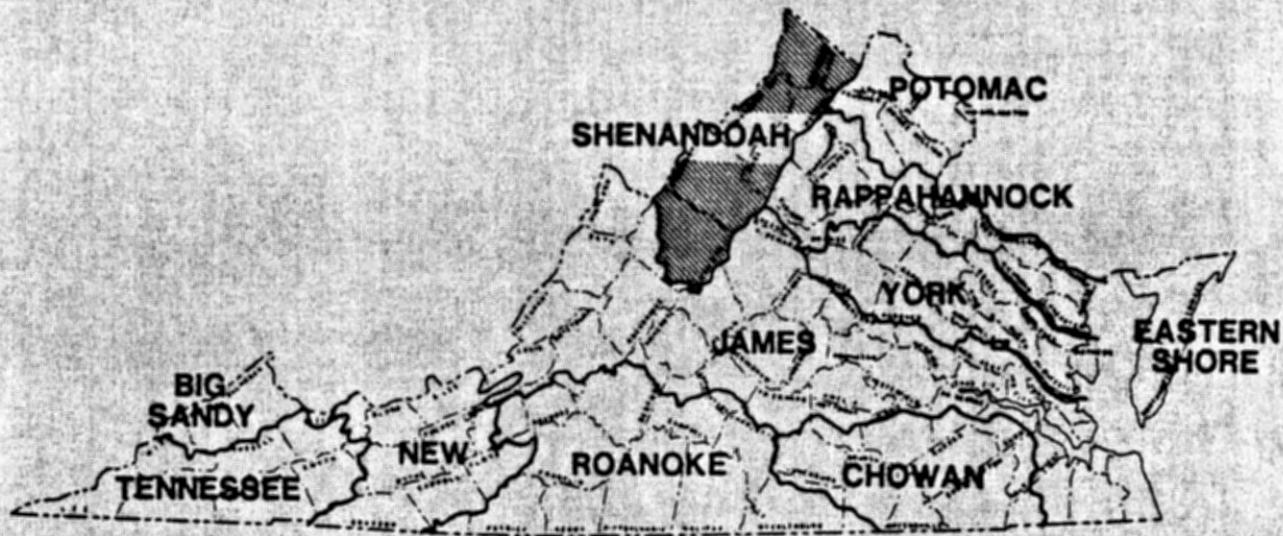


Exec Summary - Reference list

*W-10
10/24/87*

SHENANDOAH WATER SUPPLY PLAN



Commonwealth of Virginia
Virginia State Water Control Board
Planning Bulletin 345

March 1988

PLAN STATUS

On September 29, 1987 the seven-member citizen policy Board of the Virginia State Water Control Board agency, by unanimous vote,

- (a) approved the plans as advisory documents,
- (b) authorized their formal publication, and
- (c) directed the staff to use them along with all other relevant information in its future recommendations and decisions.

This is recorded as Minute No. 44.

SHENANDOAH WATER SUPPLY PLAN

STATE WATER CONTROL BOARD

RICHMOND, VIRGINIA

MARCH 1988

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NORTH FORK SHENANDOAH RIVER SUBAREA

General Description

Geography

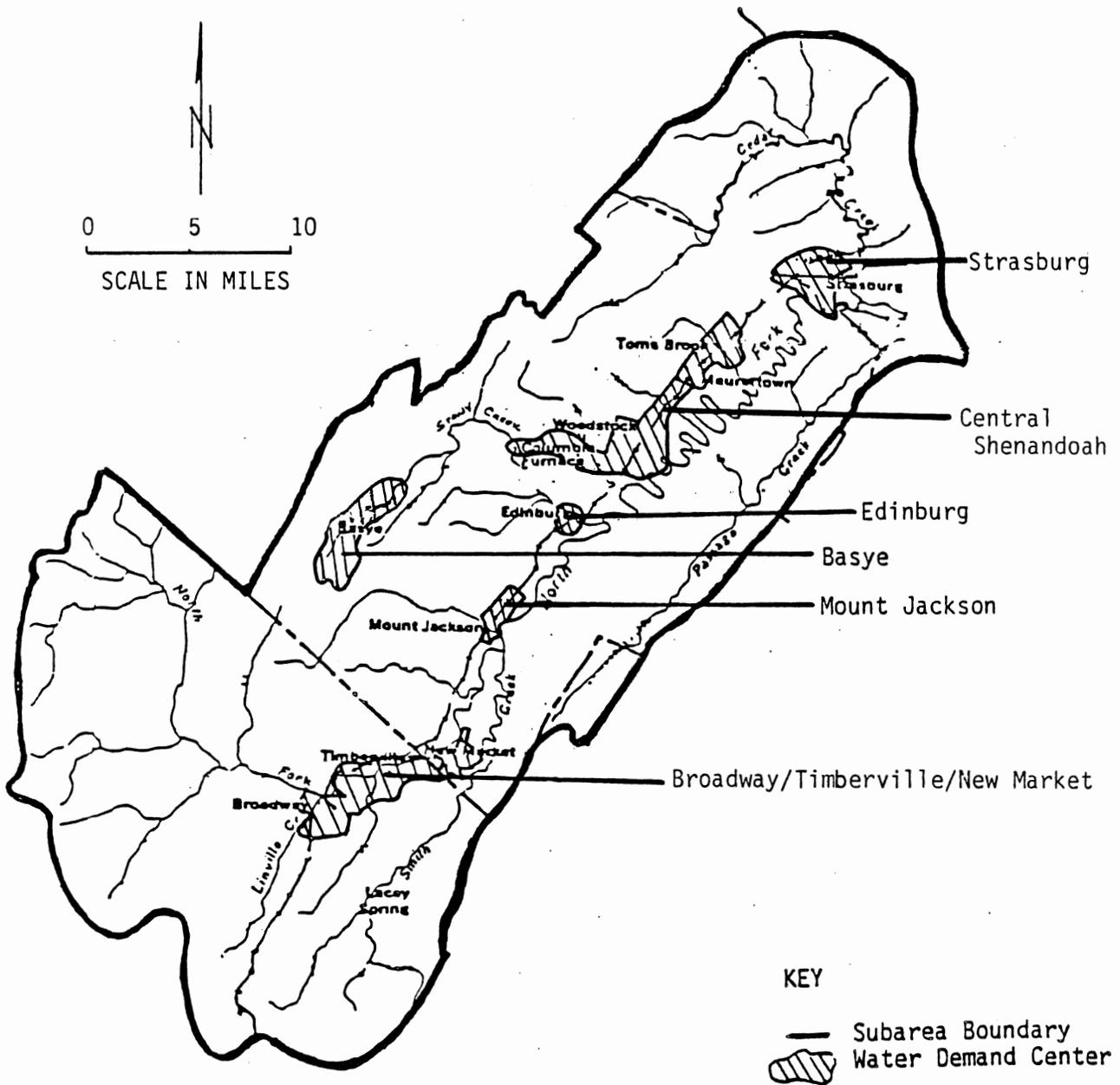
The North Fork Shenandoah River Subarea is located in the northwest portion of the Shenandoah Valley (Figure 39). It is one of the four subareas that comprise the Shenandoah River Planning Area. The 1,102 square-mile subarea is bounded on the southeast by Massanutten Mountain and on the northwest by Shenandoah Mountain and Great North Mountain. The southwestern boundary conforms primarily to the general divide with the South Fork Shenandoah River, while the northeastern boundary is formed by the general watershed divide with the Shenandoah River-Potomac River Tributaries Subarea.

This subarea is drained by the North Fork Shenandoah River and its major tributaries which include Stony Creek, Smith Creek, Passage Creek and Cedar Creek. It includes all of Shenandoah County (512 square miles) and portions of Rockingham (551 square miles), Frederick (116 square miles), Page (6 square miles), and Warren (21 square miles) Counties. The subarea includes the towns of Timberville, Broadway, Edinburg, Mount Jackson, New Market, Woodstock, Toms Brook and Strasburg, and the communities of Columbia Furnace, Maurertown, Basye, and Orkney Springs. For planning purposes there are six water demand centers (Figure 40):

1. Basye Demand Center
2. Broadway/Timberville/New Market Demand Center
3. Central Shenandoah Demand Center
4. Edinburg Demand Center
5. Mount Jackson Demand Center
6. Strasburg Demand Center.

The Basye Demand Center includes the Orkney Springs/Basye corridor and the developed area around Basye associated with Bryce Mountain Resort. Included in this demand center are Stoney Creek Sanitary District, Shrine Mont, and Bryce Resort. Bryce Resort supplies only recreational water for snow-making, golf course irrigation, and swimming.

FIGURE 40
 WATER DEMAND CENTERS
 NORTH FORK SHENANDOAH RIVER SUBAREA



The Broadway/Timberville/New Market Demand Center includes these incorporated towns and the self-supplied industrial withdrawals for Rockingham Poultry Marketing Cooperative, Inc., Food Processors Water Cooperative, and Howell Metal Company. Food Processors Water Cooperative sells water to several industries located in the demand center.

The Central Shenandoah Demand Center includes the incorporated towns of Woodstock and Toms Brook, the unincorporated areas of Maurertown and Columbia Furnace, and the adjacent rural areas that may be served in the future. Also included are the self-supplied industries of Rocco Farm Foods, Inc. and Bowman Apple Products Company, Inc.

The Edinburg, Mount Jackson and Strasburg Demand Centers include these incorporated towns and the adjacent unincorporated areas presently served or that may be served in the future.

Population

Table 56 summarizes the existing and projected future subarea population. The subarea population is expected to increase 24.8% over the period 1980-2030. In 1980, 38% of the subarea's population was located within the demand centers, the greatest population centers being the Broadway/Timberville/New Market and Central Shenandoah Demand Centers. Thirty-one percent of the subarea's population was served by centrally-supplied waterworks. The Virginia Department of Planning and Budget (DPB) projections for the counties and incorporated towns are provided in Appendix A. Note that only portions of Rockingham, Frederick, Page, and Warren Counties are located within the subarea for planning purposes. Major growth can be expected around the Broadway-Timberville area (Central Shenandoah Planning District, District Comprehensive Plan, June 1979); the Woodstock-Edinburg area, particularly along Routes 42 and 675; and the Strasburg area (Shenandoah County, Comprehensive Plan, 1980). Most of the population increase in the counties is expected to be within the demand centers.

TABLE 56

EXISTING & PROJECTED POPULATION & POPULATION SERVED
NORTH FORK SHENANDOAH RIVER SUBAREA

		1980	1990	2000	2010	2020	2030
Basye*	Total	312	500	690	880	1,070	1,260
Demand Center	Total Served	80	240	400	560	720	880
Broadway/Timber-	Total	5,935	7,110	8,130	8,870	9,380	9,920
ville/New Market	Total Served	4,940	6,140	7,290	8,250	9,050	9,920
Demand Center							
Central	Total	5,872	6,970	7,800	8,510	9,150	9,800
Shenandoah	Total Served	4,048	5,240	6,360	7,450	8,570	9,800
Demand Center							
Edinburg	Total	780	900	960	1,040	1,070	1,150
Demand Center	Total Served	780	900	960	1,040	1,070	1,150
Mount Jackson	Total	1,530	1,740	1,890	2,010	2,100	2,220
Demand Center	Total Served	1,530	1,740	1,890	2,010	2,100	2,220
Strasburg	Total	3,011	3,730	4,350	4,960	5,450	6,000
Demand Center	Total Served	2,800	3,520	4,170	4,780	5,370	6,000
Demand Center	Subtotal	17,440	20,950	23,820	26,270	28,220	30,350
Totals	Subtotal Served	14,178	17,780	21,070	24,090	26,880	29,970
Outside Demand Centers**							
Frederick County		3,080	3,460	3,540	3,520	3,460	3,370
Rockingham County		9,637	10,570	10,770	10,940	11,160	11,360
Shenandoah County		14,769	15,780	15,910	15,510	14,990	14,320
Warren County		841	1,200	1,300	1,400	1,400	1,500
GRAND	Total	45,767	51,960	55,340	57,640	59,230	60,900
	Total Served	14,178	17,780	21,070	24,090	26,880	29,970
	(% Served)	31	34	38	42	45	49

*Does not include part-time residents.

**Includes only portions of county located in subarea and excludes population contained within other subareas.

See Ch. 7 1980 = 60.2

It is projected that 49% of the subarea's population will be supplied by demand center water systems by 2030, an increase from 31% in 1980. The Broadway/Timberville/New Market and Central Shenandoah Demand Centers will account for nearly 66% of all those served in the subarea with the Strasburg Demand Center accounting for 20% and the Mount Jackson Demand Center accounting for 7%. Demand center supply systems are anticipated to serve 15,792 more persons in 2030 than in 1980.

Land Use

About 49% of the subarea is forested including Federally-owned land in the George Washington National Forest. Agricultural land comprises approximately 33% of the subarea, and developed land accounts for approximately 16% of the subarea. (Percentages are based on total acreage of the respective counties; sources are Central Shenandoah Planning District Commission and Lord Fairfax Planning District Commission District Comprehensive Plans). Most of the development is located in the urban centers along Route 11. Interstate 66 is inducing land use changes in the northern part of the subarea. These changes will result in increased residential, commercial and industrial development. (Impacts: I-66 and Growth, Lord Fairfax Planning District Commission, 1980).

Surface Water

Surface water includes freely flowing water as well as water stored in impoundments. Major reservoirs are tabulated in Table 57 with locations shown in Figure 41. Table 58 and Figure 42 show stream gage data and locations for the subarea.

The spatial variability of streamflows is demonstrated by drainage area yields defined as cubic feet per second per square mile (cfs/square mile). Differences in these yields can reflect differences in the amount of precipitation falling upon the various drainage areas and the ability of surface runoff and ground water to reach the stream channel. There are also relative differences in the rankings of average and low flow

TABLE 57
INVENTORY OF IMPOUNDMENTS
NORTH FORK SHENANDOAH RIVER SUBAREA

Map No. (Figure 41)	Impoundment (Inventory No.)	Owner	Drainage Area Acres+	Normal Volume (Max Volume) Acre-Ft.++	Surface Area Acres+++	Purpose	Storage Allocation Acre-Feet	Stream
1	Stony Creek Dam #9 (17101)	Bryce Mountain Corp.	4,666	660 (3,260)	44	Recreation Flood control	3,260* 660	Stony Creek
2	Stony Creek Dam #10 (17102)	Col. G.C. Hamm	2,944	170 (1,910)	15	Recreation Flood control	1,910 170	Alum Run
3	Woodstock Dam (17104)	Town of Woodstock	4,480	52 (102)	2.8	Water supply***	52	Little Stony Creek
4	Seven Vistas Dam (6916)	Gerlick, Vernon, Climpson		44 (59)		Recreation	44	Tributary of Cedar Creek
5	Kelchner's Dam (6908)	George Kelchner		116 (182)		Recreation	116	Tributary of Furnace Branch
6	High View Manor Dam (6910)	High View Manor, Inc.		78 (97)		Recreation	78	Hogue Run
7	Lehman's Dam (6906)	Sam Lehman		90 (118)		Recreation	90	Gough Run
8	John Dam (18702)	Richard D. Bernstein		129 (237)		Recreation	129	Molly Booth Run
9	Strasburg Dam (17105)	Town of Strasburg	570	55 (189)	5.08	Water supply	54.6**	Little Passage Creek
10	Burnshire Dam	Britt R. Gilbert	390,400	291 NA	48.5	Hydroelectric		North Fork Shenandoah River
11	Chapman Dam (17106)	Byron B. Wenger		90 (165)		Hydroelectric	90	North Fork Shenandoah River
12	Seven Fountains Dam (17103)	Seven Fountains Farm Corp.		77 (150)		Recreation	77	Tributary of Passage Creek (offstream)
13	Edinburg Dam (17107)	T.G. & J.S. Scully		85 (145)		Recreation	85	North Fork Shenandoah River
14	New Market Dam	Town of New Market				Water supply	3.7	Grim's Run

+640 acres = one square mile.

++Normal - volume in storage when pool is at the elevation of the spillway (control pool).

Maximum - volume in storage when pool is at the elevation of the crest of the non-overflow portion of the dam.
One acre-ft equals 326,000 gallons.

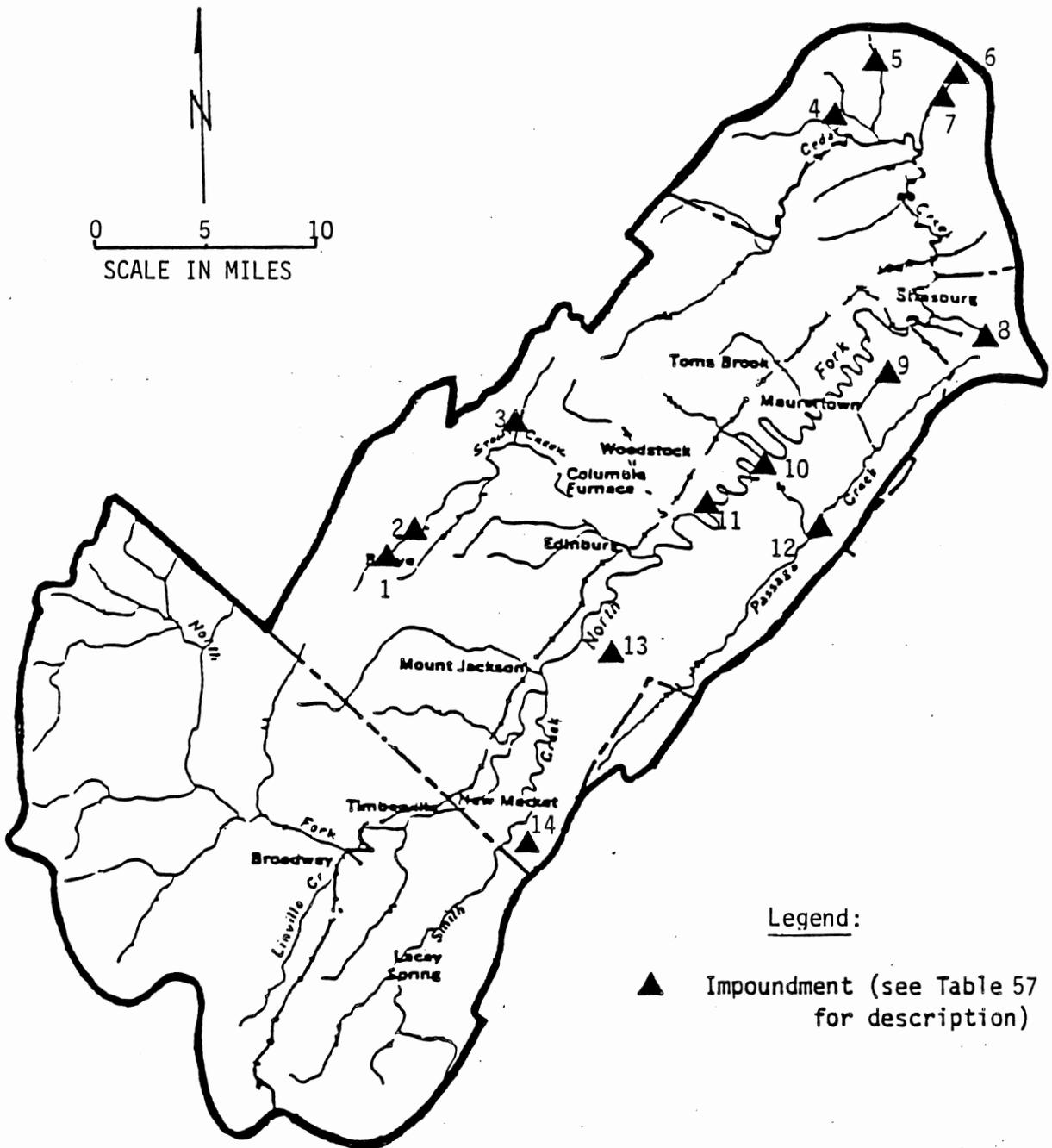
+++At normal pool.

*To top of dam.

**Based upon design figures, no correction for sediment.

***No longer used for water supply; permanently drained during summer of 1986.

FIGURE 41
 IMPOUNDMENTS
 NORTH FORK SHENANDOAH RIVER SUBAREA



Legend:

▲ Impoundment (see Table 57 for description)

TABLE 58
 STREAM GAGES
 NORTH FORK SHENANDOAH RIVER SUBAREA

Map No. (Figure 42)	Gage	Period of Record	Drainage Area (sq. mi.)	Average Flow* cfs (cfs/sq. mi)	Low Flows**		
					7Q10 cfs (cfs/sq. mi)	1Q30 cfs (cfs/sq. mi)	Minimum Flow cfs
1	North Fork Shenandoah River at Cootes Store, VA 01632000	1925 - Present	210	191 (0.910)	0.75 (0.0036)	0.27 (0.0013)	0.2
2	Smith Creek near New Market, VA 01632900	1960 - Present	93.2	72.2 (0.775)	7.89 (0.085)	6.24 (0.067)	4.5
3	North Fork Shenandoah at Mt. Jackson, VA 01633000	1943 - Present	506	385 (0.756)	17.80 (0.035)	10.20 (0.020)	7.0
4	North Fork Shenandoah near Strasburg, VA 01634000	1925 - Present	768	585 (0.759)	66.58 (0.087)	46.5 (0.061)	41
5	Cedar Creek near Winchester, VA 01634500	1937 - Present	103	93.1 (0.892)	4.13 (0.040)	2.78 (0.027)	2.3
6	Passage Creek near Buckton, VA 01635500	1932 - Present	87.8	68.5 (0.776)	1.21 (0.014)	0.47 (0.005)	0.1
7	Stony Creek at Columbia Furnace, VA 0163500	1947 - 1956	76.0	70.4 (0.926)	5.60 (0.073)	5.20 (0.068)	5.1

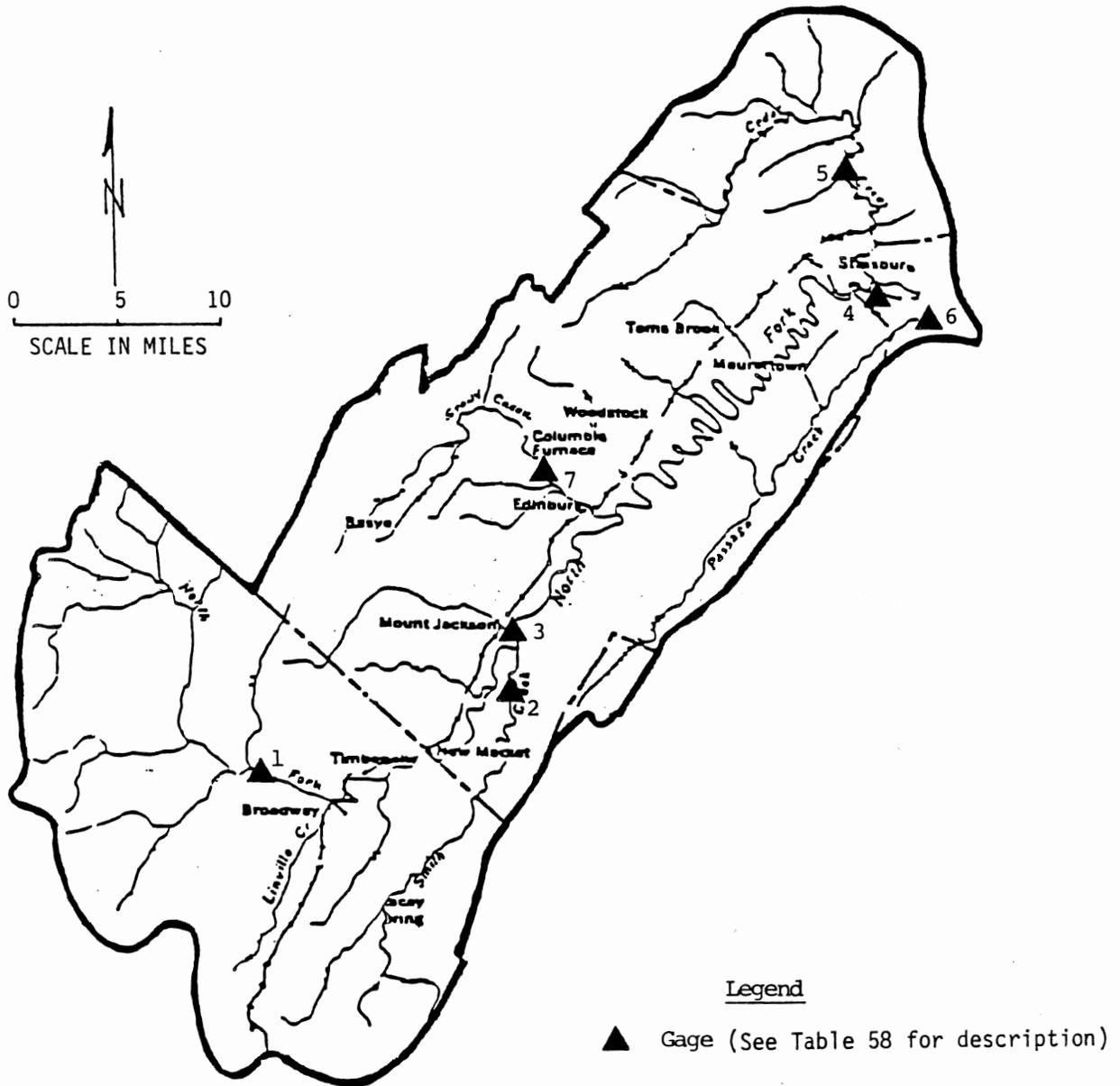
*Average flows are from data through 1983.

