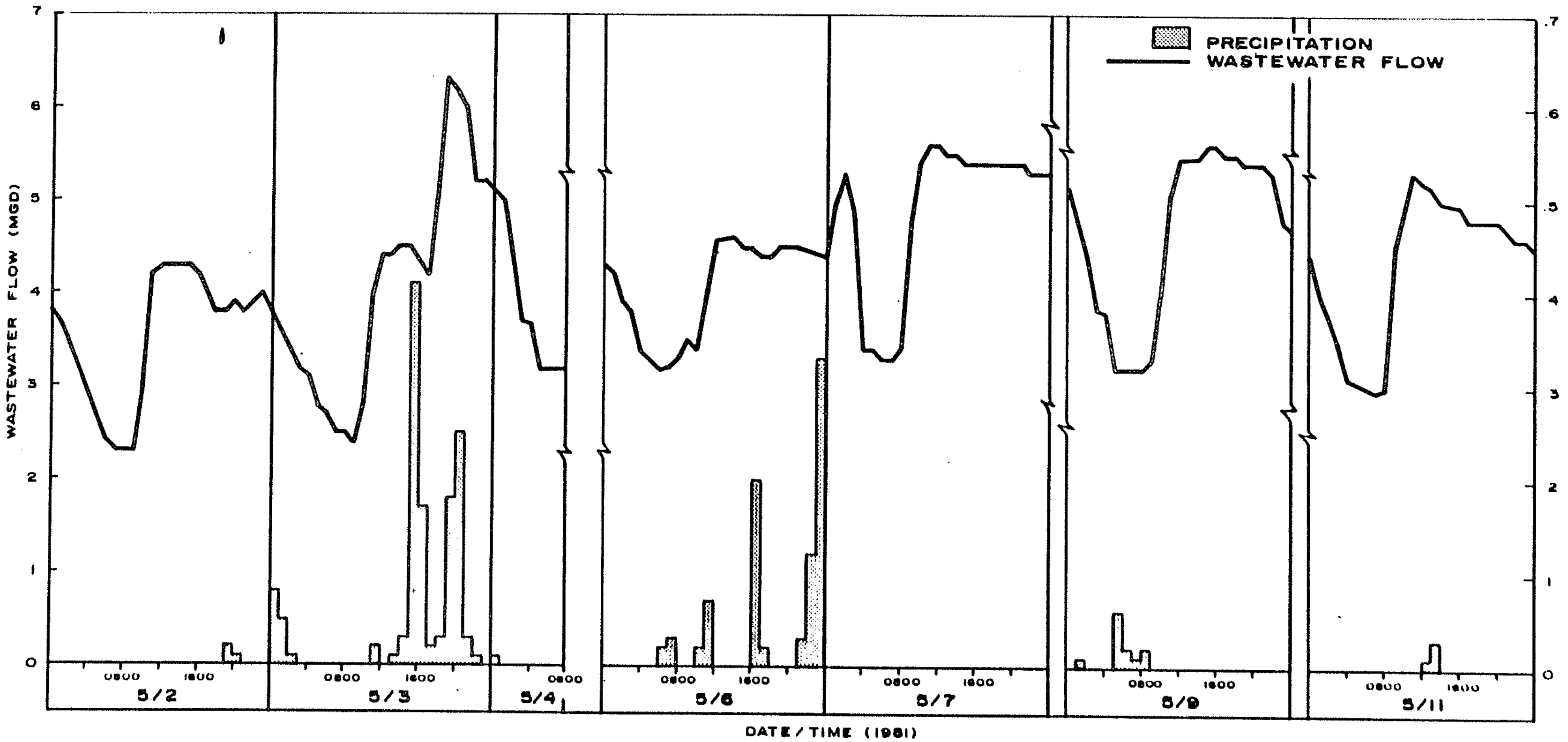


FIGURE F-10

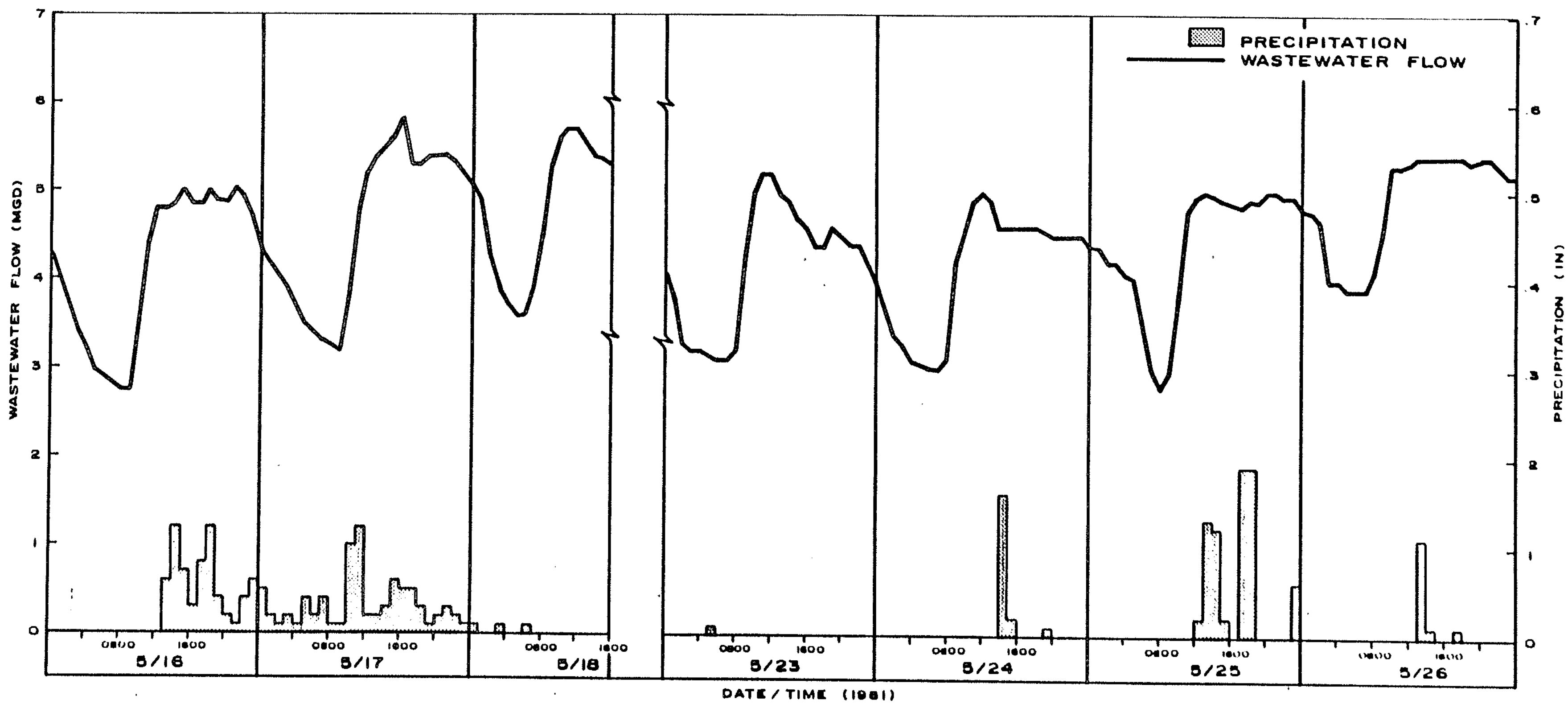
CROW CREEK WWTP

WASTEWATER FLOW & PRECIPITATION



CROW CREEK WWTP
WASTEWATER FLOW & PRECIPITATION

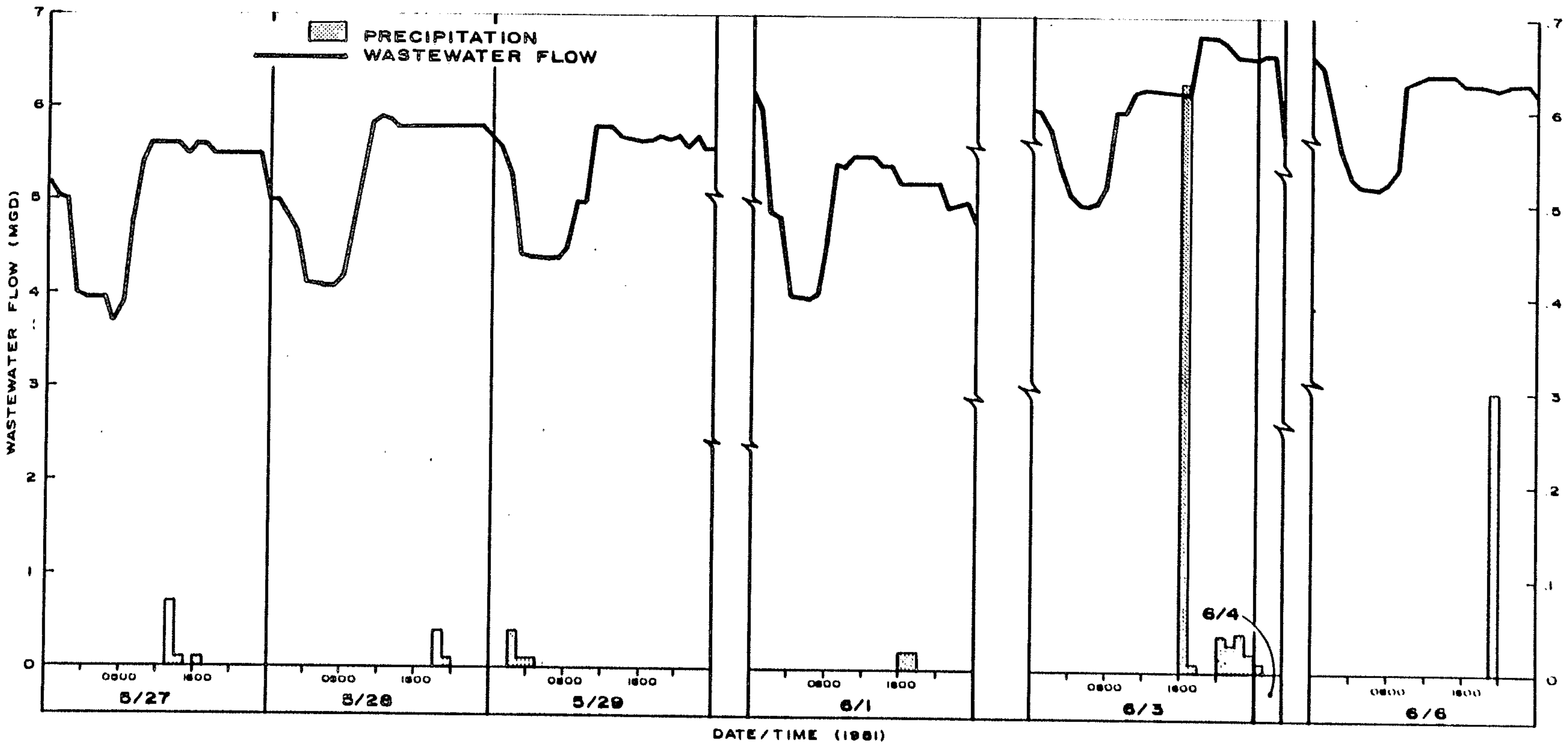
FIGURE F-11



CROW CREEK WWTP

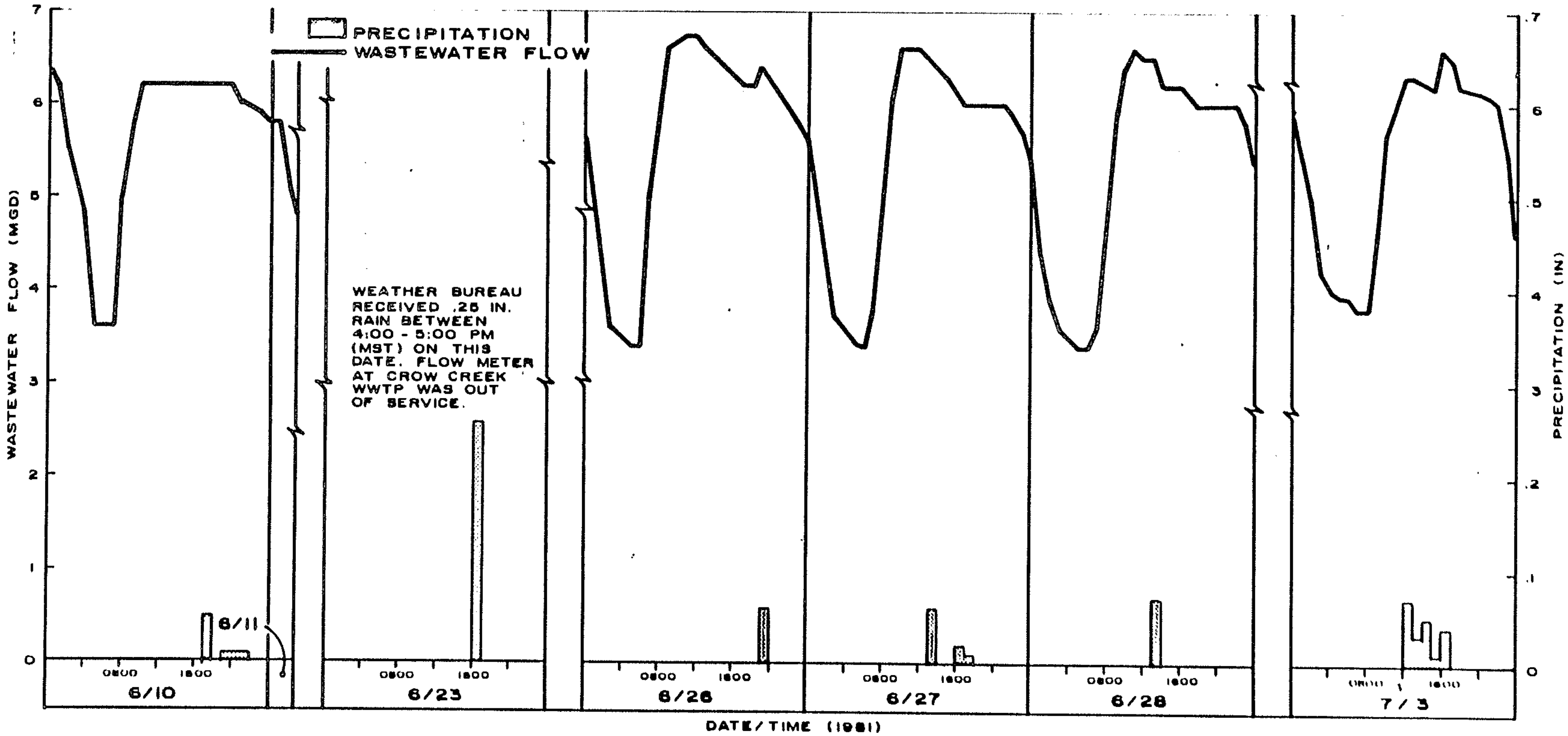
WASTEWATER FLOW & PRECIPITATION

FIGURE F-12



CROW CREEK WWTP
WASTEWATER FLOW & PRECIPITATION

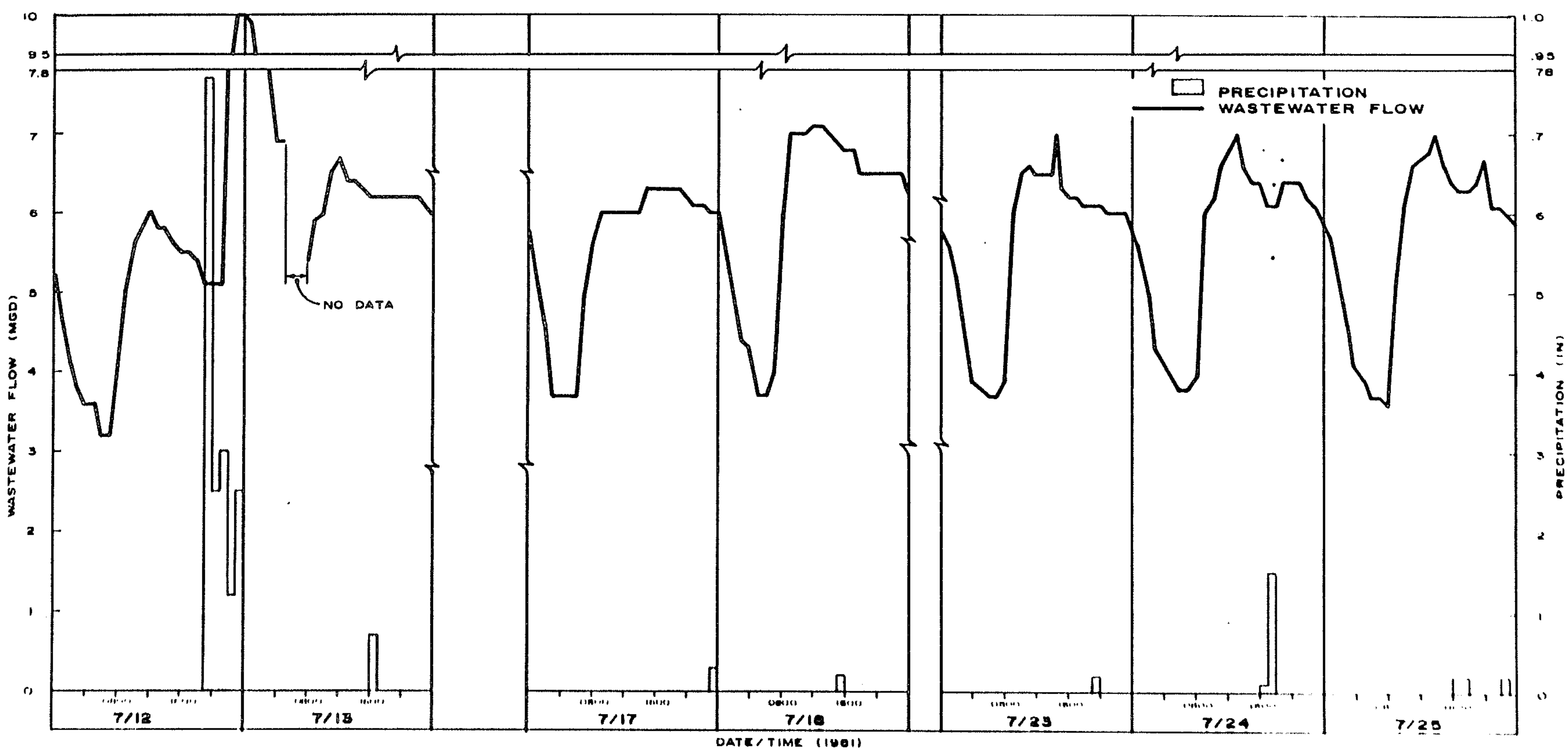
FIGURE F-1



CROW CREEK WWTP

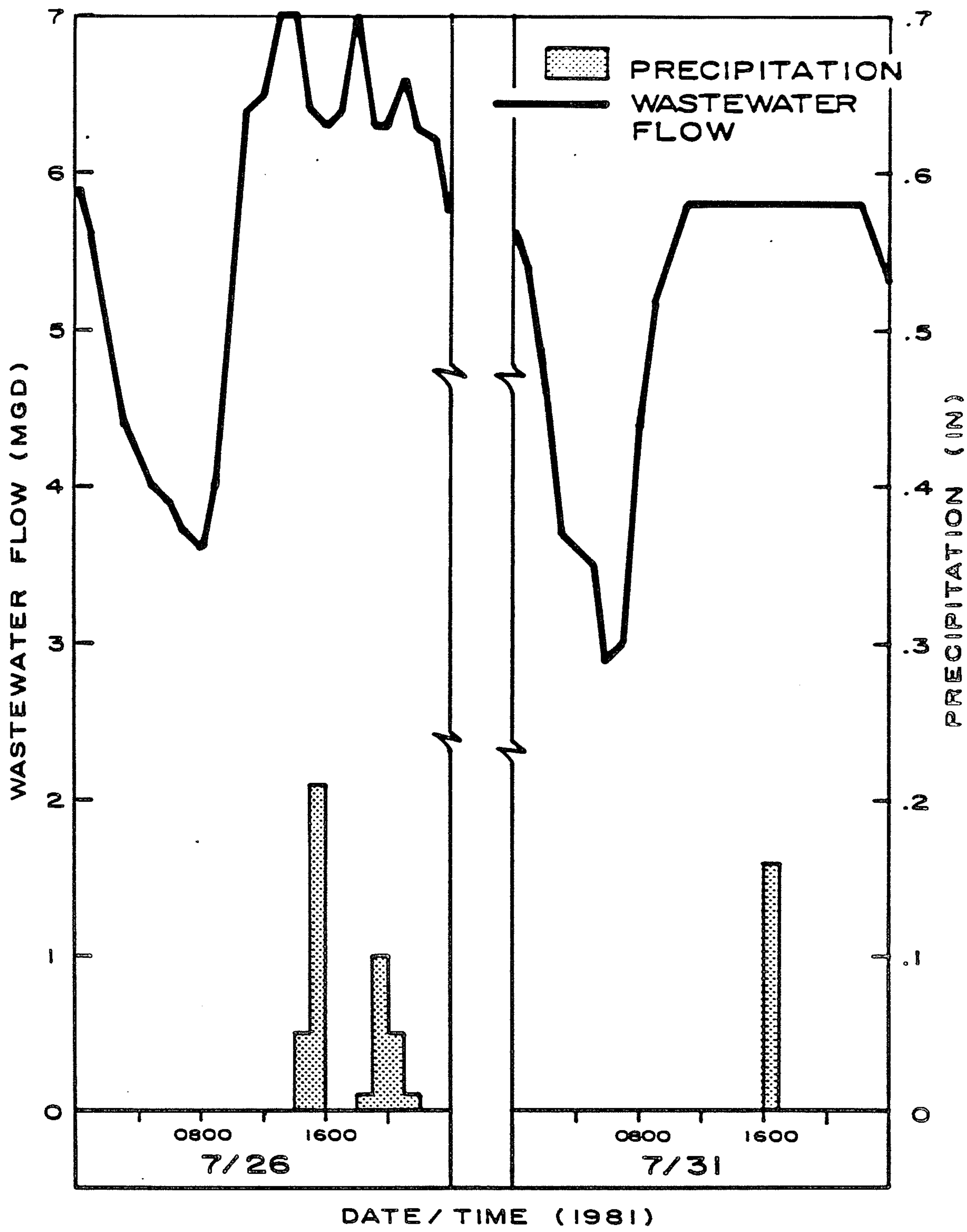
WASTEWATER FLOW & PRECIPITATION

FIGURE F-1



CROW CREEK WWTP
WASTEWATER FLOW & PRECIPITATION

FIGURE F-1



CROW CREEK WWTP

WASTEWATER FLOW & PRECIPITATION

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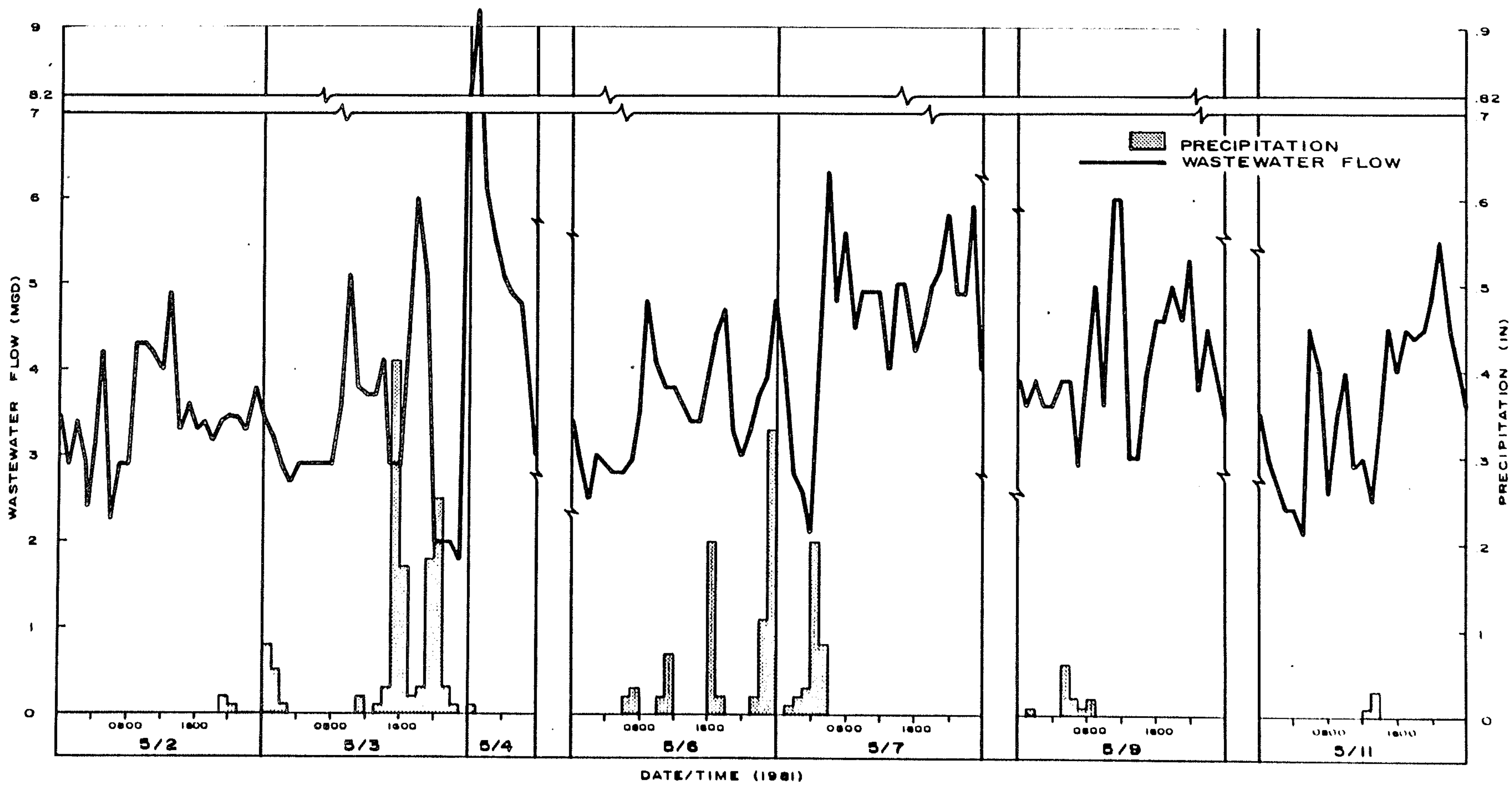
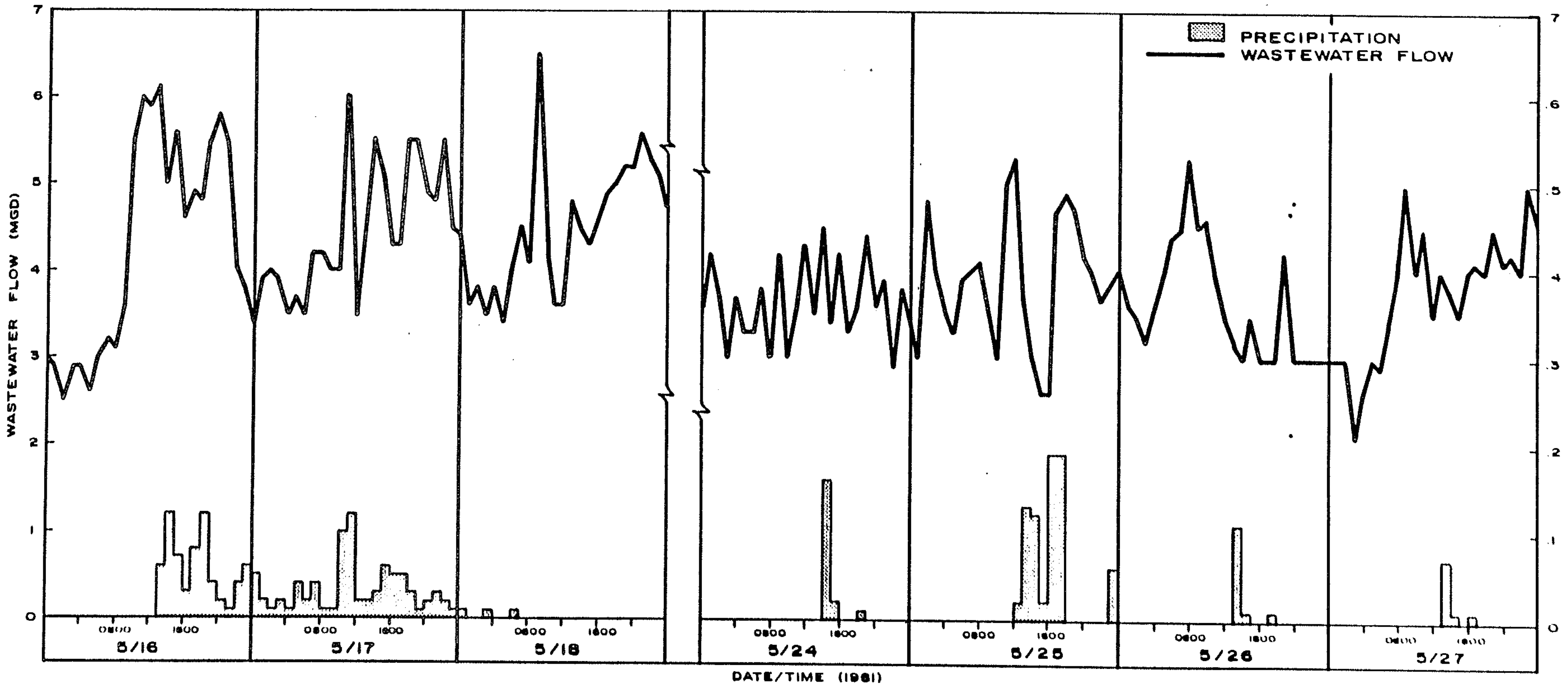
FIGURE F-16



DRY CREEK WWTP

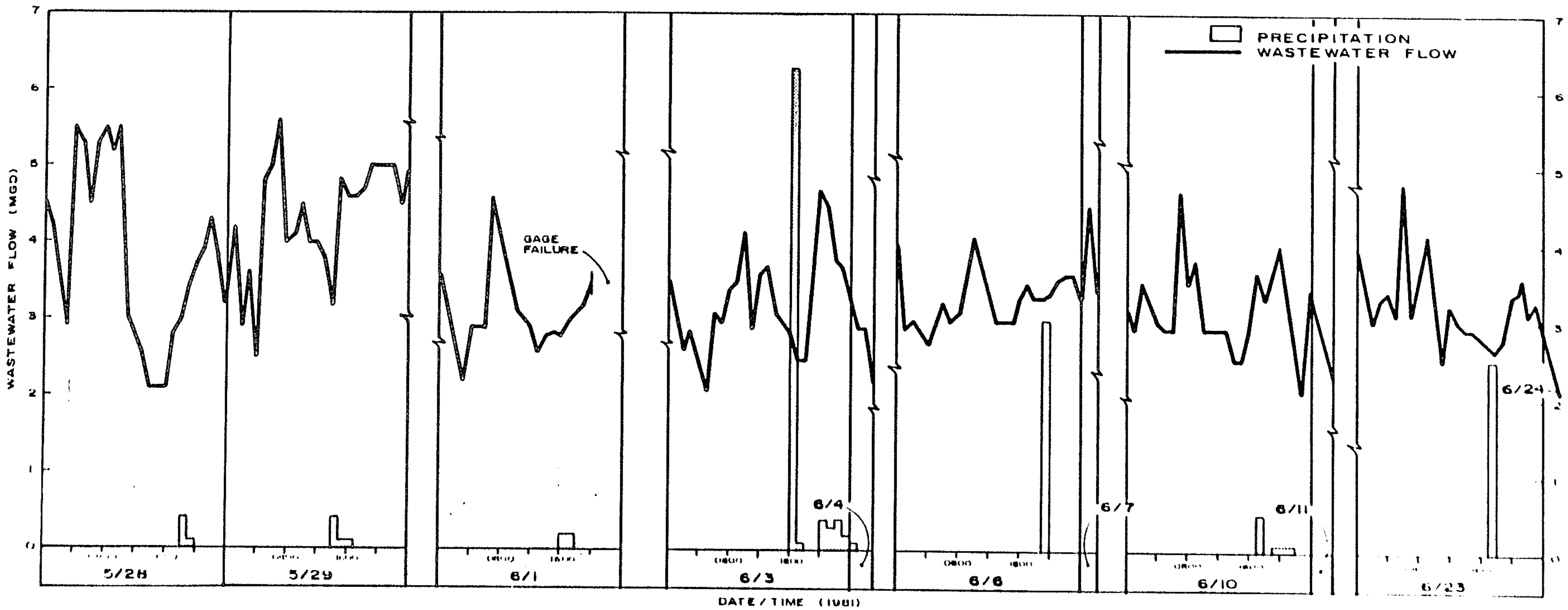
WASTEWATER FLOW & PRECIPITATION

FIGURE F-17



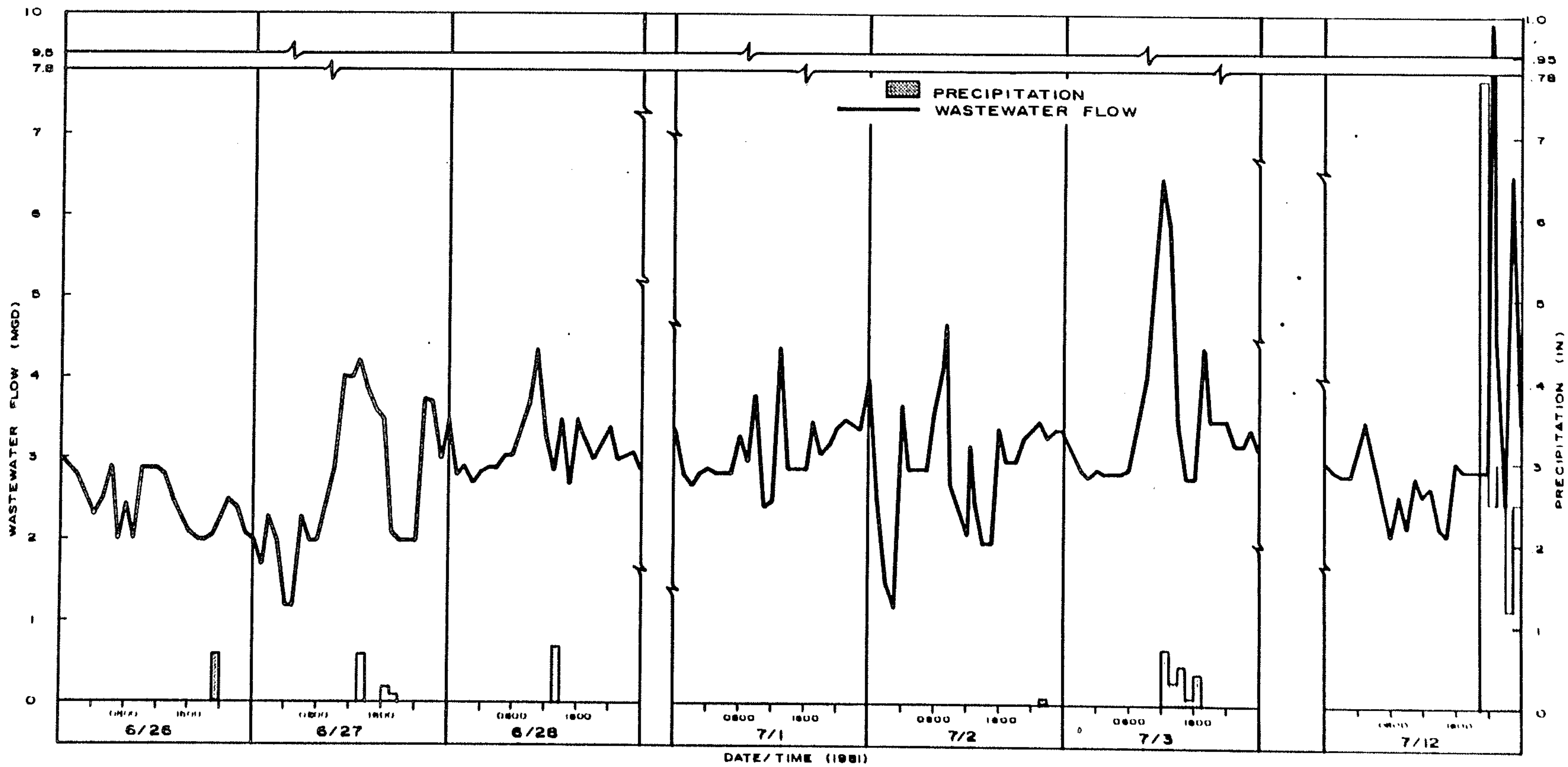
DRY CREEK WWTP
WASTEWATER FLOW & PRECIPITATION

FIGURE F-1[illegible]



DRY CREEK WWTP
WASTEWATER FLOW & PRECIPITATION

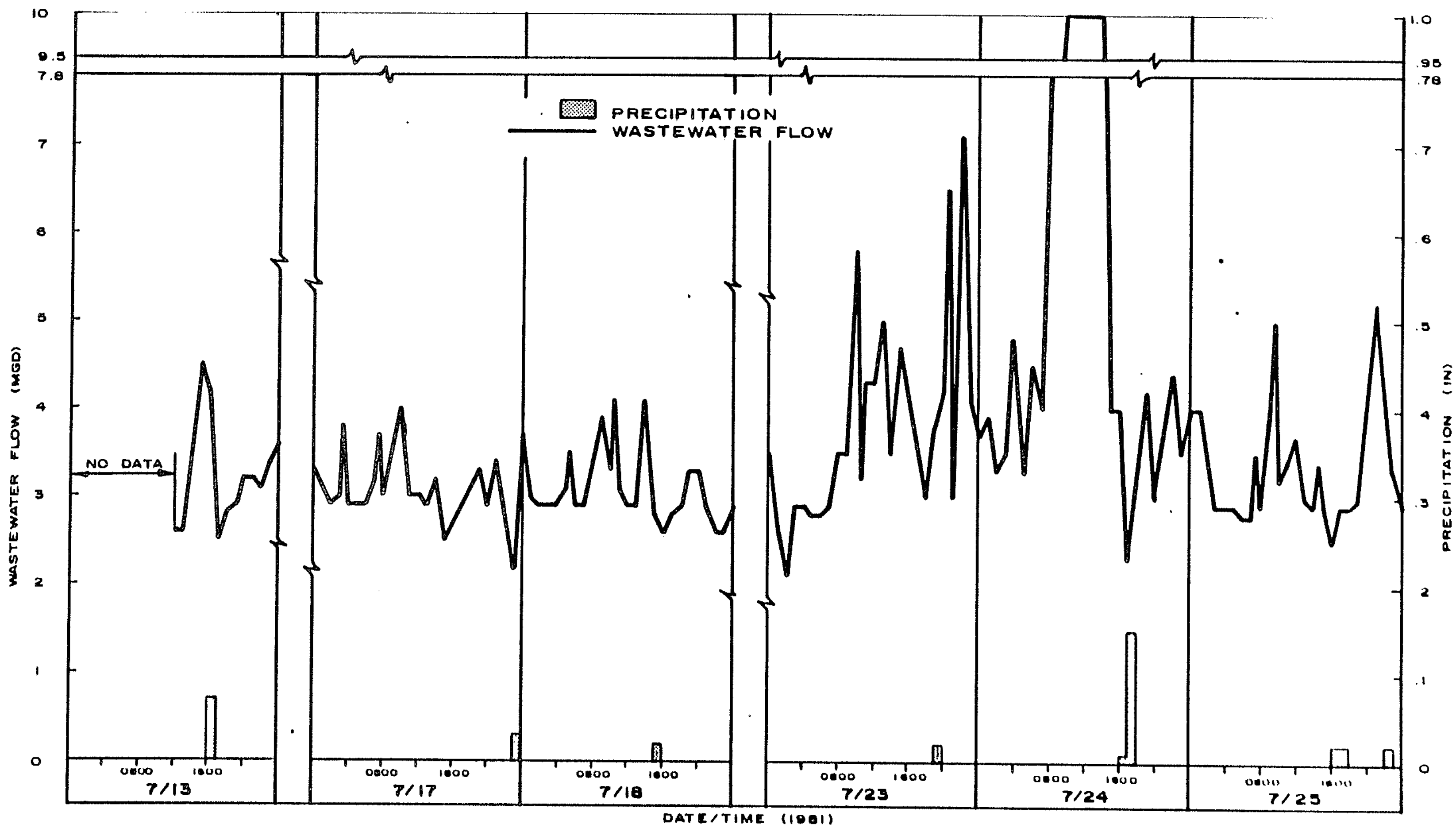
FIGURE F-19



DRY CREEK WWTP

WASTEWATER FLOW & PRECIPITATION

FIGURE F-20



DRY CREEK WWTP
WASTEWATER FLOW & PRECIPITATION

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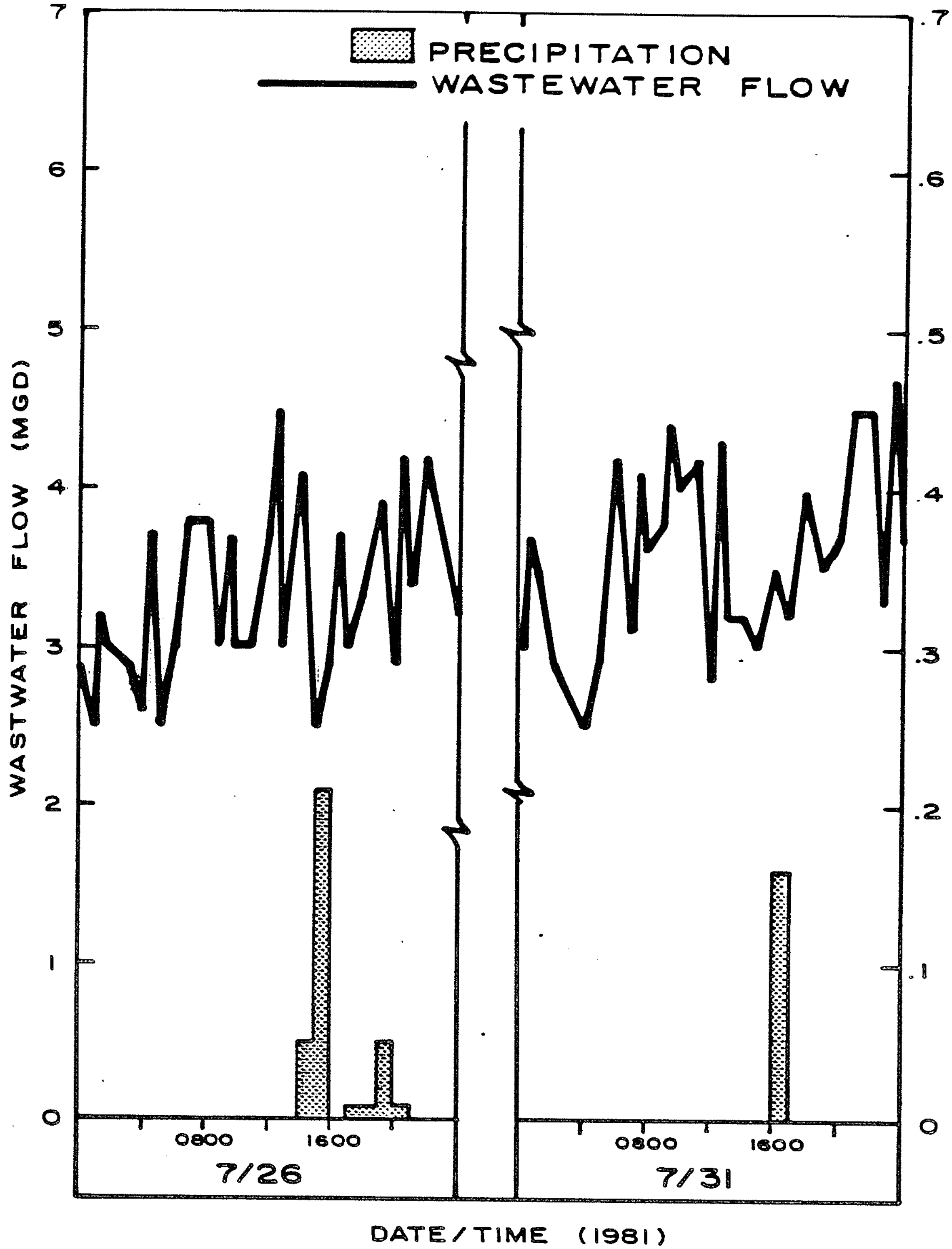
FIGURE F-2



DRY CREEK WWTP

WASTEWATER FLOW & PRECIPITATION

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FIGURE F-22

Table F-8
Water Use Data for 1979 and 1980
