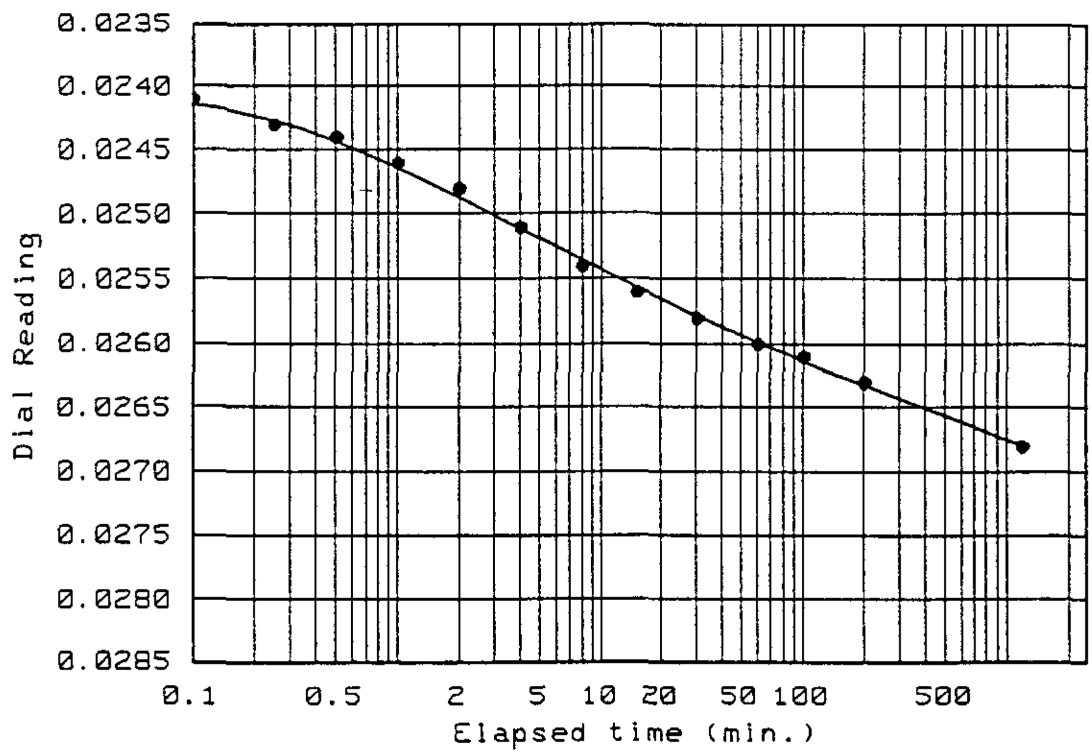
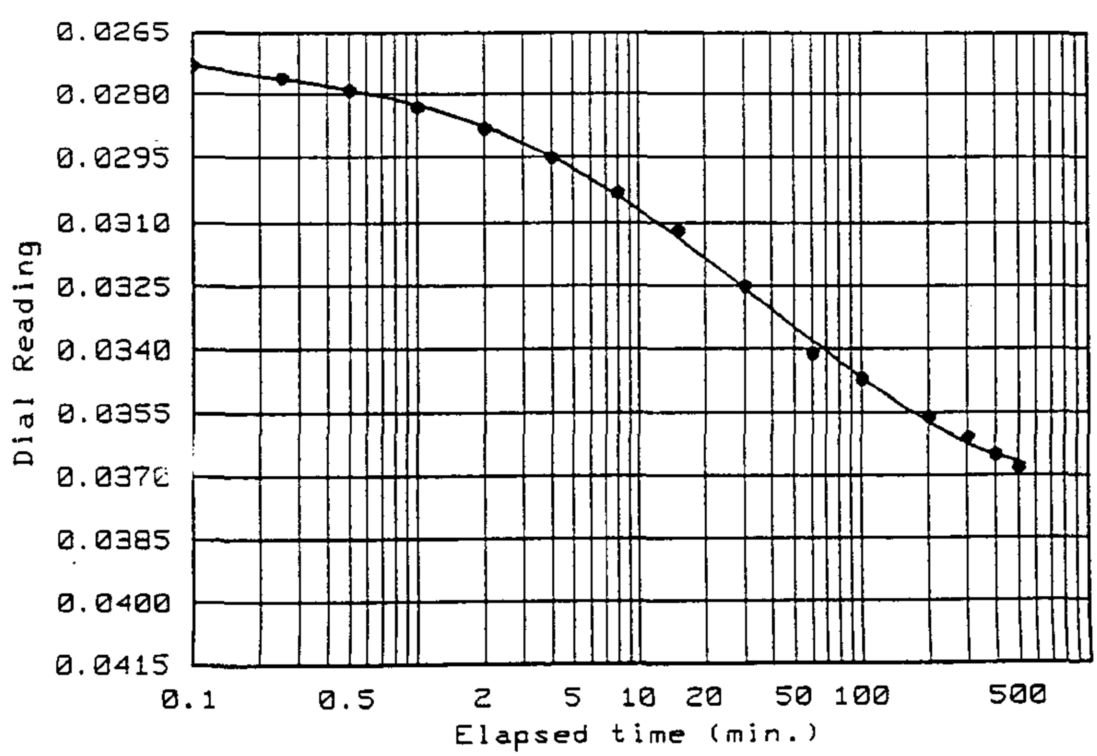
Dial Reading vs. Time

Project No.: 28512.A90
Project: ST.JOSEPH,MO WTP
Location: BORING NO.GF-8 / U-2
SAMPLE DEPTH 10.0'-12.0'
Date: FEB.15,1993



Load No.= 1
Load= 0.25 tsf
D_0 = 0.0239
D_{50} = 0.0248
D_{100} = 0.0258
T_{50} = 1.82 min.

C_v @ T_{50} = .027 in.^{2}/min.



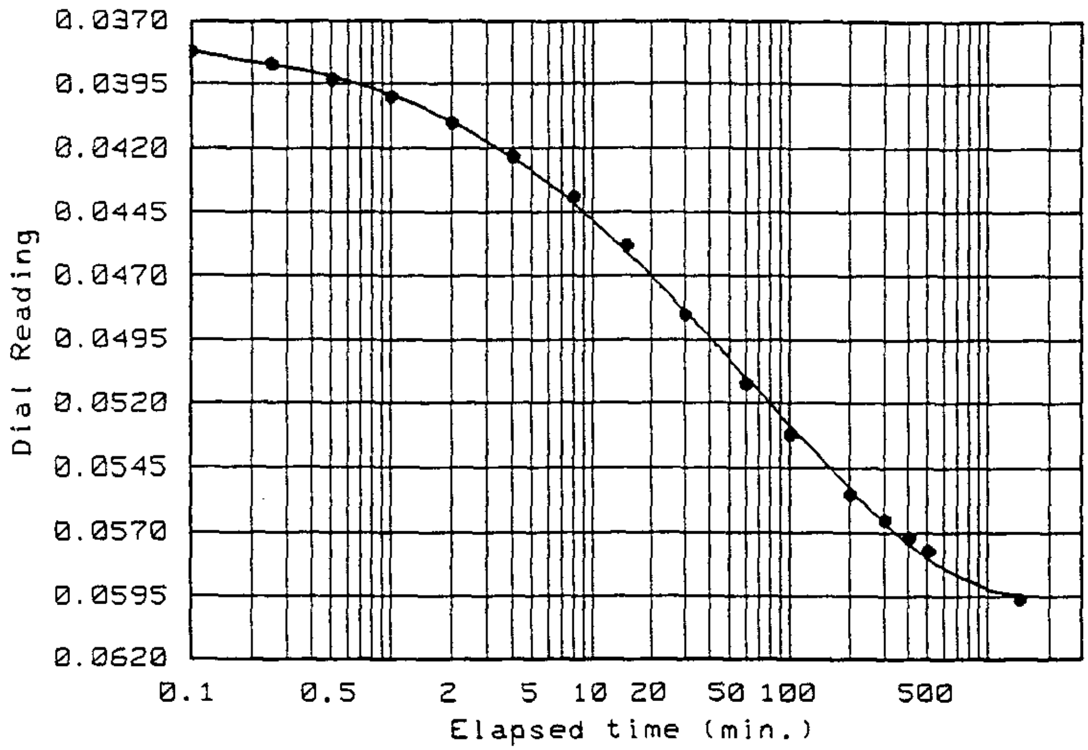
Load No.= 2
Load= 0.50 tsf
D_0 = 0.0268
D_{50} = 0.0315
D_{100} = 0.0363
T_{50} = 16.90 min.

C_v @ T_{50} = .003 in.^{2}/min.

GANNETT FLEMING, INC.

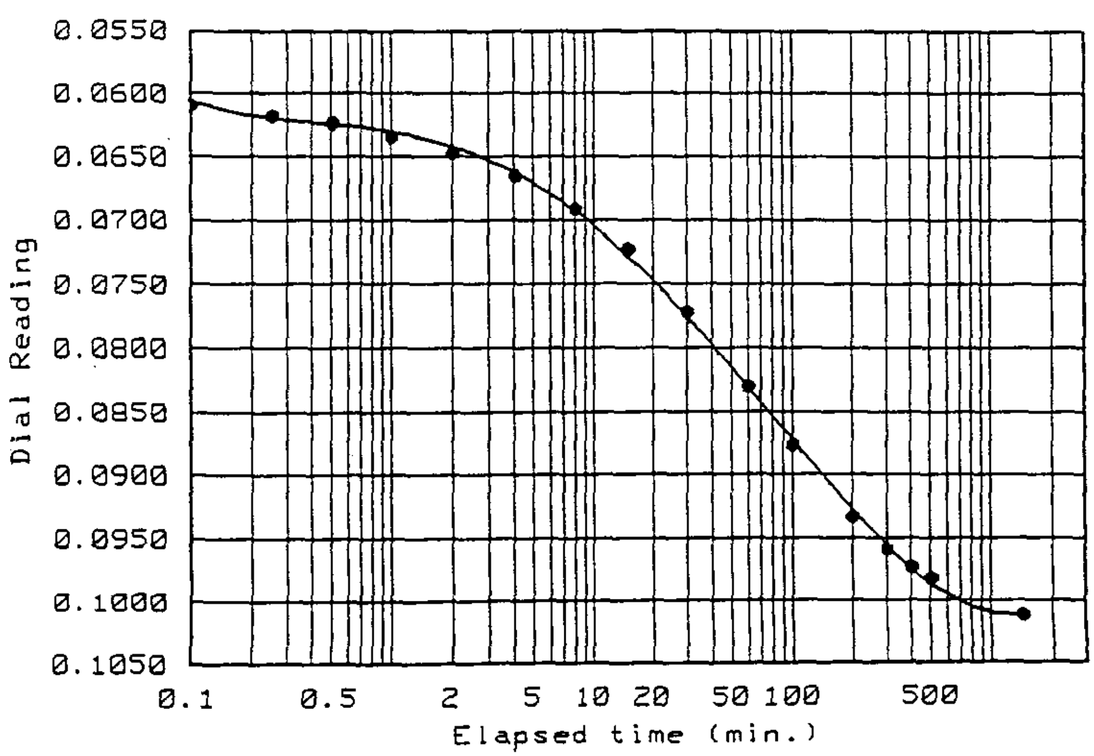
Dial Reading vs. Time

Project No.: 28512.A90
Project: ST.JOSEPH,MO WTP
Location: BORING NO.GF-8 / U-2
SAMPLE DEPTH 10.0'-12.0'
Date: FEB.15,1993



Load No.= 3
Load= 1.00 tsf
D_0 = 0.0374
D_{50} = 0.0476
D_{100}= 0.0578
T_{50}= 23.71 min.

C_v @ T_{50} =
.002 in.²/min.



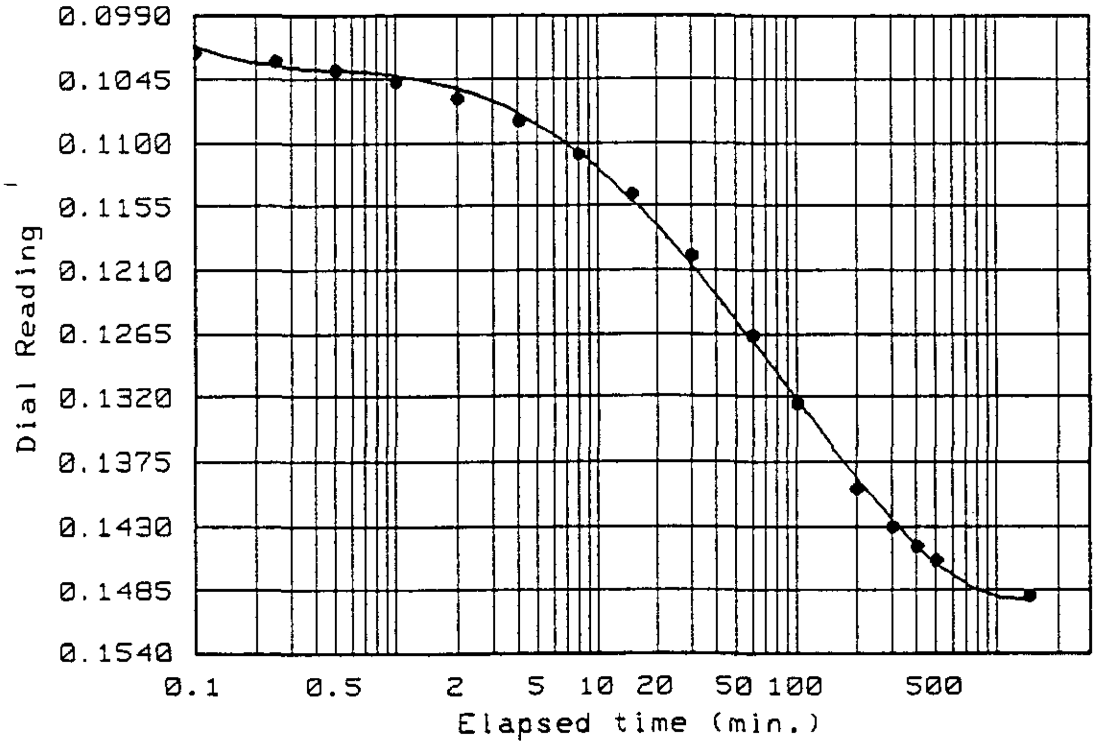
Load No.= 4
Load= 2.00 tsf
D_0 = 0.0589
D_{50} = 0.0788
D_{100}= 0.0988
T_{50}= 34.89 min.

C_v @ T_{50} =
.001 in.²/min.

GANNETT FLEMING, INC.

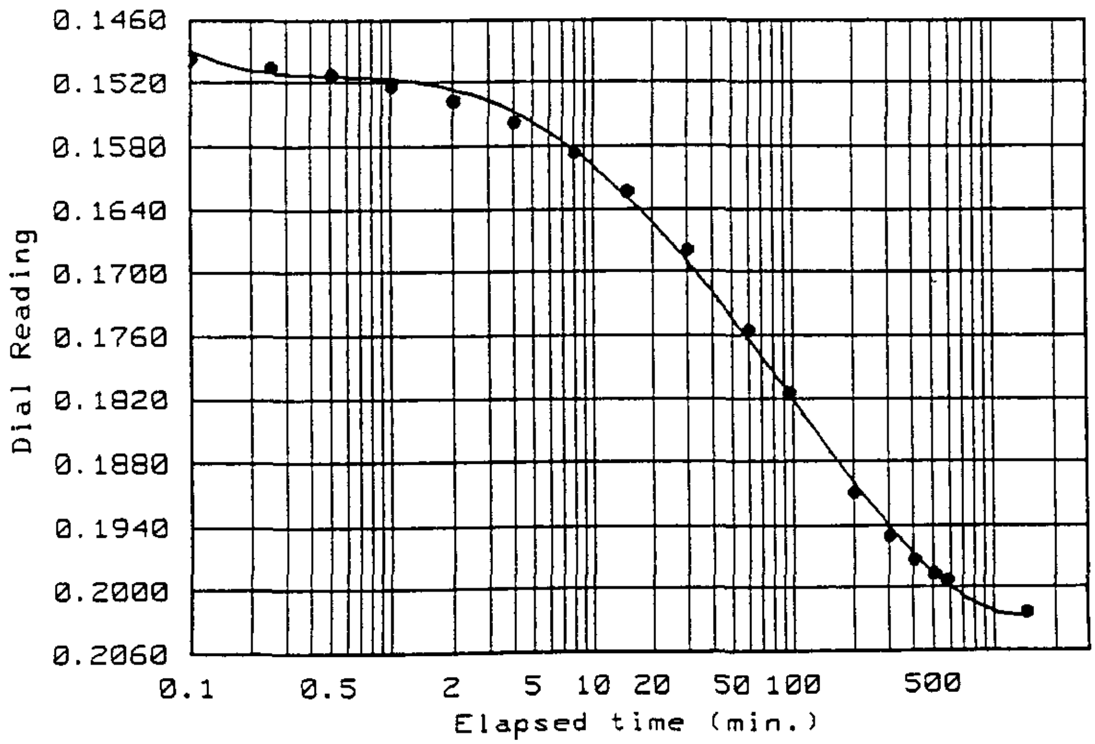
Dial Reading vs. Time

Project No.: 28512.A90
Project: ST.JOSEPH,MO WTP
Location: BORING NO.GF-8 / U-2
SAMPLE DEPTH 10.0'-12.0'
Date: FEB.15,1993



Load No. = 5
Load = 4.00 tsf
D_0 = 0.0996
D_{50} = 0.1230
D_{100} = 0.1464
T_{50} = 38.64 min.

C_v @ T_{50} =
.001 in.²/min.



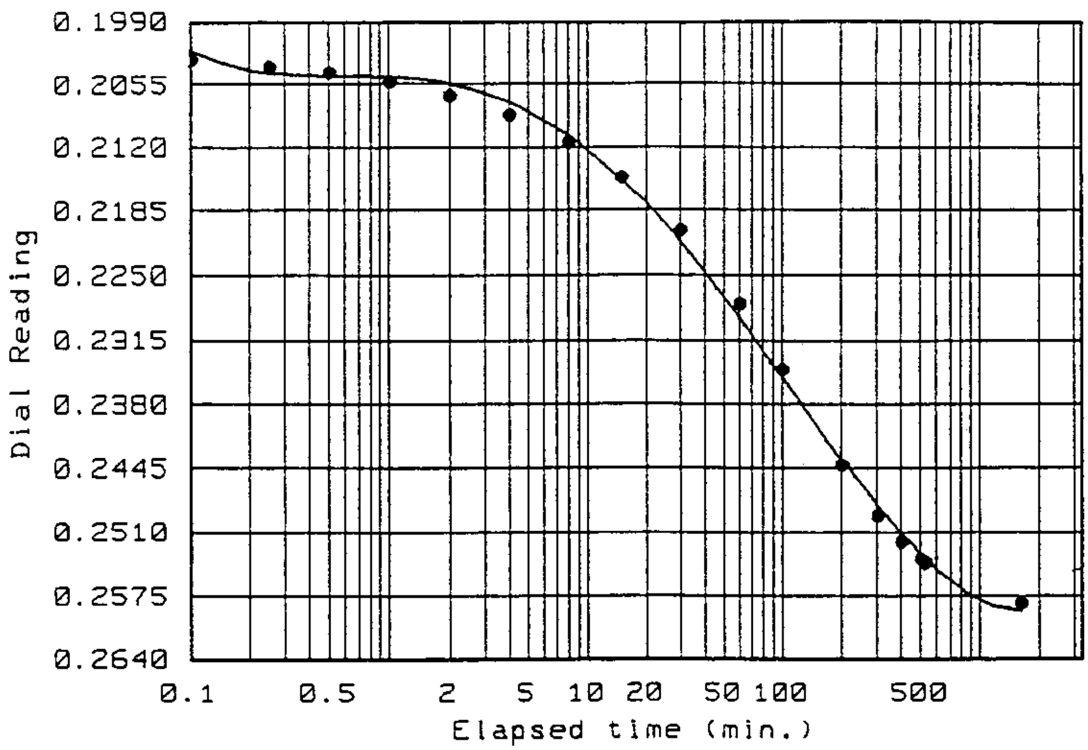
Load No. = 6
Load = 8.00 tsf
D_0 = 0.1467
D_{50} = 0.1730
D_{100} = 0.1994
T_{50} = 43.61 min.

C_v @ T_{50} =
.001 in.²/min.

GANNETT FLEMING, INC.