**7Q10 = 7 day-10 year low flow (from data through 1977).

1Q30 = 1 day-30 year low flow (from data through 1977).

FIGURE 42

STREAM GAGING STATIONS
NORTH FORK SHENANDOAH RIVER SUBAREA



yields. For instance, the 210 square-mile drainage area of North Fork Shenandoah River at Cootes Store has the greatest average yield but the least 1Q30 low flow yield.

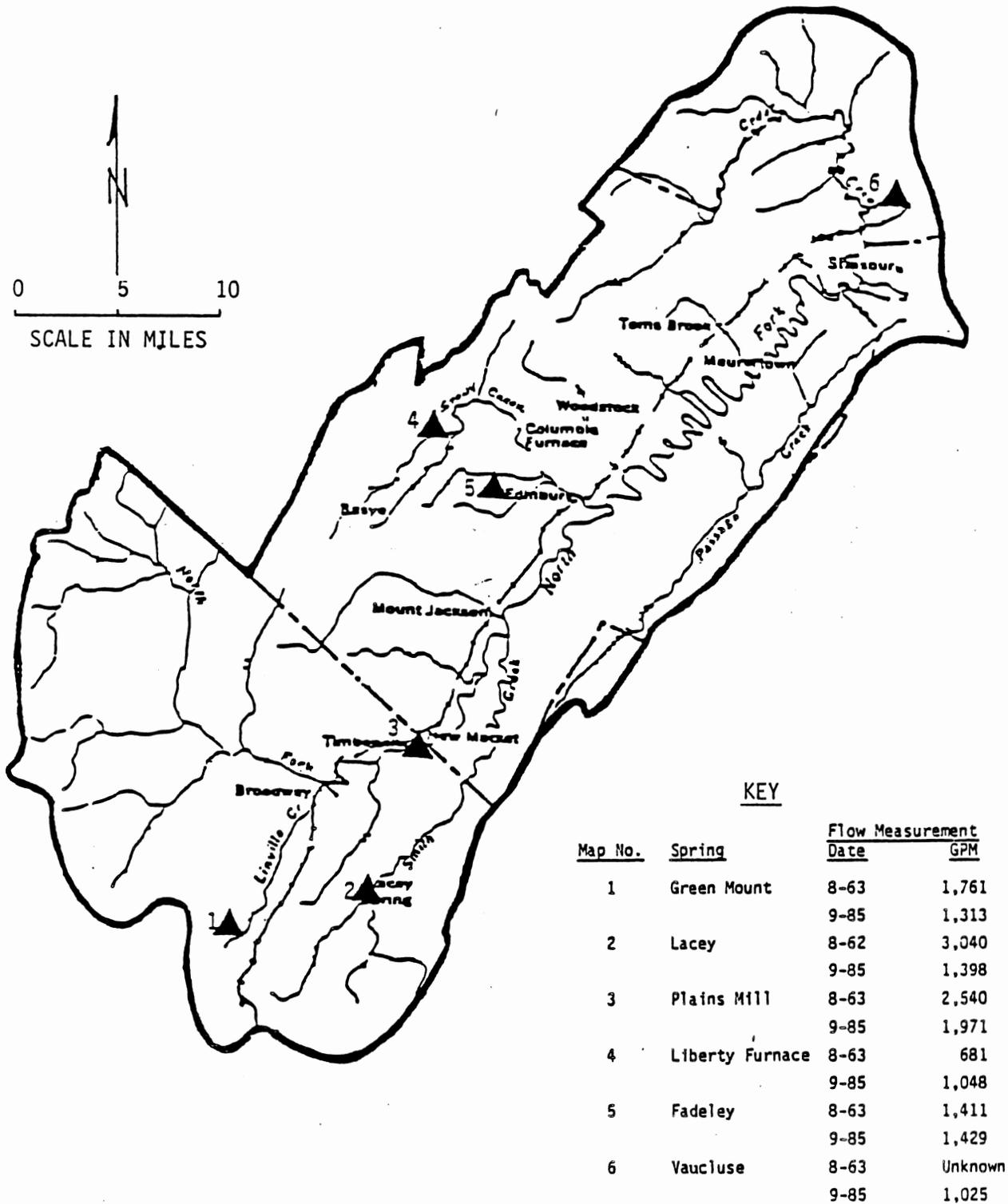
The greatest 1Q30 yields are along Smith Creek near New Market and the North Fork Shenandoah River at Strasburg. Because ground water comprises virtually all of the flow during drought conditions, these drainage areas appear to release the most ground water to the stream channel. Thus the drainage areas that are most efficient in releasing ground water to the stream channels have the higher 1Q30 cfs/square mile yields.

Springs can contribute a significant portion of surface streamflow during base flow conditions. Spring measurements taken during the summer of 1963 by the Virginia Division of Water Resources were compared to streamflow measurements in those watersheds for the same time period. Comparison of the data shows that spring flow in the North Fork Shenandoah River Subarea comprised a significant amount of the total measured streamflow (see Appendix C). Identified springs in the Mount Jackson-Smith Creek watershed accounted for more than 62% of the total streamflow. This area combined with the Cootes Store watershed shows that major springs provide nearly half the base flow; this underscores the significance of major springs in a headwaters area. Figure 43 shows some of the larger springs in the subarea.

Ground Water

Ground water availability in this subarea varies with the local geology (Figure 44). The highest potential yields are along the North Fork Shenandoah River between New Market and Woodstock, and the entire Edinburg/Woodstock area. This is an area of carbonate rock (limestone and dolomite) overlain by alluvial material (sediments, such as sand and gravel, deposited by streams). This situation creates favorable conditions for high ground water yields.

FIGURE 43
 SELECTED MAJOR SPRINGS
 NORTH FORK SHENANDOAH RIVER SUBAREA



The major portion of the central valley area is made up of carbonate rocks which lack extensive alluvial overburden. Good well yields are common from these rocks, though potential is not as great as in those areas with alluvial cover. The shale and sandstone units in the western portion of the subarea and Massanutten Mountain offer significantly less ground water potential.

Demands

The average 1980 water withdrawal in the North Fork Shenandoah River Subarea was approximately 18 MGD with 16% of the withdrawal occurring in the Broadway/Timberville/New Market Demand Center (Table 59). The remaining demand centers account for the following portions of the total withdrawal: Central Shenandoah, 6%; Strasburg, 2%; Edinburg, 1%; Mount Jackson, 1%; and Basye, 1%.

The greatest concentration of withdrawals is in the Broadway/Timberville/New Market Demand Center. Rockingham Poultry Marketing Cooperative withdraws a total of 0.633 MGD, 4% of the subarea's total withdrawal. The City of Winchester, which withdraws 5.2 MGD from this subarea but transfers, uses, and returns its wastewater in the Shenandoah River-Potomac River Tributaries Subarea, accounts for 29% of the subarea's demand.

Manufacturing accounts for 22% of the subarea water usage; the textile and food-related industries are responsible for the bulk of this demand (Table 60). According to a survey of all known irrigators in the subarea conducted by the VWCB through the County Extension Service, irrigation is concentrated in the central and southern portions of the subarea. During the irrigation season (four months) withdrawals are 9.8 MGD; annualized over the calendar year the average annual rate becomes 3.22 MGD. The demands from the survey were obtained from pump capacities by assuming a 60% efficiency factor and operating 20 hours in a 24-hour period.

TABLE 59

EXISTING AND PROJECTED WATER USAGE BY DEMAND CENTER
ASSUMING NO CONSERVATION (MGD)
NORTH FORK SHENANDOAH RIVER SUBAREA

	1980	1990	2000	2010	2020	2030
Basye Demand Center						
Waterworks-supplied Dom/Com/Inst*	0.27	0.37	0.57	0.68	0.79	0.89
Self-supplied Dom/Com/Inst <i>75 GPCD</i>	0.02	0.02	0.02	0.02	0.03	0.03
Subtotal <i>(p. 189)</i>	0.29	0.39	0.59	0.70	0.82	0.92
Broadway/Timberville/New Market Demand Center						
Waterworks-supplied Dom/Com/Inst	0.33	0.41	0.49	0.56	0.61	0.68
Waterworks-supplied Ind/Mfg/Min**	0.33	0.36	0.40	0.44	0.47	0.51
Unaccounted	0.16	0.18	0.21	0.23	0.25	0.27
Self-supplied Dom/Com/Inst <i>66 gpcd</i>	0.07	0.06	0.06	0.04	0.02	0.00
Self-supplied Ind/Mfg/Min <i>(p. 201)</i>	1.88	2.10	2.29	2.50	2.89	3.14
Subtotal	2.77	3.11	3.45	3.77	4.24	4.60
Central Shenandoah Demand Center						
Waterworks-supplied Dom/Com/Inst	0.27	0.35	0.42	0.49	0.57	0.58
Unaccounted	0.09	0.12	0.15	0.17	0.20	0.23
Self-supplied Dom/Com/Inst <i>60 gpcd</i>	0.11	0.10	0.09	0.06	0.04	0.00
Self-supplied Ind/Mfg/Min <i>(p. 214)</i>	0.59	0.64	0.70	0.76	0.83	0.89
Subtotal	1.06	1.21	1.36	1.48	1.64	1.70
Edinburg Demand Center						
Waterworks-supplied Dom/Com/Inst	0.06	0.07	0.07	0.08	0.08	0.09
Unaccounted	0.08	0.09	0.10	0.11	0.11	0.12
Subtotal	0.14	0.16	0.17	0.19	0.19	0.21
Mount Jackson Demand Center						
Waterworks-supplied Dom/Com/Inst	0.08	0.09	0.10	0.11	0.11	0.12
Unaccounted	0.05	0.06	0.06	0.06	0.07	0.07
Self-supplied Ind/Mfg/Min	0.07	0.07	0.08	0.09	0.09	0.10
Subtotal	0.20	0.22	0.24	0.26	0.27	0.29
Strasburg Demand Center						
Waterworks-supplied Dom/Com/Inst	0.16	0.20	0.24	0.27	0.31	0.34
Waterworks-supplied Ind/Mfg/Min	0.15	0.16	0.18	0.19	0.21	0.23
Unaccounted	0.04	0.05	0.06	0.06	0.07	0.08
Self-supplied Dom/Com/Inst <i>51 gpcd</i>	0.01	0.01	0.01	0.01	0.01	0.00
Subtotal <i>(p. 214)</i>	0.36	0.42	0.49	0.53	0.60	0.65

4.82

TABLE 59

EXISTING AND PROJECTED WATER USAGE BY DEMAND CENTER
ASSUMING NO CONSERVATION (MGD)
NORTH FORK SHENANDOAH RIVER SUBAREA

	1980	1990	2000	2010	2020	2030
Outside Demand Centers						
Self-supplied Dom/Com/Inst	1.75	1.94	1.96	1.95	1.93	1.90
Self-supplied Ind/Mfg/Min	0.91	1.13	1.28	1.41	1.47	1.50
Irrigation***	3.22	3.22	3.22	3.22	3.22	3.22
Non-irrigated Agriculture	1.78	1.95	2.14	2.36	2.59	2.85
Winchester****	5.20	5.88	6.75	7.25	8.20	8.89
SUBTOTAL (Excluding Power Uses)	17.68	19.63	21.65	23.12	25.17	26.73
Hydropower*****						
Burnshire Dam	190.00	190.00	190.00	190.00	190.00	190.00
Chapman Dam	320.00	320.00	320.00	320.00	320.00	320.00
Subtotal	510.00	510.00	510.00	510.00	510.00	510.00
GRAND TOTAL	527.66	529.64	531.63	533.12	535.14	536.71

*Domestic/Commercial/Institutional.

**Industrial/Manufacturing/Mining.

***Irrigation has been annualized for comparison. Seasonal irrigation is 9.8 MGD.

****Winchester's demand and wastewater return are in the Shenandoah River - Potomac River Tributaries Subarea.

*****The Virginia Hydro Dam Inventory (June 1981) indicates that Burnshire Dam has available head of 12 feet and installed capacity of 230 kw. Chapman Dam has available head of 16 feet and has plans for 550 kw of installed capacity.

In Appendix E, irrigation water demand information is presented for each subarea in the Shenandoah Planning Area utilizing a methodology that has been applied statewide. The statewide methodology looks at Census of Agriculture data on acres irrigated and assumes an eight-inch application rate over the irrigation season. The application of the statewide methodology results in an annual average irrigation demand of 0.85 MGD for the North Fork Shenandoah River Subarea, which is less than the irrigation value contained in this chapter. consult the Appendix for more details.

TABLE 60

EXISTING & PROJECTED WATER USE BY CATEGORY (MGD)
NORTH FORK SHENANDOAH RIVER SUBAREA

<u>Water Use Category</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
Dom/Com/Inst ⁽¹⁾	3.12	3.63	4.03	4.28	4.48	4.62
Ind/Mfg/Min ⁽²⁾	3.92	4.47	4.93	5.38	5.96	6.37
Unaccounted ⁽³⁾	0.42	0.45	0.57	0.63	0.69	0.76
Irrigation ⁽⁴⁾	3.22	3.22	3.22	3.22	3.22	3.22
Non-Irrigated						
Agricultural	1.78	1.95	2.14	2.36	2.59	2.85
Winchester ⁽⁵⁾	<u>5.20</u>	<u>5.88</u>	<u>6.75</u>	<u>7.25</u>	<u>8.20</u>	<u>8.89</u>
Subtotal (Excluding Hydropower)	17.66	19.60	21.64	23.12	25.14	26.71
Hydropower	<u>510.00</u>	<u>510.00</u>	<u>510.00</u>	<u>510.00</u>	<u>510.00</u>	<u>510.00</u>
TOTAL	527.66	529.60	531.64	533.12	535.14	536.71

- (1) Domestic/Commercial/Institutional.
- (2) Industrial/Manufacturing/Mining.
- (3) Water that has been pumped or otherwise sent into the distribution system but has not been sold, measured, or otherwise accounted for.
- (4) Irrigation data are annualized. Seasonal irrigation is 9.8 MGD.
- (5) Winchester's demand and return are in the Shenandoah River-Potomac River Tributaries Subarea.

Total water demand for the subarea (excluding power uses) is expected to increase 51% ^(7 mgd) from 1980 to 2030. The largest increase is expected to occur in the Basye Demand Center (224%). Most of this increase results from the increase in the

waterworks-supplied domestic/commercial/institutional component. Water demands in the Strasburg Demand Center are expected to increase 78%. Both the waterworks-supplied domestic/commercial/institutional and industrial/manufacturing/mining components account for the majority of this increase. Water demand increases for the other Demand Centers are as follows: Broadway/Timberville/New Market - 67%; Central Shenandoah - 60%; Edinburg - 48%; and Mount Jackson - 46%. Winchester's demand can be expected to increase by 3.7 MGD and account for 41% of the subarea's increase in water demand.

3.7
1.5
1.2
9.35

The domestic/commercial/institutional and industrial/manufacturing/mining components are projected to increase 1.50 MGD and 2.45 MGD, respectively, over the planning period. Together these components account for 44% of the 9 MGD increase in the subarea's water demand. The non-irrigation agricultural water demand is expected to increase 1.7 MGD whereas irrigation is assumed to remain constant. The irrigation survey indicated that irrigators expected their demands would not increase significantly.

Ground water is used to satisfy 21% of the subarea's water demands, and surface water 79% (excluding irrigation and hydropower). Ground water accounts for virtually all the water used in the Edinburg and Mount Jackson Demand Centers. Locations and amounts of major ground water and surface water withdrawals are shown in Figure 45 and Tables 61 and 62. Evaluation of Subarea (Problem Identification).

Problems that public water systems in the subarea are likely to experience are summarized in Table 63. The six Demand Center Narrative sections provide a more detailed discussion on these problems and of problems associated with the distribution systems. The Introduction in Chapter 2 defines specific terms. The public water system evaluation section in Appendix A contains additional details on the method used for gathering information.

FIGURE 45

SIGNIFICANT WATER WITHDRAWALS
NORTH FORK SHENANDOAH RIVER SUBAREA

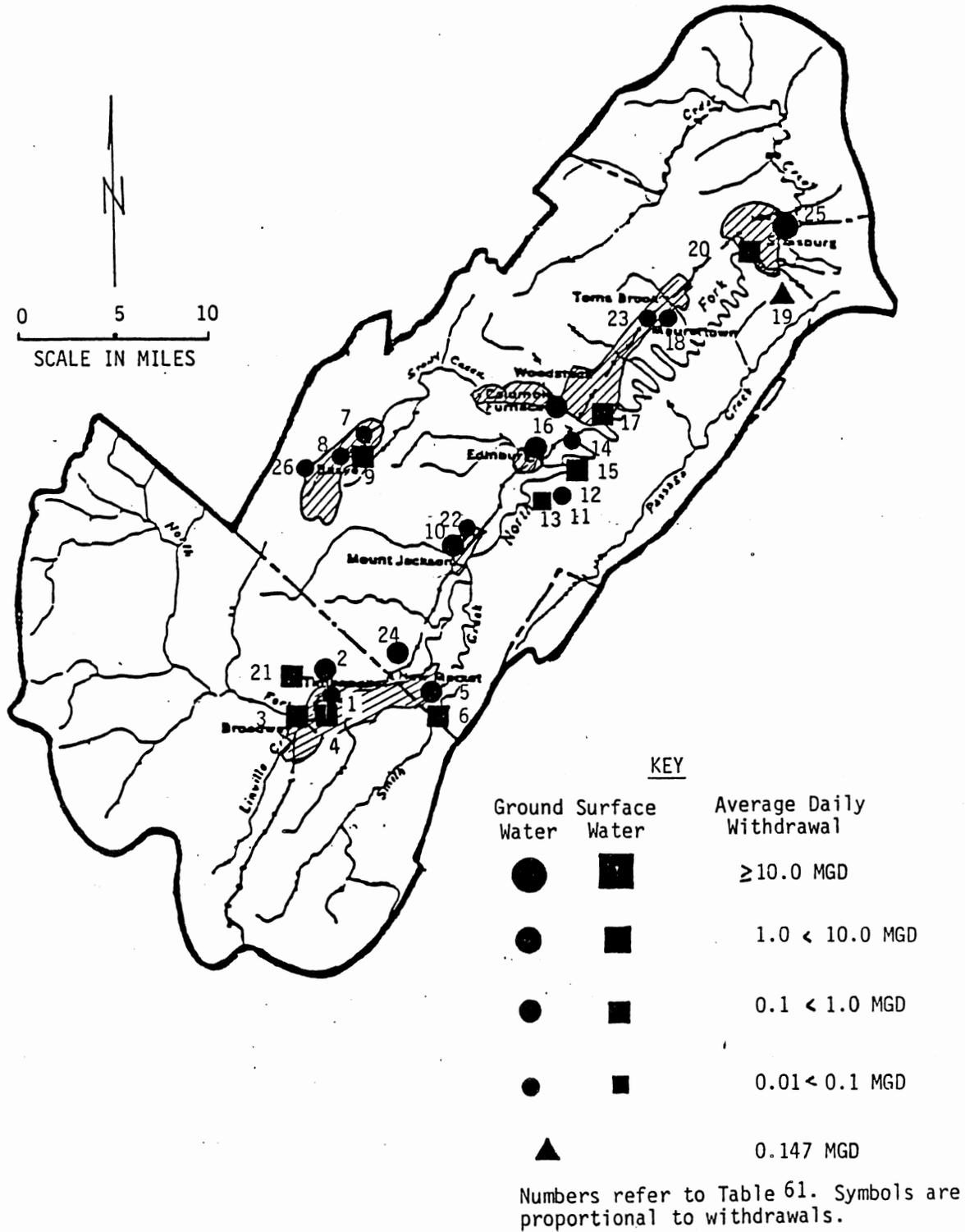


TABLE 61

MAJOR RESERVOIRS, STREAM INTAKES & WELLS
NORTH FORK SHENANDOAH RIVER SUBAREA

Map No. (Fig. 45)	Withdrawer	Description	1983* Withdrawal
1	Timberville	2 wells	0.005
2	Timberville	Spring	0.205
3	Broadway	North Fork Shen. River	0.200
4	Food Processors Water Corp.	North Fork Shen. River	0.605
5	New Market	Well	0.202
6	New Market	Smith Creek	0.234
7	Stoney Creek San. District	7 wells	0.075
8	Bryce Resort	Well	0.001
9	Bryce Resort	Stony Creek	0.111
10	Mt. Jackson	Well	0.142
11	Edinburg	Well	0.201
12	Edinburg	Spring	0.025
13	Edinburg	2 streams	0.050
14	Aileen	2 wells	0.001
15	Aileen	North Fork Shen. River	0.981
16	Rocco	3 wells	0.552
17	Woodstock	North Fork Shen. River	0.398
18	Toms Brook/ Maurertown	2 wells	0.054
19	Strasburg	Reservoirs	0.146
20	Strasburg	North Fork Shen. River	0.207
21	Rockingham Poultry Marketing Cooperative	North Fork Shen. River	0.633
22	Bowman Apple - Mt. Jackson	Wells	0.067
23	Bowman Apple - Maurertown	Wells	0.021
24	Howell Metal	2 wells	0.196
25	Winchester	North Fork Shen. River	5.520
26	Shrine Mont	Well	0.012

*Withdrawals as reported under VWCB Annual Report of Water Withdrawals
(Regulation 11).