City of Cheyenne

Year & Month	Total Water Delivered (gal÷1000)	Union Pacific Use (gal÷1000)	Husky Oil Use (gal÷1000)	Little America Use (gal÷1000) *	Water to South Chey. (gal÷1000)	Total Water Delivered For Domestic Use (gal÷1000)
1979						
Jan.	261,984	10,117	54,110	2,179	14,414	181,164
Feb.	226,792	8,525	47,085	2,393	11,506	157,283
March	282,839	8,479	50,791	1,362	11,424	210,783
April	328,458	7,678	54,838	360	13,195	252,387
May	359,740	3,765	46,352	1,764	12,713	295,146
June	445,764	3,266	48,302	1,763	15,289	377,144
July	609,341	3,556	54,470	6,000	22,385	522,930
Aug.	477,372	5,184	49,818	4,620	17,171	400,579
Sept.	510,283	7,095	42,951	6,507	17,430	436,300
Oct.	343,447	3,162	52,456	6,104	15,077	266,648
Nov.	311,187	5,499	48,356	207	13,392	243,733
Dec.	322,267	4,131	46,454	93	11,012	260,577
Σ	4,479,474	70,457	595,983	33,352	175,008	3,604,674
1980						
Jan.	318,356	5,382	37,275	92	12,827	262,780
Feb.	285,771	4,316	46,957	21	12,472	222,005
March	255,793	3,838	39,770	63	12,551	199,571
April	292,288	5,484	42,289	22	13,211	231,282
May	438,270	3,914	44,130	1,840	13,291	375,095
June	687,546	3,906	43,832	11,354	24,941	603,513
July	637,039	3,998	43,832	10,761	22,903	555,545
Aug.	542,216	5,043	56,844	9,319	26,400	444,610
Sept.	483,889	3,409	52,836	2,478	23,423	401,743
Oct.	305,974	4,060	30,444	3,168	14,767	253,535
Nov.	238,197	5,898	38,790	25	11,478	182,006
Dec.	233,309	4,449	53,417	46	13,018	162,379
Σ	4,718,648	53,697	530,416	39,189	201,282	3,894,064

*Billing date for Little America was not consistently at the end of the month.