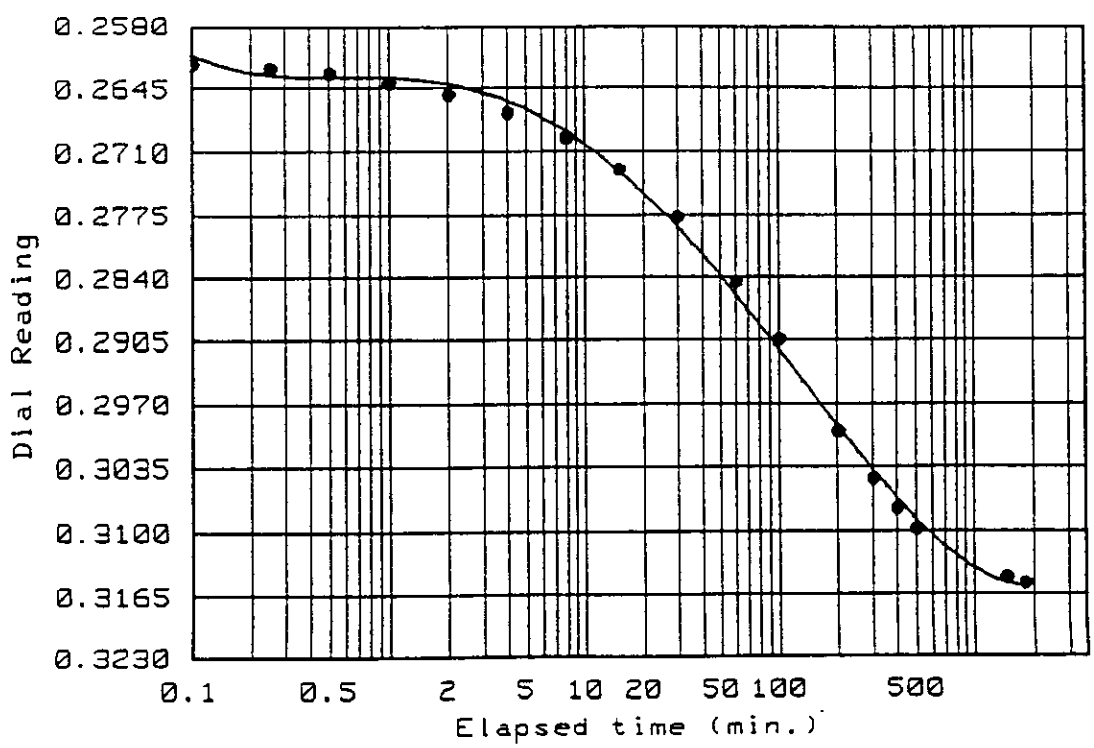
Dial Reading vs. Time

Project No.: 28512.A90
Project: ST.JOSEPH,MO WTP
Location: BORING NO.GF-8 / U-2
SAMPLE DEPTH 10.0'-12.0'
Date: FEB.15,1993



Load No.= 7
Load= 16.00 tsf
D_0 = 0.1993
D_{50} = 0.2268
D_{100}= 0.2542
T_{50}= 48.15 min.

C_v @ T_{50} =
.001 in.²/min.



Load No.= 8
Load= 32.00 tsf
D_0 = 0.2589
D_{50} = 0.2865
D_{100}= 0.3142
T_{50}= 63.58 min.

C_v @ T_{50} =
.000 in.²/min.

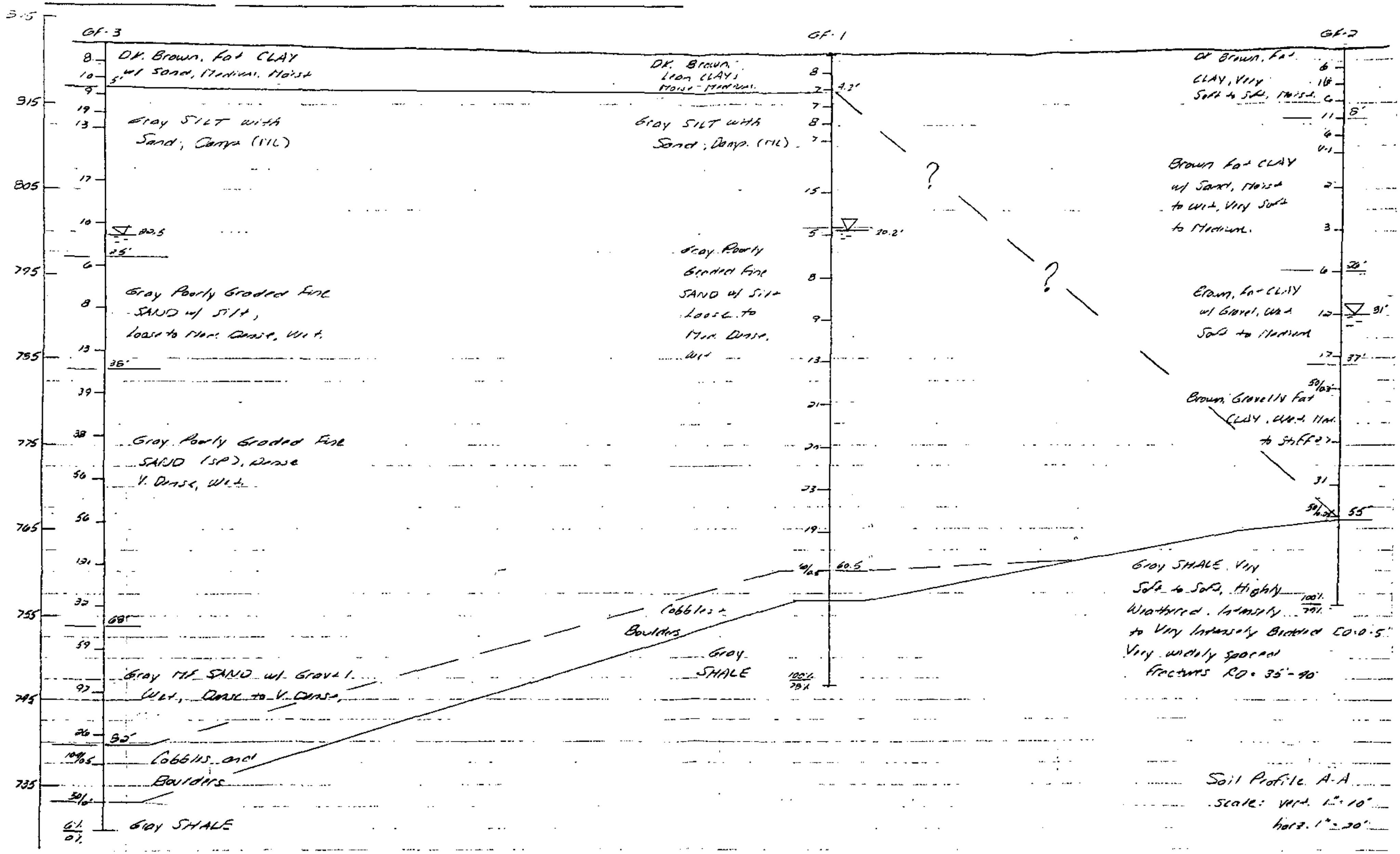
GANNETT FLEMING, INC.

APPENDIX C

• SOIL PROFILES •

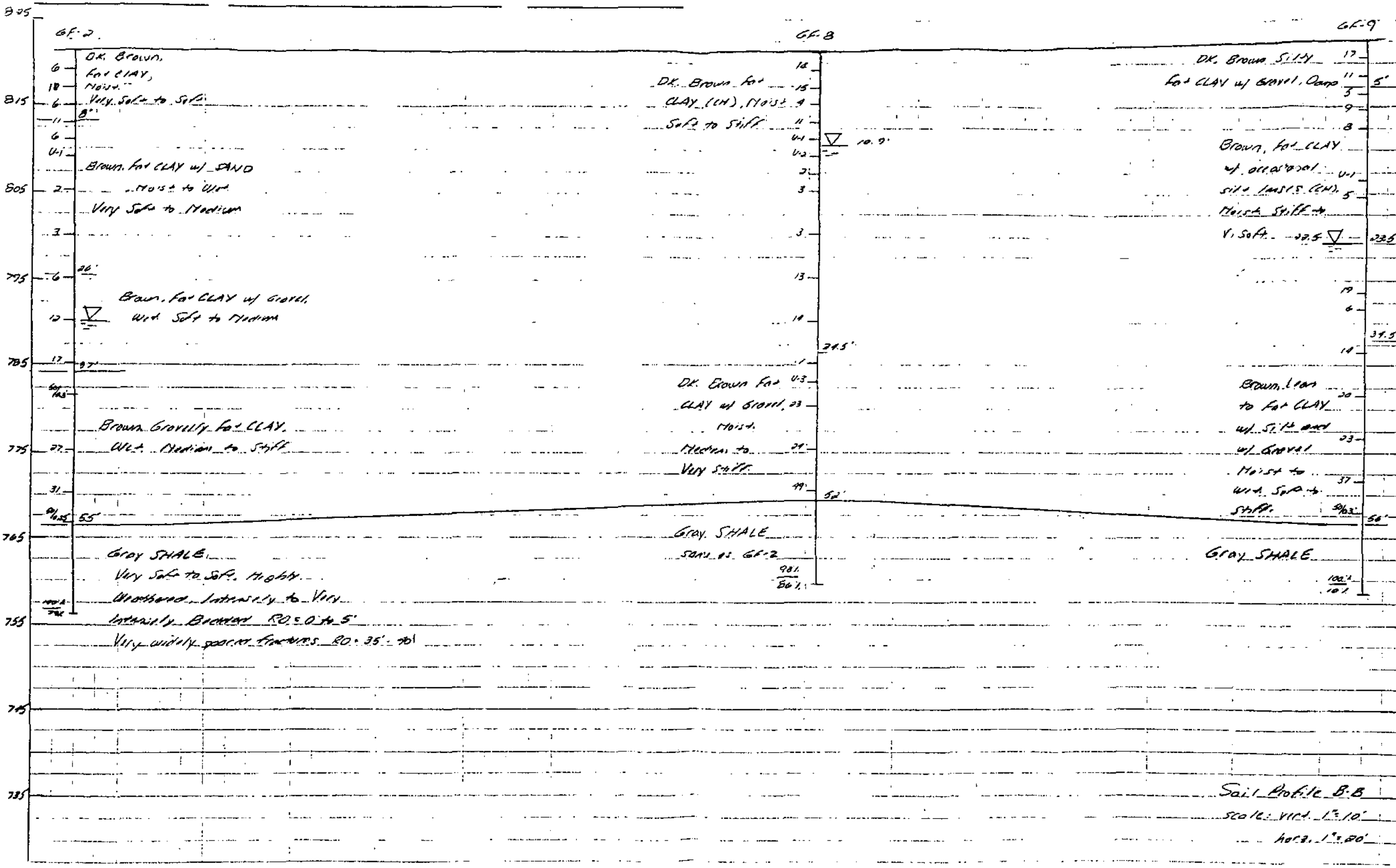
BY MSG DATE 3/93 SUBJECT St. Joseph WTP SHEET NO. 1 OF 4

CHKD. BY ______ DATE ______ JOB NO. 95512.A90

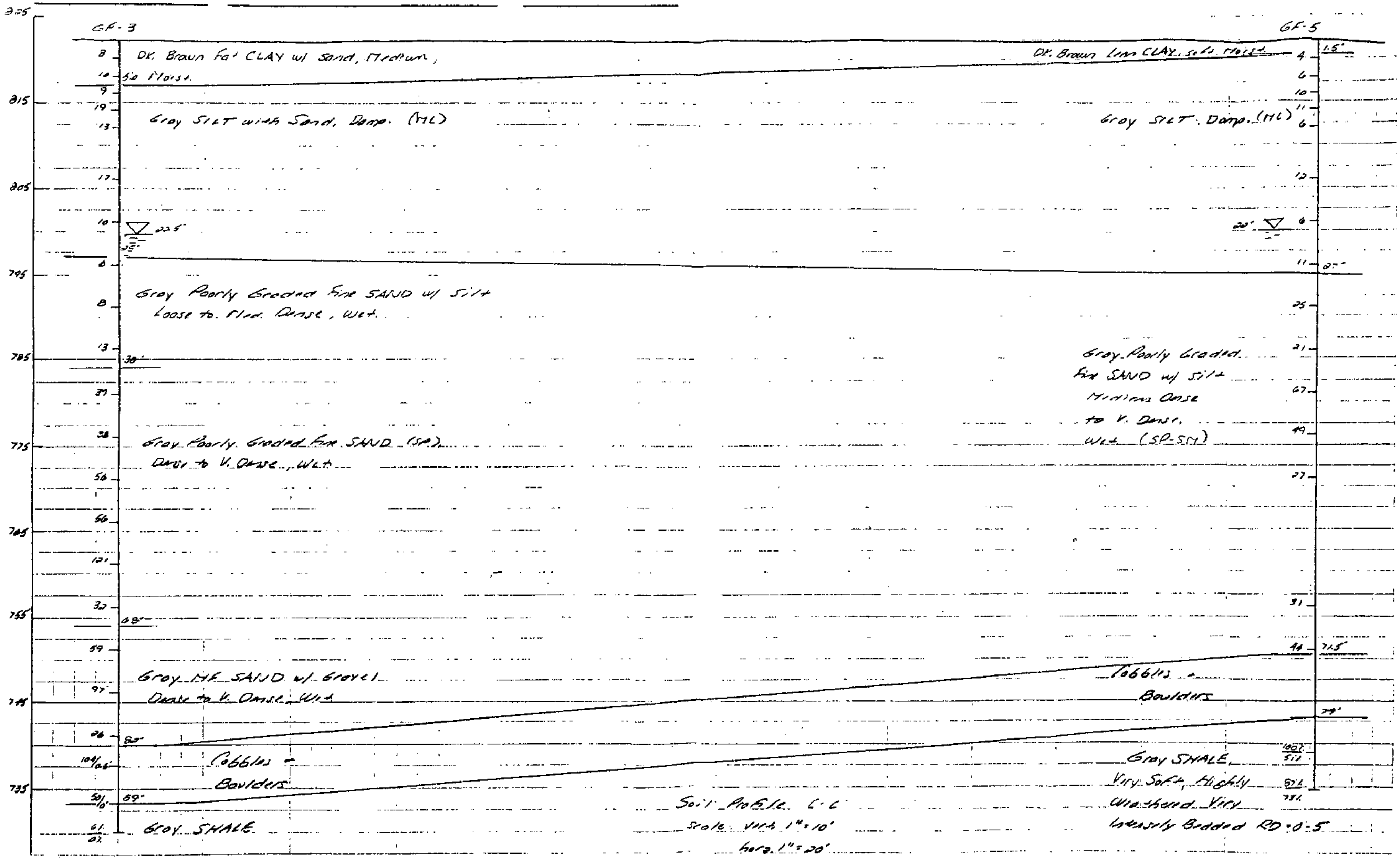


BY MSG DATE 3/93 SUBJECT St. Joseph WTP SHEET NO. 2 OF 4

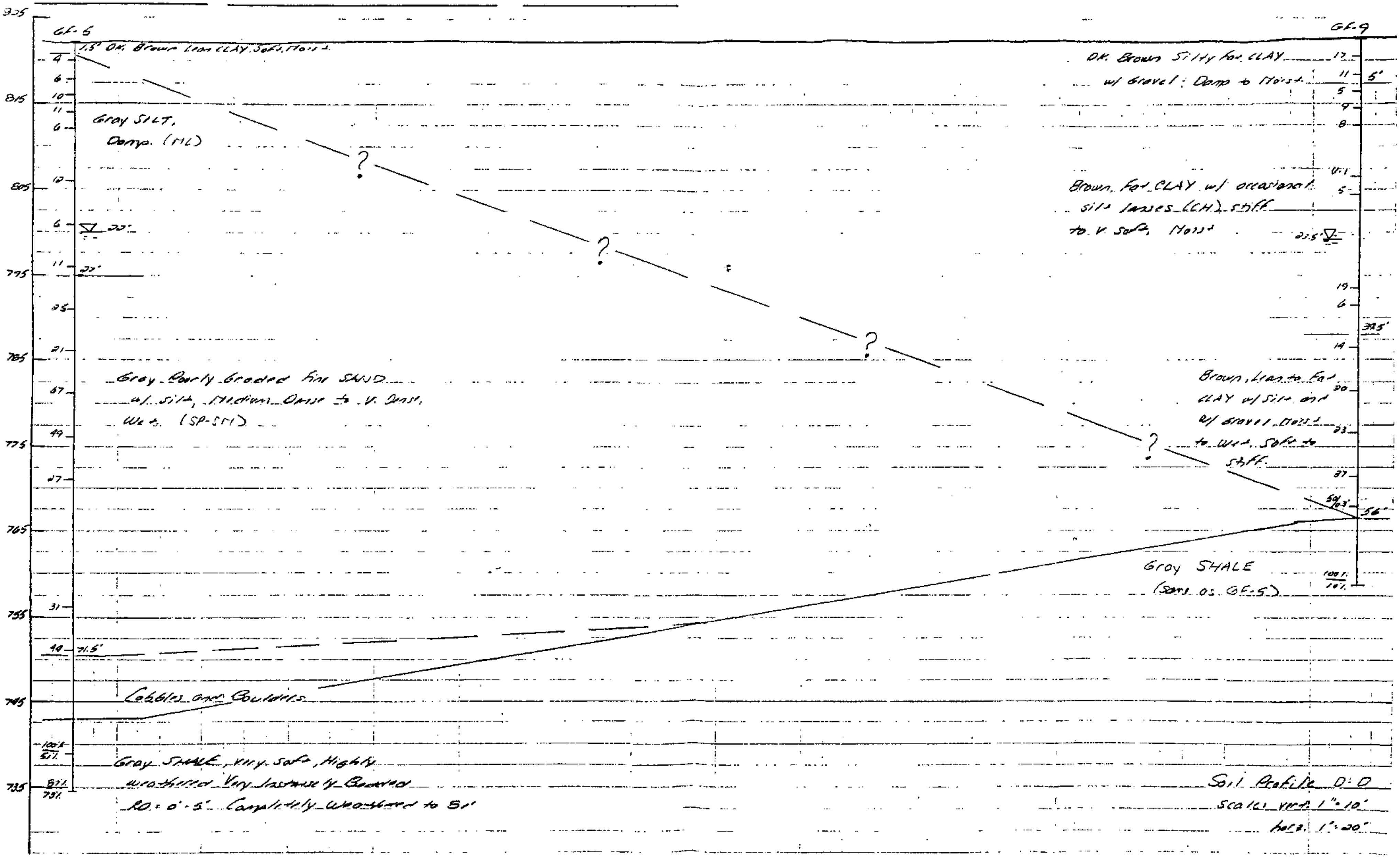
CHKD BY ____ DATE ____ JOB NO. 25512-290



BY MSG DATE 3/93 SUBJECT St. Joseph WTP SHEET NO. 3 OF 4
CHKD BY ____ DATE ____ JOB NO. 29513.A20



BY LLSG DATE 3/93 SUBJECT St. Joseph WTP SHEET NO 4 OF 4
CHKD. BY ____ DATE ____ JOB. NO. 25512.A90



MISSOURI-AMERICAN WATER COMPANY
ST. JOSEPH DISTRICT
TREATMENT PLANT IMPROVEMENTS
PROJECT COST ESTIMATE
June 4, 1993

	PHASE 1		PHASE 2		TOTAL
	12/93 Dollars	Escalate to 2/95 Dollars	12/93 Dollars	Escalate to 2/98 Dollars	
CONSTRUCTION COST	$12,300,000	$12,900,000	$14,800,000	$17,500,000	$30,400,000
Omissions and Contingencies 10%	$1,230,000	$1,289,000	$1,480,000	$1,748,000	$3,037,000
ENGINEERING SERVICES					
Design Overview, Liason, Bidding – AWWSC	$250,000	$250,000	$50,000	$59,000	$309,000
Design Consultant	$504,000	$504,000	$856,000	$856,000	$1,360,000
Pilot Plant Study – Water Co	$60,000	$60,000	$15,000	$18,000	$78,000
Construction Administration – AWWSC	$123,000	$129,000	$123,000	$145,000	$274,000
Construction Technical Review – Consultant	$300,000	$314,000	$375,000	$443,000	$757,000
Field Inspection – Consultant	$189,000	$198,000	$189,000	$223,000	$421,000
Permits	$50,000	$50,000	$50,000	$59,000	$109,000
CPS charges	$62,500	$63,000	$0	$0	$63,000
Water Company expenses	$767,000	$767,000	$931,000	$931,000	$1,698,000
Community Relations	$462,000	$462,000	$558,000	$558,000	$1,020,000
Attorney Fees	$150,000	$150,000	$100,000	$100,000	$250,000
Builder's Risk Insurance	$36,900	$39,000	$44,400	$52,000	$91,000
Water Company supplied material	$100,000	$105,000	$50,000	$59,000	$164,000
SUB-TOTAL	$16,584,400	$17,280,000	$19,621,400	$22,751,000	$40,031,000
AFUDC	$1,628,000	$1,690,000	$2,066,000	$2,347,590	$4,038,000
********* TOTALS ************	$18,212,400	$19,000,000	$21,687,400	$25,100,000	$44,100,000

NOTES

PHASE 1 Includes Superpulsator clarifiers, Chemical Building and equipment, offices, lab, control room

PHASE 2 Includes Filters (30 mgd), transfer pump station, and clearwell

Inflation is projected at 4 percent annual rate

Construction Cost is assumed to include 15% omissions and contingencies

Phase 2 construction cost has been increased by 3% to account for additional costs of phased construction.