**1985 Regulation 11 data.

TABLE 62

WATER WITHDRAWAL (MGD) BY SOURCE IN 1980
NORTH FORK SHENANDOAH RIVER SUBAREA

Demand Center	Ground Water	Surface Water	Total
Basye	0.15	0.13	0.28
Broadway/Timberville/New Market	0.64	1.67	2.31
Central Shenandoah	0.75 <i>to</i>	0.31 <i>1/89</i>	1.06 <i>Larry Bradford</i>
Edinburg	0.14	0.00	0.14 <i>expects</i>
Mt. Jackson	0.20	0.00	0.20 <i>current</i>
Strasburg	0.01	0.35	0.36 <i>withdrawal</i>
Subtotal	1.89	2.46	4.36 <i>about 1.00 MGD</i>
Outside Demand Centers*			
Frederick County	0.19	0.07	0.27
Rockingham County	0.62	1.56	2.18
Shenandoah County	0.93	4.20 **	5.13
Warren County	0.05	5.23 ***	5.28
TOTAL	3.69	13.53	17.21

*Domestic/Commercial/Institutional demand calculated by using 62 GPCD and assumed to be ground water.

**Includes Aileen, Inc.

***Includes City of Winchester withdrawal of 5.2 MGD. The City's demand and wastewater return are in the Shenandoah River-Potomac River Tributaries Subarea.

TABLE 63

SUMMARY OF IDENTIFIED PROBLEMS FOR PUBLIC WATER SYSTEMS
NORTH FORK SHENANDOAH RIVER SUBAREA

Expected Deficits to be Encountered by 2030*

<u>System</u>	<u>Source</u>	<u>Delivery</u>	<u>Treatment</u>	<u>Storage</u>
Basye Demand Center				
Stoney Creek Sanitary District	Y**	N	Y	Y
Shrine Mont	N	N	NA	N
Broadway/Timberville/New Market Demand Center				
Broadway	Y	N	N	N
Timberville	N	N	NA	N
New Market	N	N	N	N
Central Shenandoah Demand Center				
Toms Brook-Maurertown Service Authority	Y	N	NA	N
Woodstock	N	N	N	N
Edinburg Demand Center				
Edinburg	N	N	N	N
Mount Jackson Demand Center				
Mount Jackson	N	N	N	N
Strasburg Demand Center				
Strasburg	N	N	N	N

*Deficits were determined using average day demands.

**Y = Yes, there is a projected deficit; N = No projected deficit, NA = Not applicable.

Three systems in the subarea have source problems. Two of these systems rely on ground water, and a preliminary evaluation of alternatives shows that one of the systems may have difficulty meeting its deficit from ground water sources. The third system currently experiencing surface water source problems is actively pursuing another surface water source.

Alternatives for these systems should focus on additional source development.

Only one system is expected to encounter problems associated with water treatment and storage, and no systems are anticipated to experience delivery problems.

To determine conflicts among offstream and instream uses in this subarea, the effect of withdrawals on streamflows in the North Fork Shenandoah River, Smith Creek, and Stony Creek was evaluated at drought flow conditions. Conflicts between offstream and instream uses are expected to occur throughout the subarea during drought flow conditions. Potential water supply problems or offstream conflicts are expected to occur along the reaches of the North Fork Shenandoah River for municipal, industrial and irrigational withdrawers. Sufficient water appears to be unavailable to meet current surface water withdrawals at projected 2030 demands. The Town of Broadway, Food Processors and Rockingham Poultry should consider water sources other than the North Fork Shenandoah River to satisfy projected 2030 demands. Water quality conflicts or instream use conflicts are also expected to occur at these aforementioned locations. A complete discussion of the methodology used and the conclusions developed in determining conflicts among various offstream and instream uses is contained in Appendix C. Each demand center contains a brief summary outlining more details.

The water demand center analysis section includes a discussion on Introduction and Description, Existing Facilities, Projected Demands, Problem Identification, Alternative Analysis, and Recommendations.

Basye Demand Center

Introduction and Description

The Basye Demand Center (Figure 46) is in the western part of the subarea along Stony Creek, a tributary of the North Fork Shenandoah River. The Basye Demand Center includes the Orkney Springs-Basye corridor and the developed area around Basye associated with Bryce Mountain Resort. The following water systems are included in the demand center:

1. Stony Creek Sanitary District
2. Bryce Resort
3. Shrine Mont.

The boundaries of the demand center were determined primarily by the 1974 Shenandoah County Comprehensive Plan which identified the Orkney Springs-Basye area as a secondary (or rural) growth center. The area of the demand center is 8.25 square miles; total 1980 population was 312.

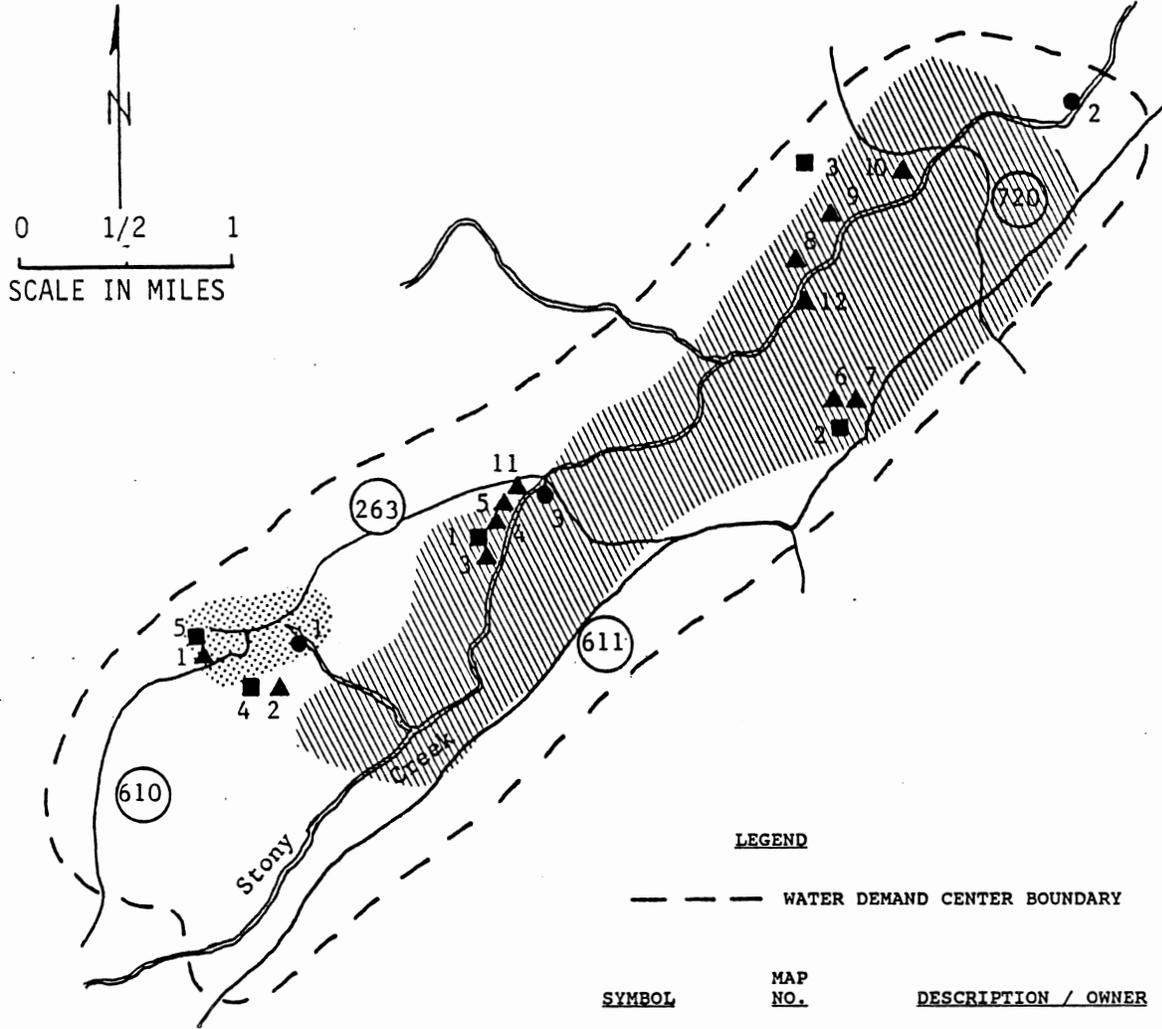
Existing Facilities

Stoney Creek Sanitary District. The Stony Creek Sanitary District (comprised of the former Stony Creek Utilities, Lake Laura Water Company, and Bryce Hill Condominiums) served 30 connections housing 80 full-time residents in the Bryce Mountain Resort complex in 1980. They also provided water to 1,570 part-time residents of single-family dwellings and condominium and townhouse units (part-time residents are not included in official census records) for a total service population of 1,650. All of the 0.124 MGD demand was domestic/commercial; there are no manufacturing connections on either system. Demands by full-time residents accounted for 0.006 MGD, while demands by part-time residents totalled 0.118 MGD.

Stoney Creek Sanitary District is supplied by a public water system consisting of eight wells. Two of the wells in use are not permitted by VDH, while one which is permitted is no longer in use. The VDH rated capacity of this system is 0.167 MGD, but according to VDH guidelines the actual capacity of the system represented by the wells currently in use is 0.145 MGD. Chlorination and manganese and iron removal are

FIGURE 46

BASYE DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA



LEGEND

--- WATER DEMAND CENTER BOUNDARY

KEY
(Future Service Areas)

-  - Orkney Springs and Shrine Mont Service Area
-  - Stoney Creek Sanitary District Service Area

SYMBOL	MAP NO.	DESCRIPTION / OWNER
 (Source)	1	Well/Shrine Mont Springs/ Orkney Springs Hotel
	2	Well #5/Stoney Creek Sanitary District
	3	Well #1/(SCSD)
	4	Well #3/(SCSD)
	5	Well P2/(SCSD)
	6	Well P1/(SCSD)
	7	Well P11/(SCSD)
	8	Well P3/(SCSD)
	9	Well P6/(SCSD)
	10	Well/Bryce Resort
	11	Intake/Bryce Resort
	12	
 (Storage)	1	Concrete Tank (0.10 MG)/(SCSD)
	2	Tank (0.015 MG)/(SCSD)
	3	Standpipe (0.072 MG)/(SCSD)
	4	Tank (0.020 MG)/Orkney Springs Hotel
	5	Tank (0.050 MG)/Shrine Mont
 (Wastewater Return)	1	WWR/Orkney Springs
	2	WWR/(SCSD)
	3	WWR/(SCSD)

provided on six of the wells. Total storage capacity is 0.194 MG.

In addition to the public well system, the Sanitary District also owns and operates a "private" well system consisting of approximately 90 active wells. Each well serves one or more residences in the resort area, but none serve more than 15 connections or more than 25 individuals and are therefore exempt from VDH regulation.

Bryce Resort. Bryce Resort supplies recreation water exclusively for the Bryce Mountain Resort complex at Basye; it is therefore not permitted by VDH. Water demands are all seasonal, and the 1980 annualized daily demand of 0.131 MGD included 0.050 MGD for golf course irrigation; 0.001 MGD for the swimming pool; and 0.080 MGD (1983 data) for snow-making at the ski center. Daily demands during each recreational season are: 0.086 MGD for golf course irrigation (based on 210 days); 0.003 MGD for the swimming pool (based on 150 days); and 0.326 MGD for snow-making (based on 90 days).

The system is supplied by surface water and ground water. Stony Creek is the source for irrigation and snow-making water. The irrigation system is powered by one 450-gpm (0.648 MGD) pump with an identical pump on standby. Water is pumped through approximately 10 miles of PVC lines. The snow-making system is driven by one 750-gpm (1.08 MGD) pump with an identical pump on standby. Water is pumped through approximately 10,000 feet of six-inch steel lines.

The pool system is supplied by a 265-foot well, reported to have yielded 41 gpm (0.059 MGD) after a 48-hour pump test. A 180-gpm (0.26 MGD) submersible pump transfers water through 85 feet of two-inch steel line. The pool system is the only system requiring treatment. Iron and manganese removal is provided by three sand filters (filtration rate unknown). There is no storage provided on any of the systems.

Shrine Mont. Shrine Mont, Incorporated, operates three months out of the year and provides water to a church retreat

facility serving approximately 44 connections in the Shrine Mont-Orkney Springs Hotel complex. Maximum day demand is 0.027 MGD; average day demand is 0.012 MGD. The Shrine Mont system is rated by VDH at 0.020 MGD, based on the source limitation of a 200-foot well with a reported yield of 30 gpm (0.043 MGD). There are seven springs on the Orkney Springs Hotel system, which recently has been purchased by Shrine Mont. No information is available on the flow or use of the spring system. There is a 0.050 MG concrete reservoir on the well system and a 0.020 MG steel tank on the spring system. The well system water is softened, and the spring water is chlorinated.

Projected Demands

Water demands for the Basye Demand Center are based on 1980 population and water usage rates for Stoney Creek Sanitary District, Bryce Resort and Shrine Mont (Tables 64, 65 and 66). The Shenandoah County Administrator expects the Basye area to grow at a rate twice that of the County average annual rate. Demand center population was based on 1980 census data. The portion of the demand center served was based on an assumption of a 10% permanent occupancy of a maximum 2,700 single-family units, plus 10% permanent occupancy of a maximum 800 townhouse/condominium units, all at a rate of 2.5 persons per unit. Demand by the self-supplied portion of the demand center was assumed to equal 75 GPCD, the same as the served population.

TABLE 64

POPULATION PROJECTIONS - BASYE DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
<u>Waterworks-Supplied</u>						
Stoney Creek Sanitary District*	80	240	400	560	720	880
<u>Self-Supplied</u>	232	260	290	320	350	380
TOTAL	312	500	690	880	1,070	1,260

*Full-time residents only.

TABLE 65

PROJECTED DEMANDS - BASYE DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA*

	1980	1990	2000	2010	2020	2030
----- Without Conservation -----						
Waterworks-Supplied						

Stoney Creek San. Dist.						
Dom/Com/Inst	0.12	0.23	0.34	0.44	0.55	0.66
(GPCD)	(75)	(75)	(75)	(75)	(75)	(75)
Bryce Resort						
Dom/Com/Inst**	0.13	0.13	0.22	0.22	0.22	0.22
Shrine Mont						
Dom/Com/Inst	0.01	0.01	0.01	0.01	0.01	0.01
(GPCD)	(45)	(45)	(45)	(45)	(45)	(45)
Waterworks-Supplied Subtotal						
Dom/Com/Inst	0.26	0.37	0.57	0.67	0.78	0.89
Self-Supplied						

Dom/Com/Inst	0.02	0.02	0.02	0.02	0.03	0.03
(GPCD)***	(75)	(75)	(75)	(75)	(75)	(75)
Subtotal	0.02	0.02	0.02	0.02	0.03	0.03
Demand Center Total						

Dom/Com/Inst	0.28	0.39	0.59	0.69	0.81	0.92

*This table includes demands of the part-time residents served by Stoney Creek Sanitary District.

**All usage for Bryce Resort is for recreational purposes (commercial).

***GPCD is same as for Stoney Creek Sanitary District; held constant over the planning period.

TABLE 66

PROJECTED DEMANDS - BASYE DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA*

	1980	1990	2000	2010	2020	2030
	----- With Conservation -----					
Waterworks-Supplied						

Stoney Creek San. Dist.						
Dom/Com/Inst	0.12	0.21	0.29	0.37	0.44	0.49
(GPCD)	(75)	(68)	(65)	(62)	(59)	(56)
Subtotal	0.12	0.21	0.29	0.37	0.44	0.49
Bryce Resort						
Dom/Com/Inst**	0.13	0.13	0.22	0.22	0.22	0.22
Subtotal	0.13	0.13	0.22	0.22	0.22	0.22
Shrine Mont						
Dom/Com/Inst	0.01	0.01	0.01	0.01	0.01	0.01
(GPCD)	(45)	(41)	(40)	(40)	(40)	(40)
Subtotal	0.01	0.01	0.01	0.01	0.01	0.01
Waterworks-Supplied Subtotal						
Dom/Com/Inst	0.26	0.35	0.52	0.60	0.67	0.72
Subtotal	0.26	0.35	0.52	0.60	0.67	0.72
Self-Supplied						

Dom/Com/Inst	0.02	0.02	0.02	0.02	0.02	0.02
(GPCD)**	(75)	(68)	(65)	(62)	(59)	(56)
Subtotal	0.02	0.02	0.02	0.02	0.02	0.02
Demand Center Total						

Dom/Com/Inst	0.28	0.37	0.54	0.62	0.69	0.74
Total	0.28	0.37	0.54	0.62	0.69	0.74

*This table includes demands of the part-time residents served by Stoney Creek Sanitary District.

**All usage in this category for Bryce Resort is for recreational purposes (commercial).

Evaluation of Demand Center (Problem Identification)

Stoney Creek Sanitary District. The ability of Stoney Creek Sanitary District to provide an adequate quantity of water is summarized in Figure 47 and Table 67. The system evaluation was based only on the public water facilities and did not consider the "private" well system, though water demand projections for the service area included those people served by the private well system. Therefore, based on average day demands the public water system is projected to experience source/delivery problems prior to 1990, exceeding the public well source capacity of 0.145 MGD. This capacity is based on pump test yields of two wells and pump capacities for five wells. Treatment capacity of the three treated wells in use is 0.19 MGD; this capacity will be exceeded prior to 1990. The demand supported by storage, 0.388 MGD, is projected to be exceeded by 2010.

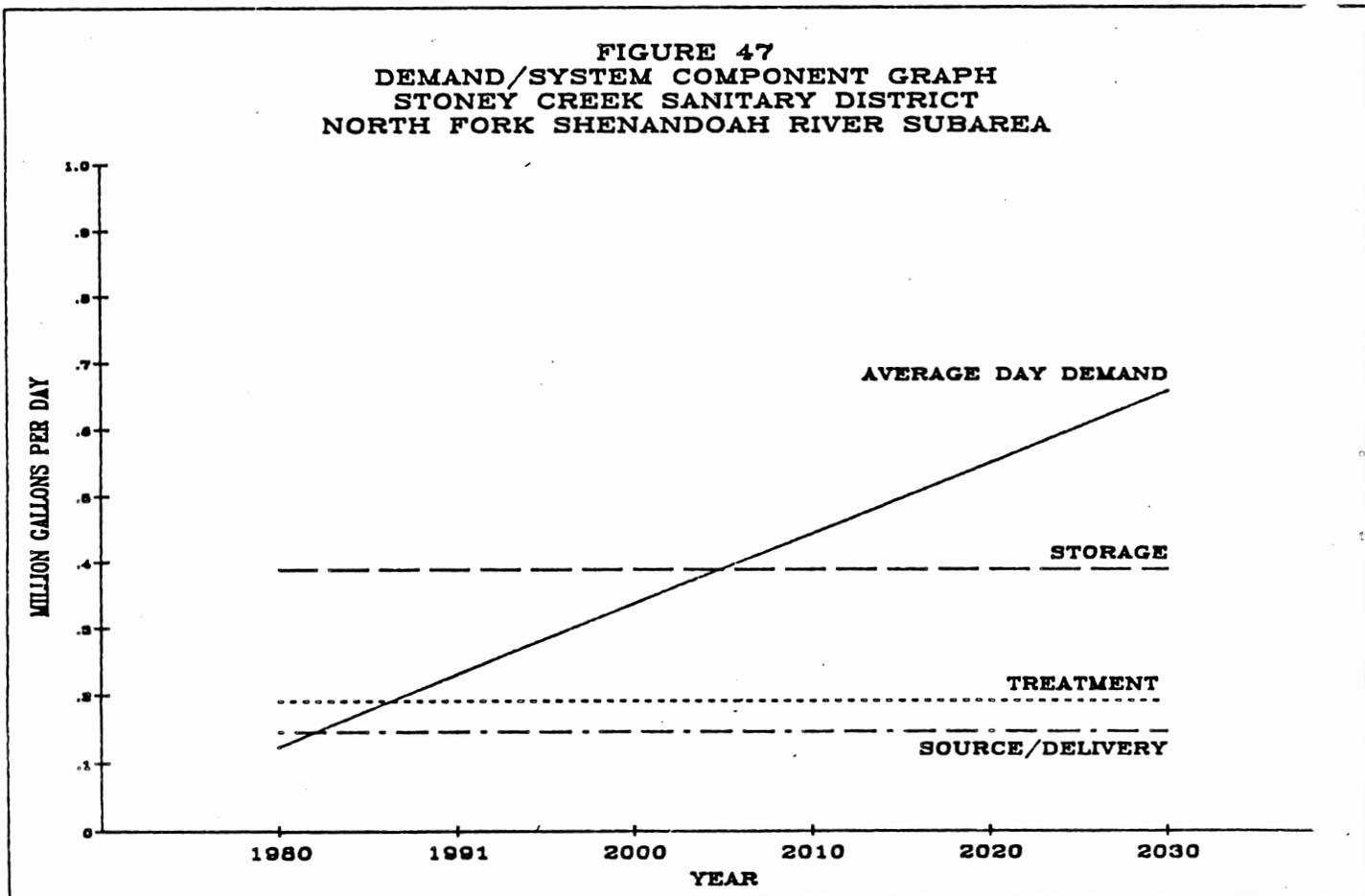


TABLE 67

PROJECTED WATER SUPPLY DEFICITS -
 STONEY CREEK SANITARY DISTRICT*
 IF NO REMEDIAL ACTION IS TAKEN
 NORTH FORK SHENANDOAH RIVER SUBAREA

Surplus (+) or Deficit (-), MGD

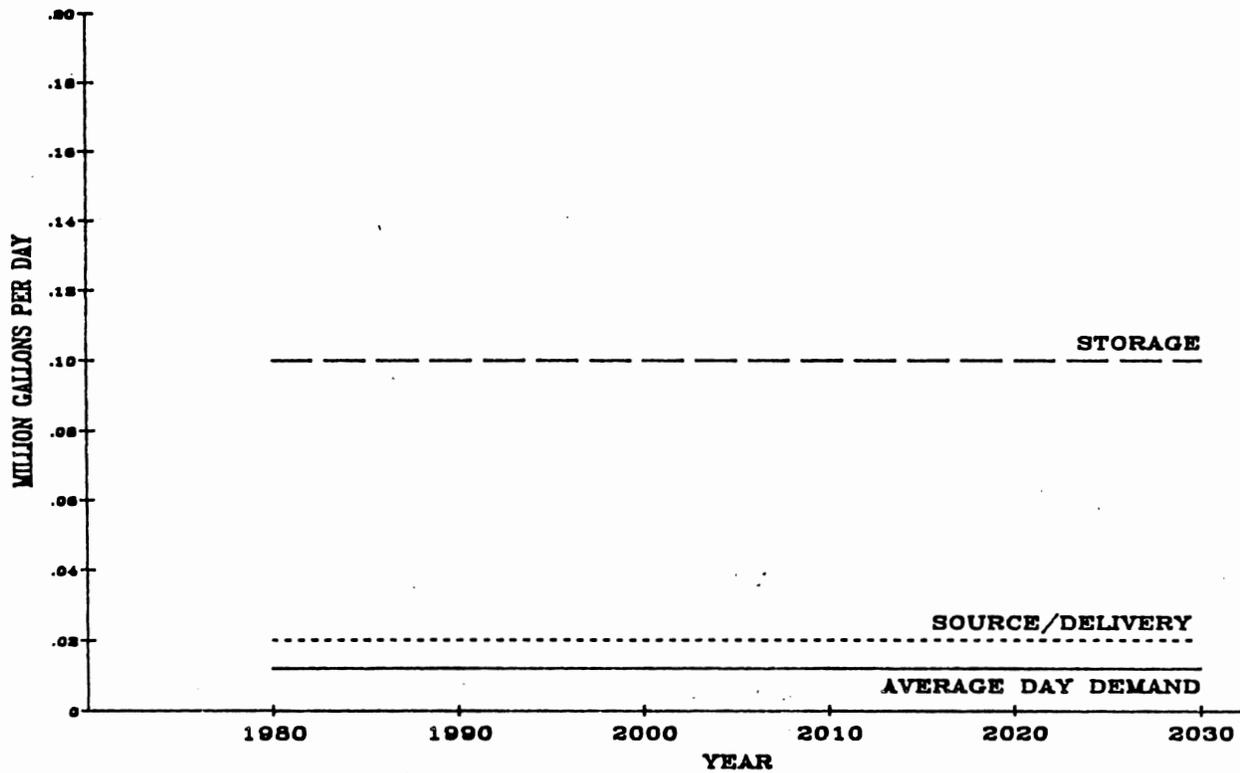
<u>System Component</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
<u>Without Conservation</u>						
Source/Delivery (0.145 MGD)	+0.03	-0.09	-0.20	-0.30	-0.41	-0.52
Treatment (0.19 MGD)	+0.07	-0.04	-0.15	-0.25	-0.36	-0.47
Storage (0.388 MGD)	+0.27	+0.16	+0.05	-0.05	-0.16	-0.27
<u>With Conservation</u>						
Source/Delivery (0.145 MGD)	+0.03	-0.07	-0.15	-0.23	-0.30	-0.35
Treatment** (0.19 MGD)	+0.07	-0.02	-0.10	-0.18	-0.25	-0.30
Storage (0.388 MGD)	+0.27	+0.18	+0.10	+0.02	-0.05	-0.10

*Projected deficits based on average day demands.