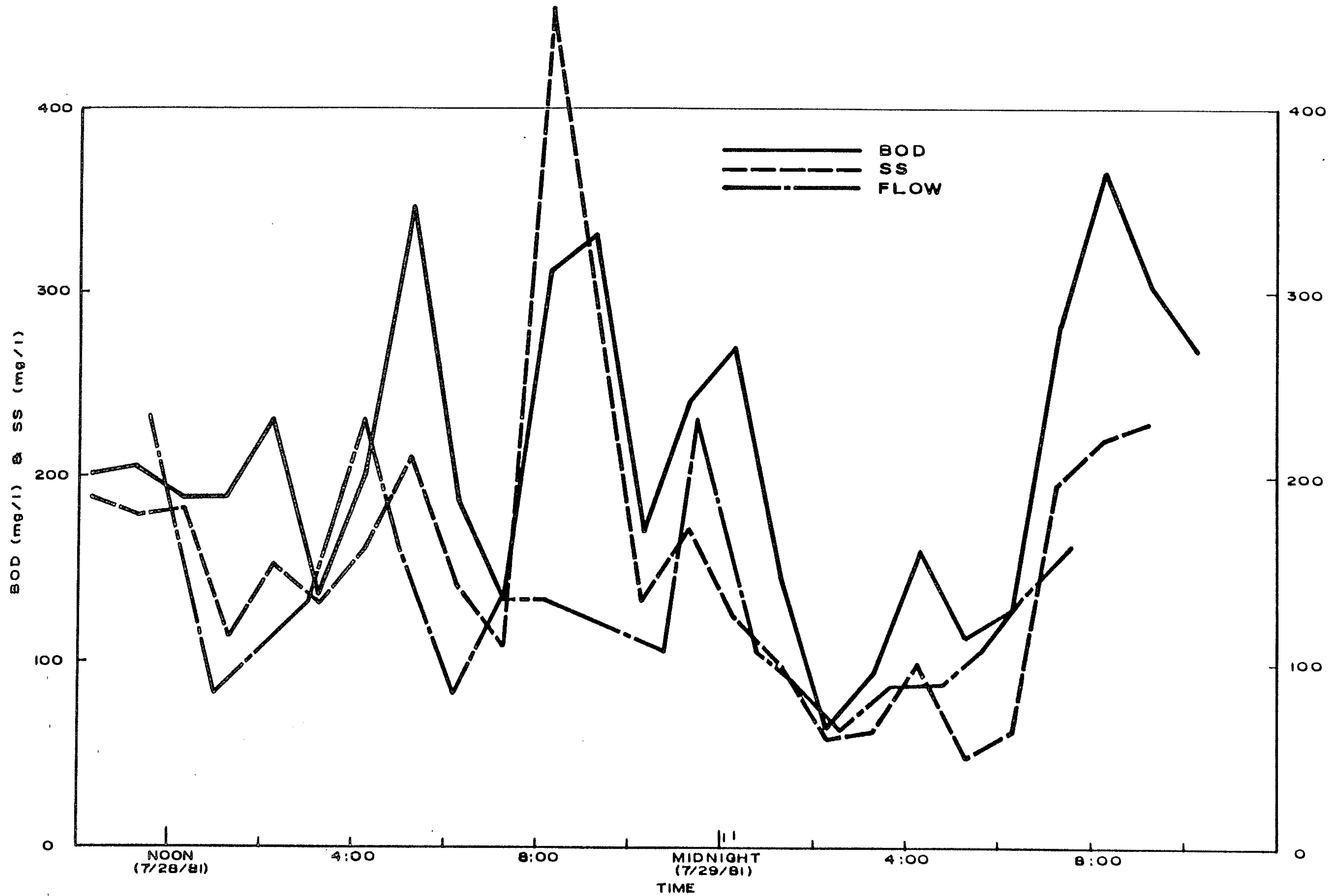
billing records at the City Water and Sewer Department.

Table E-9 indicates the "corrected" volume of water delivered and the actual volume of wastewater appearing at the Dry Creek and Crow Creek WWTPs. Also given in Table E-9 are the theoretical amounts of wastewater generation based on 60%, 70%, and 80% of water supplied becoming sewage. The "worst case" scenario occurred in February 1979 when 111.71% of the water delivered became sewage. If 60% of the water delivered becomes sewage, the difference between the actual volume of wastewater generated and this amount (60%) is considered to be I/I in origin. This difference amounts to 81,338,000 gallons for the month, or an average of 2,904,930 gpd. The calculations above indicated that I/I less than 3,252,330 gpd is considered non-excessive. Therefore, based on this "worst case" scenario, the I/I into the sewer system in Cheyenne is non-excessive as defined by the EPA.

Specific sections of Cheyenne were investigated to determine whether excessive I/I is contributed from these areas. Manholes used to isolate chosen sections based on recommendations of John Price and are indicated in Figure B-IV-7, Working Paper No. 3. During the months of June and July 1981, flows in six manholes in the City of Cheyenne were monitored for flow rate, BOD_5, and SS. The samples were taken to James H. Stewart and Associates in Fort Collins, Colorado, for analysis. The results of this monitoring program are shown in Figures E-23 through E-29. Calculations to determine I/I were done in the same manner as described for South Cheyenne, and the results are shown in Table E-10.

The manhole monitored at 5th Street and Parsley Blvd. passes wastewater collected from the Upland Park area. Approximately 40.1-inch diameter-miles of sewer system comprise the pipe network upstream of this location. This is a 24-inch line that flows only 2 to 3 inches deep at peak times of the day and was designed with extensive future development