SCHEDULE JSY-7

ILLINOIS-AMERICAN WATER COMPANY
ALTON RAW WATER PUMP STATION
SCHEDULE OF VALUES - 1999/2000

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4060224	**Special Crossings**	
			2360 Great River Road Crossing (River City Const)	
			Material	11,932.00
			Labor	48,475.00
		4060302	**Footings Concrete**	
			Material (Kienstra)	10,855.00
			Labor (River City Const)	32,817.00
			Rebar	
			Material (Gate City)	8,513.00
			Labor (River City Const)	14,508.00
		4060304	**Walls Concrete**	
			Material (Kienstra)	100,019.00
			Labor (River City Const)	358,079.00
			Rebar	
			Material (Gate City)	69,293.00
			Labor (River City Const)	81,325.00
		4060306	**Columns, Piers, Pits**	
			Concrete	
			Material (Kienstra)	39,009.00
			Labor (River City Const)	410,838.00
			Rebar	
			Material (Gate City)	4,069.00
			Labor (River City Const)	5,223.00
		4060308	**Slab on Grade**	
			Concrete	
			Material (Kienstra)	18,234.00
			Labor (River City Const)	105,399.00
			Rebar	
			Material (Gate City)	10,109.00
			Labor (River City Const)	8,586.00

SCHEDULE
JSY-8

ILLINOIS-AMERICAN WATER COMPANY
ALTON RAW WATER PUMP STATION
SCHEDULE OF VALUES - 1999/2000

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4060310	**Elevated Slabs/Beams**	
			Concrete	
			Material (Kienstra)	23,792.00
			Labor (River City Const)	129,755.00
			Rebar	
			Material (Gate City)	13,281.00
			Labor (River City Const)	15,907.00
		4060322	**Fill Concrete/Thurst Blocks (River City Const)**	
			Thrust Blocks	2,000.00
		4060324	**Hollow Core Planks**	
			3415 Precast Panels	
			Material (St Louis Prestress)	8,468.00
			Labor (River City Const)	4,396.00
		4060330	**Grouting (With Concrete)**	-
		4060401	**General Masonry**	
			4200 Unit Masonry	
			Diecker Terry	94,520.00
		4060402	**Exterior Masonry**	
		4060404	**Interior Masonry**	

ILLINOIS-AMERICAN WATER COMPANY
ALTON RAW WATER PUMP STATION
SCHEDULE OF VALUES - 1999/2000

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4060501	**General Metals**	
			5120 Structural Steel	
			Material (Hanley Steel)	28,000.00
			Labor (ART Steel)	12,728.00
			5500 Site Metal Fabrication	
			Material (Hanley Steel)	1,320.00
			Labor (River City Const)	880.00
			5700 Carbon Steel Day Tanks	
			Material (General Ind)	
			Labor (Condaire)	
		4060502	**Misc Metals, Grating, Handrails, Etc**	
			5531 Hatches	
			Material (VanDevanter)	9,876.00
			Labor (River City Const)	410.00
		4060504	**Structural Steel Framing, Trusses, Beams**	
		4060506	**Steel Bar Joists and Decking**	
		4060601	**General Woods & Plastics**	
			6300 Plastic Storage Tanks	
			Material (Sunday)	
			Labor (Condaire)	
			6350 Fiberglass Reinf Plastic Storage Tanks	
			Material (Design Pastic System)	
			Labor (Condaire)	

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4060602	**Rough Carpentry**	
			6100 Rough Carpentry	
			Material (River City Const)	497.00
			Labor (River City Const)	400.00
		4060604	**Finish Carpentry**	
			Material (Rothan)	
			Labor (River City Const)	
		4060606	**FRP Fabrications**	
			6600 FRP Fab Wiers/Baffles	
			Material (River City Const)	
			Labor (River City Const)	
			Labor (Condaire)	
			6610 FRP	
			Material (River City Const)	
			Labor (River City Const)	
		4060702	**Waterproofing and Dampproofing**	
			7100 Waterproofing	
			Material (Coatings Unlimited)	
			Labor (Coatings Unlimited)	
			7270 Fireproofing	
			Material (River City Const)	
			Labor (River City Const)	
		4060704	**Insulation and Thermal Protection (With Units)**	
		4060706	**Roof Covering Systems**	
			7530 Single Ply Membrane	
			Material (Kehrer Bros)	13,711.00
			Labor (Kehrer Bros)	

ILLINOIS-AMERICAN WATER COMPANY
ALTON RAW WATER PUMP STATION
SCHEDULE OF VALUES - 1999/2000

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4060708	**Flashing/Sheet Metal**	
			7600 Flashing & Sheet Metal	
			Material (DSM)	10,581.00
			Labor (DSM)	
		4060712	**Caulking and Sealants With Units**	
		4060714	**Fireproofing With Units**	
		4060802	**Doors & Frames**	
			8110 HM Doors/Frames/Hardware	
			Material (Lyon Ind)	37,638.00
			Labor (River City Const)	3,893.00
			8210 Wood Doors	
			Material (H & G)	
			Labor (River City Const)	
		4060806	**Special Doors Access FRP**	
			8275 Fiberglass Doors	
			Material (Atlas)	14,364.00
			Labor (River City Const)	3,526.00
			8330 Roll Up Doors	
			Material (Zumwalt)	5,210.00
			Labor (Zumwalt)	820.00

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4060808	**Windows Glazing, Skylights, Storefronts**	
			7700 Roof Acc/Hatches Skylights	
			Material (River City Const)	7,386.00
			Labor (River City Const)	2,217.00
			8800 Glass & Glazing	
			Material (Moore Glass)	
			Labor (Moore Glass)	
		4060810	**Hardware With Doors**	
		4060901	**General Finishes**	
			9260 Gypsum Wallboard	
			Material (Phillips)	
			Labor (Phillips)	
			9300 Tile	
			Material (Hussman)	
			Labor (Hussman)	
			9660 Resilient Floor	
			Material (Overburg)	
			Labor (Overburg)	
		4060908	**Ceilings (Acoustic, Drywall)**	
			9510 Acoustic Ceiling System	
			Material (Phillips)	
			Labor (Phillips)	
		4060910	**Painting**	
			9900 Painting	
			Material (Coatings Unlimited)	14,677.00
			Labor (Coatings Unlimited)	22,015.00

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4061002	**Building Specialties (Partitions Etc)**	
			10100 Visual Display Boards	
			Material (Marsh Ind)	
			Labor (River City Const)	
			10160 Toilet Partitions	
			Material (RCI)	
			Labor (River City Const)	
			10200 Louvers	
			Material (Condaire)	1,320.00
			Labor (Condaire)	440.00
			10350 Flagpoles	
			Material (AAAA)	220.00
			Labor (River City Const)	195.00
			10500 Lockers	
			Material (Bulte)	
			Labor (Bulte)	
			10800 Toilet Accessories	
			Material (Spec 10)	
			Labor (River City Const)	
			10850 Safety Equipment	
			Material (Condaire)	
			Labor (River City Const)	
			Folding Partition	

ILLINOIS-AMERICAN WATER COMPANY
ALTON RAW WATER PUMP STATION
SCHEDULE OF VALUES - 1999/2000

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4061104	**Pumping Equipment**	
			11153 Vertical Turbine Pumps	
			Material (IPECO)	165,000.00
			Labor (Condaire)	27,789.00
			11300 Solenoid Metering Pumps	
			Material (Hydro)	
			Labor (Condaire)	
			11305 Mechanical Dia Metering Pumps	
			Material (Hydro)	
			Labor (Condaire)	
			11306 Chemical Resistant Sump Pump	
			Material (Westfall)	2,866.00
			Labor (Condaire)	1,760.00
			11310 Sample Pumps	
			Material (LAIBE)	
			Labor (Condaire)	
			11315 Jet Pump Eductors	
			Material (T.G. Rankin)	
			Labor (Condaire)	
		4061108	**Mixing and FLOC Equipment**	
			11220 Static Mixing Equipment	
			Material (Gierse)	4,180.00
			Labor (Condaire)	220.00
		4061110	**Clarification Equipment**	
			13000 Upflow Clarifier	
			Material (Progress Env)	
			Labor (River City Const)	
			Labor (Condaire)	

ILLINOIS-AMERICAN WATER COMPANY
ALTON RAW WATER PUMP STATION
SCHEDULE OF VALUES - 1999/2000

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4061112	**Gravity Filtration Equipment**	
			13400 Filter Underdrain	
			Material (Flo Systems)	
			Labor (Condaire)	
			Labor (River City Const)	
		4061116	**Filter Media**	
			13400 Filter Media	
			Material (BOS Sand)	
		4061120	**Other Plant Equipment**	
			11205 Traveling Screens	
			Material (Ressler)	163,717.00
			Labor (River City Const)	4,769.00
			Misc Equipment	
			Labor (Condaire)	11,220.00
			16495 VFD's	311,125.00
		4061122	**Chemical Storage & Feed Equipment**	
			11320 Ammonia Feed Equipment	
			Material (Durkin)	
			Labor (Condaire)	
			11330 Chemical Transfer Pumps	
			Material (IPECO)	
			Labor (Condaire)	
			11340 Chemical Tank Scales	
			Material (Ressler)	
			Labor (Condaire)	
			11360 Powered Activated Carbon Feed System	
			Material (Formpak)	
			Labor (Condaire)	
			11365 Potassium Permangate Feed System	
			Material (Ressler)	
			Labor (Condaire)	

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
			11370 Liquid Poly Feed System	
			Material (Ressler)	
			Labor (Condaire)	
			11372 Liquid Poly Feed System	
			Material (Ressler)	
			Labor (Condaire)	
			11380 Chlorine Feed System	
			Material (Durkin)	
			Labor (Condaire)	
		4061125	**Water Softening Equipment**	
			11250 Water Softening Equipment	
			Material (Condaire)	
			Labor (Condaire)	
		4061129	**Chlorine Scrubber Equipment**	
			11266 Chlorine Scrubber Equipment	
			Material (Ressler)	
			Labor (Condaire)	
		4061130	**Blower Equipment**	
			11280 Positive Displacement Air Blower	
			Material (Cochrane)	
			Labor (Condaire)	
		4061140	**Transportation Equipment**	
			14670 Trolley/Hoists	
			Material (Central Crane)	
			Laboar (Central Crane)	

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4061202	**Furnishing (Furniture/Access, Window Treatment Etc)**	
			12345 Lab Casework	
			Material (Glen Alspaugh)	
			Labor (Glen Alsphaugh)	
			12500 Window Treatment	
			Material (Drapries Unique)	
			Labor (River City Const)	
		4061318	**Instrumentation and Control Systems**	
			Material (Guarantee Electric)	93,682.00
			Labor (Guarantee Electric)	
			Syntronix	62,260.00
		4061502	**Plumbing System**	
			15400 Plumbing	
			Material (Condaire)	
			Labor (Condaire)	
		4061504	**Fire Protection System**	
			15300 Fire Protection (National Fire Suppresion)	
			Material	
			Labor	
			Design	
			Bond	

ILLINOIS-AMERICAN WATER COMPANY
ALTON RAW WATER PUMP STATION
SCHEDULE OF VALUES - 1999/2000

Code	Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
	4061508	**Process Piping, Valves, Gates**	
		15003 PVC Pipe	
		15006 DIP	
		Material (Condaire)	
		Labor (Condaire)	
		15012 Steel Pipe	
		Material (Condaire)	209,711.00
		Labor (Condaire)	222,831.00
		15020 Pipe Supports	
		Material (Condaire)	
		Labor (Condaire)	
		15030 Pipe & Equipment ID	
		Material (Condaire)	
		Labor (Condaire)	
		15095 Valves	
		Material (Condaire)	50,000.00
		Labor (Condaire)	50,000.00
		15100 Valves and Gates General	
		Material (Condaire)	
		Labor (Condaire)	
		15101 Butterfly Valves	
		Material (Condaire)	31,928.00
		Labor (Condaire)	77,206.00
		15108 Gate Valves	
		Material (Condaire)	
		Labor (Condaire)	
		15109 Plug Valves	
		Material (Condaire)	
		Labor (Condaire)	

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
			15114 Misc Valves	
			Material (Condaire)	
			Labor (Condaire)	
			15116 Valve Act Pneumatic	
			Material (Condaire)	
			Labor (Condaire)	
			15206 Sluice Gates	
			Material (Vandevanter)	51,029.00
			Labor (Condaire)	18,500.00
			15290 Pipe Insulation	
			Material (Condaire)	
			Labor (Condaire)	
		4061510	**Chemical Piping, Valves and Fittings**	
			See Process Piping	
		4061512	**Compressed Air System**	
			11180 Compress Air Equpment	
			Material (Condaire)	
			Labor (Condaire)	

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4061514	**HVAC Systems**	
			15584 Rooftop Package Gas Unit	
			Material (Condaire)	
			Labor (Condaire)	
			15590 Power Ventilators	
			Material (Condaire)	
			Labor (Condaire)	
			15599 HVAC Insulation	
			Material (Condaire)	
			Labor (Condaire)	
			15600 Ductwork Accessories	
			Material (Condaire)	
			Labor (Condaire)	
			15610 Gas Fired Heating Units	
			Material (Condaire)	30,000.00
			Labor (Condaire)	10,000.00
			15615 Self Contained AC Units	
			Material (Condaire)	
			Labor (Condaire)	
			17000 Temperature Controls	
			Material (Condaire)	12,000.00
			Labor (Condaire)	12,000.00

ILLINOIS-AMERICAN WATER COMPANY
ALTON RAW WATER PUMP STATION
SCHEDULE OF VALUES - 1999/2000

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4061516	**Specialty Pi;ping & Mech System**	
			15210 Davit Doors	
			Material (G A Rich)	
			Labor (River City Const)	
			15995 Pipe Test & Disinfection (Condaire)	

ILLINOIS-AMERICAN WATER COMPANY
ALTON RAW WATER PUMP STATION
SCHEDULE OF VALUES - 1999/2000

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4061601	**General Electrical Requirements**	
			Material (Guarantee Electric)	21,849.00
			Labor (Guarantee Electric)	5,049.00
		4061602	**Primary Electrical Service**	
			Material (Guarantee Electric)	20,730.00
			Labor (Guarantee Electric)	10,989.00
		4061604	**Grounding System (Lighting, Surge, VFD)**	
			Material (Guarantee Electric)	7,092.00
			Labor (Guarantee Electric)	5,293.00
		4061606	**Electrical Raceways, Cable Tray and Conduits**	
			Material (Guarantee Electric)	12,686.00
			Labor (Guarantee Electric)	25,664.00
		4061608	**Cables, Wiring, and Terminations**	
			Material (Guarantee Electric)	3,602.00
			Labor (Guarantee Electric)	4,671.00
		4061610	**Motor Control Centers, Switchgear, & Transformers**	
			Material (Guarantee Electric)	46,107.00
			Labor (Guarantee Electric)	5,778.00
		4061612	**Misc Starters, Control Panels and Switches**	
			Material (Guarantee Electric)	4,115.00
			Labor (Guarantee Electric)	6,535.00
		4061614	**Interior, Exterior and Emergency Lighting**	
			Material (Guarantee Electric)	18,930.00
			Labor (Guarantee Electric)	6,890.00
		4061616	**Voice, Data and Video Communicatoins**	
			Material (Guarantee Electric)	1,866.00
			Labor (Guarantee Electric)	2,507.00
		4061618	**Fire and Intrusion Alarm System**	
			Material (Guarantee Electric)	3,585.00
			Labor (Guarantee Electric)	2,253.00

ILLINOIS-AMERICAN WATER COMPANY
ALTON RAW WATER PUMP STATION
SCHEDULE OF VALUES - 1999/2000

Code		Subcode	Task Description	Fixed Asset #1 Raw Water Pump Stat
		4061620	**Auxiliary Power Equipment (UPS)**	
			Material (Guarantee Electric)	8,434.00
			Labor (Guarantee Electric)	1,823.00
		4061622	**Electrical Testing**	
			Material (Guarantee Electric)	3,844.00
			Labor (Guarantee Electric)	5,968.00
		4061624	**Low Voltage Electrical System**	
			Material (Guarantee Electric)	8,441.00
			Labor (Guarantee Electric)	19,806.00
		4061626	**Medium Voltage Equipment**	
			Material (Guarantee Electric)	12,670.00
			Labor (Guarantee Electric)	24,421.00
		4061628	**High Voltage Equipment**	
			Material (Guarantee Electric)	23,166.00
			Labor (Guarantee Electric)	12,911.00
		4061630	**Miscellaneous Electrical Appurtenances**	
			Material (Guarantee Electric)	3,774.00
			Labor (Guarantee Electric)	3,259.00
				5,962,657.00

Schedule JSY-15 is a listing of the trihalomethane results for the St. Joseph

The demand projection chapter from the 1994 CPS is attached as Schedule JSY-16.

error by Mr. Biddy can be seen in the attached worksheet, Schedule JSY-17

Virginia Waterworks Regulations (Section 5.08), attached as Schedule JSY-18, state.

Mr. Peter Macy, attached as Schedule JSY-19,

Schedule JSY-20 contains an excerpt from the Connecticut Department of Utility

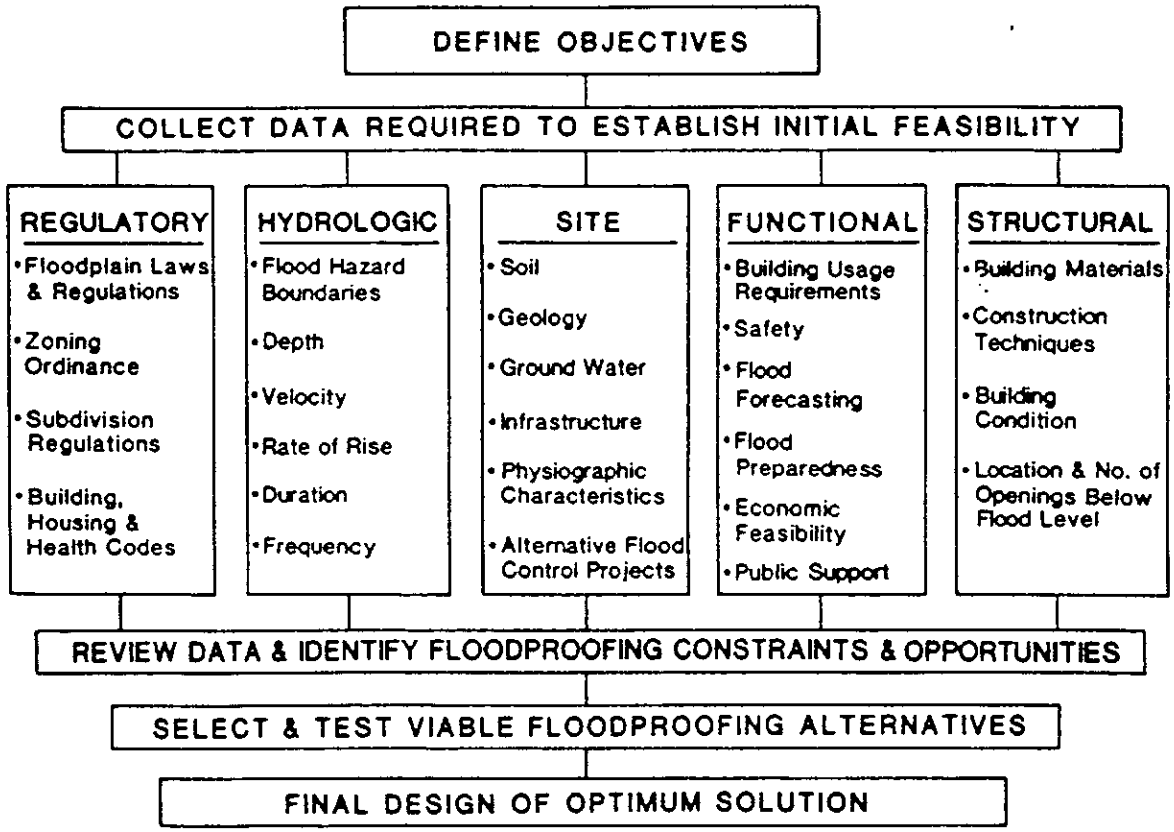


Figure II-1. General Floodproofing Design Process

B. REGULATORY CONSIDERATIONS

A variety of floodplain management programs have been developed and adopted throughout the United States as part of a long term effort to reduce flood damages. The floodproofing analysis process should begin with contacts to appropriate federal, state, regional, and local agencies to identify sources of technical assistance and to develop an understanding of floodplain regulations and other code requirements that are applicable to the proposed action. Figure II-2 provides an overview of the general range of floodplain management services that are available through various levels of government. As described below, the programs and regulations that are administered by these agencies can influence decision on where floodproofing may be applied, what techniques may be used, and the design of specific floodproofing components.