**Assumes all sources now in use or developed in future would require treatment.

Shrine Mont. The ability of this system to provide an adequate quantity of water is summarized in Figure 48 and Table 68. Based on projected demands and existing facilities, Shrine Mont should have adequate source/delivery and storage components through 2030. The source/delivery capacity of 0.020 MGD used in developing Table 69 is based on the well being a single source. The source is not treated, and the storage capacity of 0.050 MG is sufficient to support a demand of 0.10 MGD. The entire distribution system consists of lines less than four inches in diameter, which do not meet VDH regulations

**FIGURE 48
DEMAND/SYSTEM COMPONENT GRAPH
SHRINE MONT
NORTH FORK SHENANDOAH RIVER SUBAREA**



for fire protection.

Quantity and Quality Conflicts

Potential conflicts exist within this demand center. As withdrawals increase for offstream uses such as water supply, irrigation, and snow-making, less water will remain in the stream for instream uses such as protection of aquatic life and waste assimilation. The 1Q30 low flow at the Bryce Resort intake (which supplies golf course irrigation and snow-making water) is insufficient to meet the 2030 demands. In addition, the risk of 7Q10 low flows not being available at the Stoney Creek Sanitary District wastewater discharge rises from an annual risk of 10% under natural conditions to 80% by 2030 at projected net withdrawals. In the future Bryce Resort may have

TABLE 68

PROJECTED WATER SUPPLY DEFICITS - SHRINE MONT*
 IF NO REMEDIAL ACTION IS TAKEN
 NORTH FORK SHENANDOAH RIVER SUBAREA

Surplus (+) or Deficit (-), MGD

<u>System Component</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
<u>Without Conservation</u>						
Source (0.020 MGD)	+0.01	+0.01	+0.01	+0.01	+0.01	+0.01
Storage (0.100 MGD)	+0.09	+0.09	+0.09	+0.09	+0.09	+0.09
<u>With Conservation</u>						
Source (0.020 MGD)	+0.01	+0.01	+0.01	+0.01	+0.01	+0.01
Storage (0.100 MGD)	+0.09	+0.09	+0.09	+0.09	+0.09	+0.09

*Projected deficits based on average day demands.

to seek alternate water sources, such as wells or springs, or move their intake below the wastewater discharge. Similarly, Stoney Creek Sanitary District may have to discharge a higher quality effluent, possibly requiring costly improvements and higher sewer rates. Drought contingency plans for water supply and waste assimilation should be established ahead of time.

The effects of withdrawals on Stoney Creek are presented in more detail in Appendix C.

Alternative Analysis

Stoney Creek Sanitary District. Three alternatives are available to Stoney Creek Sanitary District to prevent future water supply deficits: (1) connect existing private wells owned by the Sanitary District to the public well system; (2) develop new wells; (3) develop Lake Laura as a water supply by building a water treatment plant.

Stoney Creek Sanitary District believes connecting the existing private wells to the public well system is the most realistic alternative, followed by developing new wells, and finally by developing a treatment plant on Lake Laura (see Table 69). The Sanitary District has approximately 90 private wells in use in addition to their public wells, and connecting these wells would consist mainly of adding new lines and possibly replacing some existing lines. No costs have been developed for this alternative. The Basye area is not a prolific area for ground water development, and using existing wells of known capacity might be more economically feasible than developing new wells. It is estimated that as many as 43 wells might be needed to satisfy projected deficits at a total capital cost of \$1,470,000. If Lake Laura is developed, it is projected that two package water treatment plants would be necessary over the planning period at an estimated cost of \$1,957,000.

TABLE 69

ALTERNATIVE ANALYSIS - STONEY CREEK SANITARY DISTRICT
 BASYE DEMAND CENTER
 NORTH FORK SHENANDOAH RIVER SUBAREA

Alternative Number	1	2	3
Description	Connect existing private wells.	Develop 43 new wells.	Develop water treatment plant on Lake Laura.
Projected Impacts			
Financial		Unit	Total
Total Capital Costs		\$34,200	\$1,470,000
Total Annual Costs (Includes O & M)	Unknown	\$7,600	\$326,800
O & M Costs		\$4,600	\$197,800
Hydrologic	May increase ground water withdrawals in the area.	May increase ground water withdrawals in the area.	Less flow available in Stony Creek downstream of impoundment.
Environmental	Short-term effects.	Short-term effects.	Short-term effects.
Social	May increase water rates.	May increase water rates.	Less flow in Stony Creek for recreational water needs and irrigation.
Legal	Obtaining permits from VDH.	Obtaining permits from VDH.	Obtaining permits from VDH. May be ownership question.
Jurisdictional	None anticipated.	None anticipated.	Ownership and water rights may be a problem.

Shrine Mont. No deficits are projected through the planning period.

Recommendations

Stoney Creek Sanitary District. Alternative 1 (connecting existing private wells) is recommended because it takes advantage of existing water supply sources and could easily be phased in as demands warrant. The utility is pursuing this alternative and feels it is the most feasible. Alternative 2 (drilling new wells) might prove to be cost-effective and more practical if a geohydrologic study of the area by qualified professionals could significantly reduce the number of wells required to meet projected demands.

Broadway/Timberville/New Market Demand Center

Introduction and Description

The Broadway/Timberville/New Market Demand Center, located in the southwestern part of the subarea, is situated along the upper reaches of the North Fork Shenandoah River (Figure 49). This demand center is located in Rockingham and Shenandoah Counties and includes the following public water systems:

1. Town of Broadway
2. Town of Timberville
3. Town of New Market.

The following major self-supplied users are also located in the demand center: Food Processors Water Cooperative; Rockingham Poultry Marketing Cooperative; and Howell Metal.

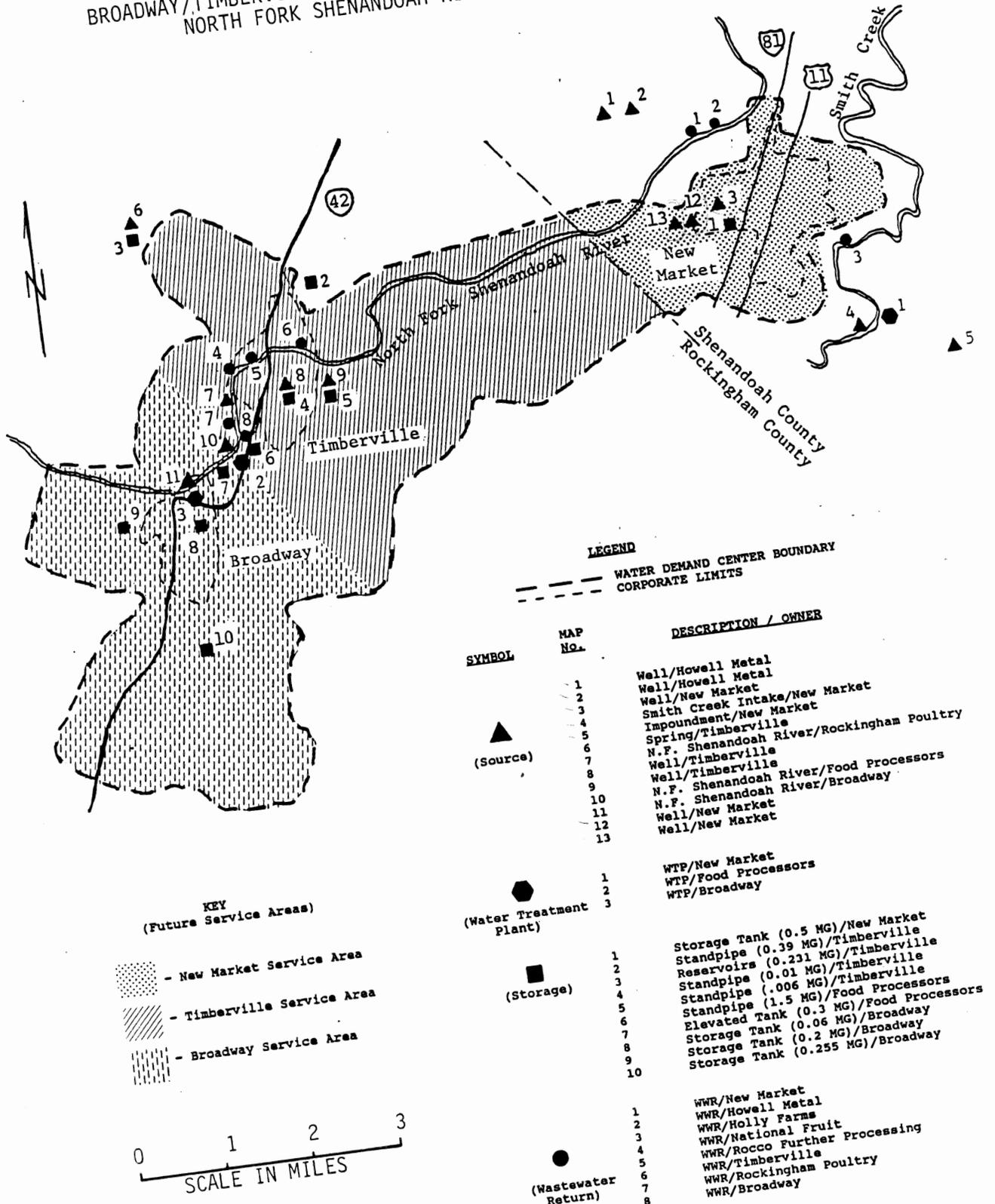
The demand center area is 17.23 square miles. The boundaries were determined primarily by the Central Shenandoah Planning District Commission's Comprehensive Plan, which identified the area as one likely to develop rapidly in the future. Total population of the demand center is 7,175 (1980).

Existing Facilities

Broadway. The Town of Broadway water system supplies 1,700 of the 1980 service area population of 2,190. There are approximately 825 connections, and domestic/commercial/institutional demands accounted for 74% (0.143 MGD) of the total 1980 demand of 0.193 MGD. Manufacturing accounted for 21% (0.04 MGD), and unaccounted water made up the remaining 5% (0.010 MGD).

The water system is supplied by the North Fork Shenandoah River which has a safe yield of 0.27 MGD at the intake (VWCB Safe Yield Data Bulletin, 1985). The intake is located just above the river's confluence with Linville Creek, which at low flow conditions adds approximately 0.880 MGD, including flow from Green Mount Spring. Water is pumped through a six-inch cast iron main to the water treatment plant; the pumps are rated by the VDH at a capacity of 0.5 MGD. The water treatment plant is a conventional one with a VDH-rated capacity of 0.5 MGD based upon the sedimentation basins. Finished water is pumped from

FIGURE 49
 BROADWAY/TIMBERVILLE/NEW MARKET WATER DEMAND CENTER
 NORTH FORK SHENANDOAH RIVER SUBAREA



LEGEND

--- WATER DEMAND CENTER BOUNDARY
 - - - CORPORATE LIMITS

SYMBOL	MAP No.	DESCRIPTION / OWNER
▲ (Source)	1	Well/Howell Metal
	2	Well/Howell Metal
	3	Well/New Market
	4	Smith Creek Intake/New Market
	5	Impoundment/New Market
	6	Spring/Timberville
	7	N.F. Shenandoah River/Rockingham Poultry
	8	Well/Timberville
	9	Well/Timberville
	10	N.F. Shenandoah River/Food Processors
	11	N.F. Shenandoah River/Broadway
	12	Well/New Market
	13	Well/New Market
● (Water Treatment Plant)	1	WTP/New Market
	2	WTP/Food Processors
	3	WTP/Broadway
■ (Storage)	1	Storage Tank (0.5 MG)/New Market
	2	Standpipe (0.39 MG)/Timberville
	3	Reservoirs (0.231 MG)/Timberville
	4	Standpipe (0.01 MG)/Timberville
	5	Standpipe (.006 MG)/Timberville
	6	Standpipe (1.5 MG)/Food Processors
	7	Elevated Tank (0.3 MG)/Food Processors
	8	Storage Tank (0.06 MG)/Broadway
	9	Storage Tank (0.2 MG)/Broadway
	10	Storage Tank (0.255 MG)/Broadway
● (Wastewater Return)	1	WWR/New Market
	2	WWR/Howell Metal
	3	WWR/Holly Farms
	4	WWR/National Fruit
	5	WWR/Rocco Further Processing
	6	WWR/Timberville
	7	WWR/Rockingham Poultry
	8	WWR/Broadway

KEY
 (Future Service Areas)

- New Market Service Area
- Timberville Service Area
- Broadway Service Area

0 1 2 3
 SCALE IN MILES

the water treatment plant by two vertical turbine pumps with a rating of 0.504 MGD. The system has two elevated storage tanks with a combined capacity of 0.26 MG and a ground storage tank with a 0.255 MG capacity. There is one booster pumping station on the system with a rated pumping capacity of 0.504 MGD. The system is therefore limited by the safe yield of its source, 0.27 MGD.

Timberville. The Town of Timberville water system serves 2,000 of the service area's 1980 population of 2,470. There were 717 connections in 1980 and domestic/commercial/institutional demand accounted for 70% (0.118 MGD) of the total 1980 demand of 0.169 MGD. The remaining 30% (0.051 MGD) was unaccounted water.

The system is supplied by ground water sources: two wells and a spring. The spring is the primary source and, using current VDH guidelines, is rated at 0.144 MGD based on a low-flow rate of 100 gpm. The two wells are used as backup sources; their combined VDH rating is 0.248 MGD based upon the installed pump capacities. Well 1 was pump tested at 270 gpm (50 hour test, 1961) and Well 2 was pump tested at 257 gpm (32 hour test, 1965). Based upon the pump tests, the combined rating of the two wells would be 0.422 MGD according to VDH guidelines. Water from the wells and spring is chlorinated and fluoridated. The Town has five storage facilities with a combined capacity of 0.637 MG. Water from the spring is conveyed to the town through a six-inch gravity main with a capacity of 0.26 MGD. The effective capacity of Timberville's system is, therefore, 0.392 MGD based upon the spring rating according to VDH guidelines and the pump capacity of the two wells. The Town of Timberville maintains an emergency connection with Food Processors Water Cooperative.

New Market. The Town of New Market water system supplies 1,240 of the 1980 service area population of 1,285. There are approximately 591 connections. Manufacturing accounted for 64% (0.285 MGD) of the total 1980 demand of 0.448 MGD; Holly Farms

accounted for 72% (0.206 MGD) of the manufacturing withdrawal. Domestic/commercial/institutional demands accounted for 15% (0.069 MGD) of the total demand, and unaccounted water of 21% (0.094 MGD) made up the remaining demand.

The water system is supplied by ground water and surface water. Smith Creek and the Town's well are the primary sources for the system. Smith Creek at the Town's intake has a safe yield of 3.2 MGD (VWCB Safe Yield Data Bulletin, 1985). Raw water is pumped through a six-inch cast iron force main by two pumps with a VDH rating of 0.49 MGD. The water treatment plant is a conventional one and based on filter capacity is rated at 0.443 MGD according to VDH guidelines. Finished water is pumped through an eight-inch force main by three pumps with a rated capacity of 0.49 MGD.

Well 1 had a test yield of 160 gpm (1959), and on this basis the rated capacity is 0.128 MGD according to VDH guidelines. The well is equipped with a 200 gpm (0.288 MGD) pump. Total system capacity is therefore 0.571 MGD based upon the water treatment plant rating of 0.443 MGD and well capacity of 0.128 MGD. The Town recently developed two new wells near the Shenandoah Academy; each was pump tested at 225 gpm after 72 hours. The combined rating of these two wells according to VDH guidelines is 0.36 MGD based upon their pump capacities. Assuming these wells are equipped with pumps equalling their test yields, connecting them with the system in mid-1986 will increase the total system capacity to 0.931 MGD.

The Massanutten Impoundment serves as an emergency source for the system and is used about twelve times a year. The impoundment has a water supply storage capacity of 1.2 MG. Raw water from the impoundment is treated by the water treatment plant.

The water system's storage consists of a 0.5 MG steel standpipe. There is one booster pump station on the system.

Major Self-Supplied Users

Food Processors Water Cooperative. The Food Processors water system, located in Timberville, serves both industrial and commercial establishments in the area. It has seven connections. The three largest users (Rockingham Poultry Marketing Cooperative, Rocco Further Processing, and National Fruit) accounted for 88% (0.568 MGD) of Food Processors' 1982 demand of 0.633 MGD.

Food Processors withdraws water from the North Fork Shenandoah River just below Broadway's intake and the river's confluence with Linville Creek. The safe yield of the river at Food Processors' intake has not been determined. Raw water is conveyed to the water treatment plant by two pumps with a VDH-rated capacity of 0.828 MGD. The water treatment plant is a conventional one with a rated capacity of 1.6 MGD, based upon the settling basin capacity. Finished water is delivered to Food Processors' customers through 14-inch, 12-inch and 10-inch mains. Storage consists of a 0.3 MG elevated tank and a 1.5 MG standpipe. Food Processors maintains an interconnection with the Town of Timberville.

Rockingham Poultry. Rockingham Poultry, located in Timberville, withdraws water from the North Fork Shenandoah River downstream of Food Processors' intake. No safe yield determination has been made for this intake. The water is used for noncontact cooling purposes and is not treated prior to or after use. The system's 1983 demand was 0.633 MGD in addition to that purchased from Food Processors. Rockingham Poultry has indicated that the water demands will increase in the future.

Howell Metal. Howell Metal, located just west of New Market, withdraws water from two wells. The water is used exclusively for noncontact cooling purposes and is not treated prior to or after use. Its 1983 demand was 0.204 MGD including 0.008 MGD purchased from New Market for sanitary water.

Projected Demands

Water demands for the Broadway/Timberville/New Market Demand Center are based on 1980 water usage and population

projections for the service areas and are shown in Tables 70, 71 and 72. According to information obtained from the Rockingham County Planning Commission and Shenandoah County Administrator, 8% and 4.7% of the respective county population growth is expected to occur within the demand center boundary. Demand center population was calculated by applying these values to the Rockingham and Shenandoah County population projections provided by the Department of Planning and Budget. The percent of the demand center served was assumed to increase linearly from 83% in 1980 to 100% in 2030. Demand by the unserved population in the demand center was assumed to equal the 66 GPCD average of the served population.

Projections of Rockingham Poultry's and Food Processors' water demands were made according to the standard projection methodology using OBERS employment projections for the Food and Kindred Products Standard Classification (SIC 20). Howell Metal's projections were made using OBERS employment projections for the Primary Metals Standard Classification (SIC 33).

TABLE 70

POPULATION PROJECTIONS -
BROADWAY/TIMBERVILLE/NEW MARKET DEMAND CENTER.
NORTH FORK SHENANDOAH RIVER SUBAREA

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
<u>Waterworks-Supplied</u>	4,940	6,140	7,290	8,250	9,050	9,920
Broadway	1,700	2,180	2,660	3,070	3,420	3,790
Timberville	2,000	2,530	3,070	3,520	3,880	4,280
New Market	1,240	1,430	1,560	1,660	1,750	1,850
<u>Self-Supplied</u>	995	970	840	620	330	0
TOTAL	5,935	7,110	8,130	8,870	9,380	9,920

Handwritten notes:
 NM 45/98 = .045
 45
 x .045
 44
 32
 25
 15

Evaluation of Demand Center (Problem Identification)

Broadway. The ability of this system to provide an adequate quantity of water is summarized in Figure 50 and Table 73. Broadway is projected to experience a source deficit by

TABLE 71

PROJECTED DEMANDS - BROADWAY/TIMBERVILLE/NEW MARKET DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

	1980	1990	2000	2010	2020	2030
----- Without Conservation -----						
Waterworks-Supplied -----						
Timberville						
Dom/Com/Inst (GPCD)	0.12 (59)	0.15 (59)	0.18 (59)	0.21 (59)	0.23 (59)	0.25 (59)
Unaccounted	0.05	0.06	0.08	0.09	0.10	0.11
Subtotal	0.17	0.21	0.26	0.30	0.33	0.36
Broadway						
Dom/Com/Inst (GPCD)	0.14 (84)	0.18 (84)	0.22 (84)	0.26 (84)	0.29 (84)	0.32 (84)
Mfg	0.04	0.05	0.07	0.07	0.07	0.08
Unaccounted	0.01	0.01	0.02	0.02	0.02	0.02
Subtotal	0.19	0.24	0.31	0.35	0.38	0.42
New Market						
Dom/Com/Inst (GPCD)	0.07 (56)	0.08 (56)	0.09 (56)	0.09 (56)	0.10 (56)	0.10 (56)
Mfg	0.29	0.31	0.34	0.37	0.40	0.43
Unaccounted	0.09	0.10	0.11	0.12	0.13	0.14
Subtotal	0.45	0.49	0.54	0.58	0.63	0.67
Waterworks-Supplied Subtotal						
Dom/Com/Inst	0.33	0.41	0.49	0.56	0.61	0.68
Mfg	0.33	0.36	0.40	0.44	0.47	0.51
Unaccounted	0.16	0.18	0.21	0.23	0.25	0.27
Subtotal	0.82	0.95	1.10	1.23	1.33	1.46
Self-Supplied -----						
Dom/Com/Inst (GPCD) *	0.07 (66)	0.06 (66)	0.06 (66)	0.04 (66)	0.02 (66)	0.00 (66)
Rockingham Poultry	0.72	0.78	0.84	0.92	1.19	1.30
Howell Metal	0.26	0.33	0.38	0.41	0.43	0.45
Food Processors	0.90	0.99	1.07	1.17	1.27	1.39
Subtotal	1.95	2.16	2.35	2.54	2.91	3.14
Demand Center Total -----						
Dom/Com/Inst	0.40	0.48	0.55	0.60	0.64	0.68
Mfg	2.20	2.46	2.69	2.94	3.36	3.65
Unaccounted	0.16	0.18	0.21	0.23	0.25	0.27
Total	2.76	3.12	3.45	3.77	4.25	4.60

*Average of GPCD from service areas.