WP 82 8/81
1767

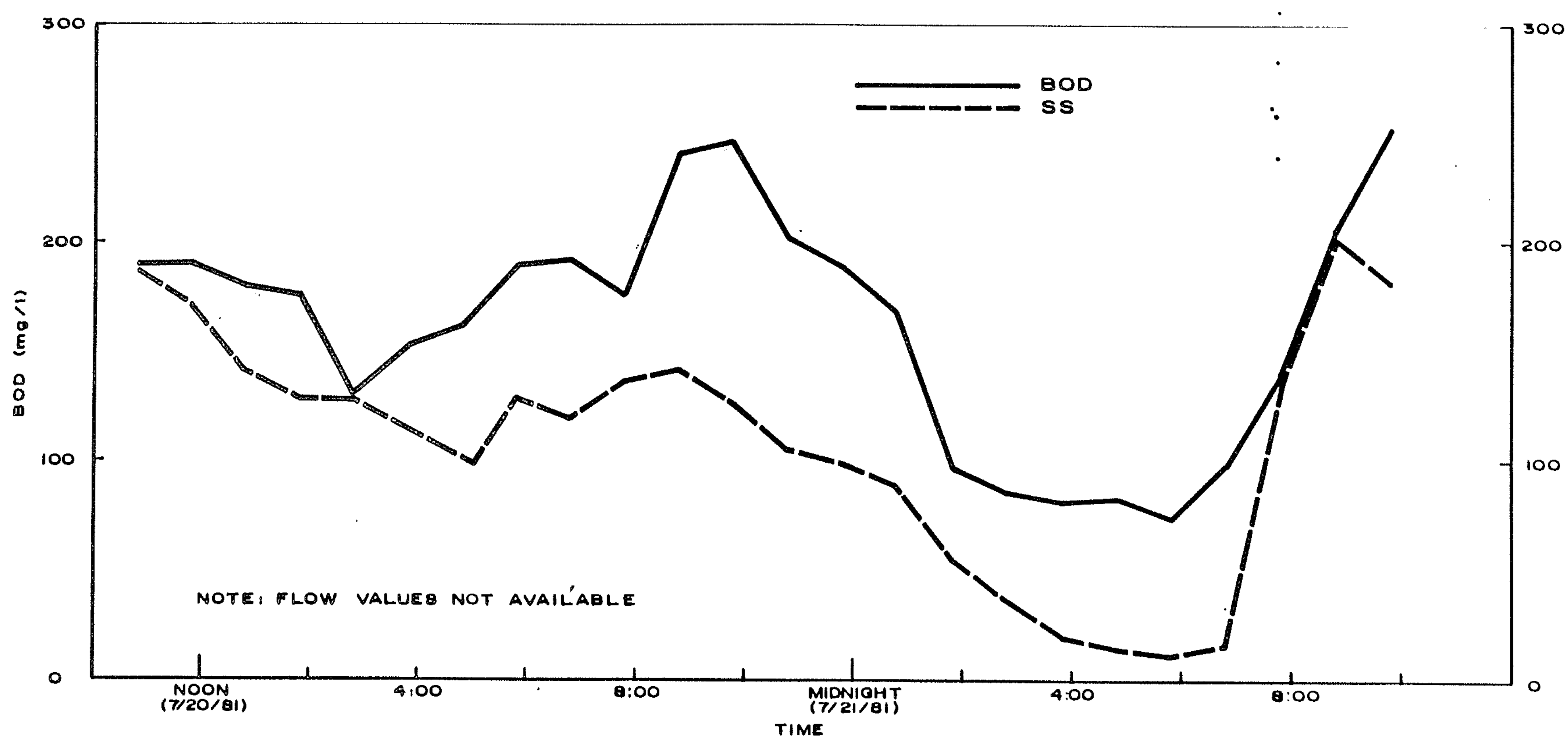


CHEYENNE

SAMPLE SITE I

FLOW, BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-23

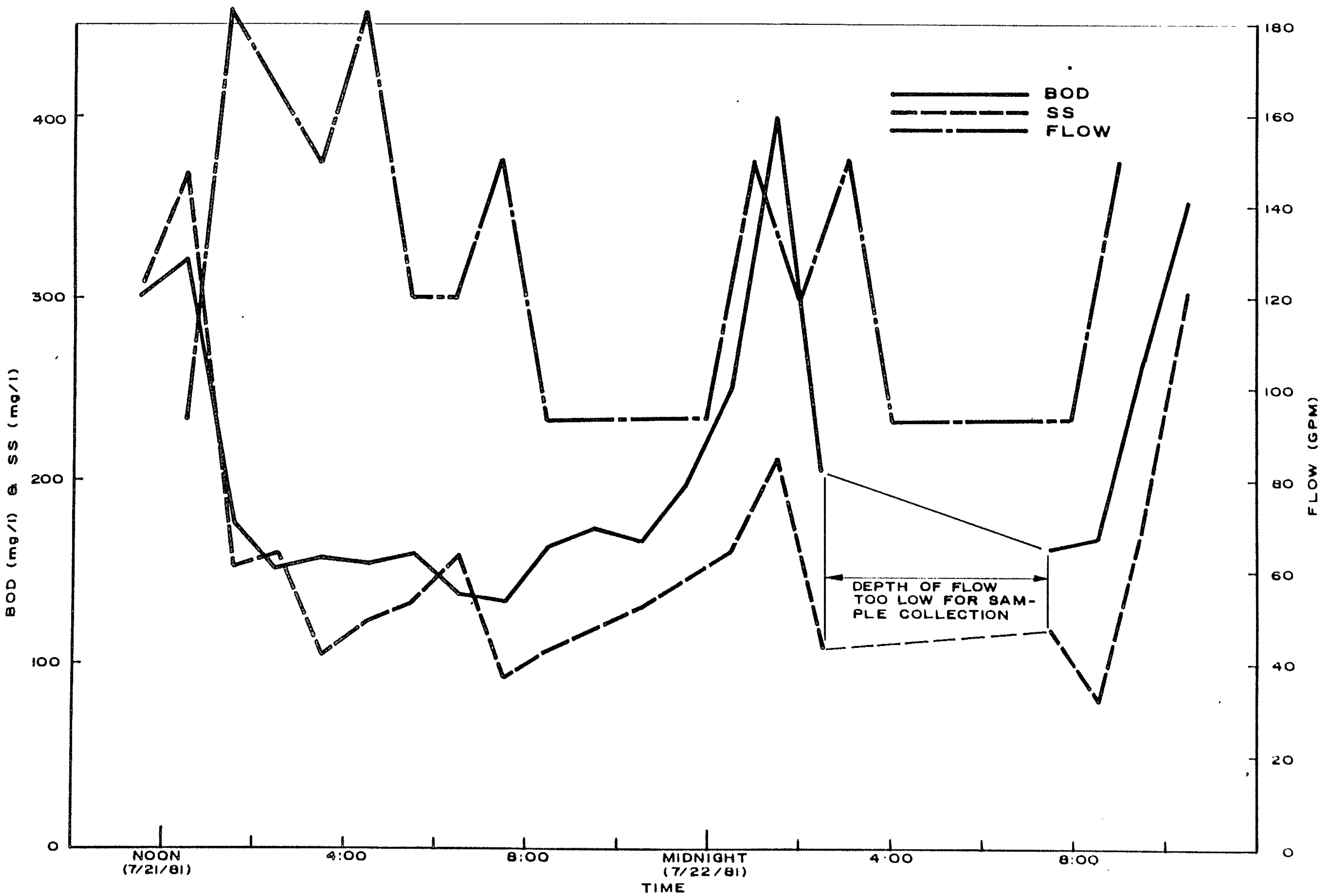


CHEYENNE

SAMPLE SITE 2

FLOW, BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-24

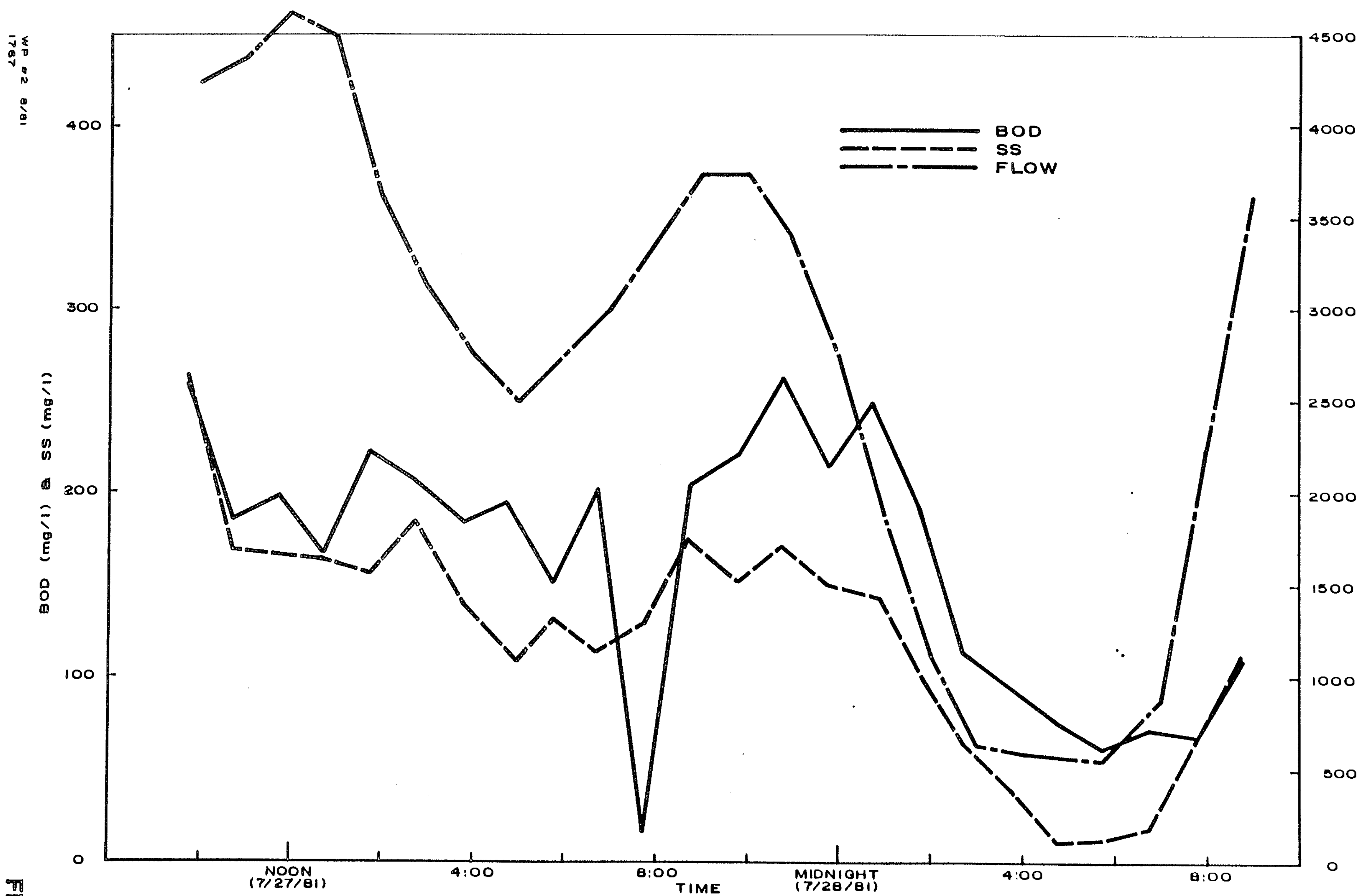


CHEYENNE

SAMPLE SITE 3

FLOW, BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-25



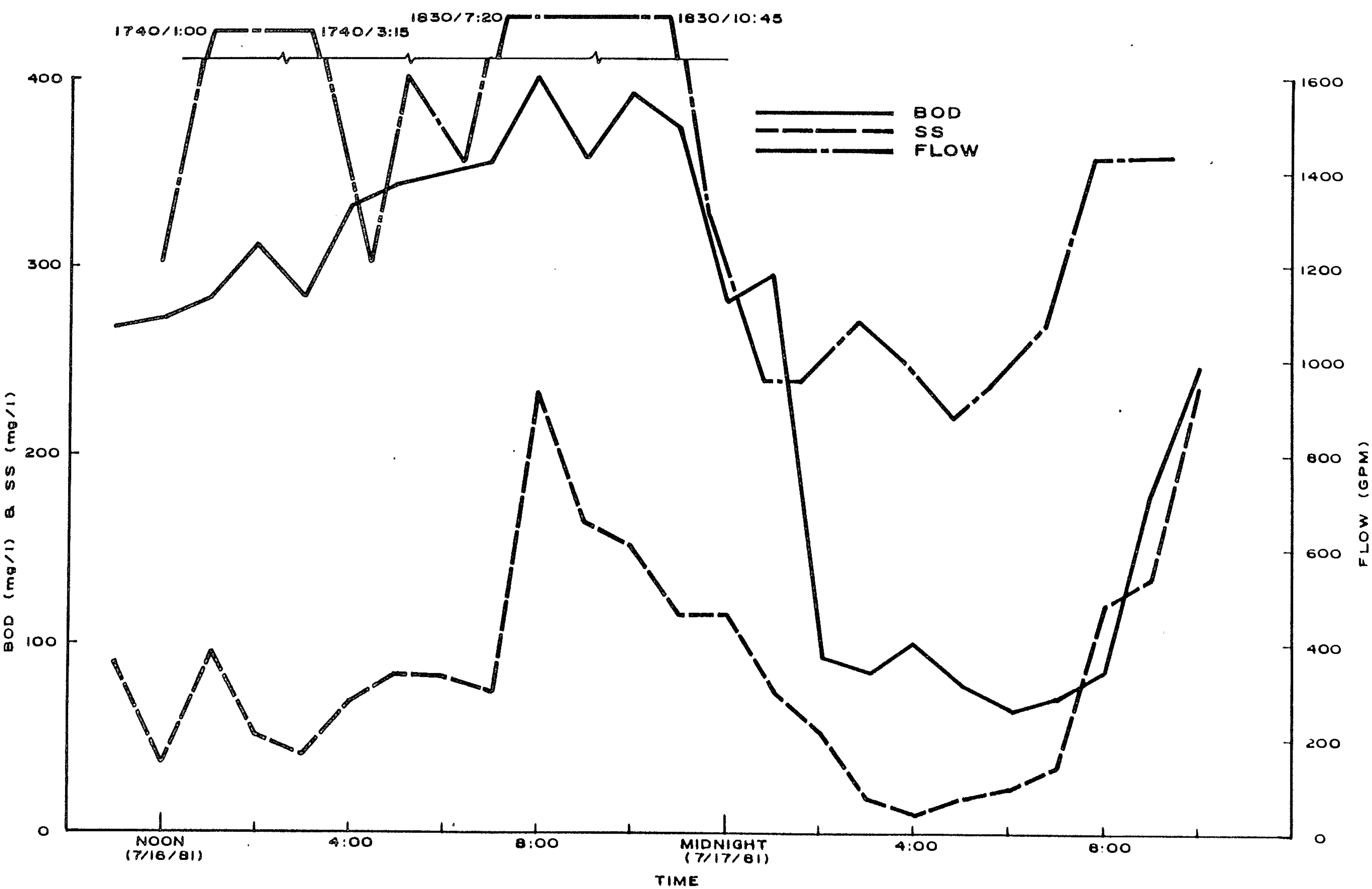
CHEYENNE

SAMPLE SITE 4

FLOW, BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-26

WP #2 1767 8/81

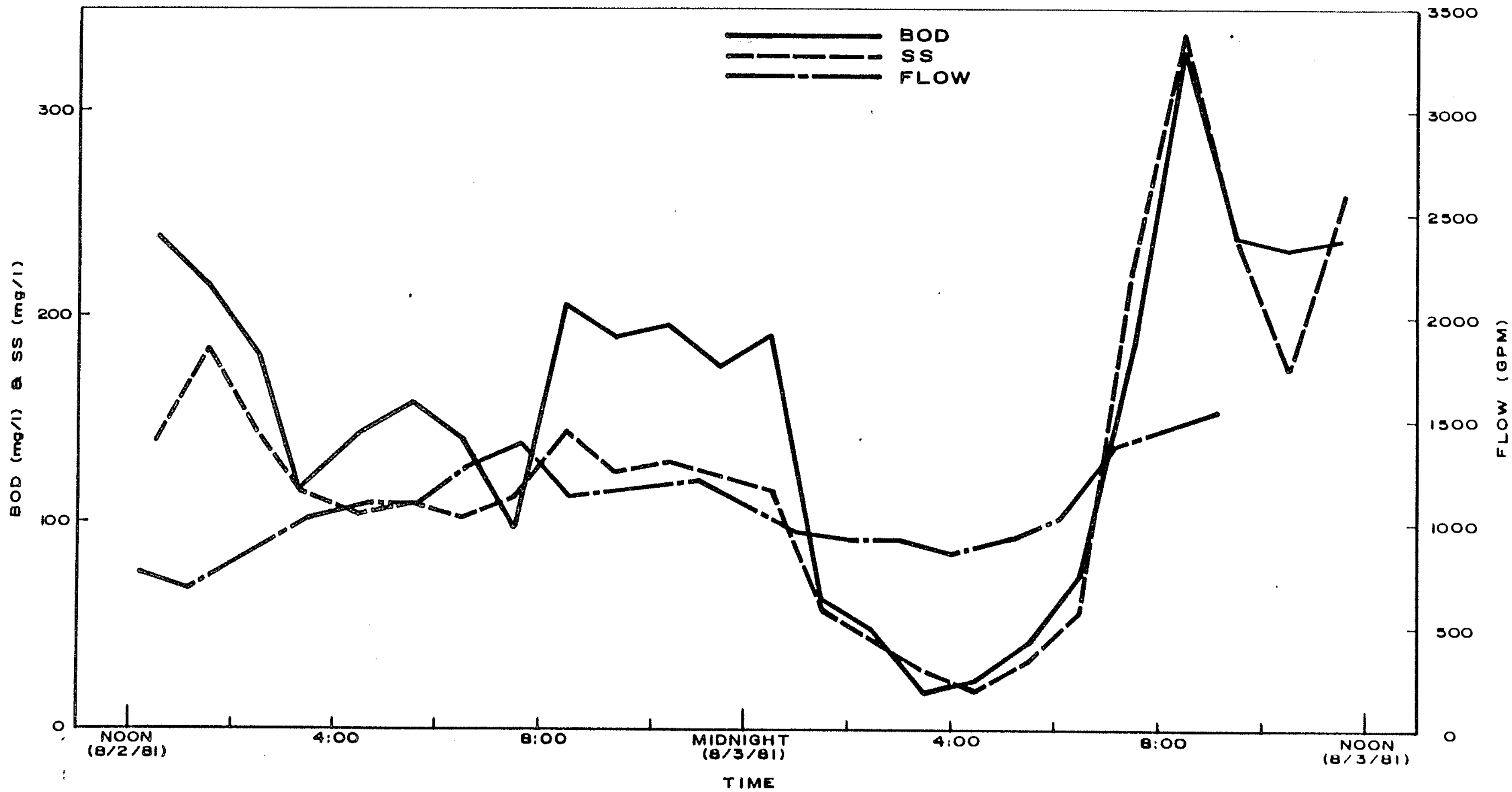


CHEYENNE

SAMPLE SITE 5

FLOW, BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-27



CHEYENNE

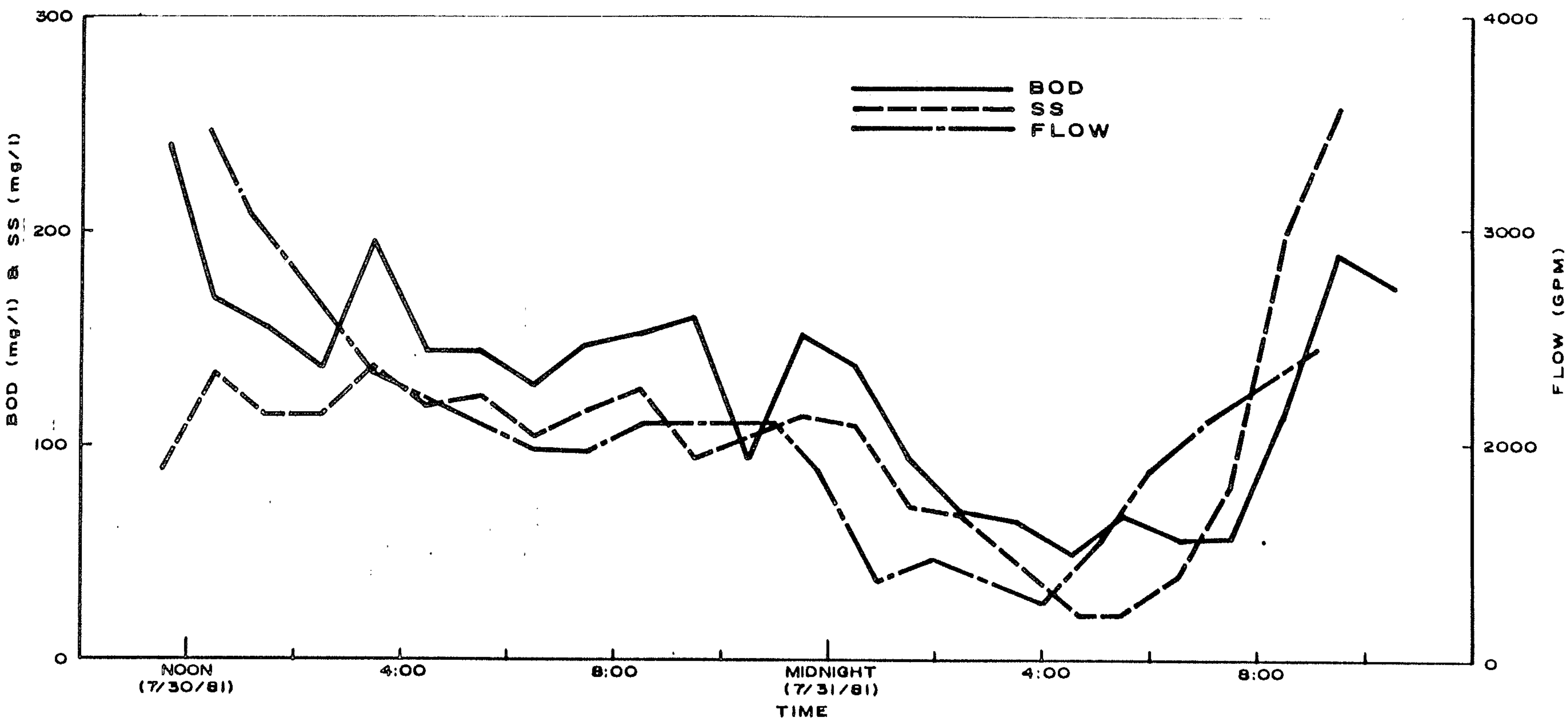
SAMPLE SITE 6

FLOW, BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-28

WP #2 8/81 1767

WP #2 1767 8/81



CHEYENNE

SAMPLE SITE 7

FLOW, BIOCHEMICAL OXYGEN DEMAND & SUSPENDED SOLIDS

FIGURE F-29

Table F-9
Theoretical Wastewater Generation
Analysis of City of Cheyenne, Including Warren A.F.B.
(60% - 80% of Water Supplied Reaches WWTP)

Year & Month	Total Water Delivered For Domestic Use (Gal ÷ 1000)	Wastewater Flow at 60% Of Water Supply (Gal ÷ 1000)	Wastewater Q @ 70% (Gal ÷ 1000)	Wastewater Q @ 80%	Actual Waste-Water Q_{in} to Dry & Crow Creek WWTP (Gal ÷ 1000)	% of Q_{in} @ Dry & Crow To Water Delivered
1979						
J	181,164	108,698	126,815	144,931	180,014	99.37
F	157,283	94,370	110,098	125,826	175,708	111.71
M	210,783	126,470	147,548	168,626	203,594	96.59
A	252,387	151,432	176,671	201,910	201,214	79.72
M	295,146	177,088	236,117	236,117	205,519	69.63
J	377,144	226,286	264,001	301,715	221,240	58.66
J	522,930	313,758	366,051	418,344	220,867	42.24
A	400,579	240,347	280,405	320,463	229,988	57.41
S	436,300	261,780	305,410	349,040	175,016	40.11
O	266,648	159,989	186,654	213,318	177,489	66.56
N	243,733	146,240	170,613	194,986	170,014	69.75
D	260,577	156,346	182,404	208,462	178,057	68.33
Σ	3,604,674				2,338,720	64.88
1980						
J	262,780	157,668	183,946	210,224	179,115	68.16
F	222,005	133,203	155,404	177,604	183,442	82.63
M	199,571	119,743	139,700	159,657	200,547	100.49
A	231,282	138,769	161,897	185,026	184,392	79.73
M	375,095	225,057	262,567	300,076	248,449	66.24
J	603,513	362,108	422,459	482,810	213,867	35.44
J	555,545	333,327	388,882	444,436	210,263	37.85
A	444,610	266,766	311,227	355,688	184,071	41.40
S	401,743	241,046	281,220	321,394	173,984	43.31
O	253,535	152,121	177,475	202,828	162,984	64.28
N	182,006	109,204	127,404	145,605	157,445	86.51
D	162,379	97,427	113,665	129,903	160,493	98.84
Σ	3,894,064				2,259,052	58.01

in the immediate area planned. The I/I rate of 1122 gpd/in/mi is non-excessive based on EPA Guidelines of 1500 gpd/in/mi allowable I/I.

The 30" Dry Creek Interceptor appears to be fairly tight. Low flow measurements showed a flow of .79 MGD and a BOD_5 of 62 mg/l. Correcting for normal flow yields an infiltration/inflow rate of .41 MGD. The I/I equals 826 gpd/in/mi, well below the EPA allowable limit of 1500 gpd/in/mi.

The manhole on Talbot Street, by Pioneer Park, passes wastewater collected on the Francis E. Warren Air Force Base. This is a 15" line in which the flow recorded was 1.43 MGD and the BOD was 67 mg/l. For the 360-inch diameter-miles of pipe composing this service area, an infiltration/inflow rate of 1927 gpd/in/mi was determined to exist. This exceeds the EPA Guidelines of 1500 gpd/in/mi, thereby requiring further investigation concerning the reduction of I/I into the sewer system from this area. According to George Cormier of the Engineering Branch on the Base, a detailed engineering survey of the sewer system is planned. This survey should identify the problem spots and make recommendations for a solution.

Measurements on the 15" line at Belaire Avenue, Grier Blvd., and Henderson Drive showed an early morning flow of 1.23 MGD and a BOD_5 of 20 mg/l. Based on 0.0 mg/l BOD for I/I water and 130 mg/l (as explained in the discussion of the South Cheyenne sewage flows) for domestic sewage, the corrected infiltration/inflow is 1.04 MGD. For the 352-inch diameter-miles of sewerage serving this area, the I/I rate of 2957 gpd/in/mi was determined. This is greatly in excess of the EPA limit of 1500 gpd/in/mi. It is felt that the value of 20 mg/l BOD_5 may be unrealistically low, compared with all the values from other parts of the city. A second set of flow measurements and BOD_5 values from this sampling point were obtained to substantiate or reject the above value. At 4:00 A.M. on September 2, 1981, a flow of .32 MGD was measured, and the corresponding BOD_5 value was 18 mg/1. These values compute to an I/I amount of 780 gpd/in/mi. It is possible that inaccurate depth measurements were obtained during the initial sampling, resulting in a higher determined flow rate and corresponding infiltration rate. This line is vitrified clay pipe (VCP) and was installed during the 1930's. Investigation of 5 manholes on this line upstream of the sampling site revealed the existence of severely deteriorated manholes. Of these 5 manholes, 3 were bricked, one with 40" of bricks. All three showed signs of infiltration where water had actually washed the mortar out from between the bricks, leaving the bricks extremely loose. One of these manholes, located near the drainage gutter, not only had a broken top but also had 32 holes in the top, providing a source for considerable inflow. Despite the favorable results of the second set of tests, a more detailed investigation of this line may be in order, as allowed by available funds.

Flow measurements and BOD_5 samples taken from the manhole on Maxwell Ave., between 2nd and 3rd Streets, indicate excessive I/I (2120 gpd/in/mi) from the 500-inch diameter-miles of sewer system upstream of this location.

A second set of tests was also performed at this site on the same date as the second tests at Henderson, Grier, and Bellaire. The results of this second test, as shown in Table F-10, indicate even greater excessive I/I than was initially determined. The possibility of an inhibitory agent in the wastewater that would show a lower BOD value than is actually present was considered. This led to the collection of more samples in order to run a COD:BOD ratio. Chemical oxygen demand (COD) is not as susceptible to inhibitory agents as is the BOD. Normally accepted COD:BOD range is from 2.0-2.5. Samples taken at 6:30 A.M. on September 17, 1981 resulted in a COD:BOD ratio of 5.50 at this location. Table F-11 shows the

Table F - 10
Infiltration/Inflow Analysis For the City
of Cheyenne Sewer System

Manhole Location	Line Size (in)	Recorded Flow (MGD)	Recorded BOD_5 (mg/l)	Corrected I/I (MGD)	Inch-Diameter-Miles of Sewer	I/I (gpd/in/mi)
5th & Parsley	24	.09	65	.05	40.1	1120
Cole Fire Station		N/A	74	--	159.0	--
Crow Creek Interceptor Line (1st & Russel)	30	.13	>130*	--	--	--
Dry Creek Interceptor Line	30	.79	62	.41	500	830
Pioneer Park Cribbon Street	15	1.43	67	.69	359.76	1930
Belaire, Henderson, and Grier	15	1.23 .32†	20 18†	1.04 .28†	352	2960 780†
Maxwell, Between 2nd & 3rd Street	27	1.84 1.84†	55 13†	1.06 1.66†	500	2120 3312†

* When lowest BOD_5 recorded value is greater than 130 mg/l, assume I/I is negligible.

N/A = data not available

† Second set of samples collected at these locations on 9/1/81-9/2/81.

results of COD and BOD tests run for both the Henderson and Maxwell locations.

Table F-11
Chemical Oxygen Demand:Biochemical Oxygen Demand

Sample No.	COD (mg/l)	BOD (mg/l)	COD/BOD
H6:30	231	98	2.36
M6:30	72	13	5.50
H2:30	660	326	2.03
M2:30	463	189	2.45

The results of this test indicate that an inhibitor could indeed be present in the wastewater flow at the Maxwell Street location. This gives reason to believe that the number given in Table F-10 for I/I at the Maxwell Street location is higher than is the actual situation; it is high enough to justify further investigation of the sewerage upstream of this location.

This line is vitrified clay pipe and was installed during, or before, the 1930's. Investigation of 6 manholes upstream of this location showed signs of deteriorated conditions. All 6 manholes had bricked tops, some with bricks so loose that they could be removed by hand. Signs were prevalent of large quantities of infiltration entering the sewer system through these manholes. One manhole, near Parsely Blvd., on the Union Pacific right-of-way, indicated that the storm sewer discharges into the sanitary sewer. The storm sewer is a 12" pipe and was carrying approximately 4" of flow when observed.

If funds are available, a more detailed investigation of this line is in order.

h. Conclusions and Recommendations

Although it is indicated that the I/I for the overall sewer system in the City of Cheyenne is non-excessive, a more thorough investigation of certain sections of the city may be beneficial. Since I/I is non-excessive as a whole, such an investigation is not eligible for funding through the EPA. Plans for such an undertaking are already developed for the sewerage on the Francis E. Warren Air Force Base. The 15" line above Belaire Ave., Grier Blvd., and Henderson Dr. and the 27" line above Maxwell Ave., between 2nd and 3rd Streets, should be studied in detail. The possible existence of inflow into the sanitary sewer system by means of cross-connections with the storm sewer system should be more extensively researched.

With the exception of the above mentioned lines, it appears that the City of Cheyenne has a relatively tight sewer system. This sewer system is also maintained by a very organized program which prevents the development of more difficult problems (tree roots, oil, grease, etc.).

IV. Soils Evaluation

A. Purpose

There has been significant growth in Cheyenne and the surrounding area in recent years. The vast majority of growth outside the city limits utilizes onsite wastewater treatment employing septic tanks followed by absorption fields. In the past, conventional soil absorption fields have at times been installed on land that is not suitable for this type of application, resulting in potentially serious health hazards. Contaminated wells may result when septic tank effluent enters the groundwater following a soil absorption field that was installed in an area with unsuitable geologic or soil conditions.

Soil Conservation Service information and information from the City/County Environmental Health Unit, coupled with field investigations by Banner Associates, were used to develop a detailed discussion of the soils that are present in housing developments throughout the study area. This information is discussed and presented on a map in Appendix G and identifies areas that pose potential difficulties for onsite wastewater treatment. The reader desiring specific information regarding a particular development is referred to Appendix G. Currently, the action of the City Planning Office and the City/County Environmental Health Unit effectively eliminates development of areas with conditions that are unsuitable for onsite wastewater treatment.

B. Properties of Soils

Large portions of the 201 study area adjacent to the city limits are relatively densely populated. These areas include South Cheyenne, Sunnyside Addition, and North Cheyenne. Although South Cheyenne has its own wastewater treatment facilities, Sunnyside and North Cheyenne rely on onsite wastewater treatment, i.e., septic tanks and absorption fields, and obtain their water supply from onsite wells. Extensive soil data was collected to determine how conducive the soils in the Sunnyside and North Cheyenne areas are for proper onsite wastewater treatment.

Most soils, with proper planning, are capable of effective wastewater treatment, provided ambient groundwater and geological conditions are suitable. The depth to bedrock or other impermeable layers must be great enough to transmit and treat wastewater in the soil strata above. The depth to groundwater must also be great enough to treat septic tank effluent before discharging it into the groundwater. Soil has the capacity to treat organic and inorganic materials and pathogens by acting as a filter, cation exchanger, and adsorber.

The main strength of soil in wastewater treatment is its ability to retain organic matter found in wastewater in the pores of the soil as the septic tank effluent is passed through. This ability is optimal when the soil is unsaturated because as the soil becomes saturated the small pores fill with water first and it is in these pores that the most effective retention of organics (suspended solids) occurs. If the soil is saturated, the wastewater will pass only through the large pores and the adsorption of the organics in the effluent is minimal.

Another factor related to the soil's ability to retain wastewater particles is the soil's Cation Exchange Capacity (CEC). Most soil particles are negatively charged; therefore, they attract and hold positively charged particles such as those found in domestic wastewater. The total charge on the surface of the soil system is measured and included in Soil Conservation Service information.

Regardless of soil type available for onsite treatment, several factors limiting treatment effectiveness must be taken into consideration. These limitations include: groundwater level, soil depth, slope of terrain, proximity to streams and lakes and flood plains, and population density. These limitations are discussed later under the descriptions of individual test sites.

C. Problems Associated with Onsite Treatment

Effective onsite treatment is essential to health and safety, especially in moderately populated areas. The growth in the study area and the increased cost of land and housing have eliminated the luxury of large acreages for many people. Consequently, absorption fields have been placed on lots that are not properly designed or large enough to handle the volumes of wastewater applied to them. As a result some wells have been located dangerously close to absorption fields.

Several hazards exist in association with poor wastewater treatment. The first and most obvious occurs when unfiltered sewage reaches the surface. Flooding, high groundwater, poor soil conditions, or other means of saturating the absorption field, or improperly maintained septic tanks could cause wastewater to reach the surface causing an unhealthy miasma. This not only looks bad and causes unpleasant odors but also attracts flies and other disease-bearing insects.

Another threat to health and environment occurs when improperly treated wastewater is discharged into surface waters from nearby developments. The waters become nutrient-enriched causing excessive growth of undesirable vegetation, impeding growth of marine life and limiting industrial and domestic use of the water.

A third problem and probably the most applicable to the study area is well contamination attributed to inadequately treated septic tank effluent. Mr. Gary Hickman of the Laramie County Environmental Health Unit provided extensive information on this problem in the Cheyenne area. Figure B-V-19, Working Paper No. 3, shows the exact locations of contaminated wells.

When the soil in an area is improperly suited for an absorption field or an absorption field and a well are in too close proximity, high nitrate concentrations in well water may exist. High nitrate concentration in well water may also result from livestock manure, petroleum products, nitrogen rich fertilizer, runoff water from subdivisions containing lawn fertilizer and waste, and from naturally occurring deposits. The EPA allowable limit for nitrate concentrations in drinking water is 45 mg/l-NO_3^-. This expresses the nitrate concentration in terms of NO_3^-. Nitrate concentration may also be expressed in terms of the amount of nitrogen present by the following calculation:

$$(45 \text{ mg/l } NO_3^-) \frac{14 \text{ mg N}}{62 \text{ mg } NO_3^-} = 10.16 \text{ mg/l } NO_3^- \text{-N}$$

where: 14 = atomic weight of nitrogen

62 = molecular weight of nitrate

The EPA Drinking Water Standards recommend that the upper limit on nitrate for public water supplies be 10 mg/l NO_3^--N. This is approximately equivalent to 45 mg/l NO_3^-. Nitrate concentrations reported in this paper are in terms of nitrate, i.e. 45 mg/l NO_3^-. High concentrations of nitrates are credited for the disease methemoglobinemia, a blood disease found in children less than four months of age. The disease renders an infant's red blood cells incapable of combining with molecular oxygen and leads to asphixia.

Raw wastewater contains nitrogen combined in proteinaceous matter and urea. Bacteria consume this matter converting the nitrogen to ammonia (NH_3-N). Ammonia is oxidized first to nitrite (NO_2-N) and then to nitrate (NO_3-N).

Available data indicates approximately 2-10% of the total nitrogen from household waste will be removed in the septic tank. Biological denitrification is carried out if a sufficient organic carbon source is present. Septic tank effluent can serve as an organic carbon source. Also, an outside carbon source, such as methanol, may be required to provide the appropriate carbon to nitrogen ratio of approximately three-to-one. Operation and maintenance requirements for denitrification systems are normally complex and call for semi-skilled labor for proper performance. When a system is improperly maintained, high nitrate concentrations result in the ambient soil environment, a condition that has been recorded in part of Laramie County -- more specifically, in heavily developed areas adjacent to Cheyenne.

The depth of soil needed for effective onsite treatment is determined by the soil permeability. Fine-textured or clayey soils have small, discontinuous pores and act as an excellent solids filter. Clayey soils, however, retain water for a long period of time and do not drain well, which could result in untreated sewage reaching the surface in the event of heavy precipitation. As a result, a very large land area is required to handle average volumes of household wastewater.

On the other end of the soil spectrum are the coarse-textured or sandy soils. Sandy soils have large, continuous pores and drain very well. Sandy soils, due to their rapid draining characteristics, do not filter very well which could result in partially treated sewage being discharged into the groundwater. As a result a very deep absorption field is required to treat average volumes of household wastewater.

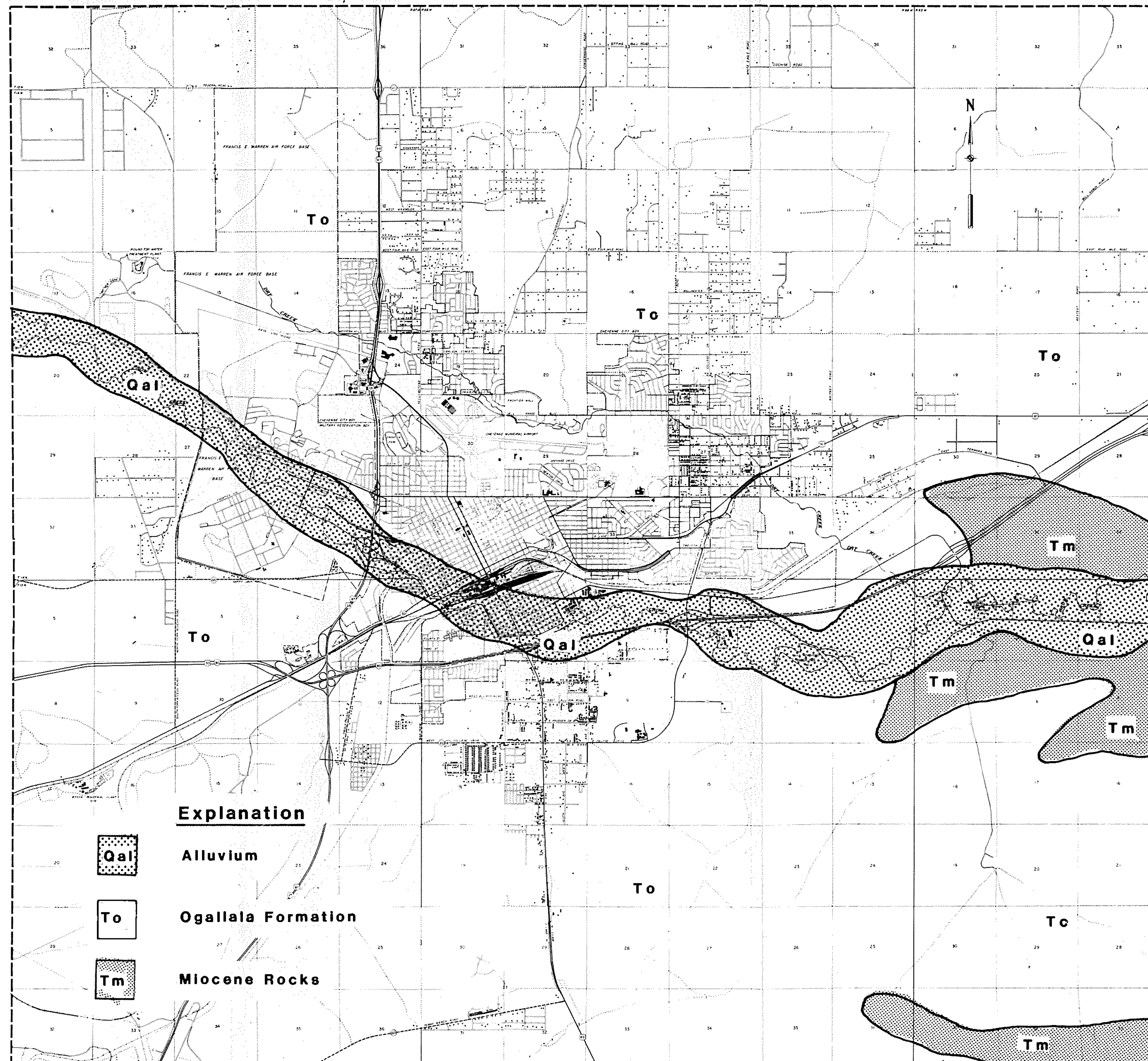
Loamy soils, on the other hand, fall somewhere between clayey soils and sandy soils. Loamy soils contain large pores which accept and transmit wastewater at a moderate rate and small pores which provide better filtering characteristics. Loamy soils are best suited for septic tank absorption fields.