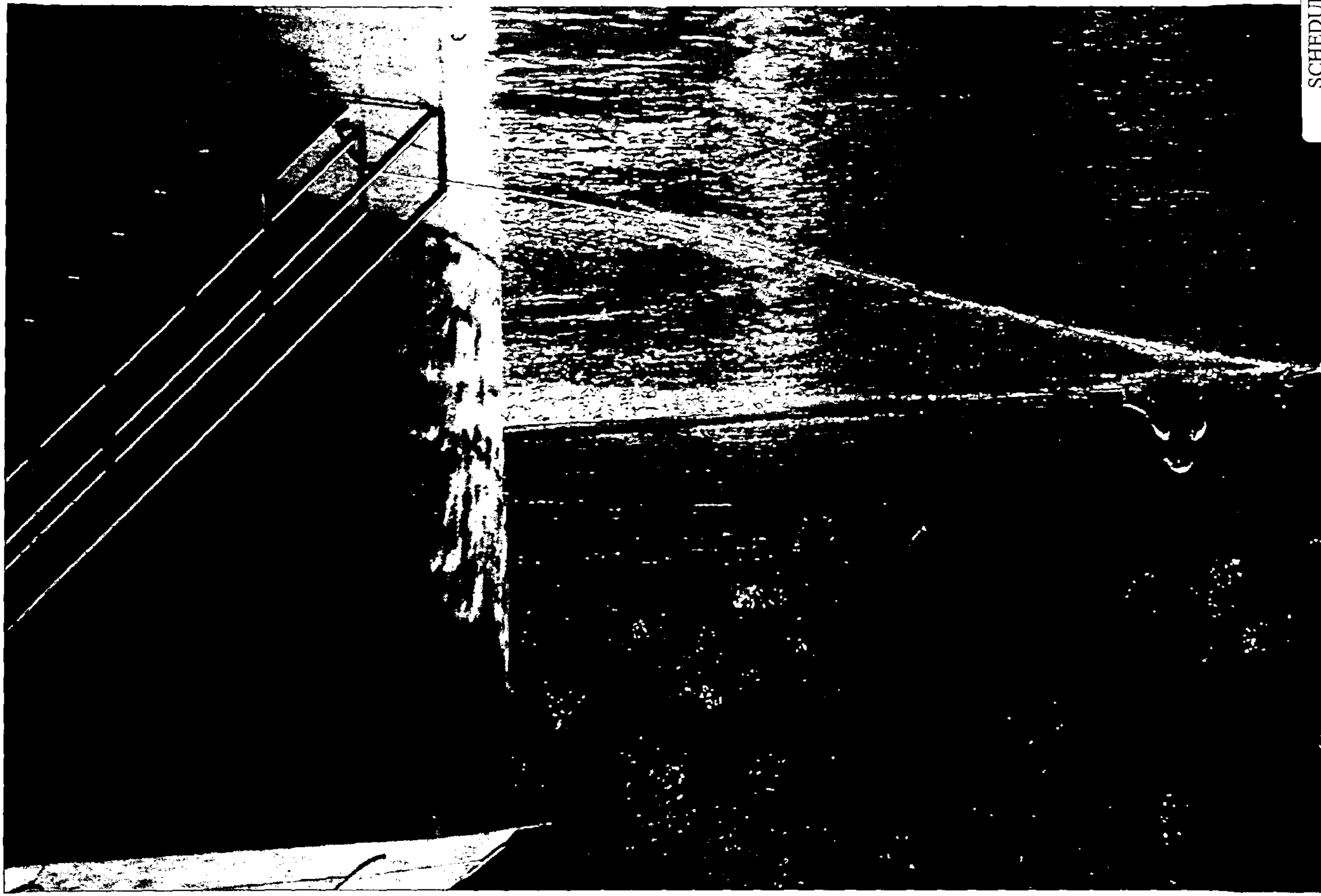
1. FEDERAL PROGRAMS. There are a variety of federal agencies that have direct or indirect involvement in flood protection issues. Several agencies support major research and program efforts in specific areas of floodproofing. For example, many of the Corps of Engineers District Offices have been involved in floodproofing projects and all of them provide flood and floodplain related technical assistance including information on floodproofing through the Flood Plain Management Services Program. The Corps of Engineers also maintains a National Advisory Committee on Floodproofing that has directed several floodproofing demonstrations and tests. Other federal agencies that support major programs related to floodproofing include the Federal Emergency Management Agency and the Soil Conservation Service.

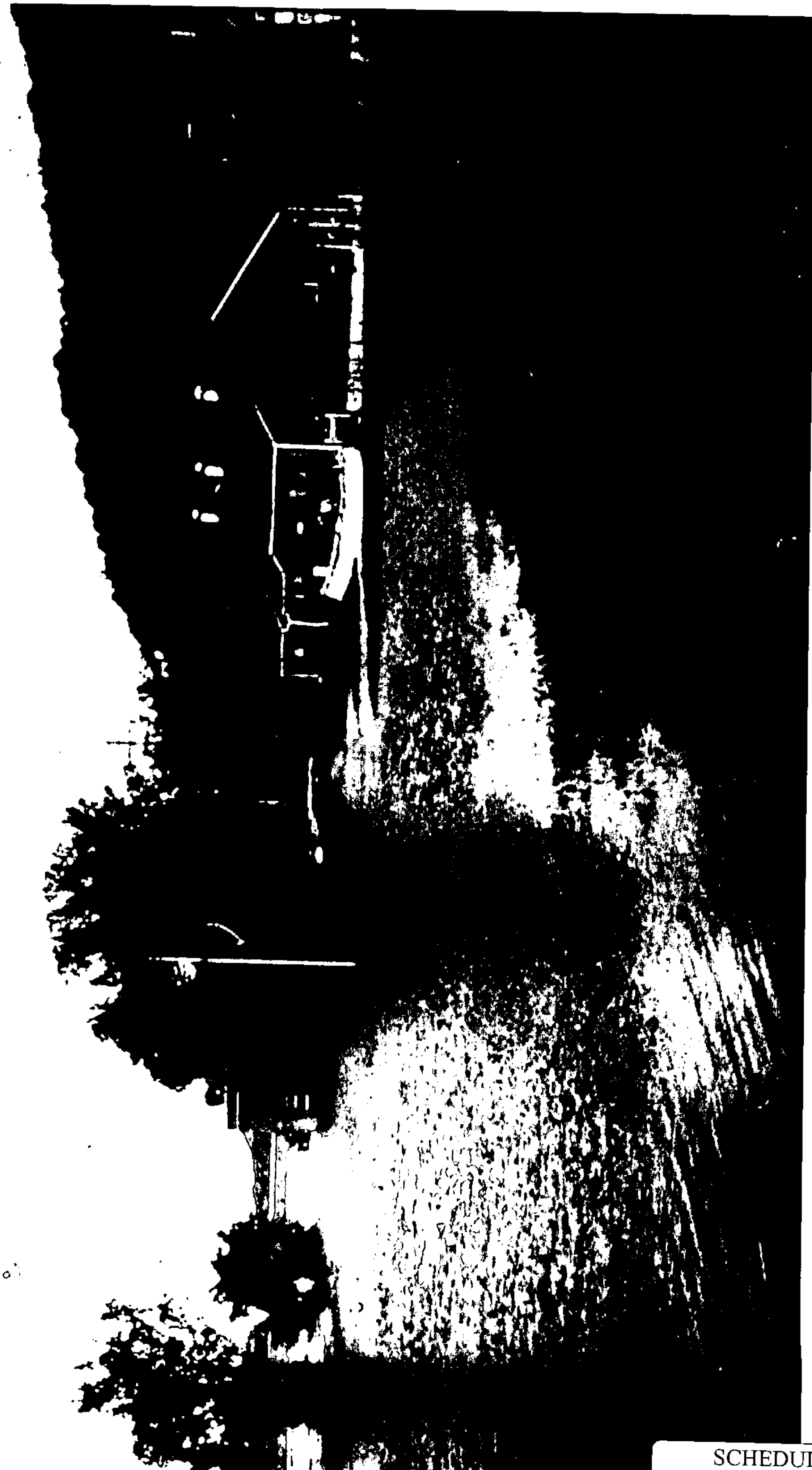
SCHEDULE
JSY-9

SCHEDULE
JSY-10

SCHEDULE
JSY-11

SCHEDULE
JSY-12





SCHEDULE
JSY-13

MISSOURI-AMERICAN WATER CO.

ST. JOSEPH DISTRICT

TRIHALOMETHANE RESULTS

Milligrams per Liter (mg/L)

YEAR	QUARTER	AVERAGE- DIST. SYSTEM	RUNNING AVERAGE
1991	1 st	0.041	0.051
1991	2 nd	0.045	0.052
1991	3 rd	0.104	0.056
1991	4 th	0.046	0.059
1992	1 st	0.078	0.068
1992	2 nd	0.095	0.081
1992	3 rd	0.127	0.087
1992	4 th	0.040	0.085
1993	1 st	0.105	0.092
1993	2 nd	0.138	0.103
1993	3 rd	0.069	0.088
1993	4 th	0.059	0.093
1994	1 st	0.064	0.083
1994	2 nd	0.102	0.074
1994	3 rd	0.122	0.087
1994	4 th	0.049	0.084
1995	1 st	0.054	0.082
1995	2 nd	0.094	0.080
1995	3 rd	0.060	0.064
1995	4 th	0.045	0.063
1996	1 st	0.077	0.069
1996	2 nd	0.078	0.065
1996	3 rd	0.094	0.074
1996	4 th	0.045	0.074
1997	1 st	0.066	0.071
1997	2 nd	0.072	0.069
1997	3 rd	0.085	0.067
1997	4 th	0.048	0.068
1998	1 st	0.043	0.062
1998	2 nd	0.085	0.065
1998	3 rd	0.134	0.078
1998	4 th	0.075	0.084
1999	1 st	0.060	0.089
1999	2 nd	0.095	0.091
1999	3 rd	0.112	0.086
1999	4 th	0.072	0.085
2000	1 st	0.068	0.087

SECTION 2
DEMAND PROJECTIONS

2.1 OVERVIEW

The Joplin and St. Joseph service areas of Missouri-American Water Company serve approximately 50,000 customers in two regions of the State of Missouri. The Joplin service area is located in the southwestern corner of Missouri near the Kansas border and serves approximately 20,000 customers. The St. Joseph service area is located in northwestern Missouri along the Missouri River which forms the state border between Missouri and Kansas. The St. Joseph area serves approximately 30,000 customers. As of 1990, St. Joseph was Missouri's fifth largest city, and Joplin was the eleventh largest city.

Of the customers in the Joplin service area, 84.9% are residential accounts, 12.9% are commercial accounts, 0.3% are industrial accounts, 0.8% are "Other" accounts, and 1.1% are fire services. Based on the 1990 Census figures, MAWC-Joplin directly serves a population of approximately 42,000, and including the customers in the re-sale area, the population served increases to 48,900.

Of the customers in the St. Joseph service area, 87.6% are residential accounts, 10.5% are commercial accounts, 0.4% are industrial accounts, 0.6% are "Other" accounts, and 0.9% are fire services. Based on the 1990 Census figures, MAWC-St. Joseph directly serves a population of approximately 77,000, and including the customers in the re-sale areas, the population served increases to 99,800.

The fifteen year projections for the total number of customers and their associated demands are presented in this Section. Table 2-3 and Exhibit 2-1 summarize the projected levels of consumption by customer category for the target years 1999, 2004 and 2009 for the Joplin District. The same information is presented for the St. Joseph District in Table 2-6 and Exhibit 2-3. These projections were developed based on a review of population trends, local Planning Commission forecasts, customer data and discussions with area representatives.

Where applicable, statistical analyses of customer data from 1977 through 1993 was incorporated into the demand projections. In 1993, both Joplin and St. Joseph were impacted by the extremely wet summer weather, and in the case of St. Joseph, the flood-related outage of the water plant. The 1993 consumption figures generally were not used in the statistical analysis of water demand trends. Data for 1992, as well as 1993, are shown throughout this chapter for illustrative purposes.

Non-revenue usage and unaccounted-for water were projected based on Water Company usage data and from anticipated effects of water management programs. Non-revenue use generally includes water used in fire fighting, water main flushing, sewer flushing, and identifiable leakage where quantifiable. Unaccounted-for water represents the difference between metered production and the sum of all metered sales and non-revenue usage. This category includes water lost due to meter inaccuracy, undetected leakage, illegally opened fire hydrants and theft.

The projected average day demand was developed from the summation of the residential, commercial, industrial, other, non-revenue and unaccounted-for-water projections.

Future maximum day to average day demand ratios were estimated using a statistical analysis of similar data gathered since 1977. Both a point estimate and an interval estimate of this ratio were determined. The point estimate is the mean value of the ratio. This ratio reflects a value for which the past ratios were higher 50 percent of the time and lower 50 percent of the time. While this value may be adequate to estimate annual operational parameters, the level is not adequate to base long term capital planning decisions on.

To define the ratio that will not be exceeded in a given number of years, an interval estimate around the mean value of this ratio is determined. The interval estimate defines the interval of values that the maximum to average day ratio will fall within for a certain degree of confidence. The upper boundary defined by the confidence level of 95% is chosen for maximum day demand projections. This value is applied to the maximum to average demand ratio to develop the upper boundary for the maximum day projection. In this way, the maximum day projection represents a level that is not expected to be exceeded more than once in twenty years. The following subsections present the detailed analysis.

2.2 JOPLIN SERVICE AREA

2.2.1 Joplin Residential Customer Classification

The residential customer base in the Joplin service area makes up approximately 85% of the total customer base and uses approximately 40% of the total water sales. Since 1977 the residential customer base has shown a steady increase, growing 224 customers per year on average to 17,166 in 1993. Over the past ten years, the residential customer base grew on average 295 customers per year; over the past five years, it grew on average 263 customers per year. 1993 showed an increase of 264 new residential customers. It is apparent from these increases, that the past trend has been a rapid growth rate.

A portion of this increase in residential customers is due to the extension of service by MAWC to some areas previously using private wells. The Duquesne area is an older, developed community that was on private wells. Public water service has recently been extended to this area by MAWC. Since 1990, 233 customers have been added in the Duquesne area. It is located directly east of the Rex Street elevated tank in the high service area. Also, 230 homes are now being serviced by MAWC in Silver Creek, located in the southeastern part of the system in the high service area. Their transition to the MAWC system occurred between February and August of 1992.

A major reason for extension of service by MAWC to areas previously using private wells is due to water quality problems with the existing wells. For example, the wells in Silver Creek were contaminated with trichlorethylene. Therefore, there is a public benefit realized when MAWC extends service to these areas.

Residential growth has also been rapidly increasing due to the extensive construction of new homes in the Joplin area. There are some new homes being built in the proximity of an older development in the north side of town between Missouri Southern State College and the Northern Industrial Park. In the southern part of the system, south of route I-44 and directly west of Range Line Avenue, luxury single family homes are being built in approximately a half dozen small neighborhoods, with approximately 20 to 30 new homes currently under construction. Most of the existing homes in this area have been built within the last one to two years. In the southwest corner of town, around 32nd and Shifferdecker Streets, development is also underway. The area from 32nd Street down to I-44 is prime ground for development. Within the next 5 years, approximately 32 new luxury homes are projected to be constructed. Within the next 15 years, it is possible that 100 new homes could be built in this area. Additional development is expected to continue here, although it is most likely to occur beyond the horizon of the planning study. A few new homes are also being constructed at the end of East 26th Street in the high service gradient, and five new homes are being built around Sunshine and 20th Streets, also in high service. Just south of Missouri Southern State College and north of 3rd Street, there is a new development of large homes, and additional homes are still being constructed. A few homes are also being built just south of Zora Avenue and west of St. Louis Avenue, and in the area of Zora and Independence. There also exists a new development north of Zora and Florida Avenues with the potential to develop even more. These areas are evidence of the extensive residential growth occurring in the Joplin area.

There is a tendency for growth to occur in the suburban areas outside city limits as new housing developments are constructed. This was particularly notable in Jasper County, which had increases of 19 percent in open country population and 0.3 percent in town and city population during the 1980's. In Newton County, an open country population increase of 14.4 percent and a city and town increase of 4.7 percent were experienced. Joplin appears to be following this trend, with much growth potential outside of the city limits. In fact, the in-town area contains little space available for additional development. Some areas are being rebuilt, as old buildings or homes are replaced with new ones. It is expected that the few vacant lots located with the city of Joplin will be developed. These areas are scattered throughout the city.

Table 2-1 shows the population figures since 1970 and the growth that the Joplin area has experienced.

Table 2-1
Population: Joplin Service Area

Area	1970*	1980*	1990*	1992
City of Joplin	38,958	39,023	40,961	41,100
Metro Statistical Area	108,956	127,513	134,930	135,600

*Actual Census Data

Projections were received from Sales and Marketing Management (S&MM) for the Joplin metropolitan area in Jasper and Newton counties. These estimates project the population to increase in this area from a 1991 total of 136,400 to 139,700 in 1996, an increase of 2.4 percent. During the same time period, total households are projected to increase by 3.0 percent.

As mentioned earlier, there appears to be a limited amount of additional growth potential in town due to lack of space. There exists more expansion potential in the outlying areas as a result of new home construction as well as the conversion of small towns from private wells to the MAWC system. There are more homes further east that could potentially be converted from private wells. One possibility would be the town of Duenweg, located approximately 2 1/2 miles east of Duquesne. There is no current indication that this will occur in the near future, although any problems encountered with their existing wells may necessitate such a move. Saginaw Village, which contains approximately 130 homes and is located just south of Silver Creek, is another area where MAWC is adding customers who are converting from private wells. This is occurring due to problems with contamination of their existing wells. It can be expected that extensions to smaller areas to the east of the service area, such as 20 to 30 homes, will continue to occur on a fairly regular basis.

Based on the rising customer growth since 1977, the existing development which is occurring, the potential for continued development and expansion, and the population forecasts which indicate continued growth, the Joplin residential customer base is projected to grow through 1999 at approximately 260 per year, the average over the past five years. Long range customer growth from 2000-2009 is projected to return to a level of approximately 225 per year, the average since 1977. Therefore, the residential customer base is projected to reach 18,446 by 1999; 19,591 by 2004; and 20,716 by 2009.

The per customer usage has averaged 187 gallons per customer per day (gpcd) over the past five years. The same average was also realized over the past 10 years. The highest per customer usage during this time was 204 gpcd in 1991, and the lowest was 178 in 1992 and 177 in 1993. This fluctuation was mainly a result of unusually hot and dry weather in 1991 and cooler and wet weather in 1992 and 1993. With the exception of 1991, 1992 and 1993, the per customer usage has remained relatively stable over the past ten years.

For new construction, the law will mandate that water efficient fixtures be installed in new homes. With these new fixtures in place, 70 gallons per person per day is considered reasonable usage. According to the 1990 census information, the average number of persons per household was 2.44. This will reduce the per customer usage to 170 gpcd for new homes. Since approximately 25 percent of the new residential customers will be existing, older homes, which are projected at 190 gpcd, and the remaining new residential customers will be new homes, which are projected at 170 gpcd, all new residential customers will be projected at 175 gpcd. Some remodeling of existing homes will also occur, with the old fixtures being replaced with low flow models. Therefore, a slight reduction in per customer usage from existing customers is projected to occur. It is projected that 1/2 percent of the existing customers will convert to low flow fixtures each year (that is, 7.5% of total existing residential customers over the course of the 15 year planning period), bringing their usage down to 170 gpcd.

Therefore, residential sector demand is projected to increase to 3.53 mgd by 1999, 3.72 mgd by 2004, and 3.91 mgd by 2009 based on a per customer usage of 190 gpcd for existing customers, 170 gpcd for existing homes with new low flow fixtures, and 175 gpcd for new customers.

2.2.2 Joplin Commercial Customer Classification

In 1993, the commercial customer base comprised 13% of the total customer base and accounted for 28% of the total sales. This sector includes commercial businesses and apartment buildings. There are many apartment buildings located throughout the service area. However, if the apartments are individually metered, they are classified as a residential customer. In fact, a vast majority, approximately 80 to 90 percent, of the apartments in Joplin are in the residential classification. Therefore, apartments are responsible for minimal demand in the commercial customer classification.

Since 1977, the commercial customer base has gradually increased, with some major fluctuations in the number of customers from year to year. For example, during 1981 the number of commercial customers increased by 117, during 1988 it decreased by 136, and during 1992 it increased by 150. This can be explained by an accounting change in the method by which commercial customers were accounted for. In light of this, it would not be accurate to predict any sort of trend based solely on these numbers.

A more accurate method of predicting commercial customer usage is based on commercial usage tracking residential usage at a certain percentage. This is based on the fact that commercial development is known to follow residential development. Commercial buildings are generally built in relation to the number of residential buildings. Over the past ten years, the commercial demand as a percentage of residential demand has ranged from 65 to 80 percent, averaging 73 percent, and over the past five years it has averaged 70 percent. Based on this past trend, the ratio is expected to remain at 70 percent through the year 2008.

There are a few specific areas where commercial growth is underway or expected to occur. A Wal-Mart has been constructed near the Rex Street elevated tank, replacing an existing Wal-Mart nearby. Around the 32nd Street booster station, commercial buildings are being built, including the recent completion of two large grocery stores and a shopping center. The area around I-44 and Range Line Avenue contains many hotels and potential for additional development. In fact, Range Line Avenue contains many commercial buildings and growth is continuing in that area. Also, an interstate is planned for the east side of town, which would intersect I-44 and Newman Road further north. The stretch of interstate south of I-44 is under construction, and the interstate should be in full operation to the north around the year 2000 or later. Although the exact nature and extent of growth along the interstate cannot be accurately predicted at this point, it is expected to spur additional commercial development to the east of the service area, especially at the major intersections.

The average per customer usage in the commercial category over the past ten years was 883 gpcd. This average was 881 over the past five years. Based on these numbers, it is reasonable to expect the per customer usage to continue at 885 gpcd through 2008. Also, the ratio of commercial usage to residential usage is expected to remain at 70 percent, the average over the past five years. Therefore, the commercial customer base is projected to increase to 2,790 by 1999, 2,940 by 2004, and 3,095 by 2009 with demands of 2.47 mgd by 1999, 2.60 mgd by 2004, and 2.74 mgd by 2009.

2.2.3 Joplin Industrial Customer Classification

The industrial customer base has remained relatively stable since 1977, aside from a major drop in the number of industrial customers in 1988, from 73 to 53. However, this decrease can be explained by an accounting change which affected the method in which industrial customers were classified. Since the accounting change in 1988, the customer base has increased from 53 to 61 customers. However, the industrial demand actually decreased from a high of 1.97 mgd in 1988 to 1.71 mgd in 1993. The high industrial demand in 1988 tracks the high per customer usage of 37,170 gpcd in 1988. Since 1988, the per customer usage has decreased to 28,033 gpcd in 1993, with an average of 30,062 gpcd over the past four years.