TABLE 72

PROJECTED DEMANDS - BROADWAY/TIMBERVILLE/NEW MARKET DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

	1980	1990	2000	2010	2020	2030
----- With Conservation -----						
Waterworks-Supplied						

Timberville						
Dom/Com/Inst	0.12	0.14	0.16	0.17	0.18	0.19
(GPCD)	(59)	(54)	(51)	(49)	(47)	(44)
Unaccounted	0.05	0.02	0.02	0.02	0.02	0.02
Subtotal	0.17	0.16	0.18	0.19	0.20	0.21
Broadway						
Dom/Com/Inst	0.14	0.17	0.19	0.21	0.23	0.24
(GPCD)	(84)	(76)	(73)	(70)	(66)	(63)
Mfg	0.04	0.05	0.07	0.07	0.07	0.08
Unaccounted	0.01	0.01	0.01	0.02	0.02	0.02
Subtotal	0.19	0.23	0.27	0.30	0.32	0.34
New Market						
Dom/Com/Inst	0.07	0.07	0.08	0.08	0.08	0.08
(GPCD)	(56)	(51)	(49)	(46)	(44)	(42)
Mfg	0.29	0.30	0.32	0.35	0.38	0.41
Unaccounted	0.09	0.04	0.04	0.05	0.05	0.05
Subtotal	0.45	0.41	0.44	0.48	0.51	0.54
Waterworks-Supplied Subtotal						
Dom/Com/Inst	0.33	0.38	0.43	0.46	0.49	0.51
Mfg	0.33	0.34	0.38	0.42	0.45	0.49
Unaccounted	0.16	0.07	0.08	0.08	0.09	0.09
Subtotal	0.82	0.79	0.89	0.96	1.02	1.09
Self-Supplied						

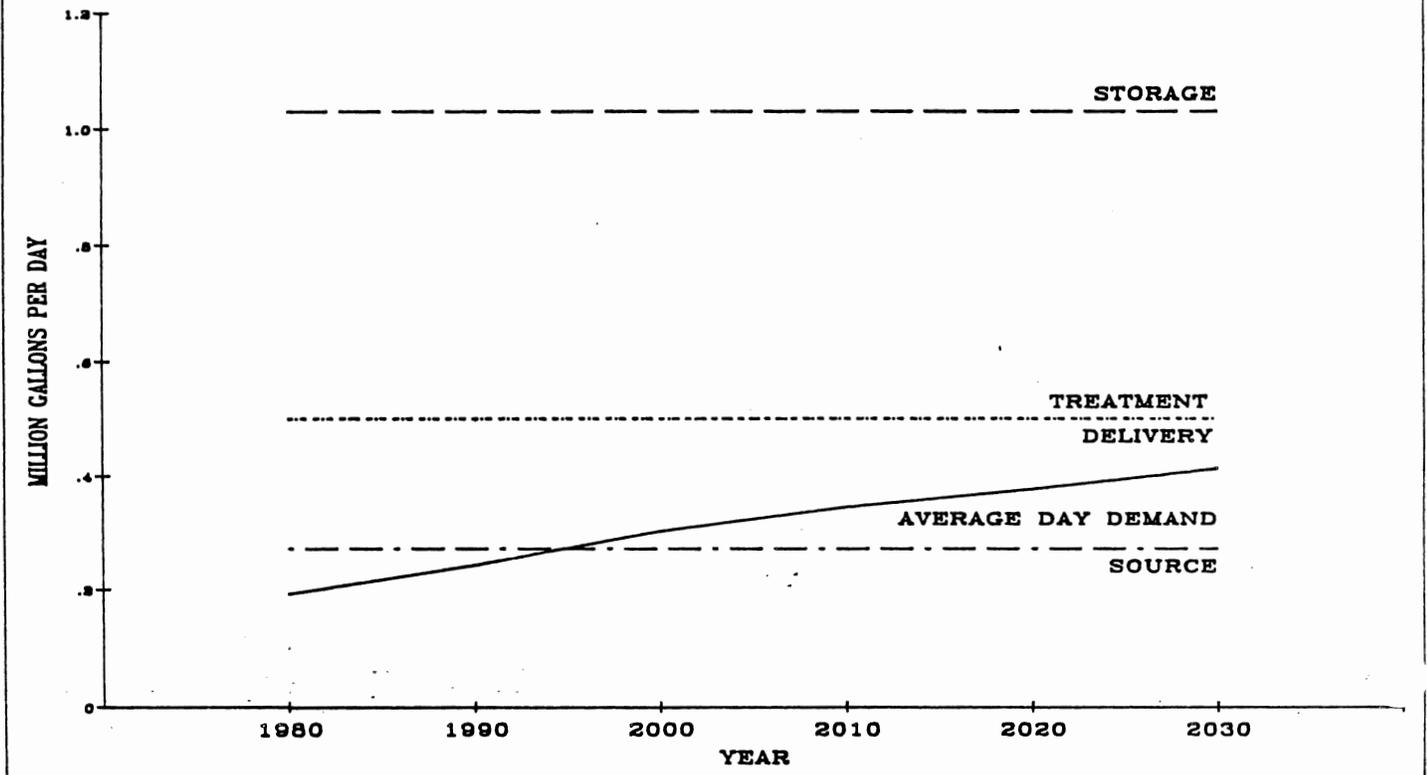
Dom/Com/Inst	0.07	0.06	0.05	0.03	0.02	0.00
(GPCD)	(66)	(60)	(57)	(55)	(52)	
Rockingham Poultry	0.72	0.55	0.69	0.75	0.97	1.12
Howell Metal*	0.26	0.27	0.31	0.33	0.35	0.37
Food Processors	0.90	0.81	0.88	0.95	1.04	1.13
Subtotal	1.95	1.69	1.93	2.06	2.38	2.62
Demand Center Total						

Dom/Com/Inst	0.40	0.43	0.48	0.50	0.50	0.51
Mfg	2.20	1.96	2.25	2.45	2.81	3.10
Unaccounted	0.16	0.07	0.08	0.08	0.09	0.09
Total	2.76	2.46	2.81	3.03	3.40	3.70

*7-day average figure.

48% of self-supplied = 1.33 MGD = 0.003 MGD

FIGURE 50
DEMAND/SYSTEM COMPONENT GRAPH
BROADWAY
NORTH FORK SHENANDOAH RIVER SUBAREA



2000. Projected demands will exceed the safe yield of the North Fork Shenandoah River at Broadway's intake which is 0.27 MGD. The treatment and storage components for Broadway are expected to be adequate through 2030. The treatment component of 0.5 MGD from the table is based on the VDH rating of Broadway's water treatment plant. The storage volume of 0.515 MG will support a demand of 1.03 MGD based upon VDH guidelines. The distribution system has pressure problems in the vicinity of the H. D. Lee Company due to small distribution lines; the Town plans to rectify this pressure problem. Unaccounted water is very low for the system (6%).

TABLE 73

PROJECTED WATER SUPPLY DEFICITS - TOWN OF BROADWAY
 IF NO REMEDIAL ACTION IS TAKEN*
 NORTH FORK SHENANDOAH RIVER SUBAREA

System Component	Surplus (+) or Deficit (-), MGD					
	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
	<u>Without Conservation</u>					
Delivery (0.50 MGD)	+0.31	+0.26	+0.20	+0.15	+0.12	+0.09
Source (0.27 MGD)	+0.08	+0.03	-0.03	-0.08	-0.11	-0.14
Treatment (0.50 MGD)	+0.31	+0.26	+0.20	+0.15	+0.12	+0.09
Storage (1.03 MGD)	+0.33	+0.28	+0.22	+0.17	+0.14	+0.11
	<u>With Conservation</u>					
Delivery (0.50 MGD)	+0.31	+0.27	+0.23	+0.20	+0.18	+0.17
Source (0.27 MGD)	+0.08	+0.04	0.00	-0.03	-0.05	-0.06
Treatment (0.50 MGD)	+0.31	+0.27	+0.23	+0.20	+0.18	+0.17
Storage (1.03 MGD)	+0.33	+0.29	+0.25	+0.22	+0.20	+0.19

*Projected deficits based on average day demands.

Timberville. The ability of this system to provide an adequate quantity of water is summarized in Figure 51 and Table 74. Based upon projected demands and existing facilities, Timberville is expected to have adequate source/delivery, treatment and storage components through 2030. The source/delivery capacity of 0.392 used in Table 74 is based upon pump tests for the two wells and flow from the spring. The treatment

component is not evaluated since chlorination and fluoridation are the only treatment necessary. The storage capacity of this system is based on the current capacity of five storage facilities with a total capacity of 0.637 MGD, sufficient to support a demand of 1.274 MGD. The distribution system has 28% unaccounted water, and age is probably the primary reason.

FIGURE 51
DEMAND/SYSTEM COMPONENT GRAPH
TIMBERVILLE
NORTH FORK SHENANDOAH RIVER SUBAREA

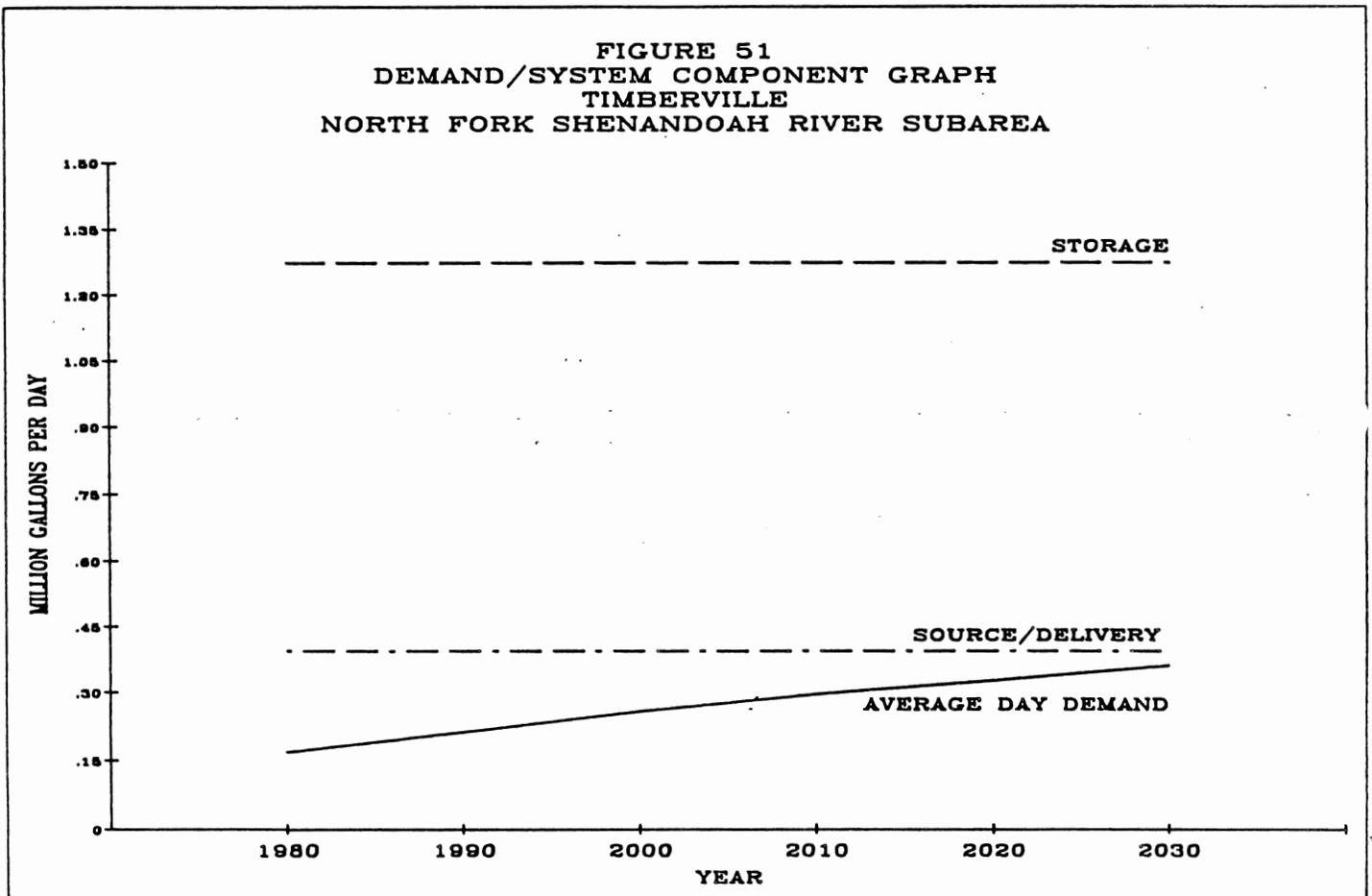


TABLE 74

PROJECTED WATER SUPPLY DEFICITS - TOWN OF TIMBERVILLE
 IF NO REMEDIAL ACTION IS TAKEN*
 NORTH FORK SHENANDOAH RIVER SUBAREA

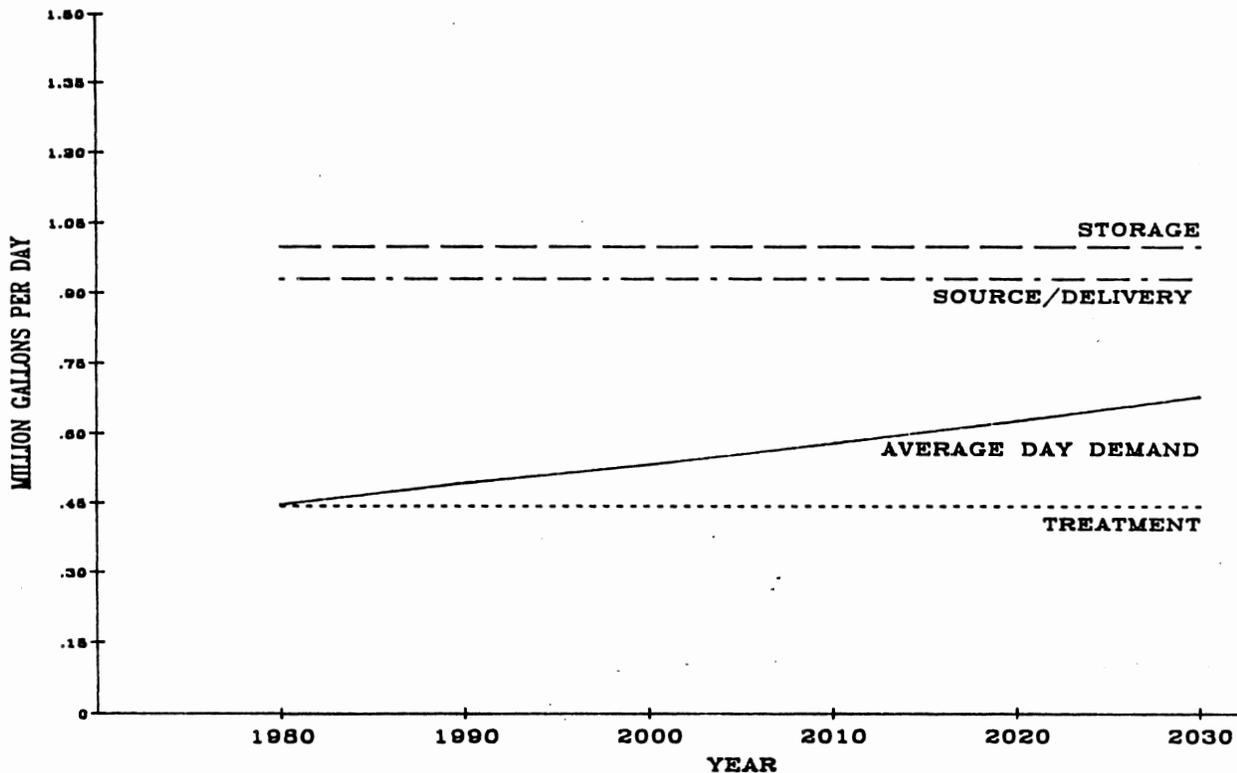
Surplus (+) or Deficit (-), MGD

<u>System Component</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
<u>Without Conservation</u>						
Source (0.392 MGD)	+0.22	+0.18	+0.13	+0.09	+0.06	+0.03
Storage (1.28 MGD)	+1.11	+1.07	+1.02	+0.98	+0.95	+0.92
<u>With Conservation</u>						
Source (0.392 MGD)	+0.22	+0.24	+0.22	+0.20	+0.19	+0.18
Storage (1.28 MGD)	+1.11	+1.13	+1.11	+1.09	+1.08	+1.07

*Projected deficits based on average day demands.

New Market. The ability of this system to provide water is summarized in Figure 52 and Table 75. Based upon projected demands and existing facilities, New Market is expected to have adequate source/delivery, treatment and storage components through 2030. The source/delivery capacity of 0.931 MGD used in Table 75 is based upon Wells 1, 2 and 3 with a combined capacity of 0.488 MGD, and 0.443 MGD delivered from Smith Creek. The treatment plant capacity is based upon filter capacity as it would be rated according to VDH guidelines. The storage volume of 0.5 MG is sufficient to support a demand of 1.0 MGD. The distribution system is composed of 12.2 miles of pipeline, and the old age of this system probably accounts for the 17.5% unaccounted water.

FIGURE 52
 DEMAND/SYSTEM COMPONENT GRAPH
 NEW MARKET
 NORTH FORK SHENANDOAH RIVER SUBAREA



Quantity and Quality Conflicts

Potential conflicts exist within this demand center. As withdrawals increase for offstream uses such as water supply, industrial processing, and irrigation, less water will remain in the stream to supply these offstream uses and instream uses such as protection of aquatic life and waste assimilation. Several instances of serious conflicts suggest potentially major water supply shortages along the upper reaches of the North Fork.

Due to agricultural irrigation, no water may be available for the Town of Broadway's intake at natural 1Q30 conditions even at 1980 demands. Based on 1980 demands, insufficient flows could also occur at Food Processors and Rockingham Poultry. The Town of Broadway, Rockingham Poultry Marketing Cooperative, and

TABLE 75

PROJECTED WATER SUPPLY DEFICITS -
TOWN OF NEW MARKET
IF NO REMEDIAL ACTION IS TAKEN*
NORTH FORK SHENANDOAH RIVER SUBAREA

Surplus (+) or Deficit (-), MGD

<u>System Component</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
<u>Without Conservation</u>						
Source/Delivery (0.931 MGD)	+0.48	+0.44	+0.40	+0.35	+0.30	+0.25
Treatment (0.443 MGD)	+0.44	+0.40	+0.36	+0.31	+0.26	+0.21
Storage (1.0 MGD)	+0.55	+0.51	+0.47	+0.42	+0.37	+0.32
<u>With Conservation</u>						
Source/Delivery (0.931 MGD)	+0.48	+0.52	+0.49	+0.46	+0.43	+0.39
Treatment (0.443 MGD)	+0.44	+0.48	+0.45	+0.42	+0.39	+0.35
Storage (1.0 MGD)	+0.55	+0.51	+0.47	+0.42	+0.37	+0.32

*Projected deficits based on average day demands.

Food Processors Water Cooperative may have to seek alternative water sources.

The annual risk of natural 7Q10 flow is expected to increase from 10% to 85% for the discharges of the Town of Broadway and Rockingham Poultry Marketing Cooperative by 2030 at projected net withdrawals. The annual risk of natural 7Q10 flow is expected to increase from 10% to 50% for the Town of Timberville discharge and for the Town of New Market discharge by 2030 at projected net withdrawals. Each of these dischargers may have to discharge a higher quality effluent in the future,

possibly requiring costly improvements.

In recent years municipal intakes along the North Fork Shenandoah and its tributaries have been affected by taste and odor problems infrequently during the winter months. It appears that non-point source runoff events associated with inappropriate applications of agricultural wastes to the land surface may be responsible for these events. Broadway and New Market have reported problems in the past.

To see the effects of withdrawals on the Upper North Fork Shenandoah River in more detail consult Appendix C.

Alternative Analysis

Broadway. Development of both surface water and ground water sources has been considered to offset projected deficits for the Town of Broadway. However, Broadway is considering only one alternative for satisfying future water demands: development of an intake structure on Linville Creek. The projected impacts of both alternatives are outlined in Table 76.

Broadway's water treatment plant is located at the confluence of the North Fork Shenandoah River and Linville Creek. Therefore, placing an intake on Linville Creek is a logical and feasible solution. The provisional safe yield of Linville Creek at Broadway is 0.15 MGD. The 0.15 MGD does not, however, reflect flow from Green Mount Spring, located approximately 12 miles southwest of Broadway. The VDH has agreed to permit Green Mount Spring as a ground water source at 1.06 MGD. Therefore, the total amount of water available at the proposed intake will be 1.21 MGD. For Broadway to obtain 1.21 MGD, separate permits will be required for the ground water source and the surface water source. The 0.15 MGD flow alone would be more than adequate to meet Broadway's projected deficit of 0.14 MGD. The estimated total capital cost of developing an intake structure and transmission main on Linville Creek at the confluence with the North Fork Shenandoah River is \$34,000. No costs have been calculated for developing Green Mount Spring since it is an undecided issue whether transmission lines would

be required, or whether the spring flow could be withdrawn from the Linville Creek stream channel.

The ground water alternative consists of drilling one well capable of producing 175 gpm. The total capital cost for developing a well is \$66,000, nearly double the cost of the Linville Creek intake.

TABLE 76

ALTERNATIVE ANALYSIS - TOWN OF BROADWAY
BROADWAY/TIMBERVILLE/NEW MARKET DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

Alternative Number	1	2
Description	Develop intake on Linville Creek.	Develop one well.
<u>Projected Impacts</u>		
Financial		
Total Capital Costs	\$34,000	\$66,000
Total Annual Costs (Includes O & M)	\$ 4,500	\$10,000
O & M Costs	\$ 1,700	\$ 4,600
Hydrologic	Will increase surface water withdrawals on Linville Creek.	Increase ground water withdrawals.
Environmental	Short-term effects.	Short-term effects.
Social	May increase water rates.	May increase water rates.
Legal	Obtain necessary easements and/or deeds. Obtain permits from VDH.	Obtain necessary easements and/or deeds. Obtain permits from VDH.
Jurisdictional	None expected.	None expected.

New Market. Prior to developing two new wells in 1984, the Town of New Market had a projected delivery deficit. An engineering study in 1979 considered three alternatives: (1) expand and upgrade the water treatment plant (total capital cost of \$474,000); (2) upgrade the existing water treatment plant (total capital cost \$214,000); and (3) develop new wells (total capital cost per well of \$83,000). The Town selected Alternative 3 and drilled two new wells in 1984. The wells are scheduled to be on line by mid-1986. The combined pump test yield is 0.36 MGD, an adequate amount of water to satisfy New Market's water supply deficit since the only treatment the well water will require is chlorination. Therefore, no further alternative development is deemed necessary.

Timberville. Timberville is projected to have a 2030 surplus of 0.03 MGD; therefore, no alternatives have been developed.

Recommendations

Broadway. Alternative 1 (developing an intake on Linville Creek) is the recommended alternative because it appears to be the most feasible and cost-effective solution to satisfy projected deficits.

Central Shenandoah Demand Center

Introduction and Description

The Central Shenandoah Demand Center (Figure 53) is located in the central part of the subarea in Shenandoah County. It follows U.S. Route 11 from Woodstock north to Toms Brook and Route 42 west to Columbia Furnace. It contains the following water systems:

1. Toms Brook-Maurertown Service Authority
2. Woodstock.

In addition, the following self-supplied users are in the demand center: Rocco Farm Foods; and Bowman Apple Products (Maurertown). The demand center area is 10.9 square miles; the boundaries were determined based upon discussions with the County Administrator. Sixty-nine percent of the population within the demand center is served by the two community water systems.