D. Description of the Study Area

The study area is located in the southeast corner of Wyoming and is situated within the northern portion of the Denver Basin. The Denver Basin in this locality is flanked by the Laramie Mountains to the west and is part of the Great Plains physiographic province.

The topography of the area includes very few flood plains associated with nearly level old fans and gently rolling to steeply sloping terraces. Elevations range from 6000 to 6500 feet, with the majority of the area drained by Crow Creek.

A surficial geologic map of the Cheyenne area is presented in Figure E-30. The surface geology is composed of nearly horizontal Tertiary strata of Oligocene and Pliocene age along with Quaternary alluvium. The



CHEYENNE, WYOMING

DRAWN BY: CMP	DATE JAN 82	BANNER ASSOCIATES, INC. — CONSULTING ENGINEERS P.O. BOX 550, LARAMIE, WY 82070 · (307) 745-7366	STUDY AREA SURFACE GEOLOGY	FIGURE F-30
CK'D BY: JIC	JOB NO. 1767			

Pliocene Ogallala Formation has the greatest surface exposure in the area. The Ogallala is composed of light-colored limy conglomerate, sandstone, and claystone with some volcanic tuff present, also. Underlying Miocene rocks consist of massive soft tuftaceous sandstone and white marl that lie above coarse-grained arkosic sandstone and conglomerate. The Quaternary alluvium contains unconsolidated and poorly consolidated lenses of clay, silt, sand, and gravel. Alluvium is most abundant along Crow Creek and also occurs in smaller drainages.

The study area is classified as semiarid. The mean annual precipitation is about 15 inches, and the mean annual temperature is 40°F (mean summer, 67°F). The frost-free season is between 120 and 140 days.

E. Soil Tests

1. Procedure

The soil testing performed consisted of percolation tests. Percolation tests are performed to measure the rate at which water will percolate through the soil on a given site by giving an approximate measure of the soil's saturated hydraulic conductivity. The results of the percolation tests when coordinated with Soil Conservation Service data and groundwater and geological data are useful in determining the soil's susceptibility to onsite wastewater treatment.

All tests were performed in accordance with EPA standards as delineated in EPA manual #625/1-80-012, Onsite Wastewater Treatment and Disposal Systems, and are outlined below:

1. A minimum of three percolation tests, spaced uniformly throughout the proposed absorption field site, are performed.
2. The diameter of each test hole is four to twelve inches dug to the proposed depth of the absorption system. The sides and bottom are then scratched with a sharp, pointed instrument to expose the natural soil

surface. All loose material is removed from the bottom of the test hole. Two inches of ½- to 3/4-inch diameter gravel is placed in the bottom of the hole to protect from scouring when the water is added.

3. The hole is carefully filled with at least 12 inches of clear water. This depth is maintained for at least four hours. This produces the saturated soil effect and will allow clay soils (if present) such as bentonite and vermiculite to swell for consistent results. In sandy soils with little or no clay, soaking is not necessary. If, after filling the hole twice with 12 inches of water, the water seeps completely away in less than ten minutes, the test can proceed immediately.

4. Percolation measurements are made between 15 and 30 hours after the soaking period. Any soil sloughed into the hole during the soaking period is removed, and the water level is adjusted to six inches.

   Immediately after adjustment the water level is measured from a fixed reference point to the nearest 5/100 inch at 30-minute intervals. The test is continued until two successive water level drops do not vary by more than 1/10 inch. At least three measurements are made.

   After each measurement the water level is readjusted to the six-inch level. The last water level drop is used to calculate the percolation rate.

   In sandy soils water level measurements are recorded at 10-minute intervals for a one-hour period. The last water level drop is used to calculate the percolation rate.

5. Percolation rate is calculated for each hole by dividing the time interval used by the last water level drop. Percolation rate for the site is calculated by averaging the rates of the individual test holes.

The areas chosen for soils evaluation were the northeastern portion of the study area known as the Sunnyside Addition (Section 27, T14N, R66W) and northwest of Cheyenne in the vicinity of Yellowstone Road and Western Hills Boulevard (Section 13, T14N, R67W). The specific test sites were chosen with the cooperation of Gary Hickman, Laramie County Environmental Health Unit, who is familiar with and has helped coordinate the various chemical analyses of the area's well water. These areas were selected for two reasons:

1. Sunnyside Addition and North Cheyenne are areas with documented water quality problems.
2. In the 201 population projection it was predicted that a large portion of the population influx for the study period will be supported by these two areas, making it a necessity to study the adaptability of these areas to onsite wastewater treatment.

2. Percolation Tests

Percolation test #1 was performed July 7, 1981, at the intersection of Rawlins and Cleveland Streets on a vacant lot in the northeast quadrant of the intersection. The site is located in a low-lying area (near Dry Creek), sparsely vegetated, and has approximately 3-6% slope. The site is located outside the city limits, and the surrounding area is fairly densely populated.

The first three to five inches of soil removed appeared to be topsoil followed by approximately fifteen inches of a dark brown loamy clay soil followed by sixteen inches of a silty clay loam. The soil is very deep and poorly drained and has high cation exchange capacity. The true piezometric head (water table) is between 30 and 40 feet. It is believed, however, that a perched water table exists in this area. A well monitored by the county within 1000 feet of the test site is located at a mean depth (from

February 1976, to May 1979) of less than three feet to groundwater. A perched water table exists when groundwater is trapped above an impermeable layer at an elevaation above the true piezometric water table. It is suspected that a dense clay layer exists due to alternating sand, silt, and clay layers deposited by Dry Creek in this alluvial valley, causing the perched water table.

Three test holes were dug and tested for percolation rates. The average rate for the site was computed to be 54 min/inch or 1.13 inches/hour, which falls under EPA estimated values for a silty clay loam (Table E-12).

Table E-12
Estimated Hydraulic Characteristics of Soil

Soil Texture	Permeability (in/hr)	Percolation (min/in)
Sand	>6.0	<10
Sandy loams Porous silt loams Sandy clay loams	0.2-6.0	10-45
Clays, compact Silt loams Silty clay loams	<0.2	>45

SCS Soil Classifications

Soil #	Soil Series	Depth (in)	Texture	Factors Limiting Application To Onsite Use
22	Bridget	0- 7	Fine Sandy Loam	Severe-Percolates Slowly
		7-60	Silty Loam	
36	Albinas	3-25	Sandy Clay Loam	Slight
		25-60	Loam	
42	Ascalon	7-18	Sandy Clay Loam	Slight
		18-25	Sandy Loam	
46	Archerson	0- 6	Fine Sandy Loam	Severe-Percolates Rapidly
		6-24	Sandy Clay Loam	
		24-60	Gravelly Sand	
162& 163	Trelona	0-14	Fine Sandy Loam	Severe-Soil too Shallow
		14-	Bedrock	
223	Kirkhom	0-44	Silty Clay Loam	Severe-Flooding, Wet, Percolates Slowly
242	Archerson-Dix Complex		Sands and Gravels	Severe-Percolates Rapidly

The size of absorption field required is normally determined by the volume of wastewater to be filtered and the absorption capacity of the soil. The amount of wastewater to be filtered can be estimated from the number of bedrooms per household. A graph adapted from Manual of Septic Tank Practice, U. S. Department of Health, Education, and Welfare, is included in this report (Figure F-31). According to these standards approximately 325 square feet per bedroom would be required to effectively treat wastewater flow.

Percolation test #2 was performed July 9 on a vacant lot in the northwest quadrant of the intersection of Rawlins and McCann Streets. The site is located on the border of the city limits and Sunnyside Addition, on an upland of 6-8% slope, and the surrounding area is relatively densely population.

The first three to five inches of soil removed was topsoil, followed by 36 inches of a dark brown sandy loam. This soil is characteristically very deep and well-drained, and has high cation exchange capacity. The true water table is 40-50 feet deep, but again the possibility of a perched water table exists.

Three holes were tested, and the average rate for the site was computed to be 19 min/inch or 3.3 inches/hour, which coincides with EPA values for a sandy loam.

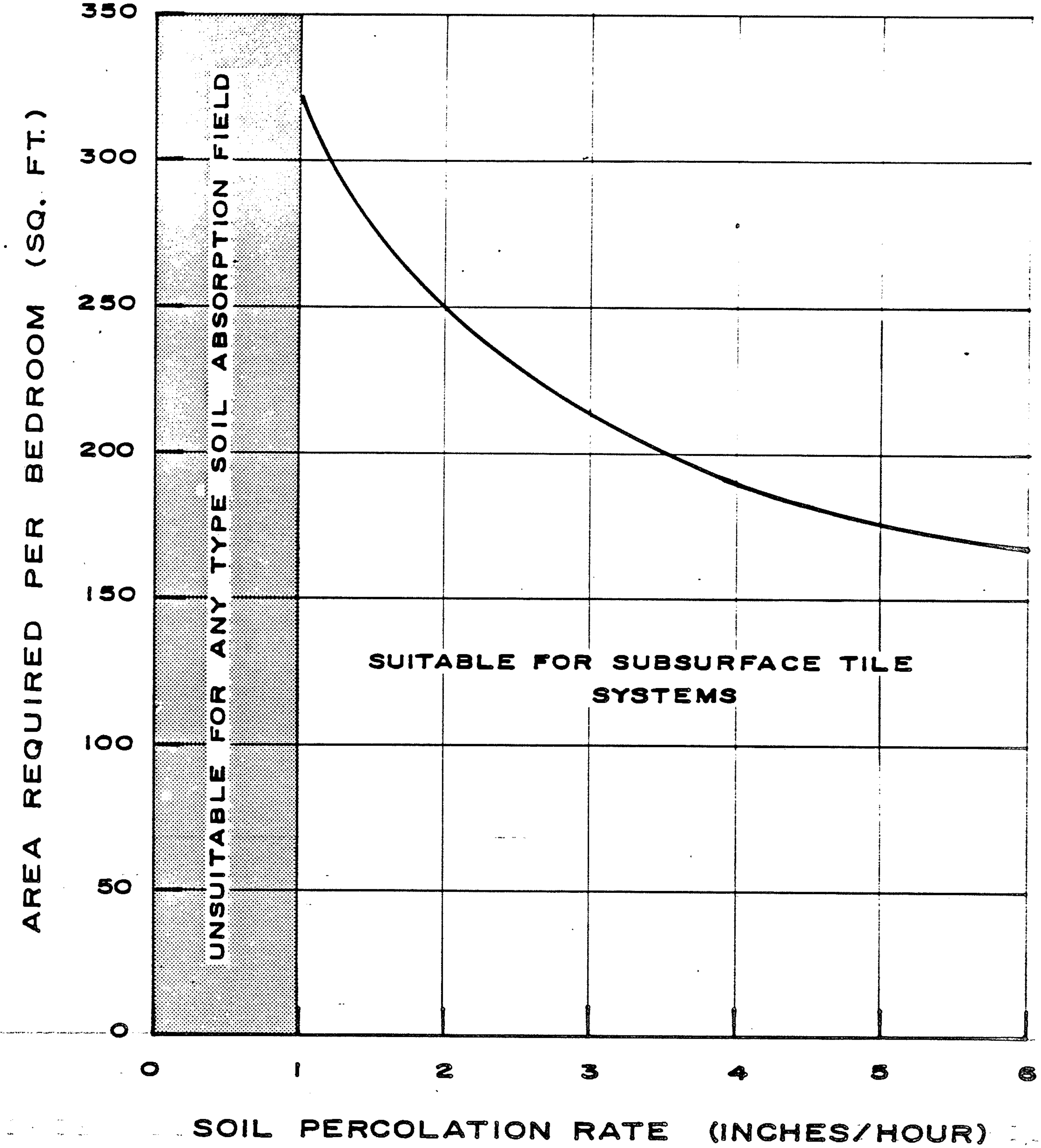
The size of absorption field required would be approximately 200 square feet per bedroom. In a soil that percolates this rapidly, the danger of discharging partially treated waste into groundwater is high, particularly where perched water tables may exist near the surface, which would be a possible explanation of high nitrate concentration in the wells in this area.

Percolation test #3 was performed on July 10, in the southwest quadrant of the intersection of Monroe and Rock Springs Street. The lot was very densely vegetated and level. The site was low-lying, next to a drainage ditch, and very near Dry Creek. The site is located outside the city limits in a moderately populated area in Sunnyside Addition.

The first 12 inches of soil were a dark brown sandy clay loam; the next 14 inches were sandy clay loam. The tests were performed two days after a rainstorm, and the ground was still extremely moist. The soils are deep and very poorly drained with the true water table at approximately 30 feet but are probably located above a perched water table (a well within 500' of the site has been monitored by the county at a mean depth from May 1976 to October 1979, of 2.5 feet). The soil has a relatively high CEC.

Four holes were tested, and the average percolation rate for the area was computed to be 30.88 minutes/inch or 2.1 inches/hour, which concurs with EPA guidelines for sandy clay loams.

The size absorption field necessary to handle sewage volume would be approximately 250 square feet per bedroom. It should be considered risky to use absorption fields in this area due to water table information



PERCOLATION RATE VS REQUIRED ABSORPTION FIELD AREA

FIGURE F-31

and the danger of flooding from Dry Creek which destroys absorption field capacity.

Percolation test #4 was performed on July 17, north of Cheyenne city limits, southwest of the intersection of Prairie Hills Drive and Plains Avenue on a vacant lot with 2-5% slope, very arid, and sparsely vegetated. The region is moderately populated.

The first 3 inches of soil were a brown silty sand with the following 24 inches being sand.

The soil is moderately deep, well drained with the water table located at 50- to 60-foot depths, and again the possibility exists of isolated perched water tables in the area.

Three holes were tested, and a very rapid average percolation rate was computed: 6 minutes/inch or 11 inches/hour, which coincides with EPA standards for sandy soils.

Absorption fields in soils of this type must be very carefully constructed. This soil type has very large pores, and filtering is minimal; therefore, before an absorption field is located in a soil of this type, extensive testing of the exact location of the absorption field should be conducted, and other alternative waste disposal systems should be considered.

Percolation test #5 was performed on July 23 on a vacant lot north of Western Hills Boulevard and west of Osage Avenue. The area was moderately populated and arid, with sparse vegetation on slopes from 0 to 5%.

The first 25 inches of soil was a medium brown loam, the next 12 inches being a light brown sandy loam. The soil is deep and well drained. The cation exchange capacity is high in the upper strata and low in the lower strata. Groundwater depth is approximately 50 feet. The possibility of perched water table exists at this site as a county-monitored well within 2000 feet of the test site has recorded water table as high as 8.6 feet below surface in the past five years.

Three holes on this site were tested, and a moderate to rapid average percolation was computed: 20 min/inch or 4.5 inches/hour, which is consistent with EPA rates for a sandy loam.

The approximate area for an absorption field for this type of soil would be 175 square feet per bedroom. Information from Soil Conservation Service indicates that at greater depths exist a very coarse grained gravely sand which combined with groundwater information could limit the use of absorption fields on sites such as this. Other alternatives should be considered, and extensive testing should be performed before any treatment facilities are constructed.

Percolation test #6 was performed July 28, south of the intersection of Sioux and Prairie Hills Drives. The lot is located in a relatively densely populated area and is sparsely vegetated and arid. The first 2-5 inches of soil were topsoil, followed by six inches of brown sandy loam, followed by 24 inches of light brown sandy loam. The percolation rates and characteristics of this soil can be classified the same as those for perc site #5.

3. Summary and Conclusions

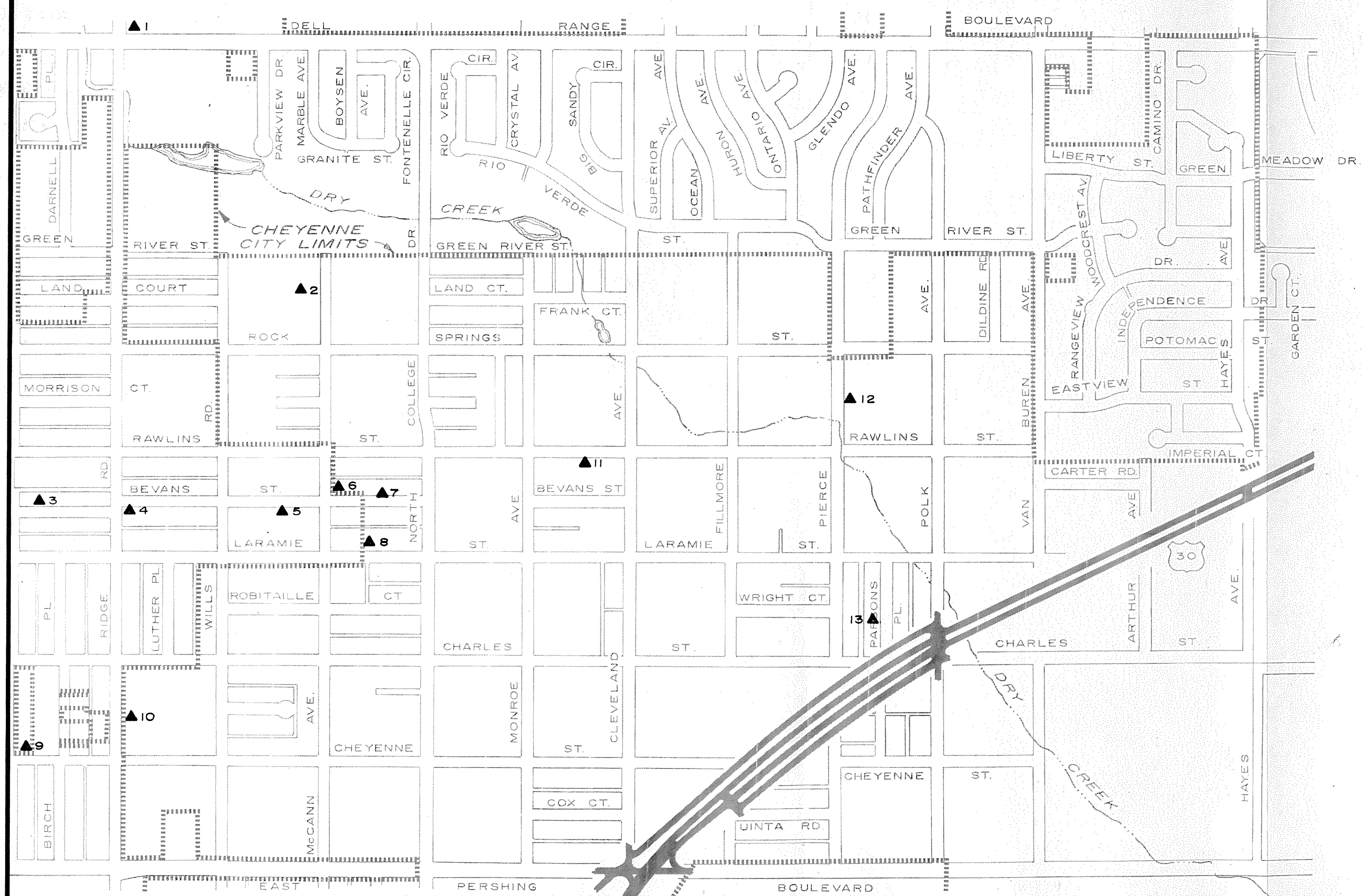
After several locations in Sunnyside Addition and North Cheyenne were tested, all locations were found to be somewhat limited to severely limited in ability to adequately treat septic tank effluent. Although not all possible sites for absorption fields could be tested and some soils may be very well suited to waste treatment, a fairly good cross section of the soil available to future growth was selected.

The large, relatively unpopulated area to the east of Sunnyside (Section 26, T14N, R66W) contains about 50% soils of slight to moderate limitations for onsite treatment characterized by sandy clay loams (moderate) and fine sandy loams (slight) as labeled by the Soil Conservation Service. The other 50% of the soils has severe limitations or is unsuitable to onsite treatment. These are characterized by poorly drained silty sediments (along Dry Creek) and a large area of fine alluvial sediments.

The large, relatively unpopulated area to the northeast of Cheyenne (Sections 22 and 23, T14N, R66W) has a very large portion of soils that are very shallow to bedrock leaving them totally unacceptable for absorption fields. Much of the area is on slopes that are undesirable for absorption fields, and some soils are poorly drained alluvial sediments also poorly suited for absorption fields. Only approximately 20% of the area is characterized by soil well suited for absorption fields classified as fine sandy loams.

This data indicates that alternative methods of onsite wastewater disposal must be implemented as opposed to the conventional septic tank and absorption field to handle future growth in these areas. Briefly, some alternatives to conventional onsite treatment include: ion exchange units, intermittent sand filters, aerobic treatment units, in-house segregation (graywater from blackwater), denitrification mechanisms, trench and bed systems, mound systems, seepage pits, fill systems, artificially drained systems (drain high groundwater), evaporation systems, and cluster systems. Connection of these private systems with City water and sewer services is also an option. These alternatives are fully discussed in Working Paper No. 3.

Another problem encountered while performing these tests was the local residents' lack of information as to what constitutes proper wastewater treatment, the hazards of improper treatment, and alternatives to the standard methods that can be employed. The residents of these problem areas need to be better informed and educated as to what the existing problems are, and what can be done to alleviate them. It is recommended that a public education program involving the City/County Health Unit, State Department of Health and Social Services, State Department of Environmental Quality, and 201 Advisory Committee be initiated. Such a program should prove beneficial in preventing the development of hazardous onsite wastewater treatment situations.