Since 1988, the total usage for the top seven industrial customers has been slightly increasing. Therefore, the reason for the decrease in overall industrial gpcd usage was a result of the smaller industrial customers, which make up a majority of the industrial customer base, using less water. Using data available through 1992, aside from the top seven industrial customers, the remaining industrial customers have averaged 12,570 gpcd over the last five years, 8,340 gpcd over the last four years, and 6,800 gpcd in 1992.

The top seven industrial customers accounted for 79.5 percent of the total industrial usage in 1992, and their overall usage has been increasing since 1988, although the percent increase each year has been decreasing. For example, in 1989, their usage increased 18.9 percent, while in 1992, their usage increased only 2.1 percent. Based on recent correspondence with these large industrial customers, their usage is projected to continue to show a slight increase through the length of the planning period.

Tamko Asphalt Products, producers of asphalt roofing products, is the largest industrial customer and the second largest customer overall, behind Jasper County Public Water District. They have shown a slight increase in usage since 1988, from 0.417 mgd to a 1992 usage of 0.464 mgd. However, they are projecting a reduction in usage and are considering plans to use recycled water. FAG Bearings Corporation, a manufacturer of bearings, is the second largest industrial customer, with a 1992 usage of 0.291 mgd. They have also shown slight increases in usage since 1988. Eagle Picher Industries, the third largest customer, used 0.229 mgd in 1992. They have implemented a recycling program, which accounts for their slightly declining usage. They are producers of batteries and chemicals. One of the fastest increasing water users is Pillsbury. Since they began as a customer in 1989, their usage has increased from 0.007 mgd to 0.063 mgd in 1992. Their usage is projected to increase to 0.120 mgd by 1999 and remain at that level through 2009.

The Joplin Industrial Park, owned by the Joplin Industrial Development Authority, is located directly east of Range Line Road and south of Cemetery Road in the northern part of town. As part of the economic development program, the city builds metal shell buildings and works to get new industries, mostly light industries, to move in. This industrial park is expanding and is expected to experience growth east to Duquesne Road, although not all the potential industries will be large water users. Also, the old industrial park in the southeast corner of the system is still attracting new industry. A large building is under construction for Consolidated Freight International (CFI), a large trucking company, on an 80 acre plot at 32nd and Duquesne Streets. Pillsbury, one of MAWC's largest customers, is located in that area. Some newer industries such as Jasper Foods and Gulf State Paper are also located there, although they are not large water users.

A new industrial customer, Cliffstar Corporation, a juice manufacturer, recently began production in the Joplin Industrial Park along Enterprise Road directly east of the Joplin City limits. Their average daily usage is estimated to reach 250,000 gpd in three years and remain at approximately the same level through the planning period. Although this is their best projection at this point, it could change in the future.

Including Cliffstar, the industrial sector is projected to grow by 5 customers through 1999 to 66, and increase by an additional 3 customers through 2004 to 69, and an additional 2 customers through 2009 to a total of 71. Aside from the seven largest customers, the existing industrial customers will be projected at 7000 gpcd, which is slightly higher than their per customer usage in 1992. Cliffstar's usage will be projected at 250,000 gpd through 2009. New industrial customers, aside from Cliffstar, will be projected at 15,000 gpcd. The usage of the seven largest industrial customers is projected at the following amounts: 1.38 mgd in 1999, 1.39 mgd in 2004, and 1.42 mgd in 2009. Using this approach, the industrial demand is projected to reach 2.07 mgd by 1999, 2.12 mgd by 2004, and 2.18 mgd by 2009.

2.2.4 Joplin "Other" Customer Classification

The "Other" customer classification includes municipal, federal government, public housing accounts and sales to other water utilities. The number of customers in this classification remained fairly constant from 1977 until 1987, and increased by 9 and 12 in the next two years. It then jumped from 91 customers in 1989 to 146 customers in 1990. The reason for this increase is due to an accounting change which affected the way "other" customers were classified. This category has increased from 138 customers in 1991 to 153 customers in 1993. Included in the "other" classification are bulk sales to the Jasper County Public Water District at seven locations. These sales amounted to 69 percent of total "other" usage in 1992.

Sales to Jasper County PWD have shown slight increases since 1988, and according to the information received from recent correspondence with the Water District, this trend is expected to continue. The area is mostly farmland and residential customers. There is some residential construction occurring and this is expected to continue at a slow but steady rate. An example of this growth is seen in the fact that another 8-inch main will be opened up to serve the Water District using an 8-inch meter. This new 8-inch main feeding the Water District is located in the northwest portion of the distribution system in Zora Avenue west of Schifferdecker Avenue. This 8-inch main will provide water to a growing residential area. 40 houses have already been built, 6 to 8 more are under construction, and a few more are expected to be built in the near future. It is expected that this new 8-inch meter will have the highest demand of all the meters to the Water District. Resale amounts as well as target year projections are shown in Table 2-2.

Some of the additional customers in the "other" customer category include the schools and colleges. The largest college is Missouri Southern State College, with an enrollment of 6,000. It is located on the east side of town and has dormitories for its students. There are also 13 public elementary schools, 3 junior high schools, and 1 high school, plus a few private schools in the area. The usage for these customers is expected to remain stable.

Table 2-2

Resale Customer Usage and Projections

Jasper County PWD

Year	Usage (mgd)
1988	0.44
1989	0.48
1990	0.47
1991	0.52
1992	0.54
1999	0.66
2004	0.76
2009	0.86

Since the increase in the customer base in 1990, the "other" customer demand has averaged 0.78 mgd, up from the average of 0.606 mgd since 1977. The average per customer usage over the last three years since the accounting change was 5,382 gpcd. Not including sales to the Water District, the average per customer usage over the last three years was 1,890 gpcd.

To project future demand in this sector, the existing customers and new customers will be projected at 1890 gpcd. This does not include the demand of the Water District, which will be added on separately based on the projections given in Table 2-2. Customer growth is expected to be 1 per year for a total of 168 in 2009. Therefore, "other" demand is projected to increase slightly to 0.96 mgd by 1999, 1.07 mgd by 2004, and 1.18 mgd by 2009.

2.2.5 Joplin Fire Service Customer Classification

There is no day to day consumption associated with fire service customers. Water consumption for these customers is addressed under the non-revenue classification since this usage occurs only under special conditions.

Since 1977 the fire service customer base increased on average by 5.2 per year. This trend is expected to continue through this study period leading to a customer base of 259 by 1999, 285 by 2004, and 311 by 2009.

2.2.6 Joplin Non-Revenue Usage and Unaccounted-For Water

Non-revenue use includes water for fire fighting, street cleaning, main flushing and identifiable leakage. The amount of non-revenue usage has averaged 0.43 mgd over the last ten years. In 1992, the non-revenue usage was 0.42 mgd and amounted to 4.4 percent of the average day demand. This increased to 0.64 mgd and 6.5 percent in 1993. Except for the increase in 1993, the percentage of non-revenue usage has averaged 4.5 percent of the average day demand over the last ten years, and has remained fairly stable. This classification is projected be 4.5 percent of the projected average day demand. Therefore, the non-revenue usage is projected to increase slightly to 0.50 mgd in 1999, 0.52 mgd in 2004, and 0.55 mgd in 2009.

Unaccounted-for water (UAF) represents the difference between total system delivery and the sum of all metered sales plus non-revenue use. This volume of water is attributed to meter inaccuracy, undetected leakage, open fire hydrants and theft. Since 1977, UAF averaged 18.9 percent of the average day demand. This was reduced to 17.3 percent, 17.1 percent and 13.6 percent in the past three years. A significant portion of the leakage is believed to occur in old Ludlow fire hydrants installed between 1900 and the

1950's, cast-iron pipes that are less than 6-inches in diameter, and plastic service lines made of polybutylene and polyethylene.

To control UAF, MAWC-Joplin maintains an aggressive leak detection program. At least 20 Ludlow fire hydrants are replaced per year. Their goal is to locate and repair at least five main line leaks per week, and at least eight plastic customer services per week. In 1993, the leak detection operation was upgraded with the purchase of additional equipment, including a leak analyzing system. Using the new equipment, leak detection crews can cover an area twice as big as the old system in the same amount of time. A noticeable difference was evident, with UAF water in 1993 at a low of 13.6 percent. Also, a 10 year customer meter replacement program is in place. With these measures in place, the UAF water as a percentage of total demand is projected to be 14% through 1999 and be reduced to 13% from 2000 to 2009. Therefore, the UAF water is projected to be 1.55 mgd in 1999, 1.50 mgd in 2004, and 1.58 mgd in 2009.

2.2.7 Joplin Average and Maximum Day Demand Projections

The average day demand in the Joplin service area since 1977 has been relatively stable, with a few slight yearly fluctuations, as increasing residential and commercial demands have been roughly balanced by reductions in unaccounted for water. Based upon projections estimated for each customer category, the average day demand is projected to be 11.08 in 1999, 11.53 mgd in 2004, and 12.13 mgd in 2009.

The projected future maximum to average day demand ratio was developed using the historic ratios from the demands since 1977. A statistical analysis was conducted to determine the 95 percent confidence interval around the sample mean, which is the level used to base long term capital planning decisions on. Based on the results of this analysis, it has been determined that there is a 95 percent confidence that the ratio of maximum day to average day demands will not exceed 1.64. Applying this ratio to the projected average day demands yields projected maximum day demands of 18.17 mgd in 1999, 18.90 mgd in 2004, and 19.90 mgd in 2009.

The results of the average and maximum day demand projections for the Joplin service area are summarized in Table 2-3 and are presented graphically in Exhibit 2-1.

2.2.8 Alternate Demand Scenarios for Joplin

The point estimate of the historic maximum to average day ratios, which reflects a value for which the past ratios were higher 50 percent of the time and lower 50 percent of the time, is 1.46. Therefore, in any given

Table 2-3

Demand Summary
Joplin Service Area

YEAR	CUSTOMER NUMBER	RESDNTL	COMMRL	INDUSTRL	OTHER	NON-REVENUE	UAF WATER	AVG DAY	MAX DAY	MAX/AVG RATIO
HISTORIC CUSTOMERS AND DEMAND (mgd)										
1977	16076	2.37	1.75	1.50	0.46	0.94	2.41	9.43	12.20	1.29
1978	16213	2.44	1.79	1.72	0.52	0.98	2.03	9.48	13.06	1.38
1979	16460	2.45	1.80	1.77	0.58	0.94	1.80	9.34	11.37	1.22
1980	16651	2.76	1.87	1.59	0.61	0.98	1.96	9.77	14.57	1.49
1981	16686	2.48	1.84	1.57	0.56	0.94	1.56	8.95	12.64	1.41
1982	16730	2.55	1.89	1.51	0.57	0.85	1.70	9.07	12.69	1.40
1983	16923	2.65		1.55	0.59	0.34	1.89	8.93	12.33	1.38
1984	17169	2.77	2.10	1.78	0.59	0.48	1.17	8.89	13.90	1.56
1985	17468	2.70	2.13	1.93	0.58	0.45	1.65	9.44	14.35	1.52
1986	17778	2.76	2.12	1.97	0.53	0.45	1.73	9.56	15.25	1.60
1987	18161	2.85	2.29	1.82	0.57	0.36	2.09	9.98	15.77	1.58
1988	18563	3.08	2.16	1.97	0.57	0.43	2.15	10.36	15.12	1.46
1989	18734	2.99	2.18	1.75	0.64	0.29	1.94	9.79	14.80	1.51
1990	19003	3.06	2.13	1.62	0.71	0.32	1.81	9.65	14.11	1.46
1991	19214	3.35	2.18	1.67	0.84	0.48	1.78	10.30	16.89	1.64
1992	19853	3.01	2.09	1.65	0.78	0.42	1.64	9.59	12.58	1.31
1993	20230	3.04	2.25	1.71	0.79	0.64	1.33	9.75	12.94	1.29
PROJECTED CUSTOMERS AND DEMAND (mgd)										
1999	22043	3.53	2.47	2.07	0.96	0.50	1.55	11.08	18.17	1.64
2004	23357	3.72	2.60	2.12	1.07	0.52	1.50	11.53	18.90	1.64
2009	24670	3.91	2.74	2.18	1.18	0.55	1.58	12.13	19.90	1.64

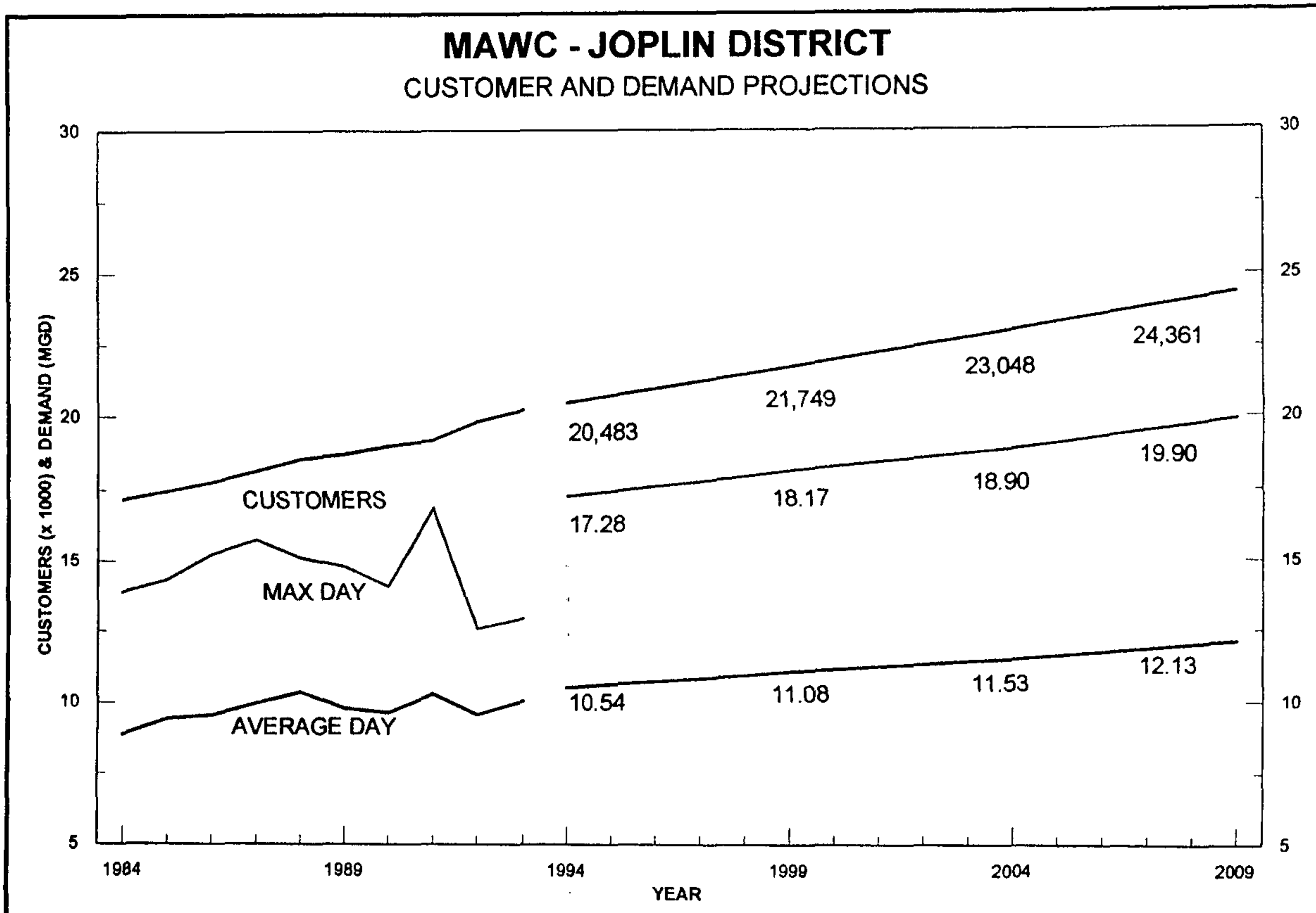

MAWC - JOPLIN DISTRICT
CUSTOMER AND DEMAND PROJECTIONS
CUSTOMERS (x 1000) & DEMAND (MGD)
30
25
20
15
10
5
CUSTOMERS
MAX DAY
AVERAGE DAY
20,483
21,749
23,048
24,361
17.28
18.17
18.90
19.90
10.54
11.08
11.53
12.13
1984
1989
1994
1999
2004
2009
YEAR

EXHIBIT 2-1

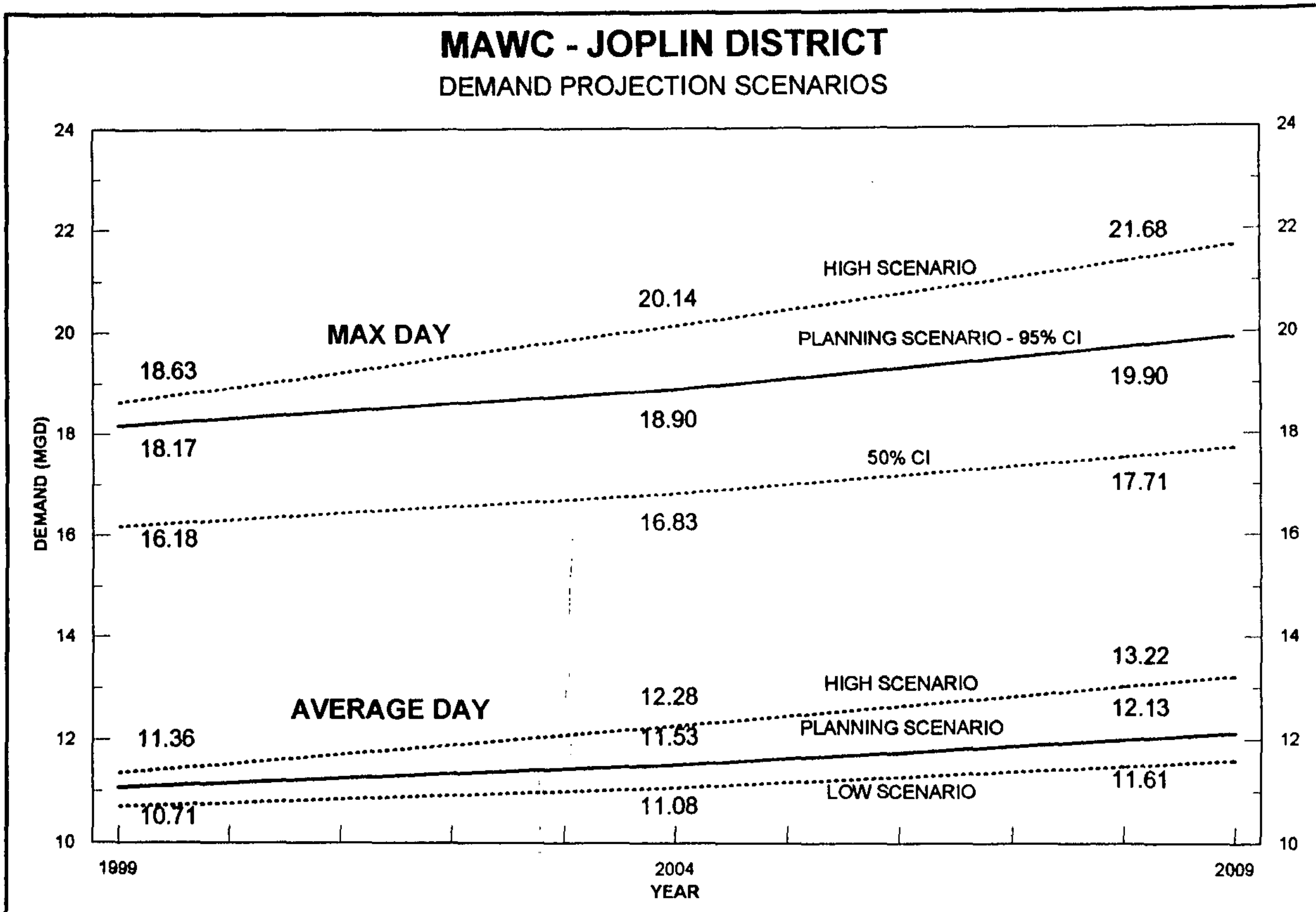

MAWC - JOPLIN DISTRICT
DEMAND PROJECTION SCENARIOS
MAX DAY
HIGH SCENARIO
PLANNING SCENARIO - 95% CI
50% CI
18.63
20.14
21.68
18.17
18.90
19.90
16.18
16.83
17.71
AVERAGE DAY
HIGH SCENARIO
PLANNING SCENARIO
LOW SCENARIO
11.36
12.28
13.22
11.53
12.13
10.71
11.08
11.61
DEMAND (MGD)
YEAR
1999
2004
2009
24
22
20
18
16
14
12
10

EXHIBIT 2-2

year there is a 50 percent confidence that the ratio of maximum day to average day demands will not exceed 1.46. Applying this ratio to the projected average day demands yields maximum day demands of 16.18 mgd in 1999, 16.83 mgd in 2004, and 17.71 mgd in 2009. While these values are not adequate to base long term capital planning decisions on, they can be used to estimate annual operational parameters. The 50 percent confidence interval is evaluated along with the 95 percent confidence interval to illustrate the probable variation in maximum day demands that will likely be experienced during the next fifteen years. The corresponding maximum day projections for both the 50 percent and 95 percent confidence intervals can be seen in Exhibit 2-2.

It is also helpful to illustrate other potential demand scenarios, each within the range of demands which can conceivably occur in the MAWC system within the planning horizon. These projections show the sensitivity and uncertainty of system demands relative to population growth, resale customer usage, industrial usage and unaccounted-for water. Exhibit 2-2 includes the average day demands for the planning scenario, and also a low scenario and a high scenario. The maximum day demands are also shown for the planning scenario and high scenario, both which use a 95 percent confidence interval (CI), and the scenario using a 50 percent confidence interval based on the planning scenario average day.