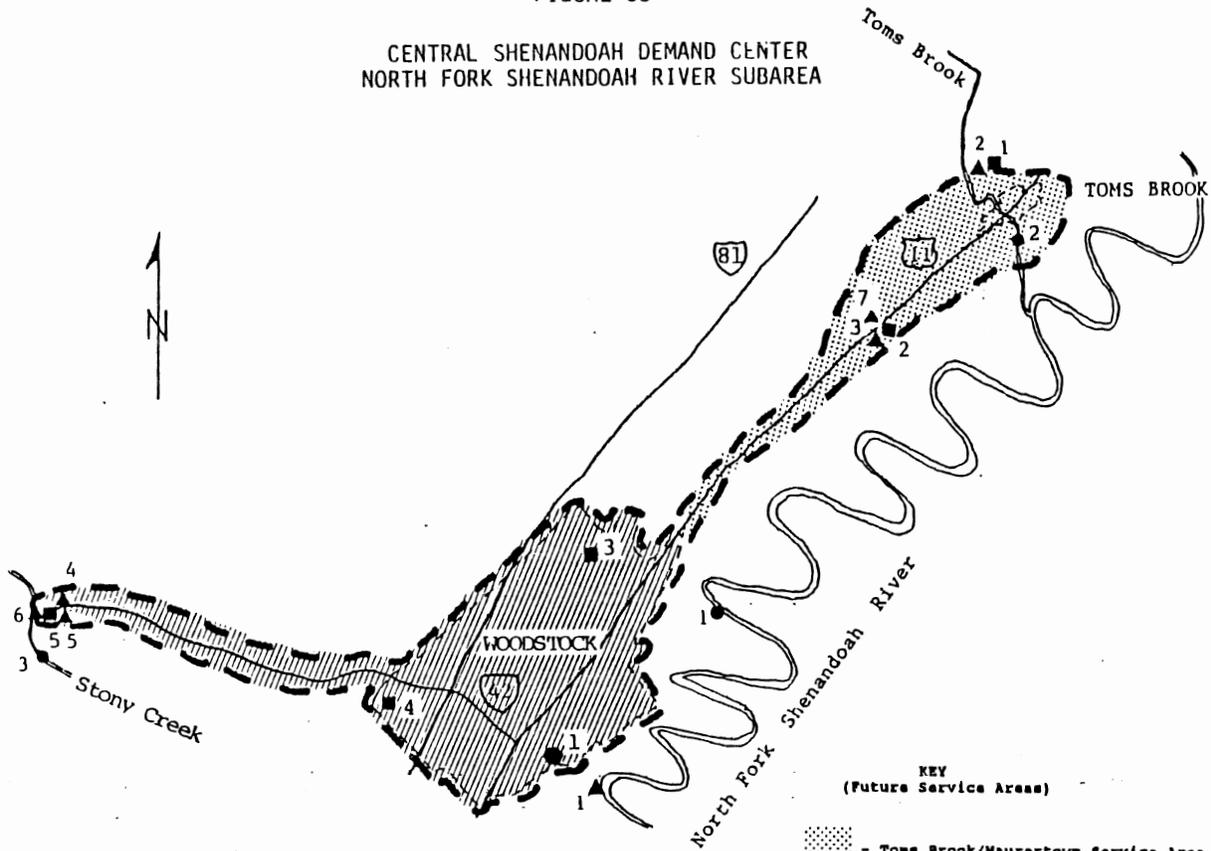
Existing Facilities

Toms Brook-Maurertown Service Authority. The Service Authority supplied 648 of the 1980 service area population of 940. There are 251 connections, and domestic/commercial/institutional demands accounted for 69% (0.033 MGD) of the total 1980 demand (0.048 MGD). Unaccounted water made up the remaining 31% (0.015 MGD).

The Service Authority is served by two wells, one located at Toms Brook and the other at Maurertown. The VDH rating of the wells is 0.078 MGD which is based upon the Well 4 pump capacity (50 gpm or 0.040 MGD), and Well 2 pump test (47 gpm or 0.038 MGD after 72 hours, 1971). However, Well 2 is currently producing 7 gpm, making the system capacity 57 gpm, or 0.046 MGD according to VDH guidelines. Thus, source/delivery capacity is 0.046 MGD. The water is chlorinated. The Service Authority has two 0.1 MG storage tanks, one located at each well. There is one booster pump station rated at 0.043 MGD that facilitates the transfer of water from one storage tank to the other.

FIGURE 53

CENTRAL SHENANDOAH DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA



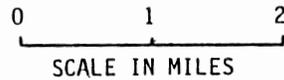
KEY
(Future Service Areas)

-  - Toms Brook/Mauretown Service Area
-  - Woodstock Service Area

LEGEND

-  - WATER DEMAND CENTER BOUNDARY
-  - CORPORATE LIMITS

SYMBOL	MAP No.	DESCRIPTION / OWNER
 (Source)	1	N.F. Shenandoah River Intake/(SCSA)
	2	Well 4/Toms Brook-Mauretown Service Auth.
	3	Well 2/Toms Brook-Mauretown Service Auth.
	4	Well 1/Rocco Farm Foods
	5	Well 2/Rocco Farm Foods
	6	Well 3/Rocco Farm Foods
	7	Wells (3)/Bowman Apple
 (Water Treatment Plant)	1	WTP/Shenandoah Co. Sanitation Auth.
 (Storage)	1	Storage Tank (0.1 MG)/Toms Brook-Mauretown Service Authority
	2	Storage Tank (0.1 MG)/Toms Brook-Mauretown Service Authority
	3	Storage Tank (0.5 MG)/Woodstock
	4	Storage Tank (0.4 MG)/Woodstock
	5	3 Storage Tanks (0.502 MG Total)/Rocco
 (Wastewater Return)	1	WWR/Woodstock
	2	WWR/Toms Brook-Mauretown Service Auth.
	3	WWR/Rocco



Woodstock. The Town of Woodstock supplied 3,400 of the service area's 1980 population of 4,932. There are approximately 1,420 connections, and domestic/commercial/institutional demand accounted for 75% (0.235 MGD) of the total 1980 demand (0.313 MGD). Unaccounted water made up the remaining 25% (0.078 MGD).

The sole source for the Town of Woodstock is a water treatment plant which treats water from the North Fork Shenandoah River. The safe yield of the North Fork Shenandoah River at Woodstock's intake is 20.0 MGD according to VWCB Safe Yield Data Bulletin, 1985. Raw water is delivered to the water treatment plant by three pumps whose capacity has been rated by VDH at 2.016 MGD. This is a conventional plant with a VDH-rated capacity of 2.21 MGD based upon the filter capacity. Finished water is delivered to the distribution system by three pumps with a VDH rating of 2.016 MGD. Effective system capacity is therefore 2.016 MGD based upon the intake pump capacity and finished water pump capacity. There are two storage tanks: a 0.4 MG elevated tank and a 0.5 MG ground storage tank. The Town also owns one booster pump station for the transmission of water west of the town along Route 42 to Columbia Furnace. In addition, a 0.01 MG hydropneumatic tank maintains pressure along the Route 42 line.

Major Self-Supplied Users

Rocco Farm Foods. Rocco withdraws water from a combination of three wells. The combined yield of the wells is 0.702 MGD. Well 1 was pump tested at 0.05 MGD (35 gpm after 12 hours, 1969); Well 2 was pump tested at 0.566 MGD (393 gpm after 24 hours, 1970); and Well 3 was pump tested at 0.086 MGD (60 gpm after 102 hours, 1973). Eighty-six percent of the water is used for processing and the remainder for cooling and sanitary purposes. Total usage in 1982 was 0.569 MGD, based on a seven-day week.

Bowman Apple. Bowman Apple withdraws water from a combination of three wells whose combined yield is 0.238 MGD. Well 1 was pump tested at 0.13 MGD (90 gpm); Well 2 was pump tested at 0.050 MGD (35 gpm); and Well 3 was pump tested at 0.058 MGD (40 gpm after 32 hours). Ninety-nine percent of the water is used for processing and the remainder is used for cooling and sanitary purposes. Total usage in 1983 was 0.021 MGD.

Projected Demands

Water demands for the Toms Brook-Maurertown Service Authority and the Town of Woodstock are based upon 1980 water usage and population projections for the service areas and are shown in Tables 77, 78 and 79. According to the Shenandoah County Administrator the population is assumed to increase at twice the rate of the County's population increase, thus increasing from 21.3% in 1980 to 26.8% of the county population in 2030. Demand center population was calculated by applying these values to the Shenandoah County population projections provided by the Department of Planning and Budget. The percent of the demand center served was assumed to increase linearly from 69% in 1980 to 100% in 2030. Demand by that portion of the population in the demand center not served by the public systems was assumed to equal the 60 GPCD average of the served population.

TABLE 77

POPULATION PROJECTIONS - CENTRAL SHENANDOAH DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
<u>Waterworks-Supplied</u>						
Woodstock	3,400	4,400	5,340	6,260	7,200	8,230
Toms Brook/Maurer- town Service Authority	648	840	1,020	1,190	1,370	1,570
<u>Self-Supplied</u>	1,824	1,730	1,440	1,060	580	0
TOTAL	5,872	6,970	7,800	8,510	9,150	9,800

TABLE 78

PROJECTED DEMANDS - CENTRAL SHENANDOAH DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

	1980	1990	2000	2010	2020	2030
----- Without Conservation -----						
Waterworks-Supplied						

Toms Brook-Maurertown						
Dom/Com/Inst	0.03	0.04	0.05	0.06	0.07	0.08
(GPCD)	(51)	(51)	(51)	(51)	(51)	(51)
Unaccounted	0.02	0.02	0.02	0.03	0.03	0.04
Subtotal	0.05	0.06	0.07	0.09	0.10	0.12
Woodstock						
Dom/Com/Inst	0.24	0.30	0.37	0.43	0.50	0.50
(GPCD)	(69)	(69)	(69)	(69)	(69)	(69)
Unaccounted	0.08	0.10	0.12	0.14	0.17	0.19
Subtotal	0.32	0.40	0.49	0.57	0.67	0.69
Waterworks-Supplied Subtotal						
Dom/Com/Inst	0.27	0.35	0.42	0.49	0.57	0.58
Unaccounted	0.09	0.12	0.15	0.17	0.20	0.23
Subtotal	0.36	0.47	0.57	0.66	0.77	0.81
Self-Supplied						

Dom/Com/Inst	0.11	0.10	0.09	0.06	0.04	0.00
(GPCD)*	(60)	(60)	(60)	(60)	(60)	
Mfg						
Rocco Farm Foods	0.57	0.62	0.67	0.73	0.80	0.86
Bowman Apple-Maurertown	0.02	0.02	0.03	0.03	0.03	0.03
Subtotal	0.70	0.74	0.79	0.82	0.87	0.89
Demand Center Total						

Dom/Com/Inst	0.38	0.45	0.51	0.56	0.60	0.58
Mfg	0.59	0.64	0.70	0.76	0.83	0.89
Unaccounted	0.09	0.12	0.15	0.17	0.20	0.23
Total	1.06	1.21	1.36	1.49	1.63	1.70

*Assumed to equal GPCD of the served population within the demand center.

TABLE 79

PROJECTED DEMANDS - CENTRAL SHENANDOAH DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

	1980	1990	2000	2010	2020	2030
----- With Conservation -----						
Waterworks-Supplied						

Toms Brook-Maurertown						
Dom/Com/Inst	0.03	0.04	0.05	0.05	0.06	0.06
(GPCD)	(51)	(46)	(44)	(42)	(40)	(40)
Unaccounted	0.02	0.00	0.01	0.01	0.01	0.01
Subtotal	0.05	0.04	0.06	0.06	0.07	0.07
Woodstock						
Dom/Com/Inst	0.24	0.28	0.32	0.36	0.39	0.43
(GPCD)	(69)	(63)	(60)	(57)	(55)	(52)
Unaccounted	0.08	0.03	0.04	0.04	0.04	0.05
Subtotal	0.32	0.31	0.36	0.40	0.43	0.48
Waterworks-Supplied Subtotal						
Dom/Com/Inst	0.27	0.32	0.37	0.41	0.45	0.49
Unaccounted	0.10	0.03	0.05	0.05	0.05	0.06
Subtotal	0.37	0.35	0.42	0.46	0.50	0.55
Self-Supplied						

Dom/Com/Inst	0.11	0.10	0.07	0.05	0.03	0.00
(GPCD) *	(60)	(55)	(52)	(50)	(47)	
Mfg						
Rocco Farm Foods	0.57	0.59	0.64	0.69	0.75	0.82
Bowman Apple-Maurertown	0.02	0.02	0.02	0.03	0.03	0.03
Subtotal	0.70	0.71	0.73	0.77	0.81	0.85
Demand Center Total						

Dom/Com/Inst	0.38	0.41	0.44	0.46	0.48	0.49
Mfg	0.59	0.61	0.66	0.72	0.78	0.85
Unaccounted	0.09	0.04	0.04	0.05	0.05	0.05
Total	1.06	1.06	1.14	1.23	1.31	1.39

Projections of Bowman Apple's and Rocco's water demands were made according to the standard projections methodology using OBERS employment projections for the Food and Kindred Products Standard Classification (SIC 20).

Evaluation of Demand Center (Problem Identification)

Toms Brook/Maurertown Service Authority. The ability of this system to provide adequate quantities of water is summarized in Figure 54 and Table 80. The Authority currently is experiencing problems in meeting demands. Well 4 has a pump capacity of 50 gpm (0.04 MGD). Well 2, which was pump tested at 47 gpm, is currently producing just 7 gpm. Chlorination is the only treatment provided. The storage capacity of 0.2 MG is sufficient to support a demand of 0.4 MGD, enough to handle projected average day demands. Unaccounted water is 37%, and the majority of lines are four-inch diameter and therefore do not provide adequate fire protection based on VDH guidelines.

**FIGURE 54
DEMAND/SYSTEM COMPONENT GRAPH
TOMS BROOK/MAURERTOWN SERVICE AUTHORITY
NORTH FORK SHENANDOAH RIVER SUBAREA**

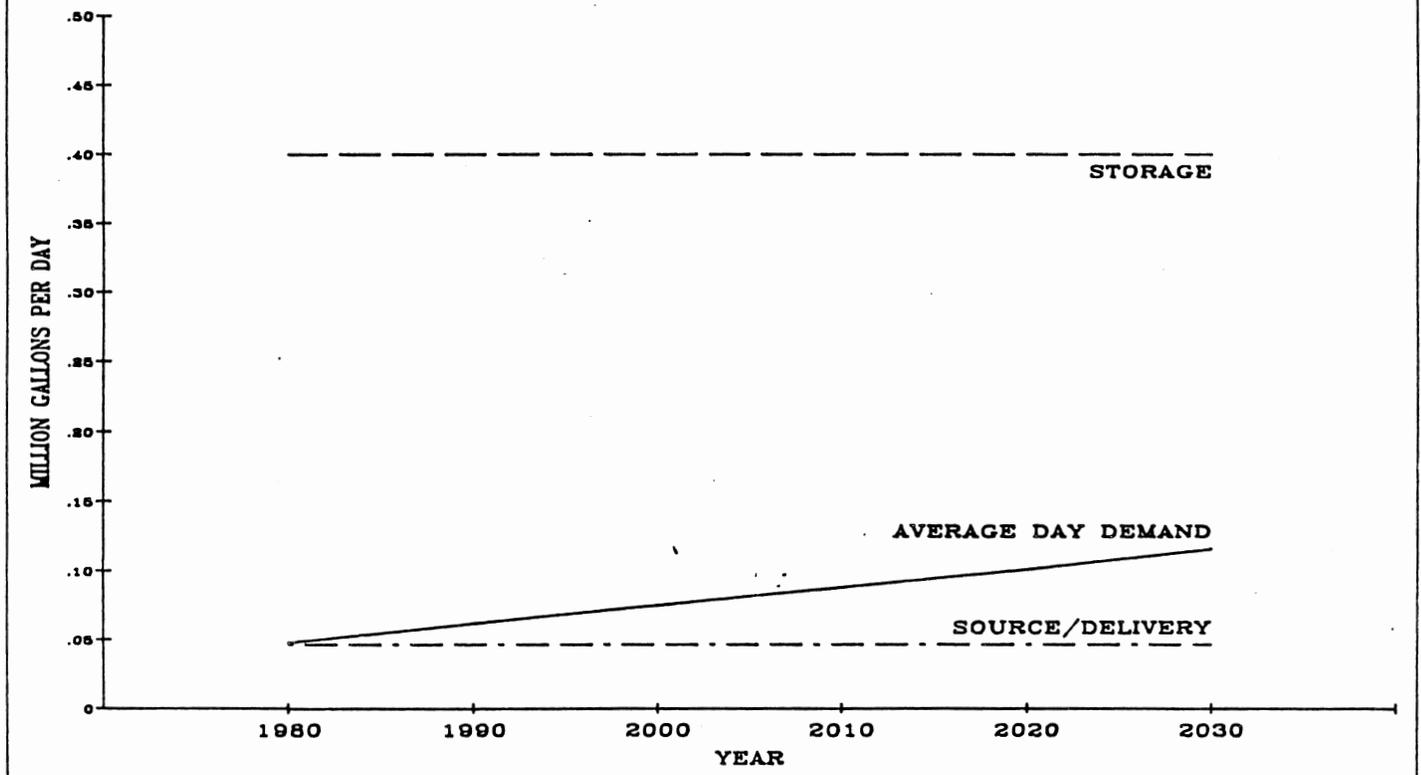


TABLE 80
 PROJECTED WATER SUPPLY DEFICITS - TOMS BROOK/MAURERTOWN
 SERVICE AUTHORITY
 IF NO REMEDIAL ACTION IS TAKEN*
 NORTH FORK SHENANDOAH RIVER SUBAREA

<u>System Component</u>	Surplus (+) or Deficit (-), MGD					
	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
	<u>Without Conservation</u>					
Source/Delivery (0.046 MGD)	0.00	-0.01	-0.03	-0.04	-0.05	-0.07
Storage (0.4 MGD)	+0.35	+0.34	+0.32	+0.31	+0.30	+0.28
	<u>With Conservation</u>					
Source/Delivery (0.046 MGD)	0.00	0.00	0.00	-0.01	-0.02	-0.02
Storage (0.4 MGD)	+0.35	+0.36	+0.35	+0.34	+0.34	+0.33

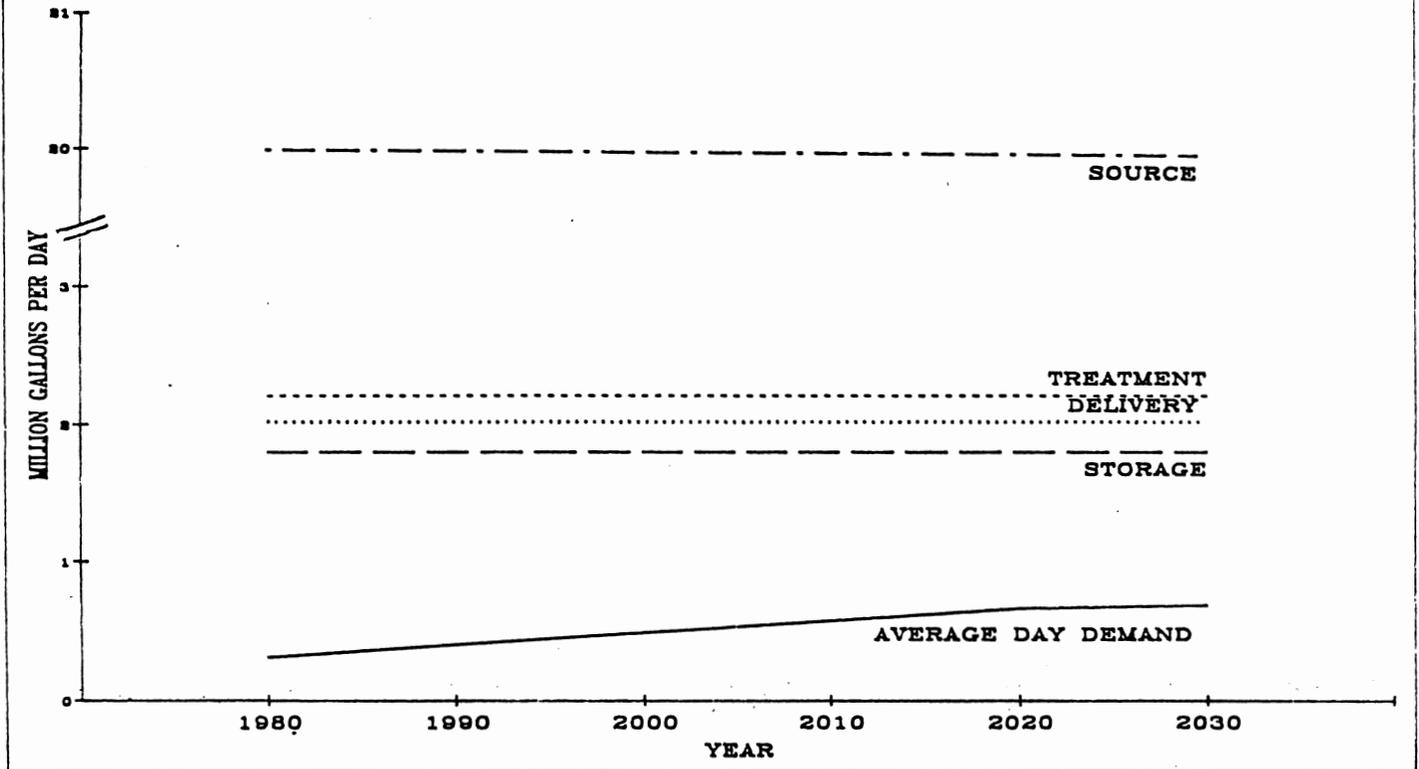
*Projected deficits based on average day demands.

Woodstock. The ability of this system to provide water is summarized in Figure 55 and Table 81. The Authority has adequate source, delivery, treatment and storage capacities to satisfy 2030 demands. The system is rated by VDH at 1.8 MGD based on a storage capacity of 0.9 MG. Delivery capacity is 2.016 MGD, while treatment capacity is 2.21 MGD based on filter capacity. Unaccounted water was 25% in 1980.

Quantity and Quality Conflicts

No serious conflicts between offstream and instream uses are anticipated throughout this demand center. The annual risk of 7Q10 low flows occurring at the Town of Woodstock treated wastewater discharge will increase from 10% to 20% by 2030 at projected net withdrawals. More details on the effects of withdrawals on the lower portion of the North Fork Shenandoah River are given in Appendix C.

FIGURE 55
DEMAND/SYSTEM COMPONENT GRAPH
WOODSTOCK
NORTH FORK SHENANDOAH RIVER SUBAREA



Woodstock has experienced occasional taste and odor problems during winter months, apparently due to non-point source runoff events associated with animal waste improperly applied to the land surface.

Alternative Analysis

Toms Brook/Maurertown Service Authority. A recent engineering study by Clean Water Engineers, Inc. evaluated three alternatives and found only one to be cost-effective: developing wells. Therefore, the Service Authority intends to develop additional wells. It is estimated that four wells will be necessary to satisfy the projected demands at a total cost of \$189,000 (Table 82). The other alternatives which were considered included developing an abandoned rock quarry in Toms Brook and connecting to the Town of Woodstock water system.