LEGEND

NOTE: NITRATE CONCENTRATIONS DETERMINED BY ENVIRONMENTAL HEALTH OFFICE

▲2 NITRATE CONCENTRATIONS IN WELL WATER

1 DEL RANGE & RIDGE RD. 205 mg/l
2 47 mg/l
3 43 mg/l
4 a) 45 mg/l
  b) 51 mg/l
  c) 90 mg/l
5 56 mg/l
6 35 mg/l
7 a) 67 mg/l
  b) 73 mg/l
8 50.5 mg/l
9 55 mg/l
10 43 mg/l
11 35 mg/l
12 a) 53 mg/l
  b) 71 mg/l
13 64 mg/l

DRAWN BY: DAMc	DATE JAN 82	BANNER ASSOCIATES, INC. — CONSULTING ENGINEERS P.O. BOX 550, LARAMIE, WY 82070 · (307) 745-7366	SUNNYSIDE AREA HIGH NITRATE CONCENTRATE IN WELL WATER	FIGURE F-32
CK'D BY: JIC	JOB NO. 1767			

APPENDIX G

CHEYENNE STEP I 201 REPORT

SOILS OF HOUSING DEVELOPMENTS
WITHIN THE 201 STUDY AREA
BUT OUTSIDE CHEYENNE CITY LIMITS

APPENDIX G

SOILS OF HOUSING DEVELOPMENTS WITHIN THE 201 STUDY AREA BUT OUTSIDE CHEYENNE CITY LIMITS

I. Introduction

1. Purpose

In recent years there has been significant growth in the area surrounding Cheyenne. The vast majority of growth outside the city limits utilizes onsite wastewater treatment systems employing septic tanks followed by absorption fields. In the past conventional soil absorption fields have at times been installed on lands that are not suitable for this type of application, resulting in potentially serious health hazards. Contaminated wells may result when septic tank effluent enters the groundwater following soil absorption field installations in areas with unsuitable geologic or soil conditions.

It is the intent of this soils evaluation to determine the suitability of soils in developing areas surrounding Cheyenne to adequately treat septic tank effluent. Data was obtained from the Soil Conservation Service, City-County Health Unit, Environmental Health Unit, Environmental Protection Agency, and field investigations by Banner Associates. These data were coordinated to achieve the results and conclusions of this evaluation.

Current ranchette development within the 201 Study Area is occurring in a number of locations. The soils in areas where development is presently occurring in the study area, and where development is likely to occur, are examined in this paper. Each soil type will be discussed regarding its capabilities of supporting onsite drainage field disposal of septic tank effluent.

The goal of this appendix is to identify such lands that pose potential problems regarding the use of conventional onsite wastewater treatment systems. By the identification of such lands, future difficulties regarding area development may be avoided with consequential savings of both time and money. Existing developments, some of which occupy parts of more than one section, are discussed, and general recommendations are presented.

2. Area Geology

The study area is located in the southeast corner of Wyoming and is situated within the northern portion of the Denver Basin. The Denver Basin in this locality is flanked by the Laramie Mountains to the west and is part of the Great Plains physiographic province. The area includes very few flood plains associated with nearly level old fans and gently rolling to steeply sloping terraces. Elevations range from 6000 to 6500 feet, with the majority of the area drained by Crow Creek. The surface geology is composed of nearly horizontal Tertiary strata of Oligocene and Pliocene age along with Quaternary alluvium. The Pliocene Ogallala Formation has the greatest surface exposure in the area. The Ogallala is composed of light-colored limy conglomerate, sandstone, and claystone with some volcanic tuff present, also. Underlying Miocene rocks consist of massive soft tuftaceous sandstone and white marl that lie above coarse-grained arkosic sandstone and conglomerate. The Quaternary alluvium contains unconsolidated and poorly consolidated lenses of clay, silt, sand, and gravel. Alluvium is most abundant along Crow Creek and also occurs in smaller drainages.

The soil classifications presented are taken from the U. S. Soil Conservation Service Cheyenne City Report, Cheyenne, Wyoming, as developed by Abe Stevenson, Soil Scientist, in 1976. Each soil type is given a limitation rating of slight, moderate, or severe regarding its use as a septic tank effluent absorption field. A rating of slight indicates that the soil has properties favorable for operation of an absorption field, including permeability, slope, and depth to bedrock. A rating of moderate is given to those soils that have properties that limit to some extent operation of conventional absorption fields. For these soils, extensive onsite testing and careful planning are required to compensate for the limitations imposed by the soil. Soils that are rated severe have properties that are not satisfactory for operation of conventional absorption fields. Soils with moderate or severe ratings do not necessarily preclude the use of onsite wastewater treatment. Onsite treatment on these soils requires the investigation of alternative and innovative treatment technologies.

3. General Soil Properties

Most soils, with proper planning, are capable of effective wastewater treatment, provided ambient groundwater and geological conditions are suitable. The depth to bedrock or other impermeable layers must be great enough to transmit and treat wastewater in the soil strata above. The depth to groundwater must also be great enough to treat septic tank effluent before discharging it into the groundwater. Soil has the capacity to treat organic and inorganic materials and pathogens by acting as a filter, cation exchanger, and adsorber.

The main strength of soil in wastewater treatment is its ability to retain organic matter found in wastewater in the pores of the soil as the septic tank effluent is passed through. This ability is optimal when the soil is unsaturated because as the soil becomes saturated the small pores fill with water first and it is in these pores that the most effective retention of organics (suspended solids) occurs. If the soil is saturated, the wastewater will pass only through the large pores and the adsorption of the organics in the effluent is minimal.

Regardless of soil type available for onsite treatment, several factors limiting treatment effectiveness must be taken into consideration. These limitations include: groundwater level, soil depth, slope of terrain, proximity to streams and lakes and flood plains, and population density. These limitations are discussed later under the descriptions of individual developments.

4. Problems Associated with Onsite Treatment

Effective onsite treatment is essential to health and safety especially in moderately populated areas. The growth in the study area and the increased cost of land and housing have eliminated the luxury of large acreages for many people. Consequently, absorption fields may have been placed on lots that are not properly designed or large enough to handle the volumes of wastewater applied to them. As a result some wells have been located dangerously close to absorption fields.

Several hazards exist in association with poor wastewater treatment. The first and most obvious occurs when unfiltered sewage reaches the surface. Flooding, high groundwater, poor soil conditions, or improperly maintained septic tanks could cause wastewater to reach the surface causing an unhealthy miasma. This not only looks bad and causes unpleasant odors but also attracts flies and other disease-bearing insects.

Another threat to health and environment occurs when improperly treated wastewater is discharged into surface waters from nearby developments. The waters become nutrient-enriched causing excessive growth of undesirable vegetation, impeding growth of marine life and limiting industrial and domestic use of the water.

A third problem and probably the most applicable to the study area is groundwater contamination attributed to inadequately treated septic tank effluent. Mr. Gary Hickman of the City-County Health Unit, Division of Environmental Health, provided extensive information on this problem in the Cheyenne area. When the soil in an area is improperly suited for an absorption field or an absorption field and a well are in too close proximity, high nitrate concentrations in well water may develop. High nitrate concentration in well water may also result from livestock manure, petroleum products, nitrogen rich fertilizer, runoff water from subdivisions containing lawn fertilizer and waste, and from naturally occurring deposits. The EPA allowable limit for nitrate concentrations in drinking water is 45 mg/l (10 mg/l NO_3-N; in terms of the amount of nitrogen present). High concentrations of nitrates are credited for the disease methemoglobinemia, a blood disease found in children less than four months of age. The disease renders an infant's red blood cells incapable of combining with molecular oxygen leading to asphixia.

Raw wastewater contains nitrogen combined in proteinaceous matter and urea. Bacteria consume this matter converting the nitrogen to ammonia (NH_3-N). Ammonia is oxidized first to nitrite (NO_2-N) and then to nitrate (NO_3-N). Available data indicates approximately 2-10% of the total nitrogen from household waste will be removed in the septic tank. Biological denitrification is carried out if a sufficient organic carbon source is present. An outside carbon source, such as methanol, may be required to provide the appropriate carbon to nitrogen ratio of approximately three-to-one. Operation and maintenance requirements for denitrification systems are normally complex and call for semi-skilled labor for proper performance. When a system is improperly maintained, high nitrate concentrations result in the ambient soil environment, a condition that has been recorded in part of Laramie County -- more specifically, heavily developed areas adjacent to the Cheyenne city limits.

The depth of soil needed for effective onsite treatment is determined by the soil permeability. Fine-textured or clayey soils have small, discontinuous pores and act as an excellent solids filter. Clayey soils, however, retain water for a long period of time and do not drain well, which could result in untreated sewage reaching the surface in the event of heavy precipitation. As a result a very large land area is required to handle average volumes of household wastewater. On the other end of the soil spectrum are the coarse-textured or sandy soils. Sandy soils have large, continuous pores and drain very well. Sandy soils, due to their rapid draining characteristics, do not filter very well which could result in partially treated sewage being discharged into the groundwater. As a result a very deep absorption field is required to treat average volumes of household wastewater. Loamy soils, on the other hand, fall somewhere between clayey soils and sandy soils. Loamy soils contain large pores which accept and transmit wastewater at a moderate rate and small pores which provide better filtering characteristics. Loamy soils are best suited for septic tank absorption fields.

II. Area Development Soils Evaluations

1. Murray Hill Estates, Project "N", and Sunset Tracts/Longview Homesites

These developments are all within Section 1, T14N, R67W and are zoned R-2 (medium density residential zone). The zoning laws for R-2 zoned areas state that approximately one-fifth acre per household for single family dwellings is required (8,500 square feet) unless the lot was recorded prior to the adoption of these regulations (1978). There exists some confusion in the Cheyenne zoning office regarding this figure. The minimum required lot size for R-1 zoning (low density residential) is listed as 7500 square feet for single family dwelling according to zoning laws published in 1978. A newer edition indicates this area to be 8000 square feet. The minimum required area for a single family dwelling zoned R-2 (medium density residential) is 8500 square feet. It appears that these numbers should be reversed; i.e., 8500 square foot minimum for R-1 and 8000 square foot minimum for R-2. The calculations presented in this section will assume this reversal. For two family dwellings, a minimum of 7000 square feet (3500 square feet/unit) is required for R-2 zoning. Townhouse structures may be built and require a total area of 8000 square feet (2000 square feet/unit minimum). Apartment complexes (multifamily dwellings) are also legal for this zoning, and require 10,000 square feet or 1000 square feet/unit minimum area.

The soil types found in this section include the Archerson series ranging in slope from 0-6% (SCS classification #46A and #46B) and the Archerson-Dix complex (242C and 242E) ranging in slope from 6-30% (SCS soil type classification, 1976).

The Archerson series, found in the Project "N" and the Sunset Tracts/Longview Homesites, has a slight limitation rating for septic tank absorption field use for slopes 0-8%, and a moderate classification for slopes greater than 8%. This soil has severe limitations for use of sewage lagoons or sanitary landfills due to seepage. Lots on slopes less than 8% should not encounter difficulties with conventional absorption fields. With an average percolation rate of 2.0 in/hr for depths up to 24", and a percolation rate ranging from 6.0-20.0 in/hr for depths from 24-60", the exact area per bedroom of the absorption field depends on the depth of the absorption field. As a preliminary estimation, the size required for an absorption field in an Archerson series soil would range from 160 square feet/bedroom (percolation rate 6.0 in/hr) to 250 square feet/bedroom (percolation rate 2.0 in/hr). The size required is not significantly reduced by percolation rates greater than 6 in/hr. A summary of the required area per bedroom for conventional absorption fields as determined by the soil type present is given in Table 5-3, at the conclusion of this section. For a minimum single family lot size of 8000 square feet, the use of conventional absorption fields must be very carefully investigated for size requirements associated with the particular dwelling in question. Adequate separation between the property boundary, the absorption field boundary, the well, and the dwelling must be provided. The 8000 square foot requirement is a minimum size, and the density of growth should be carefully watched to insure the continued successful operation of all absorption fields.

The Archerson-Dix complex (242C and 242E) is found in the Murray Hill complex as well as in Project "N" and the Sunset Tracts/Longview Homesites and is interspersed with the Archerson series. This soil complex is comprised of roughly 40% Archerson series, 30% Dix series, and 30% Calicott and other soils. The Dix series is characterized by very deep, well drained, gravelly loams with rapid permeability. This series has slight absorption field limitations for slopes 0-8%, moderate for slopes of 8-15% and severe limitations on sites with slopes greater than 15%. Sewage lagoons and sanitary landfills each have a severe rating and should not be used on these soils.

Future development in Section 1, T14N, R67W with onsite wastewater treatment employing conventional absorption fields must be carefully scrutinized regarding the slope of the area in question. Conventional absorption fields should normally not be used on sites with a slope greater than 15%, and may be used only after intensive onsite investigation when the slope ranges from 8-15%. Absorption fields may be possible on these steep sloped sites if the slope of the absorption field area can be reduced by grading, ditching, and excavation.

A "C zone" floodplain extends through the Sunset tracts. The County Engineer is responsible for reviewing the request for placement of any structure within the flood zone. Approval is given only if the County Engineer determines that the placement of the structure will not result in any increase in flood levels during the base flood discharge.

2. Gray Fox Estates, Francis Homesites

These developments are located in the NW¼ Section 6, T14N, R66W and are zoned A-1. The minimum lot size required is 2½ acres unless the dwelling is provided with public water and sewer. The soil types found in these developments include Archerson loam (slope 0-3%), Archerson-Dix complex (slope 6-10%), and Archerson-Dix complex (slope 10-30%). The Archerson loam is found on Lots 1 and 2 of the Gray Fox Estates, and also in a great part of the Francis Homesites, and has a slight limitation rating for absorption field application. Conventional absorption fields should pose no difficulties in these areas. Moderate to severe absorption field limitations do exist in the rest of this area depending on slope. Site by site evaluation should be undertaken to insure that conventional absorption fields are installed only where the slope allows them, or where additional site grading will reduce the slope to an acceptable level.

The minimum absorption field area required for soils in these developments, as well as for all soils discussed below, is given in Table 5-3, in the summary and conclusion of this section.

3. Suburban Heights, All America Subdivision, Romsa Addition and Riding Club Estates

These areas are all within Section 6, T14N, R66W and are zoned R-2 (except for Lots 1-7 of the Riding Club Estates, which are zoned A-1). The development restrictions associated with each of these zones have been previously discussed. The soil types found in these areas include Archerson loam (0-6% slope) and Archerson-Dix complex (6-30%). The restrictions associated with the use of conventional absorption fields were discussed above, and must not be overlooked in future development of these areas.

A strip of Albinas loam (1-3% slope) extends from the SE corner of this section to the vicinity of Lot 12 of the Riding Club Estates. Albinas loam is moderately permeable and has a moderate restriction rating for absorption field application. This rating is due to the relatively slow percolation rate. Use of conventional absorption fields in this soil must be investigated on a case by case basis, and development at a density greater than 2½ acres/household may create difficulties.

4. Wyoming Ranchettes and Wyoming Ranchettes II

Wyoming Ranchettes and Wyoming Ranchettes II are located in Sections 33 and 35, T15N, R66W, respectively, and are zoned A-1, requiring a minimum of 2½ acres/household. The soils found in the Wyoming Ranchettes area include Archerson loam (0-6% slope) and Archerson-Dix complex (6-10% slope). The restrictions for absorption field installations are similar to those indicated above, with slope being the primary limitation.

The Wyoming Ranchettes II development, in Section 35, T15N, R66W, contains primarily Archerson loam (0-3% slope) and Archerson-Dix complex soils (with the above mentioned restrictions). Also found in this area is the Trelona-Rock Outcrop complex (3-30% slope). The Trelona-Rock Outcrop complex is comprised of about 40% Trelona soils, which are shallow, well-drained loams on side slopes, ridges, and terraces. The underlying bedrock is at a depth of 15 to 20 inches and is soft sandstone. Permeability of this soil is moderate. Trelona soils have a severe rating for absorption field application due to the shallow depth to bedrock and slope (15% or more).

The sandstone outcrop comprises about 40% of the Trelona-Rock Outcrop complex. The remaining 20% is comprised of mainly Vetal fine sandy loam, which has slight to moderate limitation depending on the slope. The Trelona-Rock Outcrop complex is found mostly in Blocks 16, 18, and 21 of the Wyoming Ranchettes II development. The installation of conventional absorption fields in these blocks should be particularly scrutinized. It may be possible to install an absorption field by excavating the sandstone layer or by installing the absorption field below the sandstone layer.

5. Kersey Acres, Windgate Acres, Gun Hill, Bestview Subdivision, and Beartooth Estates

These developments and several dwellings unassociated with any development are found in Sections 4 and 5, T14N, R66W. Section 5 contains the Kersey Acres, Windgate Acres, Gun Hill, and Bestview Subdivision and is comprised mainly of Archerson loam soil (0-3% slope) with lesser amounts of Archerson-Dix complex (6-10% slope, and a small amount with 10-30% slope), and the Trelona-Rock Outcrop complex. Developments in this section should have no difficulty with conventional absorption fields; however, the Trelona-Rock Outcrop complex in the extreme southwest corner of the section should be investigated thoroughly to insure successful operation of an absorption field at that location.

Beartooth Estates lies in the northwestern corner of Section 4, T14N, R66W and is made up mainly of Archerson loam (0-3% slope) and Archerson-Dix Complex (6-10% slope). With proper consideration for slope, conventional absorption fields may be successfully employed in this area. Throughout the remainder of this section (4), there are randomly spaced homes that are not part of any formally named subdivision. These homes are situated primarily on Archerson loam soils (0-3% slope), and therefore no problem with absorption beds exists. Small areas of Trelona-Rock Outcrop complex do exist in this section, and the development of conventional absorption fields on these areas should be allowed only with the proper relocation, excavation, or placement below the sandstone area.

6. Briarwood Ranchettes and Arabian Hills

The Briarwood Ranchettes and Arabian Hills developments, as well as separate homesites, are located in Section 4, T14N, R67W. Being zoned A-1 (agricultural), a minimum area of 2½ acres/household is required. Archerson loam soils with a 3-6% slope compose most of the land in these developments. Smaller amounts of Archerson-Dix complex soils ranging in slope from 6 to 30% are interspersed through the area. The application of conventional absorption beds may be successfully accomplished in these areas, provided that slope considerations be thoroughly investigated.

7. Pioneer Estates

Located on the northern and eastern sides of Section 34, T15N, R67W, the Pioneer Estates consist primarily of Archerson-Dix complex soils with slopes ranging from 6-30%. Small amounts of Albinas and Archerson loams at 1-3% slopes are also present. The homesites along Horse Creek Road in the southern part of this section are situated on Albinas loam with a slope of 3-6%. The slope in parts of the Pioneer Estates may approach a severely limiting point (i.e., approximately 30%), and as such the use of conventional absorption fields may not be appropriate unless the slope of the absorption field area is reduced. Further investigation is required on a case by case basis. The areas with Albinas loam present moderate limitations due to slow percolation rates. The areas composed of Archerson loams at 1-3% slope are well suited for conventional absorption fields.

8. Quarter Circle Five

Quarter Circle Five is located in Section 5, T14N, R67W, and contains 48 lots of roughly 10 acres and eight 20-acre lots, as platted. The area consists primarily of Archerson-Dix Complex (6-30% slope) and Ascalon loam (3-6% slope). The slope in some of this area may represent a severely limiting factor regarding conventional absorption field use, but with very large lots and with the examination of innovative technologies, onsite wastewater treatment should not be a problem for this development. If, at a future time, these lots are subdivided, onsite wastewater treatment could be a problem if using conventional absorption fields.

9. Read Tracts, Sunset Tracts (Filings #1 and #3), Ponderosa Hills, and Meadowview Estates

Each of these developments is located in Section 12, T14N, R67W, east of the Francis E. Warren Air Force Base.

Read Tracts, located in the west half of Section 12, consists of Archerson loams (0-6% slope), Archerson-Dix complex (6-10% slope), and a small amount of Trelona-Rock outcrop complex. This Trelona-Rock Outcrop complex, located in lots 17, 18, 19, and 20 of the Read Tracts, may represent severe limitations in the use of absorption fields due to a shallow depth to bedrock and a fairly steep slope. These limitations may be overcome by methods previously discussed. Conventional absorption fields should present no difficulty for the remainder of the Read Tracts area if proper consideration is given to the slope of the lot when necessary.

Sunset Tracts (Filing #1), Ponderosa Hills, and Meadowview Estates are all located in the SE quarter of Section 12. Archerson loam at 0-3% is the main soil type in these developments, and as such, conventional absorption fields are acceptable. Small amounts of Albinas loam at slopes of 1-3% exist here, presenting a moderate limitation for the use of absorption fields as discussed above. A floodplain (C zone) crosses the southeastern tip of Meadowview Estates. The restrictions imposed by a C zone floodplain were discussed previously. With a zoning of R-2, development density must also be controlled if onsite wastewater treatment using conventional absorption fields is used. Detailed onsite investigation is required for future development in this area to prevent inappropriate applications of absorption fields.

Sunset Tracts (filing #3) is located in the NE quarter of Section 12, and is composed of Archerson loam (1-6% slope), Albinas loam (slope of 1-3%) and Archerson-Dix Complex (slope 6-10%). As discussed above, the main limiting factors in the use of absorption fields are the slope on the Archerson loams and the slow percolation rate associated with Albinas loam. The R-2 zoning in this area may allow for development at a density too great to facilitate the use of conventional absorption fields.

10. Roundup Heights, Westview Addition, Laughlin Tracts

Roundup Heights, Westview Addition, and Laughlin Tracts are located in the west half of Section 7, T14N, R66W. These areas are zoned R-2 and have a minimum lot size requirement of 8000 square feet.

Roundup Heights, in the NW¼ of Section 7, is situated on Archerson loam (slope 0-6%), Albinas loam (1-3% slope), Trelona-Rock Outcrop complex, and Ascalon loam (slope 0-3%). This area is zoned R-2, but a floodplain area (C-zone) extends from the northwest to the southeast of this development. This floodplain also crosses the southern end of the Laughlin Tracts. Restrictions as to the type of development that may occur in a floodplain zoned C-zone do exist, and these should be thoroughly investigated prior to the construction of any structure. Several blocks within the Roundup Heights and the Laughlin Tracts subdivision are affected. The Trelona-Rock Outcrop complex, located in the extreme southeastern portion of this development, poses the most severe limitations in the area regarding conventional absorption bed use, as previously discussed. The slope in the rest of the area presents only moderate limitations.

Located in the southwest quarter of Section 7, Laughlin Tracts and Westview Addition consist of Ascalon loam, Albinas loam, and Trelona-Rock Outcrop complex in approximately equal amounts. The Ascalon loam presents slight limitations for the use of absorption fields and should cause no difficulties. Limitations for the Albinas loams and Trelona-Rock Outcrop complex were discussed above.

11. Proposed Bluegrass Subdivision

Located in the east half of Section 7, T14N, R66W, the proposed Bluegrass Subdivision will be situated on Archerson-Dix complex of slope 6-10%, Ascalon loam (0-3% slope), Albinas loam of 1-3% slope, and Trelona-Rock Outcrop complex. This subdivision is situated on a north facing slope, the base of which lies in a floodplain (C zone). The Archerson-Dix complex is fairly extensive in this area, and poses slight to moderate absorption field use limitations depending on slope. The Trelona-Rock Outcrop complex, found in the extreme southern part of this development, has severe limitations due to shallow depth to bedrock and slope. Special techniques previously discussed must be employed if these areas are to be used for absorption fields. Slight and moderate limitations exist in the Ascalon loam and Albinas loam areas, respectively.

12. Cowboy Country

The Cowboy Country development occupies the NE¼ of Section 7 and the NW¼ of Section 8, T14N, R66W. The area is zoned A-1, requiring 2½ acres per household. A C zone floodplain intersects the southwestern part of the development, thusly restricting construction in Lots 73, 74, and 75.

The predominant soil types found in this area are Ascalon loam (0-3% slope), Trelona-Rock Outcrop complex, and Albinas loam (0-3% slope). The Ascalon loam, prevalent throughout most of this area, has a slight limitation for absorption field application and should pose no difficulties. The

Albinas loam percs moderately slowly, and therefore has moderate limitations. The density of development on the Albinas soils should be closely monitored to prevent future difficulties. The Trelona-Rock Outcrop complex is severely limited for the use of conventional absorption fields, unless the area is modified. Other soils found to a lesser extent in this area include the Archerson-Dix complex and Archerson loam (3-6% slope). These soils are rated with slight to moderate limitations, and development should be watched accordingly.