The low projections take into account two areas which display the most uncertainty in relation to being lower than planning projections. In the residential sector, growth is expected to be high and remain high for the length of the planning period. However, it is conceivable that the growth that is occurring will not be sustained at the same level and for a long period of time. Therefore, the low projection assumes a growth rate of 200 residential customers per year over the course of the planning period, which is slightly less than the planning projections. This also affects commercial demand, since it is projected at 70 percent of residential demand. The "Other" category could also show a lower demand if the Jasper County Public Water District does not meet its projections. They are projected to increase from a 1992 demand of 0.54 mgd to 0.86 mgd in 2009. However, slower than anticipated growth could conceivably occur in this area. Therefore, for the low projections, Jasper County Public Water District demand projections are reduced by 20 percent.

The high projections take into account the projected use of the Cliffstar Corporation, the new juice manufacturer. For the planning projections, they are expected to use 0.25 mgd through the course of the planning period, and this is based on Cliffstar's best estimate. However, it is possible that their usage could increase substantially, based on initial estimates which were being considered. For the high projections, they are projected to reach 0.25 mgd in 1999, 0.50 mgd in 2004, and 0.75 mgd in 2009. Another area which could increase system delivery is unaccounted for (UAF) water. Planning projections assume that it will decrease to 14 percent and then to 13 percent. This is based on an aggressive program by the Water Company to reduce unaccounted for leakage. UAF water was at 17.1 percent of system demand in 1992, and the average over the last five years prior to 1993 was 18.8 percent. Although the UAF percent has been decreasing, there is still a possibility that this percentage might still remain higher than 13 percent, in spite of the extensive ongoing efforts by MAWC to control it. Therefore, for the high projections, UAF is figured at 16 percent of system demand.

2.3 ST. JOSEPH SERVICE AREA

Water usage in the St. Joseph system in 1993 was impacted by the wet weather conditions, and by the flooding conditions which rendered the plant inoperable for approximately five days. Since 1993 represented a highly unusual weather and water demand situation, long-term demand projections have been based primarily on statistical analysis of trends from prior years. The demand projections have been modified to account for the loss of two major industrial customers in 1993.

2.3.1 St. Joseph Residential Customer Classification

The residential customer base in the St. Joseph service area makes up approximately 88% of the total customer base and uses approximately 34% of the total water sales. The acquisition of Buchanan County Public Water Service District (PWSD) No. 2 was the major reason for the increase in residential customers from 24,273 in 1991 to 26,118 in 1992, an increase of 1,845 new customers. Approximately 1,750 new residential customers were the result of the acquisition. Aside from the increase due to the acquisition, the residential customer base grew on average 100 customers per year from 1980 to 1993. During 1990, 58 new customers were added, and during 1991, 84 customers were added to the customer base. Aside from the increase due to the acquisition, approximately 95 residential customers were added in 1992. In 1993, 244 new residential customers were added; however, this was largely due to a change in classification from commercial to residential. There appears to have been a trend of slow but stable growth in the number of MAWC residential customers since 1980.

From the information provided by the St. Joseph Area Chamber of Commerce, Sales and Marketing Management (S&MM) estimates were given for the St. Joseph metropolitan area in Buchanan County. Their projection is for the population to decrease by 2.8% from a total of 82,700 in 1991 to 80,400 in 1996. Also, the total number of households is projected to decrease by 1.6% from 1991 to 1996. These projections follow the recent population trends in the area, as shown in Table 2-4, with a decrease in population since 1980 and a more noticeable decrease since 1985. This follows a decade of moderate growth in the 1970's.

This declining trend can also be seen by examination of the construction permits and money spent in new housing construction as well as industrial and commercial development projects. This declined from a high of $38.7 million in 1989 to $25.6 million in 1991.

Table 2-4
Population of Key Areas: St. Joseph Service Area

Area	1970*	1980*	1985	1990*
City of St. Joseph	72,748	76,691	75,000	71,852
Buchanan County	86,915	87,888	86,700	83,083
Andrew County	11,913	13,980	15,200	14,632
Two-County Metro Area	98,828	101,868	101,900	97,715

*actual census data

The only major residential development now occurring is located in the northeast portion of the city, directly east of the Karnes Road tank, along Twelve Oaks Drive and Lakewood Drive and the surrounding area. The construction is expected to be completed in two or three phases, with 144 lots projected to be built in the next four to five years. These are mainly luxury single family homes. Most of the limited amount of residential growth that is expected to occur will most likely take place in the Karnes Road high service area. In addition, approximately 15 to 20 homes were built within the last two years around South 22nd Street below Commercial Avenue, which is in the southern portion of main service. A few more lots are available in this area for additional homes.

In the Southern Buchanan County service area, not much residential growth is expected to occur over the length of the planning period. It is a very rural area consisting of rolling hills, with homes scattered throughout the area. There are a few clusters of homes throughout the area which make up small towns. The only growth that is expected to occur would be the construction of a couple of homes at a time. Also, a few more customers may be added as they convert from private wells to the MAWC system. Neither of these increases is expected to provide for any substantial growth in the rural water district.

Since 1980, as the population has slowly declined in the St. Joseph area, MAWC's residential customer base has shown a slight increase, averaging 100 new customers a year from 1980-1993. This has mainly been due to new home construction in the area, although this activity is also slowing. There have not been many new businesses coming into the area to increase employment opportunities and attract new growth. The fact that MAWC's residential customer base continued to increase during an overall population decline is attributed to a slight decrease in the number of people per household, which is a common trend. From 1980 to 1990, the number of people per household decreased from approximately 2.6 to 2.5. Also, certain customers that have previously been classified under the commercial category are sometimes transferred to residential status, thus increasing the recorded number of residential customers. This can occur when multi-family dwellings or apartments with one meter, which are classified commercial, are modified to include a separate meter for each family unit, thus transferring them to residential classification.

The trend of slow growth is expected to continue over the next five years. However, as new construction continues to decline, the residential customer base is expected to stabilize. Therefore, the residential customer base is projected to continue to grow at a moderate rate of 75 per year through 1999. Growth is projected to decrease to 25 per year through 2008. This will increase the residential customer base to 26,737 by 1999; 26,862 by 2004; and 26,987 by 2009.

The per customer usage has averaged 186 gpcd over the past ten years and also over the past five years. The usage has decreased over the last 5 years from a high of 204 gpcd in 1988 to the 1992 and 1993 levels of 176 gpcd, with the exception of an increase in 1991 to 195 gpcd. This was most likely due to 1991 being an exceptionally hot and dry year. Also, the low per customer usage in 1992 and 1993 was related to these years being exceptionally cool and/or wet. The higher water rates which will be in effect as a result of the new water treatment plant may have the effect of slightly reducing residential usage; however, the level of price elasticity that will occur in response to projected water rate increases is difficult to predict. Based on past trends and using a conservative approach, the per customer usage is projected at 185 gpcd for existing customers for the planning scenario. A low demand scenario considering reduced per customer consumption figures due to price elasticity is presented in Section 2.3.8.

For new construction, the law will mandate that water efficient fixtures be installed in new homes. With these new fixtures in place, 70 gallons per person per day is considered reasonable usage. According to the 1990 census information, the average number of persons per household was 2.5. This will reduce the per customer usage to a projected level of 175 gpcd. Some remodeling of existing homes will also occur, with the old fixtures being replaced with low flow models. Therefore, a slight reduction in per customer usage from existing customers will occur. It is projected that 1/2 percent of the existing customers will convert to low flow fixtures each year, bringing their usage down to 175 gpcd.

Therefore, residential sector demand is projected to increase to 4.94 mgd by 1999, 4.95 mgd by 2004, and 4.97 mgd by 2009 based on a per customer usage of 185 gpcd for existing customers, 175 gpcd for existing homes with new low flow fixtures, and 175 gpcd for new customers.

2.3.2 St. Joseph Commercial Customer Classification

In 1993, the commercial customer base comprised 11% of the total customer base and accounted for 19% of the total sales. This sector includes commercial businesses and apartment buildings. Apartment buildings are estimated to comprise from 20 to 30 percent of the total commercial demand.

Since 1977, the commercial customer base decreased by an average of 16 per year to a level of 3,156 in 1993. The acquisition of Buchanan County PWSD No. 2, now referred to as the Southern Buchanan County Service, was the main reason for an increase of 48 commercial customers in 1992. 39 of the 48 new commercial customers in 1992 were a part of this acquisition.

There is no substantial commercial development occurring in the St. Joseph area. At this point, there is preliminary talk of constructing a highway bypass loop which would extend completely around the city. If this would happen, it would open up the opportunity for additional growth, especially in the commercial sector. However, if this project were to move forward, construction would most likely not occur within the time frame of this planning study.

The largest commercial customer, Heartland Health System, is also the largest employer in St. Joseph, with over 2,000 employees. They have two locations. Heartland Hospital West is located at 8th and Faraon Streets, and Heartland Hospital East is located at Riverside and Faraon. The overall usage for Heartland was 0.237 mgd in 1992, which was 9.5 percent of the overall commercial demand. Their usage is projected to increase through 1998 and remain stable from 1999 through 2008. Heartland East will be experiencing most of the growth due to the relocation of all of their acute care to this facility, which includes a centralized laundry for both hospitals. Also, a 43 million dollar expansion is to be completed sometime in 1995. Heartland West is projected to have a slight decrease in usage due to this relocation. In addition, several water conservation measures have been initiated within the last year.

The commercial per customer usage has averaged 785 gpcd over the past ten years and 800 gpcd over the past five years. From 1989-1993, the low was 773 gpcd in 1993, and the high was 858 in 1991, with a decrease to 788 gpcd in 1992. The average of 800 gpcd over the past five years will be used for future projections. The commercial demand as a percentage of residential demand has averaged 55 percent over the past ten years and has remained relatively stable, fluctuating between 52 percent and 56 percent. Since this ratio has shown little fluctuation and has proven to be a reliable method for projecting commercial usage, 55 percent will be used as the ratio of commercial demand to residential demand. The commercial customer base is projected to increase to 3,400 by 1999, 3,405 by 2004, and 3,415 by 2009 with demands of 2.71 mgd by 1999, 2.72 mgd by 2004, and 2.73 mgd by 2009.

2.3.3 St. Joseph Industrial Customer Classification

The industrial customer base has remained fairly constant since 1977, showing only slight variations from year to year. The number of industrial customers was at 118 in 1977 and 114 in 1993. The industrial demand showed a noticeable increase in 1988 from 3.25 mgd to 3.60 mgd. The demand increased moderately to 3.89 mgd in 1992, but dropped to 3.63 mgd in 1993.

The top nine industrial customers accounted for 71 percent of the total industrial usage in 1992, and their overall usage has shown a slight increase since 1988. A majority of these customers are located in the southwest portion of the service area in the vicinity of the former stockyards. Some recent changes in the industrial base, however, will effectively decrease the demand in this sector.

The largest industrial customer, Monfort Pork, a meat processing and packaging division of ConAgra which employed approximately 1,050 people, closed effective 12/31/93. They were MAWC's largest customer in St. Joseph, using 0.941 mgd in 1992. Despite a 1991 layoff which ended with a call-back of employees, as well as the addition of a second shift, Monfort officials deemed it no longer economically feasible to keep the plant in operation.

Carnation, MAWC's largest industrial customer since the closing of Monfort Pork, has exhibited fairly stable usage since 1988, with a 1992 demand of 0.404 mgd. Only slight increases are expected in their usage. Ag Processing, the second largest industrial customer, has had fairly stable usage, with a demand of 0.317 mgd in 1992. They project their usage to increase to 0.400 mgd by 2009, with the potential expansion of their soy processing plant by 50 percent. The Blueside Company is the third largest industrial user, and they process cattle hides which are sold to a worldwide market for the manufacture of fine quality leather. Their usage has remained fairly stable and is expected to show only a slight increase, from a 1992 usage of 0.265 mgd to 0.292 in 2009. The fourth largest industrial customer is Seitz Foods, producers of luncheon meats. Their usage has remained relatively unchanged since 1989, with a 1992 usage of 0.239 mgd, and only slight increases are expected. The Quaker Oats Company, producers of cereals and flour, showed a decrease in their 1992 usage, down from 0.292 mgd in 1991 to 0.179 mgd in 1992. Their usage is projected to increase to 0.240 mgd by 2009. They employ approximately 700 people and are the fifth largest industrial customer. The sixth largest customer, Silgan Containers Corporation, has shown a slight decrease in usage since 1988, and their future usage is projected to decrease to 0.150 mgd in 2009. Sherwood Medical Company, with about 772 employees, was the eighth largest customer in 1992 with a usage of 0.125 mgd. However, after the flood in July of 1993, they decided to move the company from St. Joseph. The ninth largest customer in 1992, and now the seventh largest, Swift Chemicals used 0.107 mgd in 1992. They have shown fairly steady usage since 1988, and this is expected to continue.

The impact of the Monfort Pork and Sherwood Medical Company closings could be eased once licensing of riverboat gambling takes effect. Approximately 500 jobs are to be filled for the startup of this industry. In addition, the outlook for the sale of both the Monfort Pork and Sherwood Medical facilities is promising. Monfort is a fairly new facility which has recently been renovated.

According to discussions with the St. Joseph Development Corporation, plans are under way for a new industrial park on the extreme east side of town, located north of highway 36 and east of Riverside Road. This would be a multi-year, long-term project aimed at light industries. An additional industrial park is being considered at the Port Authority on the west side of town, to be developed further in the future and aimed at heavy industry. Since the time frame for these projects is long-term, there is no considerable change expected in the industrial customer base in the next five to ten years. Possible start-up of construction could be in the next three to five years at the earliest, and ten to fifteen years at the latest. Therefore, if the early estimates of the Development Corporation are correct, some growth may be seen in approximately ten years, at the latter stages of this planning period. There is no indication of any new industrial customers in the immediate future in the St. Joseph area.

Based on the past trend and future projections, the industrial customer base is expected to increase by 1 customer to 115 by 1999, increase by 2 customers to 117 by 2004, and increase by 3 customers to 120 by 2009. Increased growth may occur beyond 2009 depending on the status of the new industrial parks.

Aside from the seven largest industrial customers, the remaining customers have averaged 9,870 gpcd over the past five years, and this per customer usage has remained fairly stable. Based on these numbers, 10,000 gpcd will be used to project the demand of existing industrial customers, aside from the seven largest users. Most of the new industrial customers are not expected to be large water users; however, it is likely that one or two large industrial customers may buy the facilities vacated by Monfort Pork and Sherwood Medical. If these facilities do become operational again, the water usage at these sites is expected to be significantly lower than the previous usage, which will decrease the overall industrial demand. Future water usage at these sites cannot be accurately predicted. It is estimated that a new customer at the former Monfort Pork facility would have a usage of approximately 0.20 mgd, down significantly from the previous usage of 0.94 mgd by Monfort Pork. All other new customers are projected at 10,000 gpd. Therefore, the average usage projected for new customers will be 40,000 gpd. The usage of the seven largest customers is separately projected at the following amounts: 1.78 mgd in 1999, 1.83 mgd in 2004, and 1.87 mgd in 2009. Using this approach, the industrial demand is projected to reach 2.88 mgd in 1999, 3.01 mgd in 2004, and 3.17 mgd in 2009.

2.3.4 St. Joseph "Other" Customer Classification

The "other" customer classification remained fairly constant from 1977 until 1990, and increased by 9 and 7 customers in the next two years to a 1992 level of 176 customers. By the end of 1993, there were 177 customers. This category includes bulk sales to four public water service districts located on the north, east and south sides of the service territory. The cities of Elwood and Wathena in Kansas also purchase their entire water supply from MAWC. The reclassification of the customers in the Southern Buchanan County Service from commercial to residential accounts had the effect of decreasing the "other" demand in 1992, declining from 2.82 mgd in 1991 to 2.40 mgd in 1992. 1993 usage was down to 2.08 mgd, but this is primarily the result of wet weather conditions.

Re-sale customer usage accounted for 75 percent of the total "other" customer usage in 1992. The sales to the five systems since 1988, along with their projected usage, is shown below in Table 2-5. All of the resale customers obtain their entire water supply from MAWC. The projected usage was obtained from a questionnaire sent to each Water District. Since they comprise such a large portion of the demand in this category, their projected usage is an important factor.

Table 2-5

Resale Customer Usage and Projections (mgd)

Customer	Past Usage 1988	1989	1990	1991	1992	Projections 1999	2004	2009
Andrew County No. 1	0.248	0.301	0.301	0.324	0.354	0.474	0.574	0.834
Andrew County No. 2	0.584	0.562	0.557	0.587	0.581	0.639	0.705	0.800
Buchanan County No. 1	0.189	0.172	0.185	0.199	0.184	0.250	0.260	0.265
DeKalb County No. 1	0.147	0.234	0.219	0.250	0.233	0.400	0.440	0.484
Elwood-Wathena System	0.448	0.378	0.422	0.455	0.456	0.455	0.455	0.455

As can be seen from Table 2-5, usage in the Elwood-Wathena System is projected to remain stable over the course of the planning period. In Andrew County PWSD No. 1, there exists the possibility of another expansion of at least five square miles. They have also been installing approximately 50 new services each year. In Buchanan County PWSD No. 1, a new extension is planned that will take in areas north, east and south of DeKalb, adding more than 100 customers. DeKalb County PWSD No. 1 is also constructing distribution mains, which will service about 700 additional customers.

Schools and colleges are also part of the "other" customers. Two colleges are located in St. Joseph: Missouri Western State College, with an enrollment of 4,600; and Northwest Missouri Community College. Also, there are 18 public elementary schools, 4 junior high schools, 3 high schools, plus a few private schools. Their usage is expected to remain fairly constant.

"Other" customer demand remained fairly constant from 1988-1991, averaging 2.64 mgd. During this same time period, the average per customer usage was slowly increasing, averaging 16,240 gpcd. However, aside from sales to the resale customers, the average per customer usage over the past five years has been 2900 gpcd.

To project future demand in this category, the existing customers and new customers will be projected at 2900 gpcd. This does not include the demand of the resale customers, which will be added on separately, based on the projections given in Table 2-5. Customer growth is expected to be 1 per year for a total of 192 in 2009. Therefore, "other" demand is projected to increase slightly to 2.73 mgd by 1999, 2.96 mgd by 2004, and 3.38 mgd by 2009.

2.3.5 St. Joseph Fire Service Customer Classification

There is no day to day consumption associated with fire service customers. Water consumption for these customers is addressed under the non-revenue classification since this usage occurs only under special conditions.

Since 1977 the fire service customer base increased on average by 2.7 per year. This trend is expected to continue through this study period leading to a customer base of 283 by 1999, 297 by 2004, and 310 by 2009.

2.3.6 St. Joseph Non-Revenue Usage and Unaccounted-For Water

The amount of non-revenue usage in the St. Joseph District has averaged 0.90 mgd since 1983, and over the past four years, the usage has averaged 0.96 mgd. The percentage of non-revenue usage averaged 5.8 percent of the average day demand over the past ten years, and was at 5.7 percent in 1992 and 7.3 percent in 1993. Non-revenue usage is projected at 5.8 percent of the projected average day demand. Therefore, the non-revenue usage is projected to increase slightly to 0.94 mgd in 1999, 0.96 mgd in 2004, and 1.01 mgd in 2009.

Over the past ten years, UAF averaged 10.8 percent of the average day demand. In 1991, it reached a low of 8.2 percent and was at 9.4 percent in 1993.

To control UAF, MAWC-St. Joseph maintains a leak detection program and a meter replacement program. A distribution supervisor is responsible for routinely checking the entire distribution system for leaks. Using an L100 listening device, he spends approximately six days per month on foot listening for leaks. Each month he covers one area, enabling him to check the entire system in the course of one year. During 1992, 82 leaks were located through the leak detection program, with the majority of them in hydrants. The meter replacement program is up to date, and the meters are replaced on a schedule depending on the size of the meter. The UAF water as a percentage of total demand is projected to remain at 12 percent through the planning period, up from 10 percent used in the last CPS due to the aquisition of the Sourthern Buchanan County service area. This newly acquired area presents many difficulties for leak detection due to the many additional miles of pipeline in a large, rural area. Therefore, the UAF water is expected to reach 1.94 mgd in 1999, 1.99 mgd in 2004, and 2.08 mgd in 2009.

2.3.7 St. Joseph Average and Maximum Day Demands

The average day demand has shown slight increases since 1977, with a sizable increase in 1988, followed by fairly constant demands up until 1993, as increasing residential and commercial demands have been roughly balanced by reductions in unaccounted for water. Based upon projections estimated for each customer category, the average day demand is projected to reach 16.13 mgd by 1999, 16.59 mgd by 2004, and 17.34 mgd by 2009.

The projected future maximum to average day demand ratio was developed using the historic ratios from the demands since 1977. A statistical analysis was conducted to determine the 95 percent confidence interval around the sample mean, which is the level used to base long term capital planning decisions on. Based on the results of this analysis, it has been determined that there is a 95 percent confidence that the ratio of maximum day to average day demands will not exceed 1.60. Applying this ratio to the projected average day demands yields projected maximum day demands of 25.81 mgd in 1999 26.55 mgd in 2004, and 27.74 mgd in 2009.

The results of the average and maximum day demand projections for the St. Joseph service area are summarized in Table 2-6 and are presented graphically in Exhibit 2-3.