TABLE 81

PROJECTED WATER SUPPLY DEFICITS - TOWN OF WOODSTOCK
 IF NO REMEDIAL ACTION IS TAKEN*
 NORTH FORK SHENANDOAH RIVER SUBAREA

System Component	Surplus (+) or Deficit (-), MGD					
	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
	<u>Without Conservation</u>					
Delivery (2.016 MGD)	+1.70	+1.61	+1.53	+1.44	+1.35	+1.26
Treatment (2.21 MGD)	+1.89	+1.81	+1.72	+1.63	+1.58	+1.45
Storage (1.8 MGD)	+1.49	+1.40	+1.31	+1.22	+1.14	+1.04
	<u>With Conservation</u>					
Delivery (2.016 MGD)	+1.70	+1.71	+1.66	+1.62	+1.58	+1.54
Treatment (2.21 MGD)	+1.89	+1.90	+1.86	+1.81	+1.77	+1.74
Storage (1.8 MGD)	+1.49	+1.49	+1.45	+1.40	+1.36	+1.33

*Projected deficits based on average day demands.

Woodstock. No deficits are projected through the planning period.

Recommendations

Toms Brook/Maurertown Service Authority. Alternative 1 (drilling new wells) is the recommended alternative because the Authority is pursuing this alternative and the Town's engineering study by Clean Water Engineers, Inc. shows this to be the only cost-effective solution to the area's water supply deficits.

TABLE 82

ALTERNATIVE ANALYSIS - TOMS BROOK/MAURERTOWN SERVICE AUTHORITY
 CENTRAL SHENANDOAH DEMAND CENTER
 NORTH FORK SHENANDOAH RIVER SUBAREA

Alternative Number	<u>1</u>	
Description	Develop four wells.	
<u>Projected Impacts</u>	<u>Unit</u>	<u>Total</u>
Financial		
Total Capital Costs	\$47,400	\$189,600
Total Annual Costs		
(Includes O & M)	\$ 9,800	\$ 39,200
O & M Costs	\$ 5,700	\$ 22,800
Hydrologic	Will increase ground water withdrawals in the area.	
Environmental	Short-term effects.	
Social	May increase water rates.	
Legal	May require purchase of drilling sites; obtain permits from VDH.	
Jurisdictional	None anticipated.	

Edinburg Demand Center

Introduction and Description

The Edinburg Demand Center (Figure 56) is located along U.S. Route 11 between Mount Jackson and Woodstock and includes the incorporated area of the Town of Edinburg. It is served solely by the Town of Edinburg water system.

The demand center area is 0.56 square miles. The boundaries were determined based upon discussions with the County Administrator.

Existing Facilities

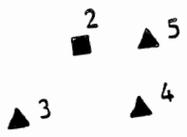
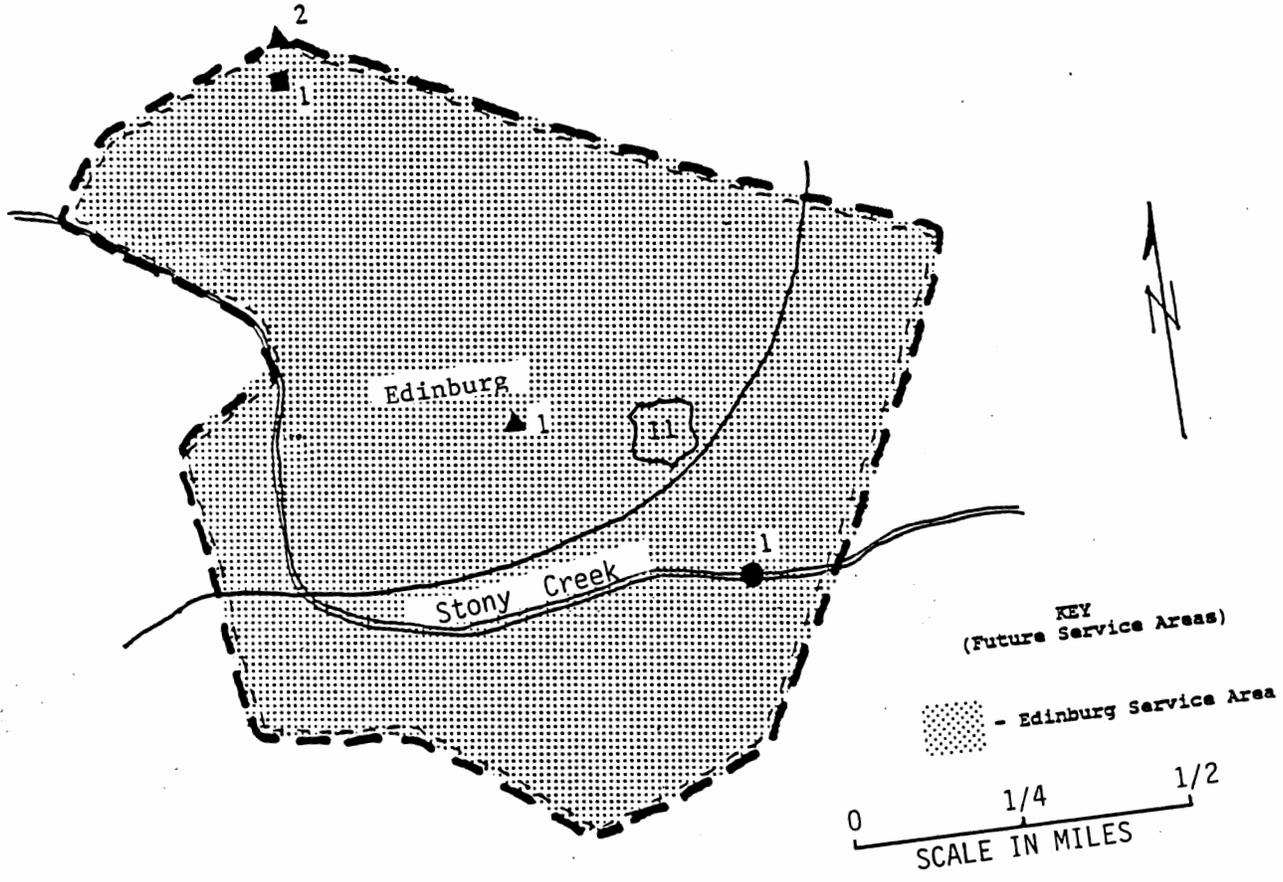
The Town of Edinburg served all of its 1980 population of 780. There were 412 connections to the system in 1980 and the Town withdrew approximately 0.140 MGD from its sources. Metered usage was only 0.06 MGD in 1980, and the utility manager reported that most of the water withdrawn overflowed from the Town's storage tank.

The Town of Edinburg is supplied primarily by ground water from two wells. Due to local water pressure problems, particularly at night, Well 1 was operated continuously for several years. When Well 2 was put into service in early 1985, Well 1 was no longer operated continuously and unaccounted water was reduced from 75% in 1980 to 57% in 1985. Therefore, the 1980 demand was estimated to be 0.14 MGD and 0.08 MGD was unaccounted water.

Well 1 is rated by the VDH at 0.160 MGD based upon the pump capacity according to VDH guidelines; it was pump tested at 0.164 MGD (205 gpm after 8 hours, 1965). Well 2 was added in 1985 and has a capacity of 0.077 MGD based upon the pump capacity according to VDH guidelines. This newer well requires treatment for iron and manganese removal; the treatment plant has a capacity of 0.138 MGD. The effective capacity of this system is therefore 0.237 MGD based upon the combined ratings of the two wells. Water from Well 1 is chlorinated.

A mountain spring and two mountain streams serve as backup sources. The mountain sources have not been rated, but a study

FIGURE 56
 EDINBURG DEMAND CENTER
 NORTH FORK SHENANDOAH RIVER SUBAREA



LEGEND

--- WATER DEMAND CENTER BOUNDARY
 - - - CORPORATE LIMITS

SYMBOL	MAP No.	DESCRIPTION / OWNER
▲ (Source)	1	Well 1/Edinburg
	2	Well 2/Edinburg
	3	Dan's Hollow Stream/Edinburg
	4	Horn's Gully Stream/Edinburg
	5	Little Sulfur Spring/Edinburg
■ (Storage)	1	Steel Tank (0.1 MG)/Edinburg
	2	Storage Reservoir (0.5 MG)/Edinburg
● (Wastewater Return)	1	WWR/Edinburg

conducted by the Town in 1979 determined that the yield was between 0.03 MGD and 0.11 MGD. Water from the mountain sources is chlorinated and treated for corrosiveness.

There is one 0.1 MG steel storage tank on the system in addition to a booster pump and 0.002 MG hydropneumatic tank at the well. A 0.5 MG open reservoir on the system was not considered as storage by the VDH.

Projected Demands

Water demands for the Edinburg Demand Center shown in Tables 83 and 84 are based upon 1980 water usage, the 1985 Edinburg Regulation 11 report, and population projections for the demand center. Unaccounted water was approximately 75% in 1980; much of this was attributed to overflow from the storage tank. Edinburg changed operational practices when Well 2 was put into service and reduced the amount of overflow from the storage tank. In 1985 the unaccounted water in Edinburg's system was calculated to be 57%, and this figure was used in making the future water demand projections. Water still may overflow from the storage facility, so it is possible that more water may be available to the Town than projected. Demand projections are provided in Table 84.

TABLE 83

POPULATION PROJECTIONS - EDINBURG DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
<u>Waterworks-Supplied</u>						
Edinburg	780	900	960	1,040	1,070	1,150

TABLE 84

PROJECTED DEMANDS - EDINBURG DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

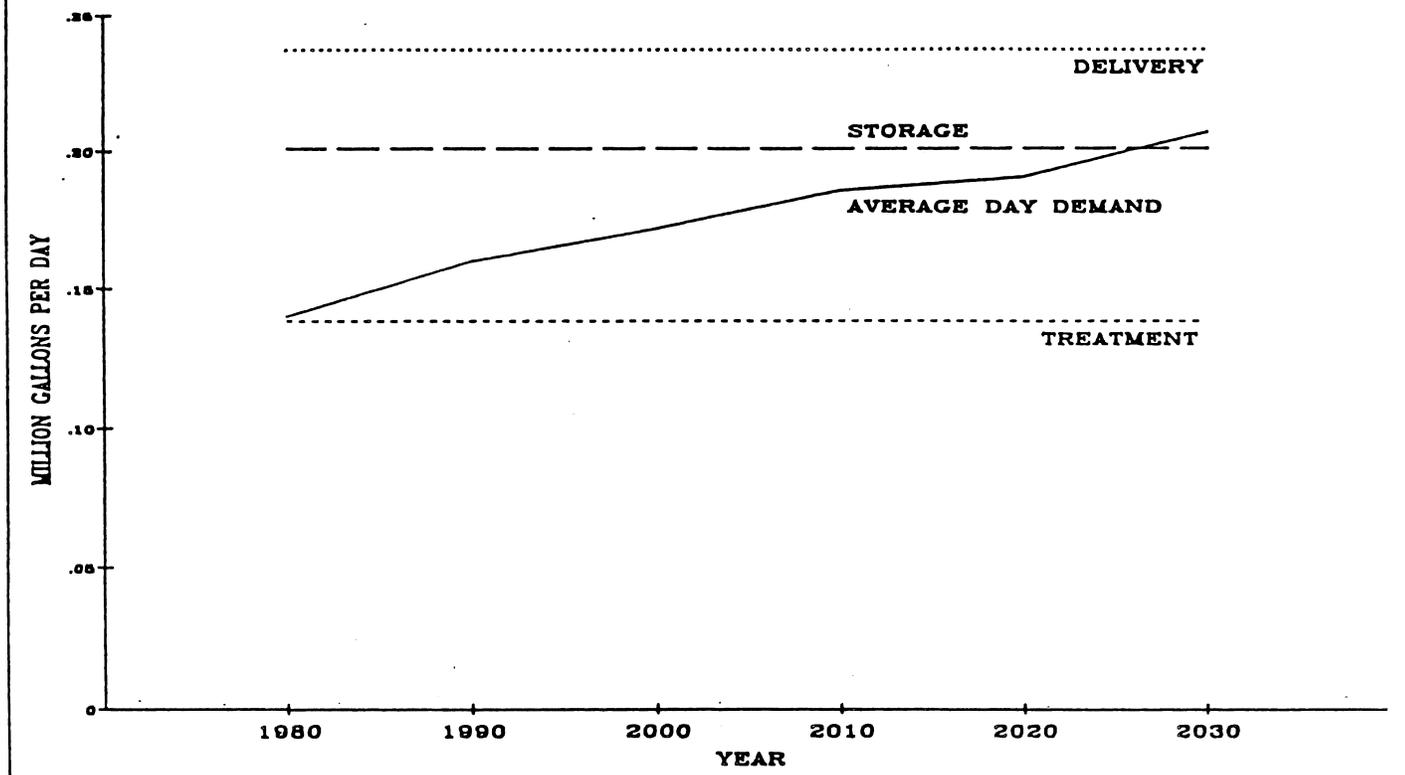
	1980	1990	2000	2010	2020	2030

	Without Conservation					
Waterworks-Supplied						

Dom/Com/Inst (GPCD)	0.06 (77)	0.07 (77)	0.07 (77)	0.08 (77)	0.08 (77)	0.09 (77)
Unaccounted	0.08	0.09	0.10	0.11	0.11	0.12
Total	0.14	0.16	0.17	0.19	0.19	0.21
	With Conservation					
Waterworks-Supplied						

Dom/Com/Inst (GPCD)	0.06 (77)	0.06 (70)	0.06 (67)	0.07 (64)	0.07 (61)	0.07 (58)
Unaccounted	0.08	0.01	0.01	0.01	0.01	0.01
Total	0.14	0.07	0.07	0.08	0.08	0.08

**FIGURE 57
DEMAND/SYSTEM COMPONENT GRAPH
EDINBURG
NORTH FORK SHENANDOAH RIVER SUBAREA**



Quantity and Quality Conflicts

There are no serious conflicts occurring between offstream and instream uses throughout this demand center. The annual risk of 7Q10 flow occurring at the Aileen (Edinburg) discharge will increase from 10% to 25% by 2030 at projected net withdrawals. For more details on the effects of withdrawals on the lower portion of the North Fork Shenandoah River consult Appendix C.

Alternative Analysis

No deficits are projected through the planning period. However, Edinburg's unaccounted water is very high (57%) and the cause(s) should be identified so there is a better understanding of the amount of water actually available to the Town.

TABLE 85

PROJECTED WATER SUPPLY DEFICITS - TOWN OF EDINBURG
 IF NO REMEDIAL ACTION IS TAKEN*
 NORTH FORK SHENANDOAH RIVER SUBAREA

System Component	Surplus (+) or Deficit (-), MGD					
	1980	1990	2000	2010	2020	2030
	<u>Without Conservation</u>					
Delivery (0.237 MGD)	+0.10	+0.08	+0.07	+0.05	+0.05	+0.03
Treatment** (0.138 MGD)	+0.16	+0.14	+0.13	+0.11	+0.11	+0.09
Storage (0.201 MGD)	+0.06	+0.04	+0.03	+0.02	+0.01	-0.01
	<u>With Conservation</u>					
Delivery (0.237 MGD)	+0.10	+0.17	+0.17	+0.17	+0.16	+0.16
Treatment** (0.138 MGD)	+0.16	+0.23	+0.23	+0.23	+0.23	+0.22
Storage (0.201 MGD)	+0.06	+0.13	+0.13	+0.13	+0.13	+0.13

*Projected deficits based on average day demands.

**Only water from Well 2 is treated.

Mount Jackson Demand Center

Introduction and Description

The Mount Jackson Demand Center (Figure 58) is located along U.S. Route 11 between New Market and Edinburg. It includes the incorporated Town of Mount Jackson and Bowman Apple, a self-supplied industry. The demand center is 0.65 square miles in area. The boundaries were determined on the basis of discussions with the County Administrator. The population of the demand center is 1,530.

Existing Facilities

Mount Jackson. The Town of Mount Jackson served all of its 1980 population of 1,530. There were 674 connections and domestic/commercial/institutional usage accounted for 62% (0.08 MGD) of the total 1980 demand of 0.129 MGD. Unaccounted water was calculated to be 0.049 MGD (38%) from the 1985 Regulation 11 report.

The Town of Mount Jackson is supplied by three wells and two unnamed springs. Well 3 is the primary source and is rated by the VDH at 0.092 MGD based upon the pump capacity. It was pump tested at 0.144 MGD (100 gpm after 48 hours, 1973). Well 2 is rated by the VDH at 0.048 MGD based upon the pump capacity. It was pump tested at 0.108 MGD (75 gpm after 28 hours, 1960). Well 1 was pump tested at 0.087 MGD (70 gpm) according to VDH guidelines and serves only as an emergency source. Two unnamed springs that originate on the western slopes of Short Mountain also serve as emergency sources; their well yield is unknown. The total source/delivery capacity of Mount Jackson's system is therefore 0.196 MGD based upon the pump ratings of the three wells. A fourth well has been developed and will be put into service in late 1987 or in 1988. The new well is producing 200 gpm. The Town has two concrete storage reservoirs with a combined capacity of 2.7 MG and has access to a 0.5 MG storage tank. There is one booster pump rated by the VDH at 0.086 MGD.

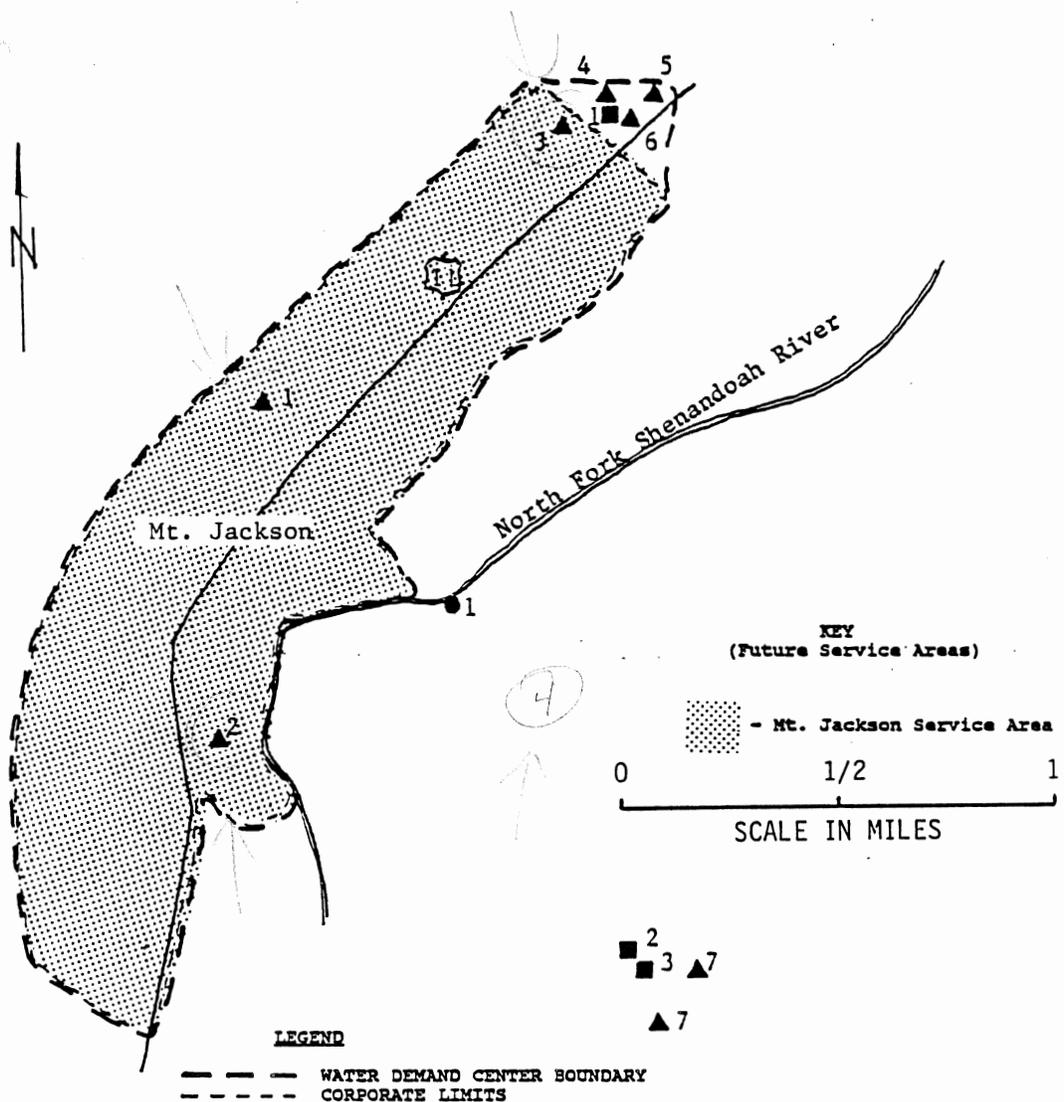
Major Self-Supplied Users

Bowman Apple Products. Bowman Apple withdraws water from a combination of three wells. The combined yield of the wells

FIGURE 58

MOUNT JACKSON DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

1 70 gpm
2 750 gpm
3 100 gpm



LEGEND

- WATER DEMAND CENTER BOUNDARY
- CORPORATE LIMITS

KEY
(Future Service Areas)

▨ - Mt. Jackson Service Area

0 1/2 1
SCALE IN MILES

2
3 ▲ 7
▲ 7

SYMBOL	MAP No.	DESCRIPTION / OWNER
▲ (Source)	1	Well 1/Mt. Jackson
	2	Well 2/Mt. Jackson
	3	Well 3/Mt. Jackson
	4	Well 1/Bowman Apple
	5	Well 2/Bowman Apple
	6	Well 3/Bowman Apple
	7	Unnamed Springs/Mt. Jackson
■ (Storage)	1	Storage tank/Bowman Apple
	2	Storage Reservoir (2.3 MG)/Mt. Jackson
	3	Storage Reservoir (0.405 MG)/Mt. Jackson
● (Wastewater Return)	1	WWR/Mt. Jackson

is 0.706 MGD (490 gpm). Well 1 was pump tested at 0.23 MGD (160 gpm, 1941). Well 2 was pump tested at 0.317 MGD (220 gpm, 1944), and Well 3 is reported to yield 0.158 MGD (110 gpm, 1953). Ninety-nine percent of the water is used for processing and the remainder for cooling and sanitary purposes. Total usage in 1983 was 0.067 MGD.

Projected Demands

Water demands for the Mount Jackson Demand Center shown in Tables 86 and 87 are based upon 1980 water usage and population projections for the demand center. According to the Shenandoah County Administrator the population is assumed to increase 1.4 times that of the County population rate by 2030. Demand Center population was calculated by applying these values to the Shenandoah County population projections provided by the Department of Planning and Budget. Mount Jackson officials believe the population figures may be too conservative. A population of 2,000 may be reached by 1990 due to the recent economic boom. The demand center population was assumed to remain 100% served throughout the planning period.

Projections of Bowman Apple's demands were made according to the standard projection methodology using OBERS employment projections for the Food and Kindred Products Standard Classification (SIC 20).