13. North Hills and Volk Estates

Located in the eastern half of Section 8, T14N, R66W, the North Hills and Volk Estates developments are comprised primarily of Trelona-Rock Outcrop complex, posing severe limitations on absorption field development as discussed above. Other soils found in smaller amounts include the Archerson-Dix complex, Albinas loam, and Archerson loam, none of which pose severe limitations. The Trelona-Rock Outcrop complex makes up most of the soil in this area, thereby requiring the development of site modifications or alternative methods of septic tank effluent treatment. A C zone floodplain goes through the middle of the Volk Estates. The development in these areas should be carefully observed to prevent the use of inappropriate wastewater treatment techniques.

14. Commuter Estates

These estates are located in the east half of Section 9, T14N, R66W, and are situated on Albinas loams, Archerson-Dix complex, and Trelona-Rock Outcrop complex. The Albinas loams have a moderate rating, with slope being the limiting factor. The Archerson-Dix complex has a slope of 10-30% thereby imposing moderate to severe limitations. Due to the shallow depth to bedrock, as well as the slope, conventional absorption fields should not be allowed unless the site is modified.

15. Paradise Valley, Woolsey Tracts, Buckles Subdivision

Trelona-Rock Outcrop complex and Albinas loam comprise the soils in these areas, all found in Section 10, T14N, R66W. Most of the area has Trelona-Rock Outcrop complex and has severe limitations for absorption field installations. The Albinas loams have relatively slow percolation rates, resulting in a moderate rating. The use of conventional absorption fields in these areas should be avoided unless the absorption field area is modified.

16. Lomalinda Subdivision

The Lomalinda Subdivision is located in SW¼ Section 7, T14N, R65W and is situated entirely on Ascalon loam (0-3% slope). This soil is well suited for conventional absorption field use.

17. North Cheyenne Vandehei Estates and Monterey Ranchettes

Vandehei Estates and Monterey Ranchettes, located in NE¼ Section 13, T14N, R67W and NW¼ Section 18, T14N, R66W, respectively, are situated primarily on Ascalon loam. This soil has a rating of slight, and is acceptable for conventional absorption field use. This area is near the existing Cheyenne city limits, and the development density is approaching the point where conventional absorption fields will no longer be acceptable. Trelona-Rock Outcrop complex is also present in approximately half of the Monterey Ranchettes. This complex has a severe rating, and conventional absorption fields may be used only if the previously discussed site modification work is done.

Soil Conservation Service information of the North Cheyenne area soils is not available at this time. The North Cheyenne area developed considerable onsite wastewater treatment problems recently which required more extensive onsite soils investigation. This investigation was undertaken by Banner Associates in the summer of 1981. Percolation tests were made at three locations in or near the North Cheyenne area: 1) Prairie Hills Drive and Plains Avenue; 2) vacant lot north of Western Hills Boulevard and west of Osage Avenue; and 3) Sioux Drive and Prairie Hills Drive. The main soil types found in these three areas were sandy-sandy loam, and sandy loam. The sandy soils have very large pores, minimizing the filtering effect of the soil, allowing unfiltered septic tank effluent to reach the groundwater. Conventional absorption fields should not be used on this soil. The sandy loams are better suited for absorption field use; however high groundwater levels may somewhat limit absorption field use. The existing situation in North Cheyenne is one in which wastewater treatment and disposal are not being satisfactorily accomplished due to undersized lots and to excessively steep slopes on some lots. Currently there is a moratorium restricting new housing in this area until public water and sewer services are supplied (telecom, Don Park, City/County Environmental Health Unit, November 18, 1981). Serious consideration should be given to connecting the entire North Cheyenne development to city services.

18. Skyline Tracts, Airport Valley Tracts

Skyline Tracts, in SE¼ Section 18, T14N, R66W, is adjacent to the city limits, and is composed of Trelona-Rock Outcrop complex and Trelona-Wages complex in approximately equal proportions. As discussed above, the Trelona-Rock Outcrop complex has severe limitations for the use of conventional absorption fields. The Trelona-Wages complex is made up of Trelona soils (approximately 63%) and Wages soils (37%). The Trelona soils have severe limitation for absorption field use due to shallow depth to bedrock and slope. The Wages soils are well drained soils formed in alluvium on alluvial fans or terraces. These soils have a slight limitation rating and can handle conventional absorption field installations. Due to the proximity of the city to the Skyline Tracts, and an increased density of development, the use of absorption fields in this area should be scrutinized thoroughly.

The Airport Valley Tracts are located in NE¼ Section 19, T14N, R66W, and have been partially annexed. The remaining areas (unannexed) are situated primarily on Trelona-Wages complex. The Trelona soils make up approximately 63% of the soils and are characterized by shallow depth to bedrock. Absorption fields should be allowed only if the treatment area has been properly modified. The Wages soils make up the remainder of this complex and are well drained soils, well suited to absorption field installations. Due to the proximity to the city and the predominance of Trelona soils, connection with city services should be considered if the population density in this area increases.

19. Lunar View Estates and Montclair Tracts

Lunar View Estates and Montclair Tracts are located in Section 17, T14N, R66W. Albinas loam is the predominant soil in the Lunar View Estates and is well suited for absorption field use. Trelona soils (Trelona-Rock Outcrop complex and Trelona-Wages complex) also exist fairly extensively in these areas, and are not well suited for absorption field installation. Archerson-Dix complex is also found here to a lesser extent, and poses moderate to severe limitations depending on the slope. A C zone floodplain crosses these tracts thus limiting development as previously discussed.

20. Cynthia Acres, Crestmoor Addition, and Crestmoor West

Cynthia Acres is located in the NW¼ of Section 15, T14N, R66W. The north half of Cynthia Acres (Lots 10 through 18) is situated on Trelona-Rock Outcrop complex thereby severely limiting the use of conventional absorption fields without the proper site modifications being done. The existing density of development in this area mandates the investigation of alternative and innovative wastewater treatment methods. The southern half of the Cynthia Acres (Lots 1 through 9) is situated on Albinas loam soil. This soil is characterized by a relatively slow percolation rate, resulting in a moderate rating. The use of conventional absorption fields on these lots may be acceptable only after thorough onsite investigation. The current development density may require the use of alternate and innovative wastewater disposal methods.

Crestmoor West is located in the SW¼ of Section 15, immediately south of the Cynthia Acres. This area also consists of a combination of Trelona-Rock Outcrop complex and Albinas loams. The same limitations discussed above apply here. The Crestmoor Addition occupies the remainder of Section 15, T14N, R66W. The predominant soils here are the Trelona-Rock Outcrop complex and the Albinas loams, with the same limitations stated above. Also found in this addition is Ascalom loam, which is well suited for absorption field applications. The predominance of the Trelona and Albinas soil types limit the extent that development should be allowed to proceed in this area. Also, a C zone floodplain crosses the Cynthia Acres and Crestmoor Addition tracts. Detailed onsite investigation is required to prevent the installation of absorption fields on unsuitable land.

21. Del Range Addition

The Del Range Addition is located in Section 22, T14N, R66W. As in the Crestmoor Addition, immediately to the north, the predominant soil types in the Del Range Addition are Trelona-Rock Outcrop complex, Albinas loam, and Ascalon loam, with the same limitation as stated above. Also found in the Del Range Addition is a small amount of Archerson-Dix complex, with slight-moderate limitations depending on the slope. This area borders the northern Cheyenne City limits, and due to this proximity, development will most likely proceed at a relatively rapid rate. The extensive existence of Trelona-Rock Outcrop complex and the Albinas loam will require the use of wastewater treatment techniques other than conventional septic tank-absorption field systems.

22. Wenandy Acres

Wenandy Acres is located in the SE¼ Section 26, T14N, R66W, just east of the Sunnyside Addition, an area with previously documented wastewater disposal problems. This area consists mainly of Albinas loam and Bridget very fine sands, with moderate and severe ratings, respectively. The Bridget sands are found extensively in Sunnyside also, and have proven to be an unacceptable soil type for conventional absorption field installations. To prevent the occurrence of future problems similar to those encountered in the Sunnyside Addition, alternative methods of wastewater treatment are recommended for this area.

23. Foster Tracts

The Foster Tracts are located in the NW and SE¼ of Section 25, T14N, R66W. The housing in the NW¼ is situated on Albinas loam and Trelona-Rock Outcrop complex, with moderate and severe limitations, respectively. With increased development density, conventional absorption fields will not adequately treat septic tank effluent without site modifications.

The area south of East Pershing Blvd., primarily in the SE¼, consists of Archerson, Albinas, and Ascalon loams and Archerson-Dix complex, with slight, moderate, slight, and moderate to severe rating, respectively. This soil is generally more acceptable for absorption field applications than the soils in the NW¼ section. As with all developments, however, when the density of development becomes great, the continued use of conventional absorption fields must be carefully scrutinized.

24. Mesa Tracts

The Mesa Tracts are located in the north half of Section 30, T14N, R65W and consist primarily of Ascalon loam with a slight limitation rating. A finger of Albinas loam extends from the northwest corner to the southeast corner of this area and has a moderate rating due to a slow percolation rate. The soils of this area are well suited for conventional absorption field applications.

25. Cox Country Estates, Rolling Hills Estates

Located west of the Francis E. Warren Air Force Base in sections 28 and 33, T14N, R67W, the predominant soil type found in these estates is Archerson loam (0-6% slope). A small amount of Kirkham, silty clay loam, exists along Diamond Creek, where no lots are planned (Kirkham silty clay loam is found extensively in the Sunnyside area, where serious difficulties have been encountered regarding disposal of septic tank effluent). No difficulty should be encountered in the use of absorption fields in the Archerson loam soils as long as adequate area is provided.

A C zone floodplain extends through the middle of Rolling Hills Estates. Foresight in planning is apparent here as a recreation area has been established in the C zone area. No structure development will occur within the floodplain.

26. Southcrest Heights

The main soil types in Southcrest Heights, located in the NW¼ Section 13, T13N, R67W, are Archerson-Dix complex (6-10% slope) and Wages loam at 0-3% slope. Due to slope, the Archerson-Dix complex has a slight to moderate limitation rating, allowing for conventional absorption field installations if proper investigation is undertaken. The Wages loam has a slight rating and thusly is an acceptable soil type for absorption field use. Care must be taken so that when the population density in the area exceeds the soils' capacity to treat the wastewater, alternative methods, including tie-in with city services, be considered. This caution has already been exerted by the City/County Environmental Health Office (Nov., 1981). There is currently a moratorium restricting new development in this area until it is either replatted with larger lot sizes, or connected with either the city or with the South Cheyenne sewer system (telecom, Don Pack, City/County Environmental Health Unit, November 18, 1981).

27. Unplatted Areas

Future developments in the Study Area that are as yet unplatted will require onsite investigation of the soil types present. Restrictions on the density of development allowed should be made at the time of platting.

III. Lot Size Requirements

1. General

Adequate lot size must be provided to allow for compliance with DEQ Minimum Design Standards for Small Wastewater Facilities. These standards require the following distances:

1. Septic tank minimum distances

    5' from dwelling

    50' from water well

    50' from waterways

    25' from water lines under pressure

    50' from negative pressure water lines

    10' from property lines

2. Disposal field distances

    100' from water well

    50' from waterway

    25' from drinking water lines

    100' from negative pressure lines

    10' from dwelling or building

    10' from septic tank

    10' from property line

For the preliminary lot sizing presented here, the following assumptions are made:

1. 3-bedroom house with with 1800 square foot area, with 40'x45' dimensions.
2. Water well located 90' from property line to insure the required 100' separation from well to disposal field (assuming neighbors' disposal field located 10' from property line).
3. No water lines on property line.
4. Negligible slope (lots situated on sloping terrace will most likely require larger absorption fields, and the relative location of the home and absorption field must be carefully planned).

The preliminary required lot size for each of the soil types discussed in this report is shown below. It cannot be overemphasized that the sizes shown here are preliminary, and no substitute should be made for thorough onsite investigation regarding the installation of private wastewater treatment facilities. Room for two absorption fields should be provided in the event of failure of one field or to allow time for regeneration of one field. According to the configuration shown in Figure G-1, the requirement of two absorption fields will double dimension "b", but will not increase the required lot size.

2. Archerson loam and Archerson-Dix complex

   a. Percolation Rate = 6.0-20 in/hr (see Table III)

   b. Required absorption field area = 160 sq.ft./bdrm.

      = 480 sq.ft./home

   Assume dimension of 30'x16'

The minimum required lot area on this type of soil is 1.0 acre, with the configuration of construction as shown in Figure G-1. For the

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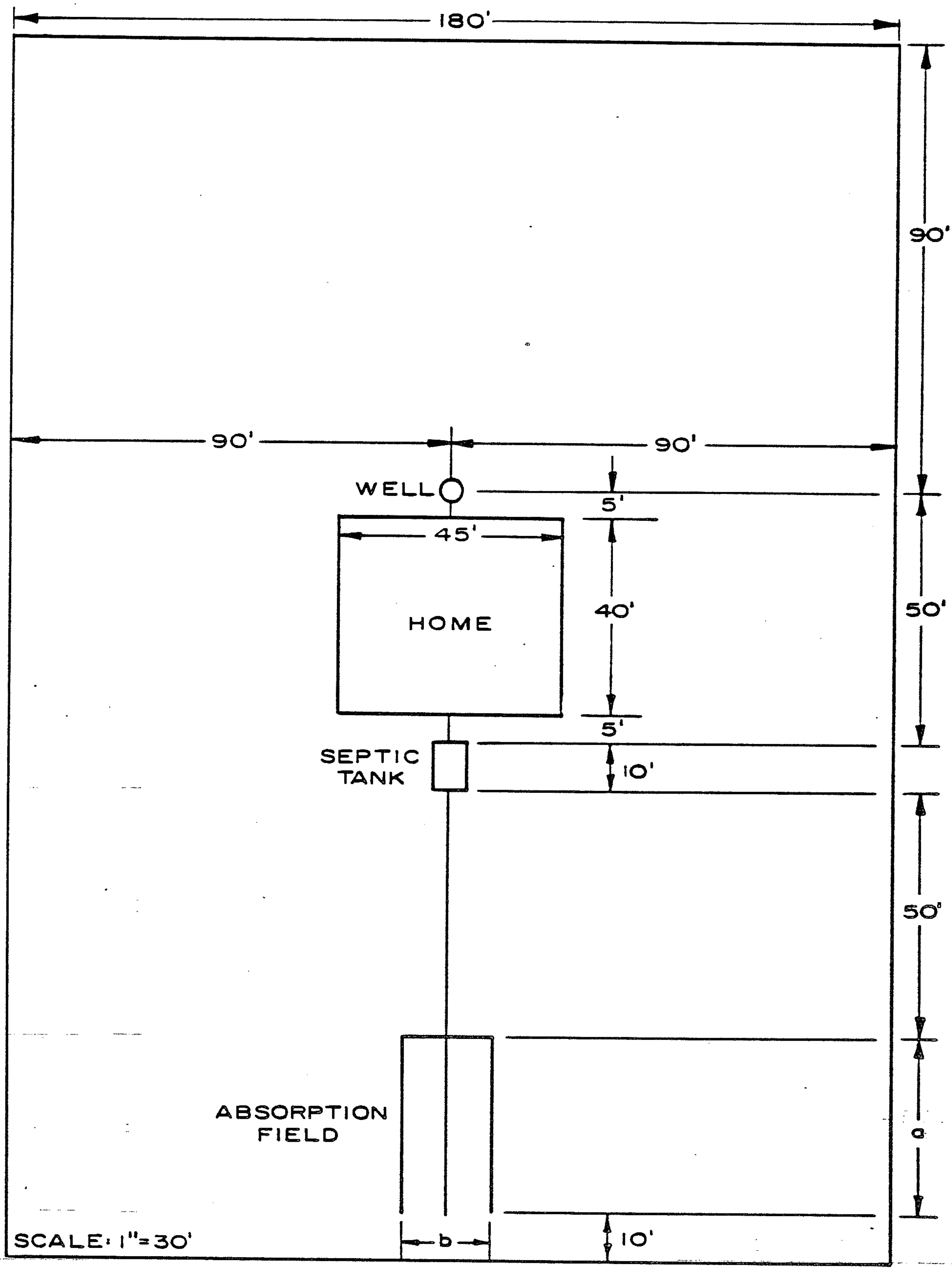

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TYPICAL DRAIN FIELD SIZING

FIGURE G-1

Archerson and Archerson-Dix complex soils, the absorption field dimensions (a and b) are 30'x16' for a total area of 480 square feet. For two absorption fields, the required dimension (axb) is 30'x32'. This does not increase the required lot size. This size of absorption field results in a lot with a dimension of 180'x240', with an area of 43,200 square feet, or nearly 1.0 acre.

3. Ascalon loam

a. Percolation Rate = 2.0-6.0 in/hr

b. Required absorption field area = 250 sq.ft./bdrm.

= 750 sq.ft./home

Assume dimension of 30'x25'

The same configuration of construction as shown in Figure 5-1 is used for this soil type, with the only difference being the absorption field dimension. If these dimensions are assumed to be 30' by 25' (a and b, respectively), the overall required lot area remains unchanged from that for Archerson soils, since only the width (b) of the absorption field changes and not the length (a). Therefore, the minimum required lot size is 1.0 acre.

4. Albinas loam

a. Percolation rate = 0.6-2.0 in/hr

b. Required absorption field area = - 250 square feet

At a percolation rate of 0.6 in/hr, conventional absorption fields should not be used. Severe flooding of the leach field may result during wet weather which would cause the system to fail. In areas where the percolation rate is determined to be 2.0 in/hr, a lot size of 1.0 acre is required, as determined above.

5. Bridget, Kirkham, and Mitchell soils

Each of these soils has very slow percolation rates (0.2-0.6 in/hr) and as such is unsuitable for the installation of conventional absorption fields. Alternative methods of wastewater disposal must be used.

6. Trelona

Although the percolation rates shown in Table G-3 indicate the possibility of employing absorption fields on this soil, the complexes formed with soil (Trelona-Rock Outcrop complex and Trelona-Wages complex) are unsuitable for the use of conventional absorption fields. Either alternative methods should be investigated, or the site should be modified as previously discussed for this type of soil.

III. Summary and Conclusions

The soils upon which housing developments outside the Cheyenne city limits are situated have been discussed on a case by case basis. A summary of this discussion is presented in Table G-1. In this table, the SCS soil classification numbers with their corresponding soil names are given initially, followed by the numbers only. Also included in Table G-1 are the development location and a listing of absorption field limitation as defined by the SCS. A brief summary of the soils encountered in this investigation, their respective SCS classification number, and a statement of each soil's limitations are given in Table G-2.

Table G-1
Housing Developments, Soil Types, and Absorption Field Limitations

Development	Location ¼	S	T	R	Soil Types	Absorption Field Ratings-Limitations
Murray Hill Estates	NE	1	14N	67W	242C: Archerson-Dix complex; 6-10% slope	Slight-moderate: slope
					242E: Archerson-Dix complex; 10-30% slope	Moderate-severe: slope
Project "N"	NE	1	14N	67W	46A: Archerson loam 0-3% slope	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
Sunset Tracts/ Longview Home-sites	SE	1	14N	67W	46A	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
					46B: Archerson loam 3-6% slope	Moderate: slope
Gray Fox Estates	NW	6	14N	66W	46A	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
Francis Homesites	NW	6	14N	66W	46A	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
Suburban Heights	NW	6	14N	66W	46A	Slight
Romsa Addition	SW	6	14N	66W	242C	Slight-moderate: slope
All America Subdivision	SW	6	14N	66W	242E	Moderate-severe: slope
					46B	Moderate: slope
All America Subdivision	SE	6	14N	66W	46A	Slight
Riding Club Estates					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
					36A: Albinas loam, 1-3% slope	Moderate: percs slowly
Wyoming Ranchettes		33	15N	66W	46A	Slight
					46B	Moderate: slope
					242C	Slight-moderate: slope
Wyoming Ranchettes II		35	15N	66W	46A	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
					162: Trelona-Rock Outcrop complex	Severe: depth to bed-rock & slope

Table G-1
Housing Developments, Soil Types, and Absorption Field Limitations
(Continued)

Development	¼	Location S	T	R	Soil Types	Absorption Field Ratings-Limitations
Briarwood Ranchettes/ Arabian Hills		4	14N	67W	42B: Ascalon loam 3-6% slope	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
Pioneer Estates		34	15N	67W	42B	Slight
					36A	Moderate: percs slowly
					46A	Slight
					46B	Moderate: slope
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
Quarter Circle Five		5	14N	67W	42B	Slight
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
Read Tracts	SW	12	14N	67W	46A	Slight
					46B	Moderate: slope
					242C	Slight-moderate: slope
					162	Severe: depth to bed-rock & slope
Sunset Tracts (Filing #1), Ponderosa Hills, and Meadowview Estates	SE	12	14N	67W	46A	Slight
					36A	Moderate: percs slowly
Sunset Tracts (Filing #3)	NE	12	14N	67W	46A	Slight
					46B	Moderate: slope
					36A	Moderate: percs slowly
					242C	Slight-moderate: slope
Roundup Heights	NW	7	14N	66W	46A	Slight
					46B	Moderate: slope
					36A	Moderate: percs slowly
					162	Severe: depth to bed-rock & slope
					42A: Ascalon loam Slope 0-3%	Slight

Table G-1
Housing Developments, Soil Types, and Absorption Field Limitations
(Continued)

Development	¼	Location S	T	R	Soil Types	Absorption Field Ratings-Limitations
Westview Addition, Laughlin Tracts	SW	7	14N	66W	162	Severe: depth to bed-rock and slope
					42A	Slight
					36A	Moderate: percs slowly
Bluegrass Subdivision		7	14N	66W	242C	Slight-moderate: slope
					36A	Moderate: percs slowly
					162	Severe: depth to bed-rock & slope
					42A	Slight
					36A	Moderate: percs slowly
North Hills & Volk Estate		8	14N	66W	162	Severe
					36A	Moderate: percs slowly
					242E	Moderate-severe: slope
					46A	Slight
Commuter Estates		9	14N	66W	36A	Moderate: percs slowly
					242E	Moderate-severe: slope
					162	Severe: depth to bed-rock & slope
Paradise Valley, Woolsey Tracts, Buckles Subdivision		10	14N	66W	162	Severe: depth to bed-rock & slope
					36A	Moderate: percs slowly
Lomalinda Subdivision	SW	7	14N	65W	42A	Slight
Vandehei Estates	NE	13	14N	67W	42B	Slight
North Cheyenne Monterey Ranchettes	SE	13	14N	67W	162	Severe: depth to bed-rock & slope
Skyline Tracts	SE	18	14N	66W	163: Trelona-Wages complex	Slight-severe: depth to bedrock & slope
Airport Valley Tracts	NE	19	14N	662	162	Severe: depth to bed-rock & slope

Table G-1
Housing Developments, Soil Types, and Absorption Field Limitations
(Continued)

Development	¼	Location S	T	R	Soil Types	Absorption Field Ratings-Limitations
Lunar View Estates Montclair Tracts		17	14N	66W	36A	Moderate: percs slowly
					163	Slight-severe: depth to bedrock & slope
					242C	Slight-moderate: slope
					242E	Moderate-severe: slope
					162	Severe: depth to bedrock & slope
Cynthia Acres	NW	15	14N	66W	162	Severe: depth to bedrock & slope
Crestmoor West	SW	15	14N	66W	36A	Moderate: percs slowly
Crestmoor Addition		15	14N	66W	162	Severe: depth to bedrock & slope
					36A	Moderate: percs slowly
					42A	Slight
Del Range Addition		22	14N	66W	162	Severe: depth to bedrock & slope
					36A	Moderate: percs slowly
					42A	Slight
					242C	Slight-moderate: slope
Wenandy Acres	SE	26	14N	66W	22B: Bridget very fine sand	Severe: percs slowly, slope
					36A	Moderate: percs slowly
					46A	Slight
Foster Tracts		25	14N	77W	36A	Moderate: percs slowly
					162	Severe: depth to bedrock & slope
					42B	Slight
					46A	Slight
					242E	Moderate-severe: slope
Mesa Tracts		30	14N	65W	42A	Slight
					36A	Moderate: percs slowly
Cox Country Estates		28	14N	67W	223: Kirkham, silty clay loam	Severe: flooding-wet
Rolling Hills Estates		30	14N	67W	46A	Slight
					46B	Moderate: slope
Southcrest Heights	NW	13	13N	67W	X63	Slight
					242C	Slight-moderate: slope

Table G-2
Soils Encountered in Developments in the Study Area, SCS Classification Number, and Absorption Field Limitations

Soil Name	Slope (%)	SCS Number	Limitation
Albinas loam	1-3	36A	Moderate: percs slowly
Archerson loam	0-3	46A	Slight
Archerson loam	3-6	46B	Moderate: slope
Archerson-Dix complex	6-10	242C	Slight-moderate: slope
Archerson-Dix complex	10-30	242E	Moderate-severe: slope
Ascalon loam	0-3	42A	Slight
Ascalon loam	3-6	42B	Slight
Bridget	3-6	22B	Severe: percs slowly
Kirkham	0-3	223	Severe: flooding, wet
Trelona-Rock Outcrop complex	10-30	162	Severe: depth to bedrock, slope
Trelona-Wages complex	10-30	163	Slight-severe: depth to bedrock, slope

Much of the Sunnyside area, in which septic tank effluent disposal has become a problem, consists of Kirkham, silty clay loam. This soil is severely limited in its ability to handle absorption field applications. The only other location in this study that was identified as having Kirkham soils is in the Rolling Hills Estates, and provisions for a recreation area on this soil have been made.