2.3.8 Alternate Demand Scenarios for St. Joseph

The point estimate of the historic maximum to average day ratios, which reflects a value for which the past ratios were higher 50 percent of the time and lower 50 percent of the time, is 1.44. Therefore, in any given year there is a 50 percent confidence that the ratio of maximum day to average day demands will not exceed 1.44. Applying this ratio to the projected average day demands yields maximum day demands of 23.23 mgd in 1999, 23.89 mgd in 2004, and 24.97 mgd in 2009. While these values are not adequate to base long term capital planning decisions on, they can be used to estimate annual operational parameters. The 50 percent confidence interval is evaluated along with the 95 percent confidence interval to illustrate the probable variation in maximum day demands that will likely be experienced during the next fifteen years. The corresponding maximum day projections for both the 50 percent and 95 percent confidence intervals can be seen in Exhibit 2-4.

It is also helpful to illustrate other potential demand scenarios within the range of demands which could conceivably occur in the MAWC system within the planning horizon. These projections show the sensitivity and uncertainty of system demands relative to rate increases which are expected as a result of the new treatment plant. Exhibit 2-4 includes the average day demands for the planning scenario, which are based on the previous discussion in this section, and also a low scenario, which is adjusted based on consideration of reduced customer consumption in response to the expected rate increases. The projected

Table 2-6

Demand Summary
St. Joseph Service Area

YEAR	CUSTOMER NUMBER	RESDNTL	COMMRL	INDUSTRL	OTHER	NON-REVENUE	UAF WATER	AVG DAY	MAX DAY	MAX/AVG RATIO
HISTORIC CUSTOMERS AND DEMAND (mgd)										
1977	26703	3.89	2.31	4.09	1.44	1.26	2.26	15.25	22.39	1.47
1978	26795	3.87	2.35	4.04	1.60	2.22	1.63	15.71	21.65	1.38
1979	27096	3.86	2.34	3.80	1.76	1.48	2.23	15.47	19.54	1.26
1980	27130	4.32	2.43	3.03	1.97	1.43	2.00	15.18	21.16	1.39
1981	27134	4.13	2.40	3.05	1.91	1.64	1.79	14.92	21.48	1.44
1982	26917	3.97	2.35	3.34	1.74	1.81	2.35	15.56	19.81	1.27
1983	26958	4.34	2.45	2.91	1.94	0.95	2.26	14.85	23.80	1.60
1984	27056	4.34	2.45	3.03	2.00	1.08	1.55	14.45	22.39	1.55
1985	27247	4.18	2.34	3.23	2.10	0.67	1.51	14.03	21.43	1.53
1986	27309	4.20	2.34	3.23	2.17	0.50	1.49	13.93	20.76	1.49
1987	27402	4.34	2.38	3.25	2.11	0.68	1.82	14.58	21.20	1.45
1988	27635	4.90	2.61	3.60	2.56	1.04	1.64	16.35	24.39	1.49
1989	27768	4.67	2.45	3.70	2.54	1.13	1.63	16.12	20.76	1.29
1990	27836	4.53	2.43	3.61	2.64	0.85	2.48	16.54	22.91	1.39
1991	27940	4.74	2.68	3.84	2.82	0.96	1.35	16.39	25.62	1.56
1992	29841	4.60	2.50	3.89	2.40	0.90	1.60	15.89	21.98	1.38
1993	30178	4.63	2.44	3.63	2.08	1.13	1.44	15.35	21.62	1.41
PROJECTED CUSTOMERS AND DEMAND (mgd)										
1999	30717	4.94	2.71	2.88	2.73	0.94	1.94	16.13	25.81	1.60
2004	30868	4.95	2.72	3.01	2.96	0.96	1.99	16.59	26.55	1.60
2009	31024	4.97	2.73	3.17	3.38	1.01	2.08	17.34	27.74	1.60

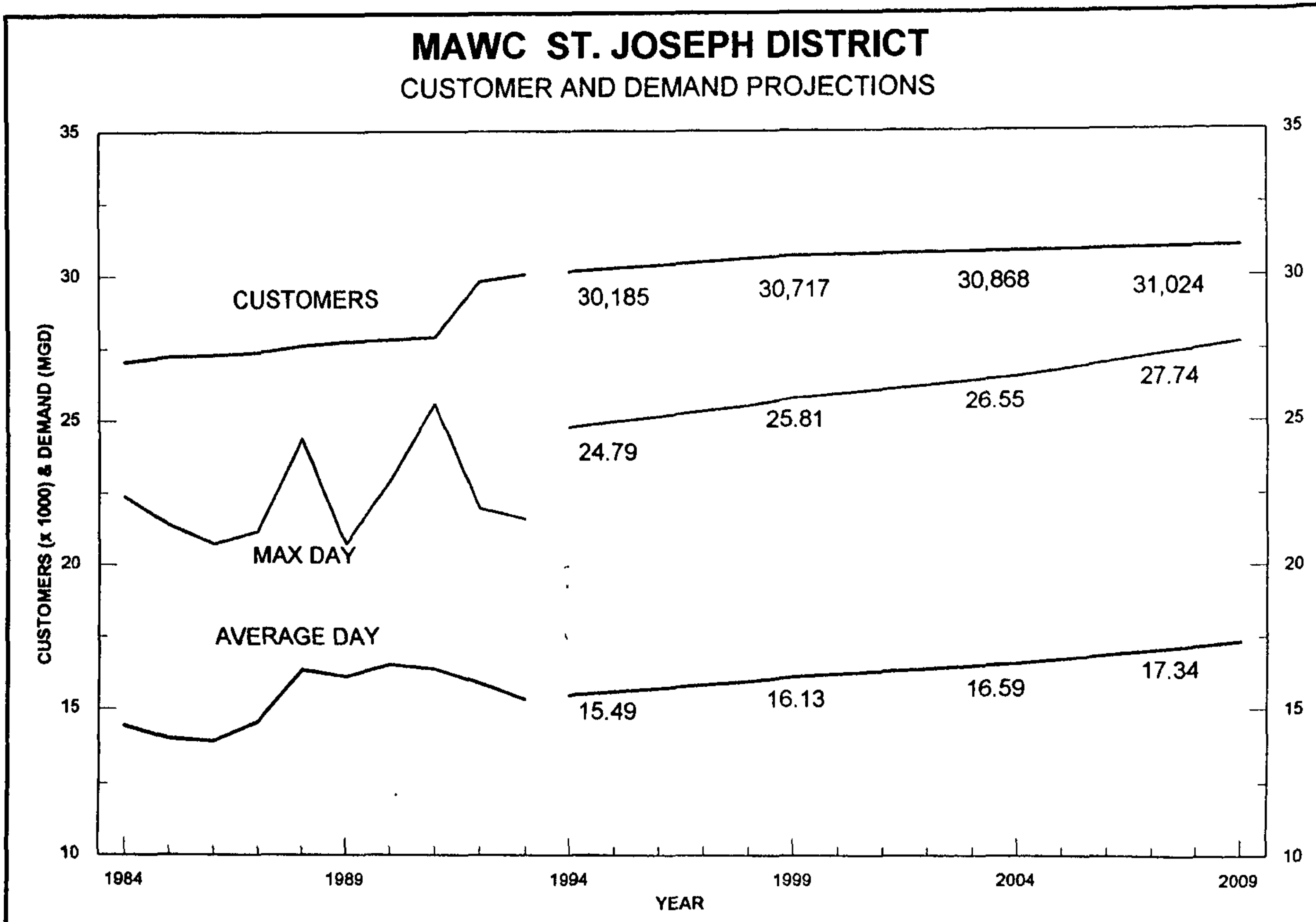

MAWC ST. JOSEPH DISTRICT
CUSTOMER AND DEMAND PROJECTIONS
CUSTOMERS (x 1000) & DEMAND (MGD)
YEAR
CUSTOMERS
MAX DAY
AVERAGE DAY
30,185
30,717
30,868
31,024
24.79
25.81
26.55
27.74
15.49
16.13
16.59
17.34
1984
1989
1994
1999
2004
2009
35
30
25
20
15
10

EXHIBIT 2-3

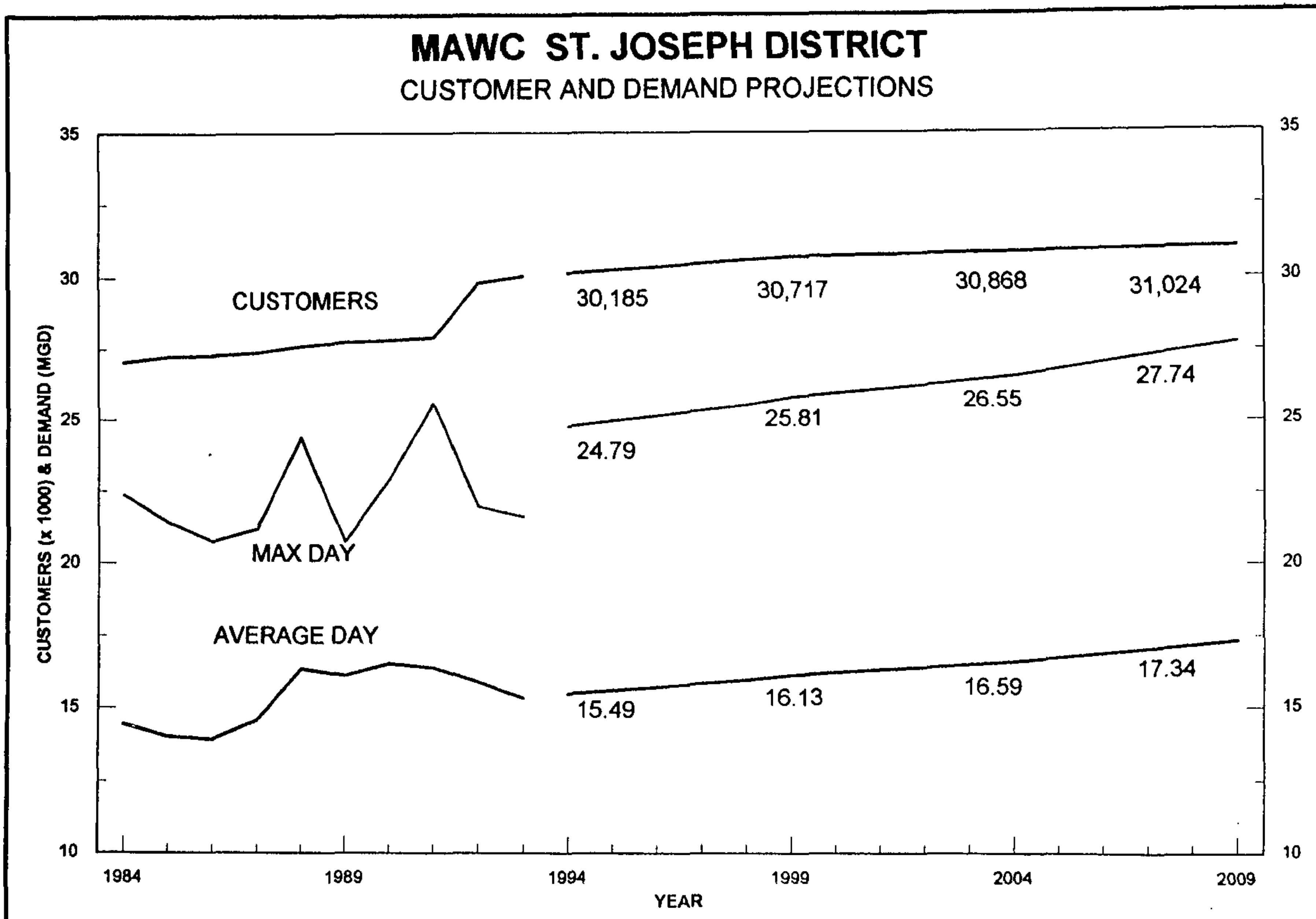

MAWC ST. JOSEPH DISTRICT
CUSTOMER AND DEMAND PROJECTIONS
CUSTOMERS (x 1000) & DEMAND (MGD)
35
30
25
20
15
10
CUSTOMERS
30,185
30,717
30,868
31,024
MAX DAY
24.79
25.81
26.55
27.74
AVERAGE DAY
15.49
16.13
16.59
17.34
1984
1989
1994
1999
2004
2009
YEAR

EXHIBIT 2-3

maximum day demands are also shown for the planning scenario, using a 95 percent confidence interval (CI), and also using a 50 percent confidence interval based on the planning scenario average day.

The rate increases could conceivably have the largest effect on the large industrial users and the resale customers. Therefore, to project this consideration in the low scenario, the projected demand of all the customer categories is reduced five percent to account for a potential elasticity effect of the rate increase. Also, for the resale customers, slower than anticipated growth in the outlying areas could also reduce their demand projections. Therefore, the projected demand in the industrial and "other" categories will be reduced with this scenario, and this is displayed in Exhibit 2-4.

MAWC - Demand Analysis (considering in-plant usage)

Year	Projected Max Day Demand (mgd) (1)	Projected In-Plant Usage (mgd) (5% of demand)	Total Projected Water Usage (mgd)
2002 (2)	26.25	1.31	27.56
2004	26.55	1.33	27.88
2009	27.74	1.39	29.13

(1) From 1994 MAWC CPS Demand Projections

(2) Year 2002 shown for comparison with Mr. Biddy's demand calculations for 20
He calculates 2002 maximum day demand at 24.135 mgd.

SCHEDULE
JSY-17

Commonwealth of Virginia /State Board of Health

Waterworks Regulations

February 1, 1982

Copies of the Regulations, as amended, may be obtained from the Bureau of Water Supply Engineering, Department of Health, 109 Governor St. Richmond, Va. 23219 or from any of the Regional Offices listed in *Appendix C.*

SCHEDULE
JSY-18

5.06.03 Waterworks utilizing groundwater as a water supply will be required to disinfect if a sanitary survey reveals a potential source of contamination and/or if the water fails to meet the bacteriological quality standards set forth in Section 4.00 of these Regulations.

5.07 Acceptable Operating Practices

5.07.01 **General**—This section is not intended to be all inclusive but reflects the concern for the public health significance of certain practices related to treatment plant operation.

5.07.02 Waterworks designed for bacteria and turbidity removal shall not be operated without adequate chemical coagulation.

5.07.03 Waterworks utilizing filtration in the treatment process shall not vary the rate of filtration through any single filtering unit above its design capacity.

5.07.04 Filtering units equipped with re-wash facilities shall not be returned to service after backwashing until being thoroughly re-washed.

5.07.05 All waterworks shall provide a minimum working pressure of 20 psi at all service connections.

5.08 Waterworks Expansion

5.08.01 At such time as the water production of a community waterworks reaches 80 percent of the rated capacity of the waterworks for any consecutive three-month period, the owner shall cause plans and specifications to be developed for expansion of the waterworks to include a schedule for construction; however, if it can be shown by the owner that growth within the service area is limited and will not exceed the rated capacity of the waterworks or if unusual transient conditions caused production to reach the 80 percent level, preparation of plans and specifications for expansion will no longer be required.

5.08.02 All waterworks shall provide metering of total water production.

5.09 Reporting

5.09.01 The results of any required monitoring activity shall be reported by the waterworks owner to the appropriate Regional Office no later than the 10th day of the month following the month during which the tests were taken.

5.09.02 It shall be the duty and responsibility of an owner to report to the appropriate Regional Office in the most expeditious manner (usually by telephone) under the following circumstances. If it is done by telephone a confirming report shall be mailed as soon as practical.

a. When a bacteriological examination shows a check sample is required (see Subsection 4.05.03), a report shall be made within 48 hours.

b. When chlorine residual is permitted to be substituted in lieu of coliform examination the owner shall report within 48 hours the lack of chlorine residual as required by Subsection 4.04.01c5.

c. When the daily average of turbidity testing exceeds 5 TU a report shall be made within 48 hours.

d. When a maximum contaminant level of an inorganic or organic chemical is exceeded for a single sample the owner shall report same within 7 days.

e. When the average value of samples collected pursuant to Subsection 4.08 exceeds the maximum contaminant level of any organic or inorganic chemical the owner shall report same within 48 hours.

f. When the maximum contaminant level for radionuclides has been exceeded as determined by Table 4.4, the results shall be reported within 48 hours.

g. The waterworks owner shall report to the appropriate Regional Office within 48 hours the failure to comply with the monitoring requirements of these Regulations.

7.00 General Design Requirements

7.01 General—Waterworks shall conform with the Public Water Supply Law, Title 32.1, Article 2, Code of Virginia. The engineer shall confer with the Bureau before proceeding with the detailed designs. The engineering report and preliminary plan shall include plant site selection. Ordinarily, waterworks shall be designed to provide for estimated population ten to 30 years hence under predicted growth conditions. All waterworks shall be designed so that they can readily be increased in capacity except where circumstances preclude the probability of expansion. Expansion by modular steps should be considered.

7.02 Objective of Waterworks

7.02.01 Production of pure water.

7.02.02 Production of a water appealing to the consumer.

7.02.03 To reach the objectives of a waterworks, finished water quality shall conform with Section 4.00 of these Regulations.

7.03 Site Location

7.03.01 Flooding—Wells and water treatment plants shall be located above the projected 100 year flood-plain elevation. Lower elevations may be considered if it can be adequately shown that the wells or treatment plants can be protected from flooding. Springs subject to flooding shall not be approved.

7.03.02 Accessibility—The waterworks shall be readily accessible in all seasons.

7.03.03 Consideration should be given to the convenience of transportation facilities to the plant site and also to the availability of electric power from more than one source of outside power.

7.04 Site Size

7.04.01 The area reserved around the well or spring site shall conform with Section 8.00.

7.04.02 The treatment plant site shall be of ample size to accommodate expansion, and ample space shall be provided at the treatment site for adequate disposal of treatment plant wastes.

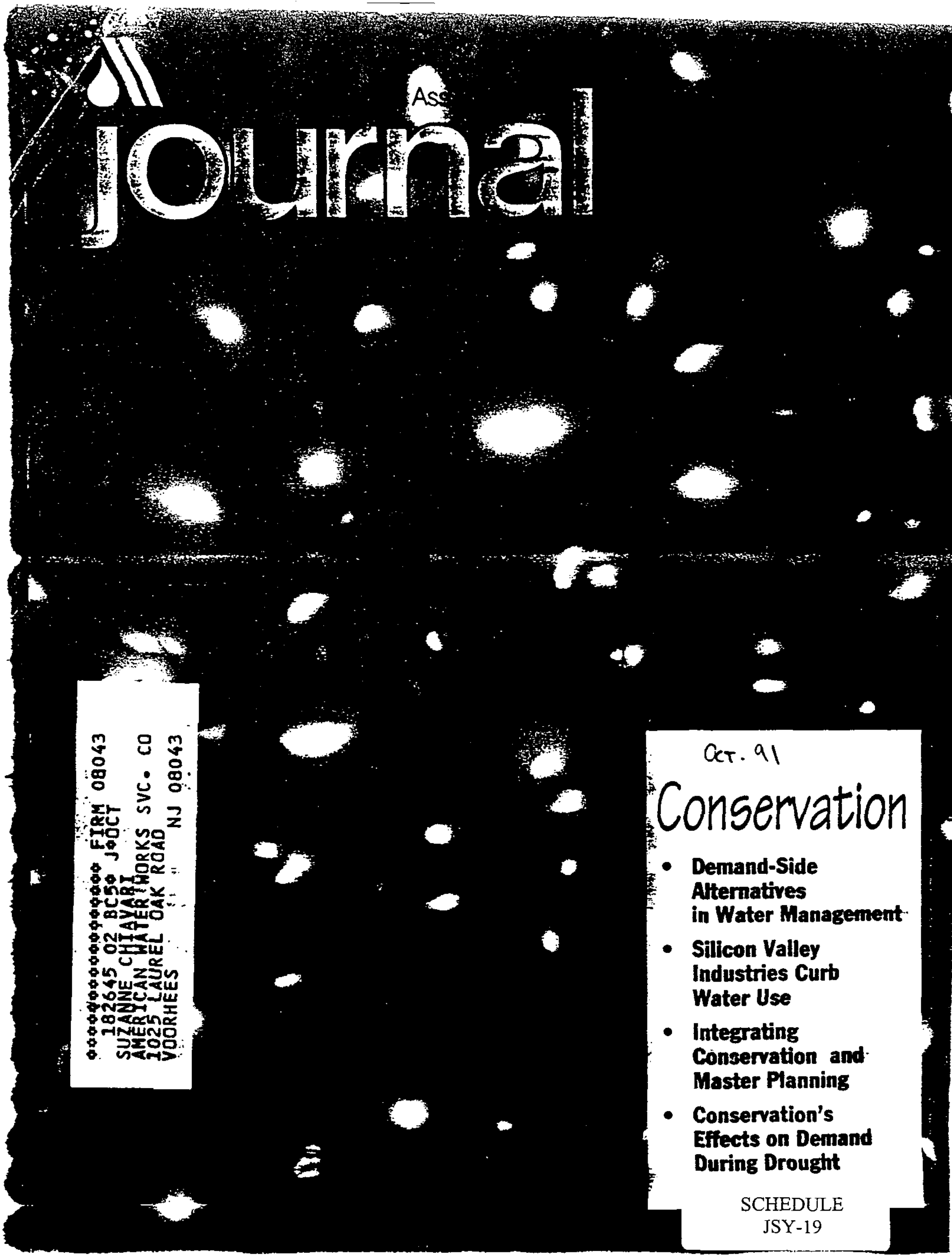
7.04.03 The disposal of water treatment plant wastes shall conform to the State Water Control Law, Title 62.1, Chapter 3.1, Code of Virginia.