TABLE 86

POPULATION PROJECTIONS - MOUNT JACKSON DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
<u>Waterworks-Supplied</u>						
Mount Jackson	1,530	1,740	1,890	2,010	2,100	2,220

Evaluation of Demand Center (Problem Identification)

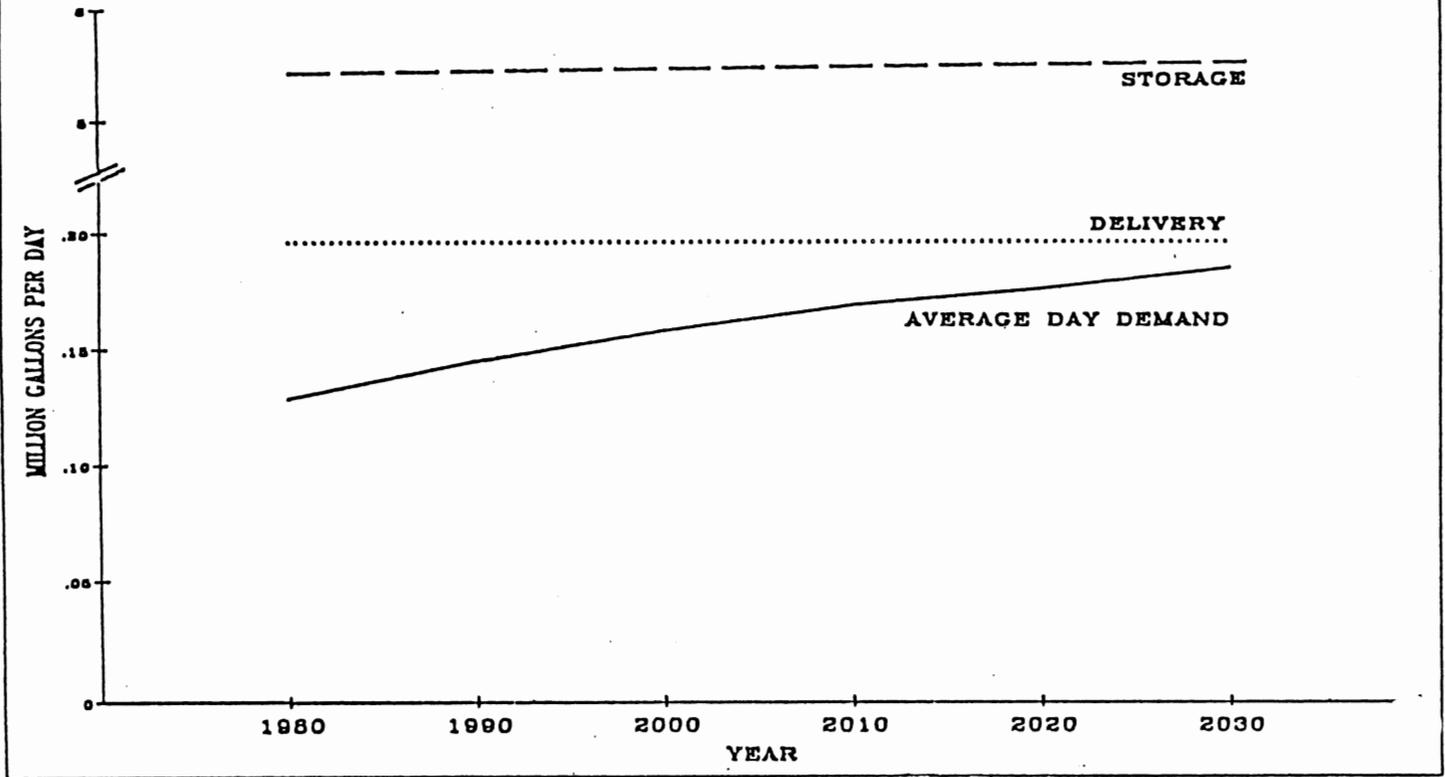
The ability of the Mount Jackson system to provide adequate quantities of water is summarized in Figure 59 and Table 88. No deficits are projected throughout the planning

TABLE 87

PROJECTED DEMANDS - MOUNT JACKSON DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

	1980	1990	2000	2010	2020	2030
----- Without Conservation -----						
Waterworks-Supplied -----						
Mount Jackson						
Dom/Com/Inst (GPCD)	0.08 (52)	0.09 (52)	0.10 (52)	0.11 (52)	0.11 (52)	0.12 (52)
Unaccounted	0.05	0.06	0.06	0.06	0.07	0.07
Subtotal	0.13	0.15	0.16	0.17	0.18	0.19
Self-Supplied -----						
Bowman Apple	0.07	0.07	0.08	0.09	0.09	0.10
Demand Center Total -----						
Dom/Com/Inst	0.08	0.09	0.10	0.11	0.11	0.12
Mfg	0.07	0.07	0.08	0.09	0.09	0.10
Unaccounted	0.05	0.06	0.06	0.06	0.07	0.07
Total	0.20	0.22	0.24	0.26	0.27	0.29
With Conservation						
Waterworks-Supplied -----						
Dom/Com/Inst (GPCD)	0.08 (52)	0.08 (47)	0.09 (45)	0.09 (43)	0.09 (41)	0.09 (40)
Unaccounted	0.05	0.01	0.01	0.01	0.01	0.01
Subtotal	0.13	0.09	0.10	0.10	0.10	0.10
Self-Supplied -----						
Mfg Bowman Apple	0.07	0.07	0.08	0.08	0.09	0.10
Demand Center Total -----						
Dom/Com/Inst	0.08	0.08	0.09	0.09	0.09	0.09
Mfg	0.07	0.07	0.08	0.08	0.09	0.10
Unaccounted	0.05	0.01	0.01	0.01	0.01	0.01
Total	0.20	0.16	0.18	0.18	0.19	0.20

FIGURE 59
 DEMAND/SYSTEM COMPONENT GRAPH
 MOUNT JACKSON
 NORTH FORK SHENANDOAH RIVER SUBAREA



period. Table 88 is based on pump capacity of the three wells (0.196 MGD) and storage volume of 2.7 MG which is sufficient to support a demand of 5.4 MGD. Chlorination is the only treatment required. Unaccounted water is estimated to be 38% and excludes reservoir overflow.

Quantity and Quality Conflicts

There are no serious conflicts occurring between offstream and instream uses throughout this demand center. The annual risk of 7Q10 low flow occurring at Mount Jackson's treated wastewater discharge will increase from 10% to 25% by 2030 at projected net withdrawals. For more details on the effects of withdrawals on the lower portion of the North Fork Shenandoah River refer to Appendix C.

TABLE 88 ✓

PROJECTED WATER SUPPLY DEFICITS - TOWN OF MOUNT JACKSON
 IF NO REMEDIAL ACTION IS TAKEN*
 NORTH FORK SHENANDOAH RIVER SUBAREA

<u>System Component</u>	<u>Surplus (+) or Deficit (-), MGD</u>					
	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
	<u>Without Conservation</u>					
Delivery (0.196 MGD)	+0.07	+0.05	+0.04	+0.03	+0.02	+0.01
Storage (6.4 MGD)	+6.27	+6.25	+6.24	+6.23	+6.22	+6.21
	<u>With Conservation</u>					
Delivery (0.196 MGD)	+0.07	+0.11	+0.11	+0.10	+0.10	+0.10
Storage (6.4 MGD)	+6.27	+6.31	+6.31	+6.30	+6.30	+6.30

*Projected deficits based on average day demands.

Alternative Analysis

No deficits are projected through the planning period. However, Mount Jackson's unaccounted water is high (38%) and the cause(s) should be identified so there is a better understanding of the amount of water actually available to the Town.

Strasburg Demand Center

Introduction and Description

The Strasburg Demand Center (Figure 60) is located along U.S. Route 11 in the northern part of Shenandoah County near the Frederick County border. It includes the incorporated area of the Town of Strasburg and adjacent areas around the Town expected to be served by the central system by 2030. It is served solely by the Town of Strasburg water system.

The demand center area is 5.61 square miles; the boundaries were determined based upon discussions with the County Administrator. The population of the demand center was 3,011 in 1980.

Existing Facilities

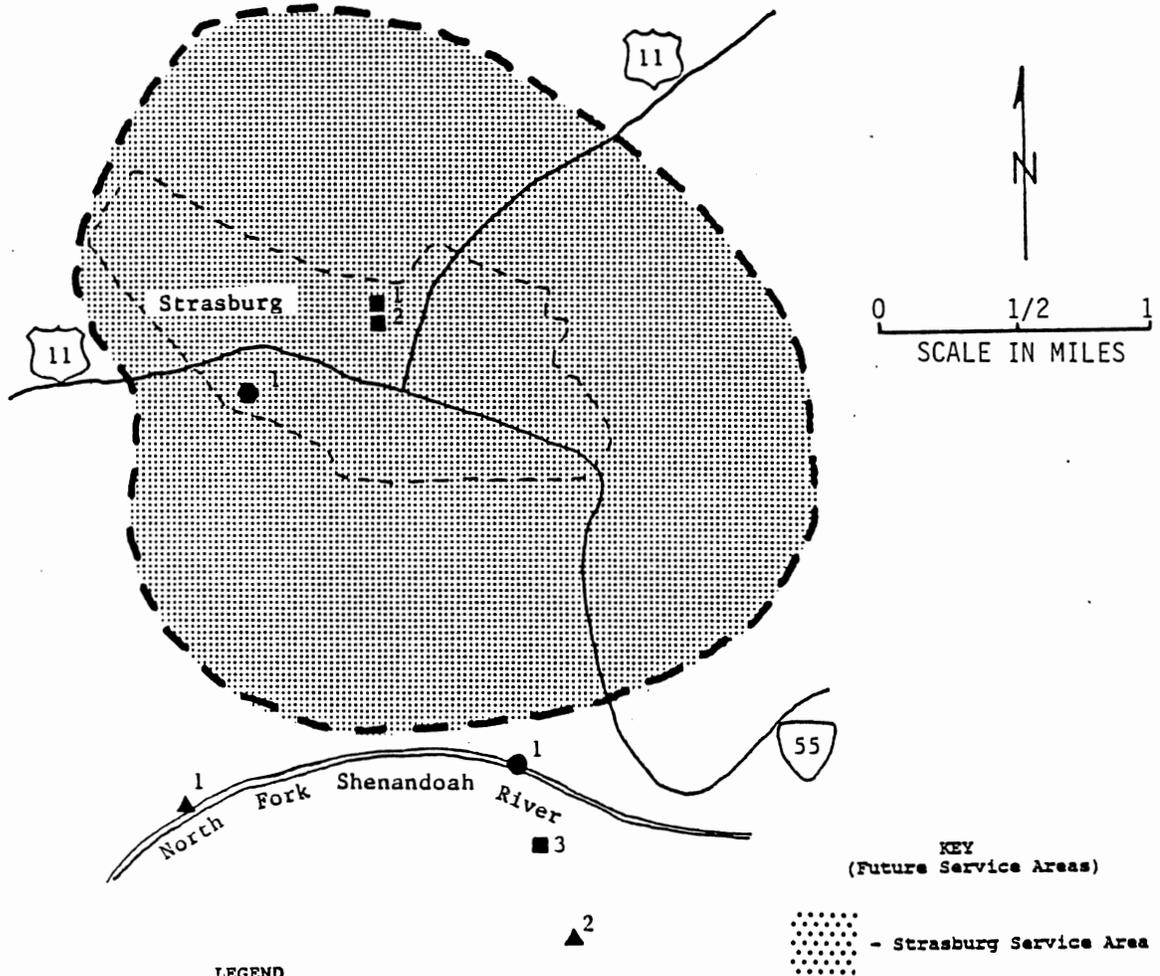
The Town of Strasburg served 2,800 of its 1980 population of 3,011. There are 1,162 connections. Domestic/commercial/institutional demands accounted for 45% (0.16 MGD) of the total 1980 demand (0.352 MGD). Manufacturing (Valley Milk Products) accounted for 43% (0.015 MGD) and unaccounted water made up the remaining 12% (0.042 MGD).

The Town is supplied by surface water. The North Fork Shenandoah River is the primary source. The safe yield determined at the Town's intake is 30.2 MGD according to VWCB Safe Yield Data Bulletin, 1985. Raw water is delivered to the water treatment plant by two pumps rated by the VDH at 0.58 MGD. The plant is rated by VDH at 0.57 MGD based on filter capacity. Finished water is delivered to the distribution system by three pumps with a VDH rating of 1.15 MGD.

Strasburg has a mountain source which consists of a reservoir on Little Passage Creek. The reservoir has a safe yield of 0.1 MGD. Combined with the 0.57 MGD treatment plant this makes the total source/delivery capacity 0.67 MGD. The only treatment required is disinfection and fluoridation. Water from this reservoir flows by gravity through an aqueduct to a covered reservoir with 1.0 MG of water supply storage capacity. Therefore, the net system capacity is 0.67 MGD based upon the

FIGURE 60

STRASBURG DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA



LEGEND
 - - - - - WATER DEMAND CENTER BOUNDARY
 - - - - - CORPORATE LIMITS

KEY
 (Future Service Areas)
 [Stippled Area] - Strasburg Service Area

SYMBOL	MAP No.	DESCRIPTION / OWNER
▲ (Source)	1	N.F. Shenandoah River Intake/Strasburg
	2	Reservoir/Strasburg
● (Water Treatment Plant)	1	WTP/Strasburg
■ (Storage)	1	Elevated Storage Tank (0.2 MG)/Strasburg
	2	Storage Tank (0.05 MG)/Strasburg
	3	Mountain Reservoir (1.0 MG)/Strasburg
● (Wastewater Return)	1	WWR/Strasburg

water treatment plant capacity of 0.57 MGD and safe yield of the mountain reservoir (0.1 MGD).

A 12-inch gravity main conveys water from the 1.0 MG reservoir to the distribution system. There are two additional storage facilities, a 0.2 MG elevated tank and a 0.05 MG standpipe, making total storage capacity 1.25 MG. There is one 0.043 MGD booster pump station.

Projected Demands

Water demands for the Strasburg Demand Center shown in Tables 89 and 90 are based upon 1980 water usage and population projections for the demand center. According to the Shenandoah County Administrator, the population is assumed to increase at a rate three times that of the County's population increase, thus increasing from 10.9% in 1980 to 16.4% of the county population in 2030. Demand center population was calculated by applying these values to the Shenandoah County population projections provided by the Department of Planning and Budget. The centrally served percentage was assumed to increase linearly from 93% in 1980 to 100% in 2030. Demand by the unserved population in the demand center was assumed to equal the 57 GPCD average of the served population.

TABLE 89

POPULATION PROJECTIONS - STRASBURG DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
<u>Waterworks-Supplied</u>						
Strasburg	2,800	3,520	4,170	4,780	5,370	6,000
<u>Self-Supplied</u>	211	210	180	180	80	0
Total	3,011	3,730	4,350	4,960	5,450	6,000

Evaluation of Demand Center (Problem Identification)

The ability of Strasburg's system to provide adequate quantities of water is summarized in Figure 61 and Table 91. No

TABLE 90

PROJECTED DEMANDS - STRASBURG DEMAND CENTER
NORTH FORK SHENANDOAH RIVER SUBAREA

	1980	1990	2000	2010	2020	2030

Without Conservation						
Waterworks-Supplied						

Dom/Com/Inst (GPCD)	0.16 (57)	0.20 (57)	0.24 (57)	0.27 (57)	0.31 (57)	0.34 (57)
Mfg	0.15	0.16	0.18	0.19	0.21	0.23
Unaccounted	0.04	0.05	0.06	0.06	0.07	0.08
Subtotal	0.35	0.41	0.48	0.52	0.59	0.65
Self-Supplied						

Dom/Com/Inst (GPCD)	0.01 (57)	0.01 (57)	0.01 (57)	0.01 (57)	0.01 (57)	0.00
Demand Center Total						

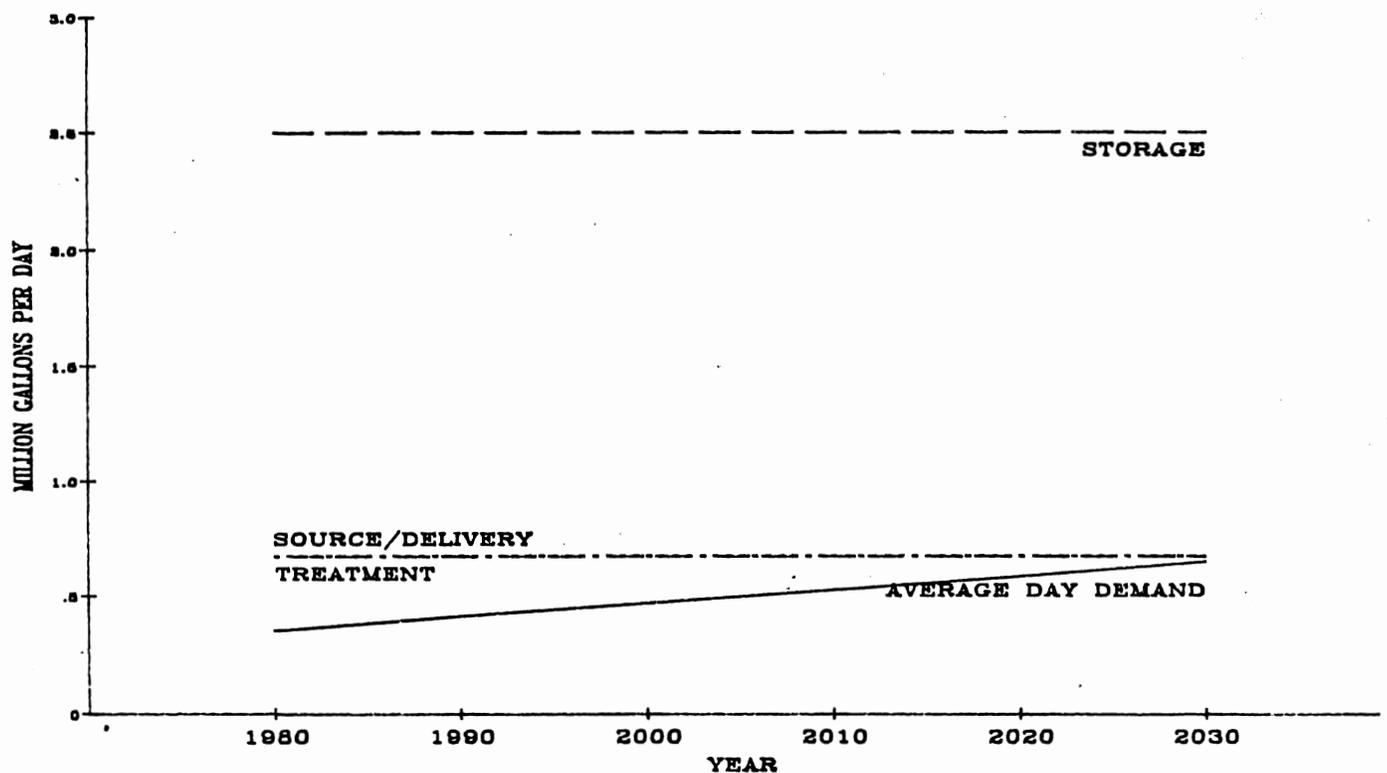
Dom/Com/Inst	0.17	0.21	0.25	0.28	0.31	0.34
Mfg	0.15	0.16	0.18	0.19	0.21	0.23
Unaccounted	0.04	0.05	0.06	0.06	0.07	0.08
Total	0.36	0.42	0.49	0.53	0.59	0.65
With Conservation						
Waterworks-Supplied						

Dom/Com/Inst (GPCD)	0.16 (57)	0.18 (52)	0.21 (50)	0.23 (47)	0.24 (45)	0.26 (43)
Mfg	0.15	0.16	0.18	0.19	0.21	0.23
Unaccounted	0.04	0.04	0.04	0.05	0.05	0.05
Subtotal	0.35	0.38	0.43	0.47	0.50	0.54
Self-Supplied						

Dom/Com/Inst (GPCD)	0.01 (57)	0.01 (52)	0.01 (50)	0.01 (47)	0.00 (45)	0.00
Demand Center Total						

Dom/Com/Inst	0.17	0.19	0.22	0.23	0.25	0.26
Mfg	0.15	0.16	0.18	0.19	0.21	0.23
Unaccounted	0.04	0.04	0.04	0.05	0.05	0.05
Total	0.36	0.39	0.44	0.47	0.51	0.54

**FIGURE 81
DEMAND/SYSTEM COMPONENT GRAPH
STRASBURG
NORTH FORK SHENANDOAH RIVER SUBAREA**



deficits are projected throughout the planning period. Table 91 is based on treatment and source/delivery capacity of 0.67 MGD (treatment plant filter capacity of 0.57 MGD plus 0.10 MGD safe yield of mountain reservoir), and storage capacity of 2.5 MGD based on a storage volume of 1.25 MG. The 12% unaccounted water probably is due to the age of the lines, some as old as 75 years.

Quantity and Quality Conflicts

There are no serious conflicts occurring between offstream and instream uses throughout this demand center. The annual risk of 7Q10 low flow occurring at the Strasburg discharge will increase from 10% to 20% by 2030 at projected net withdrawals. For more details on the effects of withdrawals on the lower portion of the North Fork Shenandoah River, refer to Appendix C.

Occasional taste and odor problems during the winter months have been reported at Strasburg. These problems are apparently related to non-point source runoff from animal waste being applied to the land surface during periods when the ground is frozen.

TABLE 91

PROJECTED WATER SUPPLY DEFICITS - TOWN OF STRASBURG
IF NO REMEDIAL ACTION IS TAKEN*
NORTH FORK SHENANDOAH RIVER SUBAREA

<u>System Component</u>	<u>Surplus (+) or Deficit (-), MGD</u>					
	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
	<u>Without Conservation</u>					
Source/Delivery (0.67 MGD)	+0.32	+0.25	+0.20	+0.14	+0.08	+0.02
Treatment (0.67 MGD)	+0.32	+0.25	+0.2	+0.14	+0.08	+0.02
Storage (2.5 MGD)	+2.15	+2.08	+2.03	+1.97	+1.91	+1.85
	<u>With Conservation</u>					
Source/Delivery (0.67 MGD)	+0.32	+0.28	+0.25	+0.21	+0.17	+0.13
Treatment (0.67 MGD)	+0.32	+0.28	+0.25	+0.21	+0.17	+0.13
Storage (2.5 MGD)	+2.15	+2.11	+2.08	+2.04	+2.00	+1.96

*Projected deficits based on average day demands.

Alternative Analysis

No deficits are projected through the planning period.

Significant Water Supply Systems Outside of Demand Centers

Following is a discussion of the significant water supply system that lies outside of the six water demand center boundaries.

Aileen, Inc. (Edinburg Plant). Aileen is located adjacent to the North Fork Shenandoah River outside the Edinburg Water Demand Center. The plant produces dyed and finished textile fibers. Approximately 0.77 MGD is withdrawn from the North Fork Shenandoah River, of which 98% is used for process water. The water treatment plant is rated at 1.3 MGD. Total water storage (including fire protection) is 1.5 MG.

Water demands in Table 92 have been projected using the standard methodology based on OBERS employment projections for "Textile Mill" category (SIC 22). Projections are as follows:

TABLE 92

DEMAND PROJECTIONS
SIGNIFICANT WATER SUPPLY SYSTEMS OUTSIDE DEMAND CENTERS
NORTH FORK SHENANDOAH RIVER SUBAREA

	<u>Water Demands (MGD)</u>					
	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
Without Conservation	0.91	1.13	1.62	1.73	1.80	1.84
With Conservation	0.91	0.99	1.07	1.14	1.22	1.30

Summary of Minor Water Supply Systems

In addition to those systems already discussed, there are also a few minor water supply systems in the subarea. A summary of these systems is provided in Table 93. Individual demand projections for these systems were not made. Demand projections for these systems, however, are included in the appropriate demand center narratives under the categories "Self-Supplied Outside Demand Centers" or "Self-Supplied Within Demand Centers."

TABLE 93

MINOR WATER SUPPLY SYSTEMS
NORTH FORK SHENANDOAH RIVER SUBAREA

<u>Owner</u>	<u>Source(s)</u>	<u>Population Served</u>	<u>1982 Average Daily Demand (MGD)</u>
Chemstone Corporation	Three Wells	115	0.02
Virginian Truck Center*	Two Wells		0.01
Winchester Rendering (Linville Plant)	Three Wells		0.02**
Harrisonburg Correctional Unit #8	Well	100	0.01

*Both wells supply potable water to the shop and restaurant.
**1983 usage.