Most of the developments in the Study Area contain a mixture of soils; some well-suited for absorption field applications, and others not well-suited for absorption field applications. Detailed onsite investigation is required to determine if a particular lot can handle conventional septic tank effluent disposal systems. General figures indicating the minimum required absorption field area per bedroom as a function of percolation rate (soil type) are presented in Table G-3. The soils that are unsuitable for absorption field application are indicated in this table, as well as the total acreage of each soil type as determined by the SCS.

According to the City-County Health Unit, the most frequent cause of septic system problems is directly related to the expansion of living space in dwellings with no change in the septic system capacity. It appears that this problem could be alleviated through a more strict building permit process. Other septic system problems are reportedly caused by lack of maintenance (i.e. pumping of septic tank), and damage caused by excessive water use and traffic patterns over the septic system area. Even under ideal conditions a septic system will not function indefinitely making it extremely important to control the above problem.

Although it is possible to have a general indication of areas with potential future onsite wastewater treatment problems based on this report, no substitute should be made for detailed onsite investigation. By having a thorough knowledge of the soil types present, potential future problems may be avoided.

Table G-3
Soil Types, Percolation Rates, and Minimum Area Required for Absorption Field per Bedroom

Soil Type	Slope	Acres Categorized by SCS in Study Area	Percolation Rate (in/hr)[1]	Minimum Area per Bedroom[2] (ft^2)
Archerson loam	0-3%	11,049	6.0-20.0	160
Archerson loam	3-6%	2,916	6.0-20.0	160
Archerson-Dix complex	6-10%[3]	8,513	6.0-20.0	160
Archerson-Dix complex	10-30%[3]	5,128	6.0-20.0	160
Albinas loam	1-3%	9,374	0.6- 2.0	∞-250[4]
Ascalon loam	0-3%	9,524	2.0- 6.0	250-160
Ascalon loam	3-6%	2,592	2.0- 6.0	250-160
Bridget	3-6%	68	0.2- 0.6	∞
Dix	6-15+%	(Archerson-Dix Complex)	6.0-20.0	160
Kirkham	0-3%	1,391	0.06- 0.2	∞
Mitchell	0-3%	21	0.2- 0.6	∞
Trelona	3-15+%	-	2.0- 6.0	250-160
Wages	0-3%	-	0.6- 2.0	∞-250
Trelona-Rock Outcrop complex	10-30%	6,361	-	-
Trelona-Wages complex	10-30%	786	-	-

[1] Conservative values; taken from "Cheyenne City Report, Cheyenne, Wyoming", USDA Soil Conservation Service, Abe Stevenson, 1976. Perc. rates given are from depths of absorption field (i.e., 24-60").

[2] Information taken from <u>Manual of Septic Tank Practice</u>, U. S. Department of Health, Education, and Welfare, Serv. Publ. 526, 1976.

[3] Slope greater than 15% severely limits use of conventional absorption field.

[4] Unsuitable for absorption field application at perc. rates 1.0 in/hr.

APPENDIX H

MISCELLANEOUS SLUDGE CALCULATIONS/INFORMATION

SLUDGE MANAGEMENT EXPLANATORY CALCULATIONS

I. Sludge Quantities Calculations

A. Cheyenne sludge quantity

1. 1980 sludge quantity = 50,750 cft @ 70% solids
2. Assume Specific Gravity = 1.25
3. Weight of dry solids = $\frac{1.25 \text{ X } 62.4 \text{ lbs/cft X } 50{,}750 \text{ cft X } 0.70}{2000 \text{ lbs/ton}}$

   = 1385 ton, USE 1400 tons/yr.

B. South Cheyenne sludge quantity

1. 1980 S. Cheyenne population = 6,400
2. 1980 Cheyenne population = 52,600
3. Weight of dry solids = $\frac{6{,}400}{52{,}600}$ X 1400 = 171 tons/yr

C. Cheyenne and S. Cheyenne sludge quantity

1. 1400 + 171 = 1571 tons of dry solids/yr.
2. $\frac{1571}{59000}$ = 0.027 tons/person/yr.

D. Projected sludge quantities

1. 1980 sewered population = 59,000
2. 2005 sewered population = 102,500
3. Wt of dry solids in 2005 = $\frac{102{,}500}{59{,}000}$ X 1,571 tons/yr

   = 2,729 tons/yr
4. Avg. Weight of dry solids for study period =

   $\frac{2729 + 1571}{2}$ = 2150 tons/yr.
5. Avg. Volume of sludge @ 5% solids for study periods

   $\frac{2150 \text{ tons/yr X } 2000 \text{ lb/ton}}{0.05 \text{ X } 62.4 \text{ lb/cft}}$ = 1,378,200 cft

II. Sludge Disposal Land Requirements

A. Narrow trench, 20 year site life

1. Sludge @ 25% solids, Specific Gravity = 1.10
2. Sludge volume = $\frac{2150 \text{ tons dry solids/year X } 2000 \text{ lb/ton}}{0.25 \text{ X } 62.4 \text{ lb/cft X } 1.1}$

   = 250,600 cft/yr.
3. Trench area required = $\frac{250{,}600 \text{ cft/yr X } 20 \text{ years}}{6 \text{ ft of sludge}}$

   = 835,000 sft.

   say 900' X 900'
4. Number of trenches needed = $\frac{900 \text{ ft}}{10 \text{ ft}}$ = 90
5. Site area required with 90 trenches, 900 ft. long, 10 ft. wide, 15 ft. between trenches and 100 ft. buffer zone

   = ((89 X 15) + (90 X 10) + 200) X (900 + 200)

   = 2,678,500 sft. = 62 Acres

B. Wide trench, 20 year site life

1. Sludge @ 30% Solids, Specific Gravity = 1.20
2. Sludge volume = $\frac{2150 \text{ tons dry solids/yr X } 2000 \text{ 16/ton}}{0.30 \text{ X } 62.4 \text{ lb/cft X } 1.2}$

   = 191,400 cft/yr.
3. Trench area required = $\frac{191{,}400 \text{ cft/hr X } 20 \text{ yr.}}{6 \text{ ft. of sludge}}$

   = 638,000 sft.

   say 800' X 800'

4. Number of trenches needed = $\frac{800 \text{ ft}}{40 \text{ ft}}$ = 20

5. Site area required with 20 trenches, 800 ft long, 40' wide, 15 ft. between trenches and 100 ft. buffer zone.
((19 X 15) + (20 X 40) + 200) X (800 + 200)
= 1,285,000 sft. = 30 Acres

C. Co-disposal with Refuse-Sludge/Refuse Mixture

1. Sludge @ 25% Solids, Specific Gravity = 1.10
2. 1980 Daily dry solids = $\frac{1571 \text{ tons/year}}{0.25 \text{ X } 365 \text{ D/yr.}}$
= 17 tons dry solids/day
3. 1980 Daily refuse = 138 tons/day
4. Sludge to refuse ratio = $\frac{17}{138}$ = 1:8
5. Study period sludge volume = 250,600 cft/yr.
6. Volume of storage required with 20 year site life = 250,600 X 20 = 5,012,000 cft.
7. Area of storage required with 40 ft. deep landfill = $\frac{5,012,000}{40}$ ÷ 43560 sft/Ac = 2.8 Ac

D. Land Application

1. Procedure taken from EPA Publication MCD-35 "Applications of Sludge and Wastewaters on Agricultural Land"
2. Assume brome grass production at 5 tons/acre, Nitrogen requirement = 166 lb/Ac/yr.
3. An average of the contaminant levels found in the Crow Creek Digester effluent and the Dry Creek Secondary Digester effluent has been used for these calculations. The concentrations found in the sludge were given on a milligram/liter basis. These had to be converted to a % of Dry Weight, and parts per million on dry weight basis for this series of calculations.

$$\% \text{ of Dry Wt.} = \frac{\text{concentration in mg/l}}{100 \text{ X Specific Gravity X \% Total Solids}}$$

$$\text{ppm} = \frac{\text{Concentration in mg/l X 100}}{\text{Specific gravity X \% Total solids}}$$

4. Calculate tons of dry sludge needed to meet Crops Nitrogen requirement.
   a. Available N in sludge
      % Inorganic N = (%NH_4-N) + (%NO_3-N)
      = (0.47%) + (0.0%)
      = 0.47%
      % Organic N = 2.67%
      Available N = (% NH_4 - N X 20)
      + (% NO_3-N X 20)
      + (%N_o X 4)
      = (0.47 X 20) + (0) (20) + (2.67) (4)
      = (20.1 lb Available N/ton dry sludge)
   b. Annual application rate
      Application rate with N requirements = $\frac{166 \text{ lb N/Ac}}{20.1 \text{ lb Avail. N/ton}}$
      = 8.3 tons dry sludge/Ac.
      Application rate with Cadmium limitations
      = $\frac{2 \text{ lb. Cd/Ac}}{18.3 \text{ ppm Cd X } 0.002}$
      = 54.6 tons dry sludge/Ac

5. Calculate total amount of sludge allowable based on heavy metal content.

Lead $= \dfrac{1000 \text{ lb. Pb/Ac}}{147 \text{ ppm} \times 0.002} = 3{,}400$ tons/Ac

Zinc $= \dfrac{500 \text{ lb. Zn/Ac}}{1509 \text{ ppm} \times 0.002} = 165$ Tons/Ac

Copper $= \dfrac{250 \text{ lb Cu/Ac}}{1120 \text{ ppm} \times 0.002} = 112$ Tons/Ac

Nickel $= \dfrac{250 \text{ lb. Ni/Ac}}{36 \text{ ppm} \times 0.002} = 3{,}470$ Tons/Ac

Cadmium $= \dfrac{10 \text{ lb. Cd/Ac}}{18 \text{ ppm} \times 0.002} = 278$ Tons/Ac

The maximum total amount of sludge which can be accumulated on the disposal site is dictated by the Copper concentration as being 112 tons dry sludge/Ac/life of site

Annual application rate $= \dfrac{112 \text{ tons/Ac}}{20}$

$= 5.6$ tons/Ac

6. The annual application rate based on heavy metal concentration is the lowest and therefore governs the annual application rate that is used.

Annual Application rate = 5.6 tons/Ac/yr.

7. Area required $= \dfrac{2150 \text{ tons/yr}}{5.6 \text{ tons/Ac/Yr}} = 384$ Ac.

8. Moisture applied to land from sludge @ 5% solids

$= \dfrac{5.6 \text{ tons/yr} \times 2000 \text{ lbs./ton} \times .95}{0.05 \times 62.4 \text{ lb/cft} \times 43560 \frac{\text{sft}}{\text{Ac}}} = 0.078'$

$= 0.9''$

9. Sludge storage required from August 31 to April 15.

a. Storage with Sludge @ 5% Solids

$= 1{,}378{,}200 \text{ cft/yr} \times \dfrac{230\text{d}}{365 \text{ D/yr}}$

$= 868{,}250$ cft

b. Storage with sludge @ 50% Solids

$= \dfrac{2150 \text{ tons} \times 2000 \text{ lb/ton}}{0.5 \times 62.4 \times 1.3} \times \dfrac{230}{365}$

$= 66{,}800$ cft

E. Incineration

1. Assume 20% of total solids remain after incineration
2. Specific Gravity of ash = 1.4
3. Ash Volume $= \dfrac{0.2 \times 2{,}150 \text{ tons dry solids/yr} \times 2000 \text{ lb./ton}}{62.4 \times 1.4}$

$= 9900$ cft/yr

4. Trench area required =

$\dfrac{9900 \text{ cft/yr} \times 20 \text{ yrs}}{4 \text{ ft of ash}} = 49{,}500$ sft

$= 250' \times 250'$ Area

5. Number of trenches needed $= \dfrac{250}{40} = 7$

6. Site area required with 7 trenches, 250 ft. long, 40 ft. wide, 15 ft. between trenches and 100 ft. buffer zone.

$= (200 + (7 \times 40) + (6 \times 15))\ (250 + 200)$

$= 256{,}500$ sft

$= 6$ Acres

RESULTS OF SLUDGE ANALYSIS

PARAMETERS - GENERAL
TABLE H-1

SAMPLE LOCATION	TOTAL SOLIDS (%)	VOLATILE SOLIDS (% TS)	ORGANIC ACIDS (mg/l)	VOLATILE ACIDS (mg/l)	SPECIFIC GRAVITY	CONDUCTIVITY (micromhos/cm)	pH
S. Cheyenne							
Secondary - New	0.46	73.1	69	19	1.00	590	6.91
Secondary - Old	0.32	73.2	304	48	1.00	730	7.14
Sludge Pond	0.56	28.3	414	117	1.01	1120	7.53
Crow Creek							
Digester Influent	3.23	78.4	4002	879	1.02	400	6.15
Digester Effluent	2.15	64.4	3560	674	1.01	2200	5.59
Dry Creek							
Primary Recirculation	2.27	60.3	317	78	1.01	1830	6.88
Recirculation	2.28	60.6	359	48	1.02	2030	6.91
Primary Digester Effluent	2.69	62.5	1352	244	1.00	1320	6.96
Secondary Digester Influent	0.52	73.2	331	49	0.99	740	7.02
Secondary Digester Effluent	9.34	49.2	1547	322	1.04	2030	7.37

PARAMETERS - NUTRIENTS/CHEMICALS
TABLE H-2

SAMPLE LOCATION	AMMONIA (As N, mg/1)		ORGANIC NITROGEN (As N, mg/1)		TOTAL KJELDAHL NITROGEN (As N, mg/1)		PHOSPHOROS (mg/1)
S. Cheyenne							
Secondary - New	3	(0.07%)	1057	(23.0)	1060	(23.0)	41.1 (0.89)
Secondary - Old	7	(0.22)	1013	(31.7)	1020	(31.9)	26.1 (0.82)
Sludge Pond	270	(4.8)	280	(4.95)	550	(9.7)	34.7 (0.61)
Crow Creek							
Digester Influent	85	(0.26)	976	(2.96)	1060	(3.22)	55.1 (0.17)
Digester Effluent	89	(0.41)	871	(4.01)	960	(4.42)	36.8 (0.17)
Dry Creek							
Primary Recir-culation	160	(0.70)	2440	(10.6)	2600	(11.3)	47.6 (0.21)
Recirculation	39	(0.17)	3121	(13.4)	3160	(13.6)	59.4 (0.26)
Primary Digester Effluent	309	(1.15)	2411	(8.96)	2720	(10.11)	35.8 (0.13)
Secondary Digester Influent	6	(0.12)	904	(17.5)	910	(17.7)	34.7 (0.67)
Secondary Digester Effluent	501	(0.52)	1279	(1.32)	2680	(2.76)	30.4 (0.03)

$$(\text{\% Concentration of T.S.}) = \frac{\text{mg/1}}{1{,}000{,}000 \text{ mg/1} \times 5.6 \times \frac{\text{\% TS}}{100}} \times 100$$

PARAMETERS - NUTRIENTS/CHEMICALS

TABLE H-2 (CONT.)

SAMPLE LOCATION	POTASSIUM (mg/1)	PCB'S (1016) (mg/1)	PCB'S (OTHERS) (mg/1)	PHENOL (mg/1)
S. Cheyenne				
Secondary - New	66.3 ± 0.5 (1.44)	ND	ND	ND
Secondary - Old	35.8 ± 0.0 (1.22	0.0166	ND	ND
Sludge Pond	67.9 ± 0.00 (1.20)	0.130	ND	ND
Crow Creek				
Digester Influent	71.4 ± 0.4 (0.22)	--	--	--
Digester Effluent	55.7 ± 0.01 (0.26)	0.0315	ND	0.0112
Dry Creek				
Primary Recirculation	68.9 ± 0.0 (0.30)	--	--	--
Recirculation	51.4 ± 0.1 (0.22)	--	--	--
Primary Digester Effluent	90.6 ± 0.1 (0.34)	--	--	--
Secondary Digester Influent	51.7 ± 0.1 (1.00)	--	--	--
Secondary Digester Effluent	155 ± 1.0 (0.16)	0.0639	ND	ND

ND - None Detected, Detection limit = 0.001 mg/1

PARAMETERS - HEAVY METALS
TABLE H-3

SAMPLE LOCATION	ARSENIC (mg/1)/ppm	BARIUM (mg/1)/ppm	CADMIUM (mg/1)/ppm	COPPER (mg/1)/ppm
S. Cheyenne				
Secondary - New	0.194 ± 0.0/42	2.08 ± 0.0/452	0.095 ± 0.001/20.7	1.52 ± 0.0/330
Secondary - Old	0.0104 ± 0.002/3.3	1.13 ± 0.0/353	0.021 ± 0.001/6.6	0.96 ± 0.0/300
Sludge Pond	0.0402 ± 0.001/7.1	2.22 ± 0.001/392	0.0889 ± 0.001/15.7	1.09 ± 0.01/193
Crow Creek				
Digester Influent	0.0041 ± 0.0001/0.12	17.3 ± 0.01/525	0.202 ± 0.001/6.1	11.1 ± 0.01/337
Digester Effluent	0.0056 ± 0.0001/0.26	4.68 ± 0.001/216	0.305 ± 0.0/14	16.5 ± 0.011/760
Dry Creek				
Primary Recirculation	0.0121 ± 0.0/.53	1.37 ± 0.0/60	1.125 ± 0.001/49.1	19.7 ± 0.0/85.9
Recirculation	0.0036 ± 0.0001/.15	1.89 ± 0.01/81	0.13 ± 0.0/5.6	1.76 ± 0.0/75.7
Primary Digester Effluent	0.0201 ± 0.001/.75	6.03 ± 0.001/224	0.323 ± 0.001/12	40.4 ± 0.01/1502
Secondary Digester Influent	0.0289 ± 0.001/5.61	4.44 ± 0.001/862	0.065 ± 0.0/12.6	5.01 ± 0.01/973
Secondary Digester Effluent	0.0254 ± 0.0001/.26	7.93 ± 0.004/81.6	2.20 ± 0.01/22.6	143.7 ± 0.1/1479

$$\text{ppm} = \frac{\text{mg/1}}{\text{Specific gravity X } \frac{\%\ \text{TS}}{100}}$$

PARAMETERS - HEAVY METALS
TABLE H -3 (CONT.)

SAMPLE LOCATION	CHROMIUM (mg/l)/ppm	LEAD (mg/l)/ppm	MERCURY (mg/l)/ppm	NICKEL (mg/l)/ppm
S. Cheyenne				
Secondary - New	0.435 ± 0.01/95	0.714 ± 0.0/155	ND	0.597 ± 0.01/130
Secondary - Old	0.067 ± 0.0/20.9	1.60 ± 0.0/500	ND	0.0114 ± 0.0001/3.56
Sludge Pond	0.274 ± 0.01/48.4	0.690 ± 0.01/122	ND	0.313 ± 0.0/55.4
Crow Creek				
Digestor Influent	6.92 ± 0.01/210	2.90 ± 0.04/88	0.0025/0.08	0.287 ± 0.001/8.7
Digester Effluent	10.4 ± 0.01/479	6.01 ± 0.1/277	0.0037/0.17	1.43 ± 0.01/65.9
Dry Creek				
Primary Recirculation	3.59 ± 0.0/157	1.00 ± 0.01/43.6	0.0041/0.18	0.517 ± 0.001/22.5
Recirculation	4.05 ± 0.01/174	0.75 ± 0.01/32.2	ND	0.35 ± 0.0/15
Primary Digester Effluent	8.54 ± 0.01/317	6.87 ± 0.06/255	0.0043/0.16	1.52 ± 0.01/56.5
Secondary Digester Influent	0.625 + 0.01/121	1.80 ± 0.0/350	ND	0.116 ± 0.0/22.5
Secondary Digester Effluent	22.6 + 0.0/232	1.70 ± 0.01/17.5	0.0022/0.023	0.554 ± 0.01/5.7

ND - NOT DETECTED, Detection limit = 0.0020

PARAMETERS - HEAVY METALS
Table H-3 (CONT.)

SAMPLE LOCATION	SELENIUM (mg/l)/ppm	SILVER (mg/l)/ppm	ZINC (mg/l)/ppm
S. Cheyenne			
Secondary - New	0.0015 ± 0.0002/0.33	0.0156 ± 0.001/3.39	2.72 ± 0.01/5.91
Secondary - Old	ND	0.0051 ± 0.0/1.6	1.75 ± 0.01/547
Sludge Pond	0.0014 ± 0.0001/0.25	0.0189 ± 0.001/3.3	3.10 ± 0.01/548
Crow Creek			
Digester Influent	0.0007 ± 0.0001/0.02	ND	16.0 ± 0.0/486
Digester Effluent	0.0005 ± 0.0/0.023	0.775 ± 0.0/35.7	35.8 ± 0.04/1649
Dry Creek			
Primary Recirculation	0.0018 ± 0.0001/0.079	0.0439 ± 0.0/1.9	28.7 ± 0.1/1252
Recirculation	0.0004 ± 0.0001/0.0172	0.058 ± 0.001/2.5	24.7 ± 0.1/1062
Primary Digester Effluent	0.0017 ± 0.0001/0.06	0.065 ± 0.0002/2.4	34.8 ± 0.0/1294
Secondary Digester Influent	0.0002 ± 0.0/0.039	0.0296 ± 0.0/5.75	3.83 ± 0.0/744
Secondary Digester Effluent	0.0036 ± 0.0/0.037	0.119 ± 0.001/1.22	133 ± 0.1/1369

ND - NOT DETECTED, detection limit = 0.0001