7.05 Treatment Process Selection—The quality of the source, giving due consideration to variations and possible future changes, and the quality goals for the finished water, recognizing the growing desire of the public for better water, forms the basis for selecting a treatment process.

7.06 Capacity of Waterworks—The rated capacity of the waterworks shall exceed the maximum daily water demand of the system. Waterworks shall normally be designed on the following basis of water consumption. If deviations are made, they shall be based on sound engineering knowledge substantiated in the designer's report and approved by the Bureau.

7.06.01 Daily water consumption rates:

Dwellings, per person	100 gpd
High Schools with Showers, per person	16 gpd
Elementary Schools without Showers, per person	10 gpd
Boarding Schools, per person	75 gpd
Motels @ 65 gals/person, minimum per room	130 gpd
Trailer Courts @ 3 persons/trailer, per trailer	300 gpd



journal

Ass

Oct. 91

Conservation

- **Demand-Side Alternatives in Water Management**
- **Silicon Valley Industries Curb Water Use**
- **Integrating Conservation and Master Planning**
- **Conservation's Effects on Demand During Drought**

SCHEDULE
JSY-19

Integrating Conservation and Water Master Planning

Peter P. Macy

Incorporating conservation into a master plan involves a risk of lost revenues, uncertainty as to exact long-term savings, and increased operating budgets to implement the programs. Utilities should, however, see a net decrease in costs because properly designed and implemented conservation programs help maximize efficiency of existing supplies, which decreases operation and maintenance expenses and capital costs. Conservation can also help satisfy environmentalists and regulators whose cooperation may be needed to obtain future water projects.

Designing a water master plan requires evaluation of present and future demands, which play an important role in determining what facilities are needed and when. Because facilities can represent major capital investments and because demand is influenced by many factors such as weather, household size, and conservation, demand must be accurately calculated. An example of integrating water conservation into the planning process is illustrated by the recent revision of the master plan for the city of Boulder, Colo. In 1990 Boulder needed an immediate increase in water treatment plant capacity of more than 15 percent and an additional increase of 10 mgd in 15 years. Its existing treated water master plan[1] needed to be updated to address peak demands that were uncomfortably close to nominal treatment capacity, future growth, and other concerns about the treated water system. The city was also cognizant that along the Colorado Front Range it is difficult to obtain support for water projects that do not satisfy criteria (such as conservation) set by environmentalists and regulators. Against this backdrop, the city wanted to update its master plan. Two important objectives of the plan were to involve the public in the decision-making process and to study water conservation potential before deciding which capital facilities would be required. Boulder's experience as well as other examples are used to illustrate the application of effective integration of water conservation and master planning.

The case for integrating conservation and master planning

Integrating water conservation into master planning has its advantages and disadvantages. The disadvantages are that conservation savings are hard to predict and that statistically valid case studies are scarce. For example, although it is a relatively straightforward process for an engineer or planner to determine the capacity of a storage reservoir, it is more difficult to determine how equivalent capacity could be gained by water conservation. It is also hard to ascertain whether voluntary conservation programs will yield dependable, long-term savings or whether retrofit kits distributed to existing homeowners will remain installed. Although these questions cannot be answered definitively, planners now have some data from which to draw conclusions. Because of extensive studies in water conservation over the last five years, it is possible to estimate long-term savings potential—the caveat being that a range of savings must be given to account for the unknown. The other drawback to integrating water conservation in the master planning process is that conservation costs. There is the cost of lost revenue when demand drops, and there is the cost of implementing the conservation measures. For example, the Metropolitan Water District of Southern California spends more than $10 million per year on its water conservation program. Fortunately most conservation savings take a while to materialize, allowing the water utility ample time to modify future rates to reflect lower-than-expected revenues and higher costs associated with implementing conservation measures. Although unit charges for

TABLE 1
Case study effects of demand reduction

Demand Scenario	Customer Category	Short-term Water Savings	Long-term Potential	Timing	References
	Residential	10 percent of water used indoors	10–30 percent retention rate, 100 percent if mandatory	Normally quick response	4,7
Indoor	Nonresidential	15–30 percent of water used indoors	High retention rate	Normally quick response	5,6,8
	Residential	50 percent of water used outdoors	Low, 100 percent if mandatory	Normally takes a while	9,11
Peak	Nonresidential	25 percent of water used outdoors	Low, 100 percent if mandatory	Normally takes a while	10,11
Drought	Combined	30–60 percent of total water use	Not applicable	Immediate	12

water must be increased to account for reduced sales as a result of conservation, the bottom line for the customer who conserves is that the annual cost of water will go down because the higher unit charge times the reduced consumption will result in a net decrease in total cost.

The advantages of implementing conservation into the master planning process are many. They include reducing or postponing capital facilities and water purchases, satisfying regulatory requirements for efficiency, satisfying the concerns of environmental groups (e.g., making water available for in-stream uses), reducing operating costs (e.g., pumping, chemicals), and good public relations.

Water-poor as well as water-rich communities benefit from reduced operations and maintenance (O&M) expenses and the delay or elimination of construction of capital facilities. For example, the Cobb County-Marietta Water Authority 1989 water master plan evaluated water conservation against 18 water supply options and found the equivalent capital cost of water conservation to be $140,000/mgd of maximum-day capacity. Alternatively, the cost for traditional storage options was between $1,880,000/mgd and $24,210,000/mgd of maximum-day capacity.[2] The Seattle Water Department estimated annual savings of $1,976,000 by implementing a plumbing-fixture retrofit program with a one-time cost of $2,400,000.[3] Boulder, Colo., is expected to delay and downsize future water treatment plant improvements based on anticipated water savings from a $700,000 (present worth) conservation program.[1] Even wastewater facilities benefit—in an effort to reduce wastewater flows by 10 percent, the city of Los Angeles enacted an ordinance that requires new construction to have ultra-low-volume (1.6 gal/flush) toilets and to retrofit existing buildings with low-flow plumbing fixtures.

In addition to the financial benefits that can be gained through conservation, the amount of community and environmental opposition to water projects will be substantially reduced if conservation is practiced by the water utility. Because of the political, environmental, and economic climate in the United States, reliance on water projects with minimal consideration of conservation (as determined by environmentalists, the public, and regulators) is virtually impossible. Recent examples of this include the failures to obtain approval for construction of the Two Forks dam in Colorado and the Big River dam in Rhode Island.

How to integrate conservation and master planning

Numerous master planning and conservation study projects have shown the most effective way to integrate the two planning processes is to have public input or acceptance and to base conservation decisions on what is needed to reduce capital facilities as well as what the community deems acceptable and desirable. This must be performed concurrently with the incorporation of locale-specific issues, such as increased reliability and environmental protection.

Public input. There is no substitute for informing the public about the master planning issues, such as needed capital facilities and conservation programs, and for getting citizens' concurrence early in the planning process as to what actions will be implemented. The city of Boulder conducted public hearings, focus groups, and public surveys for the purpose of gaining the public's opinion of and blessing for the recommendations in the master plan, particularly as they related to water conservation. It was important to find out how extensive a conservation program the public wanted. Citizens were asked if they wanted to impose conservation restrictions for new developments, exterior water uses, and public versus private users. The public was made aware of the costs for selecting one conservation scenario over another as well as other ramifications associated with each decision. This level of public input, early in the process, significantly reduced opposition to sensitive areas of the final master plan.

Study demand. Decisions regarding what is needed to reduce capital facilities require accurate demand forecasts. Existing demands, without additional water conservation, must be studied. Historical water-use patterns and projections of variables such as population, employment, and land use can be used to predict future use. Demand can be expressed as average and peak demand (sometimes minimum demand is also determined). The reason to quantify different types of demand is that each has a different effect on facilities. Average demand affects raw water storage needs, and peak-hour demand affects pumping, storage, and treatment needs. Table 1 shows how various demand categories have been affected by water conservation in the past.

Study O&M and future facilities as they relate to demand. Day-to-day O&M is influenced by demand. For example, more demand could equate to more chemicals or pumping charges. The activities and costs related to demand should be documented. This parameter can be quantified by dividing the annual costs of items affected by demand (e.g., chemicals) by the annual volume of water used with this item. This calculation should be performed for each item affected by demand. Examples of these costs for Boulder included: (1) the revenue from water sold for agricultural purposes (made possible by conserving potable water) was $0.03/1,000 gal, (2) the cost of water treatment was $0.163/1,000 gal, and (3) the cost of wastewater treatment was $0.031/1,000 gal.[1]

Future facilities, such as an additional clarifier to accommodate new demands, should also be quantified and associated with a volume of water. Calculations should be done, for example, for growth in peak-hour demands of 5 or 10 percent to determine which facilities should be built for which conditions. Figure 1 shows how to use a supply–demand

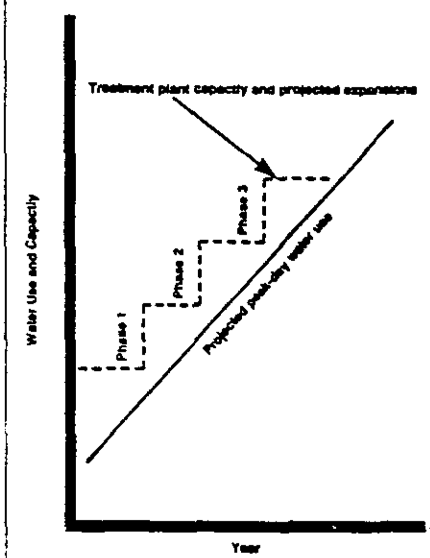


Figure 1. Peak-day use versus expansion

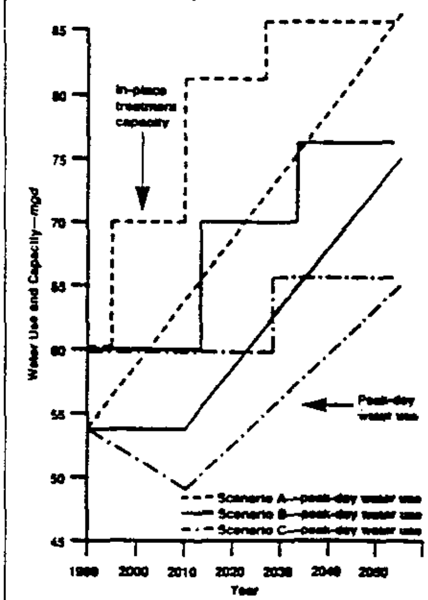


Figure 2. Projected peak-day water use and required treatment capacity expansions *(treatment capacity expansions are timed to retain a minimum 10 percent treatment capacity reserve relative to peak-day demand*

TABLE 2

Operational and capital costs associated with demand increases

Demand Scenario	Operational Needs	Annual Operating Costs $	Required Facilities	Equivalent Uniform Actual Cost of Facilities
15 mgd	Chemical treatment	120,000	Clarifier	$20,000
	Pumping	240,000	Storage tank	$30,000
30 mgd	Chemical treatment	200,000	Clarifiers	$40,000
	Pumping	480,000	Storage tanks	$90,000

TABLE 3

Economic comparison of water-use scenarios[1]

Item	Scenario B	Scenario C
	$—million	
Present worth conservation savings*	2.6	3.9
Present worth cost to implement conservation program*	(0.7)	(0.8)
Net present worth conservation program savings (cost)*	1.9	3.1
Avoided (present worth) capital cost savings for Boulder Reservoir WTP† expansions	8	11.0
Net present worth savings	10	14

*Represents cumulative savings and costs of selected conservation measures
†WTP—water treatment plant (upgrading of which was expected to be delayed)

graph to determine which capital facilities are needed, such as treatment plant capacity, based on expected demands. The purpose of this exercise is to better quantify the effects that certain volumes of demand have on operational costs and future facilities. This exercise can also be done in a tablular format (Table 2).

Knowing the expected future demands, as well as the effect current demand has on operations, facilities, and costs, a planner is prepared to make decisions about how to mitigate these effects. The planner could choose to allocate enough funds or to raise rates sufficiently to accommodate building facilities for the worst-case demand scenario, or the planner could elect to reduce demand in the interest of lowering costs. Reducing demand is not an exact science, but there is a procedure that makes this approach much easier.

Top-down approach. To calculate demand reductions, a top-down approach can be used. Using this approach, a planner evaluates facilities against anticipated demand and determines which capital facilities would be required under existing conditions. Scenario A in Figure 2 shows the existing expected demands and needed capital facilities for the city of Boulder. The next step the planner must take is to ask what sort of a demand reduction would be required to eliminate or postpone the need for capital facilities. For Boulder, it was determined that a 15 percent peak-demand reduction (scenario B in Figure 2) could save the city a present worth of $10 million by delaying expansion of its treatment plant and a 25 percent peak-demand reduction could save the city a present worth of $14 million.[1] An economic comparison of scenarios B and C is shown in Table 3. The most acceptable demand-reduction scenarios can be determined in the public input phase of master planning.

Knowing the required reduction, a utility can then establish a water budget, which is no different from an annual operating budget for a business. A business estimates how much money is available each year and then spends or does not spend accordingly. If expenditures are higher or lower than income, then corrections must be made along the way. A utility would allocate a water budget in a similar manner.

The top-down approach is innovative. Utilities have historically relied on the bottom-up approach of first estimating the water conservation potential and then determining what effect this might have on facilities. The drawback to this approach is that facility planning is based on an estimate. The top-down approach requires that water demand be managed to correspond with logical facility planning needs.

Design a water conservation program. After the preferred scenario has been selected and the associated water budget has been set, a conservation program must be devised to assure that this budget can be met. Even though this is not an exact science, careful program design provides a good operating framework from which to reduce demand. Planners with knowledge of past successes and failures of water conservation can design the programs necessary for achieving the savings needed for the water budget.

Boulder designed alternative conservation programs to yield 15 and 25 percent peak-demand reductions. The conservation program designed for the 15 percent reduction included

Residential

- Advanced plumbing code—required such items as the 1.6-gal/flush toilet and 2.0-gpm showerhead.
- Multiple-family consultation—provided for free consultation to customers and low-water-use device giveaways to help reduce consumption.
- Single-family consultation—similar to multiple-family consultation.
- Lawn-watering advice—provided free advice, informational handouts, and low-water-use device giveaways to help customers reduce lawn watering.
- Public information—provided general communication and education regarding water conservation and the city's conservation program.

Commercial and industrial

- Industrial water consultations—provided for free consultation to industrial customers.
- Turf water management—included workshops to teach landscapers about progressive turf management practices and devices; encouraged the upgrading and retrofitting of inadequate irrigation systems.

Public and utility

- Efficient landscaping—required mandating Xeriscape principles, turf limitations, and modern irrigation techniques for new landscaping.
- Consultation upgrade—called for distribution of free indoor plumbing retrofit devices and provided water conservation advice to maintenance staff.
- Parks water use and information—involved sending water consumption reports to parks department, billing for use, and providing the department information on techniques such as Xeriscaping and efficient irrigation.

The conservation program for the 25 percent reduction consisted of the following measures:

Residential

- Advanced plumbing code—required such items as the 1.6-gal/flush toilet and 2.0-gpm showerhead.
- Multiple-family consultation—provided for free consultation to customers and low-water-use device giveaways to help reduce consumption.
- Single-family consultation—similar to multiple-family consultation.
- Lawn-watering advice—provided free advice, informational handouts, and low-water-use device giveaways to help customers reduce lawn watering.
- Public information—provided general communication and education regarding water conservation and the city's conservation program.

Commercial and industrial

• Industrial water consultations—provided for free consultation to industrial customers.

• Landscape design and retrofit—promoted the retrofit of existing turf landscaping into low-water-use landscaping and required low-water-use landscaping for new developments.

• Turf water management—included workshops to teach landscapers about progressive turf management practices and devices; encouraged the upgrading and retrofitting of inadequate irrigation systems.

• Low-flow fixtures—included adoption of an ordinance to require low-flow plumbing fixtures for new facilities and retrofitted existing facilities.

Public and utility

• Consultation upgrade—called for distribution of free indoor plumbing retrofit devices and provision of water conservation advice to maintenance staff.

• Limit turf area—required modification of existing codes to limit square footage of turf area to 25 percent for new facilities and promoted alternative landscaping techniques.

• Parks water use and information—involved sending water consumption reports to parks department, billing for use, and information on such techniques as Xeriscaping and efficient irrigation.

If demand does not follow the predictions that have been made regarding water conservation, the utility would apply more or less effort toward its conservation program or would build its capital facilities sooner or later than planned so that goals could be met. This approach steers the planner away from relying on predicted water conservation savings and future demand and places the emphasis on regular and timely response to future conditions.

When a conservation program is relied on in order to defer a major capital investment (which requires lead time for raising funds to build, plan, and design the facility), monitoring the effectiveness of the water conservation program must be an integral part of the implementation strategy. Because variations in weather tend to mask conservation efforts, it is important that sophisticated monitoring identify actual savings from the conservation program being undertaken. This requires a commitment of some funds and careful design and follow-through. Feedback from the monitoring effort is critical so that the lead time to build the required expansion is not shortened.

Design three levels of conservation. When a water conservation program that may affect master planning is designed, choices can be spelled out as to the degree of demand reduction provided. Because water conservation can affect the master planning process, it is important that the utility, the public, and city leaders have some choice as to how much conservation they want and ultimately how much they want to decrease future demands. Usually, a choice of three conservation programs is sufficient. The first can represent conditions similar to the status quo. The second can be a conservation program that saves water but is not aggressive enough to anger some people in the community. The third could be an aggressive program that will save large volumes of water but that might also lose the support of those who feel the level of conservation will impose undo inconveniences on their life-styles.

Review water conservation effects with public. All choices should be thoroughly studied to determine the direct effects (such as the effect of mandatory retrofit of plumbing fixtures upon resale of a home) and the indirect effects (such as the lowering of future water rates if capital facilities can be delayed) water conservation will have on the utility's customers. Once this information has been gathered, it should be shared with the public to obtain support. Once the public has accepted a conservation program or has accepted it with some changes, the next step is to finalize the program and fine-tune the expected savings and future demand estimates.

Master plan based on selected level

The water master plan can now be completed with greater confidence, knowing that (1) demand reduction is based on the needs of the water municipality to reduce future expenditures rather than on future expenditures based on rough estimates of demand and water conservation potential and (2) the public supports the demand reductions required and will accept the effects of demand reductions.

Monitor and adjust

Implicit in the top-down approach toward the demand estimation aspect of master planning are monitoring and adjustment. The water utility has given itself a fixed annual budget of water. If demand exceeds or falls short of the budget because of the effects of such variables as water conservation, then adjustments must be made. Perhaps water conservation efforts must be increased or decreased or perhaps capital facilities must be put in place sooner or later than planned.

Conclusion

The integration of water conservation into the master planning process can have a significant effect on future facilities and operating costs. Therefore, it should not be left out of the planning process. The easiest approach in applying the component of water conservation to master planning is the top-down approach, whereby a utility planner determines what logical demand reduction would serve to eliminate or postpone future capital facilities and reduce operating costs. Knowing this demand reduction, the water conservation planner can develop a water conservation program to achieve these results. The public should be a part of this process and must select its desired level of water conservation. The water conservation effort and resultant demand will become the utility's water budget. Monitoring is fundamental in order to ensure that actual demand corresponds to that predicted or required demand. If this is not the case, then more or less effort must go into the conservation program, or facilities timing must be adjusted.

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DEPT. OF PUBLIC UTILITY CONTROL REGULATIONS

Sec. 16-11-79. Design and Construction of Plant

The design and construction of the utility's water plant shall conform to good standard engineering practice, including the minimum standards of the American Water Works Association. It shall be designed to make reasonable provisions for the company's water supply requirements for a period of at least fifteen years and operated so as to provide reasonably adequate and safe service to its customers and shall conform to the requirements of the state department of health with reference to sanitation and potability of water.

Sec. 16-11-80. Mains. Service Pipes

(1) Mains.

(A) Water mains shall be placed at such a depth below ground level, or otherwise protected, as will prevent freezing during the coldest weather experienced in the community in which laid, and will prevent damage by traffic.

(B) Insofar as practicable, the utility shall design its distribution system so as to avoid dead ends in its mains. Where dead ends are necessary, the utility shall provide hydrants or valves for the purpose of flushing the mains. Mains with dead ends shall be flushed as often as necessary to maintain the quality of water.

(C) Valves or stop cocks shall be provided at reasonable intervals in the mains so the repairs may be effected by the utility with interruptions of service to a minimum number of customers.

(D) All new mains shall be disinfected before being connected to the system. The method of disinfecting shall be in compliance with state department of health practices.

(E) Wherever feasible, the distribution system shall be laid out in a grid so that, in case of breaks or repairs, the interruptions of service to the customer shall be at a minimum.

(2) Service pipes.

(A) The size, design, material and installation of the service pipe shall conform to such reasonable requirements of the utility as may be incorporated in its rules, provided the minimum size of the pipe shall not be less than three-quarters inch nominal size except under unusual circumstances which shall be clearly defined.

(B) All service pipes shall be laid at such a depth in accordance with the rules of the utility as will prevent freezing, except where services are not intended for use during freezing weather and are actually drained during such periods.

(C) The utility shall inspect the service pipe to assure that it has been installed at proper depth and is free from any tee, branch connection, irregularity or defect.

(3) Whenever normal excavation discloses an unsatisfactory soil condition, one or more of the following corrective measures shall be employed:

(A) Excavate to good bearing soil and backfill to pipe grade with suitable material well tamped to provide adequate support:

(B) support with a concrete slab;

(C) support with piling.